Supporting Information for

River bank erosion and lateral accretion linked to hydrograph recession and flood duration in a snowmelt-dominated system

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Introduction

Figures and tables below are cited within the text of Sutfin et al. to provide supporting information and summary data. In addition, we briefly provide explanation of the statistical transformations conducted for analyses and referenced in the text.

Multiple linear regression model residuals met assumptions of homoscedasticity and normality (at the 95% confidence level) after a natural log transform of annual floodplain vertical accretion rate and boxcox power transformations with lambda (λ) exponent coefficients of 0.1010101 and 0.2626263 for the area of floodplain eroded and laterally accreted, respectively. Eroded and accreted areas appearing in equations 2 and 3 in the main text contain exponents of the reciprocal of these lambda values, necessary if one were to attempt calculation of erosion or accretion based on parameters listed in those equations.

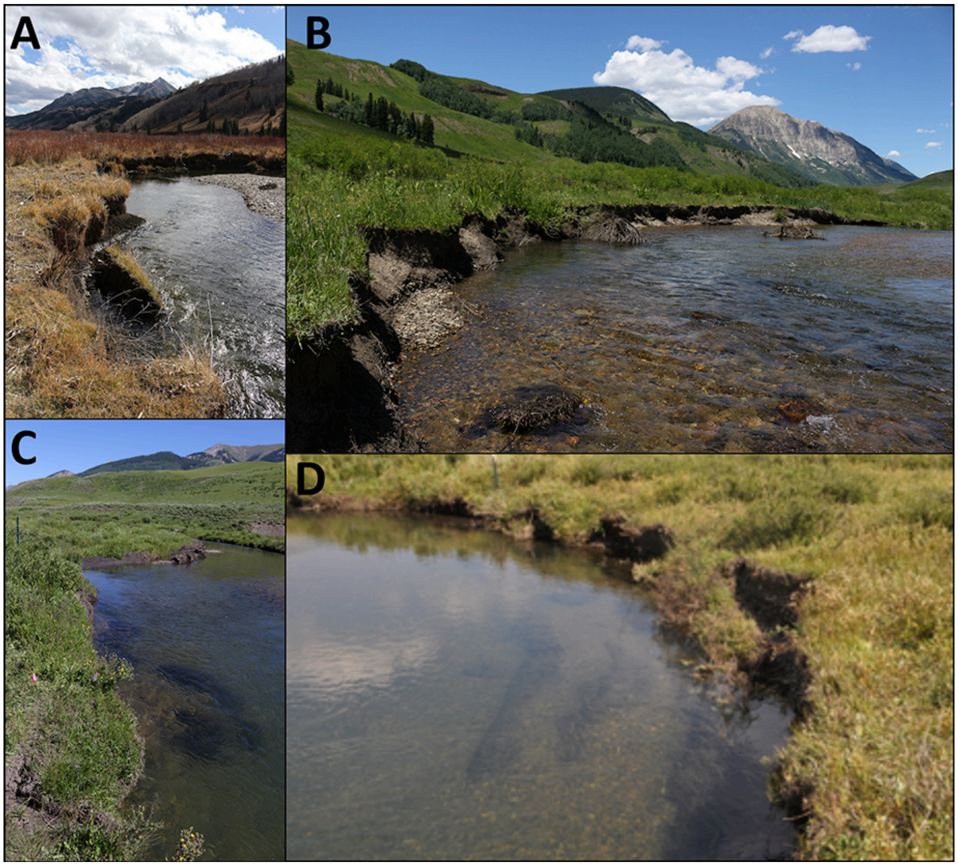

Figure S1: Bank erosion commonly observed along the East River. The upper fine-grained portion of floodplain sediment collapses in large blocks on the outside of channel bends. Following undercutting and erosion of underlying sandy gravel, channel banks crack (A, C) and eventually fall into the channel (A, B, D) where they remain on the channel bed at low flows (A, B) and can be buried by gravel during higher flows (C,D).

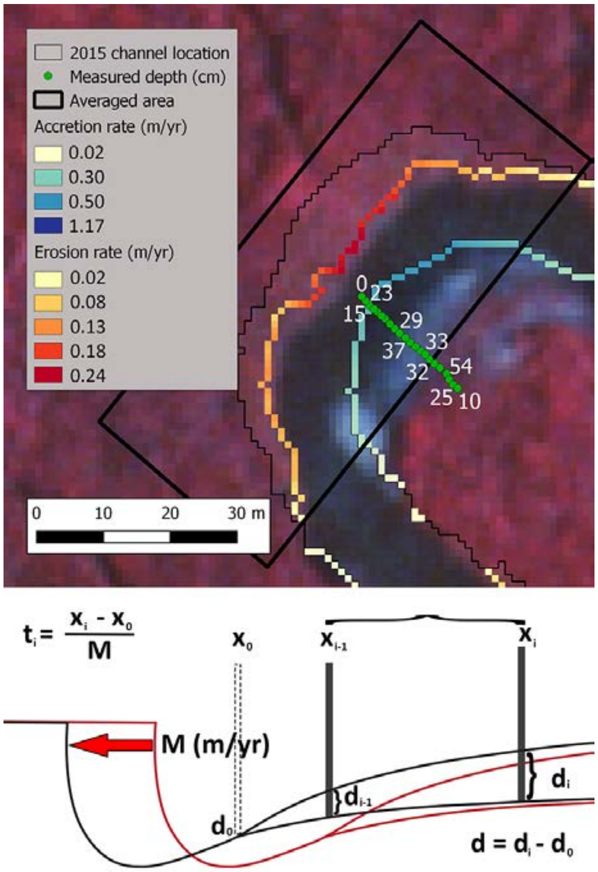

Figure S2. At each bend where a transect of measured depths was located, linear erosion rates along the bank (depicted as the outer bank in 1973 by the yellow-red spectrum) and accretion rates (depicted as the inner bank in 2015 by the yellow-blue spectrum) were averaged within a rectangle. The rectangle was drawn to capture the accreted bank pixels with a boundary defined by the approximate location where the outer bank from 1973 intersect the outer bank from 2015 (thin black line). The difference in the horizontal distances (x_i and x_{i-1}) between consecutive depth measurements (d_i and d_{i-1}) was divided by the mean migration rate to determine the duration of sediment deposition at each point (t_i). Vertical accretion rate at each point was then calculated by the difference in measured depth between consecutive points divided by the time between points. This point-by-point method was conducted in addition to that described in the main text, but yielded inconsistent results as a function of small changes in floodplain topography and possible alternative periods of point bar erosion and deposition, so this analysis was not used for the results presented.

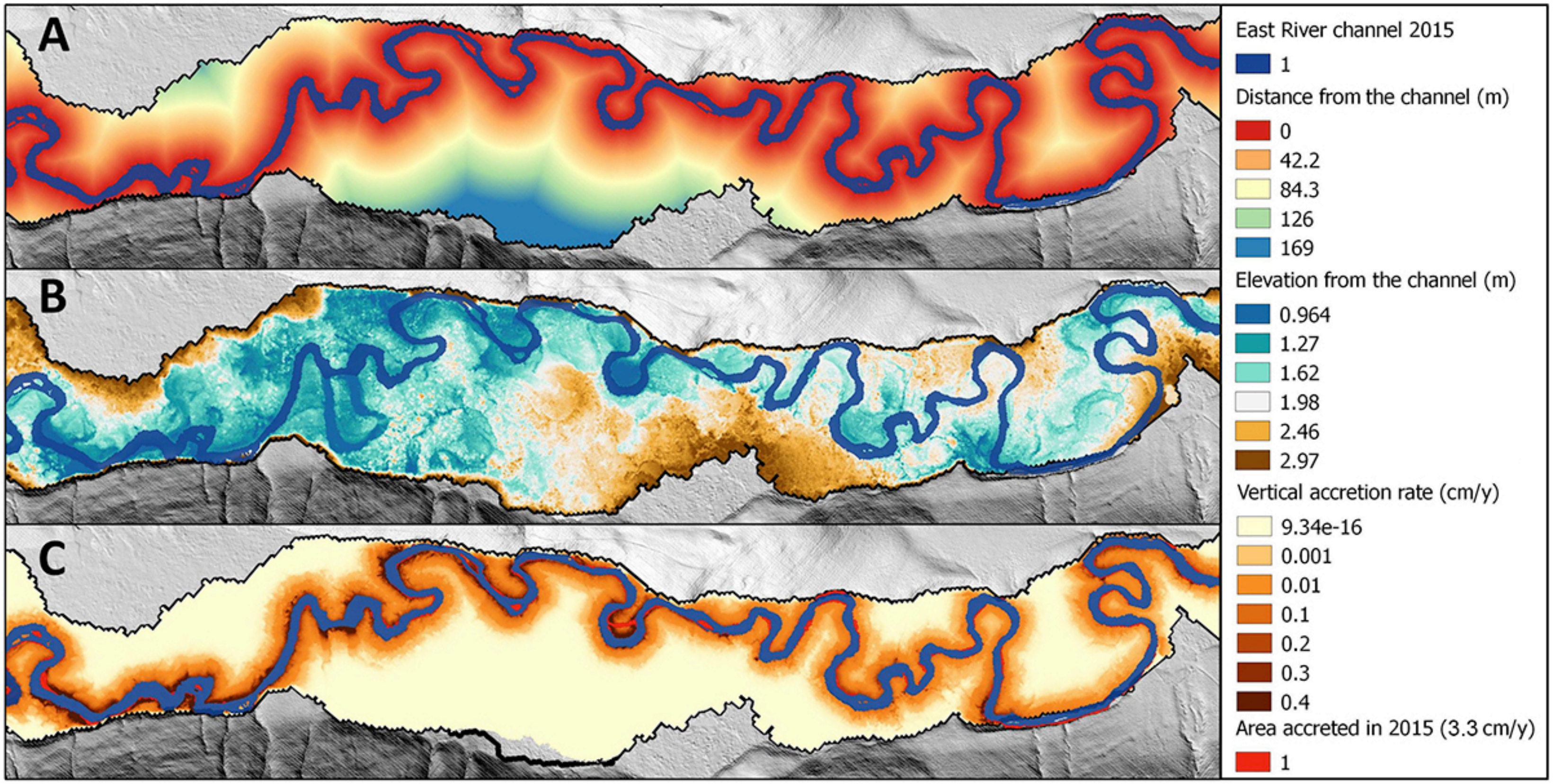

Figure S3 Example from the 2015 pixel grid calculations. Distance from the channel (A) for each time period and relative elevation (B) for all time periods were used in a multiple linear regression to estimate mean overbank vertical accretion rate (r_{va}) across the floodplain (C) using the following equation. $\ln(r_{va}) = 1.204490 - 0.072038x - 1.205276z$ where x is distance from the channel along a transects orthogonal to the channel and z is elevation from the channel. As indicated in the legend, areas in red on the vertical accretion map are those identified from SCREAM analysis from differences in channel masks in consecutive years. Long-term deposition from measured depths within 10 m from the active channel indicated a mean vertical accretion rate of 3.3 cm y^{-1}, which was applied to the area of lateral accretion. Overbank deposition outside of the red accreted areas was estimated using relationships determined in multiple regression equation 3.

TABLES

Years	Erosion	Accretion
1973-1983	17%	14%
1983-1990	25%	14%
1990-2001	16%	16%
2001-2011	19%	13%
2011-2015	41%	25%

Table S1 . Percentage error in floodplain area estimates from SCREAM, as calculated and outlined by Rowland et al. (2016). As described in the text, estimates of error for the time period between 1955 and 1973 were not obtainable through SCREAM, thus errors presented in Table 1 and Figure 3 are estimated as two times the maximum error from other time periods.

Table S2. Field and remotely sensed data for stepwise multiple linear regression of measured floodplain fine sediment depths at 315 points across 51 transects.

Table S3. Annual hydrologic indices for synthetic hydrographs at the East River study site constructed using a linear regression with the USGS East River at Almont stream gage and parameters extracted using code provided.

Variable	Floodplain vertical accretion	
	Considered	Included
Surface elevation (m)	☓	✓**
Elevation of gravel surface (m)	☓	
Distance from the channel (m)	☓	✓***
Relative elevation from the channel (m)	☓	
Duration (years)	☓	
Channel width (m)	☓	
Valley width (m)	☓	☓
Confinement (m^2/m^2)	☓	✓**
Reach valley slope (m/m)	☓	
Reach sinuosity (m)	☓	☓
Reach channel slope (m/m)	☓	
Local valley slope (m/m)	☓	
Local sinuosity (m/m)	☓	
Local Channel slope (m/m)	☓	☓
Bend orientation angle	☓	☓
Radius of curvature	☓	✓-
Inside of bend	☓	☓
Outside of bend	☓	

Table S4. Variables considered (☓) before elimination following reduction of collinearity and examined (☓) using stepwise multiple linear regression for vertical accretion. Among variables examined, those marked with (✓) indicate variables retained in the optimal multiple linear regression model. Significance of variables in the regression model is denoted at confidence levels of 99.9% ***, 99% **, 95% *, 90% . , or not significant <90% -

Variable	Floodplain area along nine reaches over 6 time periods			Entire study segment over 6 time periods		
		Examined			Examined	
	Considered	Erosion	Accretion	Considered	Erosion	Accretion
Channel slope	X	X	X			
Valley Slope	X					
Confinement	X	X	X			
Mean Channel width	X	X	✓*			
Sinuosity	X	✓**	✓***			
Mean Day of Peak Flow	X		X	X		
Mean Peak Flow (m^3s^{-1})	X			X		
Max Peak Flow (m^3s^{-1})	X			X		
Mean Bankfull Duration (days)	X	X		X		
Max Bankfull Duration (days)	X			X		
Mean Days Above Bankfull Flow	X			X		
Max Days Above Bankfull Flow	X		X	X		✓.
Mean Duration Above Baseflow (days)	X		X	X		
Max Duration Above Baseflow (days)	X	✓*	X	X		
Mean Days Above Baseflow	X	X		X		
Max Days Above Baseflow	X		✓*	X		
Mean Days Since Bankfull Flow	X			X		
Max Days Since Bankfull Flow	X			X		
Mean Day Baseflow Ends	X			X		
Mean Day Bankfull Flow Ends	X	X		X		
Mean No. Peaks Above Bankfull	X			X		
Maximum No. Peaks Above Bankfull	X			X		
Mean Total Recession Slope ($m^3\ s^{-1}\ day^{-1}$)	X			X		
Max Total Recession Slope ($m^3\ s^{-1}\ day^{-1}$)	X	✓***		X	✓**	
Mean Bankfull Recession Slope ($m^3\ s^{-1}\ day^{-1}$)	X			X		
Max Bankfull Recession Slope ($m^3\ s^{-1}\ day^{-1}$)	X		✓.	X		
Mean Total Annual Volume (km^3)	X			X		
Max Total Annual Volume (km^3)	X			X		
Mean Bankfull Volume (km^3)	X			X		
Max Bankfull Volume (km^3)	X	X		X		
Power transformation coefficient (lambda)		0.1010101	0.2626263		NA	NA
Coefficient of determination (r^2)		0.59	0.55		0.91	0.59
Regression model p-value		<0.0001	<0.0001		0.003	0.074

Table S5. Variables considered (X) before elimination following reduction of collinearity and examined (X) using stepwise multiple linear regression for lateral erosion and accretion. Among variables examined, those marked with (✓) indicate variables retained in the optimal multiple linear regression model. Significance of variables in the regression model is denoted at confidence levels of 99.9% ***, 99% **, 95% *, 90% . , or not significant <90% -

Table S6. Correlation matrix for variables considered in multiple linear regression analysis to examine linkages between hydrologic flow conditions, erosion, and accretion.