

# Do rivers really obey power laws?

## Identifying bankfull channel to evaluate downstream hydraulic-scaling over large changes in drainage area

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GORDON AND BETTY  
**MOORE**  
FOUNDATION

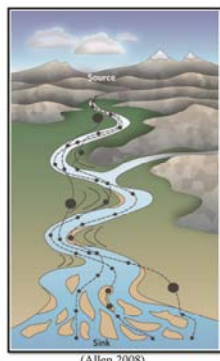


### (1) Motivation

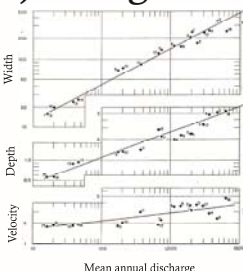
The flow of water, sediment, and nutrients through river channels shapes land- & eco-scapes, providing essential services for human & ecological systems.



Channel form and function responds to changes in both local and basin-wide supplies of water & sediment as drainage area increases. The dynamic nature of rivers and their environments challenges the development of a unifying theory to explain controls on downstream channel geometry.



### (2) Background



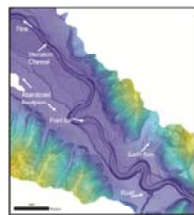
"Some hydraulic characteristics of stream channels --depth, width, velocity, and suspended load-- are measured quantitatively and vary with discharge as simple power functions ..." Leopold and Maddock, 1953

#### Downstream hydraulic scaling

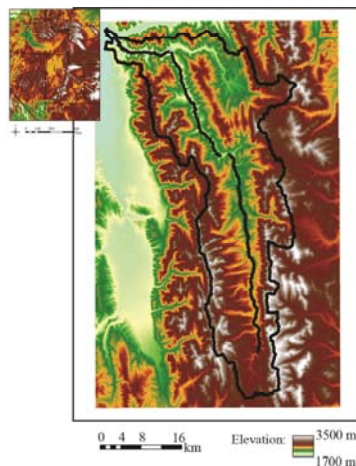
- width =  $aQ^b$
  - depth =  $cQ^f$
  - velocity =  $kQ^m$
- where,  $Q$  = discharge,  $b = 0.5$ ,  $f = 0.4$ , &  $m = 0.1$

### (3) Questions

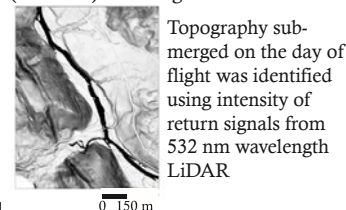
1. How does channel geometry respond to differential inputs in water & sediment as drainage area increases?
2. What is the length of spatial memory in a channel, does short-or-long term memory dominate and/or fluctuate across space?
3. How is a "bankfull channel" delineated across the length of a river network?



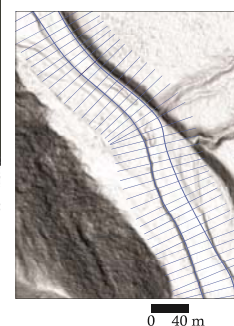
### (4) Methods and Setting



Bathymetric (532 nm) & near-infrared (1550 nm) wavelength LiDAR

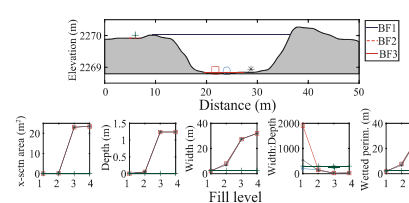


Topography submerged on the day of flight was identified using intensity of return signals from 532 nm wavelength LiDAR

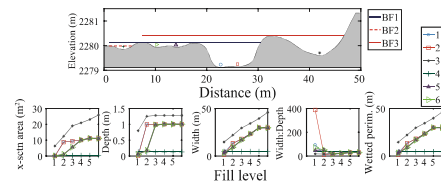


Active channels were delineated from bathymetric LiDAR return intensities and elevation values were extracted along cross-section profiles at regular 10m intervals downstream.

#### Selection of a bankfull stage height to measure channel geometry



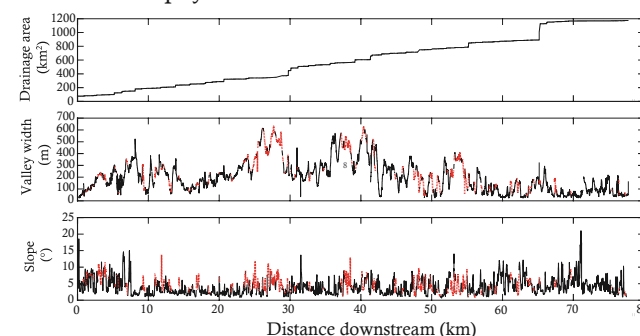
Simple case: evolution of channel geometry across increasing fill levels were used to, "pick," a bankfull stage height



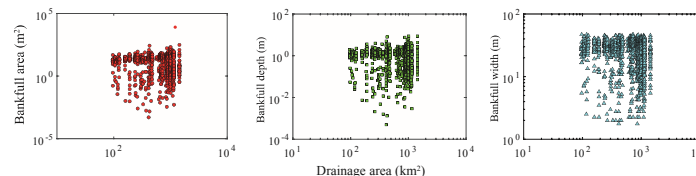
Complicated case: more information required to pick a bankfull stage level

### (5) Results

#### Catchment physical characteristics

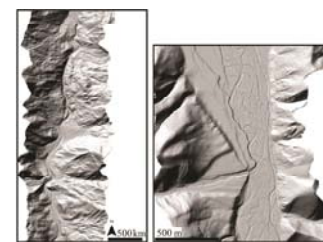


#### First look at power-law scaling



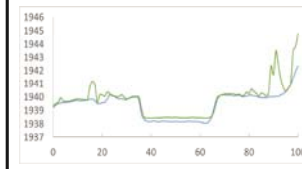
### (6) Conclusions

1. Hydraulic geometry alone does not distinguish bankfull channel
2. Variability in channel geometry challenges robust power law scaling



### (7) Future Work

1. Vegetation and landform analysis in addition to channel geometry for identification of bankfull stage height
2. Conduct statistical analyses using transfer entropy to look for mutual information between variables



References:  
1. Leopold, Luna Bergere, and Thomas Maddock Jr., The hydraulic geometry of stream channels and some physiographic implications. No. 252. 1953.  
2. Allen, Philip A. "From landscapes into geological history." Nature 451.7176 (2008): 274-276.