Critical Shear Stress of the channels of the Zekiah Swamp Run

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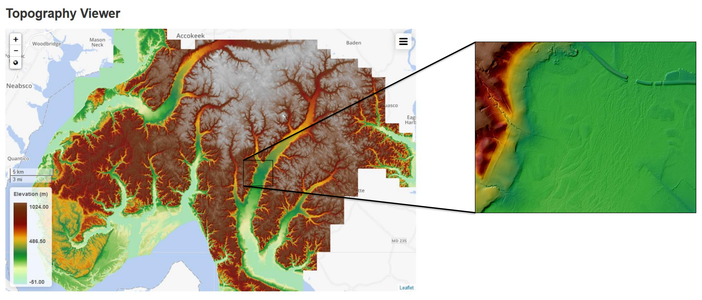
I. Abstract

The Zekiah Swamp Run is a stream that has multiple channels that share a floodplain. Using field measurements taken in several of its channels can be used to determine the critical shear stress of each channel and to compare the critical shear stress to the bankfull fluid shear stress of each channel.

II. Problem

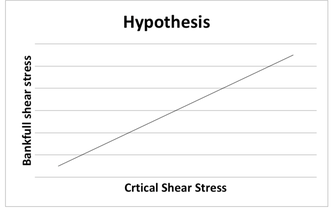
The critical shear stress of a stream describes the shear stress of a stream channel at which bedload particles start to move. When a stream is at its critical shear stress, it is at the stage where it is being reshaped, so the critical shear stress is useful for determining what flow level controls the channel's morphology. The Zekiah Swamp run is an interesting case of this because it has multiple channels that may not reach the critical shear stress at the same flow level.



LiDAR images of the Zekiah Swamp Run. The inset is zoomed to the area I am collection data in. In the inset image, the multiple channels can be seen. LiDAR images taken from the State of Maryland's LiDAR data, accessed from: http://imap.maryland.gov/Pages/LiDAR-topography-viewer.aspx

III. Hypothesis

The channels that make up the Zekiah Swamp Run are threshold channels at their bankfull stage, and therefore the critical shear stress is equal to the bankfull fluid shear stress.



IV. Study Site

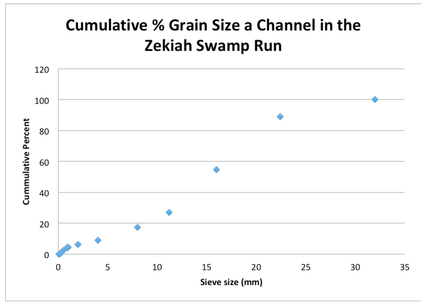
I will be collecting data from the Zekiah Swamp Run in Charles County, MD. The Zekiah Swamp Run has multiple, relatively stable channels that are divided by vegetated islands and share a floodplain.

Two images of the Zekiah Swamp Run. In both of these images, multiple channels can be seen along with the islands that separate them. In the image on the right, a channel can be seen splitting into two channels.

V. Methods

1. Collect field data. The field data collected will be grain size, channel gradient and channel cross section measurements taken from several channels in the Zekiah Swamp Run.
2. After the field data is collected, it will be used to calculate the both the critical shear stress of the channel and the shear stress at the bankfull stage.

VI. Preliminary Data



The cumulative grain size distribution. This graph is used to find D_{84} and D_{50} used in the critical shear stress equations

From the grain size data, the critical shear stress can be calculated using the grain size. From the dimensionless critical shear stress, the predicted bankfull shear stress can be calculated. This will be compared to the actual bankfull shear stress.

Equations:

$\tau_{crit} = \tau^*_{crit} (\rho s - \rho w) g D_{84}$

$\tau^*_{crit} = 0.045$ for heterogeneous gravel ($D_{84}/D_{50} \sim 2$ to 2.5)

$\tau_{bankfull} = \tau^*_{crit} (\rho s - \rho w) g D_{84}$

For this data set, $D_{84} \approx .022$m, $D_{50} \approx .011$m, so $\tau^*_{crit} = 0.045$ and the critical and predicted bankfull shear stress is 16.5 N/m^2

The actual bankfull shear stress will be calculated once the channel cross section and gradient are measured using the equation:

$\tau_{fluid} = \rho_w g d S$, where S is the gradient and d is the depth of the channel

VII. Future Work

1. Cross section and measurements will be made for each of the channels. This will be done over the summer.
2. Once these measurements have been made, the critical shear stress and the bankfull shear stress will be calculated and compared.