Deposition of Fine and Coarse Grain Sediments Along Two Reaches of the Northwest Branch Anacostia River

COLLEGE OF COMPUTER, MATHMATICAL, & NATURAL SCIENCES
DEPARTMENT OF GEOLOGY

Matthew Kraham (GEOL 393)

Advisor: Dr. Prestegaard

Introduction

River sediment loads are a consequence of erosion, transport, and deposition (sediment storage). Channelized rivers have few sources for sediment deposition. Alluvial reaches can store sand-sized sediment deposited from suspension on point bars or in the bed subsurface in central bars. Bedload sand can affect the mobility of gravel-sized sediment during flood events by reducing the shear stresses required for entrainment.

Hypothesis

a. The bed sediment in the channelized reach is mobilized at lower shear discharges and moves during more flow events than the alluvial reach.
b. In the alluvial reach, sand-sized sediment is deposited in the bed subsurface and on upper surfaces of point bars where it is mobilized only during major flow events. In the channelized reach of the river, sand is stored primarily in the subsurface due to the straightness of the channel and lack of bends where point bars form.

Study sites and Methods

Figure 1: Left: Channelized Reach Right: Alluvial Reach

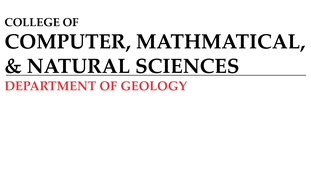
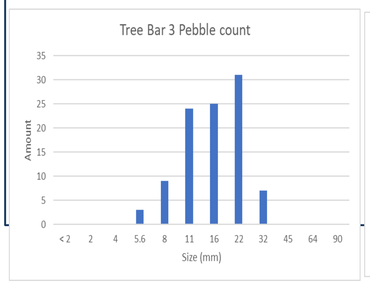


Table I: Geomorphological Data for the two river reaches

site	Ave Width, m	Sinuosity	Rc/W	Ave D50	Ave D84
Alluvial	18.47	1.32	4.52	21	28.5
channelized	21.40	1	0	22	31.3

Methods: Surface grain size measurements, particle tracer experiments during storm events, measurement of flood gradient, depth to determine fluid shear stress, Calculation of threshold dimensionless shear stress for entrainment events. .



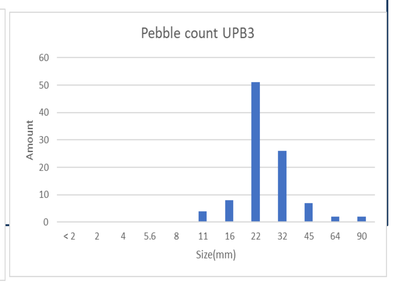


Figure 2: Surface Grain sizes obtained from Wolman Pebble Counts: Left: Alluvial Reach, Right: Channelized reach

Particle Tracer Experiments: Surface grain sizes are marked in place. The size, number, and distances that each particle moved during a flood is measured. Local flood flow depth and gradient data are used to calculate shear stress, $\tau = \rho g d S$; ρ = fluid density, g= gravity, d = depth, S = gradient

Fig. 3: Left: Marked Particles in channelized reach (3 per bar on 2 bars); Middle shows alluvial reach, Right: Alluvial reach measurement of the distance each particle traveled (Right)

Preliminary Results

Size of Transported Particles:

- During the March 24th storm varying grain sizes moved . For the alluvial site (fig 4), a lot of the sediment moved was between 10 – 20mm (near the median size).
- All surface sizes in the bed moved during the high flow event.
- For the channelized reach, the average sediment size that moved was 14 – 30mm.
- A wider range of particles were being transported in the channelized reach compared to the alluvial reach

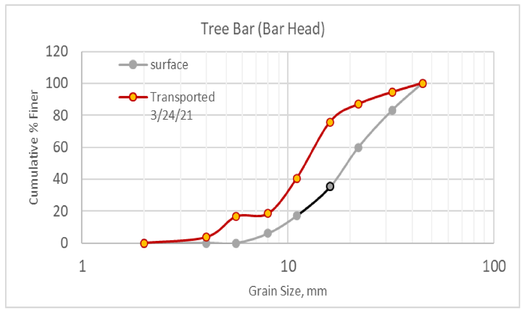
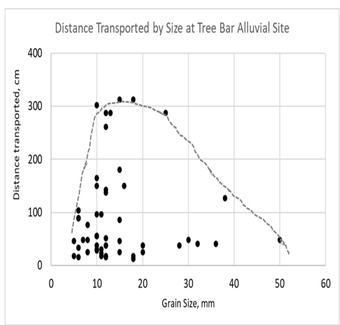


Fig. 4: Comparison of surface sizes (grey) to transported sizes)

Particle Transport Distances

- For the alluvial site, the particles in the 10 – 15 mm range moved the furthest
- For the channelized site, a similar range of grain sizes moved but particles larger than 30 mm moved further.
- The most abundant grain size class had the widest range of transport distances



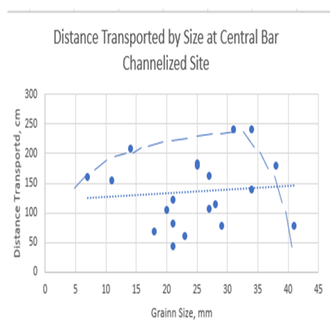
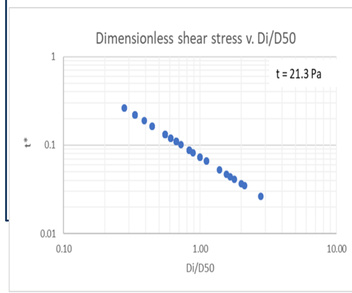


Fig. 5: Distance transported, Alluvial Site (Left), Channelized Site (Right)

Flood dimensionless shear stresses:

$t^* = (\rho g d s)/(\rho_s - \rho) g D$; ρs = sediment density, D = grain diameter

- Gravel beds break up (move most particles) when dimensionless shear stress values (t^*_{crit}) = 0.045 for D_{84} particles. Sand in the bed can decrease t*crit to values as low as 0.02 or 0.01.
- Field entrainment data for individual floods can be used to determine if: a) the amount of sand in the bed varies from flood to flood, and b) whether this influences t*crit.
- The D50 and D84 for the alluvial site are 21 and 28.5.
- The D50 and D84 for the channelized site are 22 and 31.3



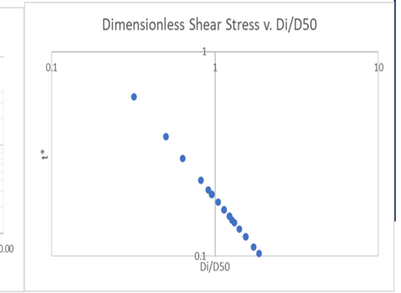


Figure 6:3/24/21 Flood: Dimensionless Shear Stress, Alluvial Site (Left), Channelized Reach (Right). Values of t*crit for D84 are: .088 and .14

Summary

- For hypothesis A, the channelized reach is mobilized at lower shear discharges and moves during more flow events than the alluvial reach. The data collected from the Wolman count, morphological data, and particle distanced travel all support this claim.
- For hypothesis B, sand sized sediments are deposited along the subsurface and upper surface of the alluvial reach. We can obtain this knowledge by using the data from the particle transport D50 and D84, and the morphological data.
- For hypothesis B, sand in the channelized reach is being stored in the subsurface and as overbank deposit

Timeline for Future Work

- Over the summer I plan on doing 2- 3 more experiments of the same magnitude to see if the results are the same and have a conclusion.
- Measure the amount of sand in the bars and what depth the sand is before we hit the gravel bedding between the two sites.