PRF# DNI-57764
Project Title: Investigating Advective and Diffusive Controls on Fine-Grained Sediment Transport and Deposition
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The purpose of this project is to investigate the controls on depositional patterns as a function of grain size, with particular interest in the controls on the deposition of silt and other fine grained sediments. As outlined in the proposal, the approach was primarily experimental in its initial conception. Over this first year, we have run the proposed experiments and have augmented the work with field measurements of depositional trends in a field setting.

The experiments were performed at the University of Arkansas sediment dynamics laboratory in the Fall of 2017 with the 9 students from PI Shaw's Dynamics of Sediment Transport graduate course. In one 20 hour continuous experiment, silica flour comprised of grain sizes from 2 – 80 microns, was added slowly by a turbulent jet into the basin. The flow pattern in the basin was measured with an Acoustic Doppler Velocimeter revealing shear velocities that ranged from 17 to 0.8 mm/s. The resulting deposit had a coarse-grained depocenter near the mouth, and a fine grained deposit that coated most of the basin. This morphology was qualitatively similar to the hypothesis that the finest grains would form a blanket of sediment that had very little to do with emergent flow patterns. The deposition, and grain size variations within the flow were also carefully measured. Students processed initial data as a final class project, finding that the Rouse parameter was more influenced by sediment fining that the reduction in shear velocity (Figure 1).

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
A	0.8	0.4	0.1	1.3	1.2	0.5	0.4	0.3	0.9
B	0.8	0.6	1.3	2.8	1.3	0.5	0.9	0.5	0.6
C	0.8	1.8	0.4	4.9	1.4	0.7	0.8	0.7	0.6
D	1.7	0.5	0.1	2.5	1.3	1.2	1.2	0.7	0.6

Figure 1: This chart from the student led experiment shows the Rouse number (settling velocity divided by shear velocity) for the experimental basin. Boxes are 20x20 cm with rows showing axial distance from inflow and columns showing lateral distance (flow input at A5). The variation in rouse number shows a greater decrease in settling velocity than the decrease in shear velocity.

I consider this to be a success, although very much in progress. The students collected high quality, precise data with a variety of techniques and analyzed them quantitatively. Their analysis is not ready for publication in its current form, but I believe that publication is possible with several months more work. It is reasonable to expect that this work can be in review by the end of the grant.

Funds also provided support for an undergraduate honors student to process a large backlog of bed material sediment samples that I have collected over the years to investigate grain size trends in deltaic systems from fine sand down to fine silt. The student used the four settling columns at the Univerity of Arkansas to directly measure settling velocity distributions down to 8 micron resolution and compare them spatially (Figure 2). This work shows that assumed advection settling in not sufficient for models of silt deposition. This work yielded a successful honors thesis that was defended *cum Laude*. This research is certainly publishable with a few more months of editing and work.

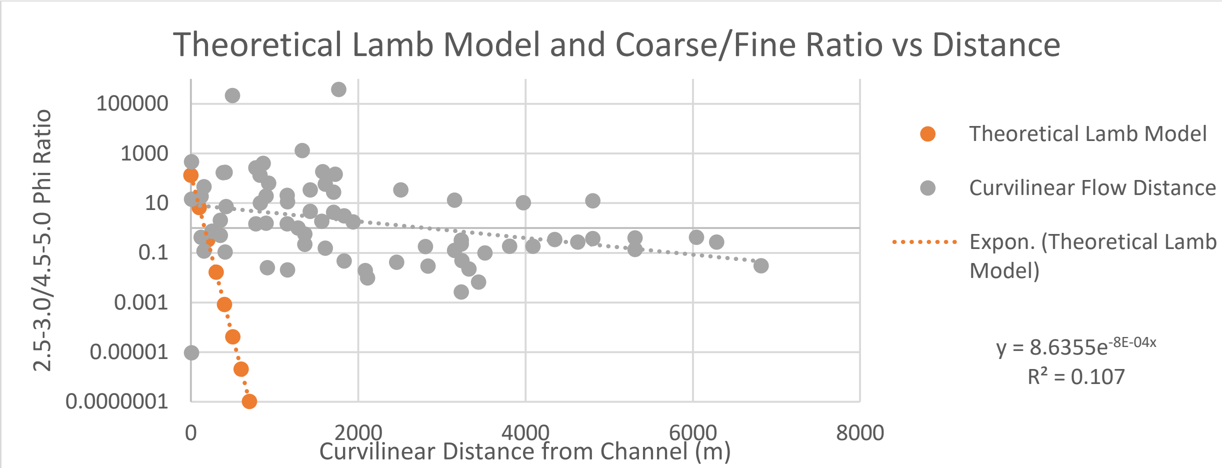

Figure 2: Gray dots show the ratio of lower fine sand to lower medium silt in 90 sediment samples with distance from the nearest distributary channel. The orange line shows the theoretical relationship assuming direct advection settling. The trend built from regression (gray line), however is an order of magnitude more gradual.

In Spring 2018, a valuable opportunity presented itself to measure fine grained sediment deposition in the field. A team of the PI, a post-doc, and graduate student, and an undergraduate set out to measure changes to fine-grained sediment transport with distance from a flooding delta. In a novel approach, we let our boat drift from distributary channel out over the delta front, collecting suspended sediment samples, velocity profiles with an acoustic Doppler current profiler, grab samples, and bathymetry. This approach is not possible with traditional mooring measurement methods and can be directly compared to the spatially variable measurement scheme that was employed in the experiments. Our goal was to see if the theory being developed about fine-grained sediment transport and deposition from experiments could be applied to a parcel of water traversing a flooding delta. During this campaign, we collected ~100 samples from ~30 sites. Initial processing of the data has yielded increasing then decreasing trends of suspended concentration with distance from distributary channels (Figure 3). Grain size distributions from these samples are currently being measured at the University of New Orleans, to compare the depositional patterns with theory.

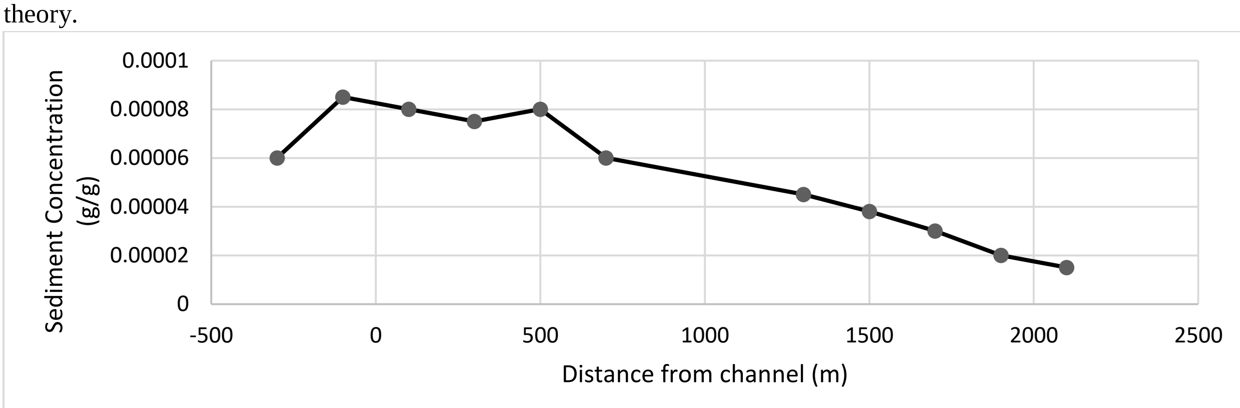

Figure 3: The trend in suspended grain size with distance from a distributary channel (negative values are samples from within the channel The rend initially increases, then decreases gradually.

This project outgrowth was also in progress, but very successful in the data acquisition phase. Proposal funds were essential to execution of the field campaign which we determined to be important only after the experiments were run, when we could see a connection between experiments and the field. While the data are not yet fully processed. I am confident that this too will lead to an important publication. The research is being led by Dr. Robert Mahon, a post-doc who recently started a tenure track job at the University of New Orleans and intends to continue this line of work.