***How does hyporheic flow affect fine sediment deposition?***

***Presentation for the research group outline***

1. ***Introduction***

The interaction between overlying water over a riverbed will generate pressure gradients at the interface between the sediment and the water, which will drive water into and out of the bedforms. This area where this happens (as we all know) is called the ***hyporheic zone*** and it is home to many natural processes where the exchange of water, nutrients, and other chemical species is important to the river ecology.

The most common example for this is that some salmonids use the hyporheic zone as a spawning area, burying their eggs into the gravel. Studies have shown that oxygen supply to salmonid eggs is important for the success of reproduction and that the quality of their spawning habitat heavily relies on the permeability of the substrate, mostly related to the subsurface grain size.

Fine sediment is abundant in rivers, in both organic and inorganic forms, such as clay and silt particles and organic plant debris and microbes respectively. During high flow events, a significant amount of fine sediment is transported through the channel, which eventually deposit into the riverbed. The deposition of fine sediment in the hyporheic layer is detrimental to many fish and macroinvertebrate species living and using the riverbed as habitat as it reduces the exchanges of nutrients and oxygen by decreasing the size of pores.

It has been found through laboratory experiments and numerical modeling that more fine sediment deposition may occur in losing than in gaining reaches due to these advective fluxes that push sediment into the bed at for downwelling conditions. However, no one has quantified or analyzed this deposition in terms of particle size, which could be more informative than just the amount of fine sediment deposited in a given reach.

This is why for this chapter in my dissertation I want to analyze hyporheic flux magnitude variations in localized areas and determine how fine sediment concentrations and particle size distributions (PSD) correlate to these spatial and temporal differences during spring and summer seasons.

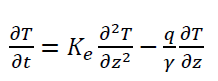
1. ***Methods***

To do this, I am going to explain how I obtained both hyporheic flux and particle size distributions of deposited sediment.

* *Hyporheic Flux:*

Eight temperature-monitoring probes were installed into the streambed along the center of the channel in 2021. These probes are able to passively capture diel substrate water temperature fluctuations at different substrate depths, which allows us to quantify the exchange between the riverbed and the surface water.

The theory behind these is finding the solution to the 1D advection-diffusion equation, which can be done multiple ways to do it depending on the boundary conditions and assumptions.



*Colocar en el ppt (no decir):* Where T is temperature (°C), t is time (s), Ke is the thermal diffusivity (m2/s), z is the depth into the streambed (m) defined positive when downward, q is the Darcinian flux (m/s) and γ is the ratio between the heat capacity of the sediment and heat capacity of water.

I was able to process these probe temperatures using Andrea’s GUI, which is a main part of his PhD project. The diffusion equation is solved using Fourier transforms assuming sinusoidal variation in surface temperature and a much more mitigated diel variation as we go deeper into the surface.



* *Fine sediment PSD:*

*~ Field deployment:*

In spring of 2023, I deployed two different designs of sediment traps next to each temperature probe, in order to quantify the deposited sediment for a specific hyporheic flux magnitude in a given location. I chose two designs in order to separate the effects of settling velocity and stream turbulence to hyporheic flux when depositing fine sediment.

(1) A solid PVC cylinder with an open bottom that allows vertical exchange flow (both upwelling and downwelling) and fine sediment deposition

(2) A more traditional solid-walled container with a sealed bottom to eliminate the vertical flux

Both trap designs are solid-walled because I am only interested in analyzing the vertical effects hyporheic flow has on fine sediment deposition.

Therefore, I am expecting to capture the effects of downwelling and upwelling hyporheic effects with the first design (1) and only the effects of particle settling deposition/turbulence from general streamflow with the second design (2).

For the open bottom design, I expect higher sediment concentrations as well as finer PSD for downwelling areas than in upwelling areas.

All PVC cylinders were filled with prewashed gravel collected from the respective sample reaches, sieved to exclude grains finer than 10 mm and will be enclosed in an open bag (at the trap top) with a 20 um mesh size (overlapped), to avoid the loss of fines as much as possible. These traps were left in situ for the entirety of snowmelt and summer monsoon season, allowing enough time for fine sediment to accumulate.

At the end of each season, the bags were carefully removed and stored in zip lock bags until processing.

*~ Sample Processing:*

For PSD analysis, these samples were dry sieved and finer than 0.5 mm was analyzed using the LISST-portable XR, which uses laser light scattering to calculate the grain size distribution in a given sample. I will not go into details on the laboratory protocol for these samples.

1. ***Results***
2. ***Extra?***