Assessment of sedimentation for reservoirs

Sediment traps help to investigate the sedimentation rate as well as its spatio-temporal variation of settling particles. They represent a low-budget alternative to investigate sediment quality.

Context

Loss of storage volume and the accumulation of nutrients due to siltation threatens drinking water supply. The amount of sediment input and internal production (plancton growth) determines the sedimentation rate, which is highly important indicator for reservoir management.

Objectives/Goals

- Determine sedimentation rates in the water columm;
- Obtain its spatio-temporal variation;
- Obtain the nutrient content of settling particles;
- Compare sedimentation rates with another methods;
- Estimate the life time of the reservoir.

Method and Equipment

The sediment traps consists of two vertically arranged transparent PVC tubes. They contain two overflow plastic hoses and two sample bottles at the bottom. The vertical pipes have an internal diameter of 86 mm (Figure 1). To prevent particles from resuspending inside the bottles the length of the tubes needs to be at least 5-times the diameter of the tubes. Sample bottles are easy to change and collect. The captured material was wheighed and analyzed for Organic Matter, Total Phosphorus and Nitrogen which were determined by the KIT. The different parameters were set in relation to the distance from inflow and collection time.

Five sediment traps were installed in 2018, two of these were installed at the surface at the "intake" and "dam" location, three were placed close to the bottom (intake, dam and park locations). The difference between the surface (SUR) and the bottom (BOT) helps to understand local production processes. In 2019, all sediment traps were placed one meter above the bottom (Figure 2). As for the two surface traps, one was relocated to the southern side arm and the other one at the entrance of the Passaúna river, south of the bridge.

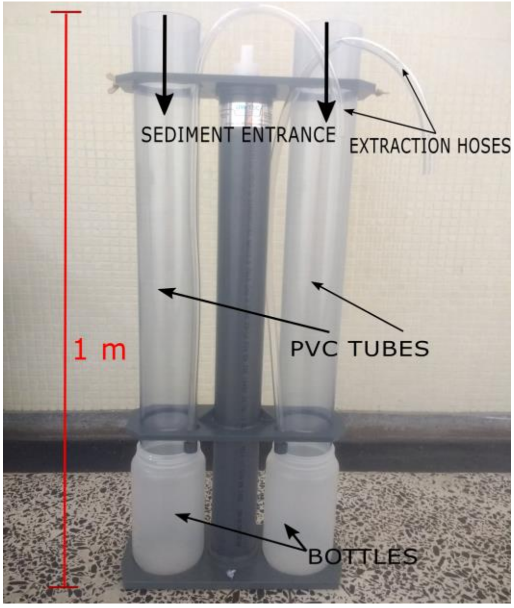

Figure 1 Sediment trap setup.

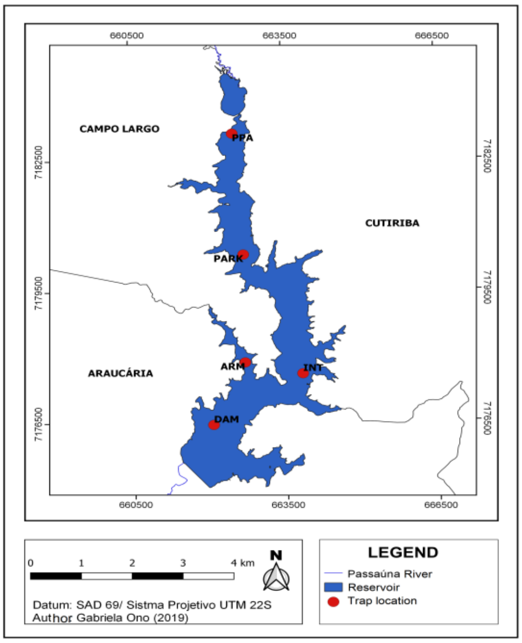

Figure 2 Locations of the sediment traps in Passaúna reservoir.

Results

Downstream of the Ferraria Bridge the sedimentation rates are extremely high with ~180,000 mg/m²/d equaling ~227 cm of sediment accumulation. They decrease over the distance from the inflow down to 1,500 mg/m²/d, ~1.9 cm sediment accumulation (Figure 3). By the differences between the samples the seasonality of sedimentation rates at the locations can be observed. Especially in the middle part of the reservoir the seasonal changes seem to be large. Close to the dam the relative changes are large, however the absolute changes of the deposited mass are low.

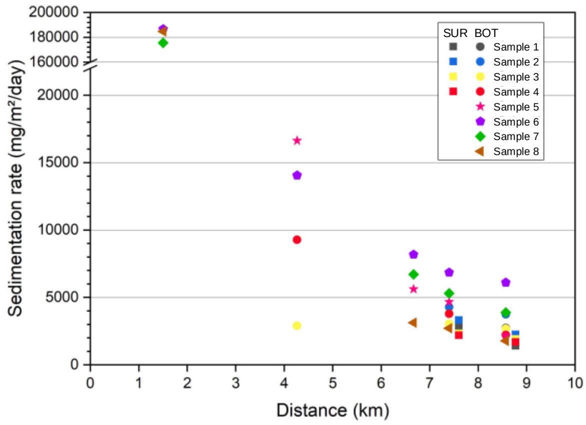

Figure 3 Longitudinal sedimentation rate variation over distance from inflow.

The weighted average sedimentation rate was 20,216 mg/m² ·d, this equals 0,8 cm/yr. This rate is in the interval proposed by Sautini et al., (2004) (0.66-3.04 cm/yr).

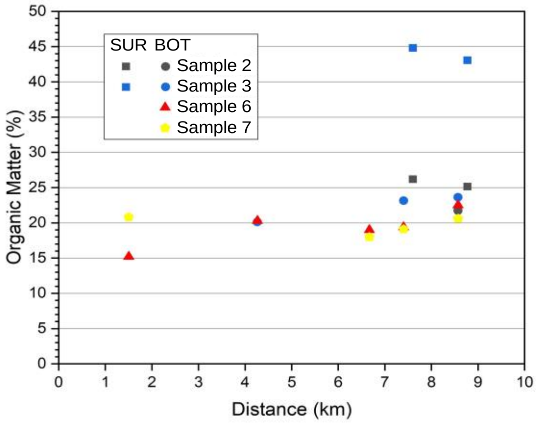

Figure 4 Organic matter content of settled material from inflow to dam.

In contrast to the decreasing sedimentation rates closer to the dam, the organic share of the settling particles increases with distance to the inflow (Figure 4). It increases from ~15% to ~25% at the bottom close to the dam. Surface samples show significantly higher organic matter shares (up to 45%).

The N/P ratio shows that Total Phosphorus as a limiting nutrient. P_T average deposition was 3,25 mg/m² ·d (Figure 5) and N_T average deposition stream found was 26,4 mg/m² · d.

Figure 5 shows the temporal variability of the settling rates. In accordance with the land cover change we can see that in March to September the sedimentation rates increase (see Flyer "sediment input modelling"). This effect is mostly prevalent in the middle and lower area close to the dam.

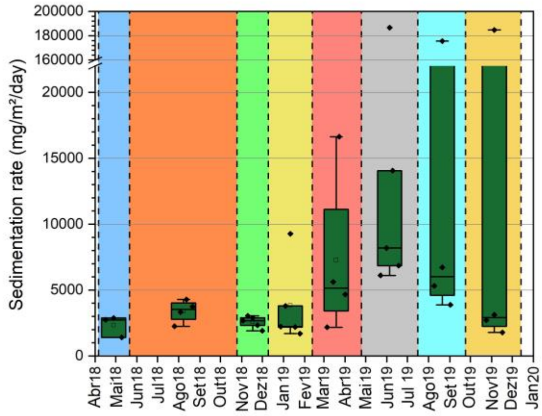

Figure 5 Temporal variation of sedimentation rates.

Innovation/Outlook

- ✓ Cheap and simple methodology for sedimentation rate assessment.
- ✓ Robust sediment mass estimation at single locations.
- ✓ Secure long-term planning for the reservoir operation.
- ✓ Important information for process understanding in combination with with other mesurements of sedimentation as Echo-bathymetry, GraviProbe data and Core data.

Authors Ono, G. M.; Mannich, M.; Hilgert, S.; and Bleninger, T.
Contact stephan.hilgert@kit.edu

Funded by Federal Ministry of Education and Research, BMBF
Web www.mudak-wrm.kit.edu