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A Low-Cost Turbidity Sensor for Deployment in Rivers

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Fine sediment supply to floodplains and coastal areas is extremely important for nutrient transport, global biogeochemical cycles, water quality and pollution in riverine, coastal and marine ecosystems. Monitoring of suspended sediment in rivers with current sensors is challenging and expensive, and most monitoring setups are restricted to few single point measurements. To better understand the spatial heterogeneity of fine sediment production and transport in river systems there is a need for new smart water turbidity sensing that is multisite and at the same time accurate and affordable.

We developed an affordable but reasonably accurate turbidity sensor, that is suitable for distributed sensing with a multitude of sensors across catchments. Our turbidity sensor is much cheaper than existing options of comparable quality. It works by illuminating a sediment-laden water sample with an 860nm IR LED and detects the amount of light scattered at two different angles (with respect to the LED) using light-to-frequency converters. It also incudes an internal temperature sensor and data storage on an SD card. We are also planning to include a water pressure sensor, a GPS module, a more compact and durable design with a printed circuit board, and the option of remote data transmission via LoRa.

Here, we present the results of two experiments with the developed new sensor: (1) a calibration test using formazin (4000 NTU) dilutions to evaluate which detector angles work best in the 0-4000 NTU range, how ambient light affects the results, and if focusing lenses and high-pass filters increase the sensor's accuracy; (2) a laboratory test with various sediment types and concentrations mixed in a large water tank to compare replicates of our sensors (six in total) to different commercially available turbidity probes. Our results show that a high accuracy in the 0-4000 NTU range can be achieved with our low cost, low power sensor.

The new turbidity sensor will allow us to localise sediment sources and sinks in catchments, i.e. where and when fine sediment is produced, transported and deposited across entire catchments. We will be able to observe the variability in suspended sediment fluxes in glacial streams (the development, expansion and collapse of subglacial channels), along river networks with different local sources (effect of tributary inputs and hillslope landslides), concentration variability due to flow-bed interactions (influence of river bed morphology and grain size), and asses the activation of erosion by rainfall across the multiple potential sediment sources of a catchment. The developed sensor will enable the development of distributed measurement setups, which hopefully can address many other complex challenges related to the spatially heterogeneous

processes of sediment activation and transport. This project lays a foundation to explore water turbidity sensing in other global environmental applications in the future, such as soil erosion, sediment trapping behind dams, lake monitoring, and ecological studies.