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Technologies Beyond Turbidity for Sediment Monitoring – Laser diffraction, High Frequency Acoustics and a new Combined acousto-optic method

Yogesh C Agrawal
Sequoia Scientific, Inc. Bellevue, Washington USA

Sediment monitoring was transformed when optical turbidity was first introduced 3 decades ago, creating a capacity to monitor sediments continuously. Despite many papers that have since noted that turbidity measures particle area concentration not volume, turbidity remains widely in use. In fact, the sensitivity to area rather than volume implies a 1/diameter variation with size on concentration measurement (Volts/volume). Consequently, small amounts of fine sediments can dominate larger amounts of sands – a phenomenon that has masked suspended load in many river profiles, as we will show. Laser diffraction, on the other hand, has constant sensitivity to a wide range of grain sizes, e.g. from 2-500 microns, and obtains size distribution at $\frac{1}{4}$-phi size intervals, with LISST instruments. However, it is expensive. An 8MHz acoustic system has recently been introduced, LISST-ABS that has advantages of a flatter response to varying grain sizes than turbidity, a higher sensitivity to suspended load than wash load, and a greater tolerance to turbidity. The response (Volts/volume) is still not flat, exhibiting a size-dependence that is inverse of turbidity at small sizes where particles are in Rayleigh regime, i.e. where ka<1 at 8MHz - diameters smaller than 60 microns. This opposing tendency of optics and acoustics lead us to the concept of combining the two methods, and this is a new idea that we call acousto-optics. Over the 1-500 micron size range, instead of 3 orders of magnitude variation in sensitivity for optics, this sensor achieves constancy within a factor of 3 even for narrow size particles, and better for distributions. The acoustic and acousto-optic sensors should significantly enhance measurement quality for sediments. We shall review and present the new concept.