Geophysical Research Abstracts
Vol. 13, EGU2011-2118, 2011
EGU General Assembly 2011

The rising air bubble technique for streamflow measurement

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In the world of hydrological measurements we know a large variety of streamflow measurement techniques, each having their own up- and downsides as it comes down to accuracy under different circumstances. One of the simplest methods to measure discharge is by using a float to obtain the water velocity and multiplying this with the cross-section. The major disadvantage of this method is that the velocity at the surface level of the waterbody is incorrectly taken as an depth-averaged water velocity or that a correction factor is applied that is highly dependent on unknown channel and bed characteristics. So wouldn't it be better to release an air bubble from the bottom of the stream and let this float average stream velocity over the depth? Measurements have proven this 'rising air bubble technique' to give accurate results and that there is high potential for this method even to be used for fixed measurements.

The basic concept of this method is that within the time an air bubble needs to surface with a constant rising velocity, the bubble is displaced over a certain distance by the depth-averaged velocity. By simple math it can be shown that the specific discharge follows from multiplying the displacement with the rising velocity of the air bubble. By releasing air bubbles over the full width of the stream one can sum the specific discharges over the width, obtaining a discharge both integrated in depth and in width. A single measurement is performed only by taking a photograph of the bubble pattern at the water surface. This way one can easily build a time series by taking several consecutive pictures of how the pattern evolves over time.

The concept and some field applications were earlier described by D.M. Sargent (e.g. 1982), but ever since there have only been few publications by others. This though there has been a huge progress in digital imagery analysis techniques, enabling us to easily read out displacements from our photographs. Besides, advances in pattern recognition techniques cleared the road towards the automated localization of surfaced air bubbles. This would make it possible to calculate discharge without human intervention and enable the possibility to apply this method for fixed discharge measurements.

The major limitation still in this method is the difficulty to obtain constant rising velocities. We performed lab experiments to find appropriate air pressures and nozzle sizes to release our air bubbles with.