ADCP Field Measurement Report

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The measurement was taken on the 13th of April 2022, on the river Fyrisån. This was the date of highwater mark of the spring flood at the location. The location of measurement was at the city centre, under the Nybron stone bridge (Fig 1.). A floating instrument known as Acoustic Doppler Current Profiler also called as ADCP was used to measure the velocity, river bed profile and the discharge. First, the water velocities and temperatures were measured separately using a thermometer and a current meter propeller. This was done to verify the measurements of the ADCP. The velocity and temperature were almost matching and hence it was safe to assume that the ADCP was measuring these two parameters correctly. To setup the ADCP, we first connected it with the laptop Bluetooth and fixed the transducer correctly on the floating device. Then we had to setup the pulley system using a single rope. Which was possible using two carabiners and two pulleys, one carabiner was used to attach the ADCP to the moving rope.

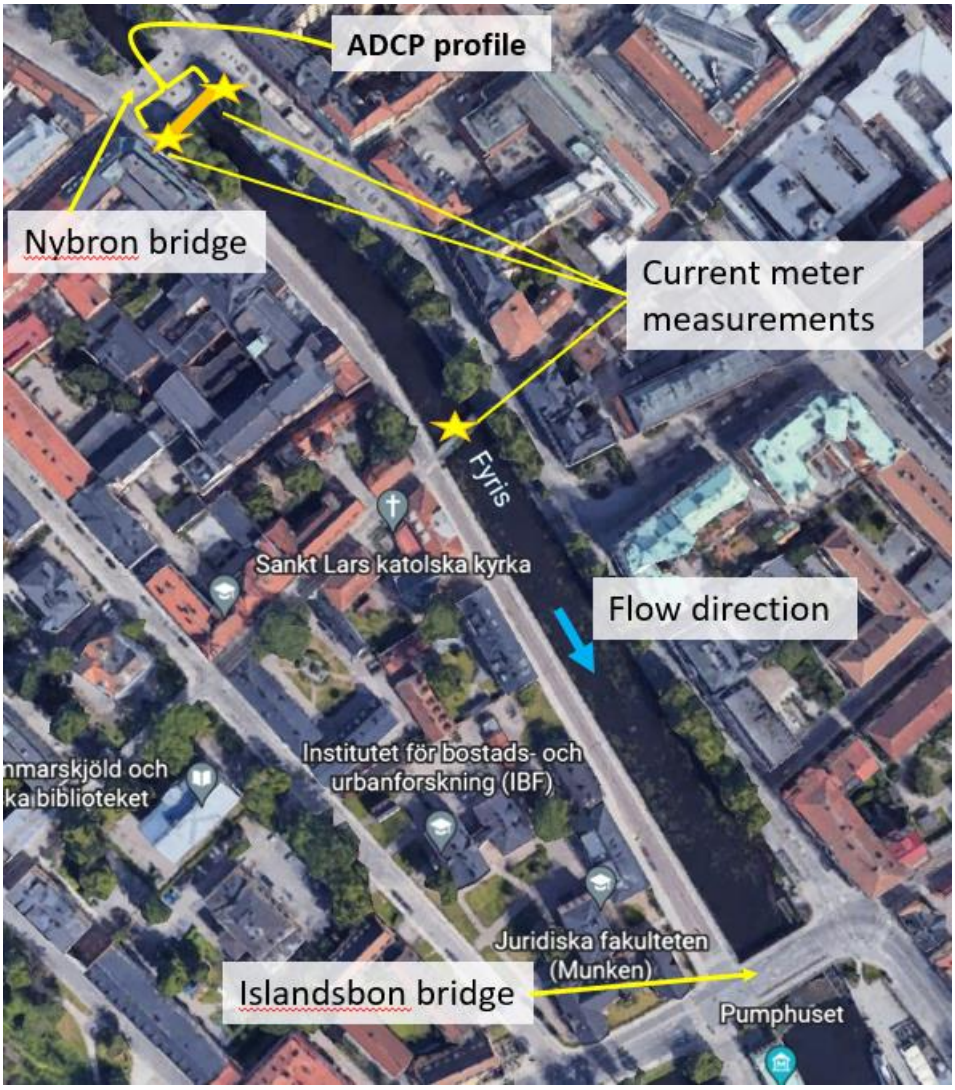

Figure 1. Google Earth image of Fyris River in central Uppsala. Image is aligned to the north. The distance between Nybron and Islandsbron bridges is 385 m. Note that the river widens downstream,

Before we kept the ADCP on the water surface we had to calibrate the compass by slowly rotating the ADCP on its own vertical axis (as the software graphics point) until the marker on the screen became dark green. While performing the rotation we had to take care that no metal objects or phones or other Bluetooth transmitters were not near the ACDP, since they would interfere with the calibration. After these processes were successfully completed the ACDP was fixed to the carabiner and gently kept on the surface of the water. Test runs were performed so as to check if the ADCP was recording the data and also to give the ADCP time to adjust itself to the water temperature.

The moving bed test was performed, by stabilising the ADCP at the centre of the river. Following was the result of the moving bed test:

Distance Upstream: ***14.149 [m]***

Duration: ***227.560 [s]***

Moving Bed Velocity: ***0.037 [m/s]***

Moving Bed Direction: ***165.272 [degrees]***

Water Velocity: ***1.237 [m/s]***

Depth: ***1.605 [m]***

Percent Bad BT: ***92.308 [percent]***

ERROR: Percentage of bad bottom track values exceeds 20.0

THE TEST IS NOT ACCURATE. TRY ANOTHER TEST.

Potential MB Error: ***2.965 [percent]***

Mean Near Bed Velocity: ***0.879 [m/s]***

As one can clearly see that the software mentioned to try another test as the result is not accurate, we tried one or two attempts but failed to get accurate results.

The next step was to start transects, which would give us the discharge, velocity and the river profile. The ADCP was moved very slowly across the bank of the river (from left to right). The starting distance from the shore was measured and recorded and so was the ending distance of the transect. Four such transects were recorded.

The data was processed using the WinRiver2 software. Temperature, velocity, boat speed, river velocity was checked and verified like temperature, velocity, boat speed, river velocity etc. Also, the velocity profiles were examined. Total discharge was calculated by summing the discharge at edges, bottom, and surface, essentially summing up all the bins and the interpolated data in-between.

Table. 1: Selected Transects with total discharge values.

Transect	Start Bank	# Ens.	Start Time	Total Q (m^3/s)
1000	Left	292	11:19:37	13.597
1002	Right	264	11:37:07	31.785
1004	Right	255	11:54:50	23.657
Average		270		23.013

Std Dev.		19		9.112
Std./| Avg.|		0.07		0.4

As we can clearly see from table one that the transect 1003 is missing. This is because while processing the data this transect was deleted. As the value of the discharge given by this transect was far more than the visible discharge on that day. Hence that value of discharge was impossible.

Table.2: Boat speed and Flow speed.

Boat speed	Flow speed
m/s	m/s
0.192	1.072
0.184	1.217
0.153	1.19
0.176	1.16
0.021	0.077
0.12	0.07

The water level according to the site upstream Islandsfallet (at Islandsbron bridge), was 0.66 meters on April 13, 2022. The discharge according the rating curve is approximately 21 m^3 per second, which is close (2.657 m^3/s less than) the discharge values of transect 1002. It is also close (2.013 m^3/s less) to the values our average discharge values of our three transects.

The major cause of uncertainty of measurement was the turbulence of the water. There were many waves on the surface and hence the ADCP was not able to get accurate measurements. Also, the boat was moving up and down due to reducing and increasing tension in the rope. Overall, our evaluation is that the measurement was not that accurate enough to produce only small discrepancies between the transects. Using the discharge calculated from the grading curve as reference the discharges of transect 1000 and 1004 can be discarded. The causes underestimation and overestimation of these two transects is unknown.

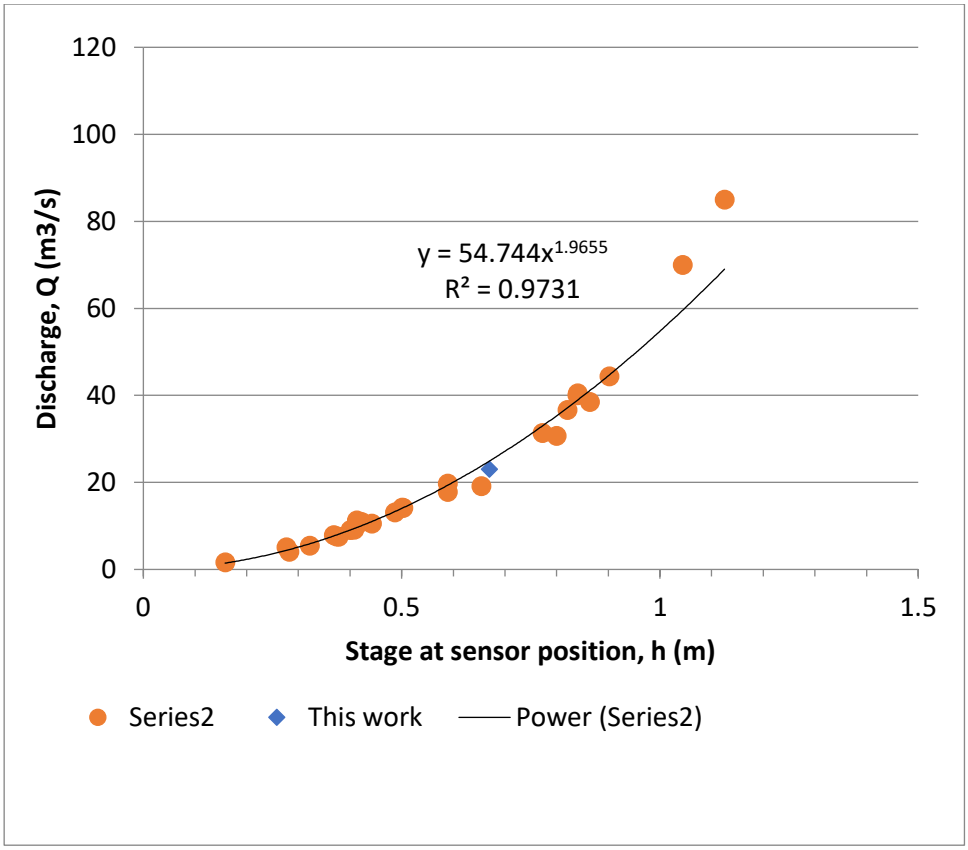

Figure 2. Rating curve for Fyris River based on 2008-2019 data and the data point of this work.

A visual evaluation of Figure 2 shows that the measured discharge of this study is wholly in line with what would be expected from the rating curve.

Summarising we have reasons to be both satisfied and concerned about our results. Our discharge values are withing the expected range. Yet given the high turbulence and the waves in the river at the time of measurement we had a low density of bins in our ADCP profiles. Also, we had to discard one of our four profiles since it had negative discharge. To asses the reliability of our results we recommend to compare it with the data of the group that measured directly after the peak of spring flood. If discharge for this group is higher than four us, we are of the idea that our data should not be considered for the rating curve.

Appendix 1. ADCP concept

The Acoustic Doppler Current Profiler or ADCP works on the principle of the doppler effect. In other words, the ADCP emits acoustic waves that are received back with a change in frequency. The change in the frequency will have a relationship to the velocity of the current given by:

$$V = \frac{CFd}{2Fs}$$

Where V is the relative velocity, C is the speed of sound, Fd is the doppler shift frequency, Fs is the frequency of sound when an object is still.

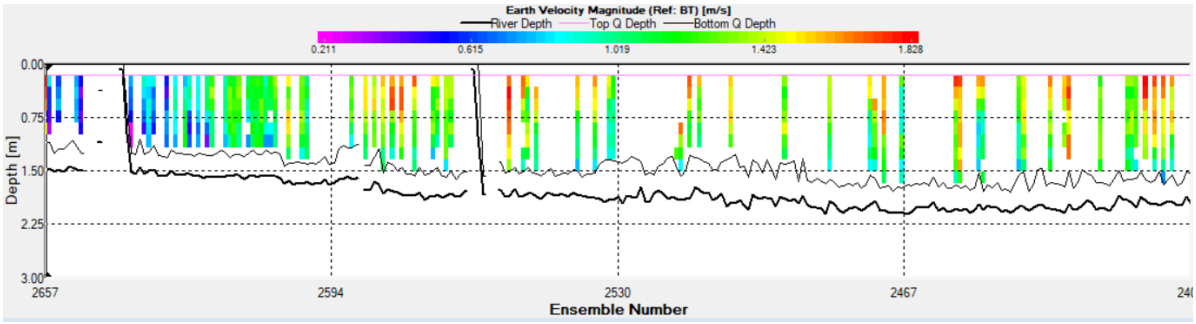

Figure 3. View of the bin in profile no. 4.

Figure 4. Floating instrument similar to the one used. Image source: Teledyne RD Instruments StreamPro ADCP | Wetec Private Limited retrieved on September 19, 2022.