Determination of the bed level at the Gameren side channel: measurements with a Fishfinder.

A report by HKV, commissioned by Rijkswaterstaat as part of the Interreg North Sea Region Building with Nature project. Translated from Dutch by Ralph Schielen (Rijkswaterstaat).

1. Introduction

The bed topography in the Dutch side channels is very dynamic due to sedimentation and erosion. This usually occurs in periods of bankfull (and higher) discharges. To get insight is the these processes it is important to regularly monitor the bed topography of side channel systems. Due to a limited navigation depth, however, it is not possible to do this with the regular multibeam measure devices on the vessels of of the Dutch Water Authority Rijkswaterstaat. This is one of the reasons that a yearly track record of the bed topography at the side channel system of Gameren, along the Waal river, is missing.

As an alternative for regular multibeam measurements we have tried to use a so called *Fishfinder*. This is a relative simple device that can be used in shallow water. In this short note, the findings of applying a Fishfinder to acquire bed topography is described.

This note is entirely based on a report (in Dutch) made by HKV consultans, commissioned by Rijkswaterstaat as part of the Interreg North Sea Region Building with Nature program. . This note does not contain any new information with respect to the Dutch report. The assignment was completely financed by the Interreg North Sea Region Building with Nature project. The reference to the Dutch report is as follows: J. Pol and L. Lokin (2018): Bodemhoogte nevengeul Gameren, Metingen met de Fishfinder, PR3763.10.

2. Measurements

In figure 1, the situation of the Gameren side channel system is visualized. The pilot study concentrated on the upstream part of the ‘Grote geul’ (Large channel). ‘Oostgeul’ and “Westgeul’ mean East channel and West channel, respectively.

Figure 1: Side channels at Gameren: West channel ('Westgeul'), East channel ('Oostgeul') and Large channel ('Grote Geul'). The red dot indicates the location of Gameren in the Netherlands.

Measurements have been carried out on February 14, 2018, two weeks after the passage of a moderate high discharge wave. At the time of the measurements, the floodplains were not inundated. The measurements have been carried out with a Fishfinder Garmin Echomap 42 mounted on a zodiac rubberboat with electrical engine. A dGPS was used to measure the water level.

The Garmin Echomap 42 is a single beam Fishfinder was a maximal frequency of 200 kHz at a measuring angle of 10 degrees. It comes with a built in 5 Hz GPS. In figure 1, a photo of the vessel and the experimental set up is shown. In figure 2, an example of the display of the Fishfinder when measuring is given.

Figure 2: equipment needed for the measurements. The Fishfinder is visible mounted on the vertical shelf.

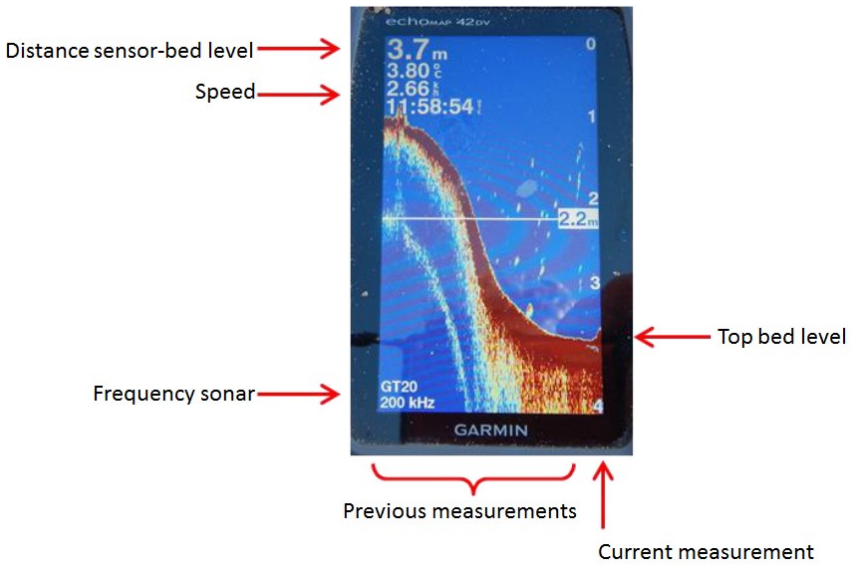

Figure 3: Display of the Garmin Fishfinder

3. Data processing

Four steps have been taken in the data-processing.

(1): The data (depth) from the Fishfinder has been calibrated using a self-made gauging rod. This resulted in a systematic adjustment of the readings with 0.1 m.

(2): Outliers in the data have been removed. Outliers have been found when the Fishfinder was still recording while the boat was no longer in the water.

(3): The GPS receiver and the Fishfinder itself where not in the same position. The GPS-signal has been corrected.

(4): The Fishfinder measures the distance between the Fishfinder and the bed level. These data have been translated to bed-position with respect to mean sea level. For this translation, the dGPS data of the water level has been used. It is assumed that the draught of the rubber boat did not changed during the measurement.

Bed levels

The measurements of the Fishfinder have been transformed into a covering map of the large channel, using the interpolation tool box in GIS. Only in the most upstream part of the large channel, the density of the measurements was sufficient to perform this interpolation. In figures 4 and 5, the Fishfinder tracks and the interpolation are shown. In figure both figures, the erosion in the upstream part, and the scour hole just downstream the bridge is clearly visible in figure 5.

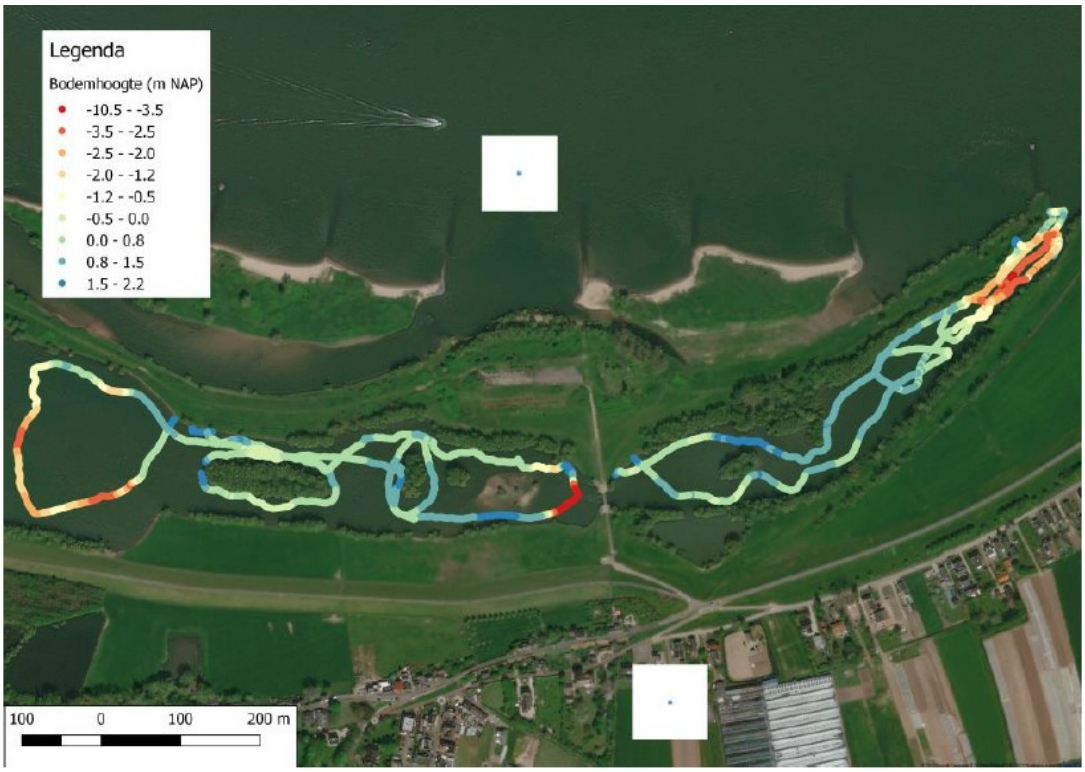

Figure 4: Tracks and measured depth, using the vessel and the fishfinder.

Uncertainty

There were several crossings in the tracks of the rubber boat when using the Fishfinder. Hence, at several spots, there is more than one data point available. This gives the opportunity to perform a statistical analysis on the data. It turns out that the standard deviation is in average 14 cm over all crossings. On locations with a mildly slope, the standard deviation is in the order of a few cm's while on steep slopes, the standard deviation can be as large as 86 cm. The reason for this large standard deviation at steep slopes may be due to (1) the GPS position with respect to the position of the fish finder, (2) measure angle of the Fishfinder and (3) movement of the rubber boat.

By coincident, Rijkswaterstaat performed multibeam measurements in a part of the large channel just two weeks before the measurements with the Fishfinder. This gave the opportunity to compare parts of the multibeam measurements with the Fishfinder measurements. The findings were the following (see also Figure 6):

- The Fishfinder data is in average 11 cm lower (standard deviation 28cm) in bed level than the multibeam data
- Deviations are mainly found in steel slopes
- The general pattern of steep and weak slopes is retrieved in the Fishfinder data (although sometimes a little bit translated in space)

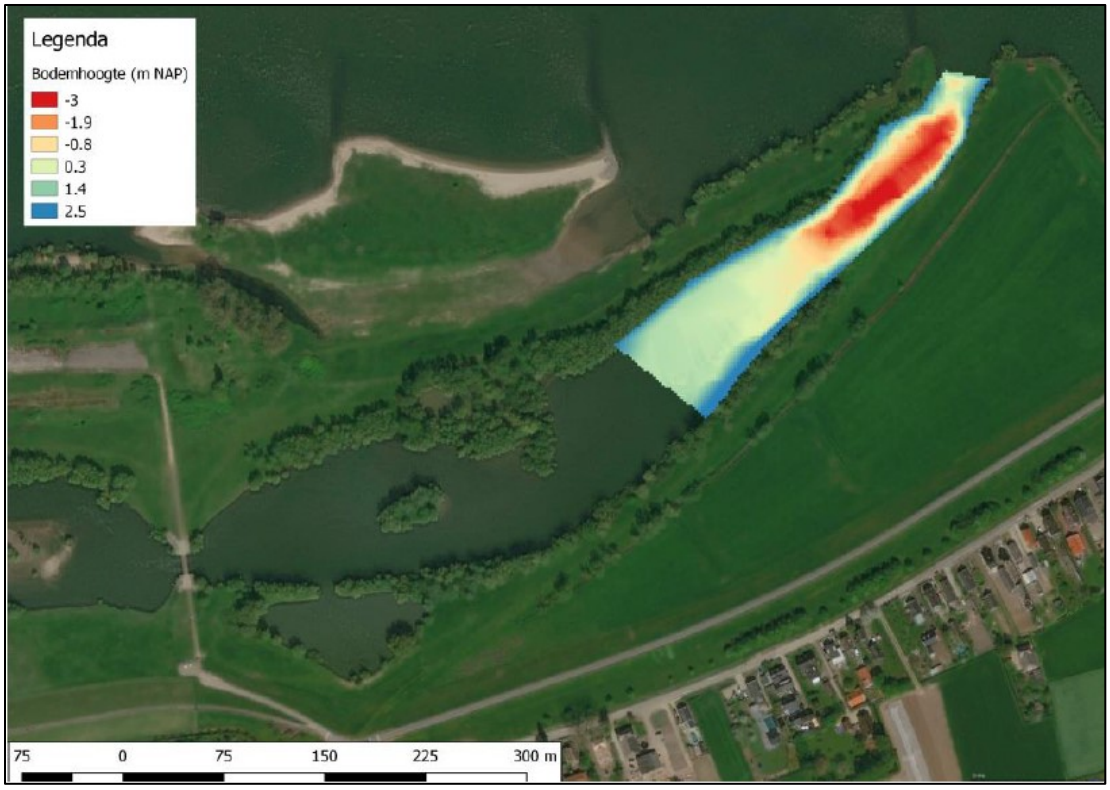

Figure 5: Interpolation of the data of the Fishfinder.

The explanation for these findings are:

- Morphological changes between the two measurements
- Presence of silt
- Uncertainty in the position of the GPS of the Fishfinder
- Uncertainty in the exact position of the sensor of the Fishfinder
- Local water level in the Large Channel
- Uncertainty in the calibration measurements (using the gauging rod) of the Fishfinder

4. Conclusions and recommendations

Results

Measurements with a Fishfinder device in side channels are simple and quick. The measurements give a good representation of the global bathymetry in a side channel. Fishfinder measurements are therefore an alternative for measurements in locations where regular multibeam measurements with a larger vessel are not possible.

To get a full cover of the bed, it is necessary that measurements are performed with sufficient density. Although the resolution of the Fishfinder is coarser than the regular maintenance measurements, the accuracy is quit good.

Uncertainties are in the order of cm's (at the flatter parts of the bed) to decimeters (at the slopes). The main source of the uncertainty seems to be the position of the GPS on the vessel. Advice is therefore to pay attention to the relative position of the GPS to the sensor.

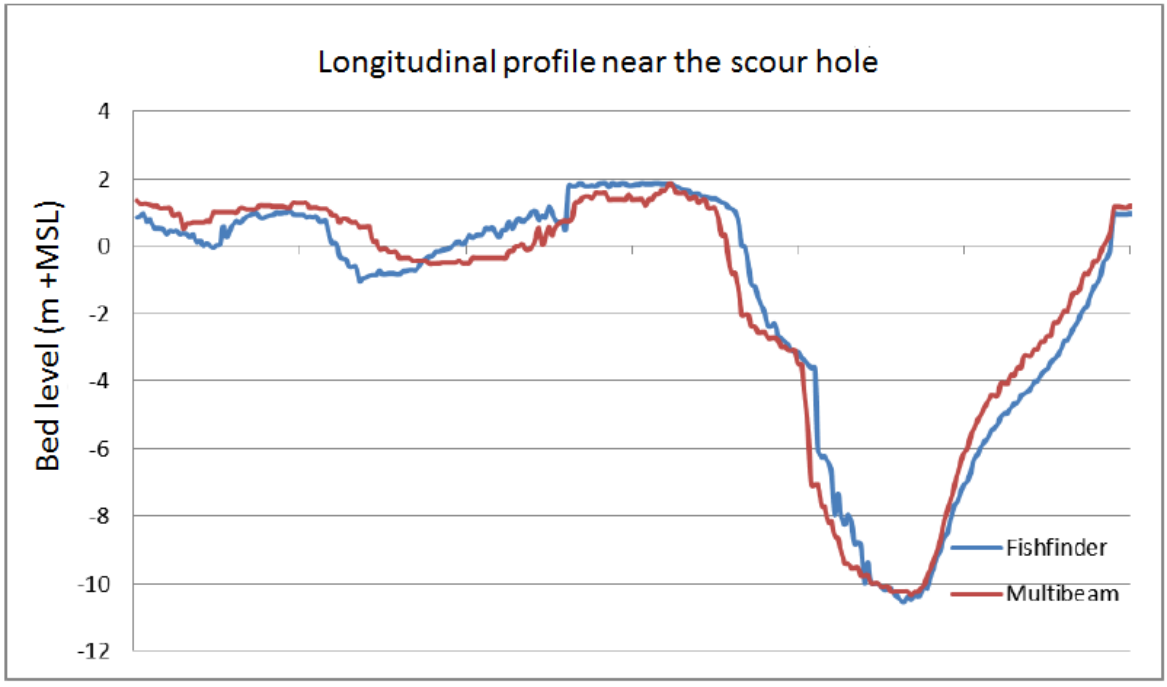

Figure 6: Comparison between the measurements with the Fishfinder and the multibeam measurements. The location is near the bridge, visible in the center of Figure 4. The scour hole is clearly visible in the figure (right hand side).

The measurements are not accurate enough to measure temporal or spatial evolution of bed forms (e.g. dunes or ripples) over time. If one is interested large scale measurements of the bed level over time (i.e. comparing measurements with a time interval of several weeks/months), one might consider using the Fishfinder. Uncertainties are then less important because they average, and the results are in principal useable to analyze trends.

It should be mentioned that accuracy may be improved by a better calibration.

Practical aspects

Recommendation is to carry along a dGPS in the vessel. The dGPS can be used for calibration, to determine the position of the vessel more accurately and to validate the GPS of the Fishfinder.

Moment of measurements

At low discharges, the range of the Fishfinder is limited because the Fishfinder needs a minimal depth of 70 cm. At high discharges, velocities are higher, and the vessel needs a strong enough motor to navigate safely. If it is cold and rainy, conditions can be harsh.