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Water management during low water level event. Measurement campaign downstream of Liège: September/October

Calibration Divers

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Calibration Divers

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Abstract

In the framework of the water management of waterbodies downstream of Liège, a monitoring campaign was set up with different parties during low water level event. A total of 40 Divers have been used in the field to map water levels for different waterbodies. The displacements of the parts of pressure sensors, exposed to the environment, are translated (using electronics) into pressure (Pa) and recalculated into water depth/height (m). Pressure sensors tend to drift due to irreversible deformation during the displacement of these measuring parts. Therefore the pressure gauges/sensors need to be calibrated before and after the deployment into the field. 40 divers from the involved parties have been collected and calibrated at Flanders Hydraulics Research. This factual report gives an overview of the calibration.

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1 Setup and execution of the calibration

1.1 Setup

1.1.1 Calibration column and instrument mounting

Flanders Hydraulic Research host a calibration column of 4 m length (Figure 1). This column is filled with water and measurement instruments can be profiled till the bottom. The position (depth, height) is acurately (+/- 0,5 cm) monitored with a measuring tape or electronically with a cable length measuring device. For this project a measuring tape has been used.

Figure 1– Calibration column @ Flanders Hydraulic Research

For the calibration of the Divers a mounting platform (Figure 2) has been purpose-built. 40 Divers can be mounted and calibrated together.

Figure 2 – Mounting platform for 40 Divers

1.1.2 Divers

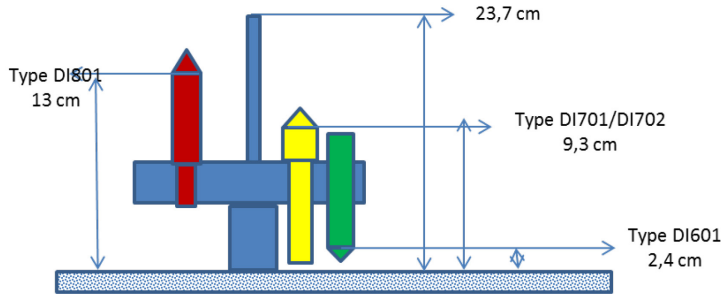
Different types of Divers have been used in this campaign.

Table 1 – List of Diver types

Divers type	Type number	Used colour in figure	Height of the 'sensor part' relative to the bottom of the platform
TD Divers	DI801	red	13,0 cm
Micro Divers	DI601	green	2,4 cm
Cera Divers	DI701 DI702	yellow	9,3 cm

Because of the different shape, the height of the 'sensor part' of the diver is different for the different type of divers. Figure 3 gives the level of the 'sensor part' relative to the bottom of the platform.

Figure 3 – Height of the 'sensor part' of the different Diver types relative to the bottom of the platform.



1.2 Execution of the calibration

1.2.1 Measuring depth

All Divers need to be set to collect data prior to submersion into the column. Divers need to be held steady at each height in the column till a minimum of 5 data points are obtained. The time needed is a function of the sampling rate.

For the first measuring level the mounting platform is submerged and lowered down till it rests on the bottom. Then the platform is lifted and held stationary at 3 more levels and 1 m spaced (e.g. 3,5m; 2,5m; 1,5m ; 0,5m). For each level, the following procedure is used:

A measure tape is connected to the shackle of the platform. The height of the connection to the underside of the platform is known. The relative height of the 'sensor part' of each type of the Diver to the underside of the platform is also known (see Table 1*). The measuring tape is read off at the top of the calibration column. The distance between the water and the top of the calibration column is also noted. Out of the obtained heights, the* ***height of the water column above the sensor is calculated****. The latter height is used for calibration and is different for the different type of sensors see Table 2).*

Table 2 – Measured calibration depth. Above: before measurement campaign; below: after the measurement campaign

Depth sensor	Type 1 (DI801 (TD diver), red) (in m)	Type 2 (DI701/ DI702, yellow) (in m)	Type 3 (DI601, green) (in m)
	Depth - 13 cm	Depth - 9,3 cm	Depth -2,4 cm
Depth 1	3,547	3,584	3,653
Depth 2	3,066	3,103	3,172
Depth 3	2,547	2,584	2,653
Depth 4	1,566	1,603	1,672
Depth 5	0,542	0,579	0,648

Depth sensor	Type 1 (DI801 (TD diver), red) (in m)	Type 2 (DI701/ DI702, yellow) (in m)	Type 3 (DI601, green) (in m)
	Depth - 13 cm	Depth - 9,3 cm	Depth -2,4 cm
Depth 1	3,707	3,744	3,813
Depth 2	2,707	2,744	2,813
Depth 3	1,707	1,744	1,813
Depth 4	0,707	0,744	0,813

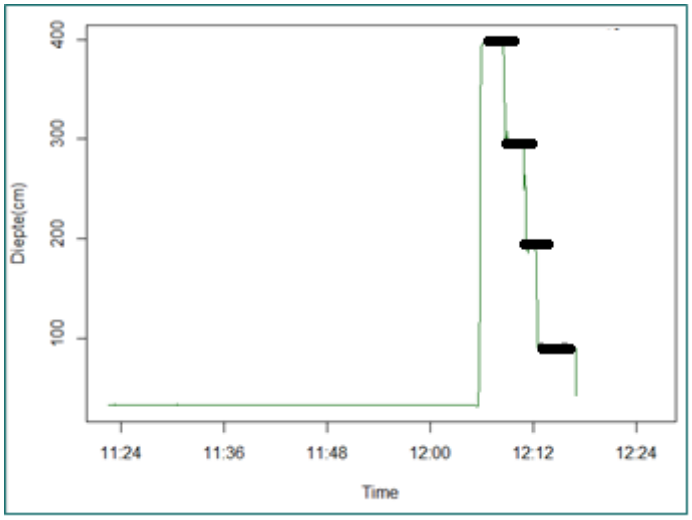
1.2.2 Data processing

The data is downloaded using the dedicated software package Diver Office and an optical communication device. The data of the divers is compensated for barometric pressure (Diver Office) using the “Barodivers” data. De application-related MON data files are saved for further processing.

The compensated MON data files are read into the open source package R-studio and visualised. The 4 measured reference levels are filled in the R-script (Figure 4). Zooming in at the region (time period) of the calibration period is needed to visualize the calibration levels. In the graph, the data processor needs to click on the 4 levels in the same order that the levels are filled in (Figure 4). After clicking, the calibration graphs are directly exported as pdf-file together with the linear relation formula: *corrected level=a*measured level + b*. A list of every calibration, before and after the measurement campaign is given in Table 3. It is clear that each diver is drifting during the measurement campaign period.

Figure 4 – Above: level values given in in the R-script. Below: measured Diver levels to click on.

```
39
40  alledіepte<-t(t(rep(NA,5)))
41  colname<-c("Depth")
42
43  #-------------------------------------
44  #hier de gemeten hoogte ingeven in cm
45  gemetenhoogte<-c(61,161,261,363,0)
46  alledіepte[,1]<-gemetenhoogte
47  #-------------------------------------
48
49  for (file in file_list)
50  {
51    colname<- c(colname,file)
52  }
53
```



1.3 Results

Table 3 – List of the calibrations, before and after the measurement campaign. Drift calculation at level 0m and 10m.

Diver	Calib before a	Calib before b	Calib after a	Calib after b	depth before (cm) 0	depth before (cm) 1000	depth after (cm) 0	depth after (cm) 1000	drift @ 0m (cm) 0	drift @ 10m (cm) 1000
zw_str05a_bc993	0,996	-5,353	0,991	-4,653	-5	991	-5	986	0	5
zw_str04b_bc998	1,001	0,518	0,995	0,376	1	1002	0	995	1	7
zw_str06b_bd164	1,004	0,364	0,991	2,916	0	1004	3	994	-3	10
zw_str01b_bd076	0,995	2,867	0,994	1,73	3	998	2	996	1	2
zw_str05b_bd012	0,99	3,435	0,995	2,351	3	993	2	997	1	-4
zw_str06a_bd003	0,998	1,256	0,994	2,421	1	999	2	996	-1	3
zw_str02a_bd078	0,994	3,24	0,995	1,037	3	997	1	996	2	1
zw_str04a_bc992	0,995	2,961	0,992	1,731	3	998	2	994	1	4
zw_str02b_bd002	1,002	0,005	0,992	1,165	0	1002	1	993	-1	9
zw_str01a_u8213	0,999	-0,633	0,992	0,283	-1	998	0	992	-1	6
OC_R02AMB_H6154	0,999	-1,013	0,992	0,612	-1	998	1	993	-2	5
bh_str01_rb_u1636	0,996	0,426	0,998	0,738	0	996	1	999	-1	-3
bh_str01_rb_u1636	0,997	7,385	0,989	9,737	7	1004	10	999	-3	5
bh_str01_ra_f5450	0,996	8,532	0,494	269,187	9	1005	269	763	-260	242
AC_STR01_LB_A4243	0,989	1,94	0,989	-5,145	2	991	-5	984	7	7
BN_STR01B_B2876	0,996	-4,419	0,991	-2,96	-4	992	-3	988	-1	4
AC_STR01_RB_A4255	0,994	-3,133	0,989	-1,73	-3	991	-2	987	-1	4
BN_STR02A_B2895	0,996	4,284	0,994	5,917	4	1000	6	1000	-2	0
BN_STR01A_B2948	0,998	-5,049	0,991	-3,252	-5	993	-3	988	-2	5
AC_STR01_LA_A3283	0,992	-3,331	0,988	-2,287	-3	989	-2	986	-1	3
AC_STR01_RA_A3208	0,99	-1,573	0,987	-0,346	-2	988	0	987	-2	1
JC_STR02_MA_A3278	0,991	-0,334	0,991	-3,772	0	991	-4	987	4	4
JC_STR02_RB_D6398	0,993	4,485	0,992	4,884	4	997	5	997	-1	0
JC_STR02_RA_A3267	0,996	-3,257	0,994	-3,4	-3	993	-3	991	0	2
BN_STR02B_A4252	0,994	-3,419	0,991	-1,778	-3	991	-2	989	-1	2
JC_STR02_MB_A4251	0,997	3,861	0,99	7,092	4	1001	7	997	-3	4
JC_STR02_LA_A3275	0,99	-1,4	0,993	-1,936	-1	989	-2	991	1	-2
JC_STR02_LB_A3266	0,992	-1,071	0,99	-0,956	-1	991	-1	989	0	2
ME_STR01A_B2899	0,995	13,769	0,989	15,22	14	1009	15	1004	-1	5
MC_STR01B_U5431	0,995	-1,37	0,991	-0,491	-1	994	0	991	-1	3
MC_STR01A_B2884	0,993	-7,353	0,994	-8,522	-7	986	-9	985	2	1
ME_STR01B_U5435	0,995	-2,114	0,991	-0,293	-2	993	0	991	-2	2
OC_STR02B_U5444	1,003	-4,492	0,993	-0,951	-4	999	-1	992	-3	7
VC_STR01B_U5430	0,991	0,094	0,992	-0,049	0	991	0	992	0	-1
OC_R02AVA_B2905	0,997	-2,082	0,993	-0,796	-2	995	-1	992	-1	3
OC_STR02A_B2955	0,994	-0,374	0,991	0,631	0	994	1	992	-1	2
OC_R02AMB_H6154	0,998	6,023	0,993	7,538	6	1004	8	1001	-2	3
OC_R02AVB_B2870	0,997	7,442	0,992	7,868	7	1004	8	1000	-1	4
OC_STR03B_B2881	1	-5,331	0,992	-2,142	-5	995	-2	990	-3	5
OC_STR03A_B2946	1,001	10,468	0,998	11,477	10	1011	11	1009	-1	2
VC_STR01A_B2891	0,992	-2,582	0,989	-1,369	-3	989	-1	988	-2	1
OC_R02AMA_B2885	0,995	-2,91	0,997	-3,544	-3	992	-4	993	1	-1

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