RAPPORT

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Calibration Factor for salt gaugings: Analysis of NVE's database

K-verdi for vannføringsmålinger der vannføringen er målt vha. saltfortynningsmetoden: Analyse av data i filarkivet

Alexandre Christophe Hauet

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K-verdi for vannføringsmålinger der vannføringen er målt vha. saltfortynningsmetoden: Analyse av data i filarkivet

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Sammendrag:

Denne rapporten beskriver fordelingen av k-verdier for alle for vannføringsmålinger i filarkivet der vannføringen er målt vha. saltfortynningsmetoden og Sommer TQtrace. 90% av målingene har k-verdi mellom 0,452 og 0,486. Median- og gjennomsnittsverdien er 0,469. I og med at 90% av målingene har en k-verdi som ikke avviker mer enn knappe 4% fra snittet vil det være 90% sjanse for at en vannføringsmåling der vi ikke kalibrerer, men bruker k-verdien 0,469 vil bli mindre enn 4% feil. Det er en svak tendens til at økende bakgrunnsledningsevne gir høyere k-verdi. Der er forskjeller mellom saltsensorene, men den er ikke statistisk relevant.

This report describes the distribution of CF-values for all for water flow measurements in NVE's file archive where the discharge has been measured using the salt dilution method and Summer TQtrace. 90% of the measurements have a CF-value between 0.452 and 0.486. The median and average value is 0.469. Since 90% of the measurements have a CF-value that does not deviate more than barely 4% from the average, there will be a 90% chance that a water flow measurement where we do not calibrate, but use the CF-value 0.469 will be less than 4% wrong. There is a slight tendency for increasing background conductivity to give a higher CF-value. There are differences between the conductivity sensors, but it is not statistically relevant.

Emneord:

Vannføring, vannføringsmåling, salt, fortynning, saltfortynning, saltmåling, nøyaktighet, usikkerhet, usikkerhetsberegning, måleusikkerhet, feilkilder, GUM, HUG, kvalitet, K-verdi, korrelasjonsverdi, CF

Discharge, discharge measurement, salt, dilution, salt dilution, salt measurement, accuracy, uncertainty, uncertainty calculation, measurement uncertainty, error sources, GUM, HUG, quality, K-value, correlation value, CF

Norges vassdrags- og energidirektorat

Middelthuns gate 29 Postboks 5091

Majorstuen 0301 Oslo

Telefon: 22 95 95 95

E-post: nve@nve.no Internett:

www.nve.no måned, år

Forord

Denne rapporten er en av flere rapporter om usikkerhet i vannføringsmålinger skrevet av Alexandre Christophe Hauet, PhD, for hydrometriseksjonen på NVE. Hydrometri - Teknikk og feltdrift HHT, Hydrologisk avdeling, NVE.

Hauet jobbet i ett år for HHT, NVE, fra august 2019 til august 2020, finansiert av FoU-midler i prosjektet 80501 «Nye metoder for måling av vannføring og sedimenttransport». Usikkerhetsberegning var en viktig del av dette prosjektet.

Hege Hisdal

avdelingsdirektør

Morten Nordahl Due

seksjonssjef

Norges vassdrags- og energidirektorat

Report

Calibration Factor for salt gaugings - Analysis of NVE's database -

Alexandre HAUET

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1 Introduction

In that study, we analyse the different values of Calibration Factors (CF) that are computed at NVE when making discharge measurement using salt dilution. The statistics of the values of CF, and the relationship between CF and the base conductivity are detailed.

2 Database and cleaning

The salt gaugings used in this study were extracted from the NVE's discharge measurements folder[1]. The xml files exported by Sommer's TQ-Commander software were used. Only the gaugings realized with two probes were selected, which consists in about 1300 measurements. A quick overview of the gauging was realized, in order to remove erroneous measurements (abnormal signals, as illustrated in figure 1). There are probably still some abnormal signals in the database (the 1300 measurements have not been checked individually), and there are probably few duplicate measurements, but we assume that their number is negligible and that it does not affect the overall statistics on the database.

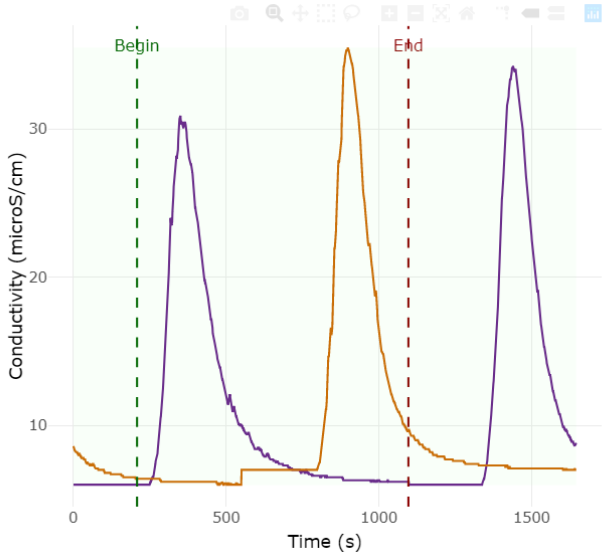

Figure 1: Example of measurement with abnormal signal, removed from the database

The final cleaned database consists in 1285 gaugings, ranging from $1L/s$ to $211m^3/s$, with a mean and median discharges of $7{,}65m^3/s$ and $1,28m^3/s$ respectively.

[1] //nve.no/fil/h/HH/Vannføringsmålinger

3 Calibration Factor analysis

3.1 Computation of the Calibration Factors

The calibration factor (CF) is the slope of the linear regression between the conductivity measured (in $\mu S/cm$) and the concentration (in mg/L) of addings of the calibration solution in a tank of river water, used for the calibration of the conductivity probes. Each gauging is realized using two probes calibrated separately, so the database includes 2600 calibration factor values. With the TQ-Tracer sensors, the conductivity is compensated at 25° and using a NFL compensation of temperature. CF were computed using the so-called "3 parameters methods" with TQ-Commander software, taking into account the use of distilled water for the calibration solution.

3.2 Global statistics

As illustrated in figure 2, the median value of CF is 0.469, with a low dispersion as 95% of the values ranges 0.448 to 0.489 (± 4%).

Table 1 shows statistics of the distribution of the values of CF.

Statistic	Mean	5%	25%	50%	75%	95%
CF	0,469	0,452	0,463	0,469	0,474	0,486

Table 1: Statistics of the CF for the gaugings used in that study

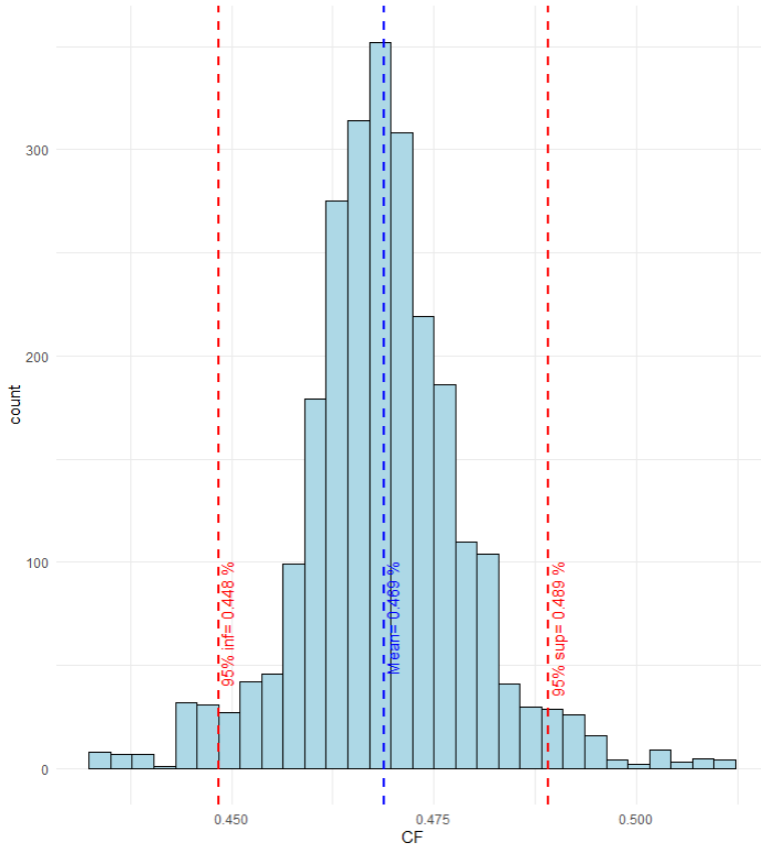

Figure 2: Distribution of the calibration factors for 2600 calibrations in NVE's database

3.3 Link between CF and the base conductivity of the water

Figure 3 shows the relationship between the values of CF and the base conductivity of the water of the gauged stream. There is a slight trend for CF to increase when the base

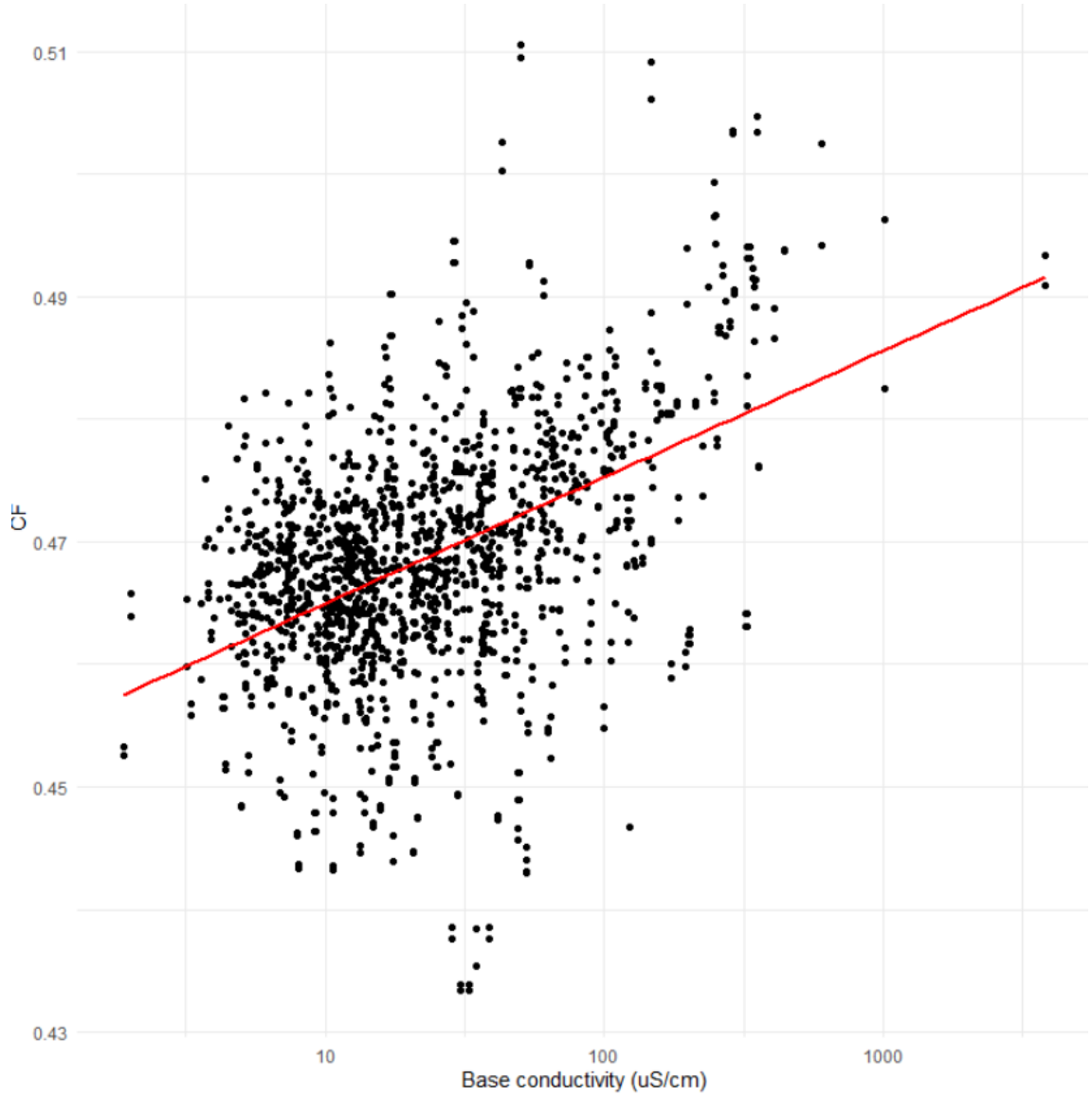

Figure 3: Relationship between the value of CF and the base conductivity of the stream water. The red line is the linear regression.

conductivity increases, as illustrated by the logarithmic regression in red in figure 3. This trend is not very pronounced. Table 2 shows the values of the mean of CF for different

ranges of base conductivity, ranging 0,466 for very low conductivity water ($< 20 \mu S/cm$) up to 0,493 for high conductivity water ($> 500\ \mu S/cm$).

Range of base conductivity ($\mu S/cm$	< 20	20 - 50	50 - 100	100 - 500	> 500
mean CF	0,466	0,468	0,473	0,481	0,493

Table 2: Average values of CF for different ranges of base conductivity

It is important to note that most of the measurements in the database have a low base conductivity. The median value of the base conductivity is only 20 $\mu S/cm$, and 95% of the calibrations have a base conductivity lower than 160 $\mu S/cm$. Only 12 calibrations have a base conductivity greater than 500 $\mu S/cm$, and 4 measurement have really high base conductivity, greater than 1000 $\mu S/cm$.

3.4 Link between CF and the conductivity probe used

Figure 4 illustrates the distribution of the values of CF for each conductivity probes used, ranked by mean values. Even if some difference can be noted for the mean values of each sensor, it is not statistically relevant considering the dispersion (the 90% confidence intervals overlap for all the sensors with more than 2 calibrations) and considering the fact that the sensors were not used for the same gaugings.

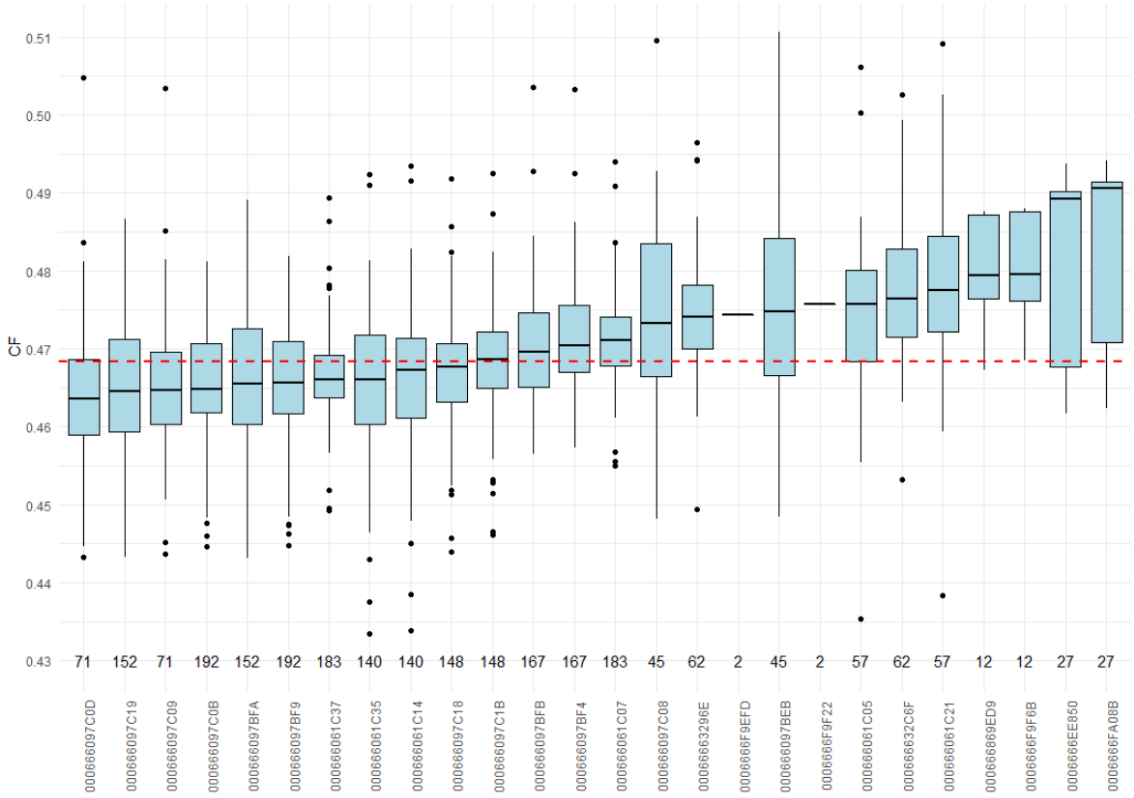

Figure 4: Relationship between the value of CF and the sensor used. Blue boxes represent the 50%. The lower and upper hinges correspond to the first and third quartiles (the 25% and 75% percentiles). The upper and lower whiskers correspond to the 5% end 95% percentiles. The red dashed line is the median of all the CF values.

4 Conclusions

In this report, we analyse the Calibration Factors (CF) computed for all the salt dilution gaugings stored in NVE's database. It consists in about 2600 calibrations.

The median value of CF is 0,469, with a low dispersion as 90% of the values ranges 0.452 to 0.486 ($\pm$ 4%). In other words, if a salt gauging is realised without calibrating the probes, there is 90% of chance to have an error of $\pm$ 4% on CF.

The value of CF increases slightly with the base conductivity of the water, from an averaged value of 0,466 for very low conductivity water ($< 20\ \mu S/cm$) up to 0,493 for high conductivity water ($> 500\ \mu S/cm$). All the conductivity probes show the same behavior.

NVE

Norges vassdrags- og energidirektorat

MIDDELTHUNS GATE 29
POSTBOKS 5091 MAJORSTUEN
0301 OSLO
TELEFON: (+47) 22 95 95 95

www.nve.no