11th Seminar for Homogenization and Quality Control in Climatological Databases and 6th Interpolation Conference jointly organized with the 14th EUMETNET Data Management Workshop

Correction of processed historical data collected by siphoned rainfall recorders

Tibor Rácz PhD

Photo: Dr. Alfred Müller Catalogue

Importance of the issue

IDF curves - the most important data for drainage engineers for 150 years.

Climate change topic: the older IDF curves are no longer valid.

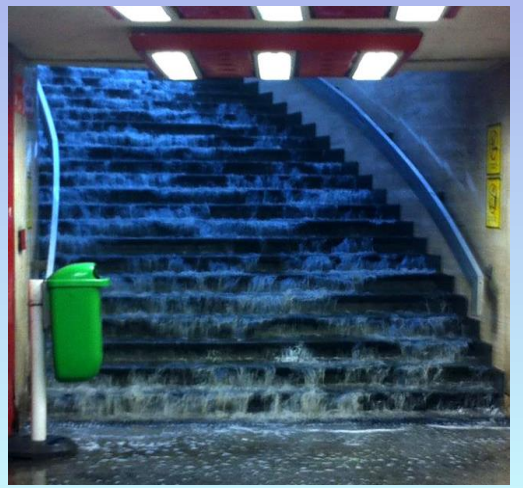
A claim: short-term rains are more intense than before.

But compared to what? By how much?

What exact data were previously used for IDF curves?

What inaccuracies are found in historical rainfall intensity data?

What is the actual capacity of drainage systems built in the past?



One of the sources of the bias: the systematic errors of rainfall gauges.

For collecting sub-daily rainfall data, the siphoned rainfall recorders were used to the 1990s.

The siphoned rainfall recorders

Main characteristics of the siphoned rainfall recorders

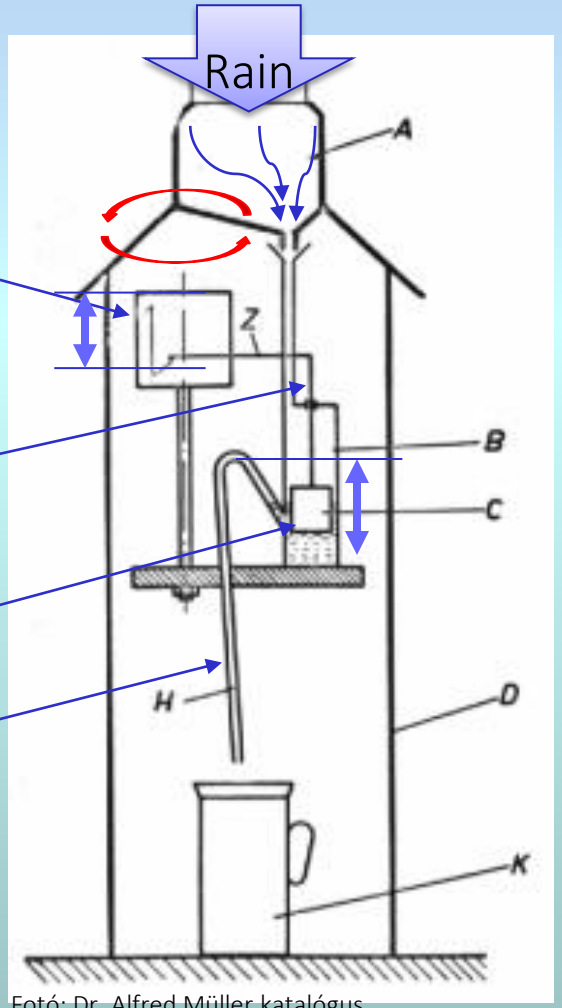
- **Direct measurement;** the collected water's volume is going to be measured
- **Analogous** water level recording
- **Intervals of measurement** during siphoning

Uniformly rotating registration drum with registration tape

Writing mechanism moved by rod transmission

Tank with a float

Siphoned emptying tube



Fotó: Dr. Alfred Müller katalógus

Specific systematic error of siphoned rainfall recorders

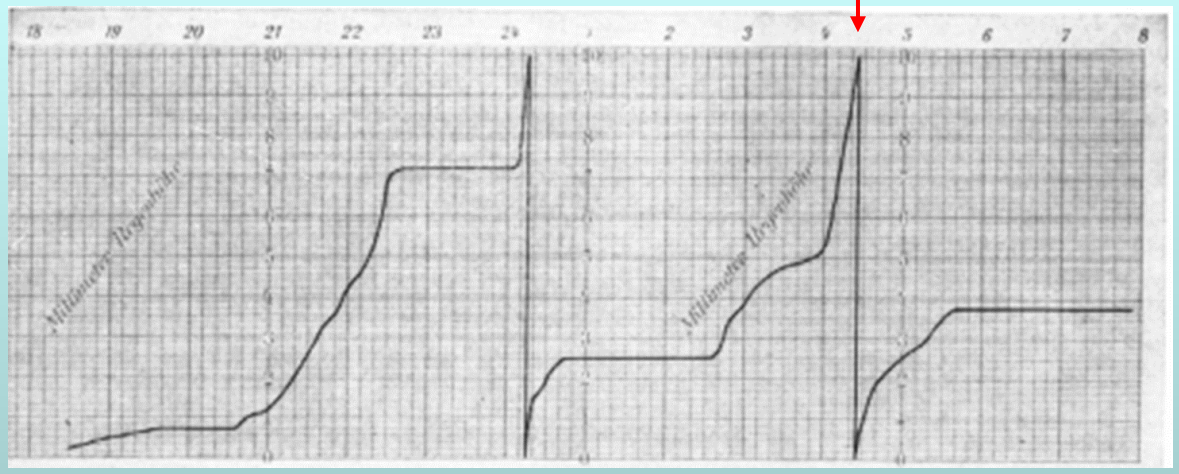
Undermeasurement during siphonage

Reason: The emptying of the device takes time (10-30 s);
During the siphoning the rainfall recording is pending

But: The time of siphonage depends on the actual rainfall intensity

Correction: method of Luyckx and Berlamont, in the possession of registration tape

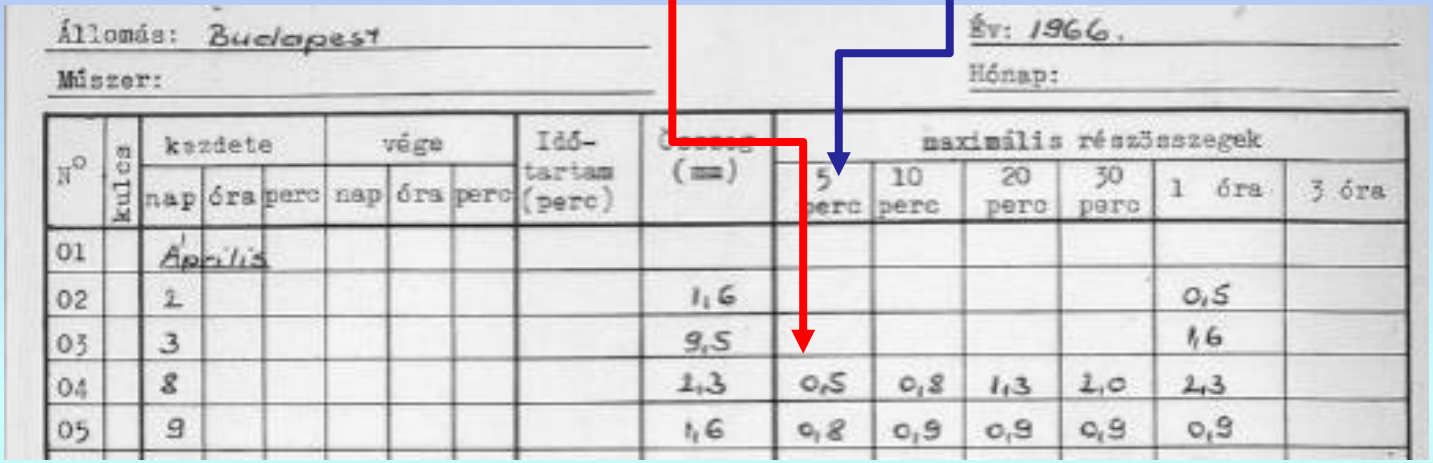
LUYCKX G., BERLAMONT J. (2002): Accuracy of siphoning rain gauges. In: Global Solutions for Urban Drainage. 2002. p. 1-12. https://doi.org/10.1061/40644(2002)251



BUT HOW TO FIX THE DATA, WHEN TAPE IS NOT AVAILABLE?

Correction of processed data of siphoned recorders

Processed data: The highest sums (intensities) of a class of duration were collected during the processing of data



Állomás: Budapest
Év: 1966.
Műszer:
Hónap:

N°	kulcs	kezdete nap	kezdete óra	kezdete perc	vége nap	vége óra	vége perc	Idő-tartam (perc)	(mm)	maximális részösszegek 5 perc	10 perc	20 perc	30 perc	1 óra	3 óra
01		Április													
02		2							1,6					0,5	
03		3							9,5					1,6	
04		8							1,3	0,5	0,8	1,3	1,0	2,3	
05		9							1,6	0,8	0,9	0,9	0,9	0,9	

Correction: modified method of Luyckx and Berlamont

$$i_{corr} = \frac{\left(t + int\left(\frac{h_0 + t \cdot i_t}{h_s}\right)\left(\frac{t_{s,0}}{1 - \frac{A_f \cdot i_t}{q_s}}\right)\right)}{t} \cdot i_t$$

- i_t Measured t minute intensity
- i_{corr} Adjusted t minute intensity
- t Duration
- $t_{s,0}$ Siphonage time (no rain supply)
- h_o Initial water level
- h_s Measurable rain depth of the tape
- A_f Surface of collecting area
- q_s Drainage discharge of the device

An example: Correction of processed data of Hellmann-Fuess recorder

Parameters of the device:

h_s measurement capacity, width of the tape 10 mm

A_f collection area of the device 20000 mm^2

q_s drainage discharge of the device 12500 mm^3/s

$t_{s,0}$ siphonage time (no rain supply) 18 s

$$i_{corr} = \frac{\left(t + int\left(\frac{5 + t \cdot i_t/3600}{10}\right)\left(\frac{18}{1 - \frac{20000 \cdot i_t/3600}{12500}}\right)\right)}{t} \cdot i_t$$

Initial water level issue:

The initial water level in the measurement tank is a random variable

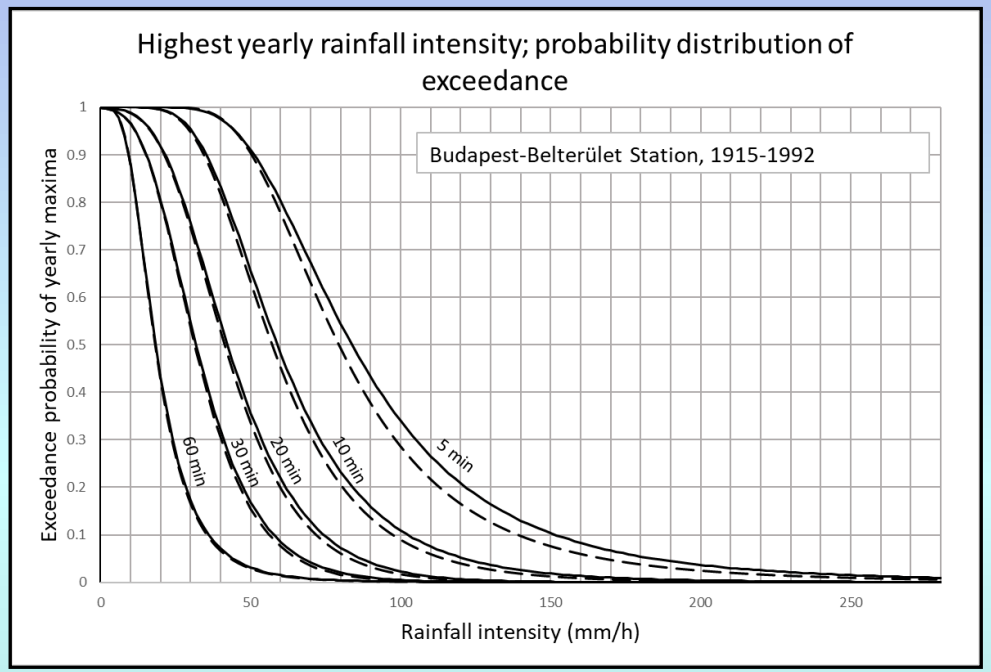
The water level is somewhere between 0-10 mm, randomly.

h_o **can be estimated** as expected value of a **uniform distribution**

($E=h_s/2=$**5 mm**)

Effect of correction on the rainfall's PDF and IDF data

General Extreme Value PDF curves on raw and adjusted data



Highest corrections:
in the range of shorter duration than 30 min.

Data: Hungarian Meteorological Service

Percentual differences between raw and adjusted IDF data

Adjusted data / Raw data, %						
Average recurrency (years)	Exceedance Probability (%)	5 min	10 min	20 min	30 min	60 min
1	99	-2,3	3,7	0,0	1,9	0,0
2	50	**5,4**	3,0	2,2	1,3	1,1
10	10	**9,0**	**5,1**	3,6	2,7	1,7
50	2	**11,1**	**7,4**	**4,9**	3,9	2,4
100	1	**11,9**	**8,6**	**5,4**	**4,3**	2,7

Significant corrections:
over 10 ys recurrency

Further research direction

A further aim of the research is the collection of relevant technical data of the widely used siphoned rainfall recorders.

I welcome any data, so please if you know

- The type of the ever used SRW at your National Met Service
- The technical description of these devices,

do not hesitate to send me, and I am open to collaboration in this field.

Racz Tibor
raczt167@gmail.com

Summary and Conclusion

- Correction of systematic errors is possible for the extracted data on a statistical basis.
- The magnitude of the correction on short durations and rare intensities is higher than 5%.
- The effect of the correction is significant.

The improvement may affect the evaluation of climate change by refining the precipitation intensity reference data.

The repair will allow a reassessment of the suitability of existing drainage facilities.

Published research papers about the method:

https://www.researchgate.net/publication/354586738_On_the_correction_of_processed_historical_rainfall_data_of_siphoned_rainfall_recorders

https://www.researchgate.net/publication/351917435_Application_of_Correction_Procedures_for_Some_Systematic_Measurement_Errors_to_Rainfall_Intensity_Data_of_a_Rain_Gauge_in_Budapest

THANK YOU FOR YOUR KIND ATTENTION!