Department of Irrigation and Landscape Engineering Faculty of Civil Engineering Czech Technical University in Prague

Particles and aggregates size distribution of soil transported due to rainsplash, surface runoff and rill erosion

STRIX CHOMUTOV

Romana Kubínová [1], Petr Kavka [1], Tomáš Laburda [1], Martin Neumann [1], David Zumr [1], Ondřej Marek [2]   1) Faculty of Civil Engineering, CTU in Prague, Czech Republic   romana.kubinova@fsv.cvut.cz   2) Strix Chomutov a. s.   strix@strixchomutov.cz

Introduction

- Soil erosion by water is commonly mentioned worldwide environmental problem.
- During a rainfall, soil surface is disturbed by rain drops and surface runoff, the soil particles get mobilized and washed out of the surface.
- Grain size distribution of the eroded soil sediment gives us information about erosion proces and formation of the rills.

Methodology

The grain size distributions of the soil sediment obtained from runoff during raining by rainfall simulator were determined.

A. Three methods for grain size distribution measurement were compared:
I. Hydrometer (+sieving method)
II. PARIO device (+sieving method)
III. Laser diffractometer Mastersizer 3000

B. By the comparison of the grain size distribution curves determined by laser diffractometer, the influence of external factors were investigated.
I. sampling time from the surface runoff
II. slope of experimental plot
III. presence of anti-erosion geotextile

Instruments

Experimental field
- Nozzle type rainfall simulator
- Rainfall intensity 60mm/h
- The sediment transported due to the runoff was collected from the discharge
- Slopes of soil erosion plots: 22°, 30°, 34°
- Slope length 8 m
- Samples were collected in 15, 30, 60 and 75 minutes from the beginning of the rain. The rain was paused in time 30-45 minutes from the beginning of the experiment .
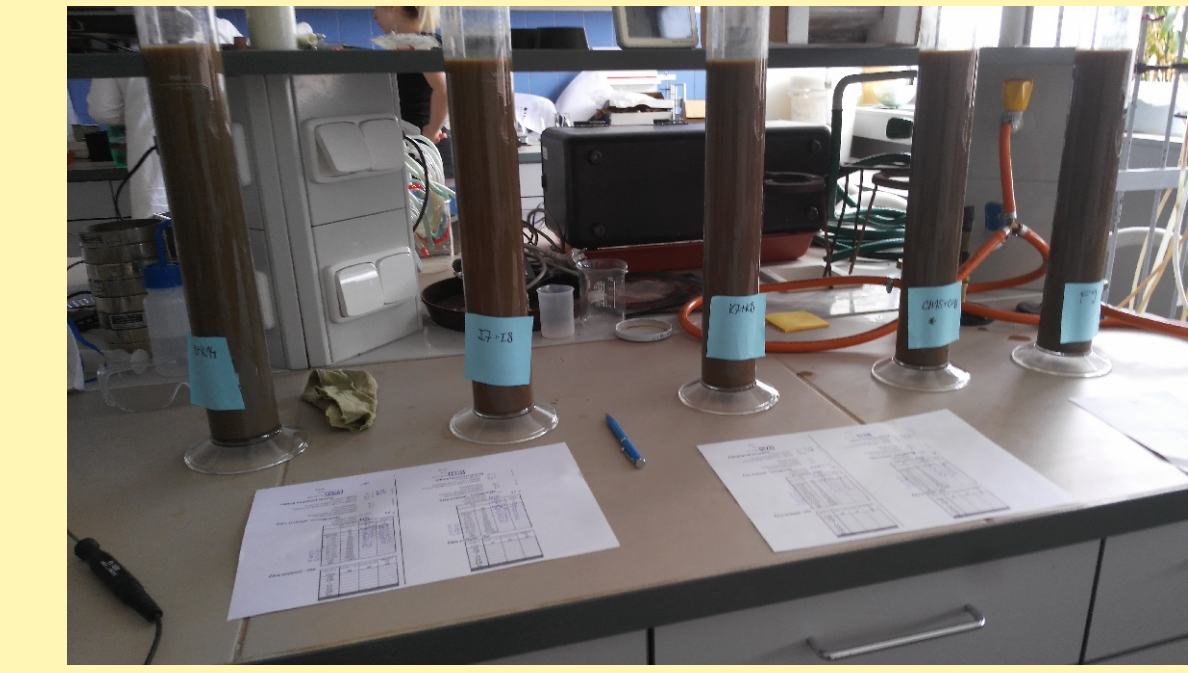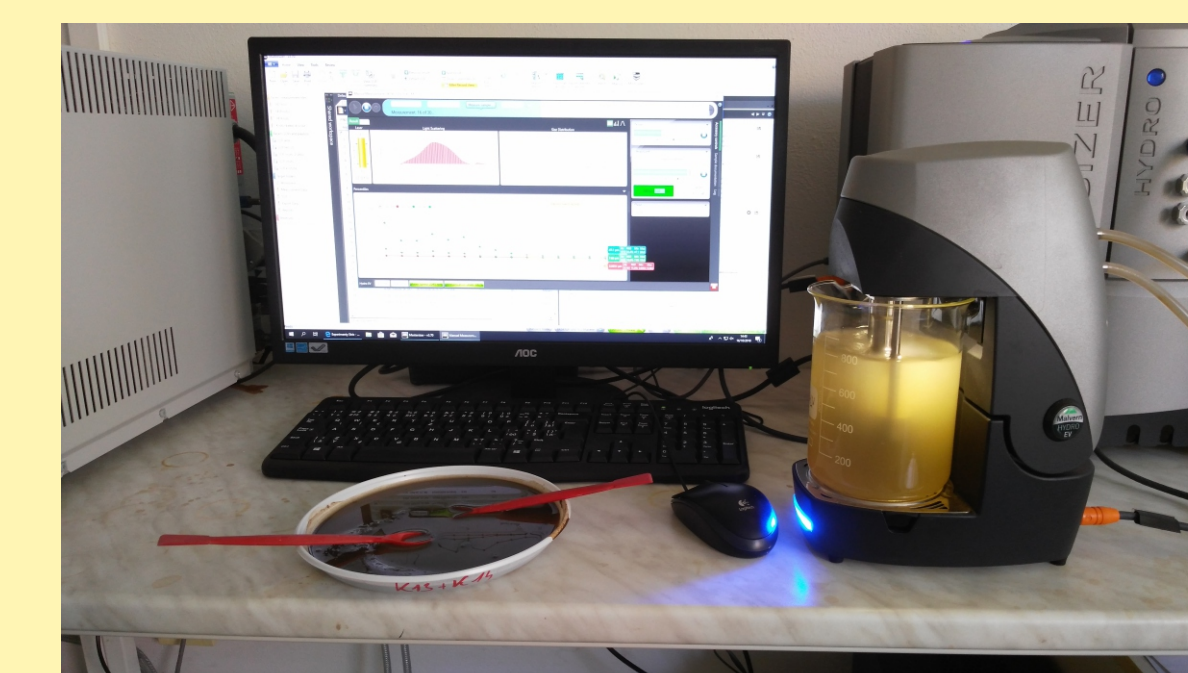

Hydrometer
- Based on Stokes law
- Necessary to destroy soil aggregates by sodium hexametaphosphate before measurement
- Measurement time: 48 hours/sample

PARIO Device
- Automated system
- Based on Stokes law
- Necessary to destroy soil aggregates by sodium hexametaphosphate before measurement
- Measurement time: 8 hours/sample

Laser diffractometer - Mastersizer 3000
- Based on laser difraction
- Allows evaluation samples containing soil aggregates and also samples without soil aggregates
- Aggregates are destroyed during the measurement by ultrasound
- Measurement time: 15 minutes/sample

Results

A. Comparison of three tested methods

| Amount of particles smaller than 10 µm	Laser Diffractometer	Hydrometer	PARIO Device
Sample 1	56%	51%	29%
Sample 2	42%	53%	32%
Sample 3	42%	53%	41%
Sample 4	50%	56%	34%
Sample 5	59%	57%	57%
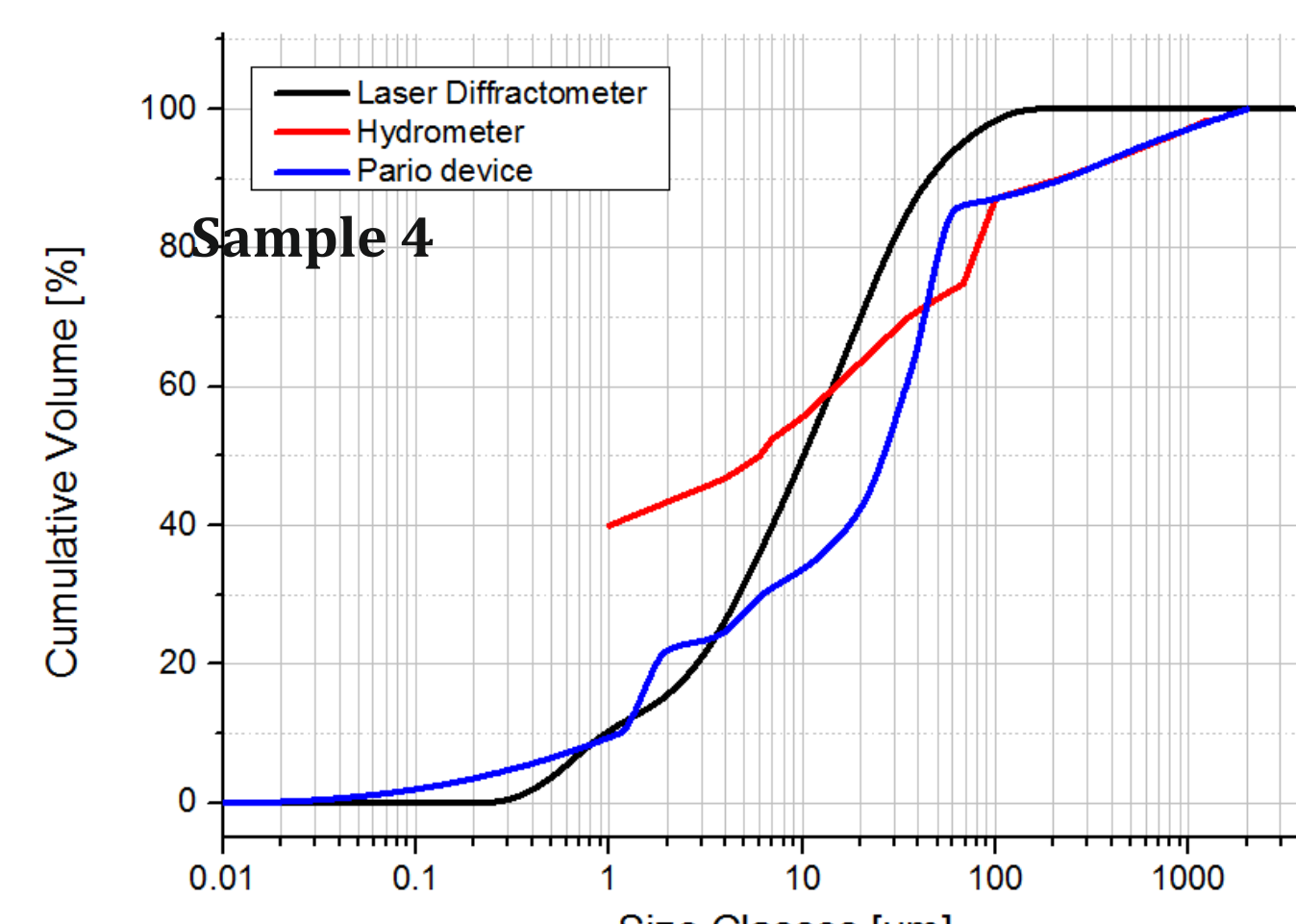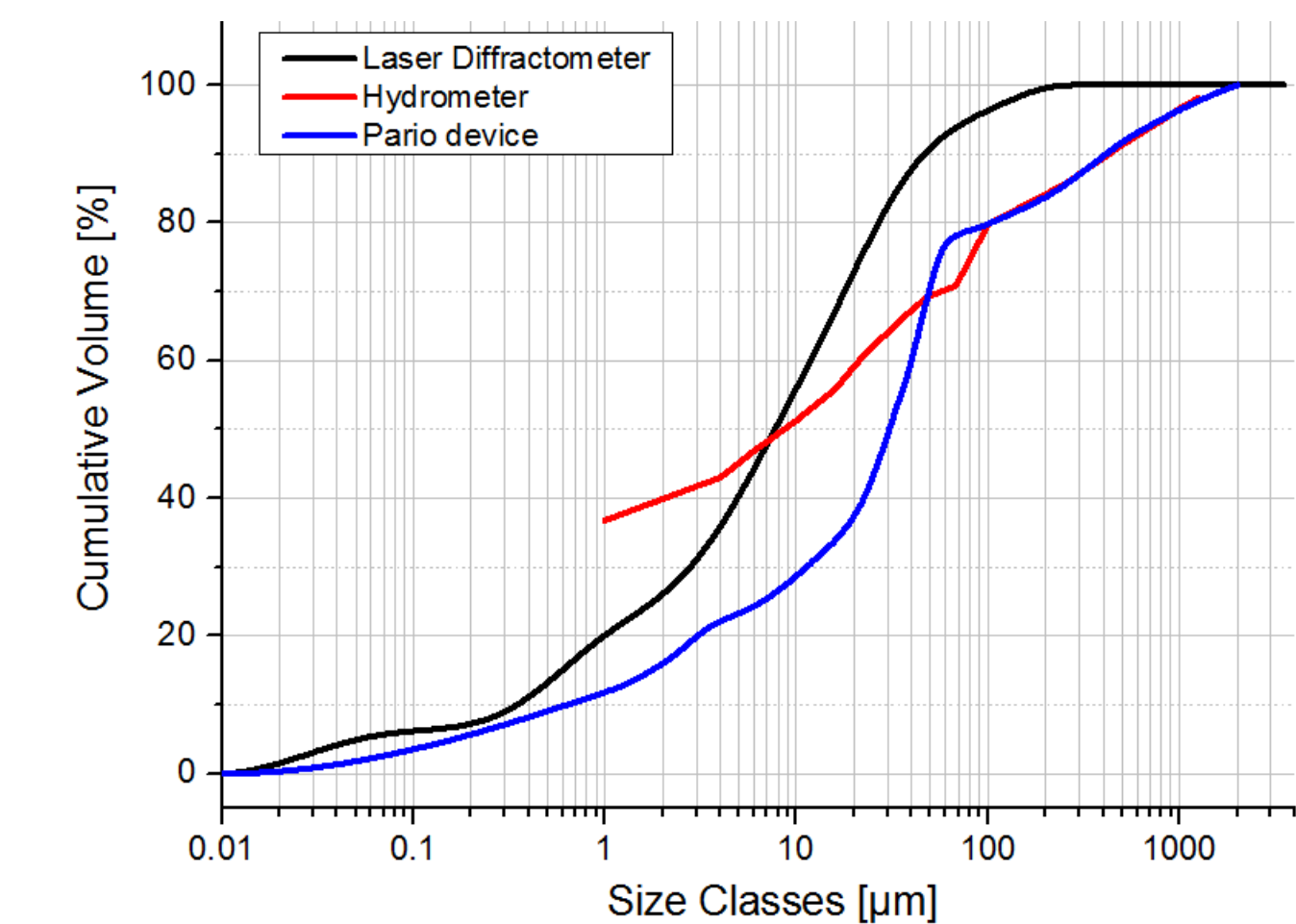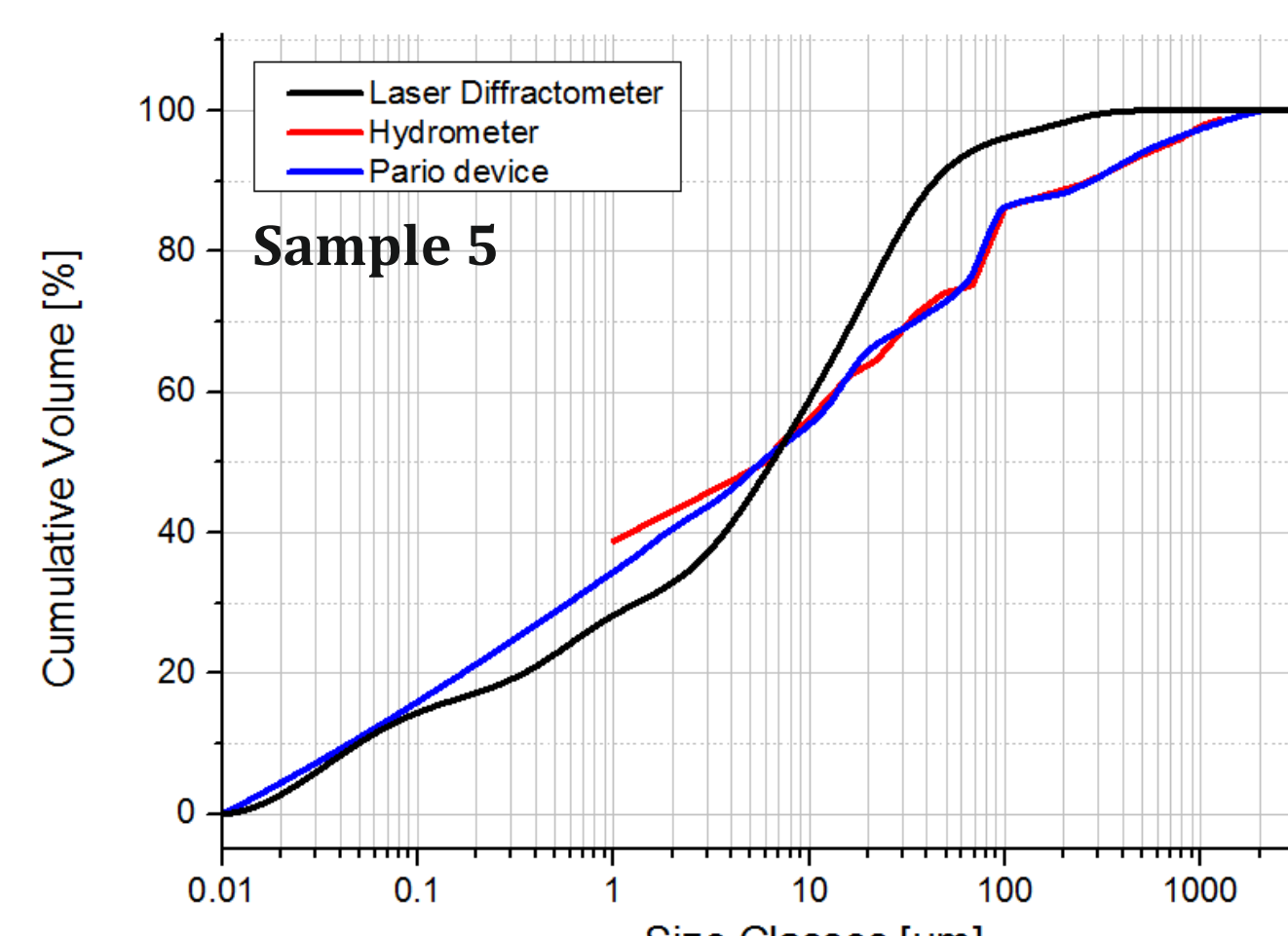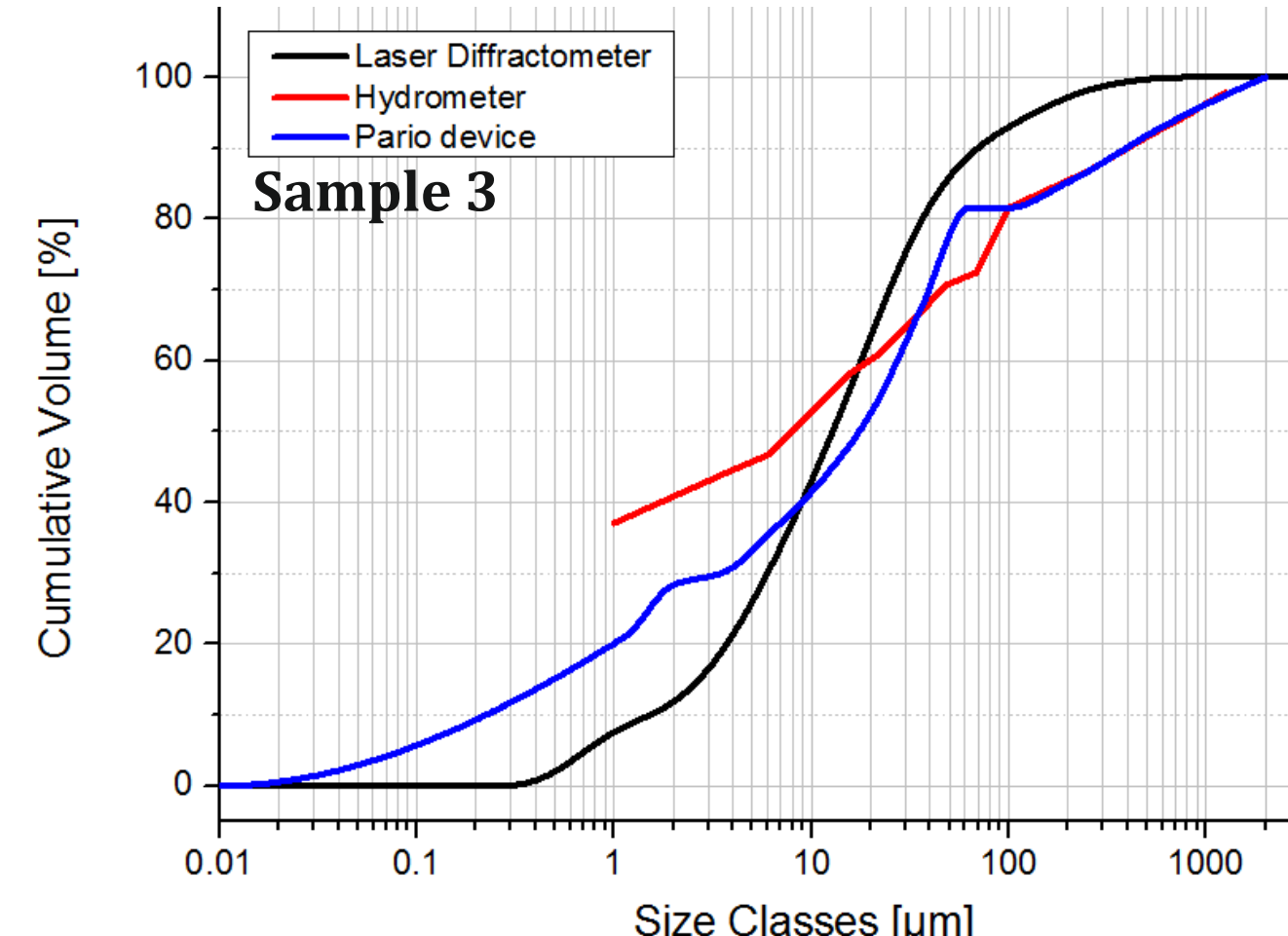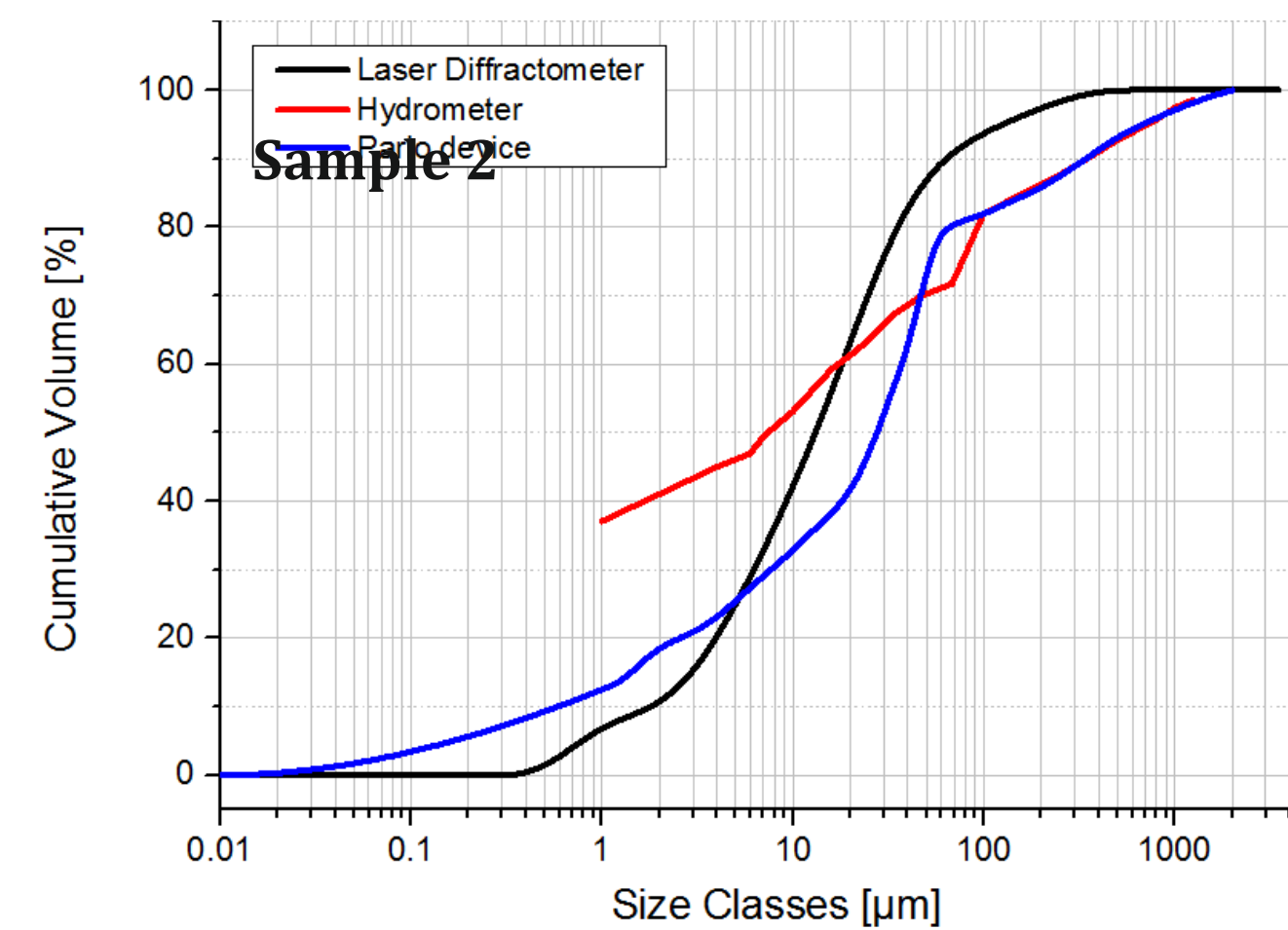
*Novák classification system use to classify soil type amount of particles smaller than 10 µm

B. Comparison of the grain size distribution determined by laser diffractometer influenced by external factors
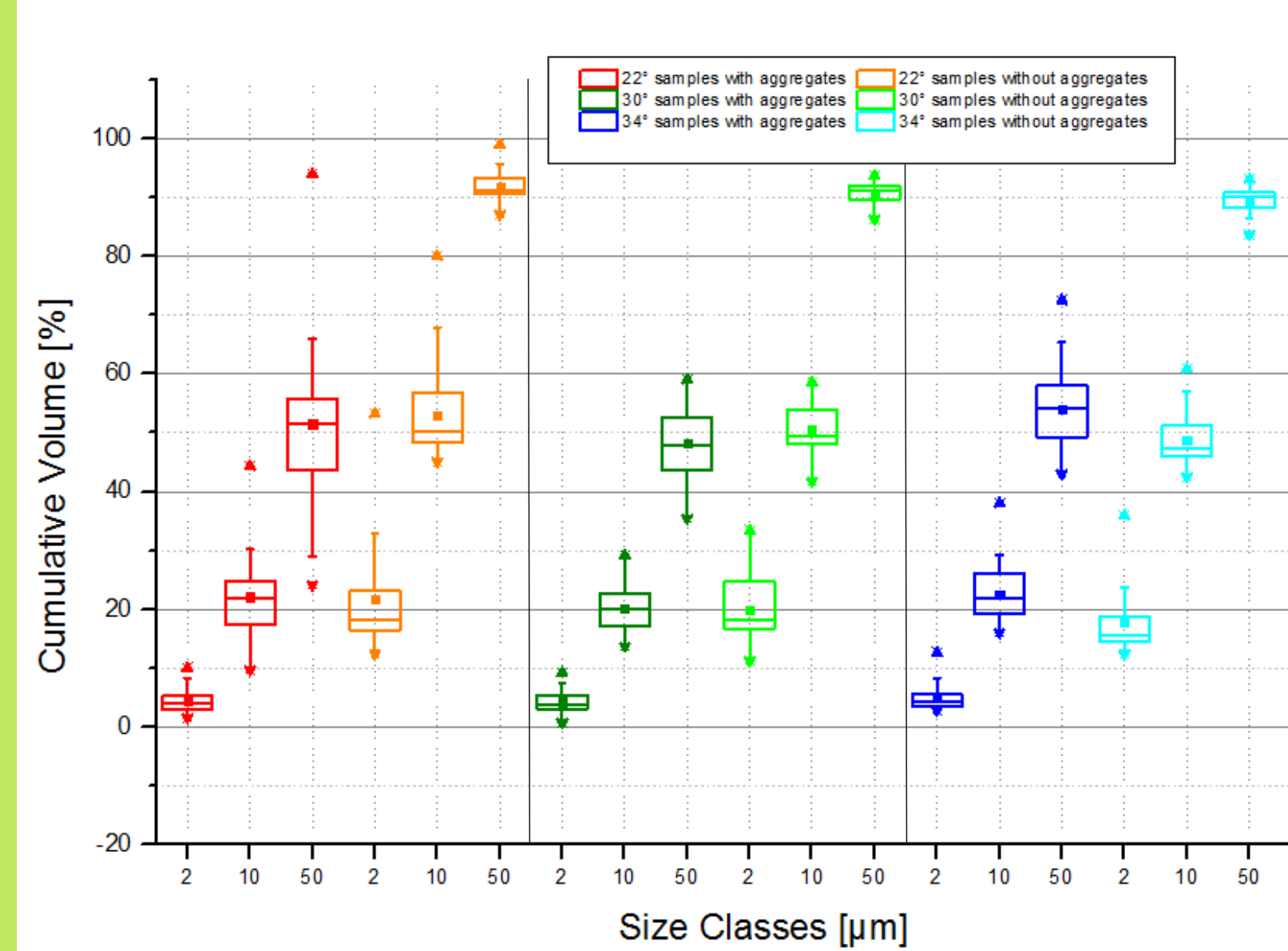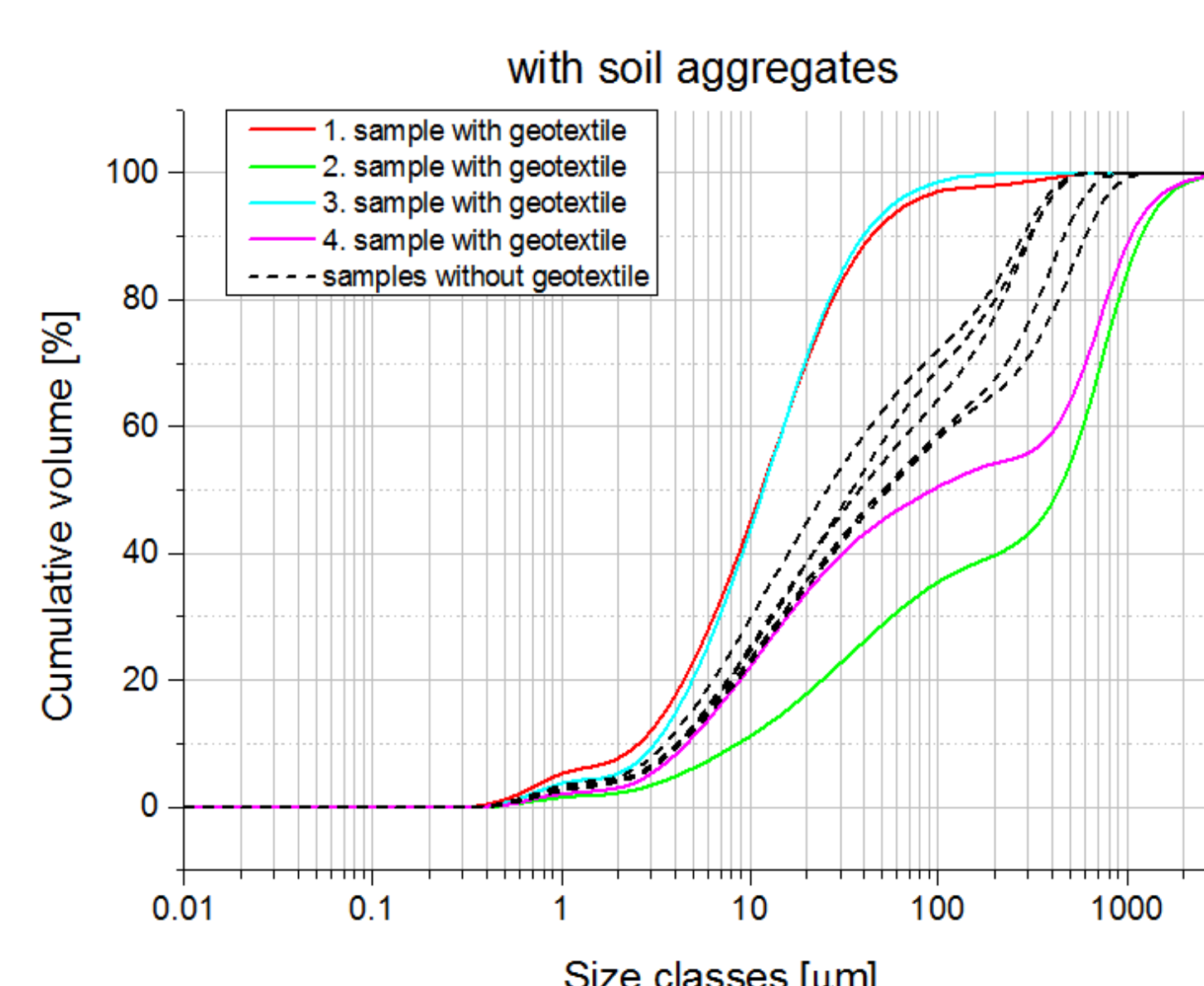
I. Sampling time from the surface runoff
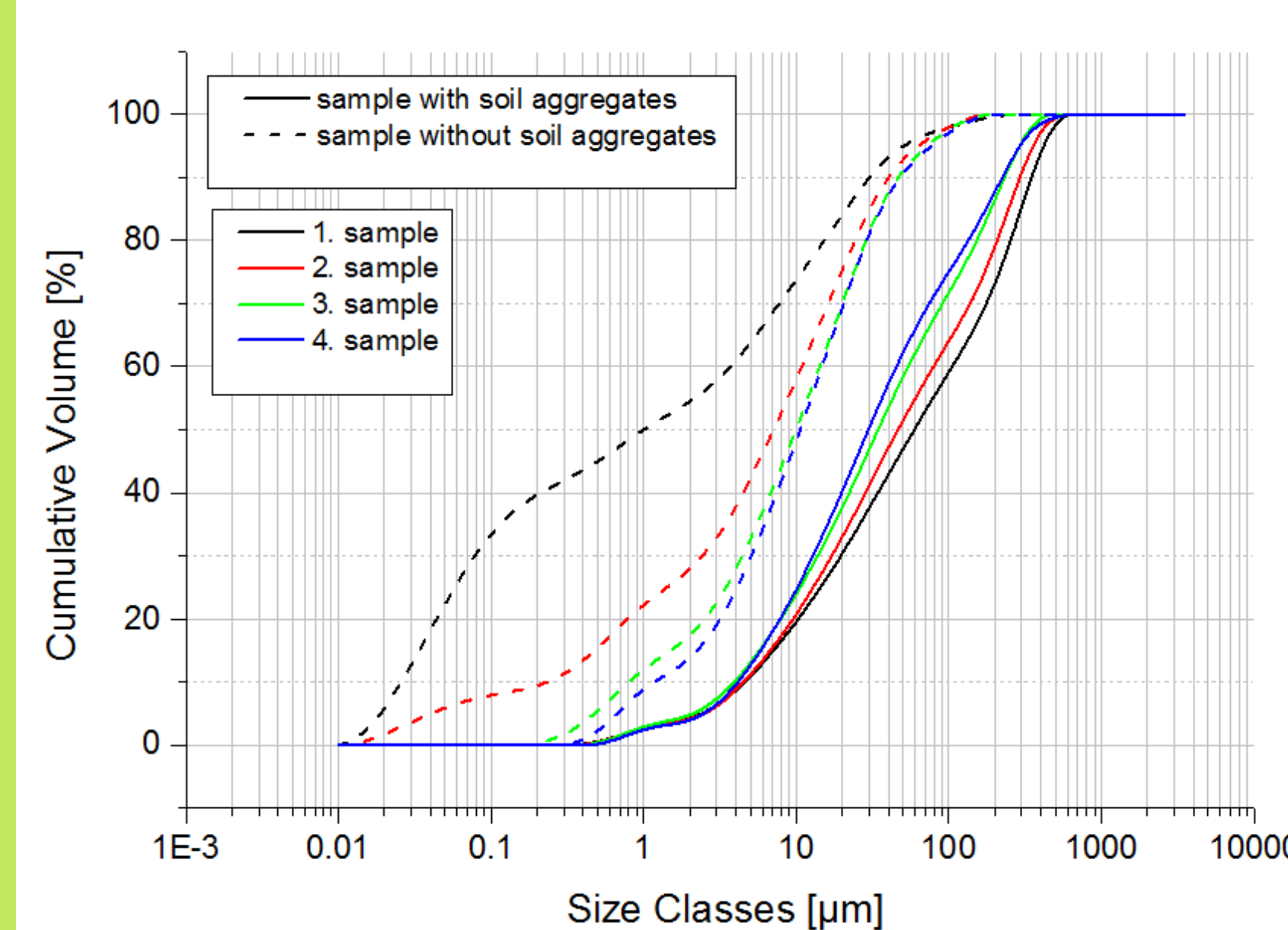
Samples with and without soil aggregates
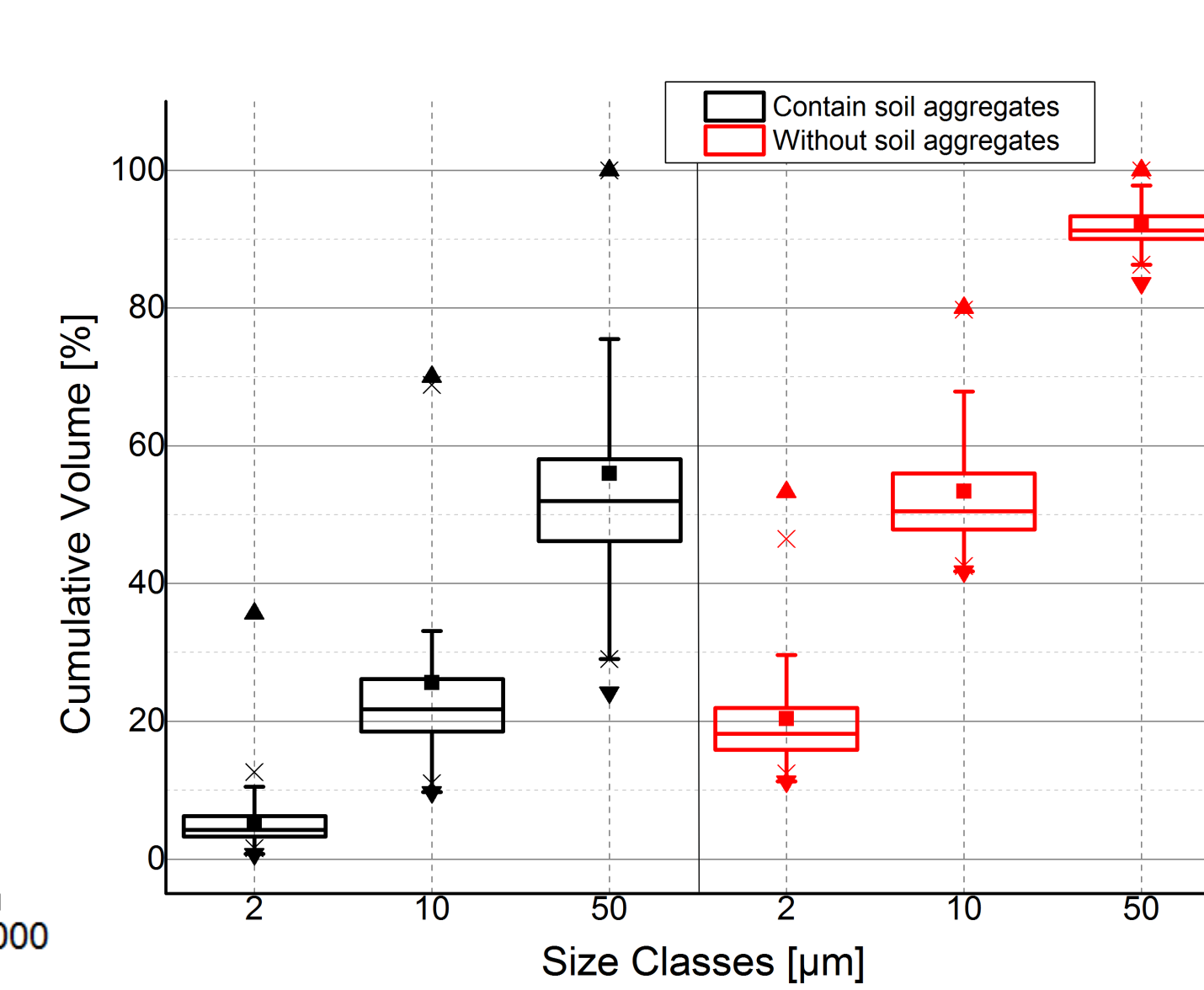
II. Slopes of the experimental plots

III. Anti-erosion geotextile

Conclusions

Comparison	Hydrometer	PARIO device	Laser Diffractometer
Time of measurement (228 samples)	462 days	1957 hours	57 hours
Amount of sample	50 g	50 g	1 g
Evaluation of samples with soil aggregates	impossible	impossible	possible

Differences in results obtained by three tested methods:		
Laser Diffractometer	7%	Hydrometer metod
Laser Diffractometer	11%	PARIO device
PARIO device	15%	Hydrometer metod

- The size of soil aggregates in the eroded soil is larger at the beginning of the rain than size of the aggregates eroded when erosion rills are made
- The largest amount of soil aggregates is at the beginning of the rain episode then decreases in time
- For steep slopes the angle value does not influence the grain size distribution.
- Soil samples from experimental field with anti-erosion geotextile contain larger amount of aggregates at the beginning of the rain and smaller amount of aggregates when the soil is saturated than samples from field without geotextile

Outlook

- Analysis of more samples with different type anti-erosion geotextile
- More experiments on laboratory rainfall simulator with possibility to set different slopes of experimental plot
- Analysis of samples obtain from experiments with different rainfall intensity