The effects of rain drop impact on soil surface microtopography

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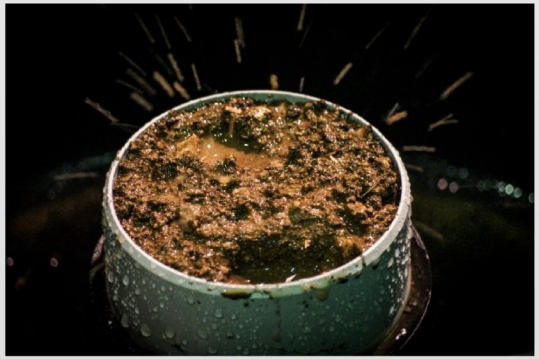

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Object and goals

- Monitoring of surface microtopography changes due to rain drop impact using photogrammetry

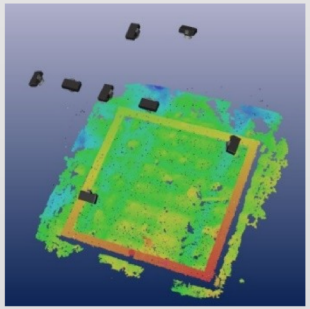
- Currently 2 projects:
  - Design of technical measures for stabilization and protection of slopes against erosion
  - **K**inetic **e**nergy of **r**ainfall as driving force of **s**oil detachment and transport (**KERS**)

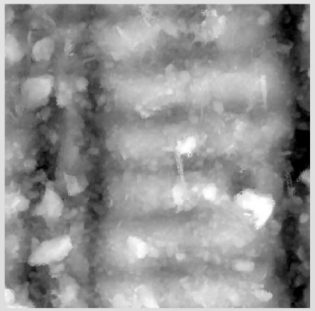
- Goal is to evaluate and quantify effect of rainfall to soil surface
  → protection of soil against erosion (agricultural and urban areas)

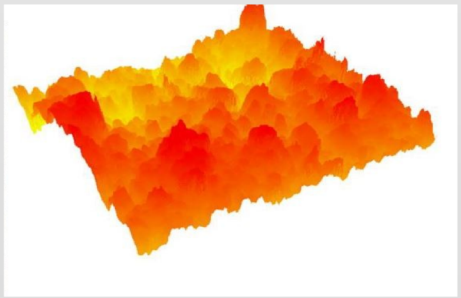
Methods

- Rainfall experiments – natural and artificial rainfall (Rainfall Simulators)
- Rainfall monitoring (disdrometers, rain gauges), soil conditions (moisture)

- Photogrammetry („Structure from Motion“)
  - soil surface to 3D data (Digital Elevation Models) with standard camera (Sony A6000)







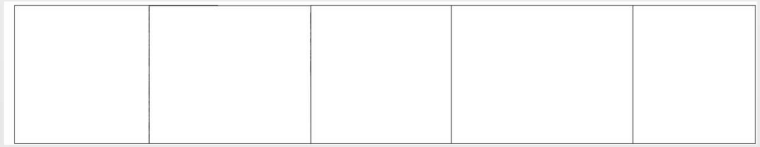
Surface parameters
- Consolidation
- Roughness
- Slope, aspect,.....

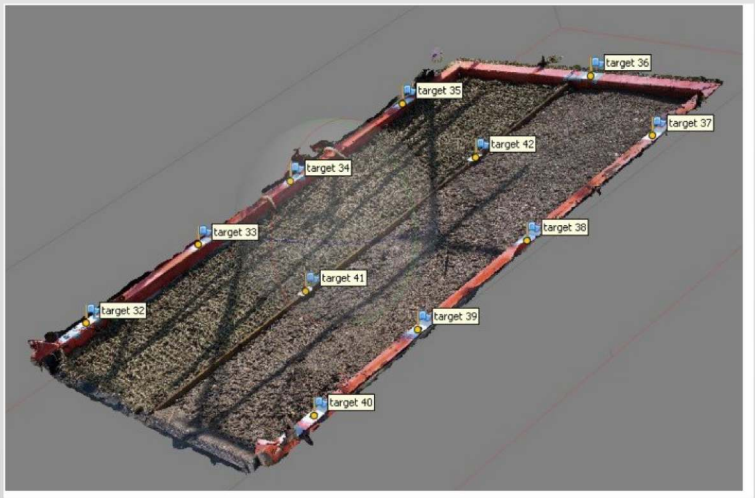
  - Processing photos in Agisoft PhotoScan
  - Processing of DEM in ArcGIS, Matlab

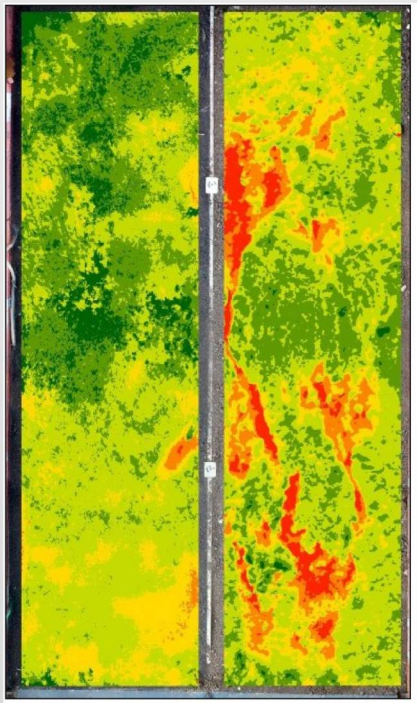
Digital Elevation Models (DEMs)
surface parameters and its changes

1st project: Assesing the effectiveness of soil erosion control technologies on steep slopes

- Comparison of bare and protected soil (different materials)
- Resolution – 1 mm/pix
- Surface parameters and volume changes



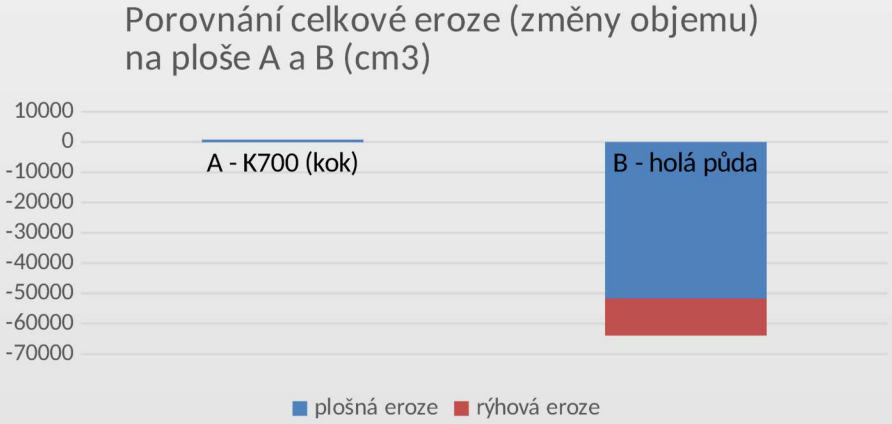


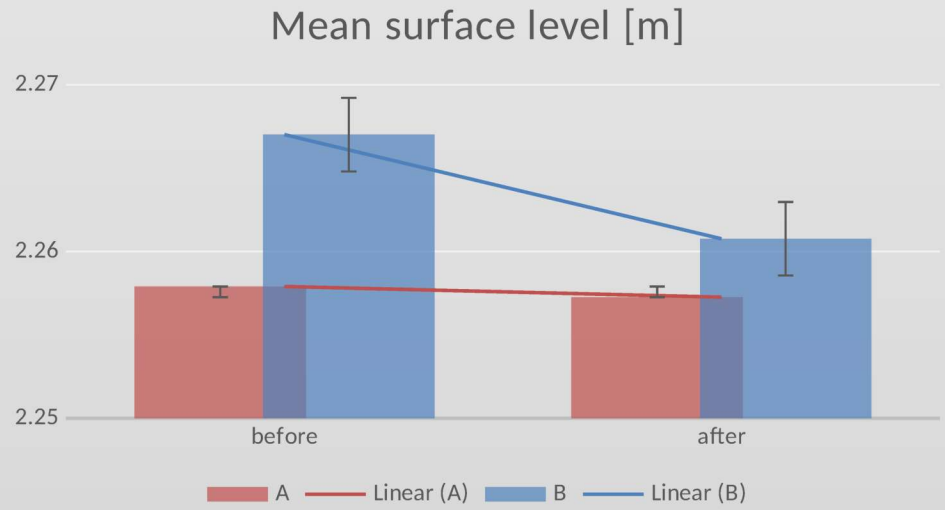


Before rainfall

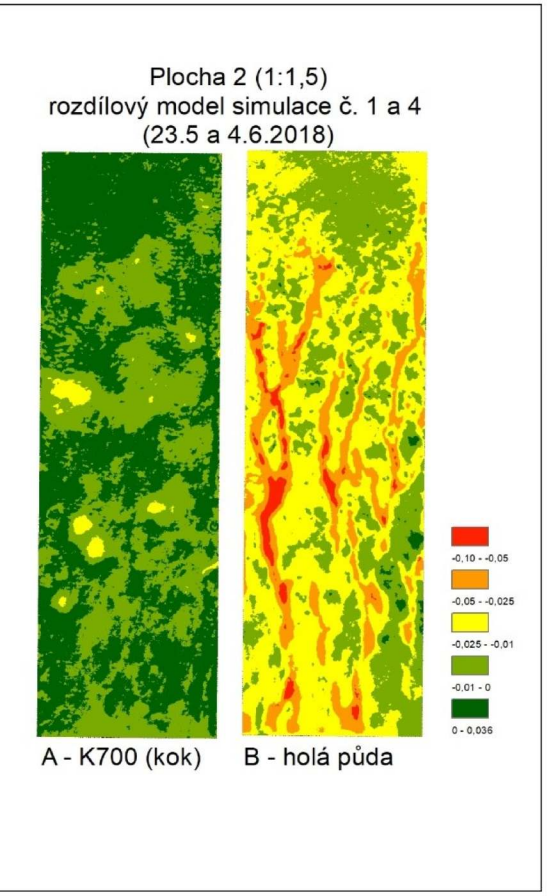
After rainfall

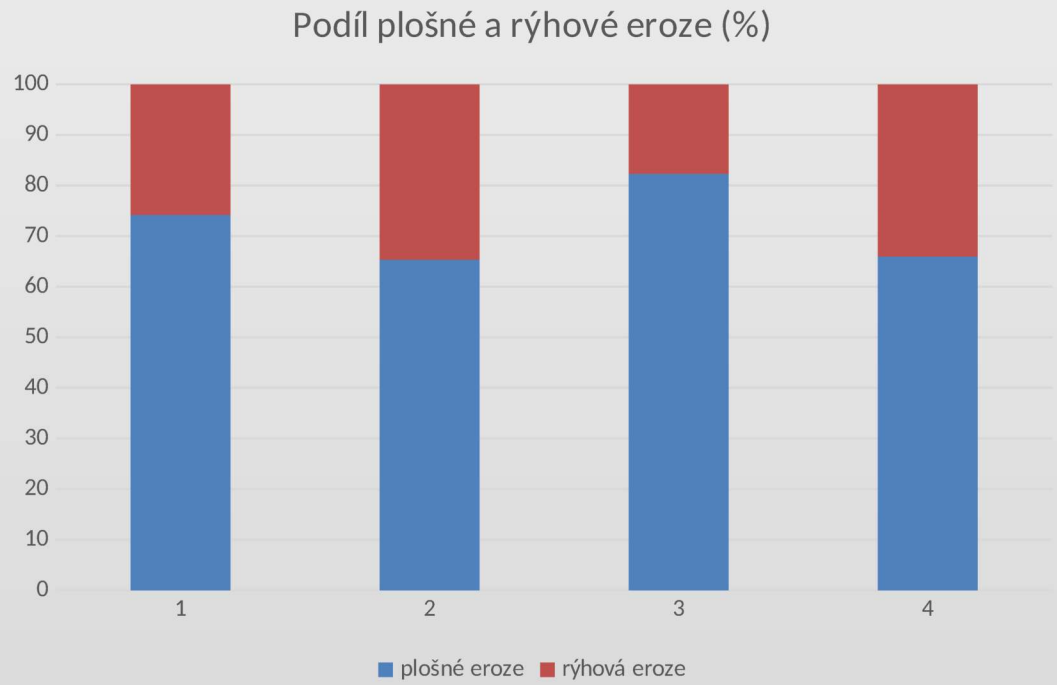
Preliminary results (only 2 experiments)



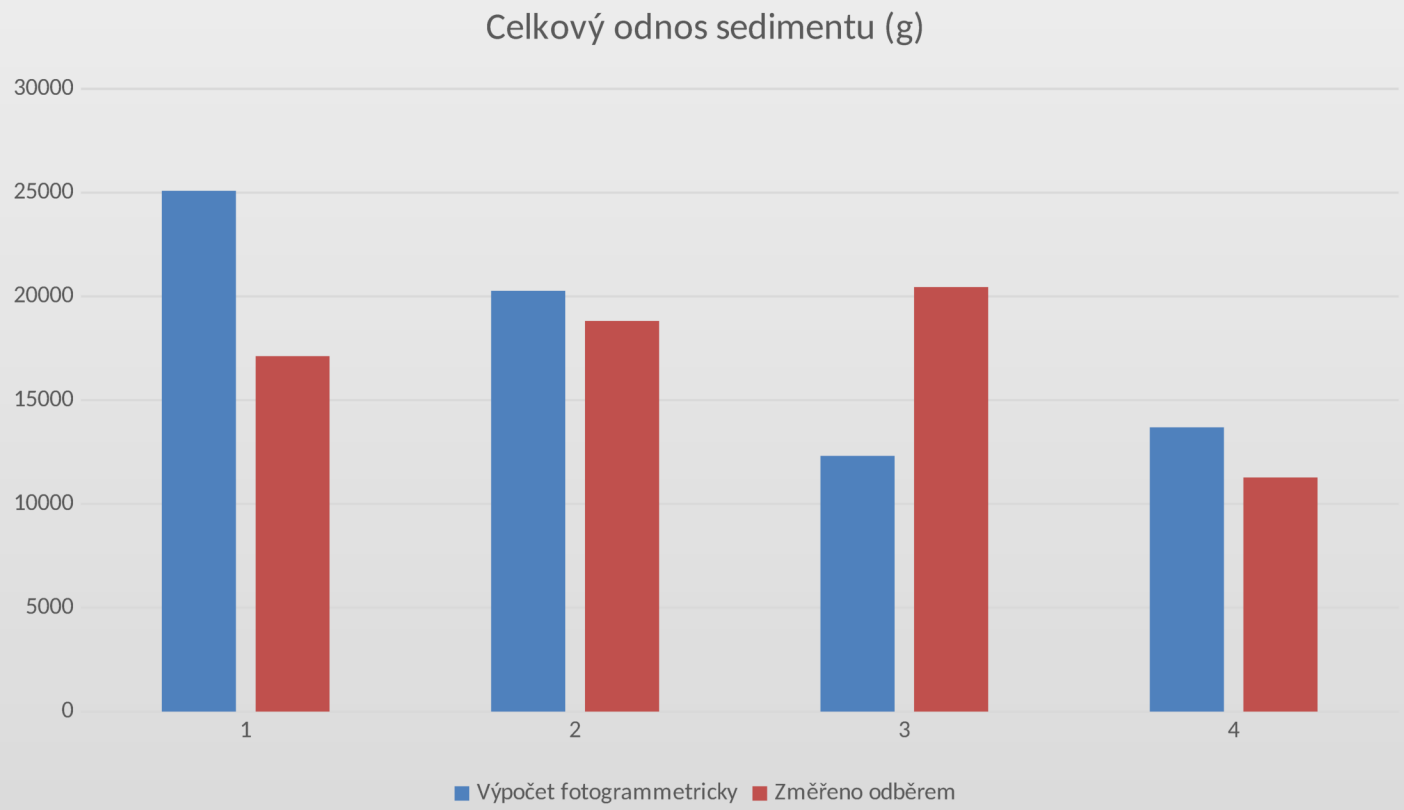


Rill vs. Interrill erosion

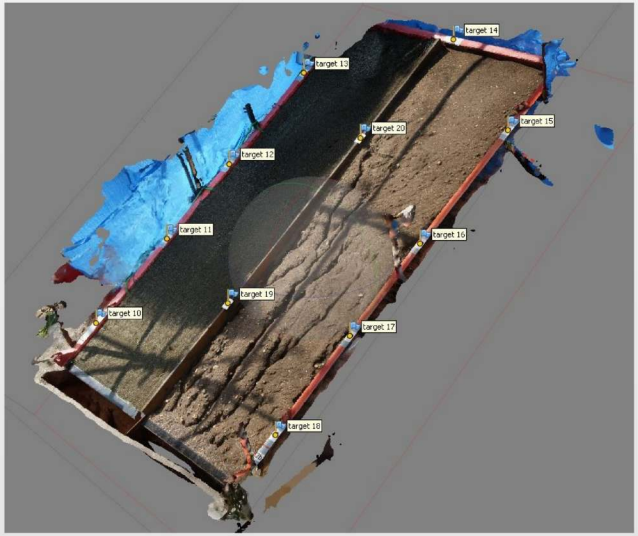




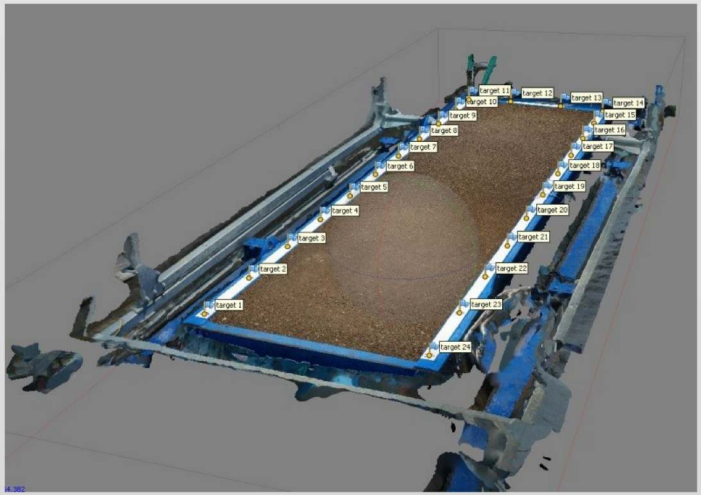
Sediment measured by photogrammetry vs. collecting buckets



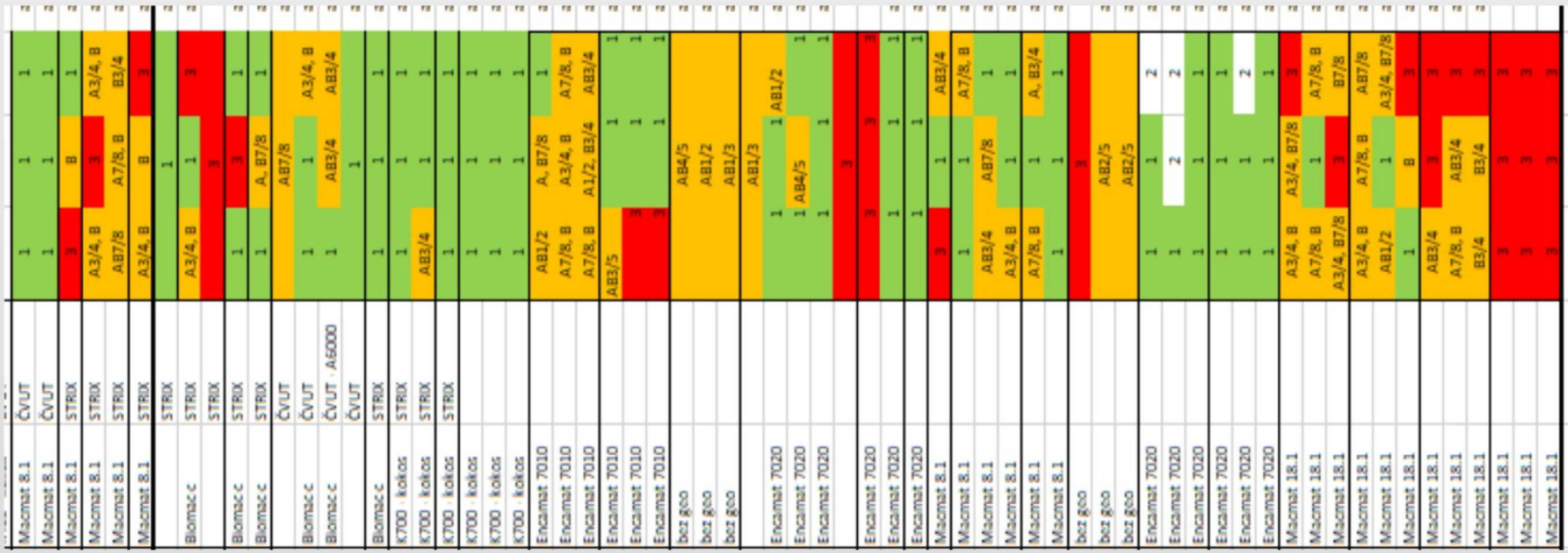
Outdoor experiments
- high contrast can caused problems



Laboratory experiments
- uniform light is



Photogrammetry measurement 2018 and 2019



Macmat 8.1	ČVUT	1	1	1
Macmat 8.1	ČVUT	1	1	1
Macmat 8.1	STRIX	3	B	1
Macmat 8.1	STRIX	A3/4, B	3	A3/4, B
Macmat 8.1	STRIX	AB7/8	A7/8, B	B3/4
Macmat 8.1	STRIX	A3/4, B	B	3
	STRIX		1	
Biomac c	STRIX	A3/4, B	1	3
	STRIX		3	
Biomac c	STRIX	1	3	1
Biomac c	STRIX	1	A, B7/8	1
	ČVUT		AB7/8	
Biomac c	ČVUT	1	1	A3/4, B
Biomac c	ČVUT · A6000	1	AB3/4	AB3/4
	ČVUT		1	
Biomac c	STRIX	1	1	1
K700 · kokos	STRIX	1	1	1
K700 · kokos	STRIX	AB3/4	1	1
K700 · kokos	STRIX	1	1	1
K700 · kokos		1	1	1
K700 · kokos		1	1	1
K700 · kokos		1	1	1
Encamat 7010		AB1/2	A, B7/8	1
Encamat 7010		A7/8, B	A3/4, B	A7/8, B
Encamat 7010		A7/8, B	A1/2, B3/4	AB3/4
Encamat 7010		AB3/5	1	1
Encamat 7010		3	1	1
Encamat 7010		3	1	1
bez geo			AB4/5	
bez geo			AB1/2	
bez geo			AB1/3	
			AB1/3	
Encamat 7020		1	1	AB1/2
Encamat 7020		1	AB4/5	1
Encamat 7020		1	1	1
			3	
Encamat 7020		3	3	3
Encamat 7020		1	1	1
Encamat 7020		1	1	1
Macmat 8.1		3	1	AB3/4
Macmat 8.1		1	1	A7/8, B
Macmat 8.1		AB3/4	AB7/8	1
Macmat 8.1		A3/4, B	1	1
Macmat 8.1		A7/8, B	1	A, B3/4
Macmat 8.1		1	1	1
bez geo			3	
bez geo			AB2/5	
bez geo			AB2/5	
Encamat 7020		1	1	2
Encamat 7020		1	2	2
Encamat 7020		1	1	1
Encamat 7020		1	1	1
Encamat 7020		1	1	2
Encamat 7020		1	1	1
Macmat 18.1		A3/4, B	A3/4, B7/8	3
Macmat 18.1		A7/8, B	1	A7/8, B
Macmat 18.1		A3/4, B7/8	3	B7/8
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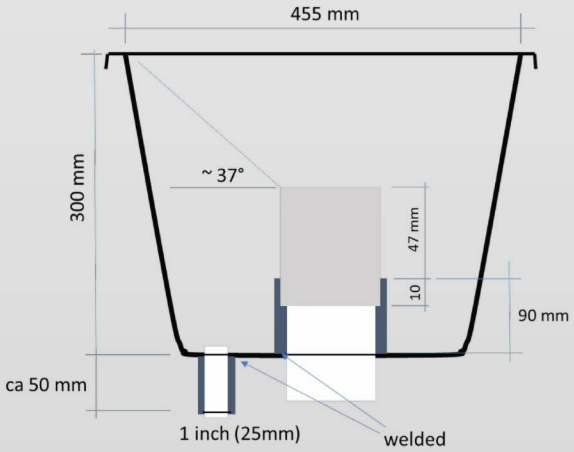
Macmat 18.1		AB1/2	1	A3/4, B7/8
Macmat 18.1		1	B	3
Macmat 18.1		AB3/4	3	3
Macmat 18.1		A7/8, B	AB3/4	3
Macmat 18.1		B3/4	B3/4	3
Macmat 18.1		3	3	3
Macmat 18.1		3	3	3
Macmat 18.1		3	3	3

2nd project: **K**inetic **e**nergy of **r**ainfall as driving force of **s**oil detachment and transport (**KERS**)

- Testing 3 soil at 3 locations (Prague, Petzenkirchen, Mistelbach)
- Measuring **splash erosion** with modified „Morgan“ splash cups
- Resolution – 0,05 mm/pix



Agisoft PhotoScan

Processing Report
27 September 2017

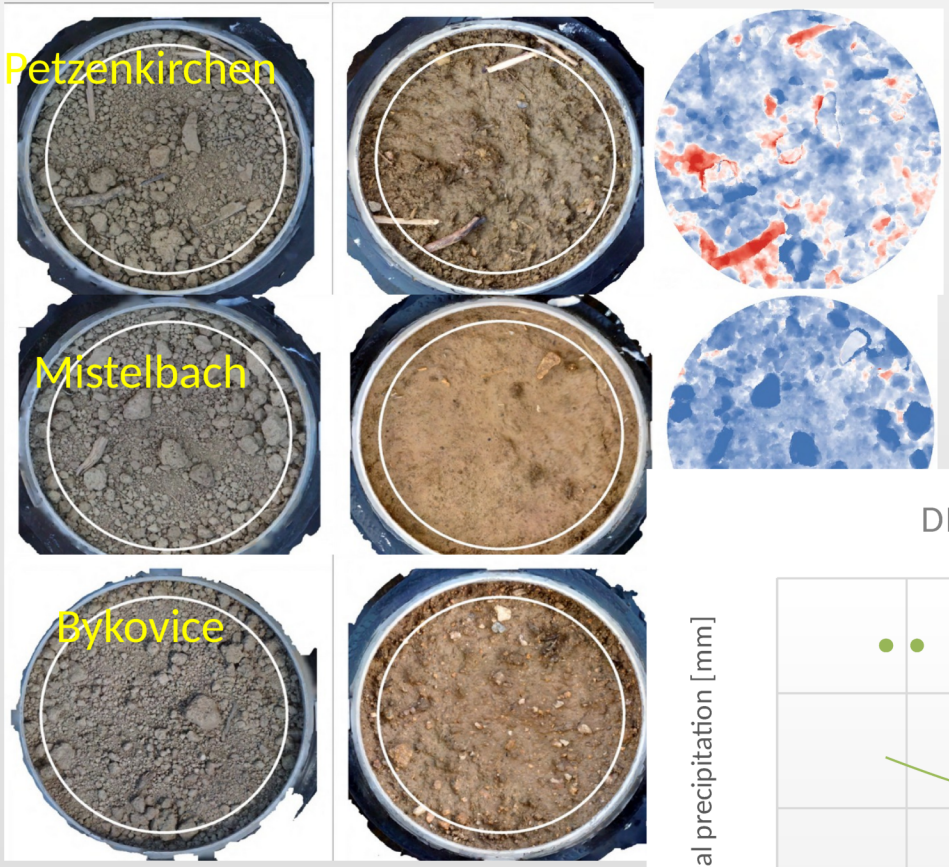
Camera Model	Resolution	Focal Length
ILCE-6000 (16 mm)	6000 x 4000	16 mm

LED ring light for evenly lit imagery

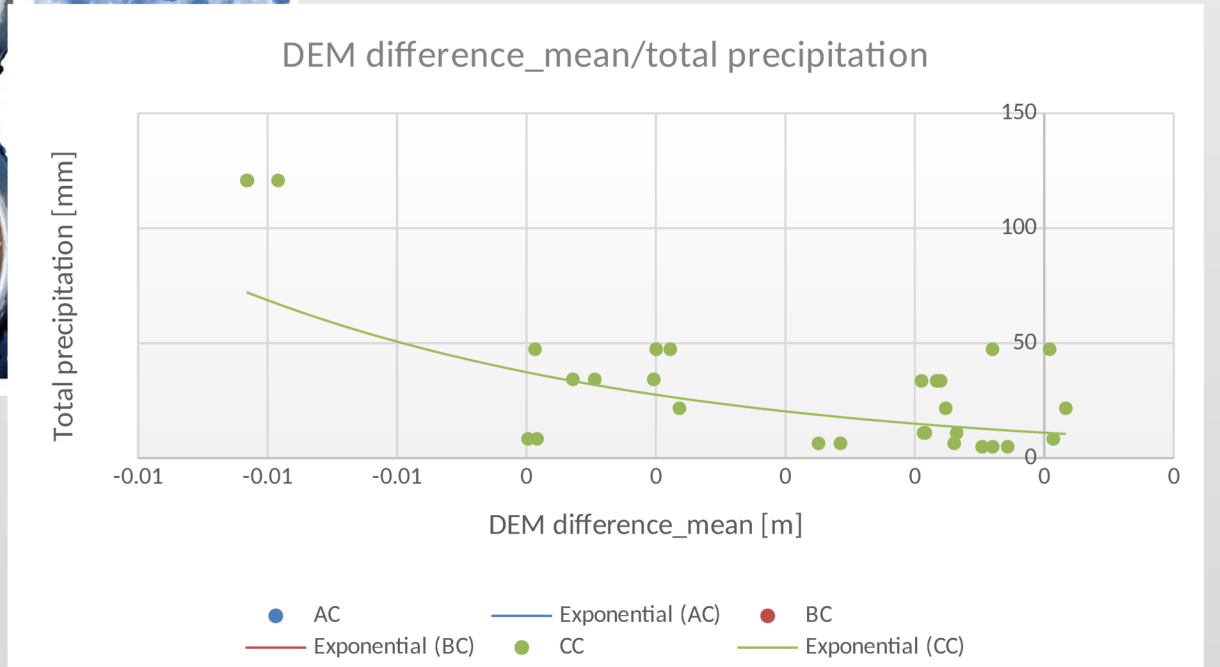
• Control points T Check points 5 cm

Count	X error (mm)	Y error (mm)	Z error (mm)	XY error (mm)	Total (mm)
16	0.118673	0.105754	0.121997	0.158956	0.200376

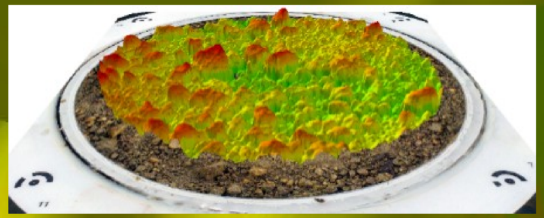
Table 3. Control points RMSE.



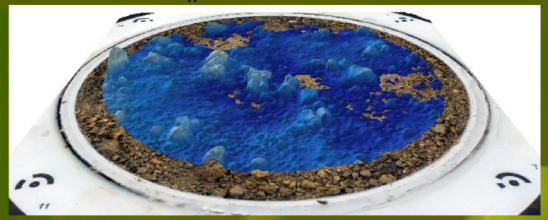
soil	splash mass (g)	tot. prec. (mm)
Petzenkirchen	4,58	48,50
Mistelbach	5,99	48,50
Býkovice	**7,41**	**48,50**



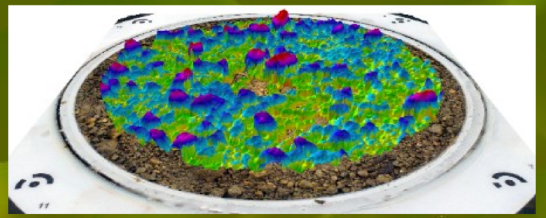
BEFORE RAINFALL
„initial state“



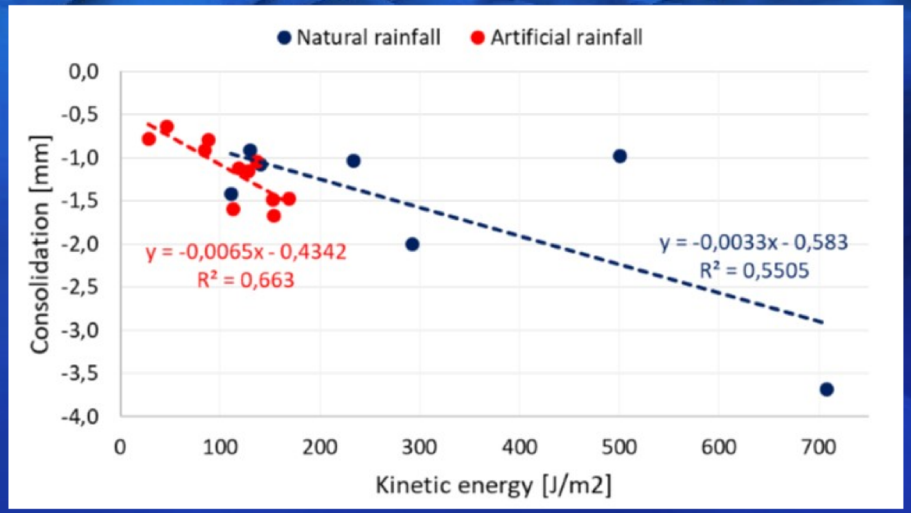
AFTER RAINFALL
„final state“

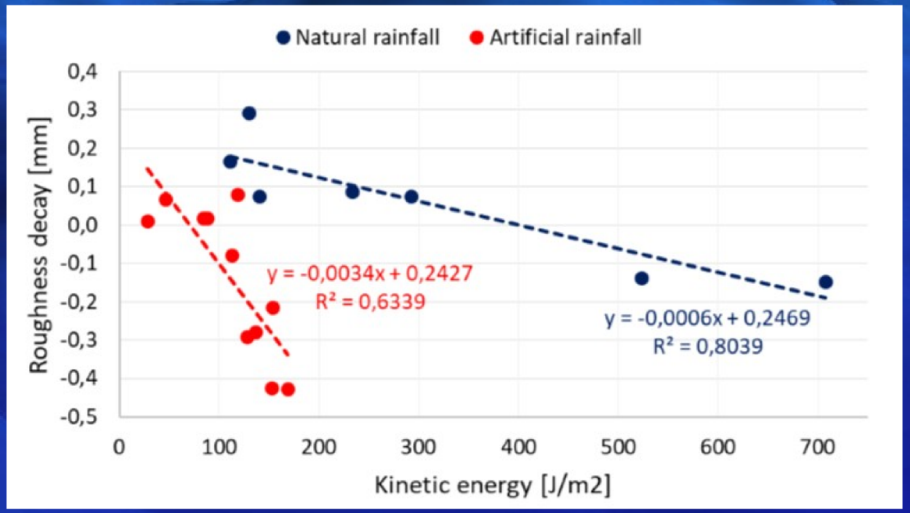


DIFFERENTIAL MODEL



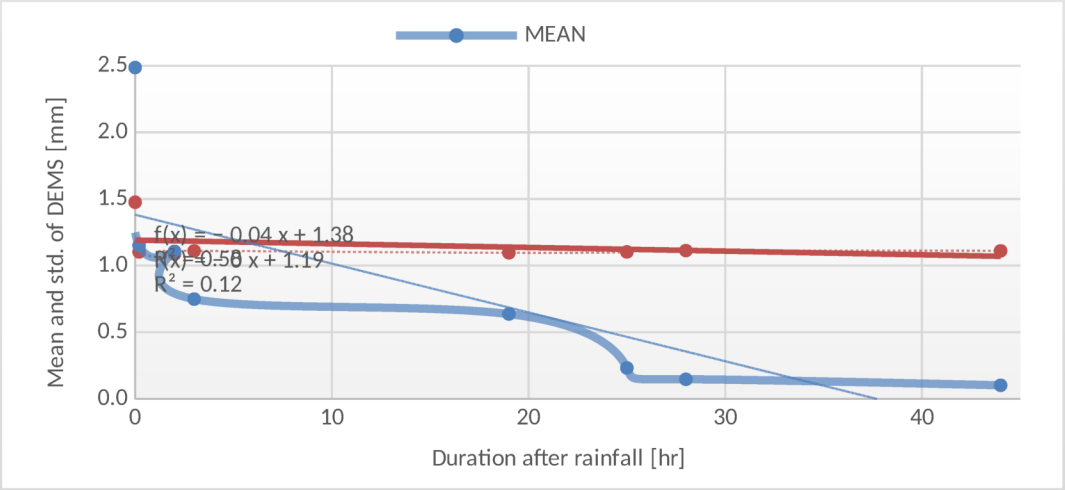
- Surface x rainfall parameters





Efect of drying soil after rainfall

Cracks begin to appear on soil surface after 30 hours after rainfall with a constant drying at 27°C.



Consolidation (MEAN) caused by drying of the soil is almost the same as caused by the rainfall itself (-1,33 mm vs -1,05 mm). Roughness (STD) does not exhibit remarkable changes.

Conclusion

- Photogrammetry is useful method for evaluating soil surface and volume changes.
- It is necessary to provide good lighting.
- Final results will be published after all scheduled experiments during this year.

Thank you for your attention!