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The SfM-monitored rill experiment, a tool to detect decisive processes?

Some cogitations by:

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Facts:

- Rill Erosion is one of the more effective types of erosion
- Experiments are often conducted in laboratories
- Processes of Rill Erosion are poorly understood

- Approach: ***In situ***-experiments
- Until ~2008 gap between Rainfall-Simulation and Gully-monitoring

Gap filled thanks to **RiFlE** (**Ri**ll **Fl**ushing **E**xperiment)







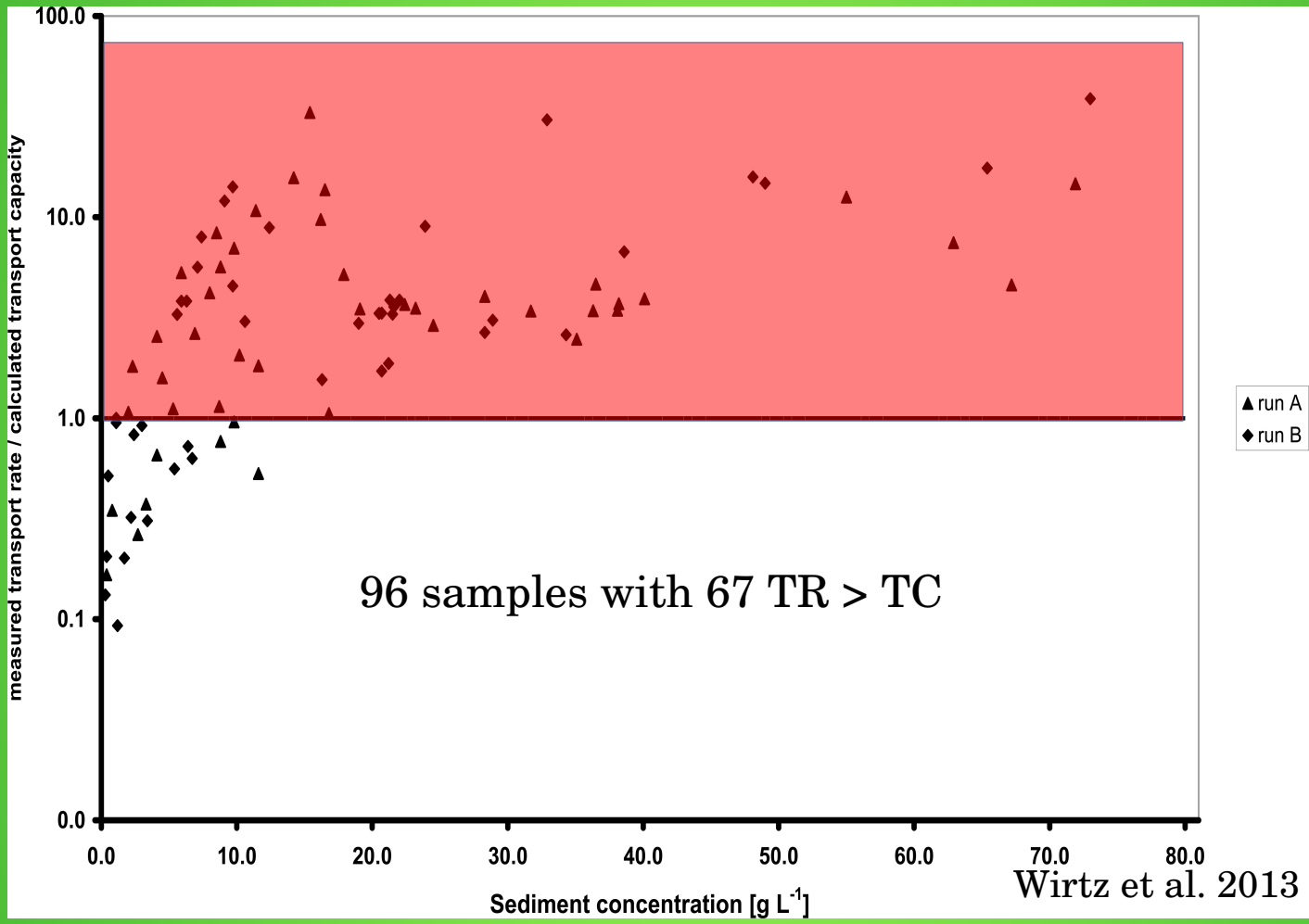




How to: Flush a rill twice for four minutes (250 L/min.)

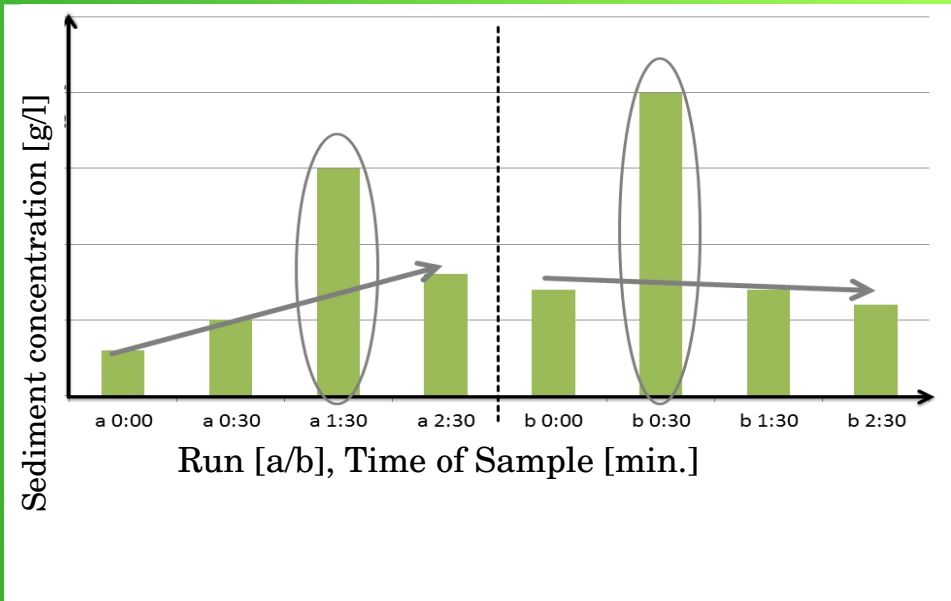
What is measured?	What can be calculated?
- Slope - Aspect - Cross-Sections - Water Level - Flow Velocity - Water Quantity - Sediment Concentration	- Transport Rate, Transport Capacity - Detachment Rate, Detachment Capacity - Wetted Perimeter - Hydraulic Radius - Shear stress - Unit length - Shear force - Stream power (diff.) - Reynoldsnumber - Froudenumber ...

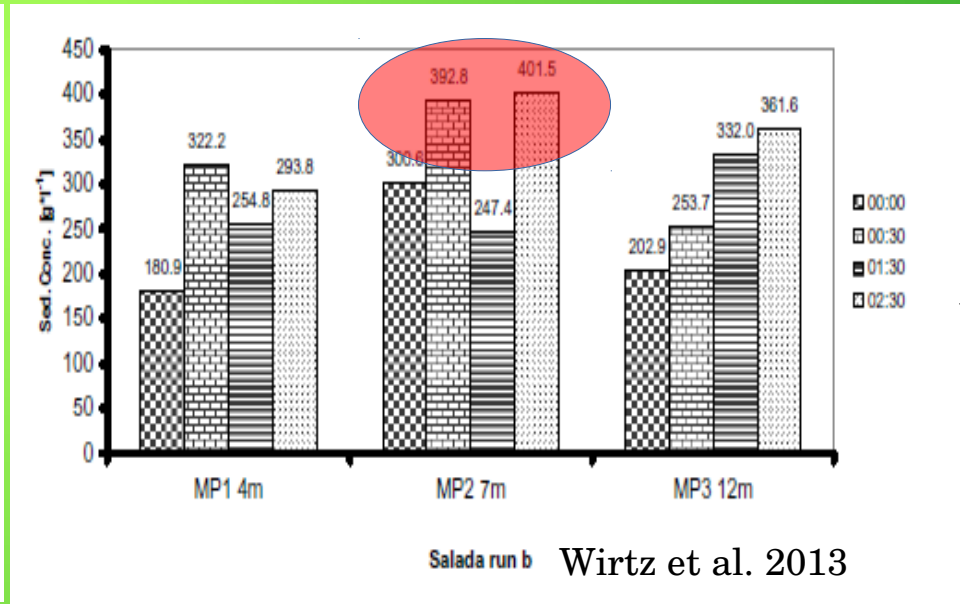
BUT: Real material loss often (75%) exceeds calculated loss



Transport Rate > Transport Capacity (calc.)

- Sediment Concentration is seldom constant or predictable
- Occurrence of „mysterious“ peaks





Wirtz et al. 2013

What is not measured?

Inside-topography!

Key question:

How does inside-topography influence RiFlE-Results?

Results are influenced by:

- Side Wall Failure (SWF)

- Plunge-pool dynamics

- Incision

If Results are influenced by Side Wall Failure (SWF), Plunge-pool dynamics and Incision, then:

Problem: How to detect SWF, plunge-pool-dynamics and Incision?

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Solution: Microtopography must be made measurable

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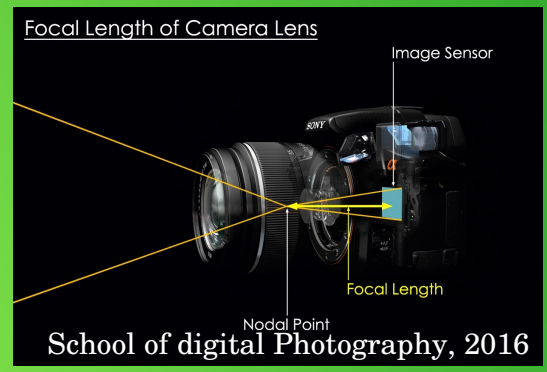
Thanks to Structure-from-Motion (SfM), microtopography can be „scanned“

Requirements on SfM-serviceable Photos:

- ideal Crop & suitable Scale (focal length)
- correct Exposure (shutter speed)
- high Contrast (shutter speed)
- sufficient Sharpness (shutter speed)
- enclosing Depth of Field (shutter speed & aperture)

- minimal Blur (suspension / mounting)
- hemispherical exposure positions



School of digital Photography, 2016

Canon, 2016

Photoble, 2016

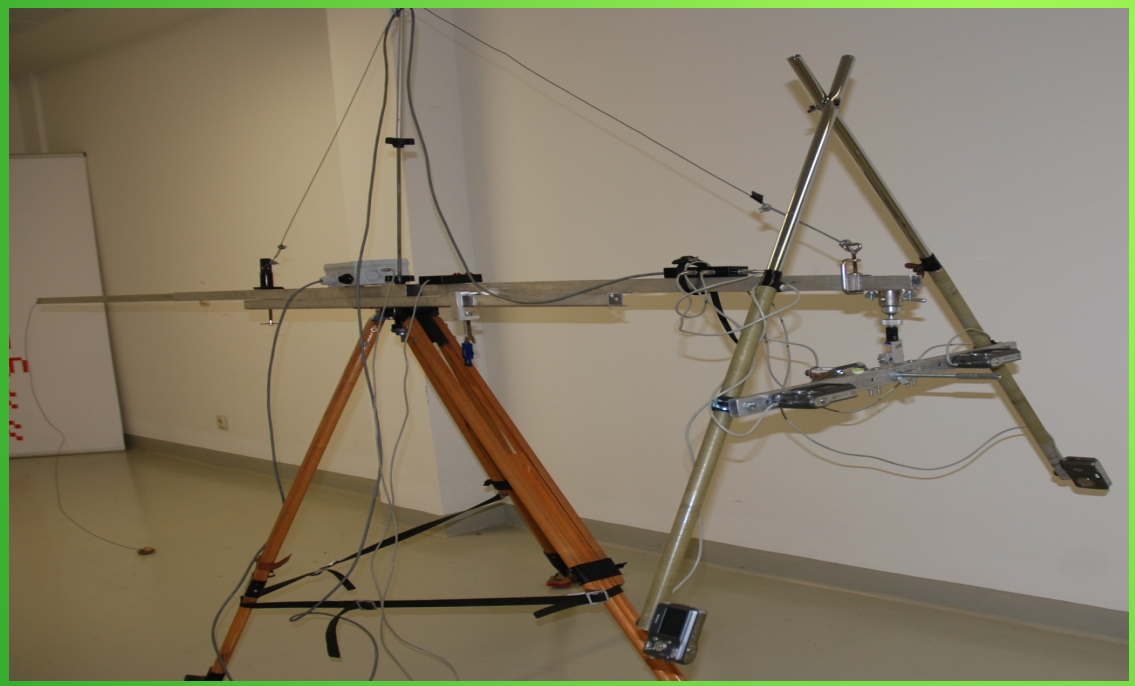
Requirement on overall accuracy:

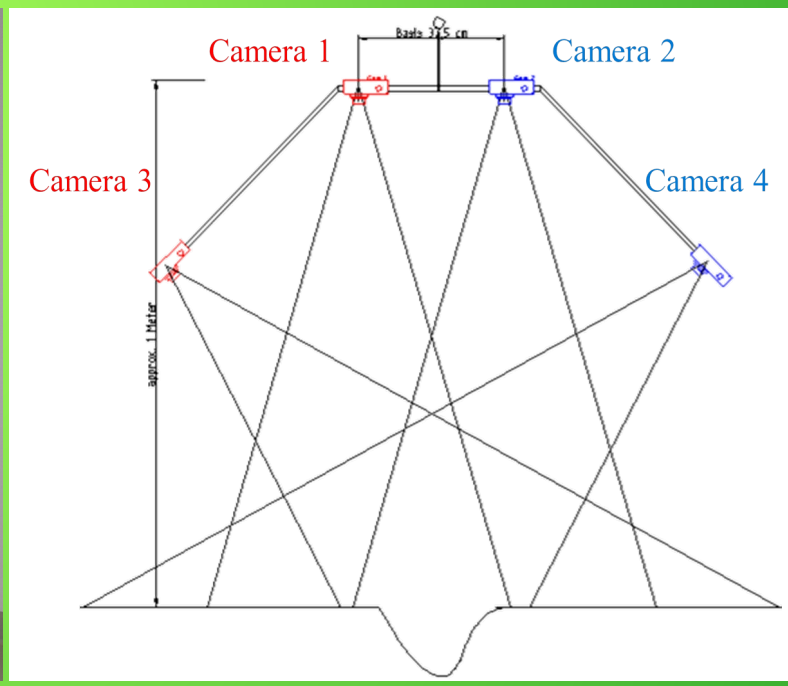
Orientation to size of target = mm ← [x] → cm

„The better the pictures, the better the 3-D-model.“

→ static 5-Camera-array, the **„Penta-GNAG“**

German for **G**eländ**e**N**a**h**A**btast**G**erät = close-range terrain scanning device





Why should one use a fixed array?

Advantages:

+ high accuracy (low shutter speed)

+ low cumputation time due to systematization (Identification of stereo-pairs)

+ (nearly) no data gaps thanks to

crisp-sharp pictures

Disadvantages:

- elaborate handling (~1 hr for 20 m rill)

- demands for storage- / transport space

Picture Orientation Matrix

	Cam 1	Cam 2	Cam 3	Cam 4
Row 1	Pic 1,1	Pic 2,1	Pic 3,1	Pic 4,1
Row 2	Pic 1,2	Pic 2,2	Pic 3,2	Pic 4,2
Row 3	Pic 1,3	Pic 2,3	Pic 3,3	Pic 4,3
Row 4	Pic 1,4	Pic 2,4	Pic 3,4	Pic 4,4

Why should one use a more-than-two-cameras-of-the-same-type-array?

Advantages:

+ no shift of positions

+ same lighting conditions

+ better visibility of side wall (45°- cameras)

+ more than usual stereo-2,5-D (overhang-detection)

+ no furling of long, narrow objects (nautilus effect purged by 90°- camera)

+ elimination of errors implanted through use of different camera models

Disadvantages:

- costs

- precarious electronical synchronisation (intrusion in camera body neccesary)

Post-processing reduces Resolution

Accuracy declines with every step

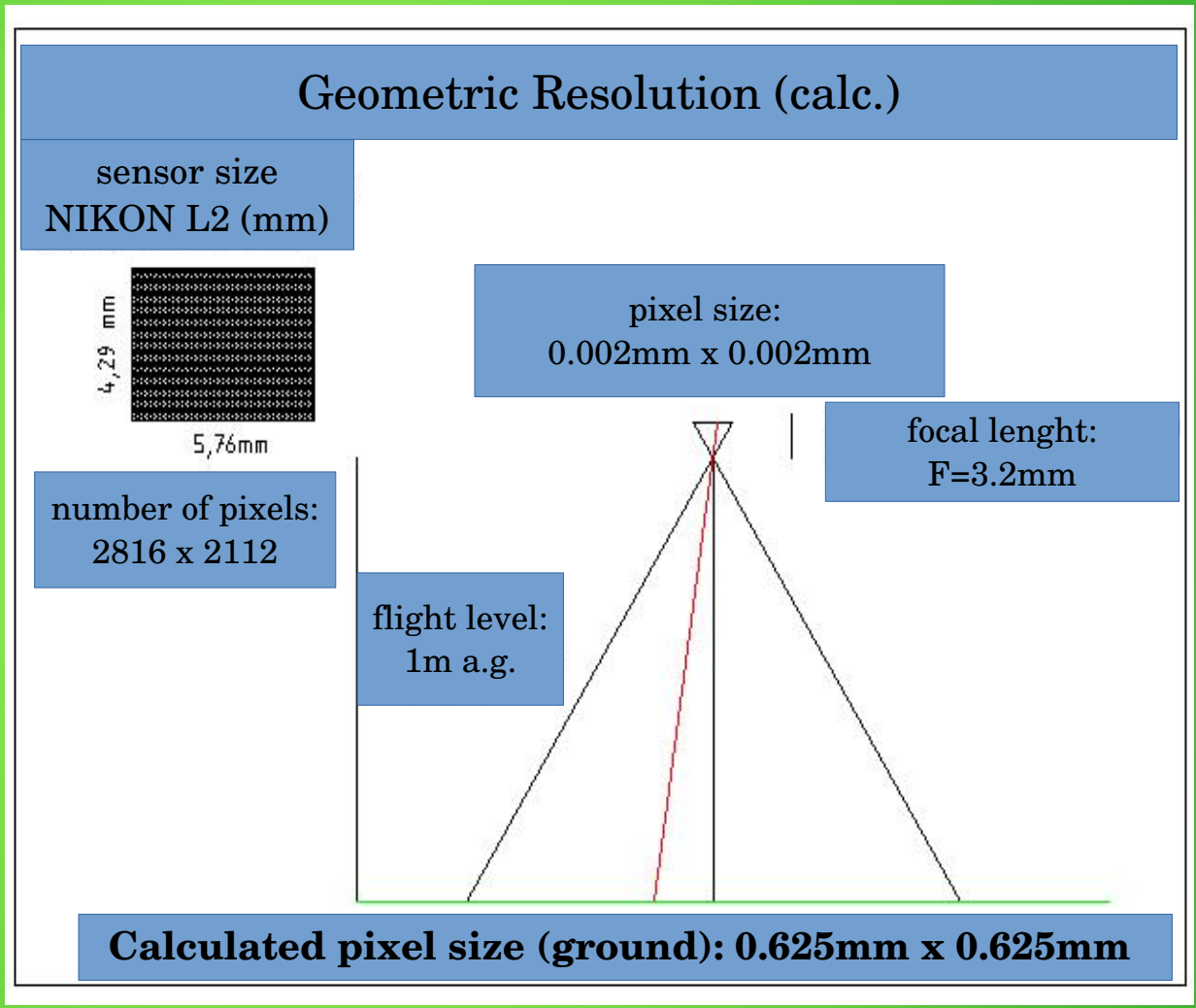
calculated value

point cloud creation

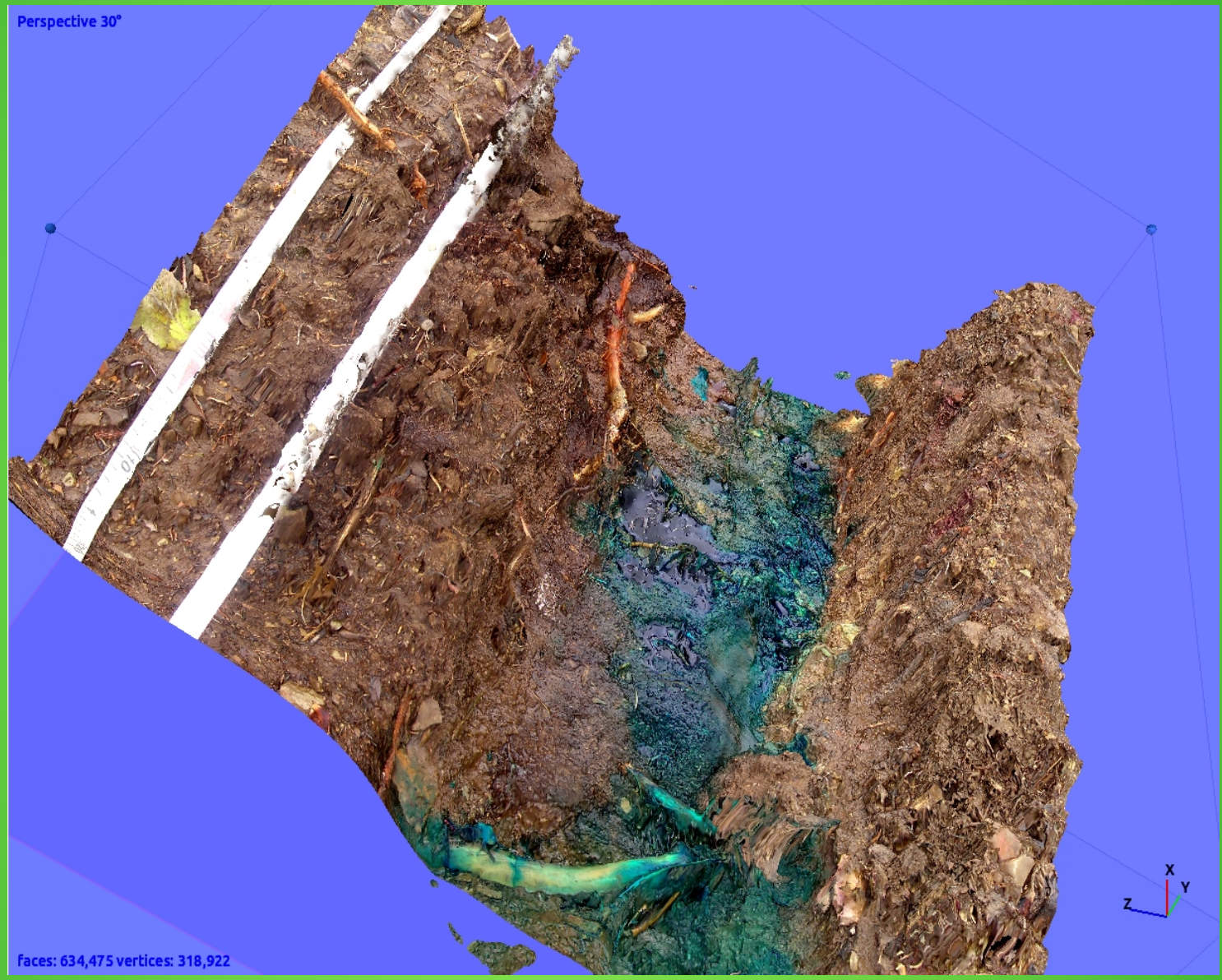
mesh creation

texture creation

DEM creation



Results



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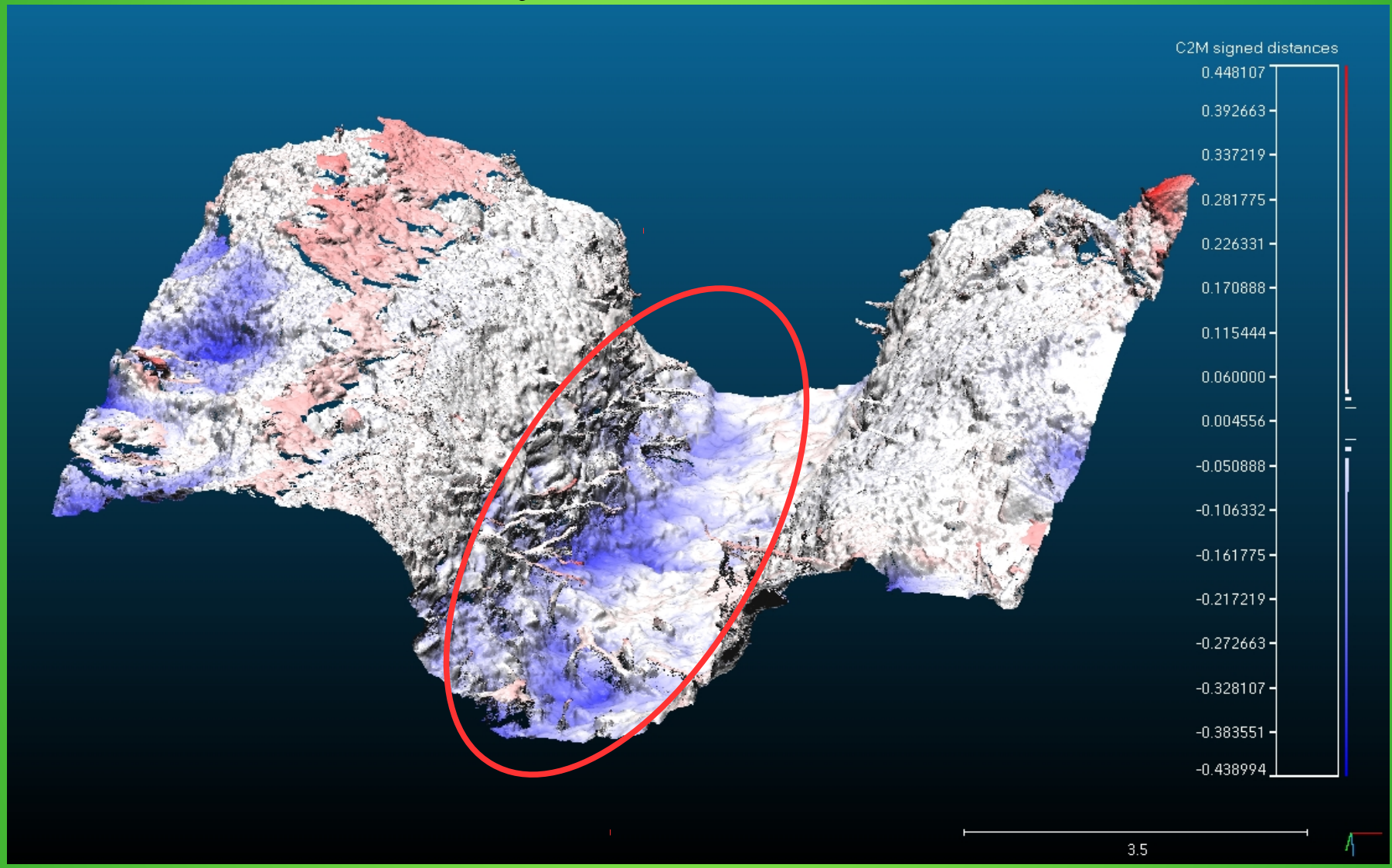
Snippet of a 3-D-model

Detection of Incision by Mass-Balance



Conclusion:

The SfM-monitored rill experiment helps us to **detect** and **link** erosion and accumulation events in eroding rills, concerning their **spatial** and **temporal** characteristics, but it does **not deliver** any exact explanation **formula**.

The microtopography measuring-device can act as a low-cost substitute for a laser scanner in erosion-orientated close-range-photogrammetry.

Future Challenges:

Adapt the SfM-monitored rill experiment in order to provide help for modelling and calculating experts.

Learn how to detect and number turbulence while running Ri.Fl.E.

SfM by Video: Please check our Poster in X1.13, Hall X1

Thanks for staying awake!

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