Watershed management in a Soil & Water Conservation (SWC) context - combining upland and channel measures

Concept and selected techniques

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ICARDA
June, 2018

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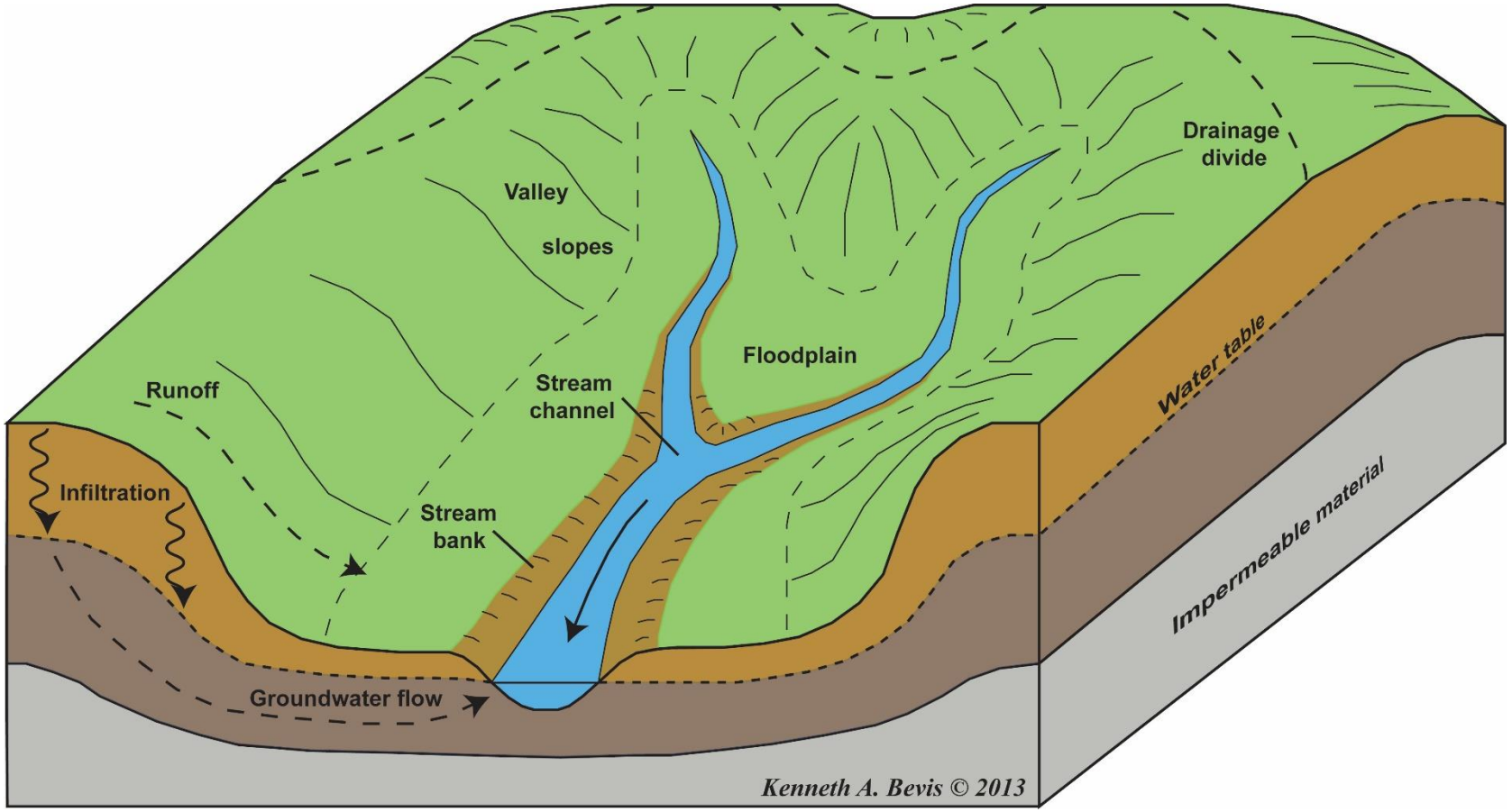
Watershed

Hydrologically



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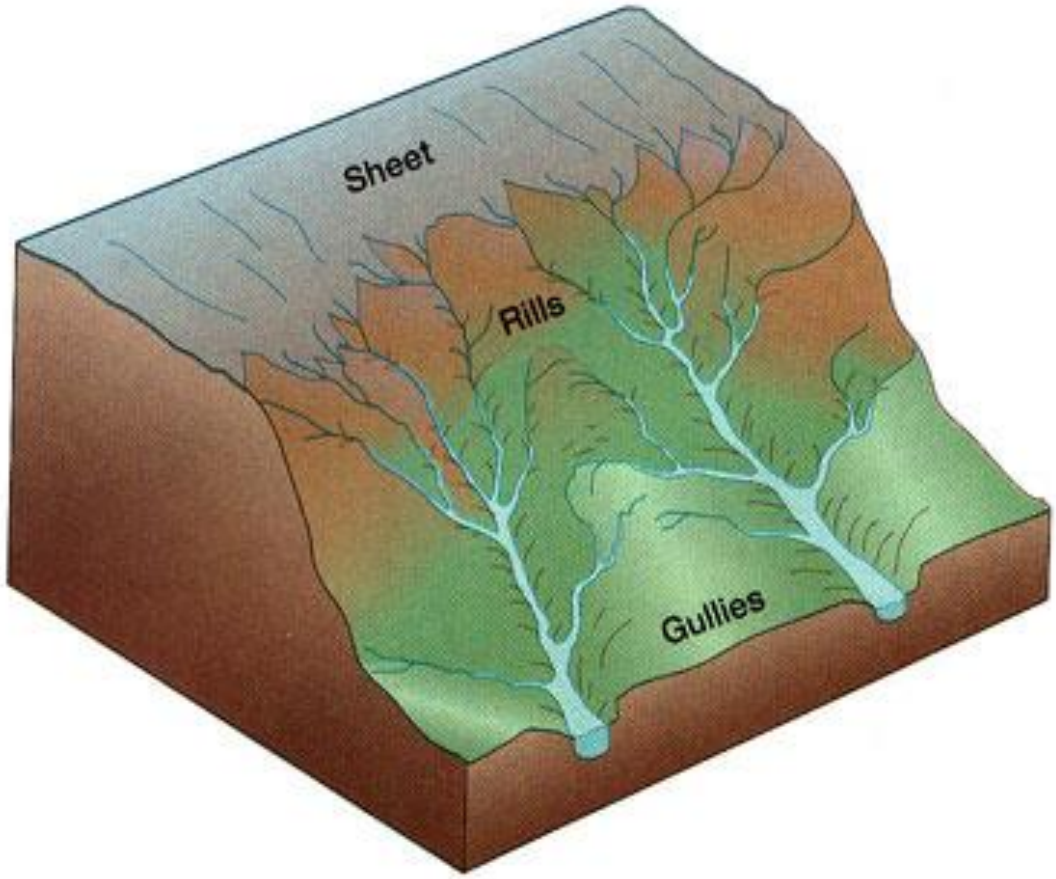
Processes at scale

Upstream and downstream



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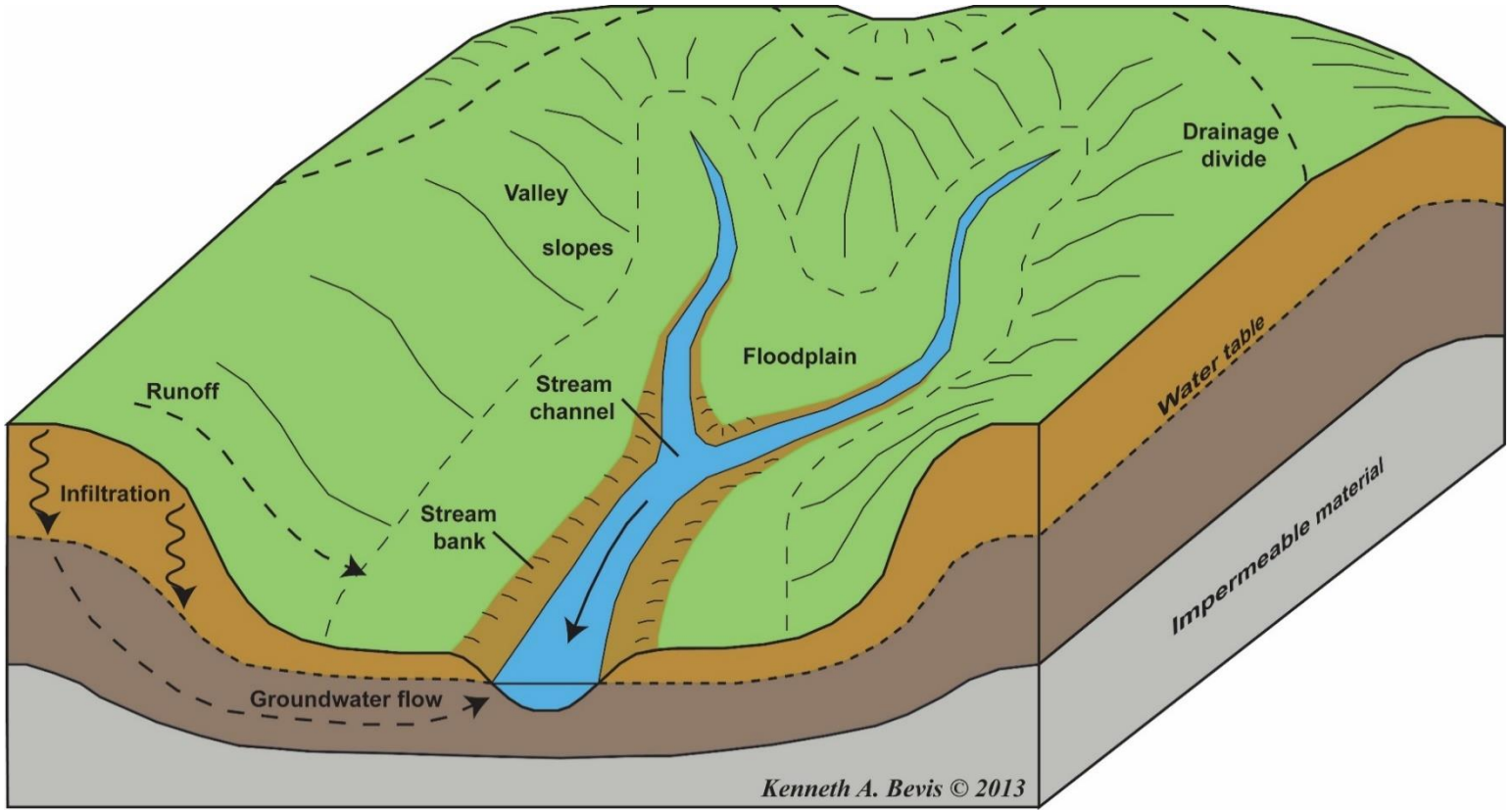
Watershed

Watershed hydrology

- **Upland processes**
- **Channel processes**



Upland

Practical Examples: Small Contour Measures

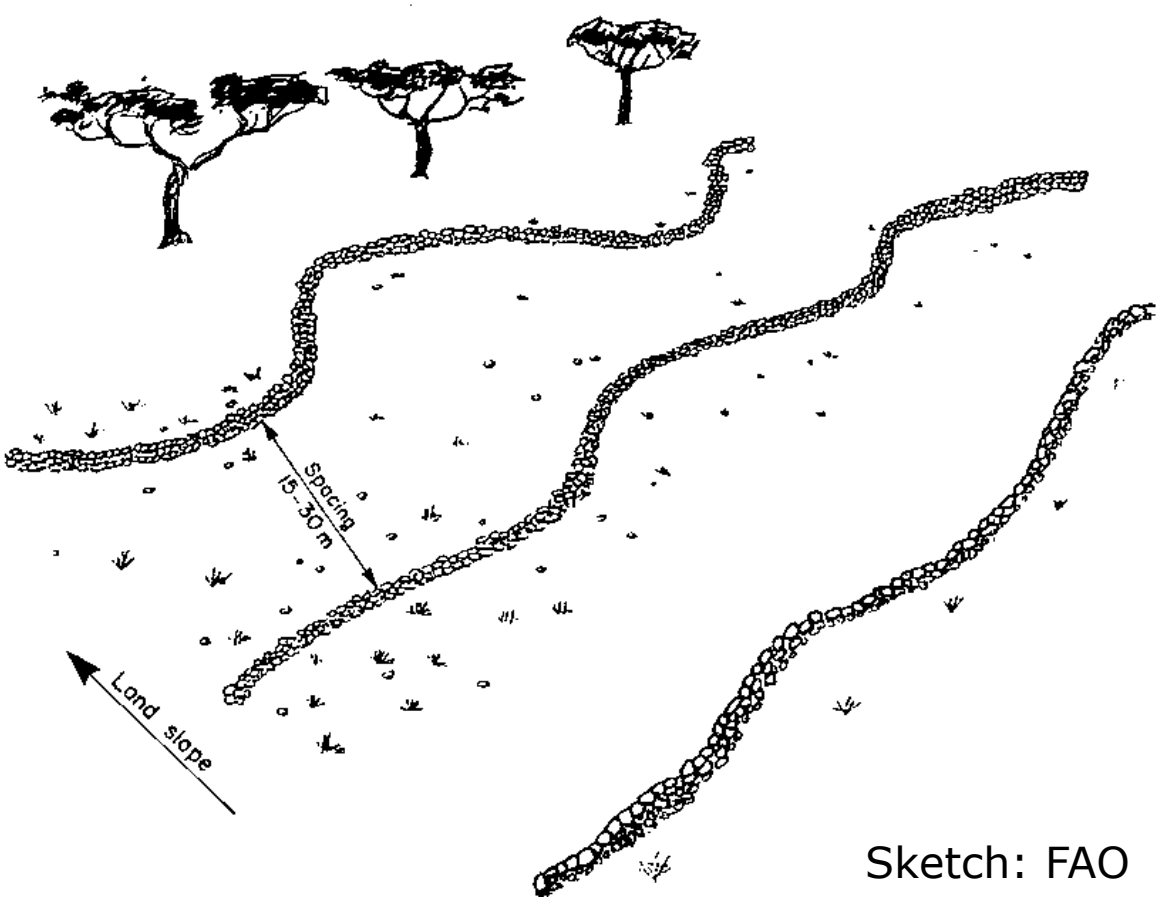
There are various ways of differentiation….

Design
- Continuous contour measure
- Interrupted contour measure

Development
- by hand
- by machine

Materials
- Stone
- Soil

…..



Sketch: FAO

Examples: Small Contour Measures

Stone bunds (Ethiopia)

Vallerani system (Jordan)

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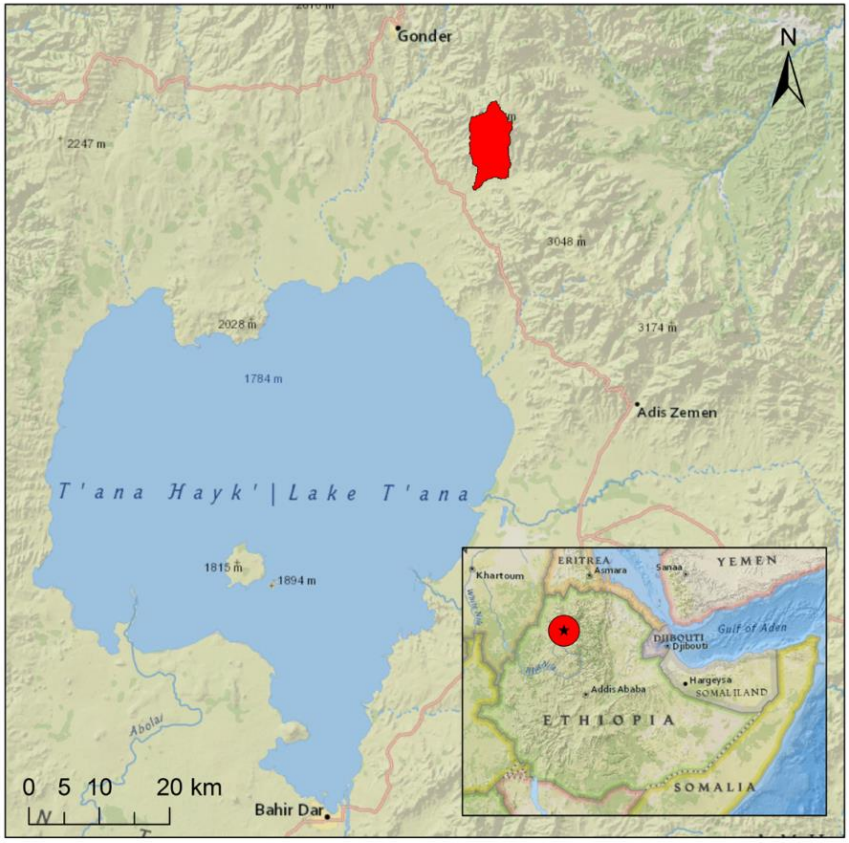
Combating land degradation and improving productivity through integrated watershed management, monitoring, and community participation

As a consequence of the extensive famine of 1973 and 1984 the Ethiopian Government initiated large-scale soil conservation and rehabilitation programs (Hurni, 1985).



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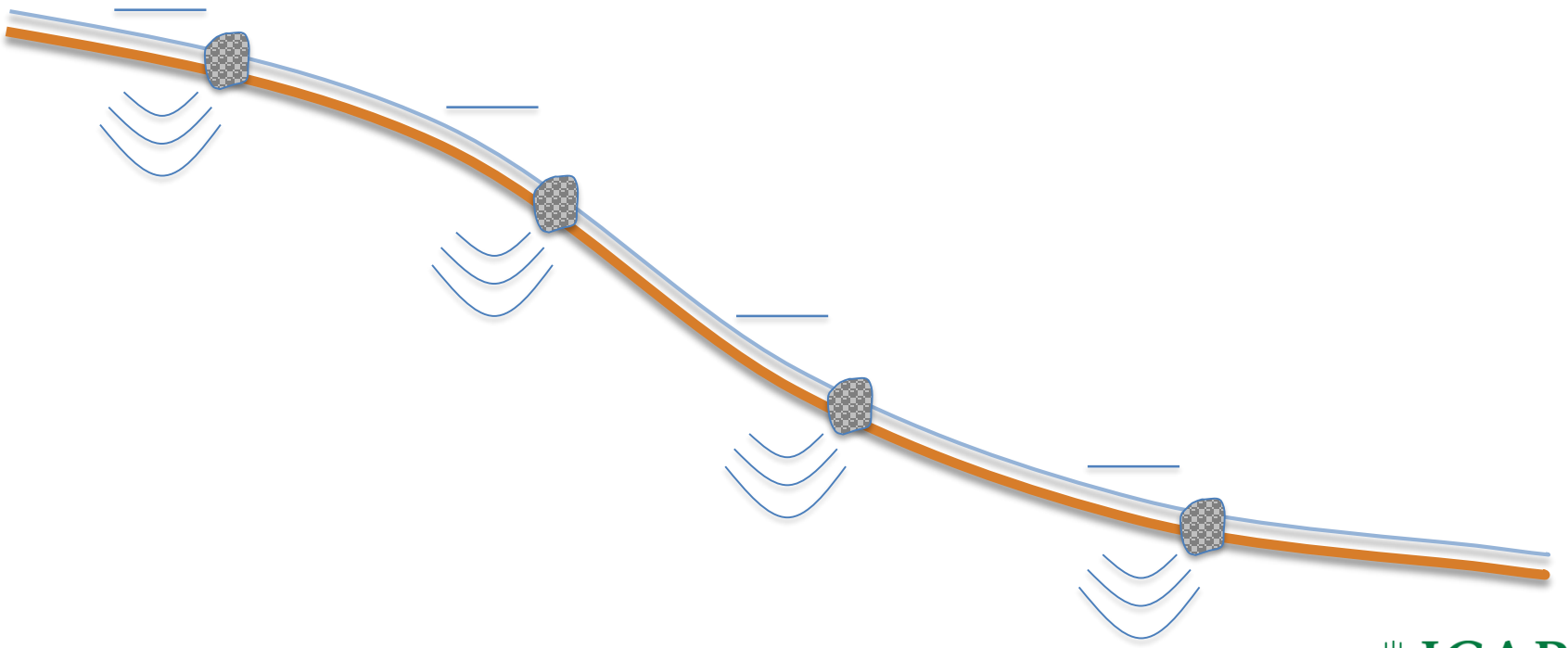
Stone Bunds

System

- Intersection of the hill slope
- Deceleration and filtering of the runoff suspension at the stone bund
- Local ponding and enforcement of infiltration at the stone bund



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Stone Bunds

Application
- *Rainfed systems*
- *Usually annual cropping and perennial (non woody)*

Environment
- *Terrain/slope: moderate – not flat or very steep*
- *Soil depth: > 20 cm*
- *Rainfall regime: very variable! (commonly 500-1500 mm)*

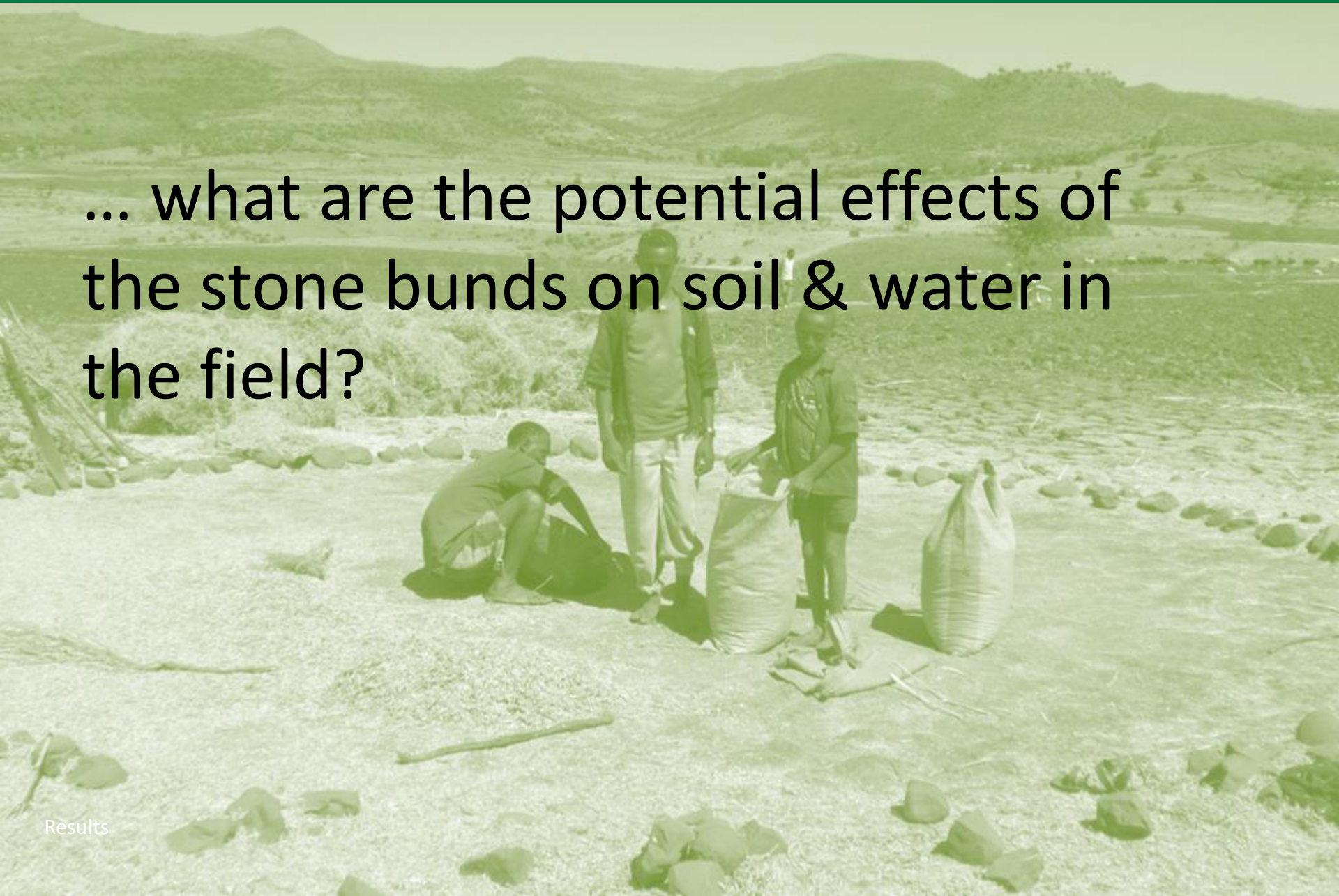
Strength
- *Simple in design and construction*
- *Cheap in application (partially labor intensive (appr. 20-50 working days per hectare)*
- *Local materials*
- *Reliable if maintained*
- *Enhances soil moisture*
- *Prevents erosion*

Weaknesses
- *Mostly for gently sloped grounds (not flat or very steep)*
- *Can lead to local water logging (impacts on cropping)*
- *Require maintenance*
- *Create problem in case of insufficient design (back-cut erosion)*

Stone Bunds

Stone Bunds

Research question

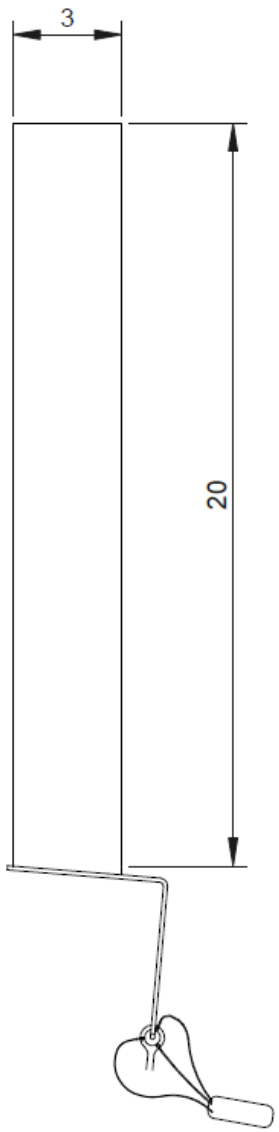


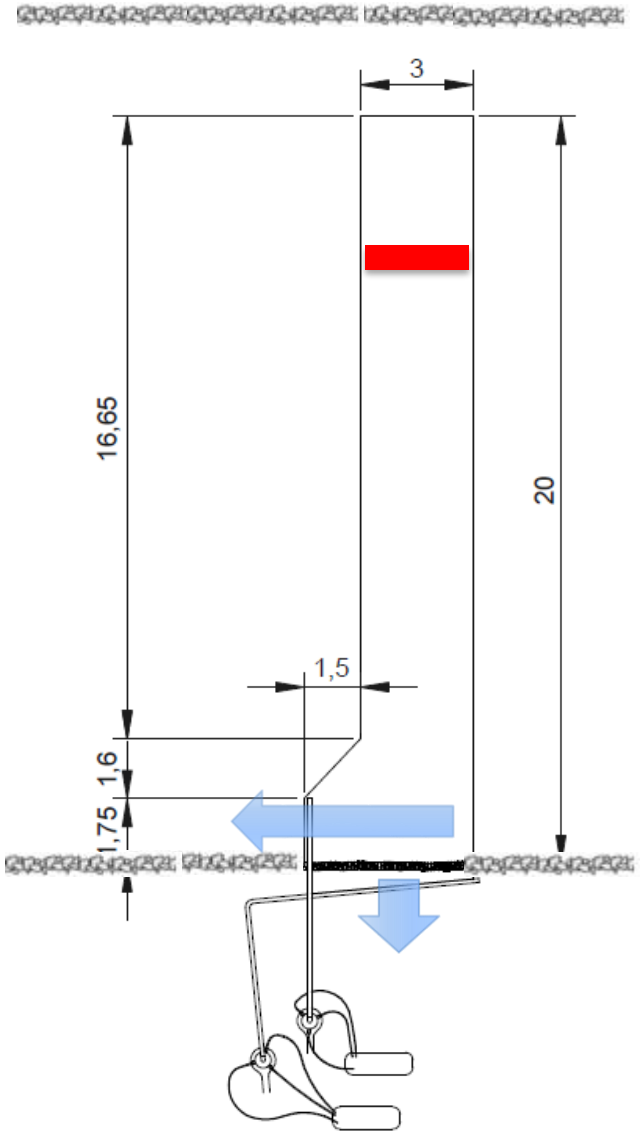
… what are the potential effects of the stone bunds on soil & water in the field?

Plot scale

Untreated hill slope

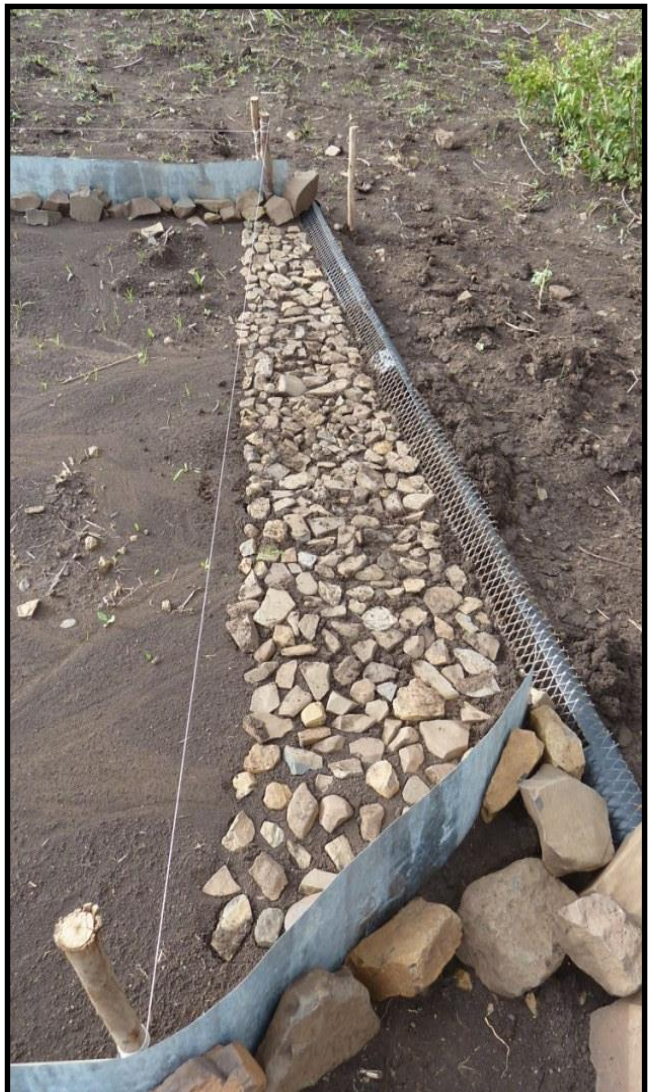
Treated hill slope





Plot experimental set-up

Untreated plot

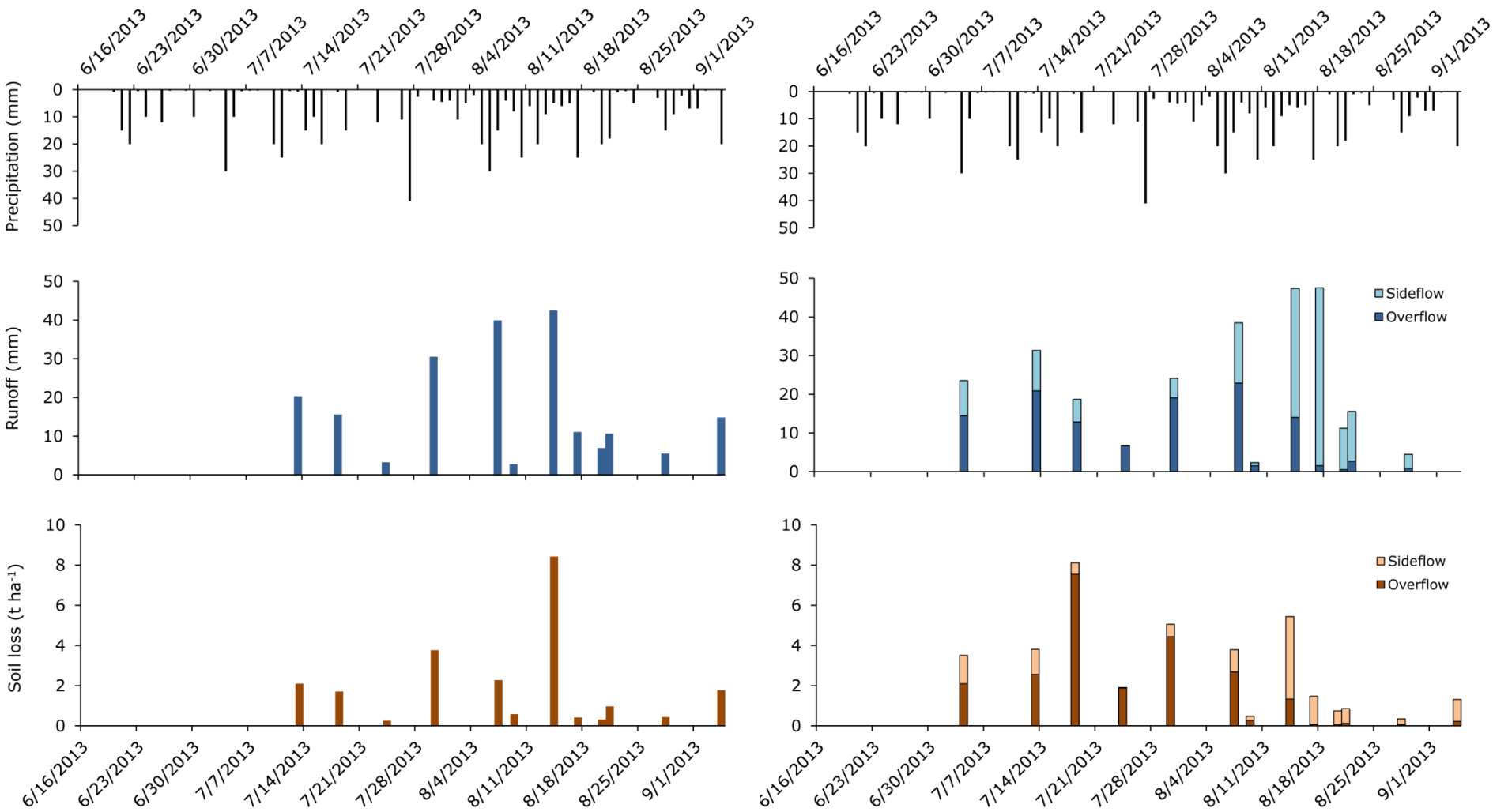


Treated plot

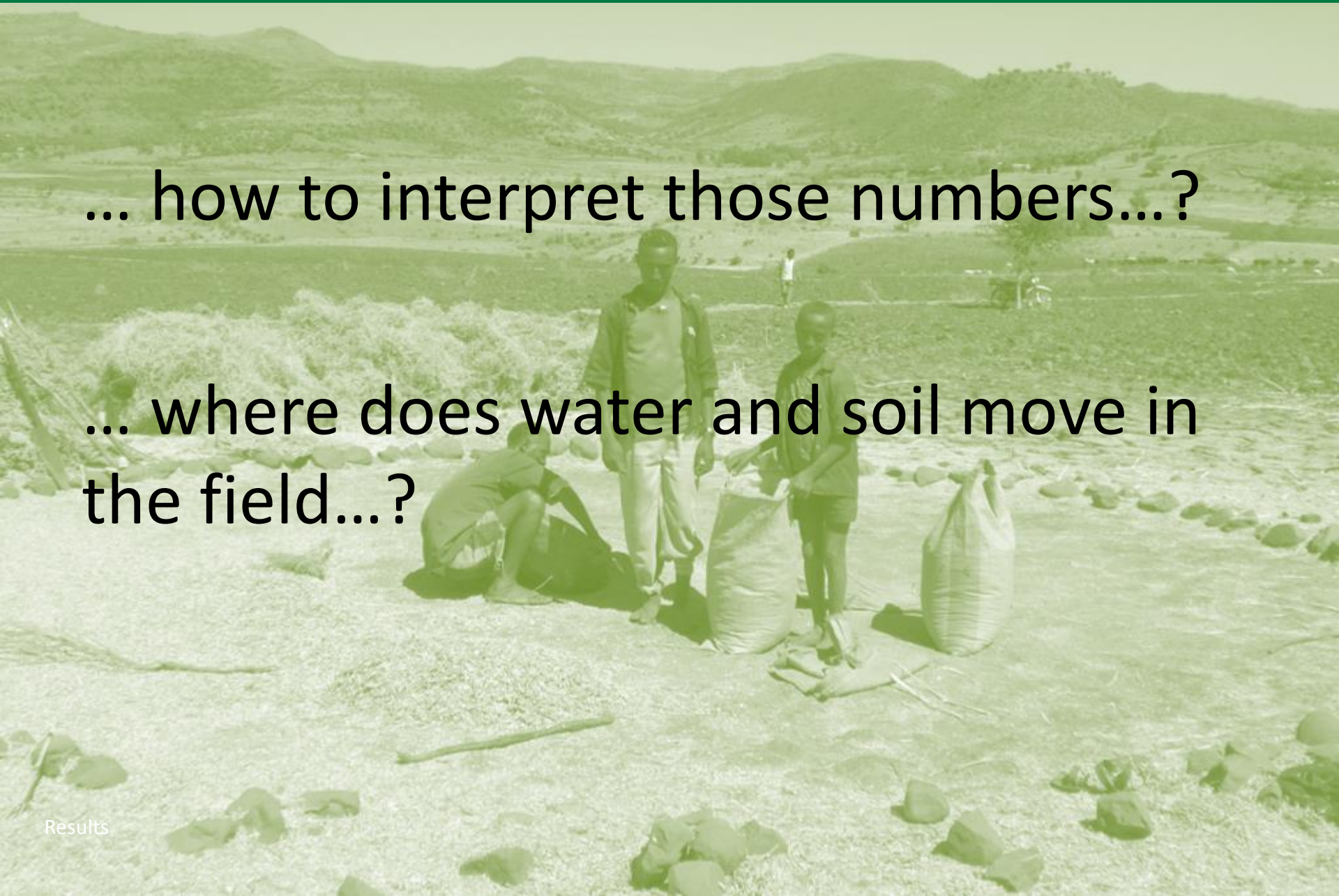
Plot experimental results

Untreated plot

Treated plot



Farmers question



… how to interpret those numbers…?

… where does water and soil move in the field…?

The path of the water – soil moisture experiment

Transect soil moisture monitoring

Untreated hill slope

Treated hill slope

Resolution

Appr. 1-3 m interval

Depth: 10, 20, 30, 40, 60, 100 cm

Temporal: circa 1-2 x weekly

Output

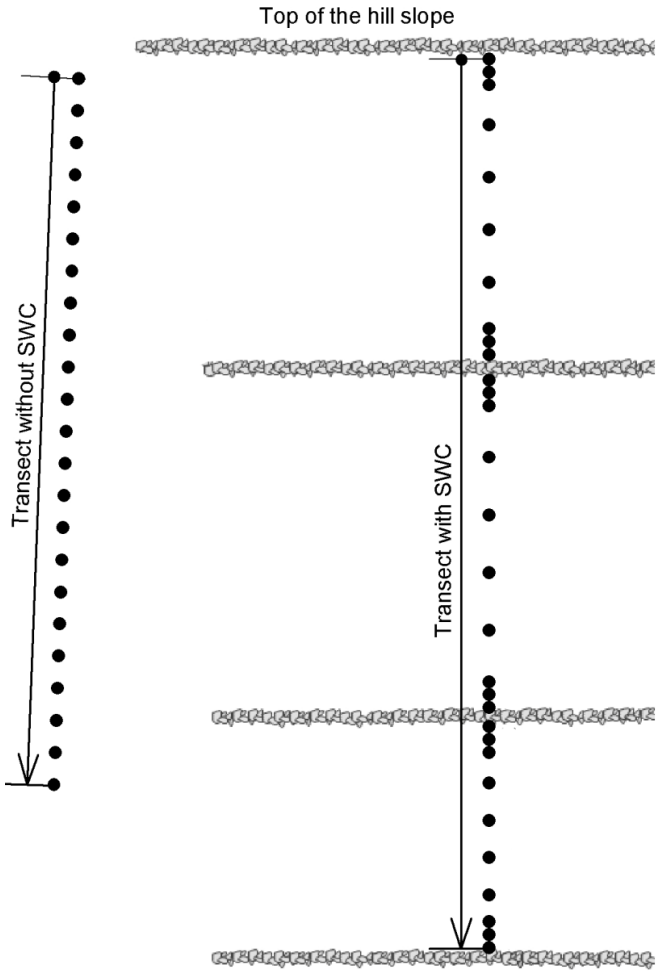
DC voltage <- soil moisture (Calibration)

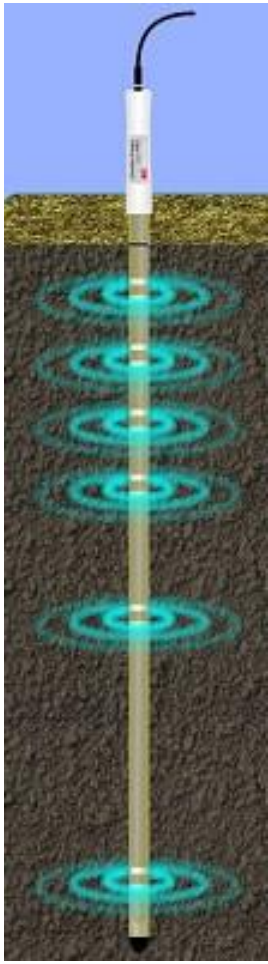
Limitation

Soil cracks

High clay content

Stones





kind thanks to Christoph Schürz et al. from BOKU

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The path of the water – soil moisture experiment

Drilling the hole

Inserting the tube

Prepared device

Reading out the data

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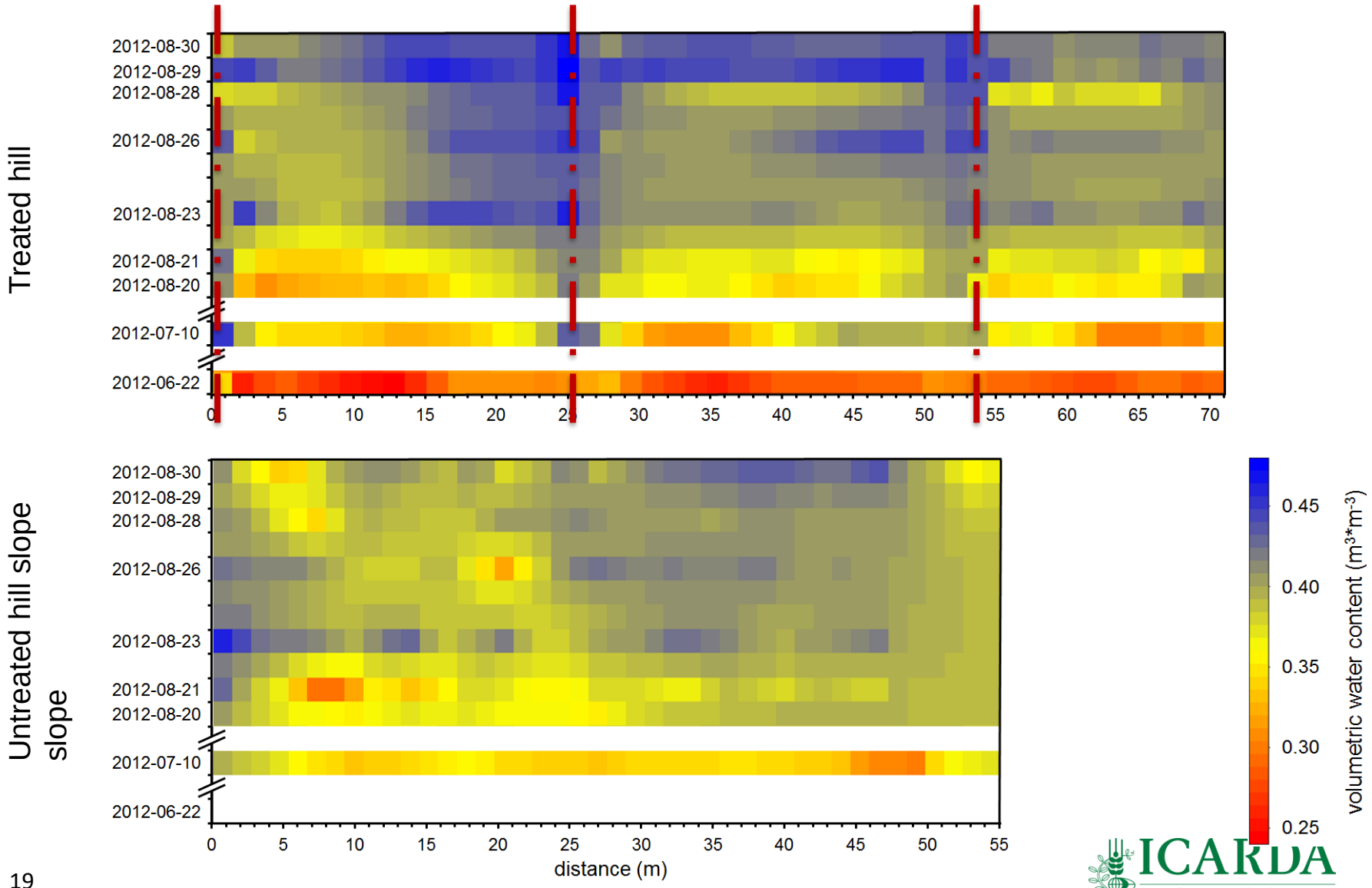
The path of the water – soil moisture experiment



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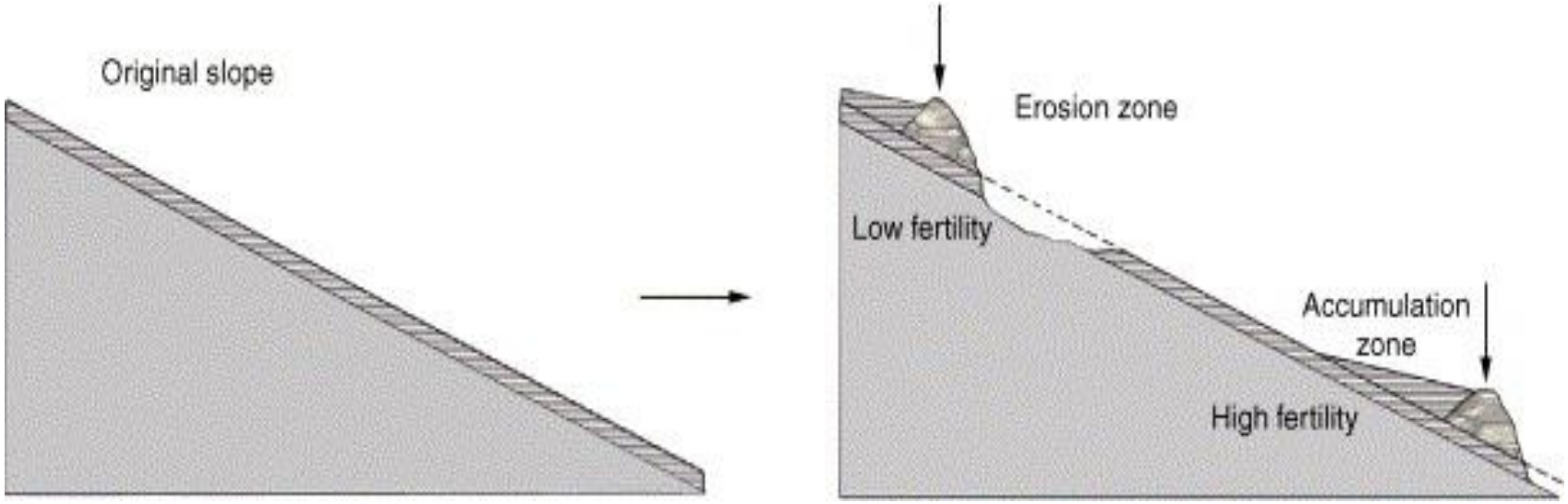
The path of the soil (sediments)



Source: Vancampenout et al. 2006

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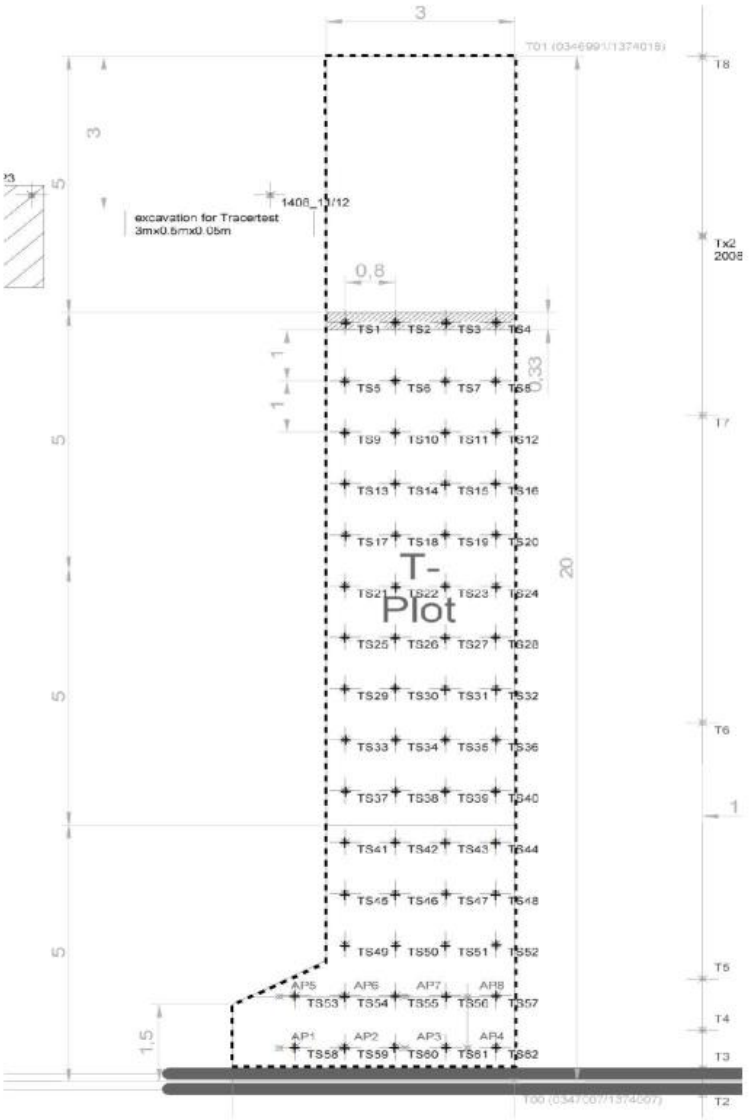
The path of the soil – tracer experiment



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The path of the soil – tracer experiment

Tracer measurement

- Field sampling using 2.5 cm core cylinders
- Transportation of the samples to CSIC Cordoba for measuring magnetic susceptibility in the lab

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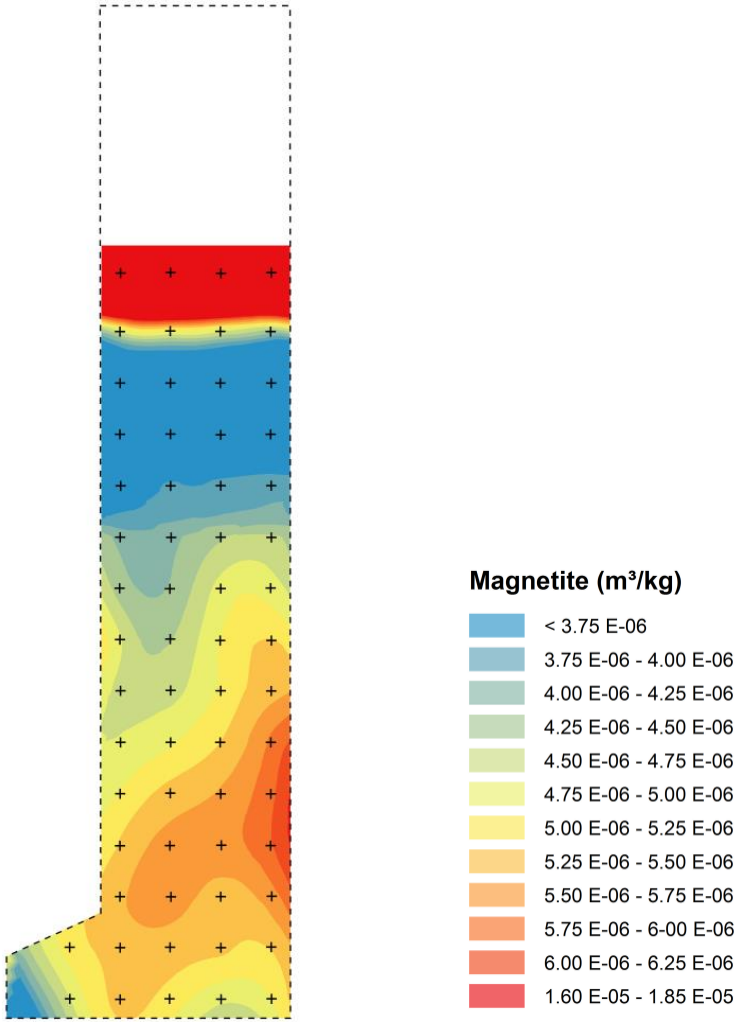
The path of the soil – tracer experiment



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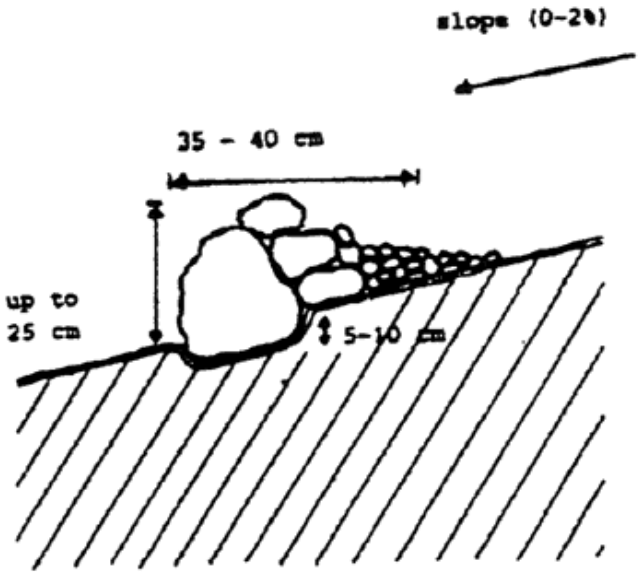
Effects on the stone bund design

Stone bund design

- Dimension of the structure (thickness, height)
- Spacing between the bunds
- Continuous or laterally interrupted
- Stone bund compound
- Contoured our graded bund layout (runoff routing)
- Bare or protected at the stone bund (grass, shrubs, ...)



-> WOCAT

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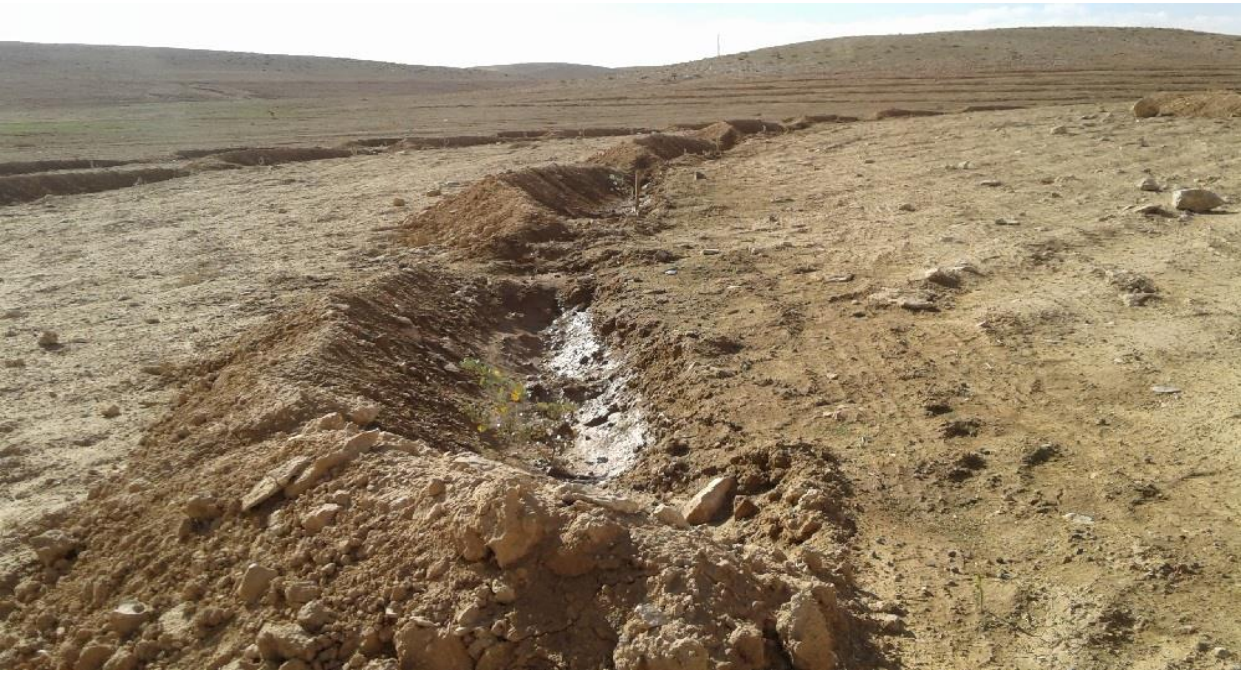
Watershed Restoration in Badia Areas of Jordan
Technology Packages for Controlling and Monitoring Gully Erosion

Jordan's rangelands, the Badia, were severely degraded during recent decades through influx of about 1.8 million sheep, goats and camels that Iraqi refugees brought during the Gulf War in 1990. Moreover, border restrictions, throughout the Middle East, changed the nomadic lifestyle of the Bedouins; inevitably linked with increased pressure on rangelands (Al-Tabini et al., 2012).



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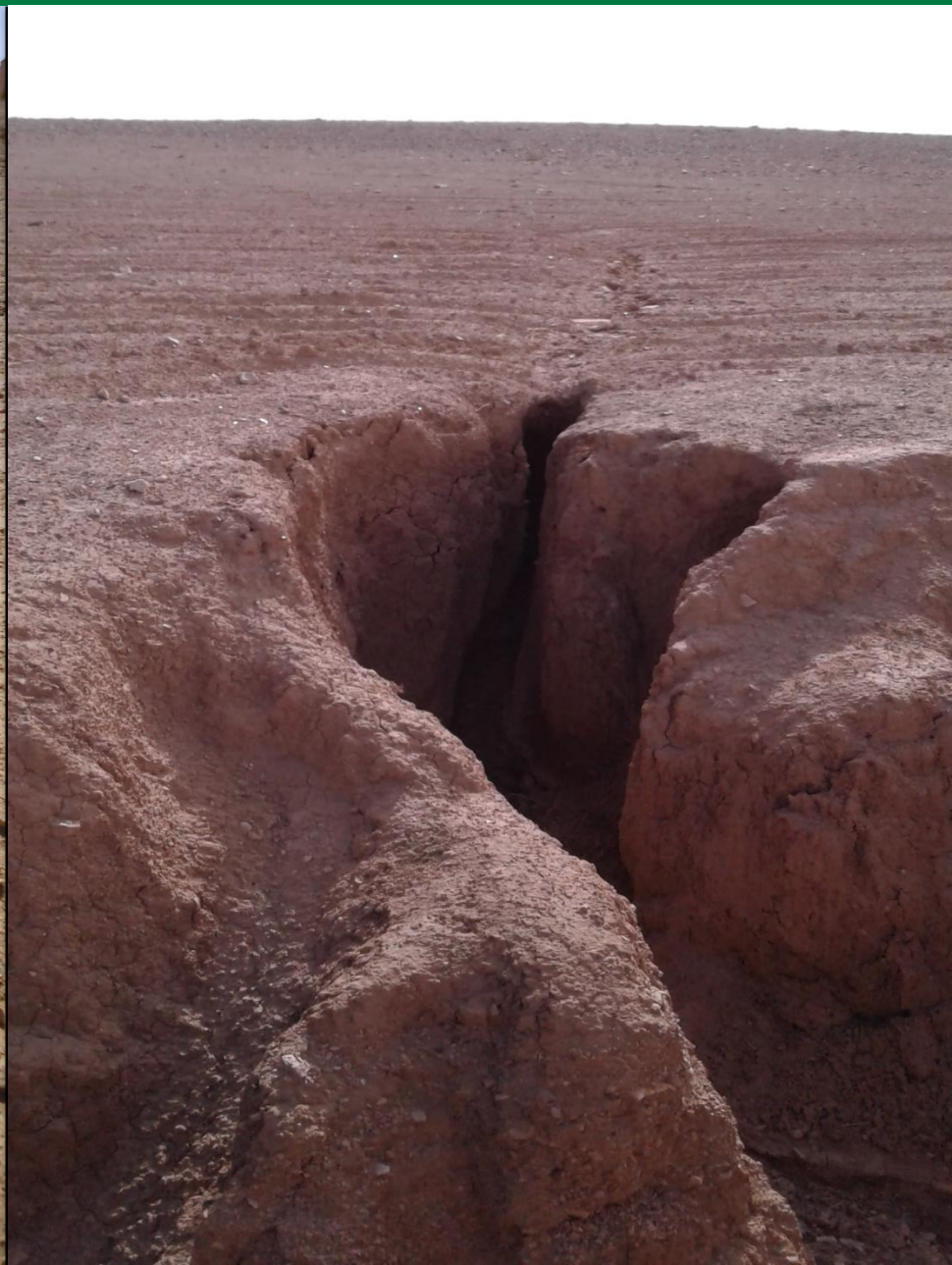
Present Badia Environment



Torrential rain, snow storms and flooding hit the Middle East

People drive past vehicles stranded on flooded streets in the Jordanian capital Amman

Picture: KHALIL MAZRAAWI/AFP/Getty Images

Restoration of Degraded Rangeland Ecosystem - Al Majidyya

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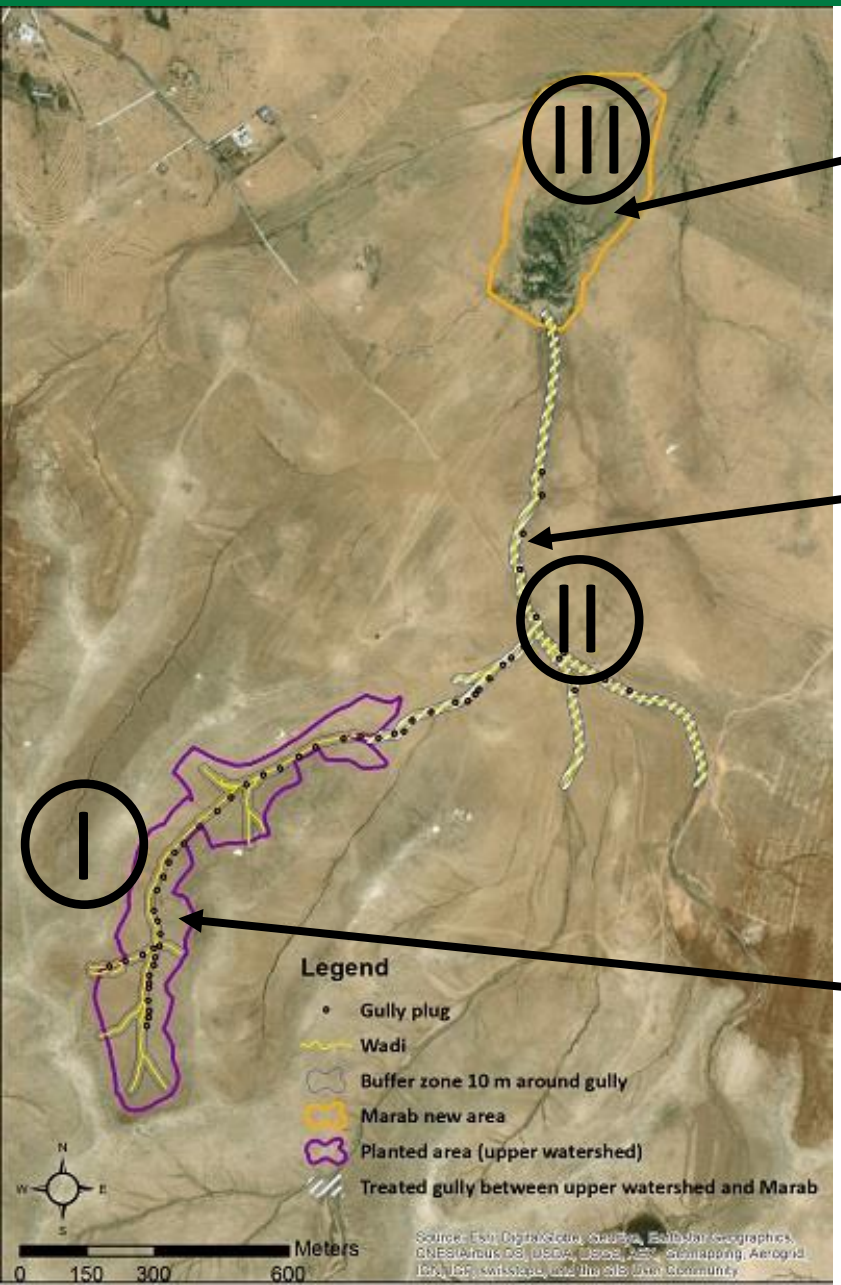
Majidyya Restoration and Research Site (USFS, AFESD, WLI)



Upland watershed retention: Vallerani micro-WH based Restoration

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Vallerani Plow

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Vallerani Plow

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Outplanting of shrub seedlings

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Counter-Measuring Degradation: Vallerani micro-WH based Restoration

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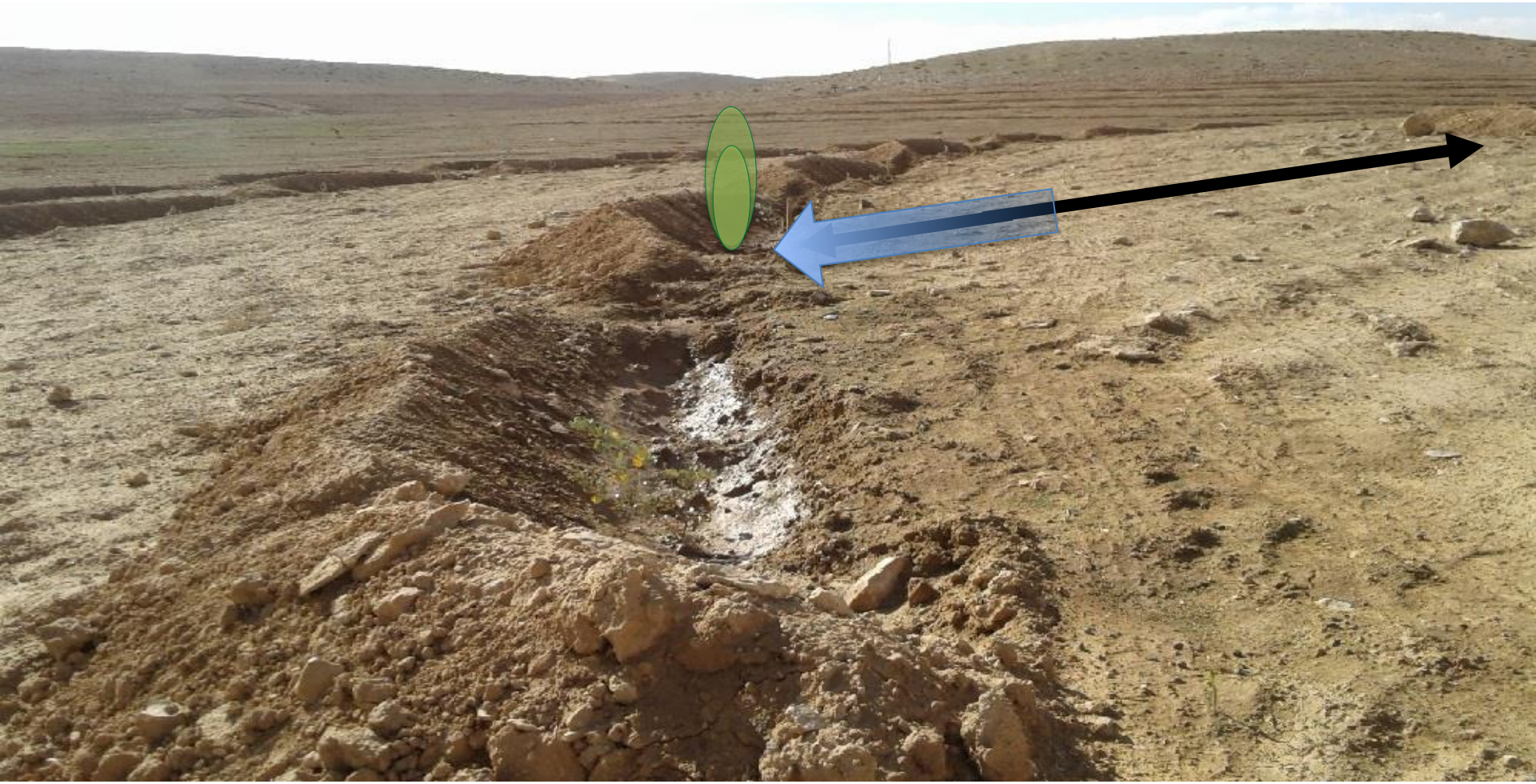
Retention of Rainwater -> Shrub Growth



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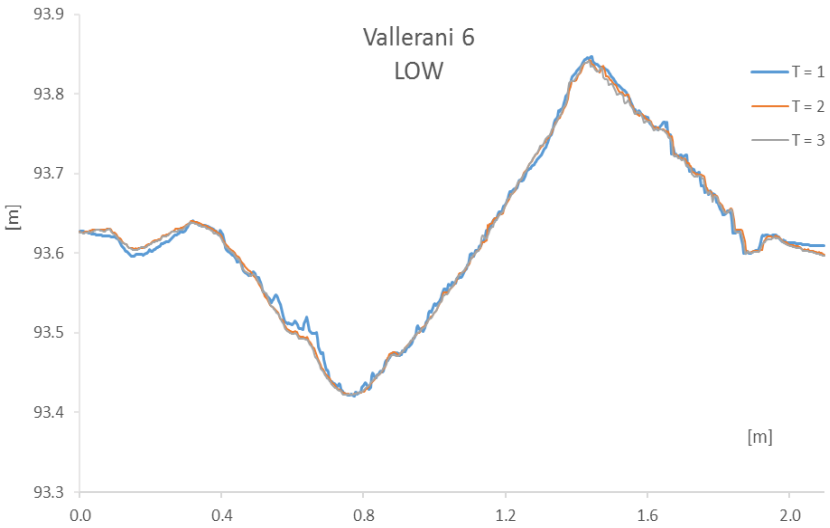
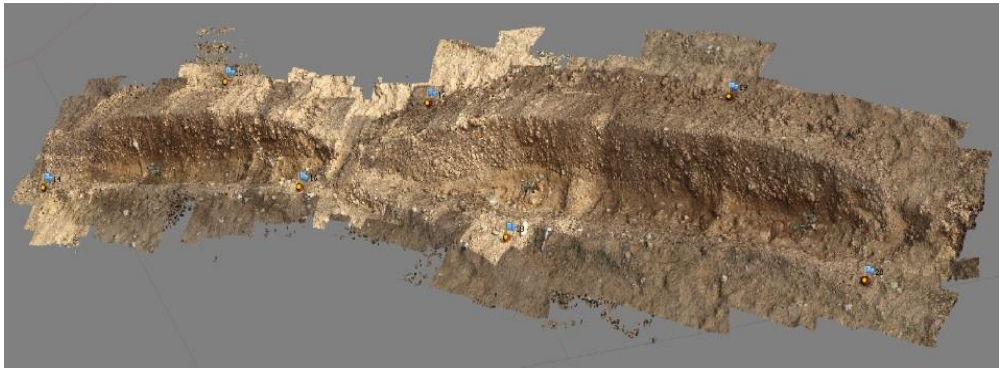
Micro-WH study

			T1	T2	T3
TOP		Area	2.77	2.80	2.81
	1	Volume	0.29	0.28	0.28
		Area	2.36	2.42	2.53
	2	Volume	0.21	0.18	0.20
MID		Area	2.11	2.20	2.20
	3	Volume	0.18	0.17	0.17
		Area	2.11	2.19	2.18
	4	Volume	0.17	0.18	0.18
LOW		Area	2.57	2.75	2.63
	5	Volume	0.26	0.26	0.27
		Area	2.68	2.71	2.69
	6	Volume	0.23	0.23	0.20





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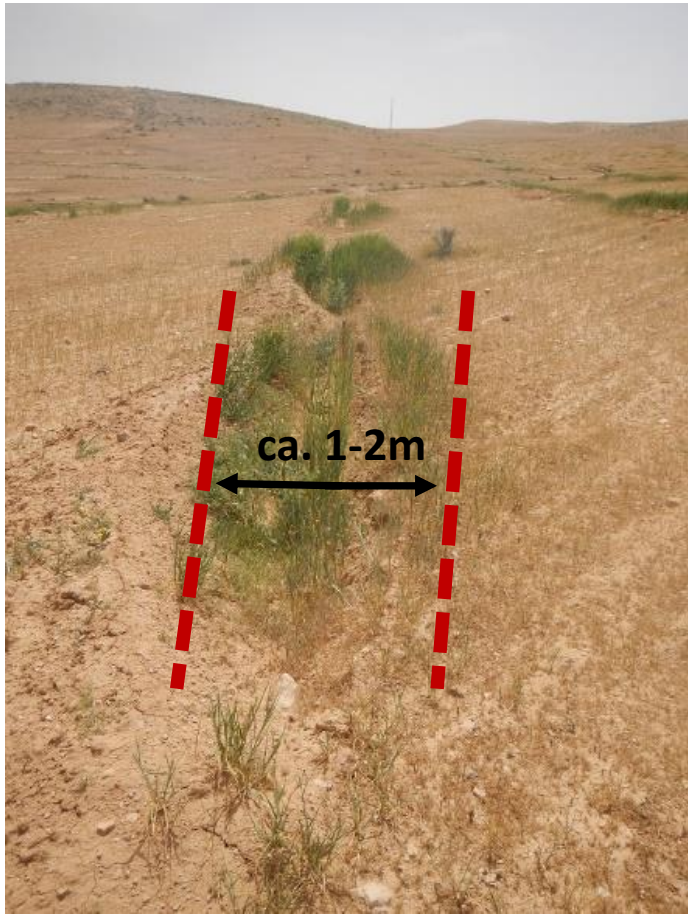
After one year…

Micro-WH study



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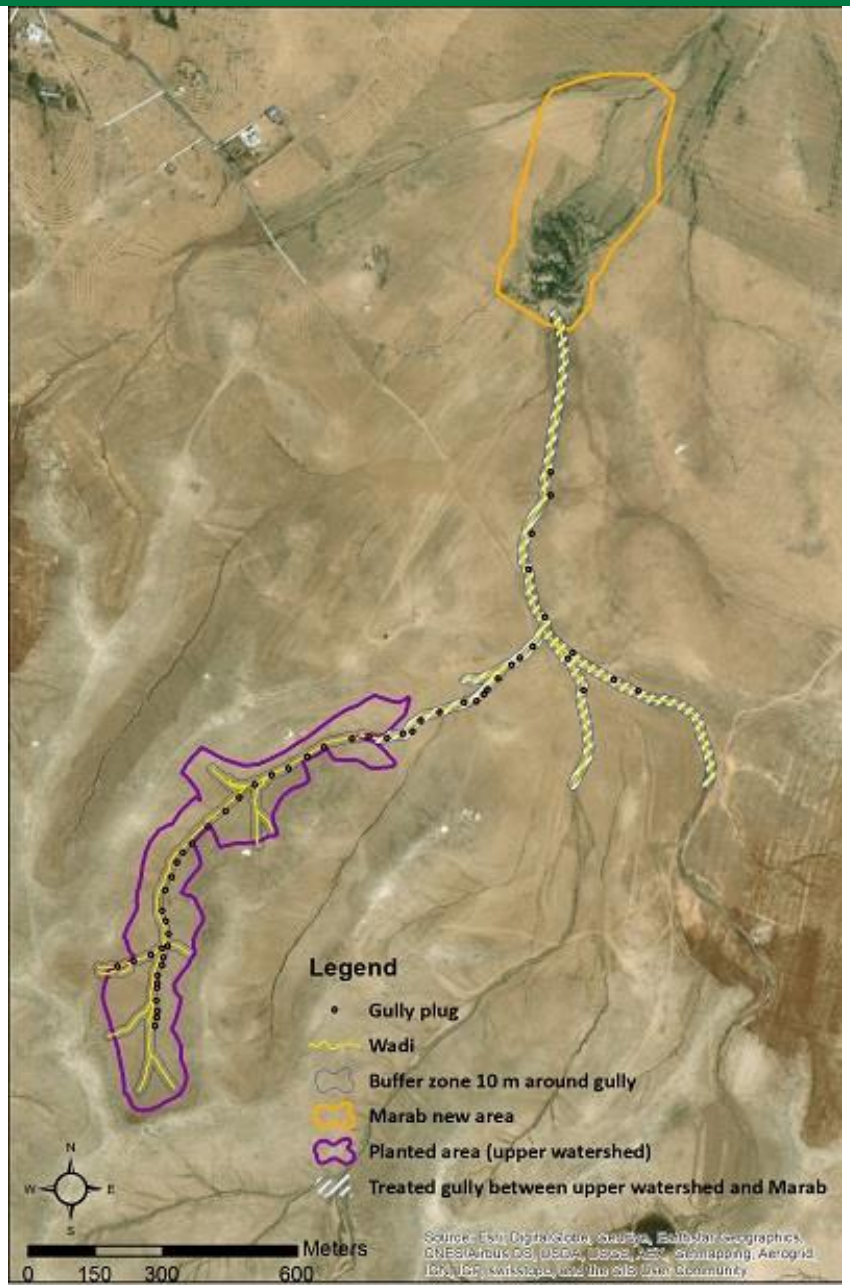
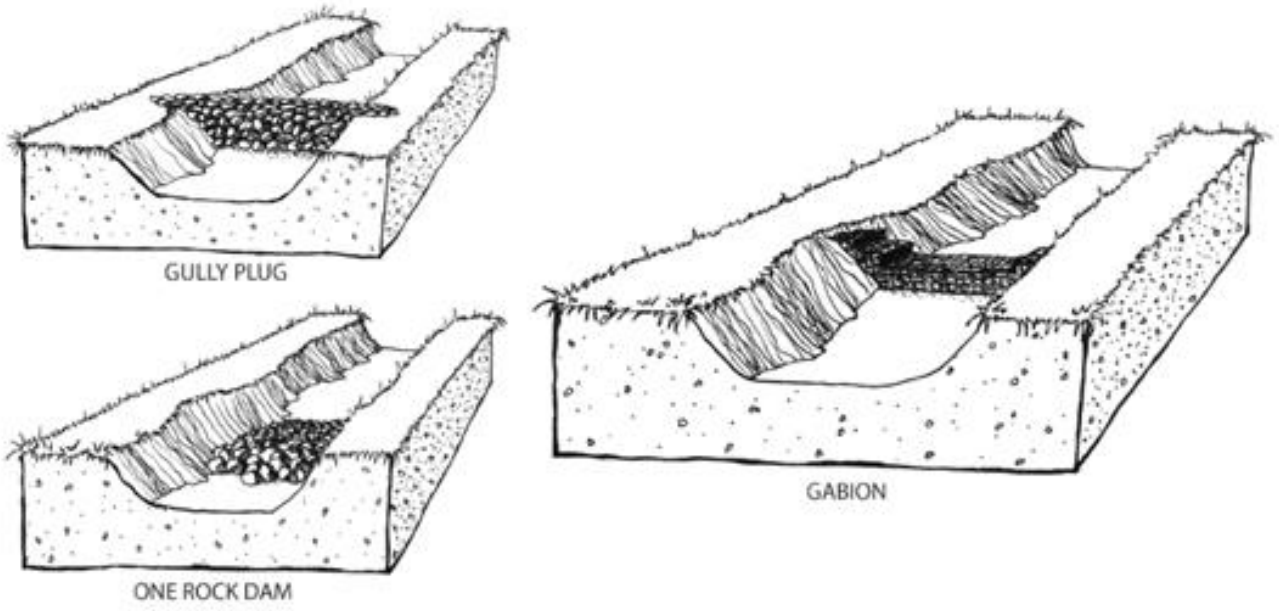
Trade Off – OPTIMIZATION (Upstream-Downstream)



Channel

Gully plug

Design of the structure



Source: USGS

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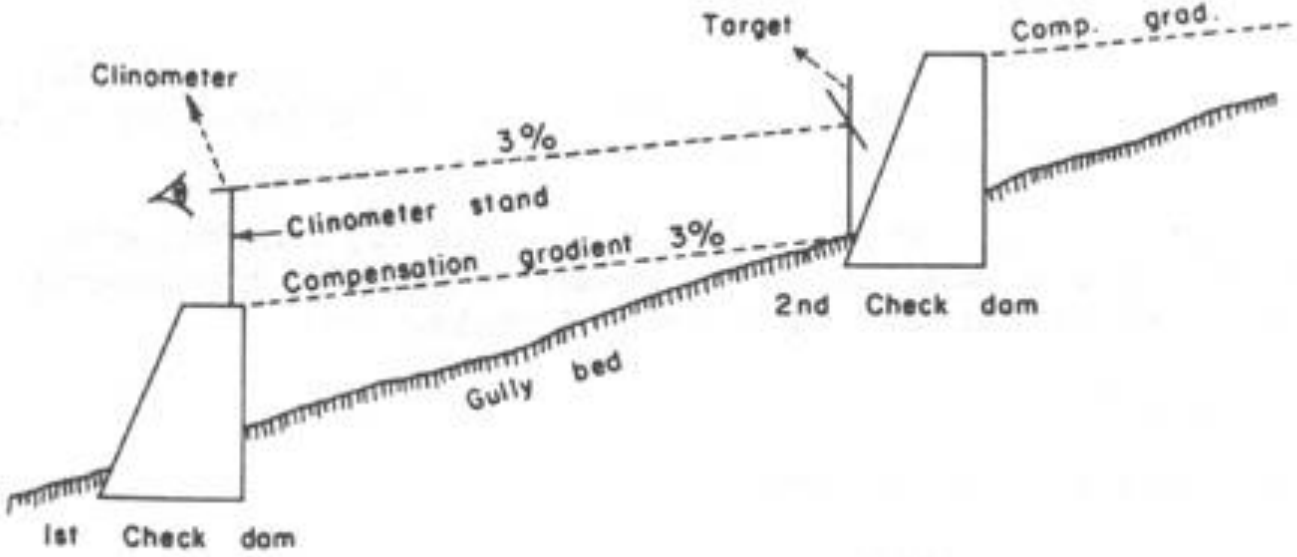
Gully plug

Design of the system



Source: FAO

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Gully plug – ‚Badia' design

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