SWISS NGO DRR PLATFORM
Climate & Disaster Resilience

ICARDA
Science for resilient livelihoods in dry areas

BOKU
150 JAHRE NACHHALTIG VORAUSSCHAUEN 1872 - 2022
UNIVERSITÄT FÜR BODENKULTUR WIEN

Assessing ecosystem services and health in space and time

Soil - Water - Plant

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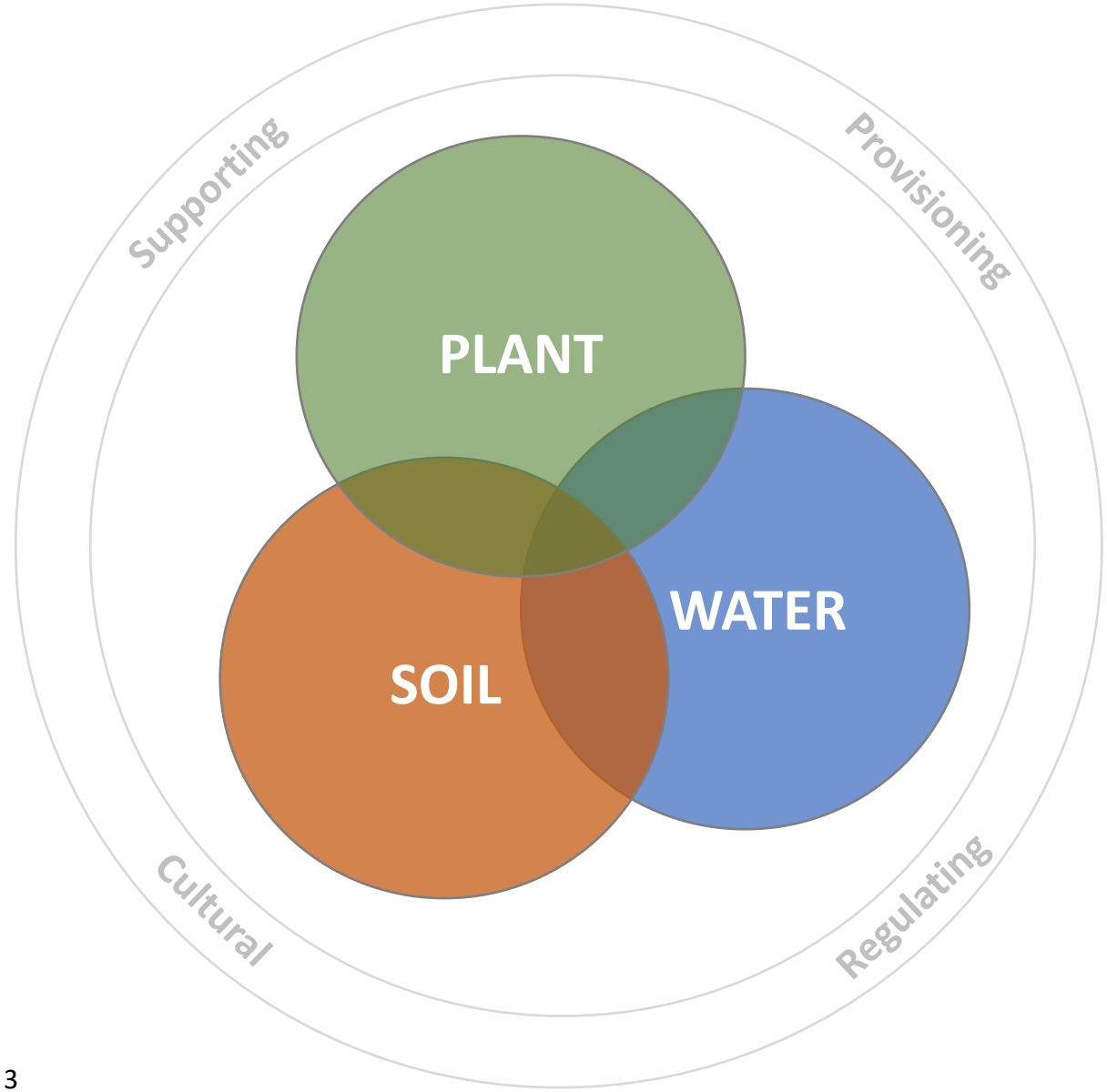
Degraded lands in East Africa and Middle East

Ecosystem services & soil health



Soil (water) health indicators

Physical
Chemical
Biological

-> Biophysical Land Degradation

Assessing ecosystem services and health in **space** and time

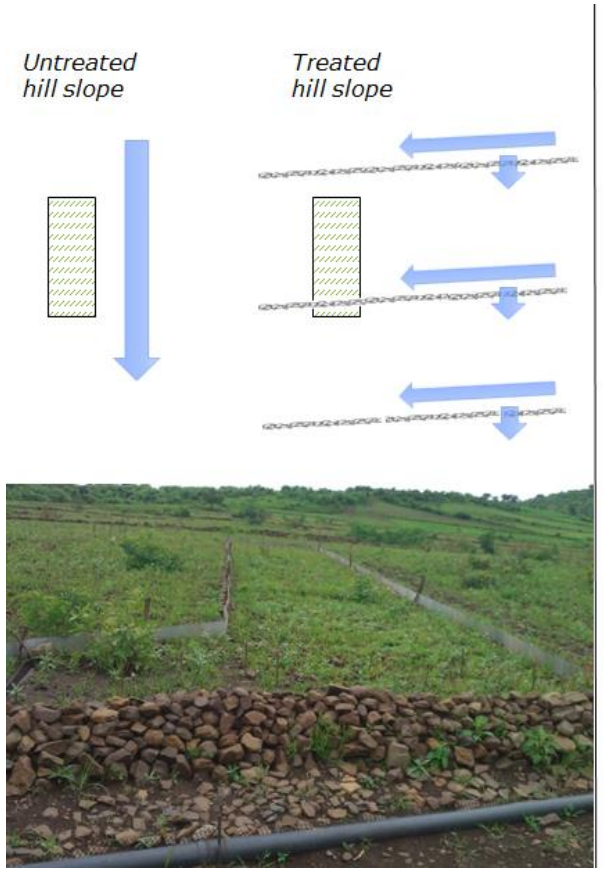
Combating land degradation in the Ethiopian highlands: Gumara Maksegnit case study

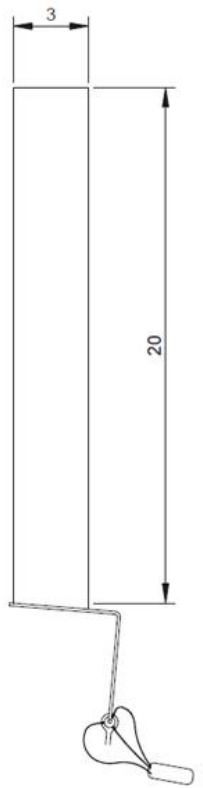
As a consequence of the severe famines in 1973 and 1984, the Ethiopian Government initiated large-scale Soil and Water Conservation and landscape rehabilitation programs to prevent further degradation and enhance agricultural productivity (Hurni, 1985) – among these the implementation of stone bunds.

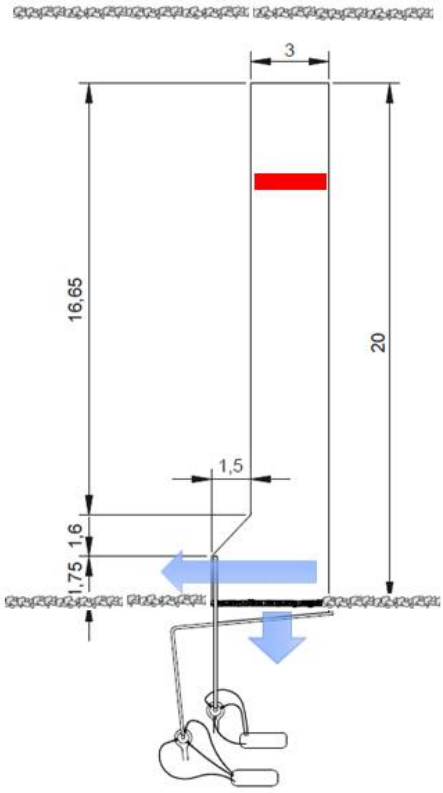
Field level monitoring using runoff plots

What happens at the farmers' field level?

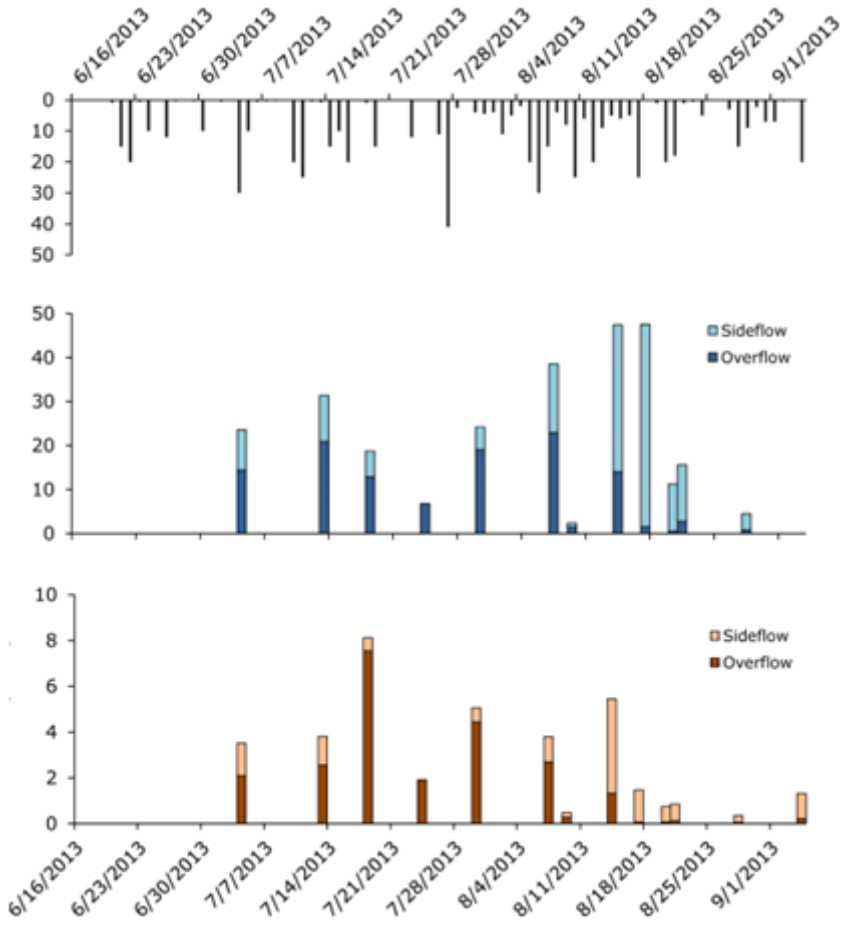
Where do water and soil go?







Stone bund runoff plot results



Observation period

4.7-4.9.2013	14.08-04.09.2013	

Rainfall

	533	150	mm

Surface Runoff

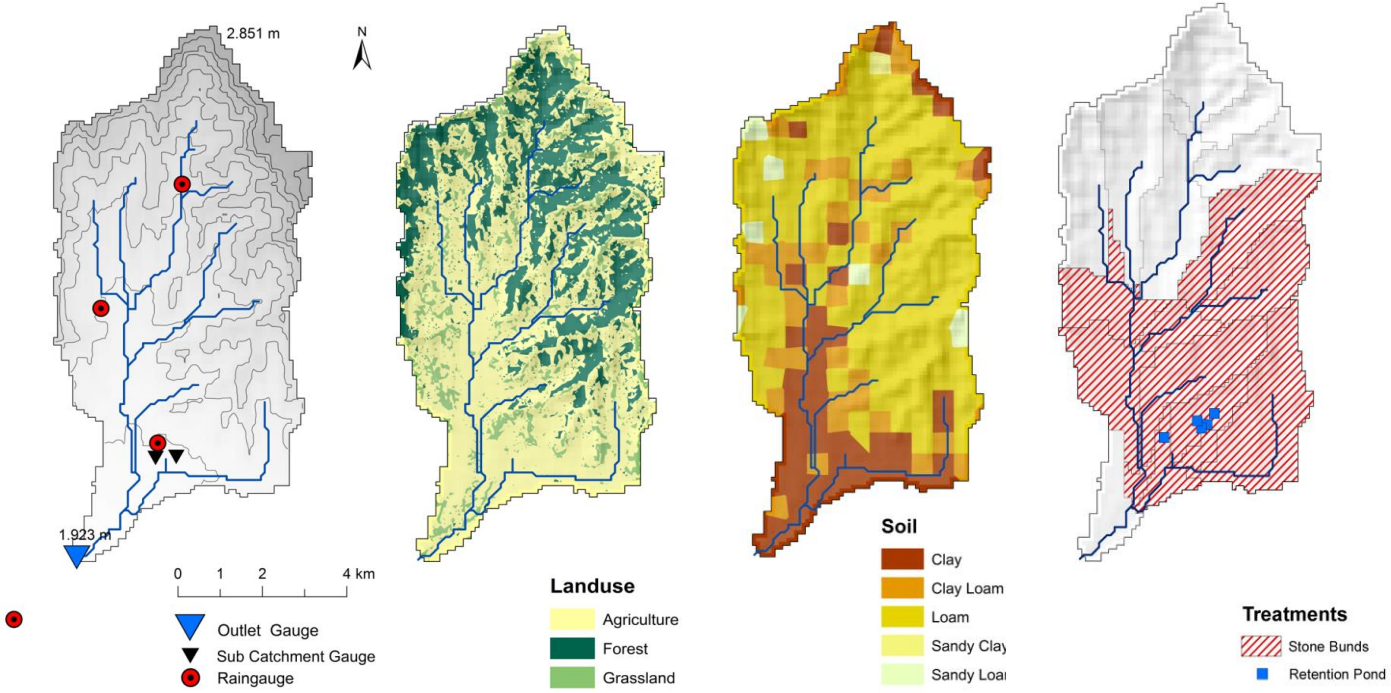
UT	204	91	mm
TOF	121	23	mm
TSF	167	120	mm
TOF/TT	**0.42**	**0.16**	

Sediment yield

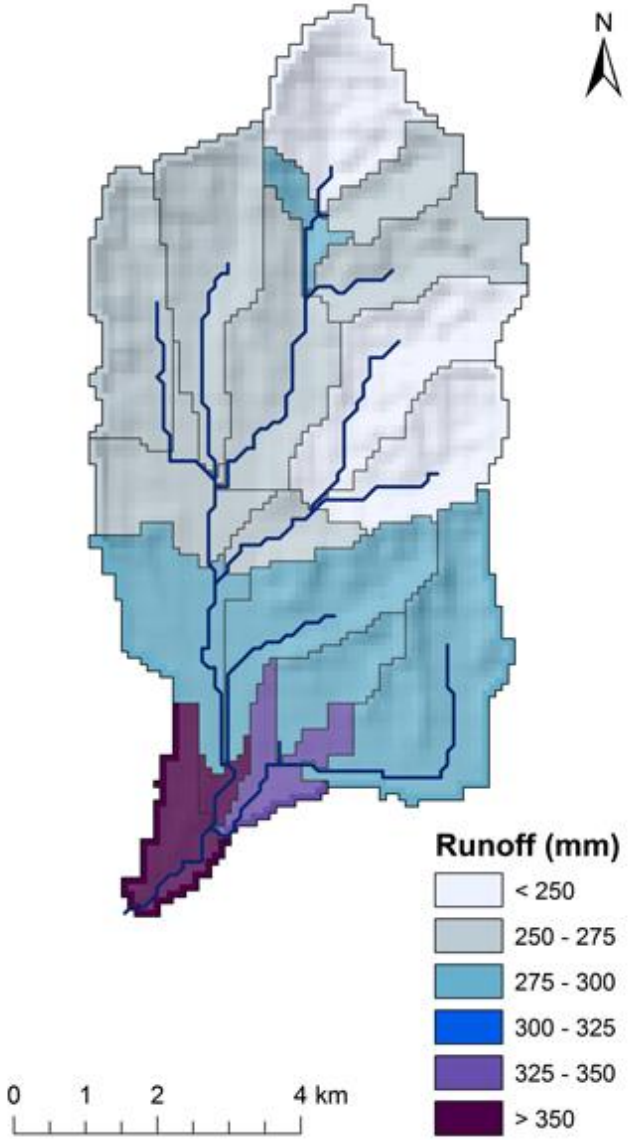
UT	23.0	12.3	t ha^{-1}
TOF	23.3	1.9	t ha^{-1}
TSF	13.5	8.3	t ha^{-1}
TOF/TT	**0.63**	**0.18**	

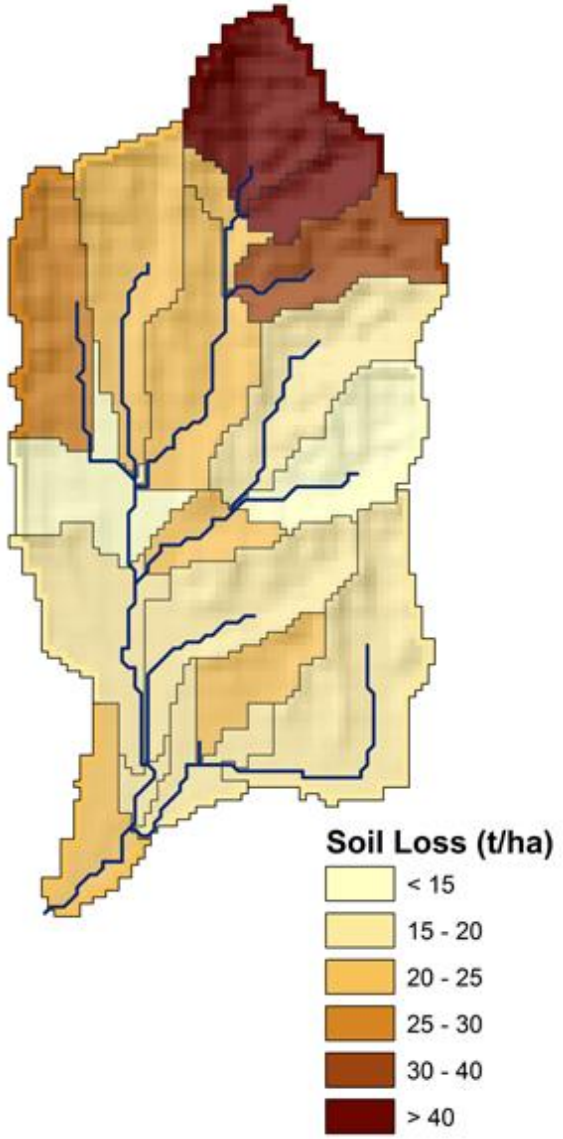
Watershed modeling: Environmental data (input)

- Climate
- Topography
- Soil
- Land cover & management

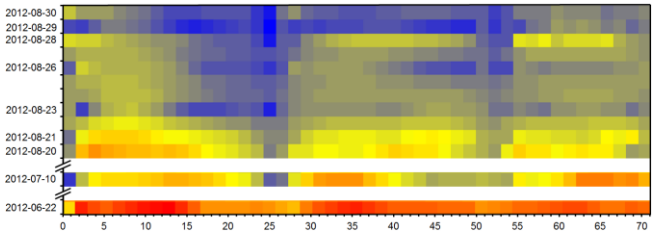


Watershed level surface runoff and erosion

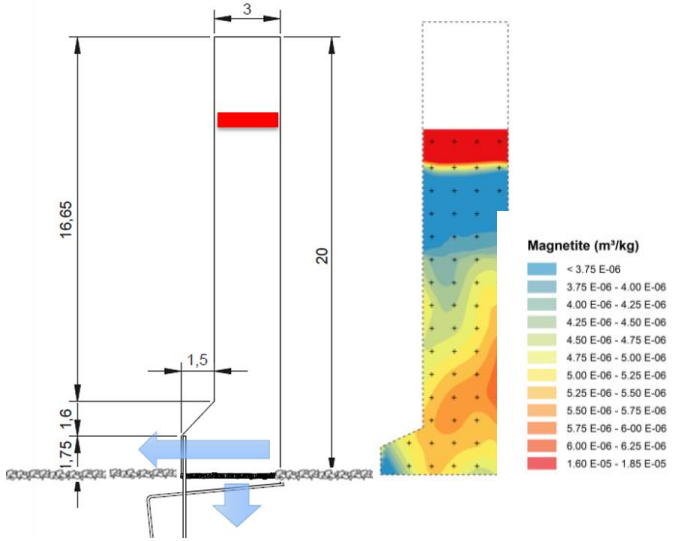




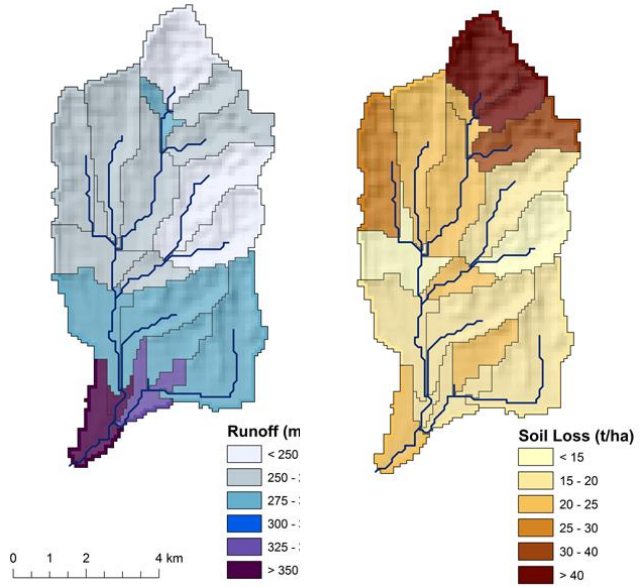
Using field measurements for spatial assessment

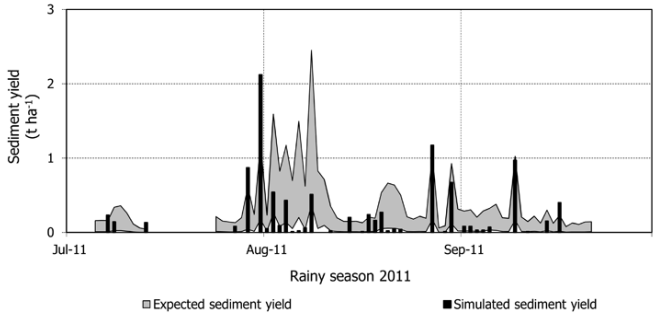


Water



Soil

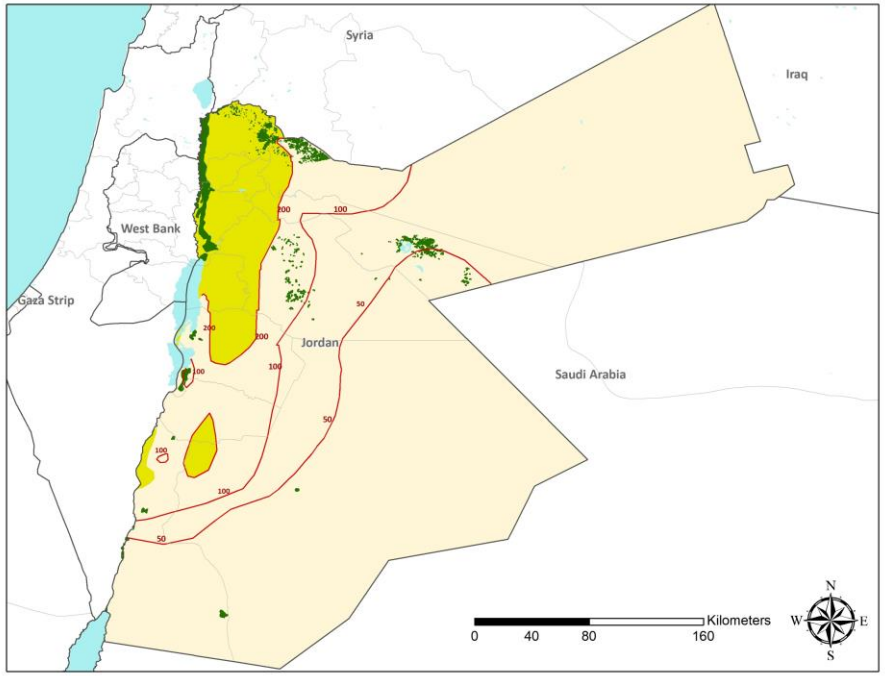




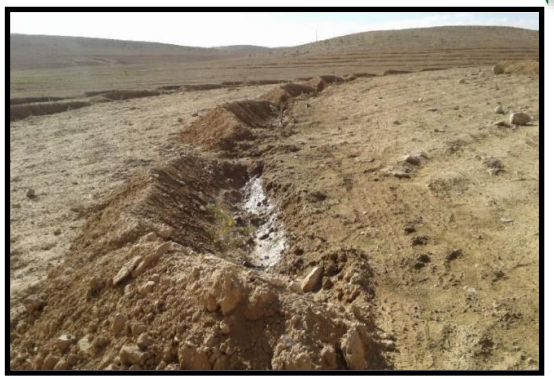
Landscape

Assessing ecosystem services and health in space and **time**

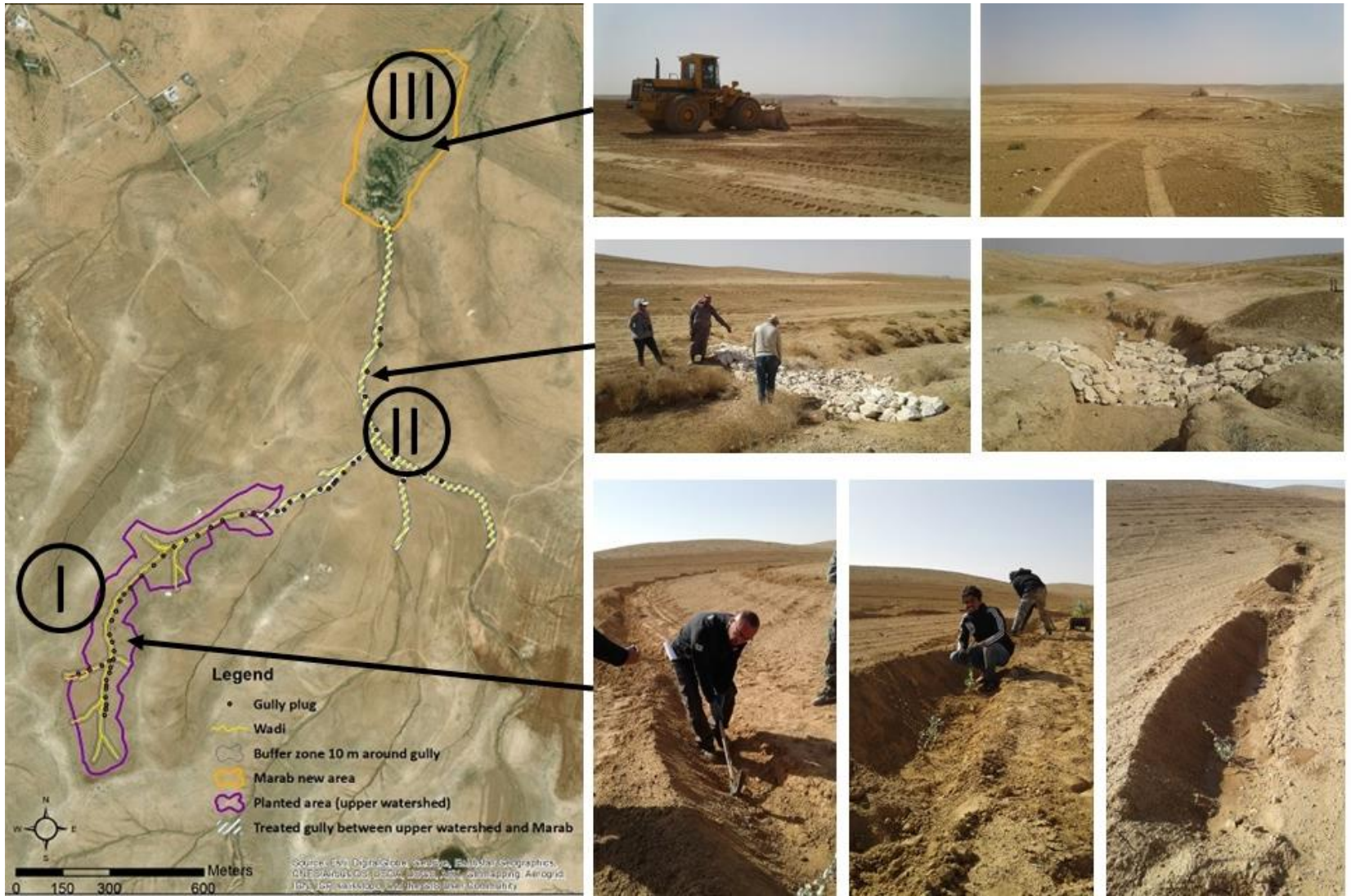
Dry rangeland degradation: Jordan Badia case study



Ecosystem status transition



Watershed rehabilitation using Water Harvesting



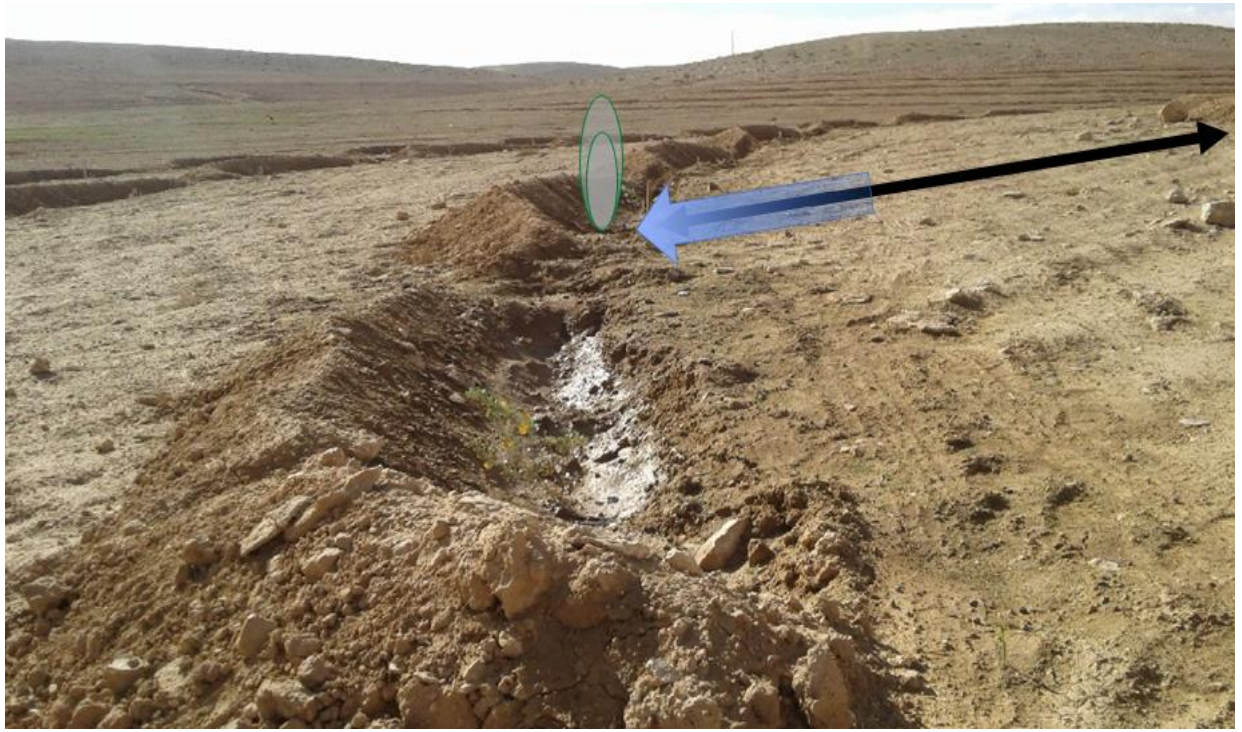
Water Harvesting interventions

I) Uplands: mechanized micro water harvesting (Vallerani plow)

II) Gully system: gully plugs and side-bank stabilization through vegetation

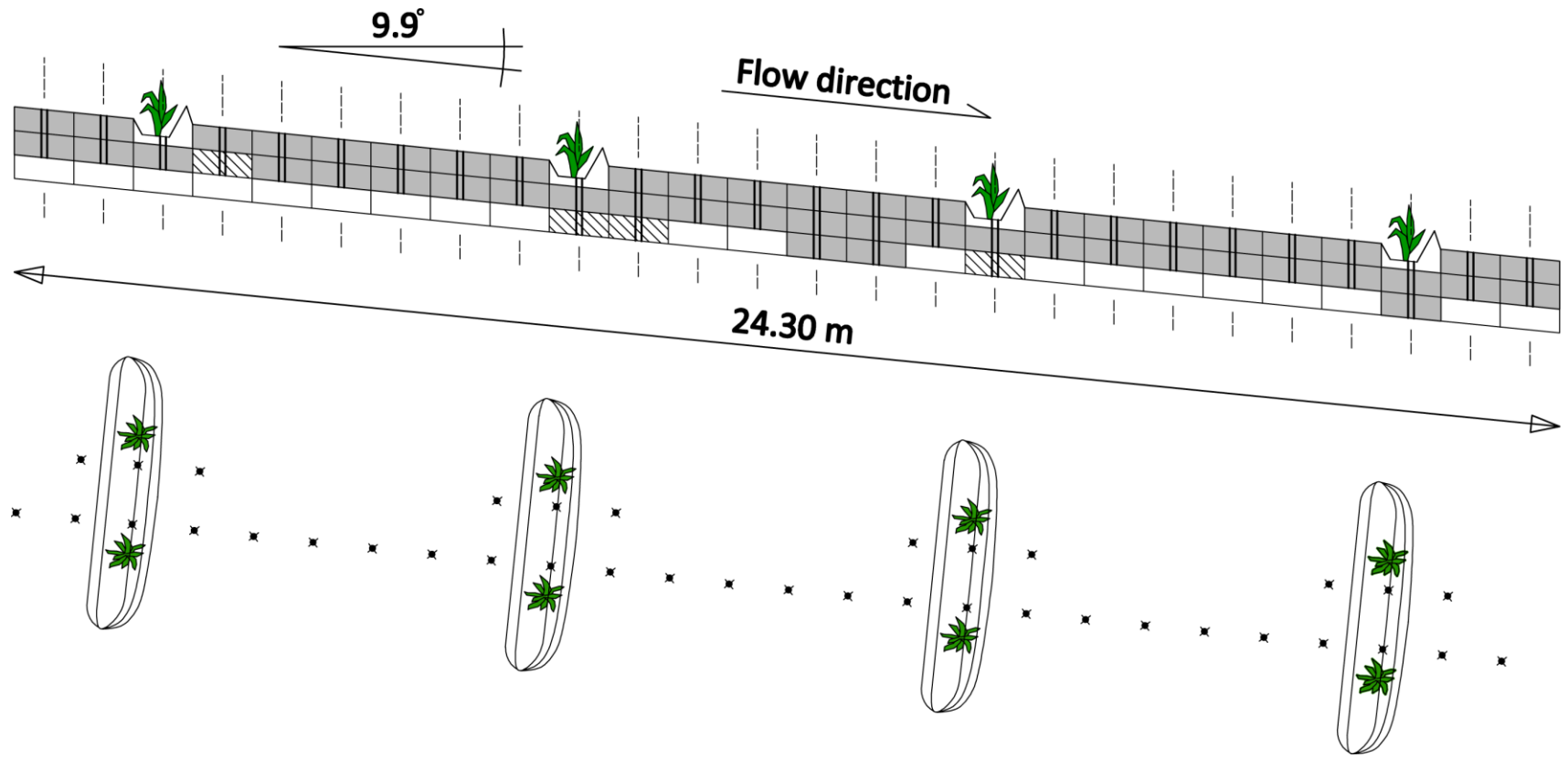
III) Lowland depressions (Marab): Floodwater harvesting based localized high-yield agriculture

Mimicking ‘healthy’ upland hydrology

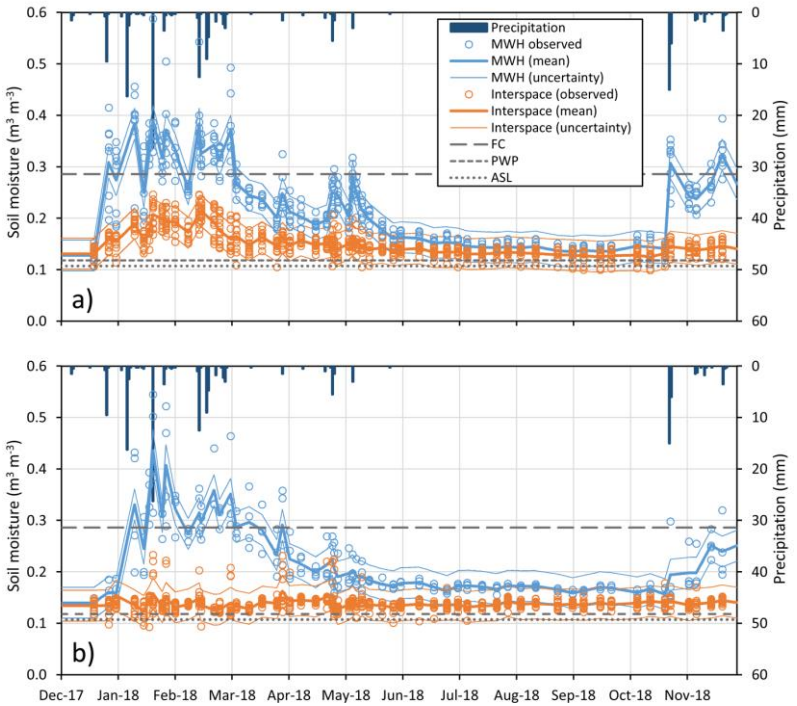


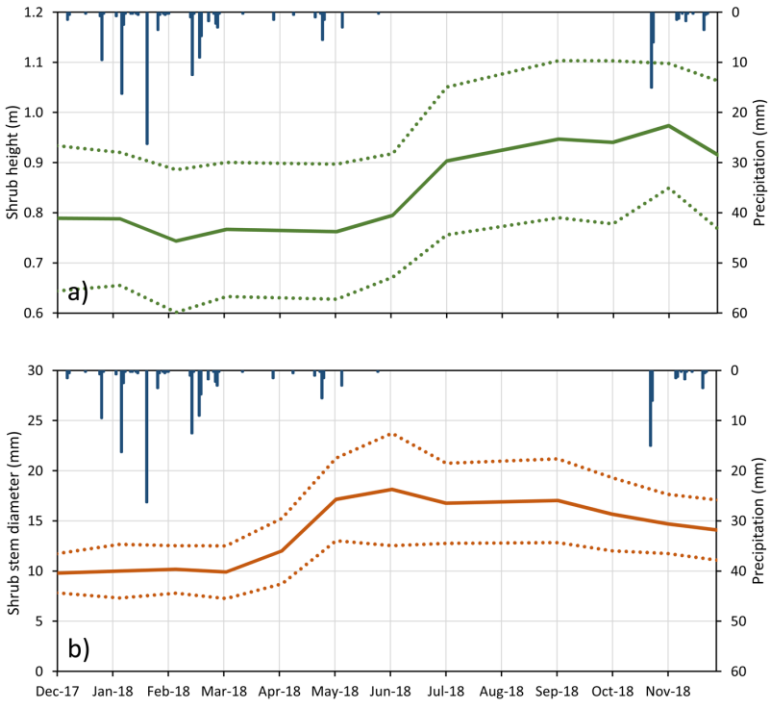
Soil moisture monitoring

Transect across a hill slope



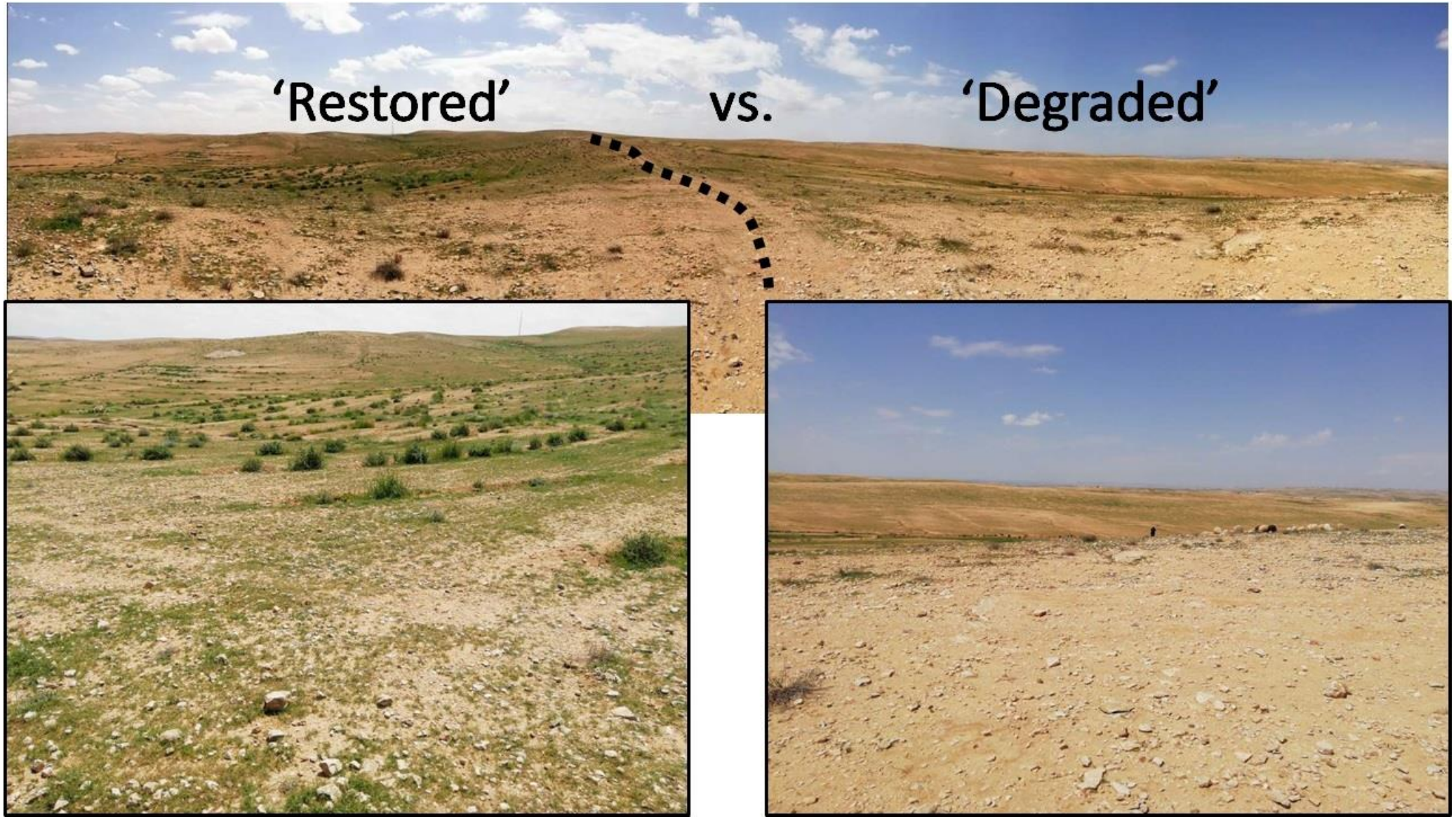
Soil water -> boosting vegetation





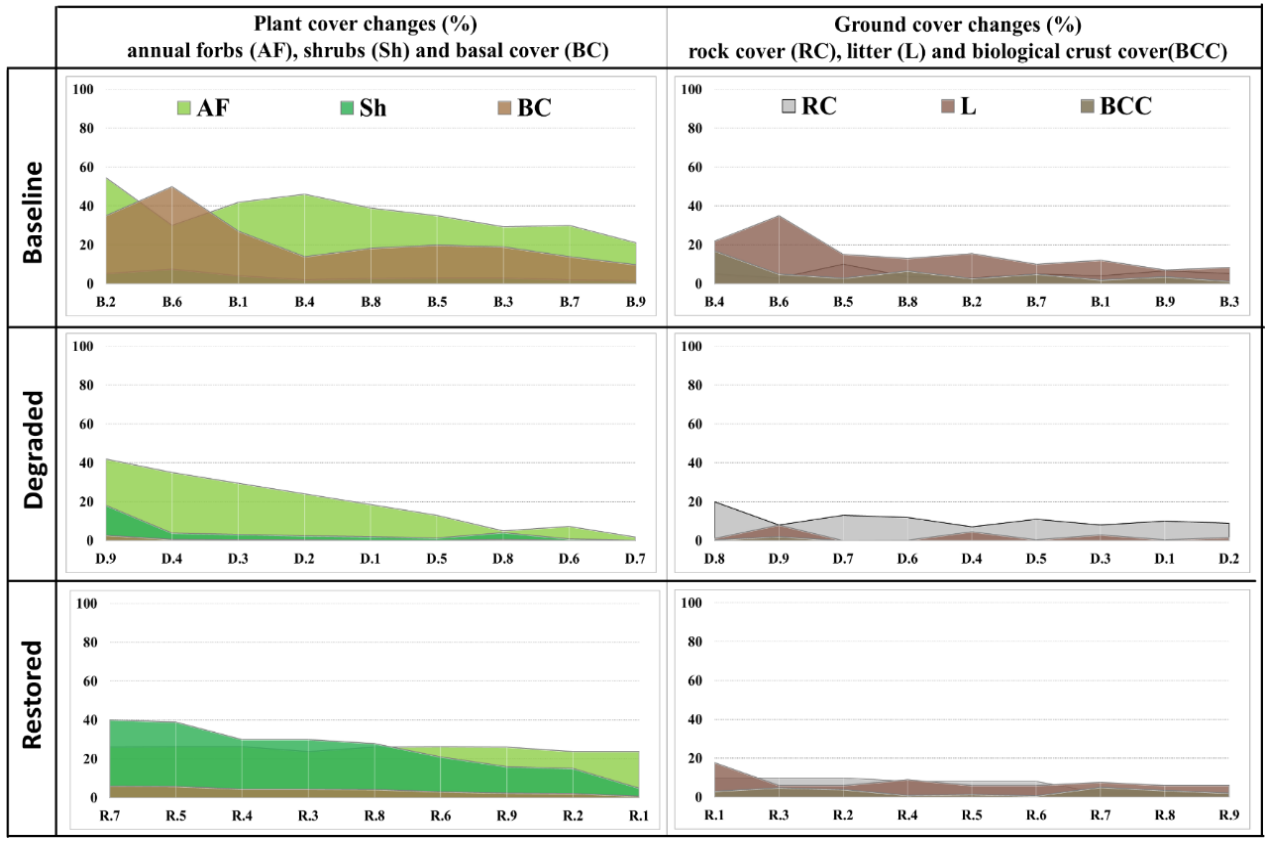
Soil Water → **Biomass**

Success over time: Reference site



There is success but is it sustainable..?

Rangeland status transition scenarios



Baseline, degraded and restored scenarios: surface runoff and soil erosion

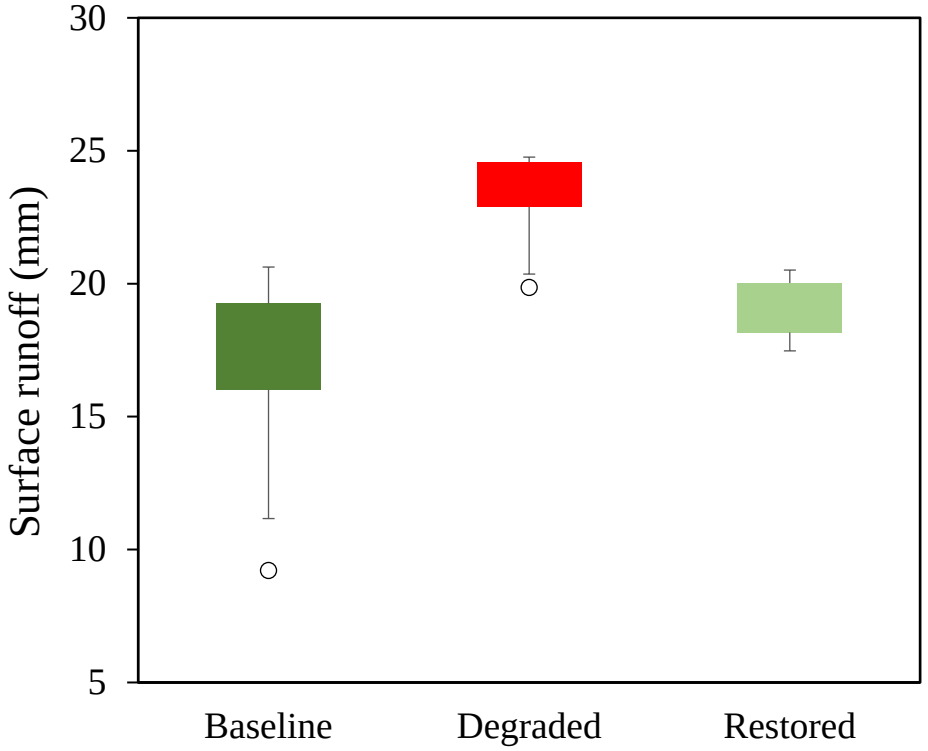


Fig. left: Average annual surface runoff per simulated scenario

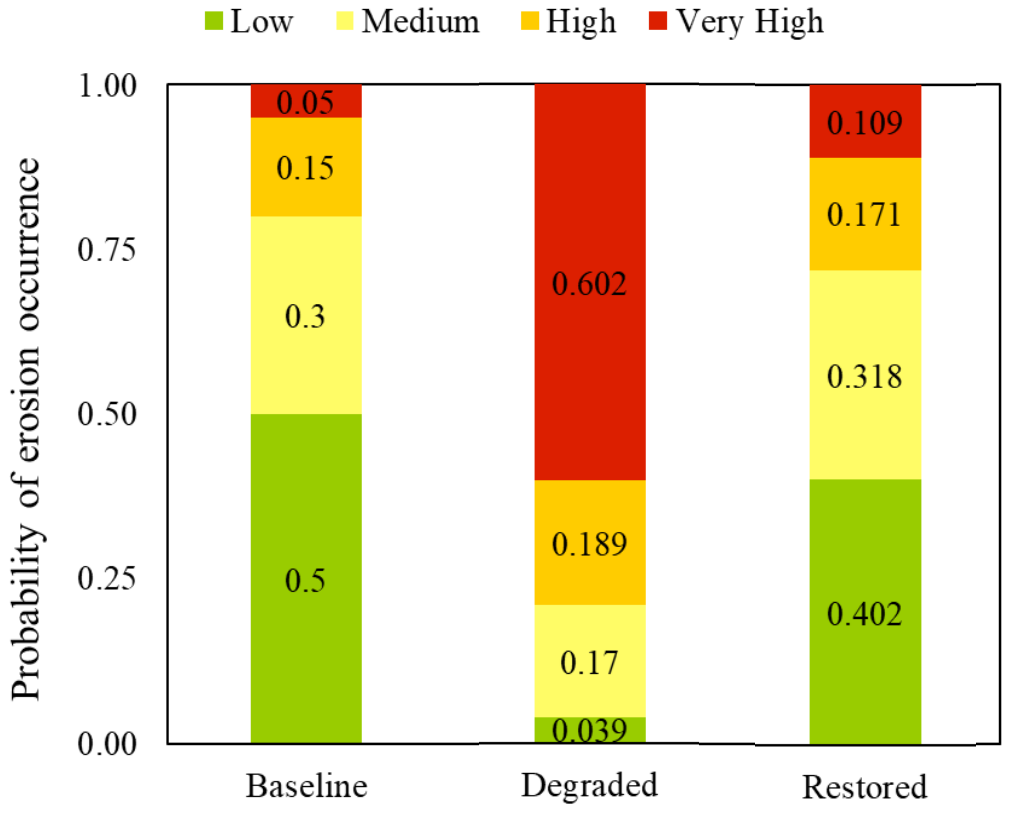


Fig. right: Annual occurrence probability of specific magnitude erosion events defined for baseline scenario conditions

Baseline, degraded and restored scenarios: surface runoff and soil erosion

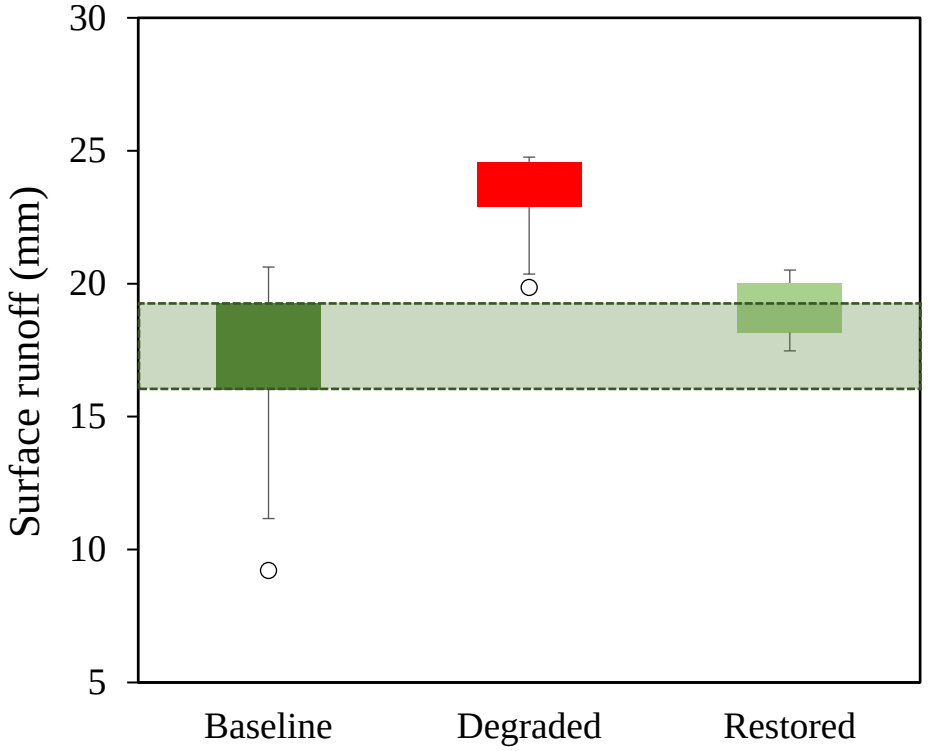
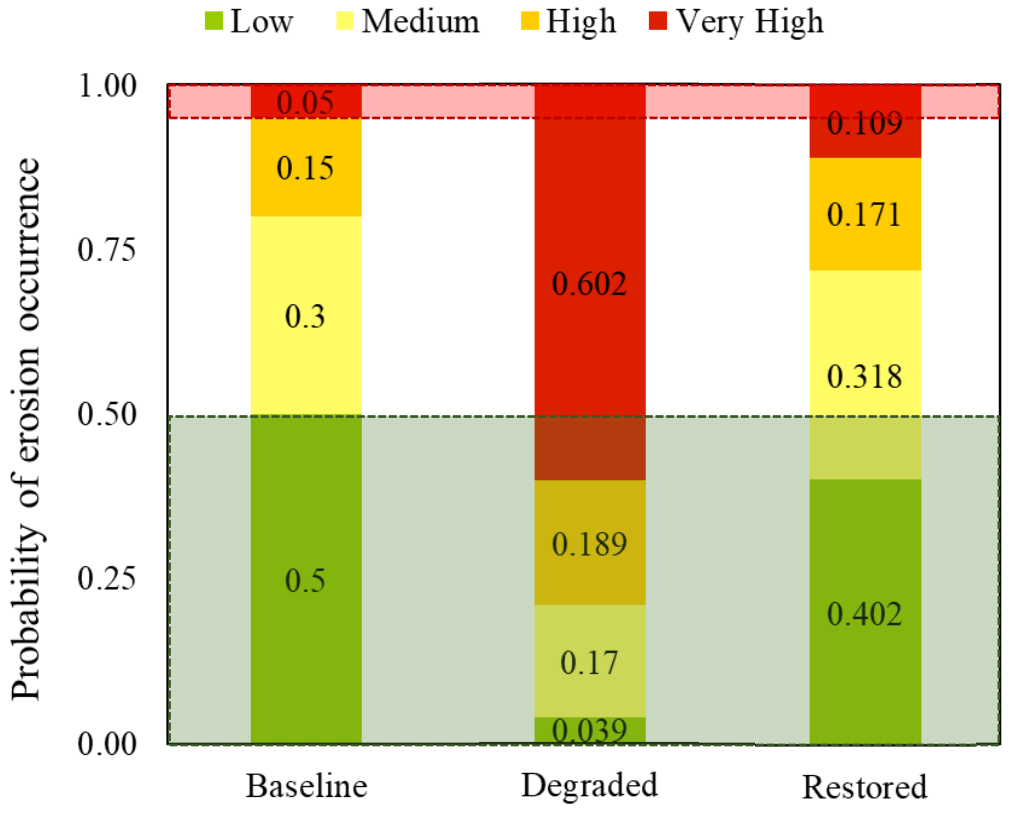


Fig. left: Average annual surface runoff per simulated scenario



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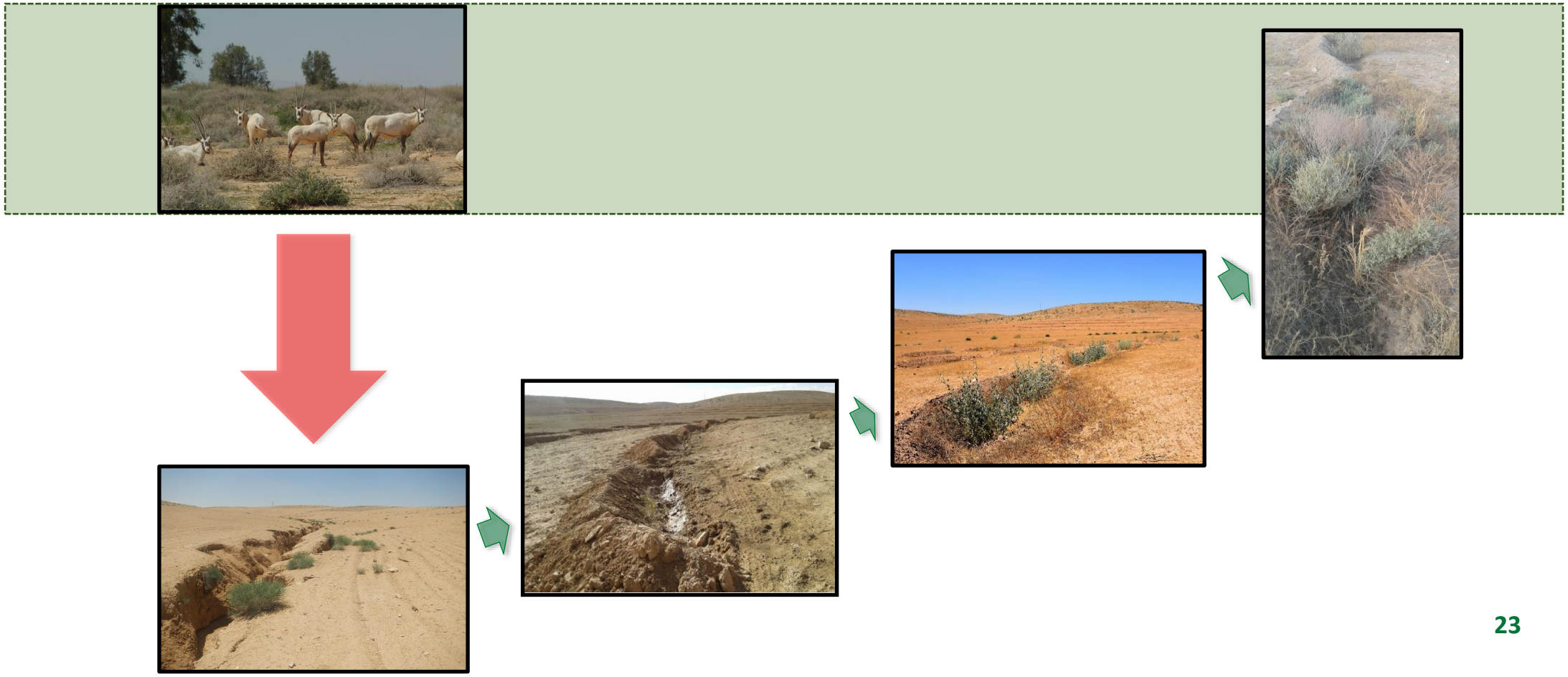
Rangeland status transition



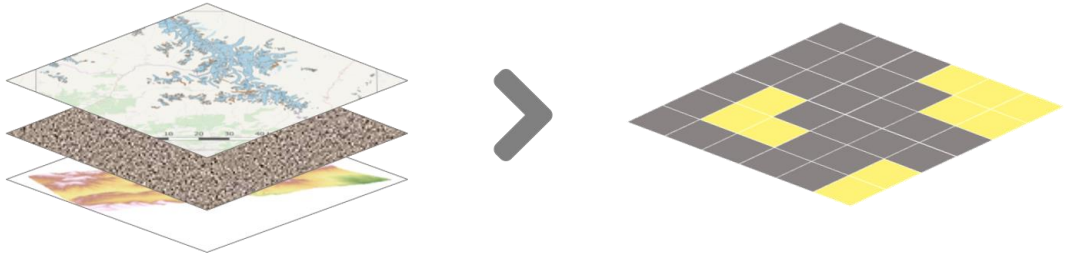
Assessing ecosystem services and health in space and time

Whats the potential at scale?

Scaling potential

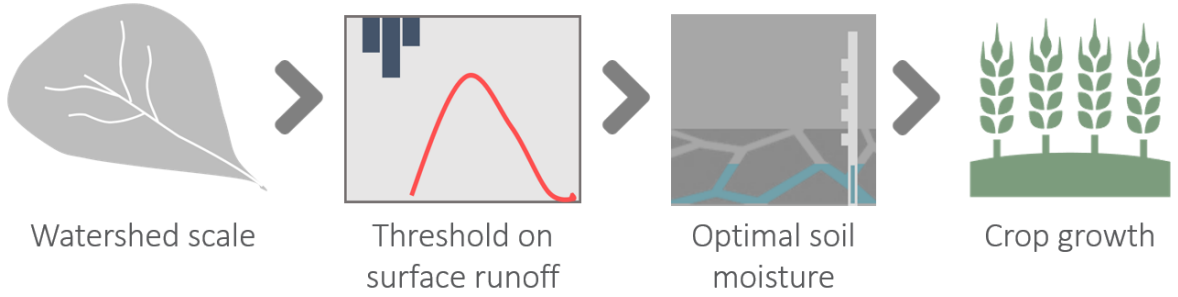
I) Land suitability criteria

- Thresholds on terrain and top-soil characteristics
- Static variables
- Globally available remote sensing datasets
- GIS-based analysis



II) Hydrological criterion

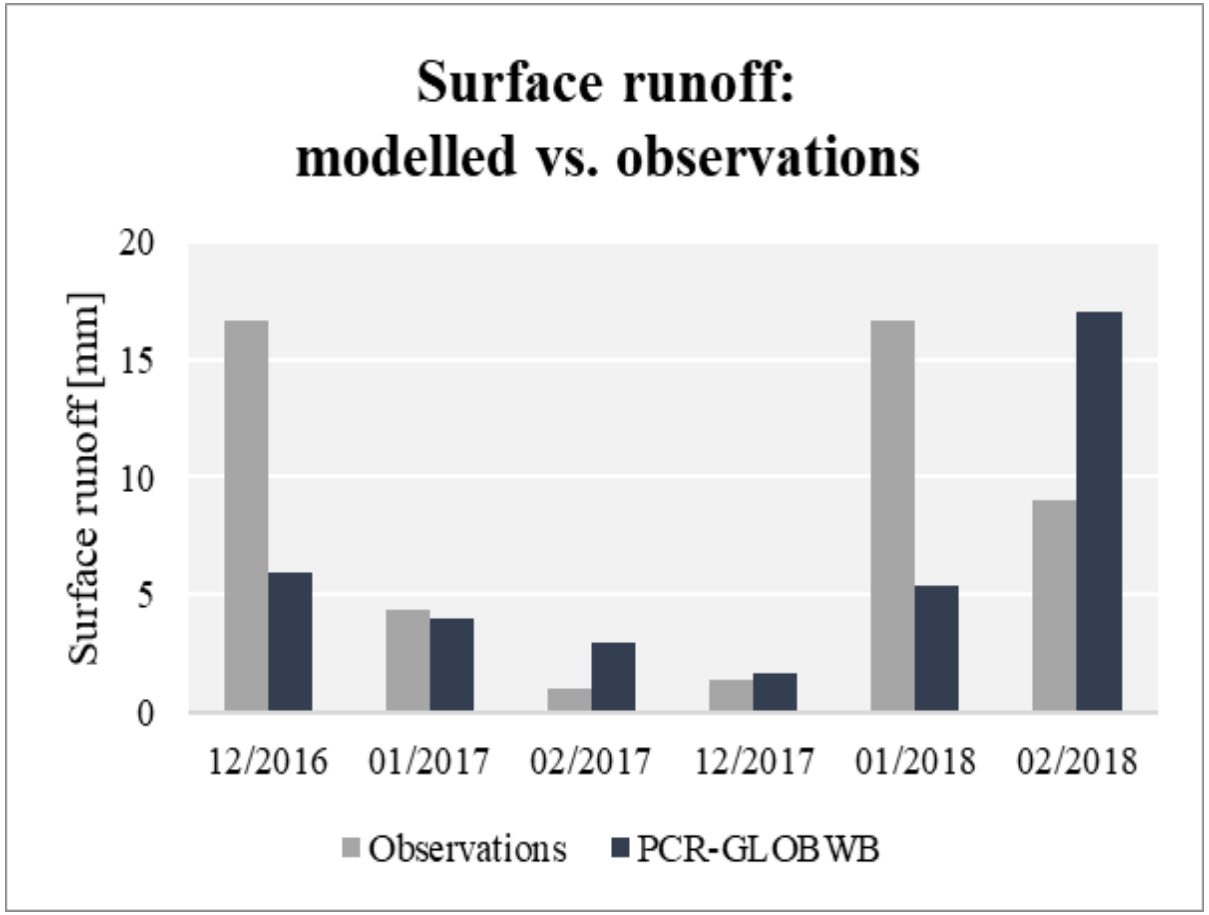
- Dynamic process
- Watershed-scale approach
- Threshold on surface runoff availability



Occurrence probability of runoff (modelling)

Age	56	54	28	85	53	29	55
Years in Majdiyya	25	23	20	45	33	20	40
How often is the Marab flooded per year?	4-6	7-10	4-6	4-6	1-3	1-3	4-6
How many days does it take before the Marab is dry again?	5-7	8-10	8-10	8-10	5-7	8-10	1-4

Aggregation window	Runoff event threshold > 0.5 mm/day			Runoff event threshold > 1 mm/day		
	3-day	5-day	all consecutive	3-day	5-day	all consecutive
DJF	10.4	8.2	7.6	6.2	4.6	6
JJA	0	0	0	0	0	0
MAM	6.4	5	3.2	1.2	1.6	1.2
SON	1.2	1.2	1.2	0.6	0.6	0.6
yearly floodings	18	14.4	12	8	6.8	7.8



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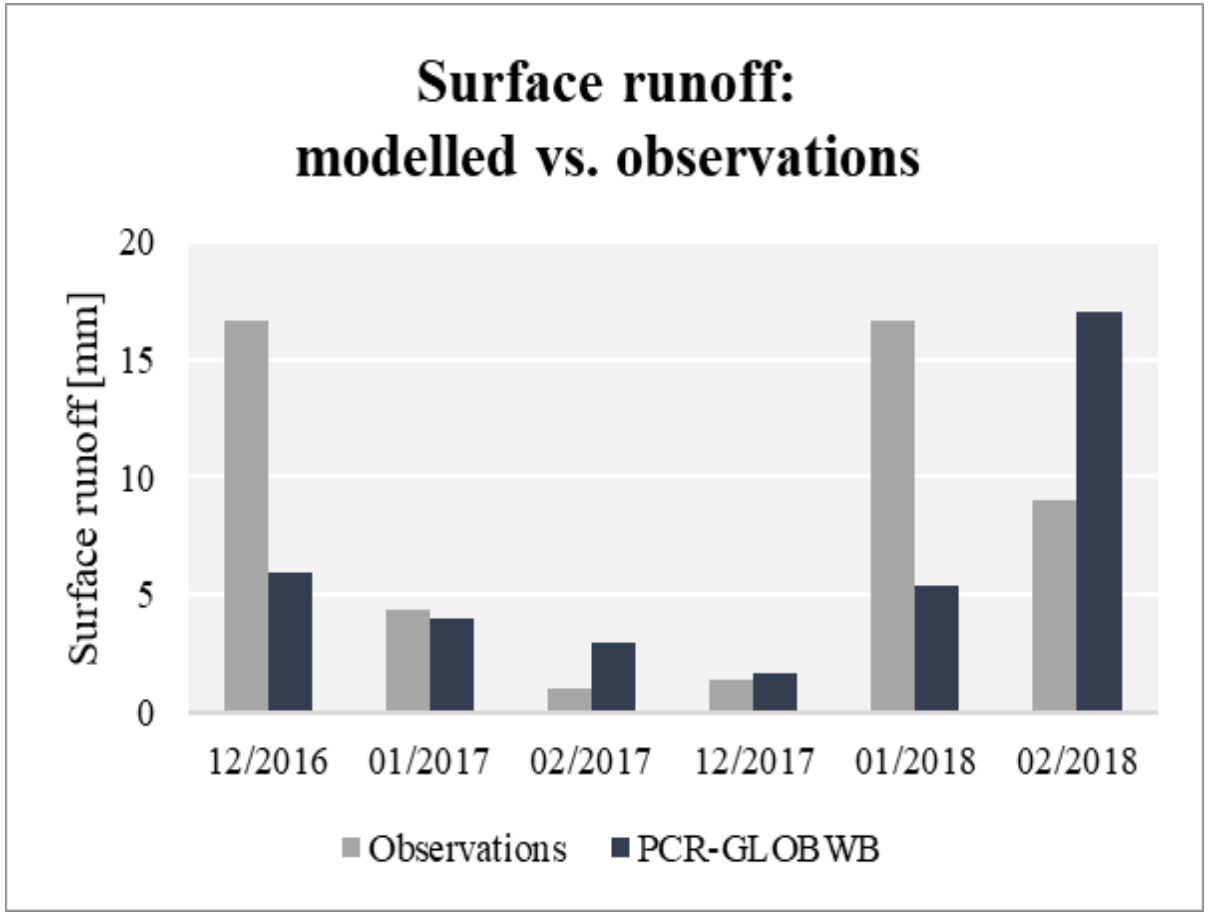
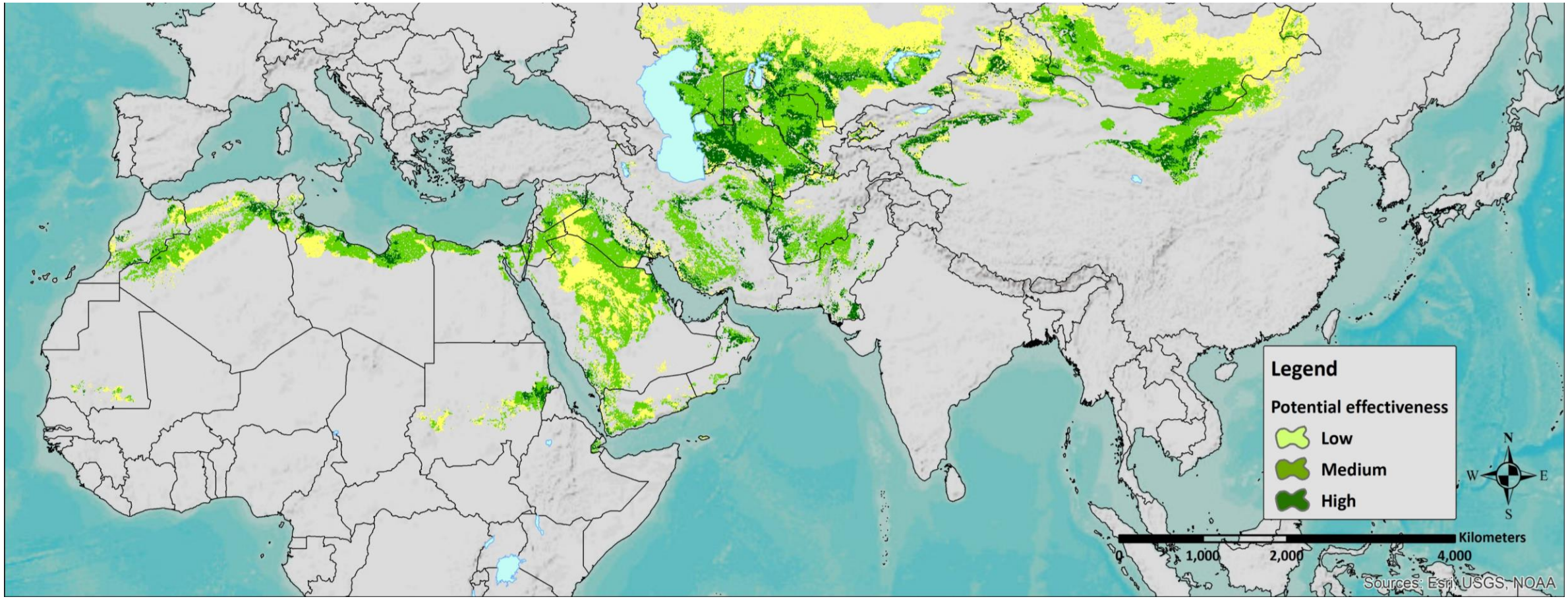


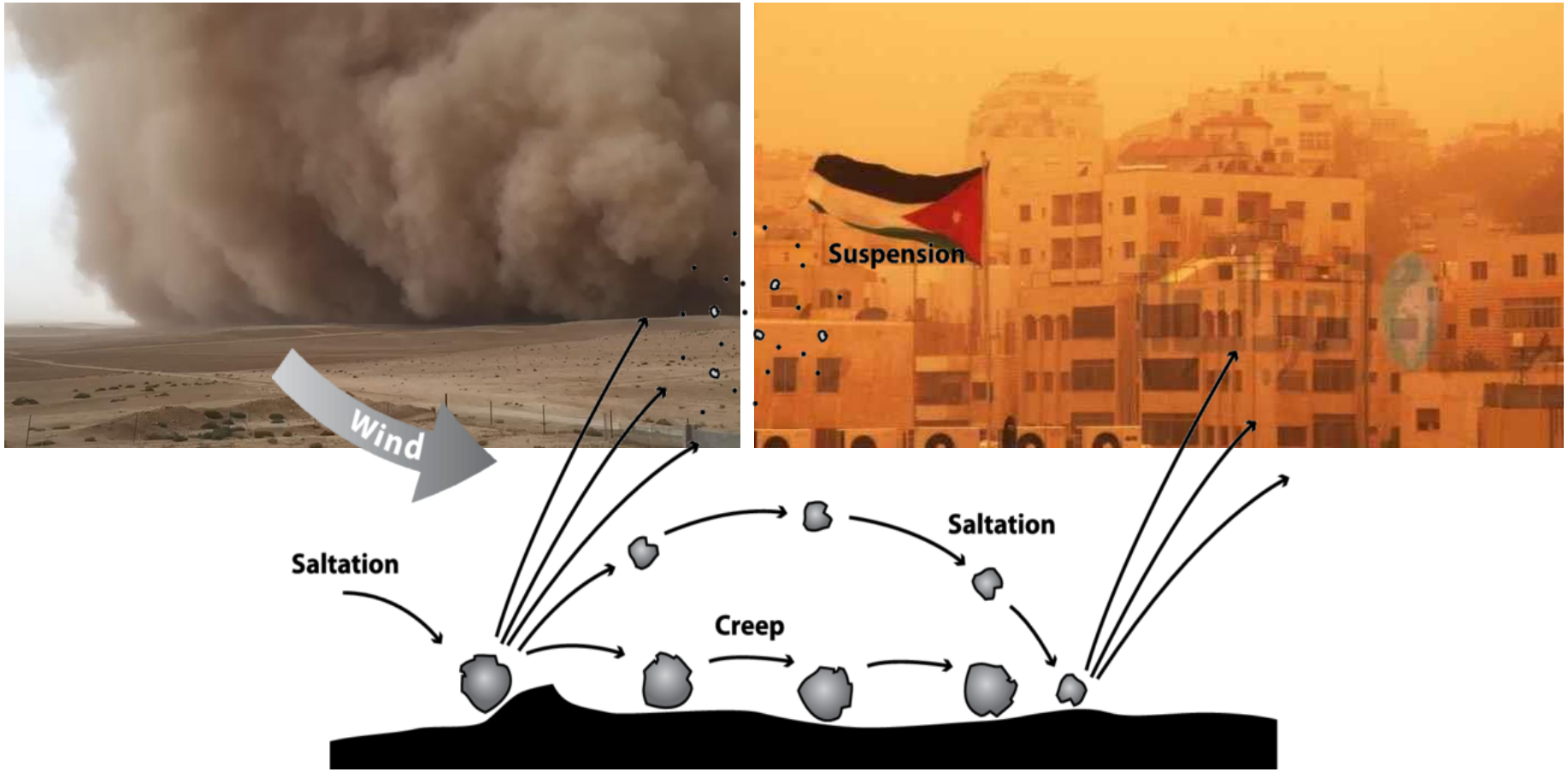
Suitability: Country to regional scale



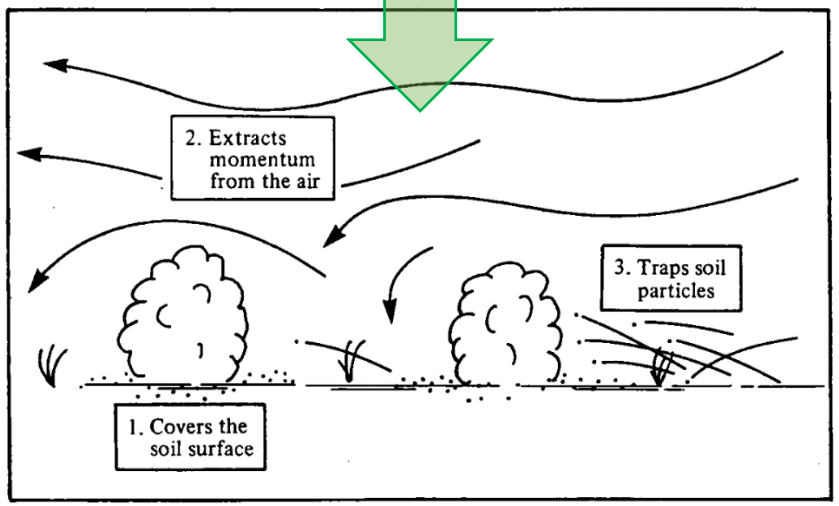
Assessing ecosystem services and health in space and time

Off-site benefits?

Wind erosion: Sand and Dust Storms



Sand and Dust Storms

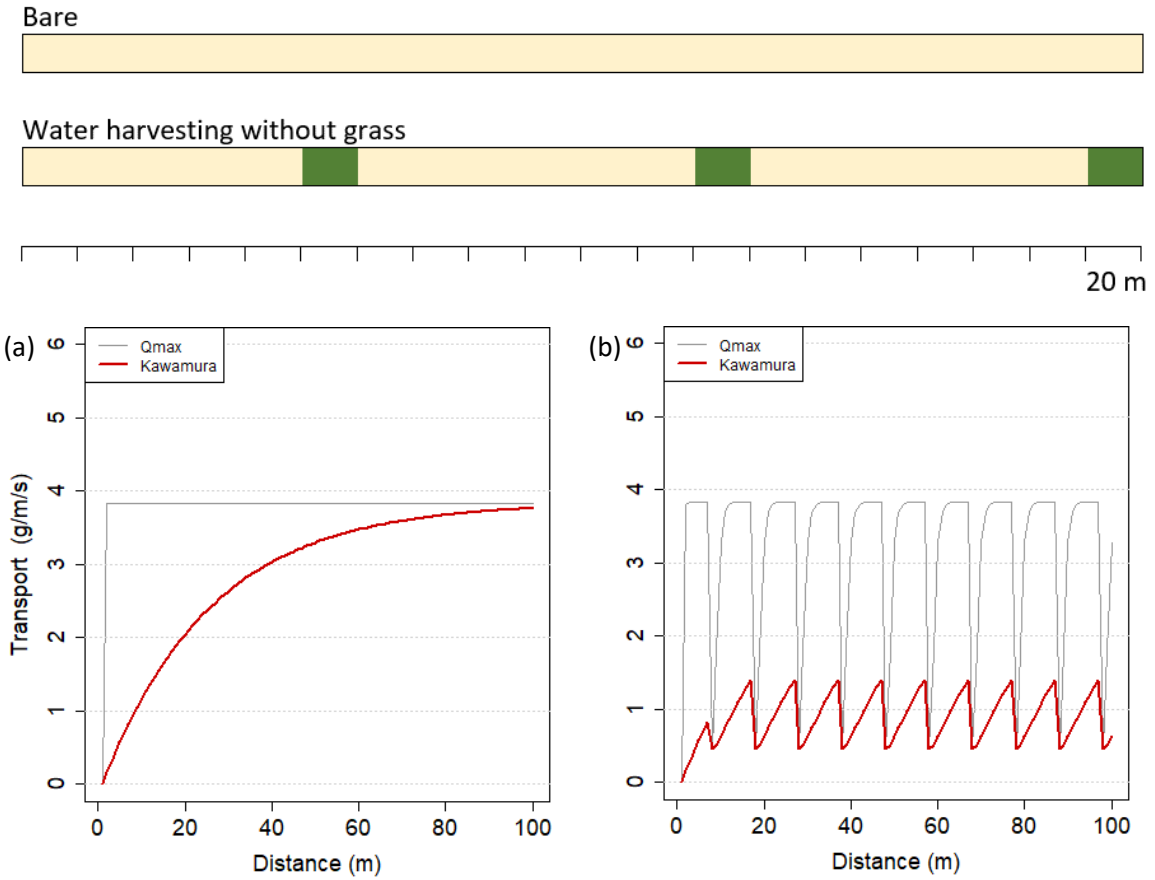


Source:
Kersten (2015)

Sand and Dust Storms

Setting up a wind erosion model

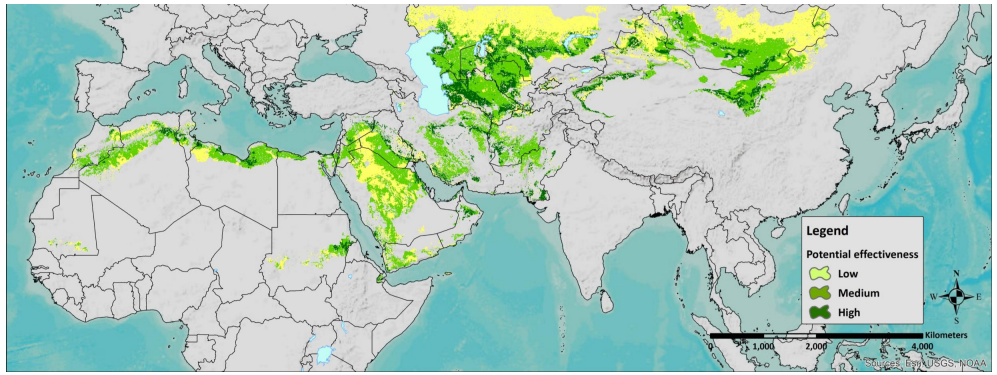
- 1D Cellular model (CCAS)
- Horizontal transport -> vertical flux
- WH and vegetation as obstacles (roughness)



Acknowledgement: Joint MSc of Utrecht University, National and Kapodistrian University of Athens, and ICARDA.

Sand and Dust Storms

Outscaling mechanized micro WH



- GIS based site suitability (preliminary assessment)
- Climate, topography, soil, land cover/use
- Large atmospheric array simulation using RAMS

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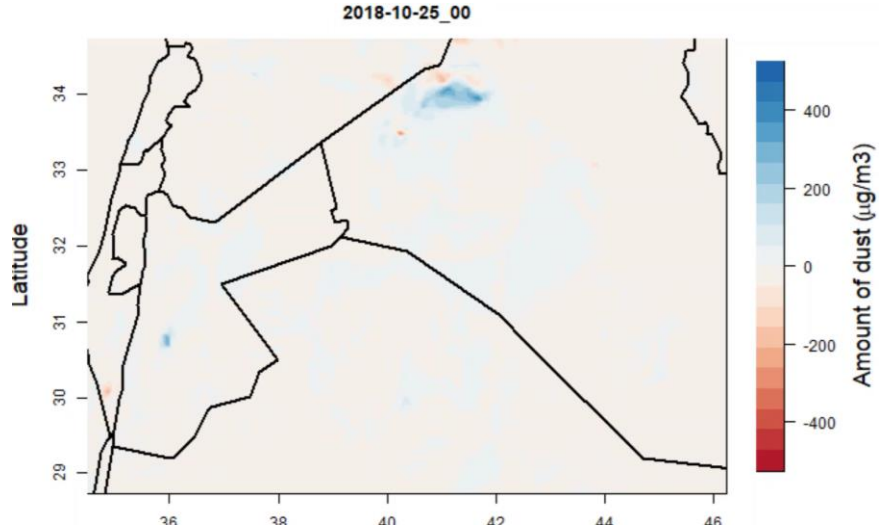

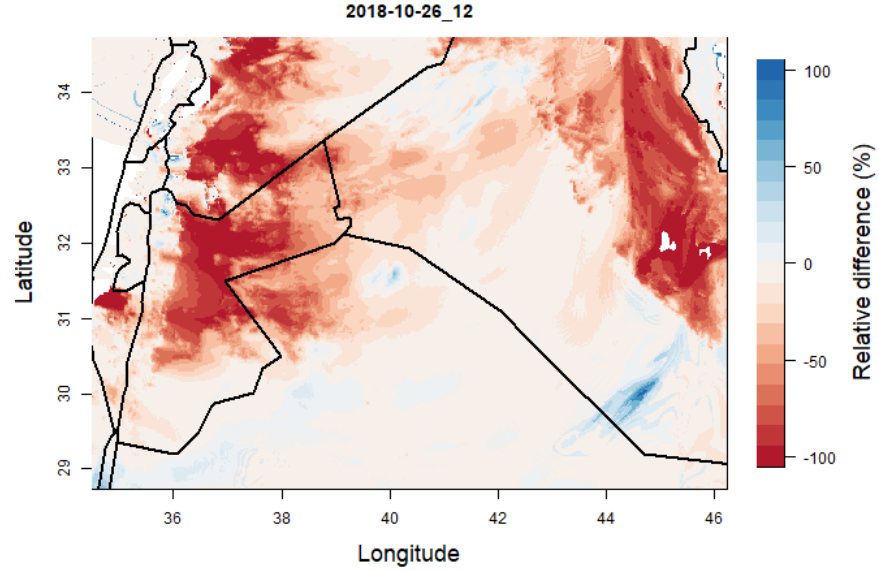

Thank you

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