



Restoring Small Water Cycles

3rd Roundtable, September 2nd 15-17CET

Hosted by
Utrecht University · NIOO-KNAW · GOPA



Why we are here

Climate action is almost entirely focused on greenhouse gases, and that focus is incomplete. Landscapes regulate climate themselves. Through vegetation, soils, and moisture, small water cycles turn solar energy into evapotranspiration, cooling the land and recycling rainfall. Where degradation has broken them, land turns into a boiling plate.

Restoring small water cycles is climate action, with direct consequences for biodiversity and health.



Manageable

Land and water decisions people already make

Local

Acted on where people live and farm

Fast

Effects within seasons, not decades

Measurable

Temperature, soil moisture, greenness

AGENDA

Today

1

Welcome and recap

Where we landed at the 2nd roundtable

2

Four presentations

Universität Zürich · Acacia Water · WOCAT · Henk Ovink

3

The narrative, and where we tell it

4

A home online, and the connection to the ground

Making the network findable and putting it to work

5

The roadmap





29 APRIL 2026 · ONLINE

Recap from the 2nd roundtable

1

Half-moon bunds cooling the land

Sander de Haas · Justdigg.it

660,000 bunds dug across sub-Saharan Africa.

Satellite data shows soil 7-13% wetter, 23-41% greener, and 0.4-0.5°C cooler.

2

Small water cycles in ESIA

Alex Puisais · NCEA (Netherlands Commission for Environmental Assessment)

The role that Small Water Cycles can play in Environment and Social Impact Assessment (ESIA).

The Mont Nimba ESIA case (iron ore mining) showed that gap.

New update: NCEA and the World Bank are already discussing how to bring small water cycles into the IFC Performance Standards.

3

The Veluwe water balance

Stefan Dekker · Utrecht University, Recharge

Around 60% of precipitation evaporates, but measuring evapotranspiration accurately is still challenging. The Recharge project now shows early result that different forest types respond to droughts differently: relevant information for small water cycle restoration.

4

Evapotranspiration and soil moisture

Theo Brandsma · KNMI, OogVoorDroog

The Netherlands has no operational network for actual evapotranspiration or soil moisture, which weakens water decisions and fire response. OogVoorDroog is building one.

5

Water harvesting and temperature

Giulio Castelli · Water Harvesting Lab, Florence

Research from Tunisia, Ethiopia, and Tanzania all point the same way. Increased tree cover and water harvesting drops land surface temperature significantly.



WHAT WE CONCLUDED

The effects are measurable, and they show up within seasons.

Local and meso-scale

This is not global climate modelling from the bottom up. It is what can be managed, measured, and acted on where people live and farm.

Livelihoods in the frame

Heat stress on farming communities is already severe. A roadmap that skips the human dimension will not land with the people doing the work.

From evidence to a roadmap

A community of practice, agendas shaped in policy and science, the climate debate including COP, and pilots shown as climate action.

02

Presentations

Maarten Eppinga · Universität Zürich

Towards restoration of forest patches in Aruba

Tessa van Hateren · Acacia Water

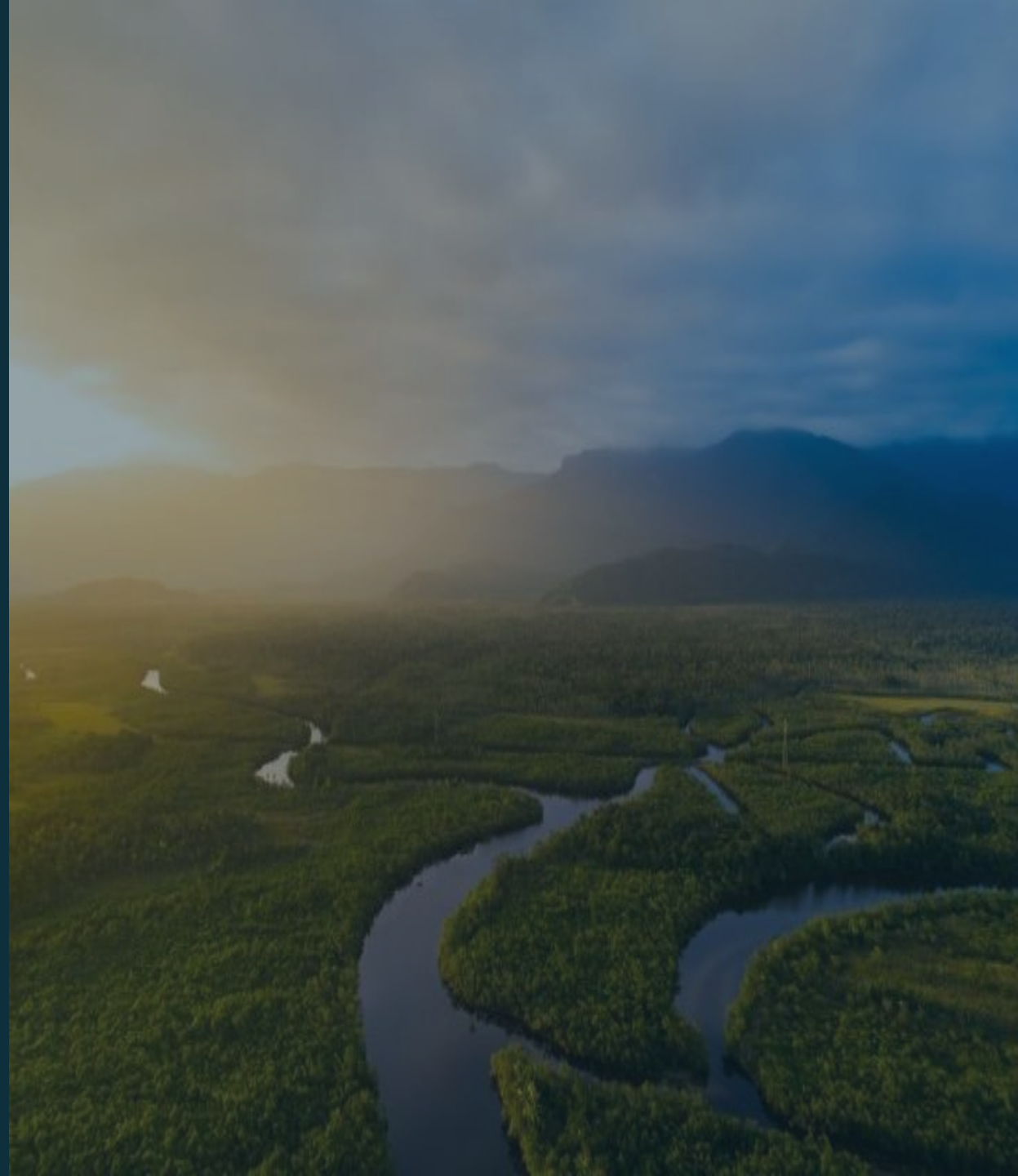
Soil moisture, the next step in water management

Hanspeter Liniger & Jovana Askrabic · WOCAT

Hot Earth Campaign and the small water cycle

Henk Ovink

Recap from Stockholm World Water Week, and the knowledge gap



The Weather Makers

Gijs Bosman

Strategic Evaporation



Our mission: Engineering Earth's Comeback

For over a decade, we've worked with partners across the globe to rethink landscapes—not as they are, but as they could be. We have seen firsthand that even the most degraded environments can be restored when balance is reintroduced. Water returns. Vegetation thrives. Local economies grow.

This isn't just about restoration—it's about resilience. Every project is an opportunity to push boundaries, applying cutting-edge engineering and ecological insight to drive large-scale, long-term regeneration.



Restoring Earth and the Bardawil & Sinai Initiative

For thousands of years, humans have shaped the Earth sometimes gently, sometimes with force. At The Weather Makers, we believe it's time to shape its healing. Through the Bardawil & Sinai Initiative, we're showing how restoring ecosystems can restore balance to nature, to climate, and to life itself.



Smart selection for sustainable solutions

The Weather Makers develop a transparent tendering model for nature compensation in North Brabant.

Nature-Based Engineering, Rivers



A vision for climate resilience in Libya

The Weather Makers and Grand Challenge AI create a roadmap for Libya's climate resilience.



A climate resilience vision for the Middle East

The Weather Makers and Austrian Centre for Peace unite stakeholders for Middle East water security.

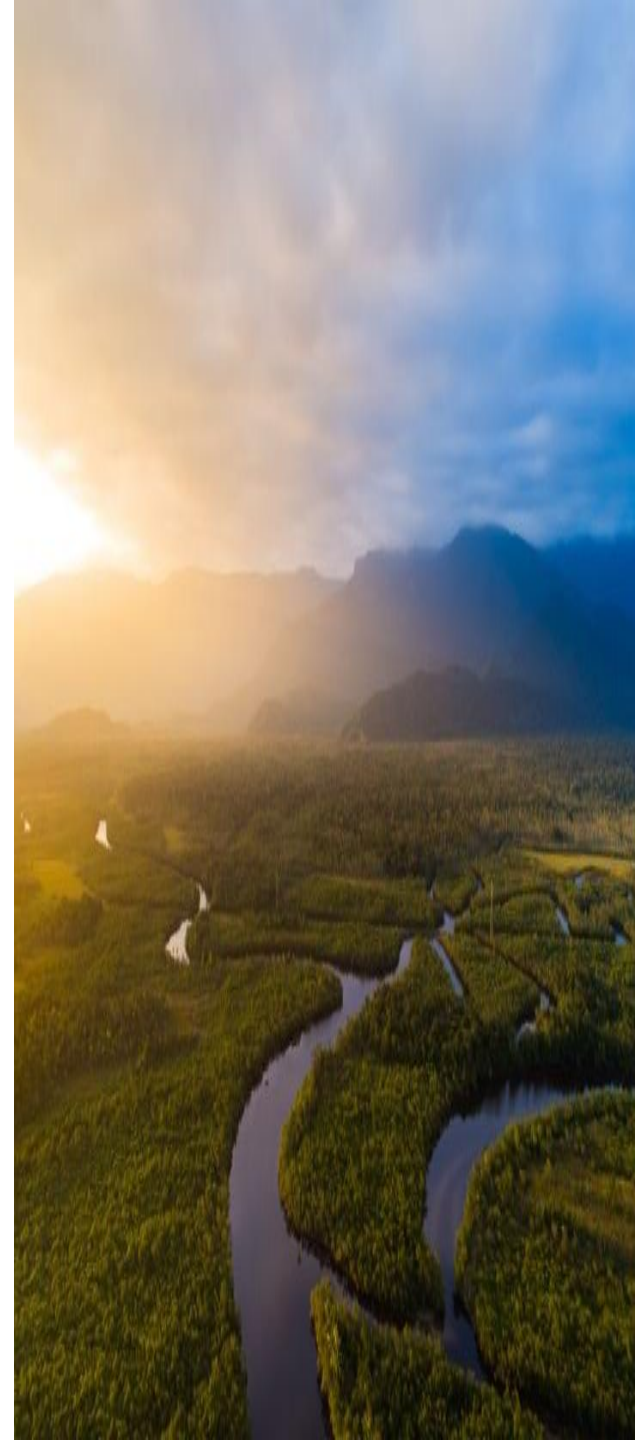
01

UNIVERSITÄT ZÜRICH

Maarten Eppinga



Towards restoration of forest patches in Aruba



Toward the restoration of dry tropical forest patches in Aruba, southern Caribbean



Maarten Eppinga, University of Zurich

Eric Mijts, University of Aruba

Ban Lanta y Planta, Trees for Aruba / Aruba Conservation Foundation

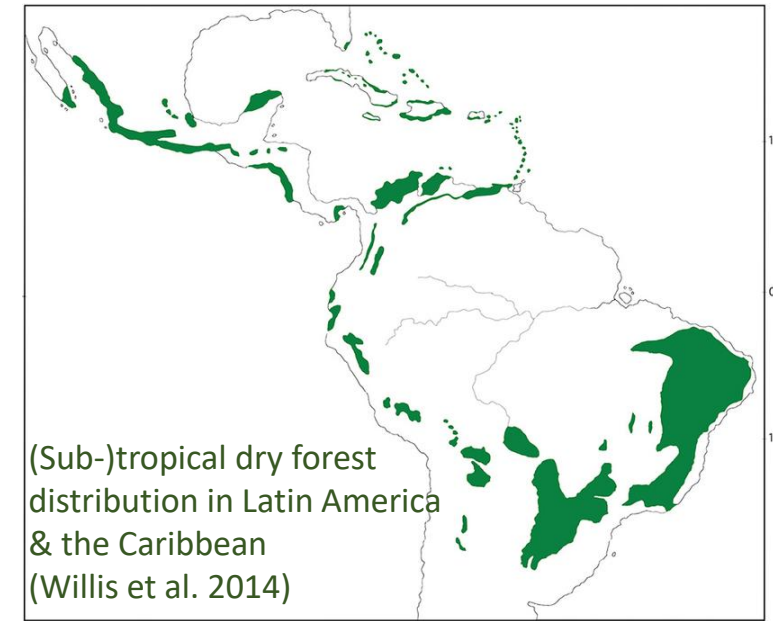
Camille Delavaux & Stefan Dekker, NIOO-KNAW (NL)

Theory: Jim Bever, Theo Michaels (University of Kansas)



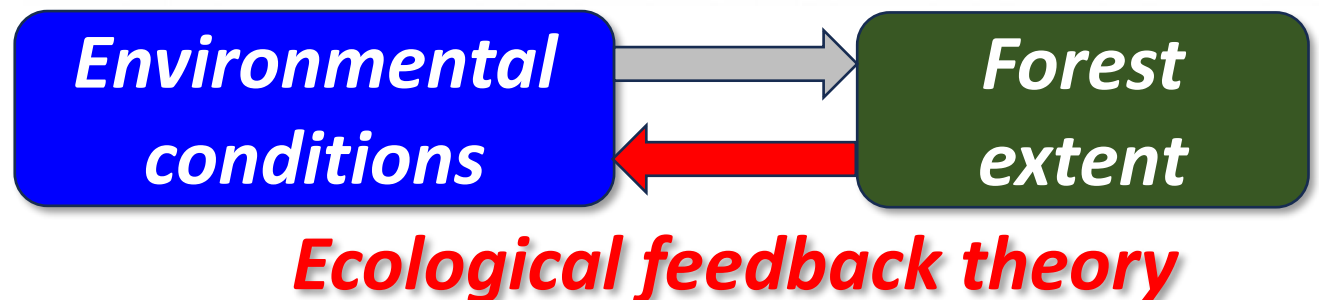
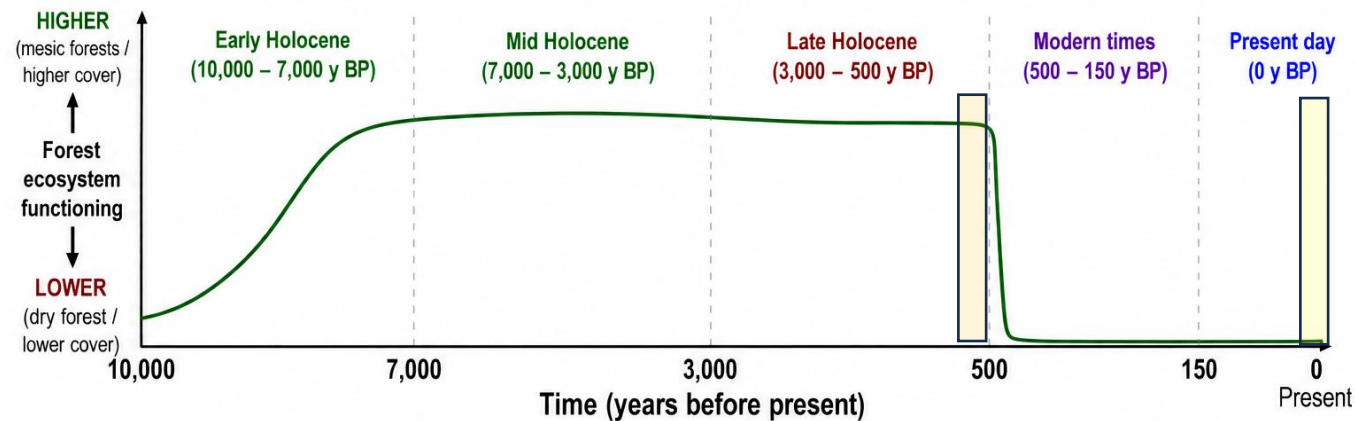
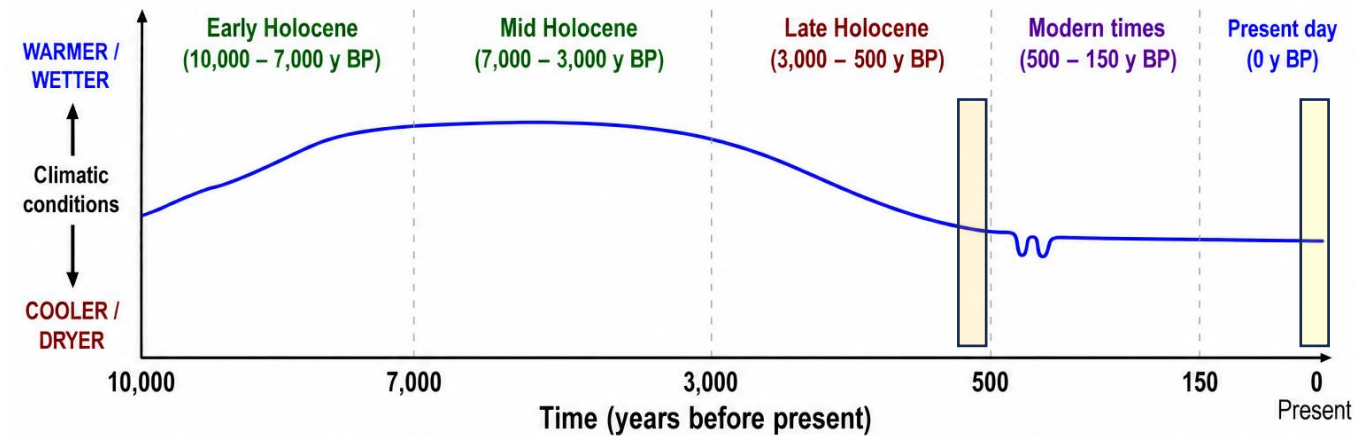
(Sub-)tropical dry forests

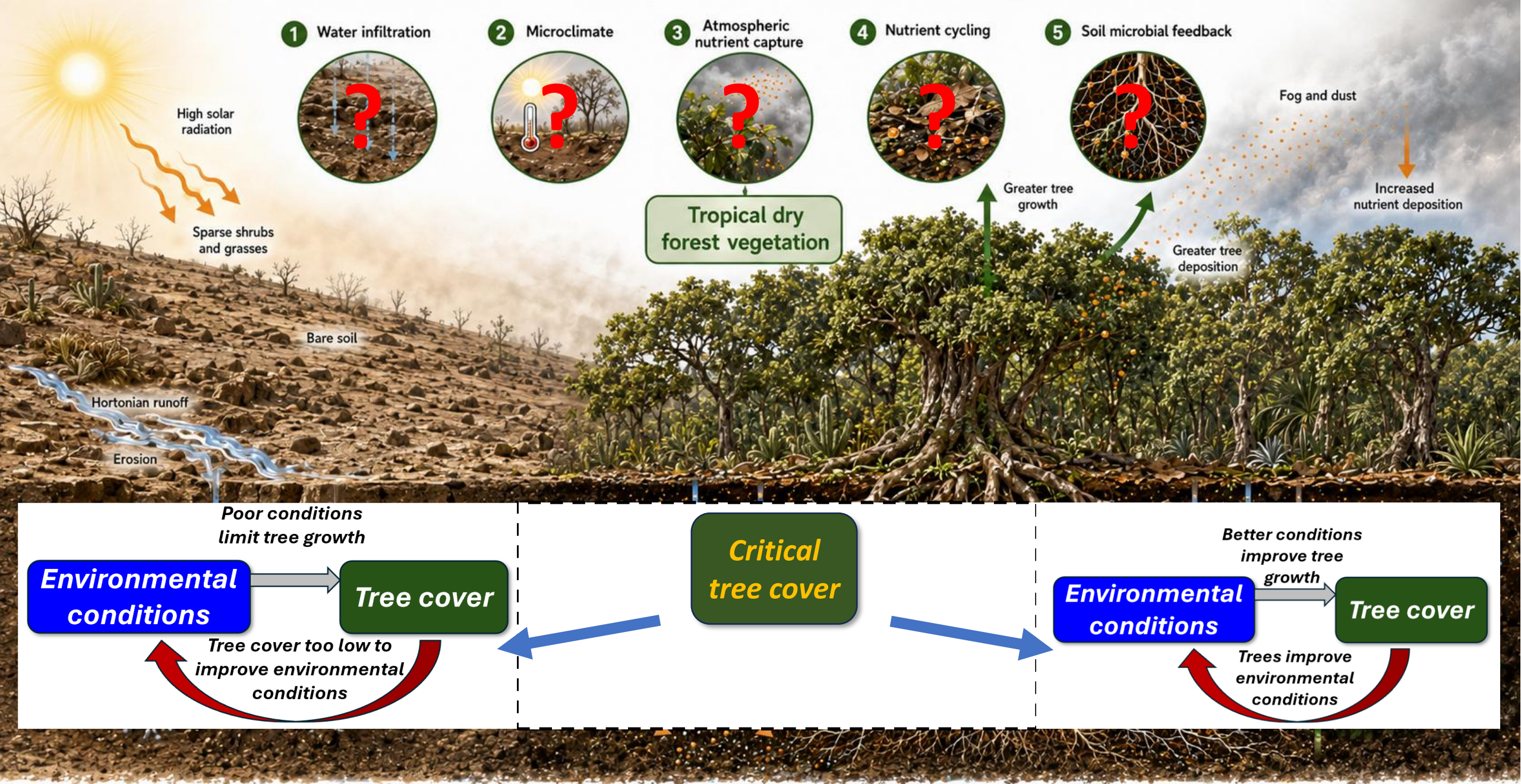
- Found in regions with annual temperature $> 17^{\circ}\text{C}$, annual prec. 250-2000 mm, $1 < \text{PET}:\text{Prec} < 2$
- Provide the habitat for the majority of Caribbean terrestrial biodiversity
- Are among the most threatened types of tropical forests in the world ($< 10\%$ left in many countries)
- Provide important ecosystem services to humans:
 - freshwater supply, flood control, climate regulation, erosion control and soil fertility maintenance, scenic beauty
- Hence, there is an urgent need to conserve and restore Caribbean tropical dry forest ecosystems



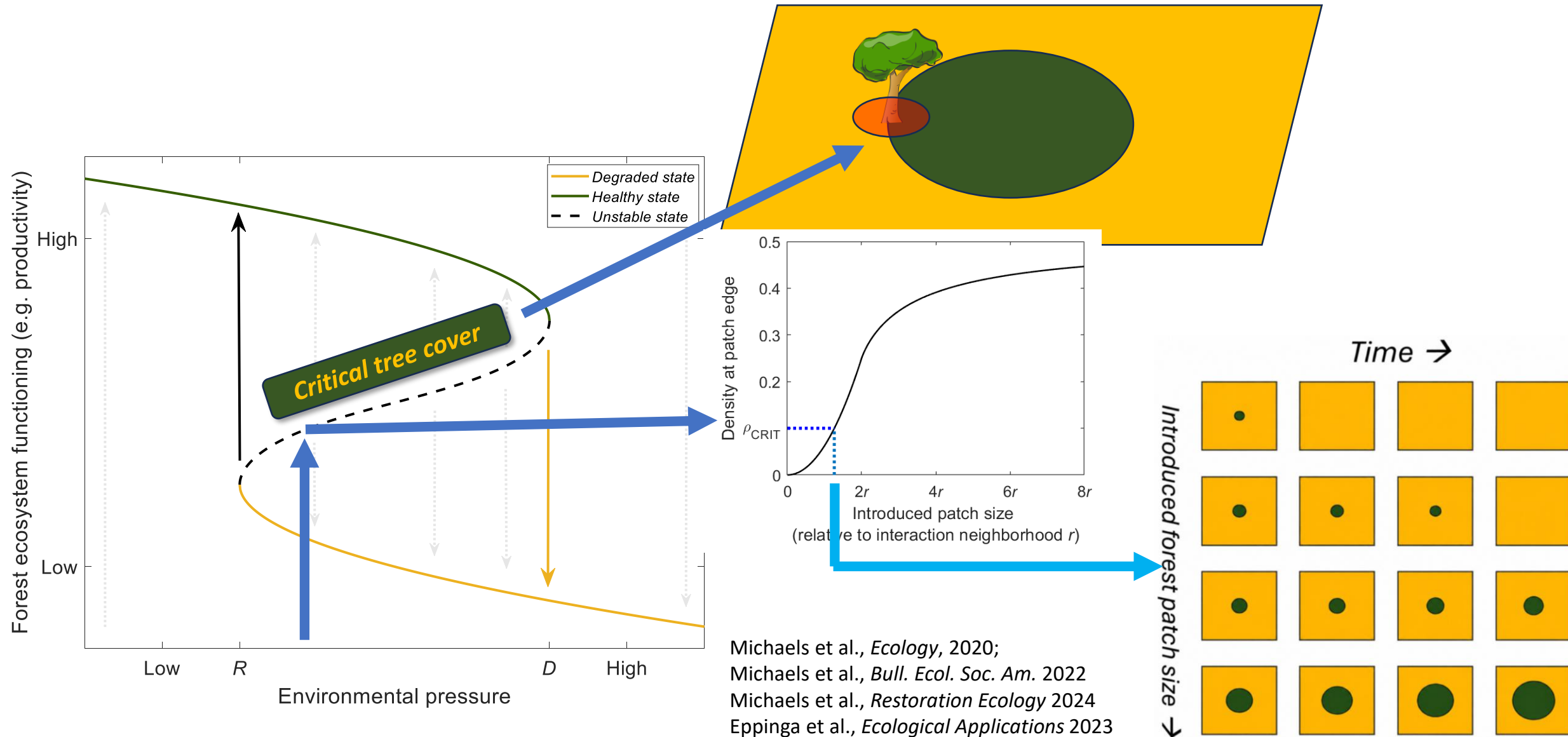
History of Caribbean dry forests

- *Early Holocene (10,000 – 7,000 y BP)*: Caribbean climate becomes warmer and wetter → good conditions for forest growth
- *Mid Holocene (7,000 – 3,000 y BP)*: Caribbean islands develop near uniform cover of mesic forests
- *Late Holocene (3,000 – 500 y BP)*: Caribbean climate becomes dryer – forest cover uniform, but shifts toward dry tropical forest species
- *Modern times (500 – 150 y BP)*: Tropical dry forest degradation due to stressors: 1) Deforestation by European colonial powers; 2) Periods of drought in Little Ice Age
- *Present day (P)*: Difficult to restore tropical dry forest ecosystems; interventions yield mixed success





Nucleation theory explains how to leverage positive feedbacks in ecological restoration

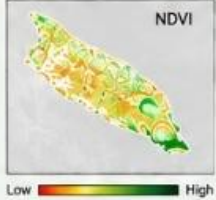


Proposed research project

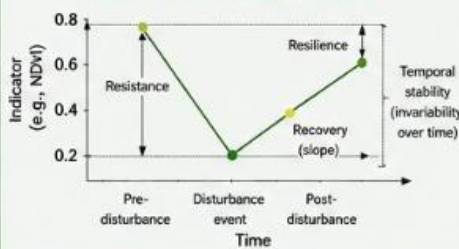
1 Identify high and low resilience patches



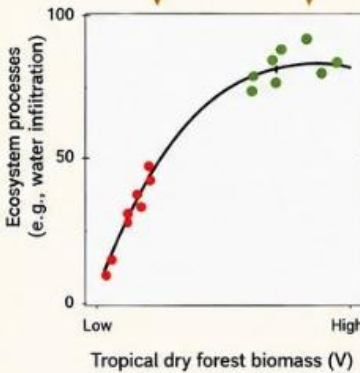
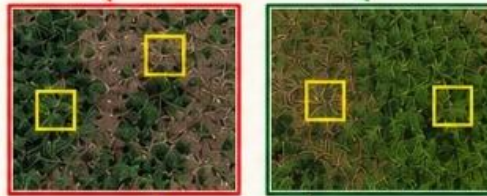
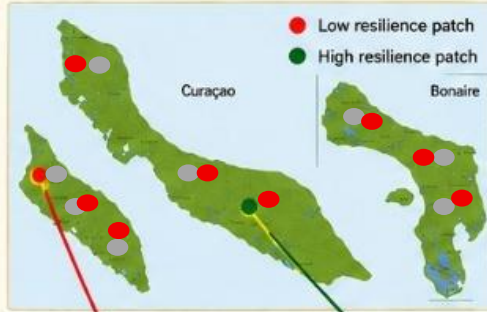
Remote sensing



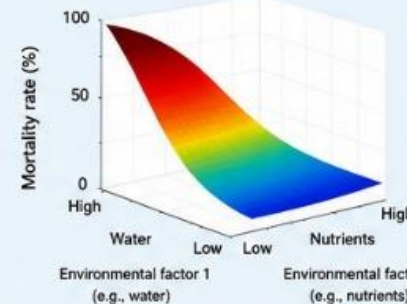
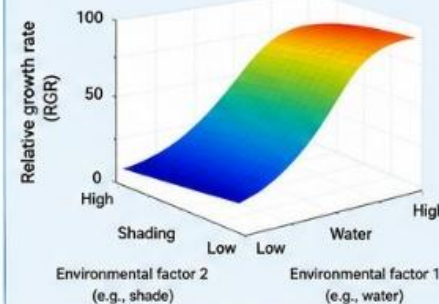
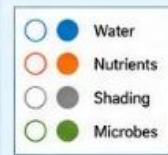
Resilience from NDVI time series



2 Vegetation → environment effects

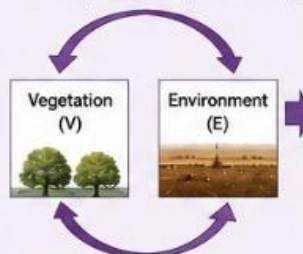


3 Environment → vegetation effects

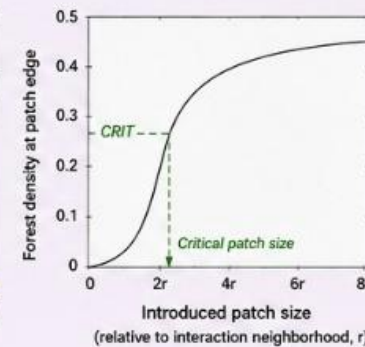
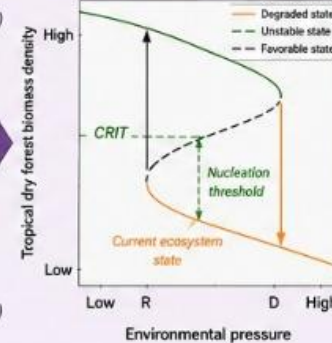


4 Environment ↔ feedbacks

From Step 2: Inflows (V) – Outflows (V)



From Step 3: Growth (E) – Mortality (E)



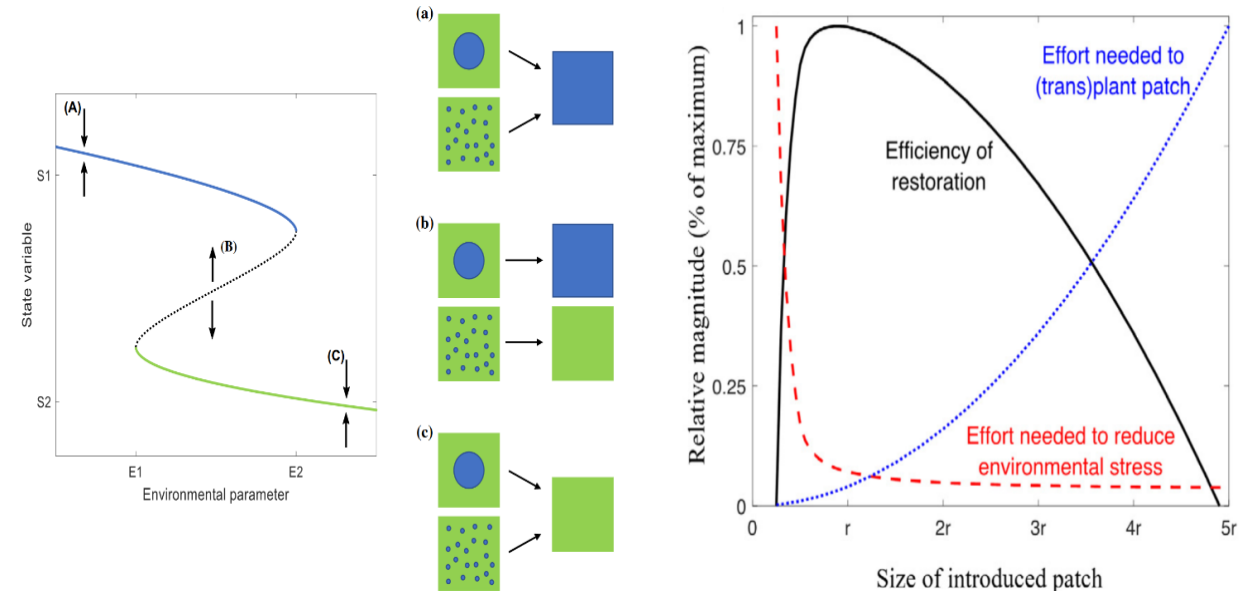
5 Community based research: Stimulating capacity building, community engagement, agency and ownership

Steps 1-3: Quantify the strength of vegetation-environment feedbacks in southern Caribbean tropical dry forests

Steps 4-5: Leverage these feedbacks in the design of efficient and effective forest restoration strategies

Summary

- In challenging environments, positive forest-environment feedbacks may explain mixed success of past restoration efforts.
- However, nucleation theory suggests that local feedbacks (individual root zone/canopy scale) can also be leveraged in restoration, by introducing patches above a critical size
- While theory has been tested in grasslands, now we would like to test it in Caribbean ecosystems, using field observations, experiments and nucleation/feedback modelling
- Our aim is to generate site-specific insights into the potential for nucleation as an active restoration strategy



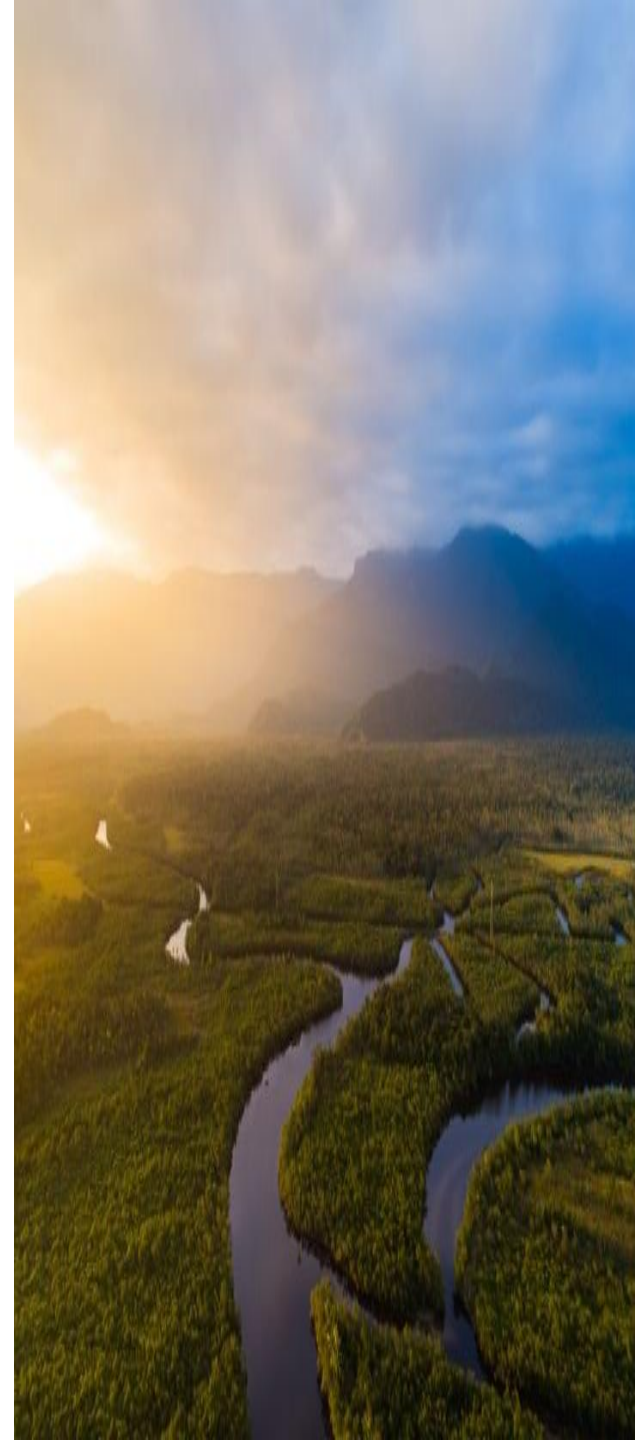
02

ACACIA WATER

Tessa van Hateren



Soil moisture, the next step in water management





Soil moisture – the next step in water management

Soil moisture

- Unsaturated zone
- Key parameter for relation between groundwater and atmosphere
 - Influences chemistry, water availability and soil strength
 - Dictates groundwater flow via groundwater recharge
 - Is an essential link in rainfall-runoff process
 - Determines functioning of agricultural- and ecosystems

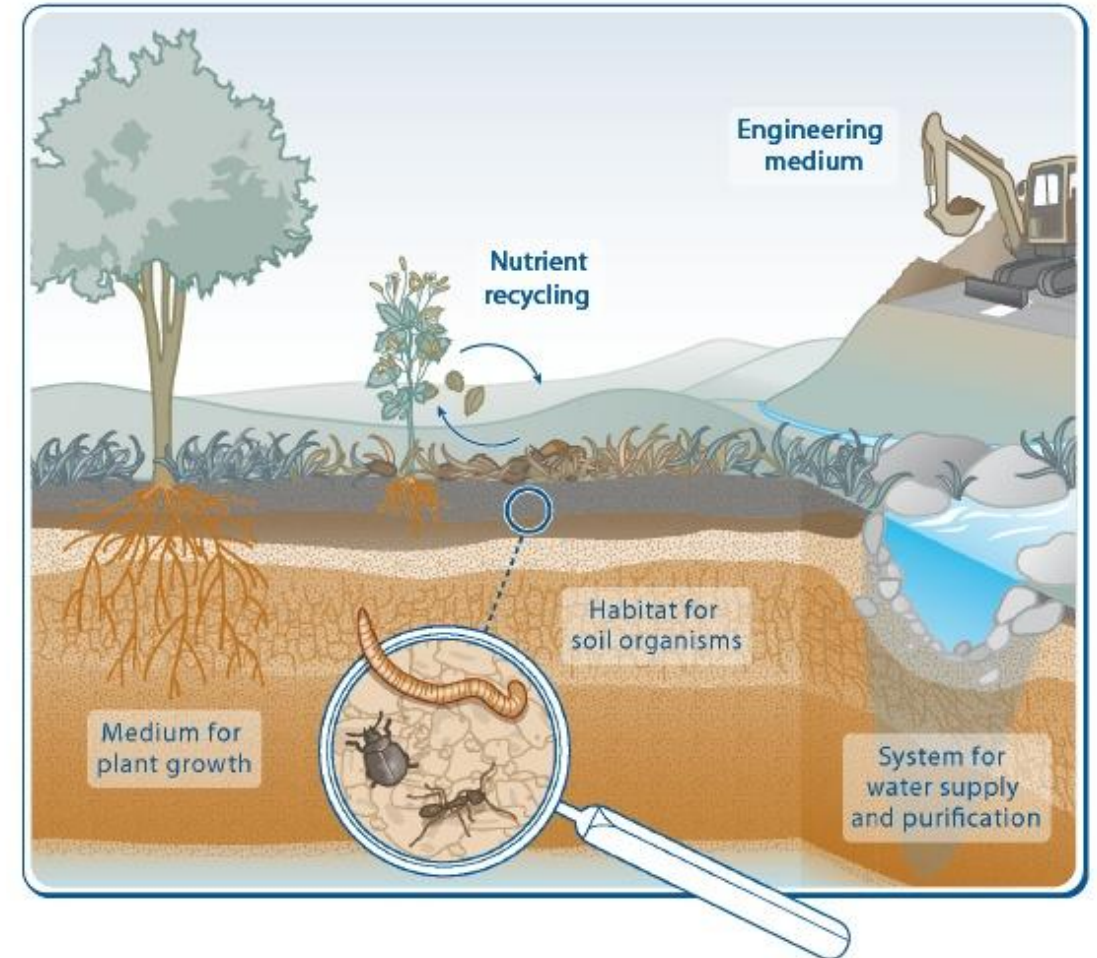


image from D. Or, ETHZ

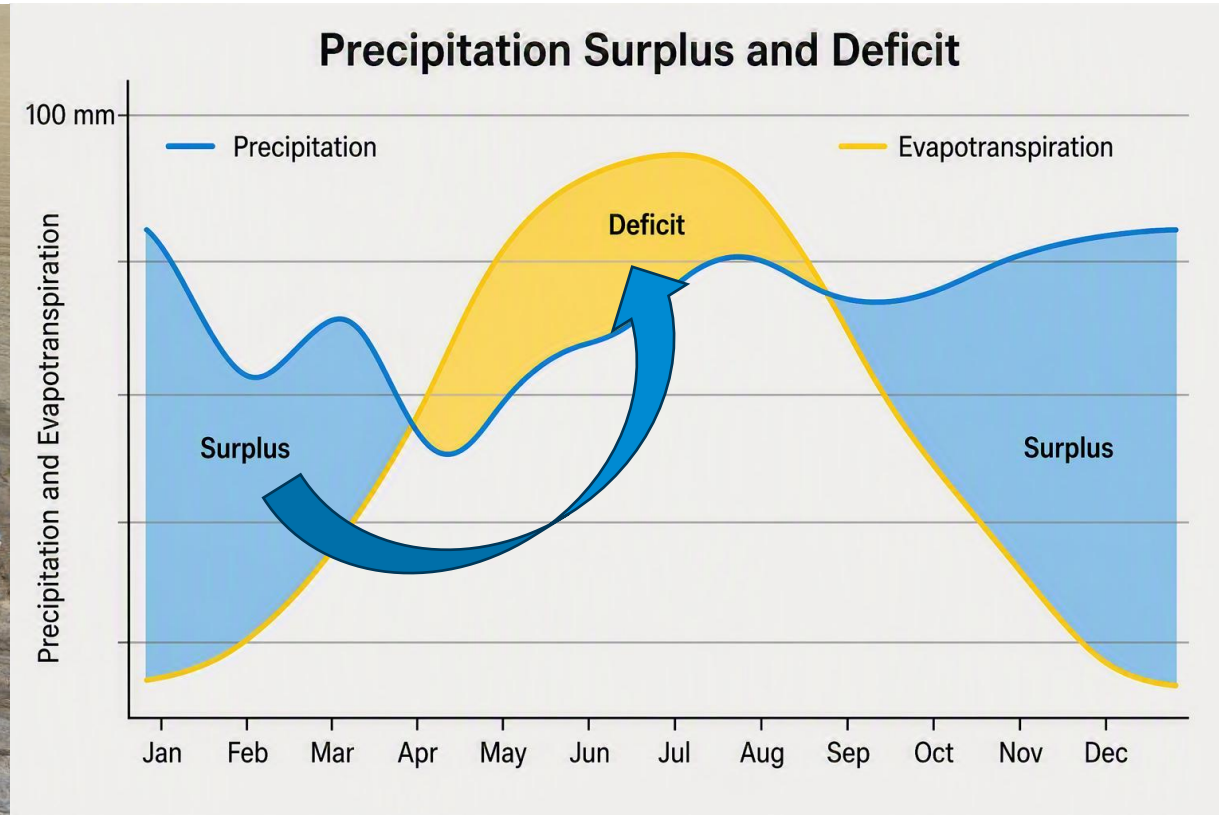
Soil moisture in water management

- Some problems that require consideration of the soil moisture
 - Soil subsidence
 - Drought
 - Dike stability
 - Water quality issues

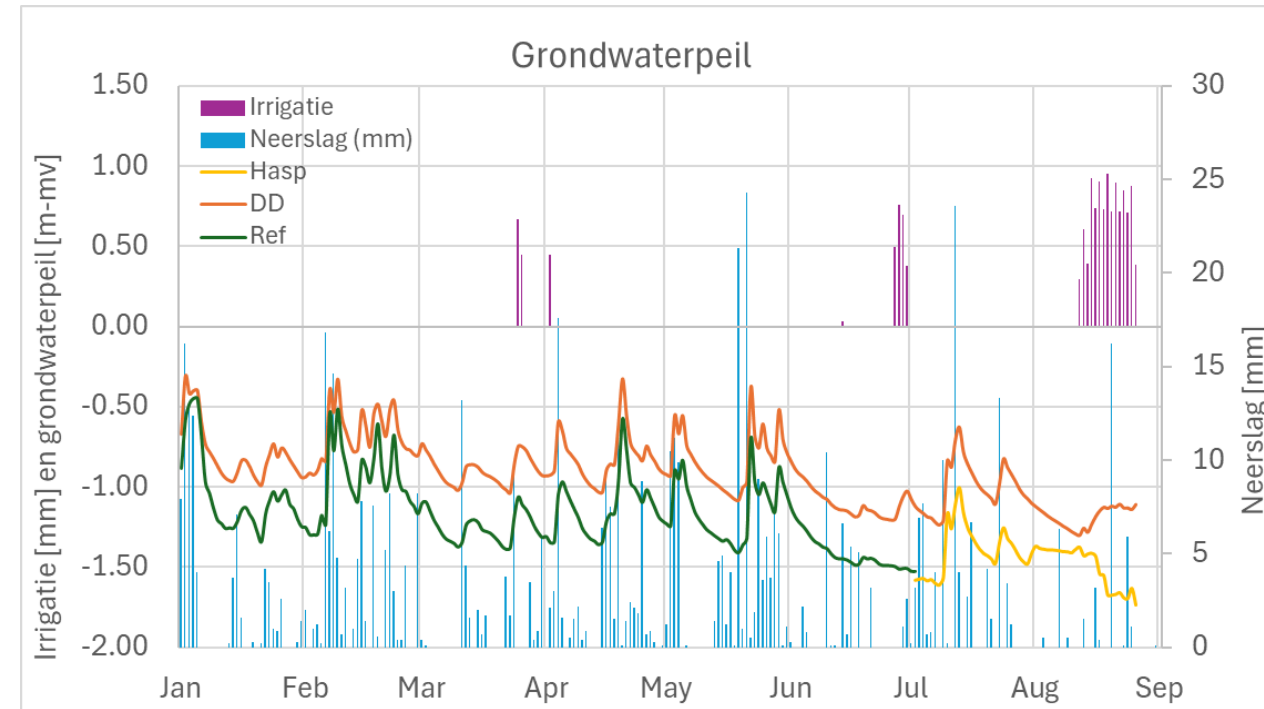
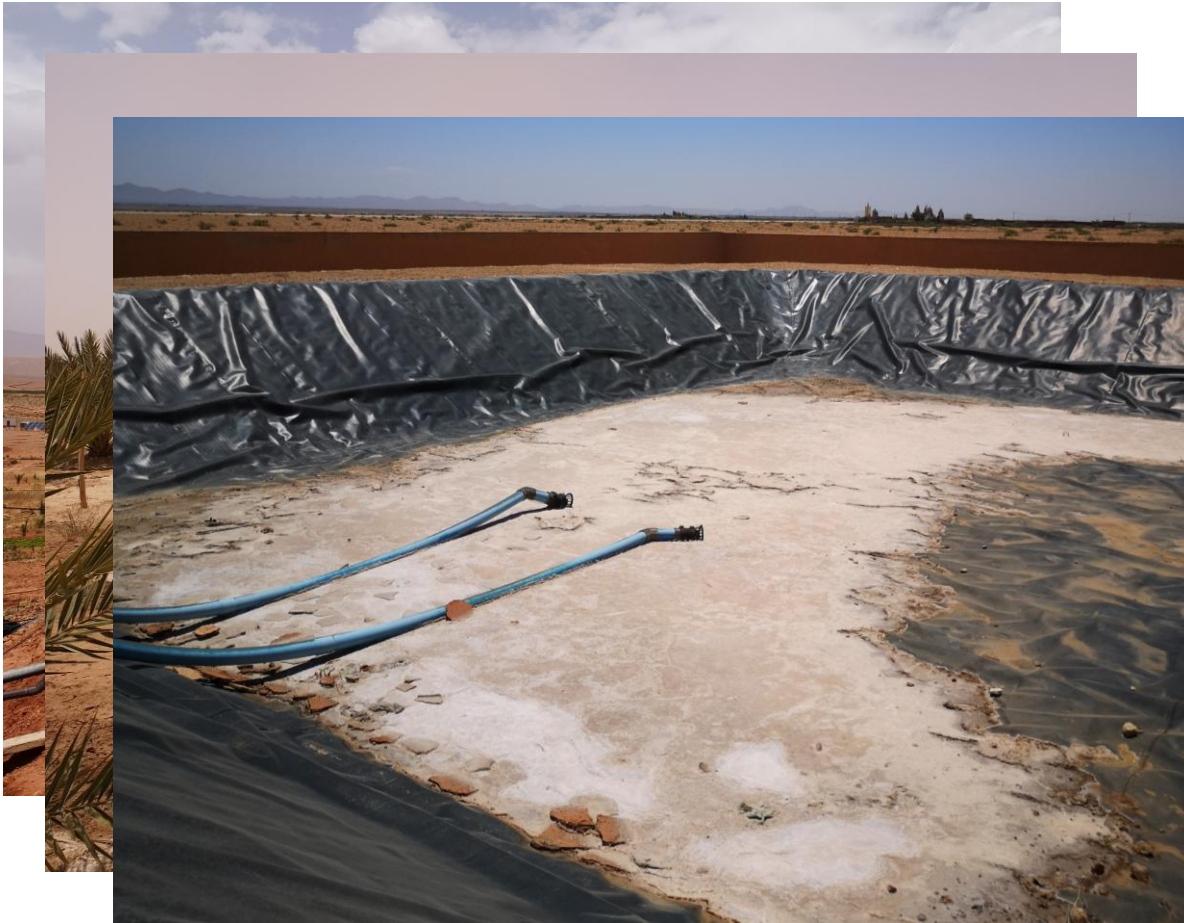
What are we working on?

- Food security
 - Soil moisture – vegetation interactions
 - Precipitation peak management
- Preservation of subsurface elements
 - Soil moisture – soil chemistry interactions

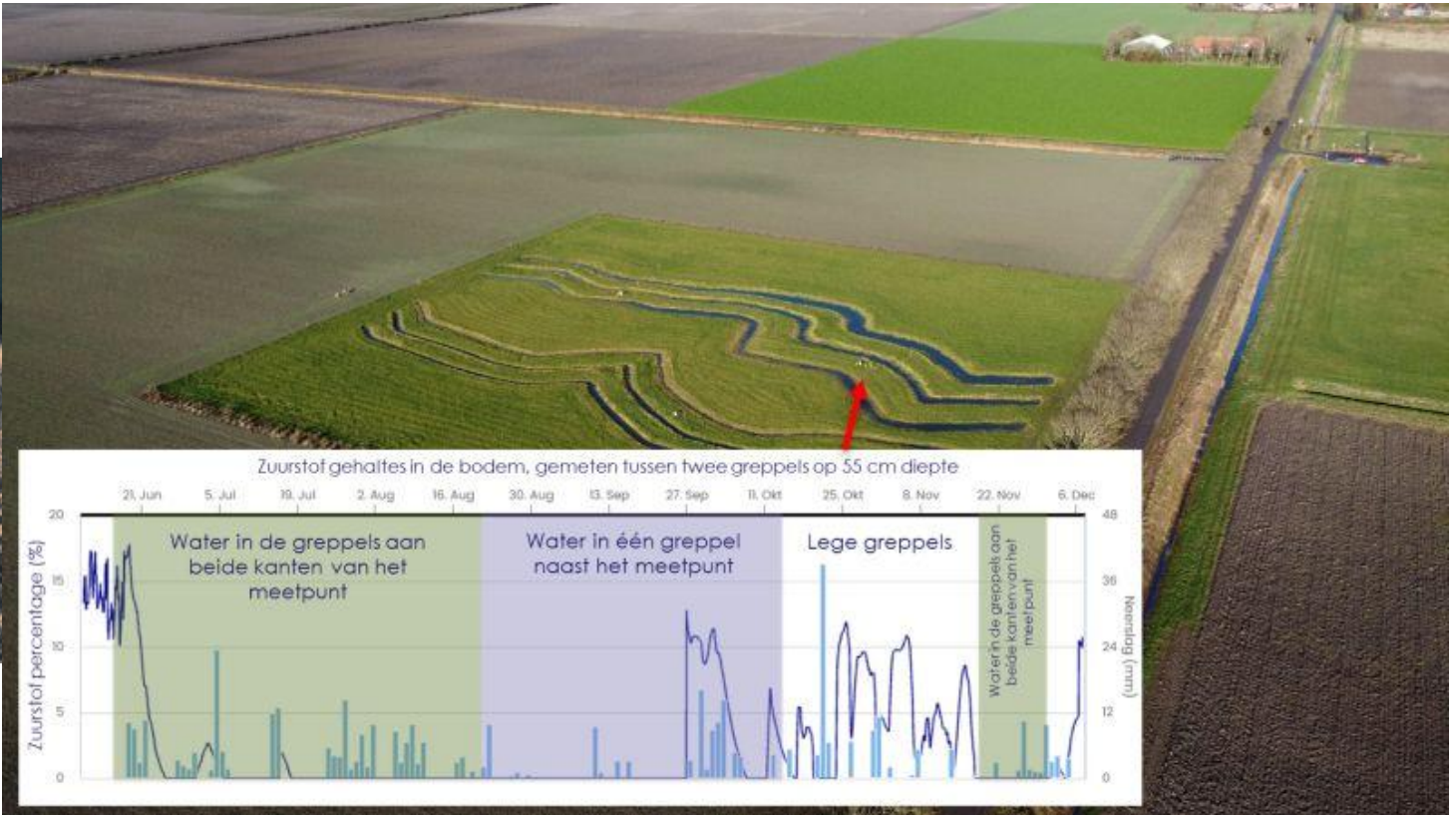
Rainfall peak management



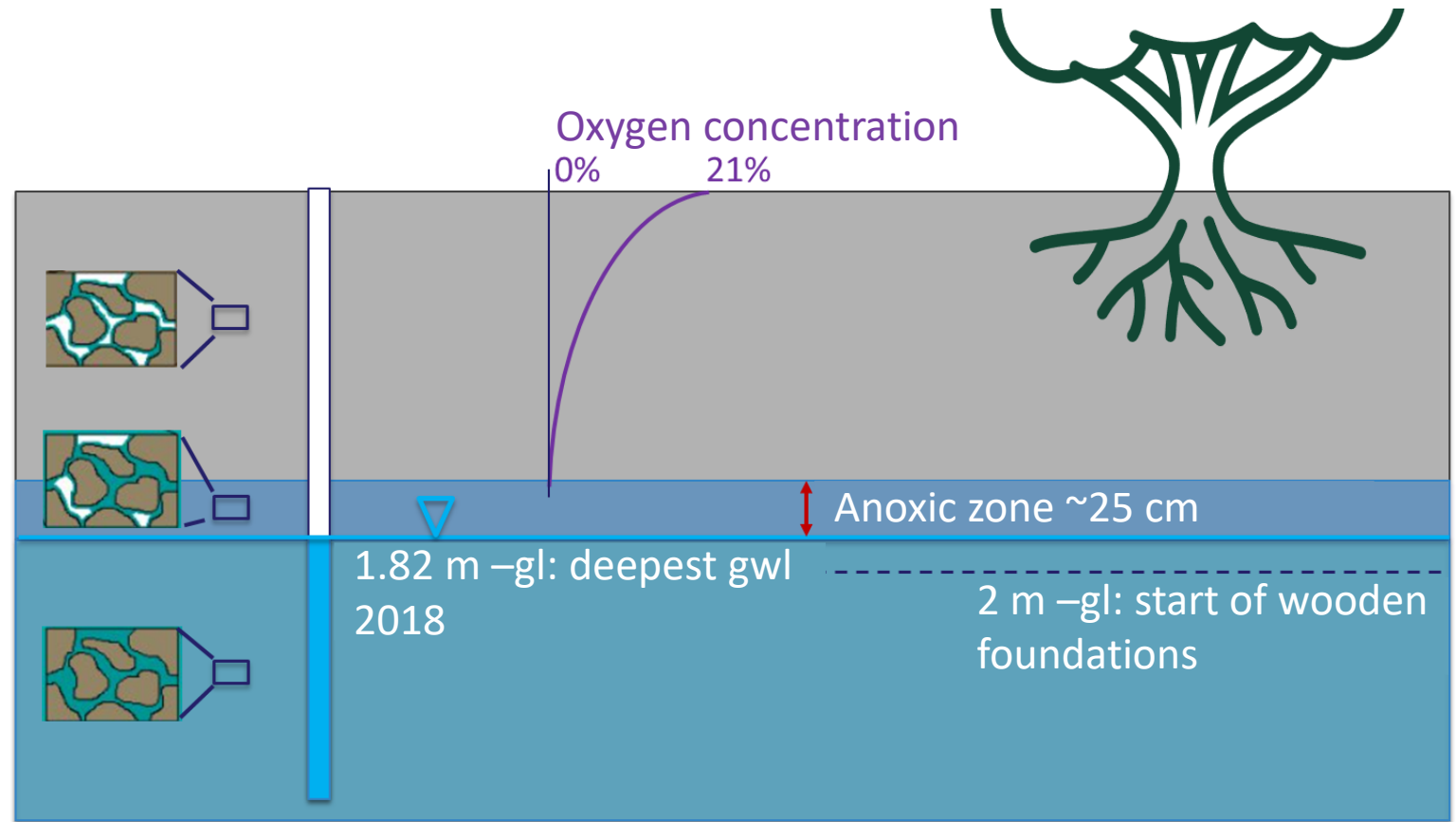
Improve irrigation efficiency



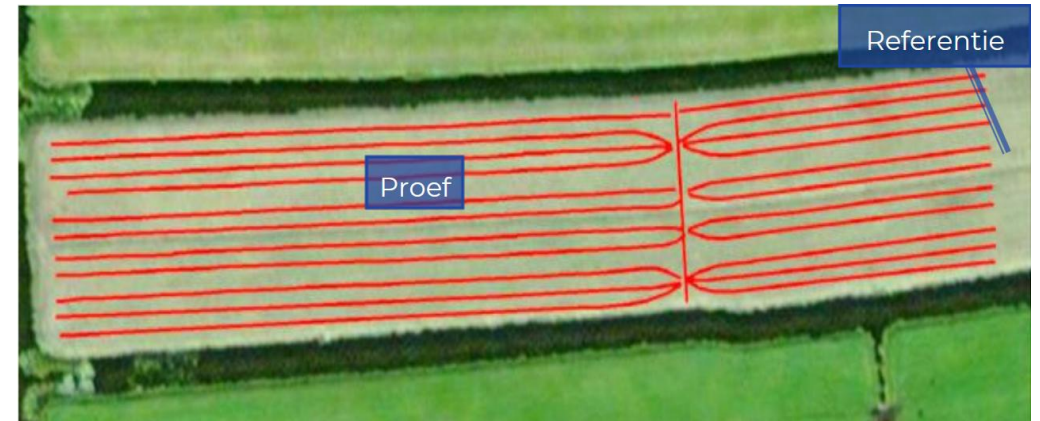
Preserving archaeology



Protecting foundations



Preserving peat

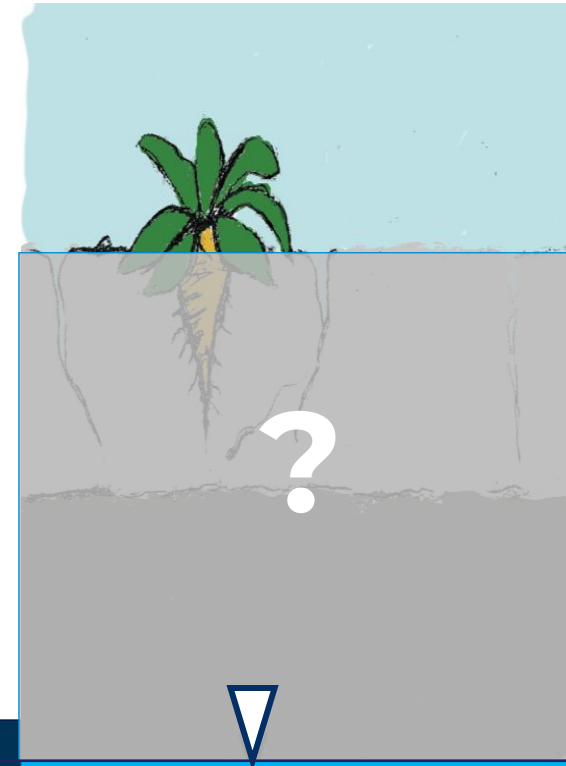
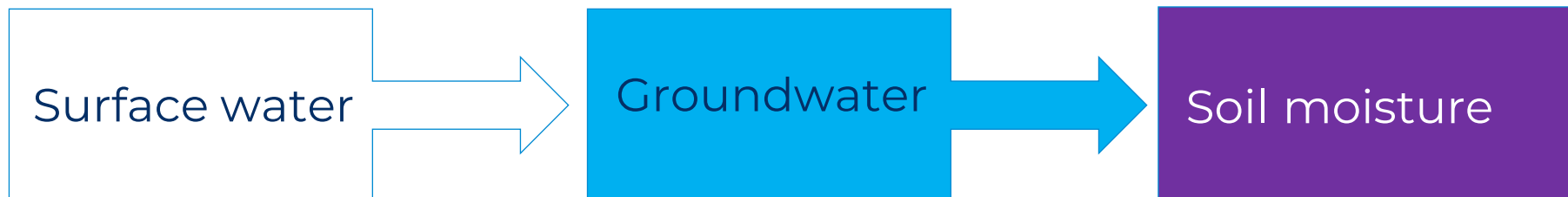


Conflicting interests in the unsaturated zone

- Reducing peat oxidation ↔ maintaining carrying capacity
- Protecting wooden foundations ↔ regreening of a city
- Protection of archaeology in the soil ↔ right conditions for agriculture

Soil moisture – why should it be the next step?

- Historically, the main focus has been on surface and ground water
- Research to understand the complexity of upper soil water storage can help
 - Understand its relevance in the water cycle
 - Maintain appropriate (ground) water levels
 - Support drought monitoring and early warning
 - Enhance food security
 - Build climate resilience



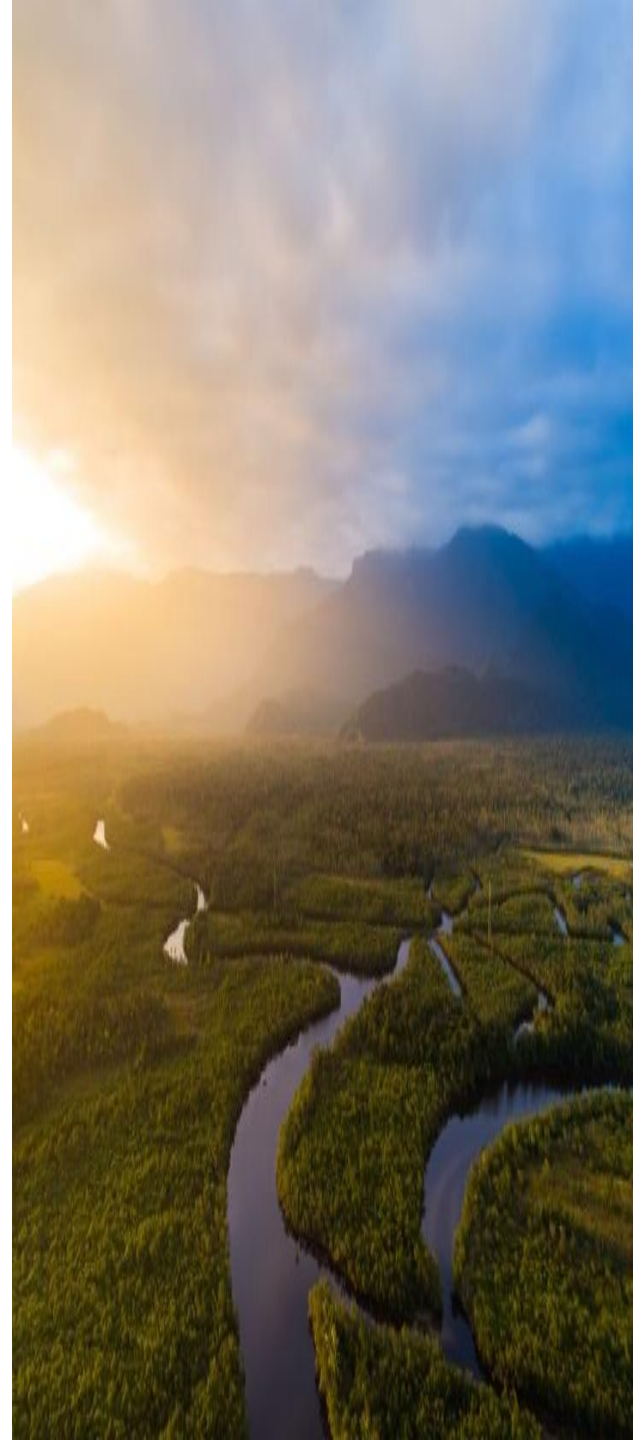
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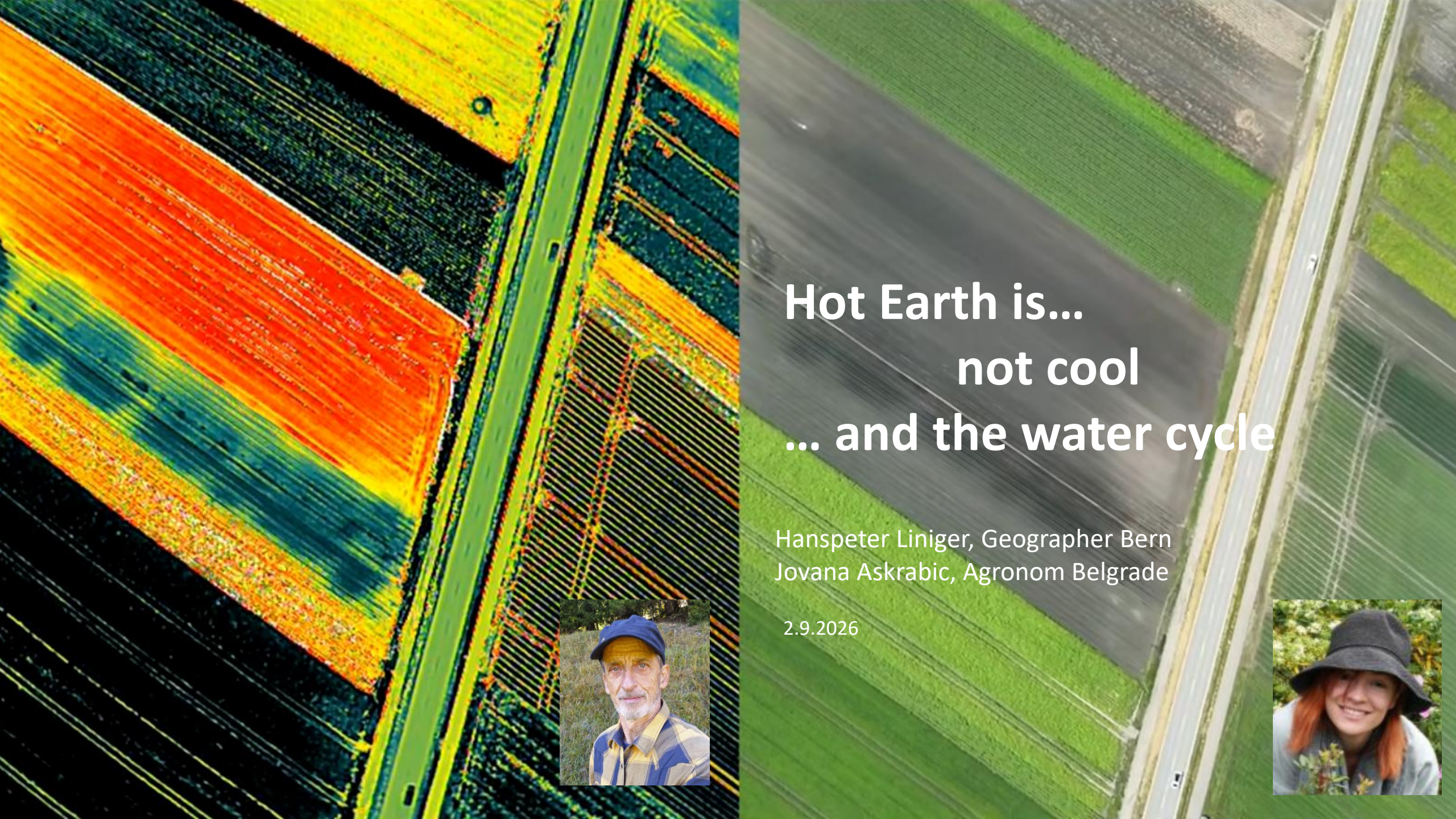
WOCAT

Hanspeter Liniger & Jovana Askrabic



Hot Earth Campaign and the small water cycle





Hot Earth is... not cool ... and the water cycle

Hanspeter Liniger, Geographer Bern
Jovana Askrabic, Agronom Belgrade

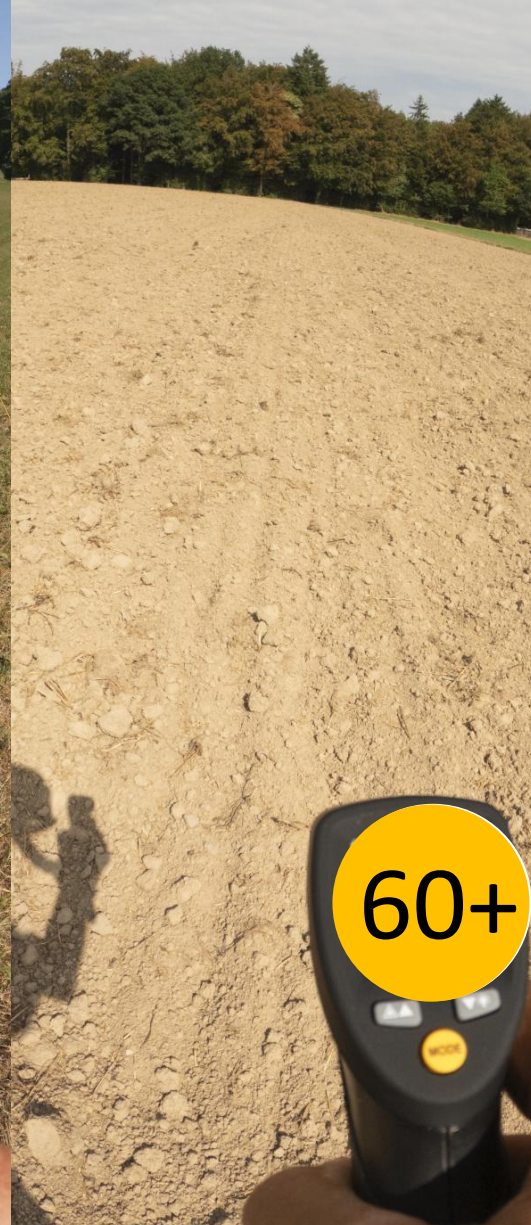
2.9.2026



Surface temperatures: Forest, Cover crop, Pasture , Cropland ploughed, Asphalt

Air temperature: around 32-35°C, sunny afternoon

18/19.8.2023: 14:00-1600





Seedorf, BE



Witzwil, BE



Bavois, VD



Gorgier, NE

Measurements summer 23/24/25/26

Different land uses

- Temperature: surface, soil, air
- Air humidity
- Soil cover
- Aggregate stability
- Activity of soil organisms, ...



Pulia, S-Italy



Spain



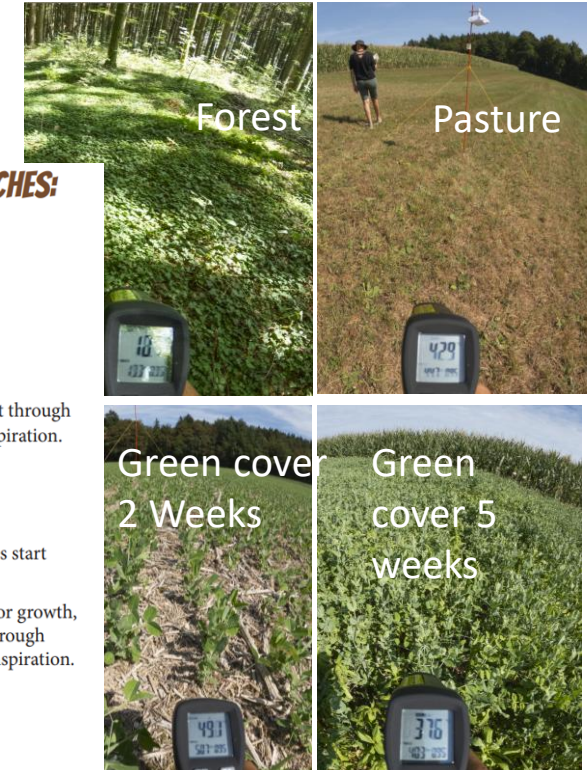
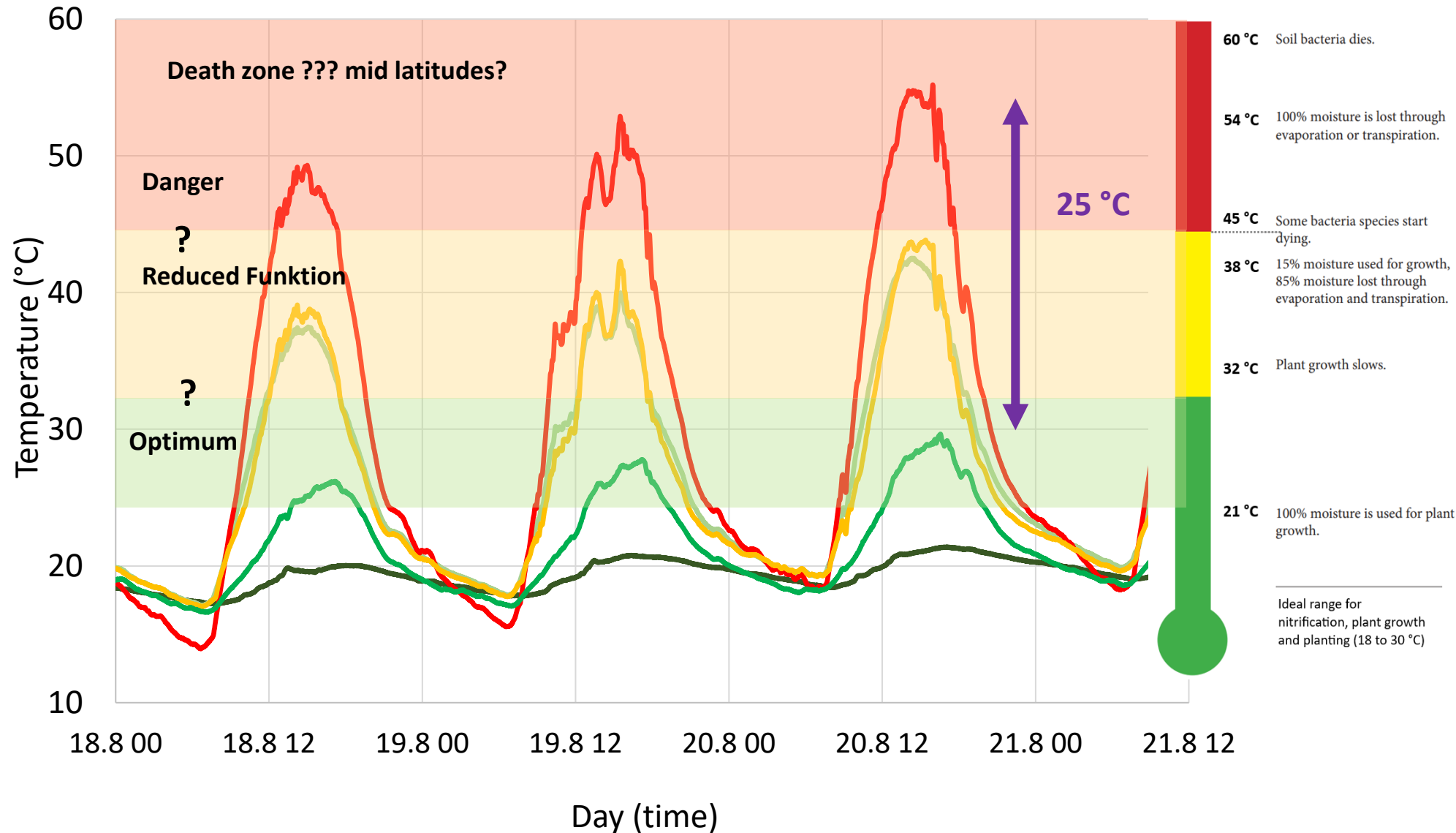
Bosnia &
Herzegovina



Spain

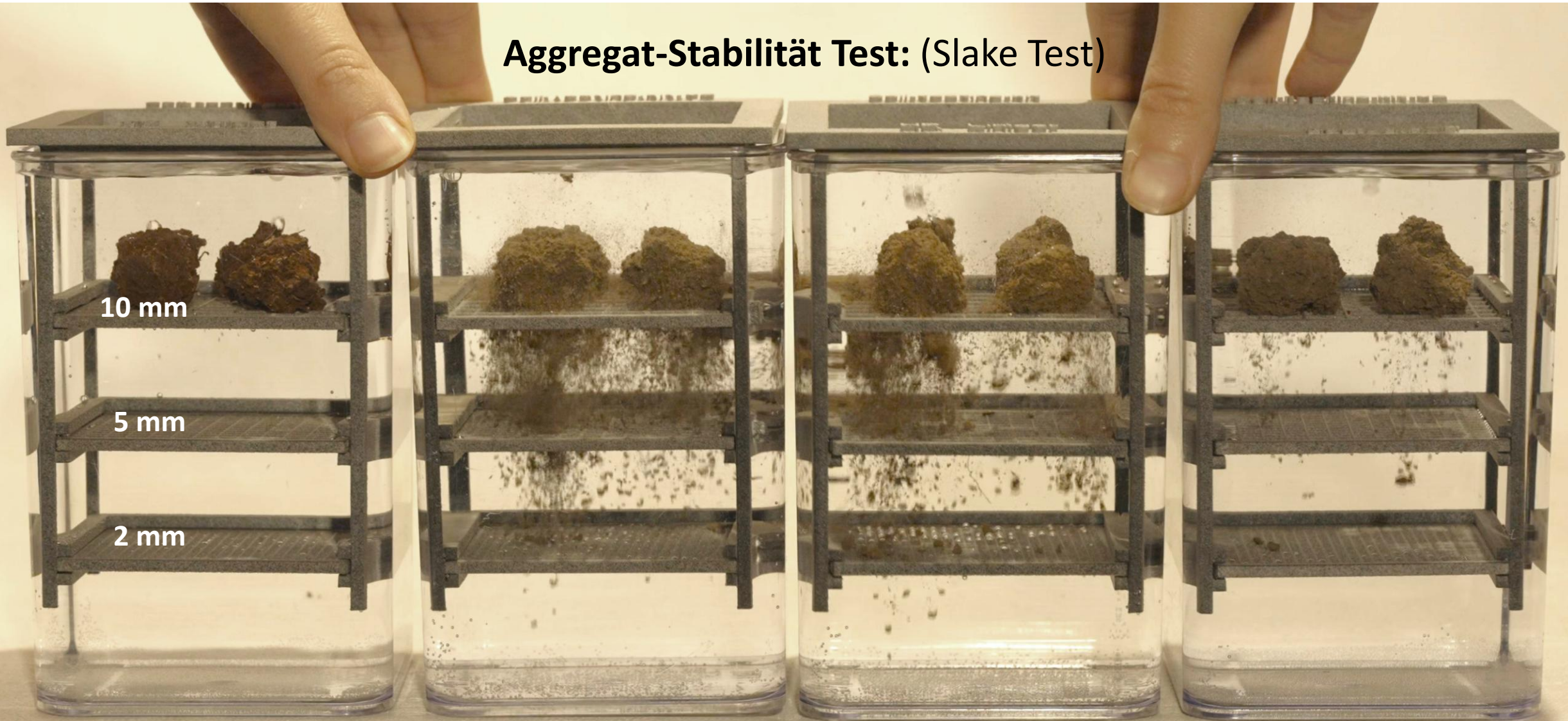
Surface temperatures of different land management practices

Frienisberg, 18.8.2023 (00:00) - 21.8.2023 (10:00)



- Tilled bare
- Pasture
- Green cover 1
- Green cover 2
- Forest

Aggregat-Stabilität Test: (Slake Test)



Forest/
Pasture

Conventional tilled
soil

Min-tilled Boden
(sunflower)

Direct seeding /
No-till (sunflower)

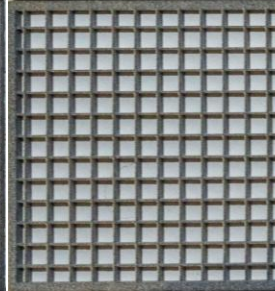
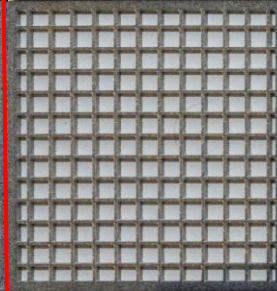
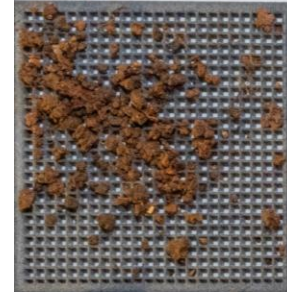
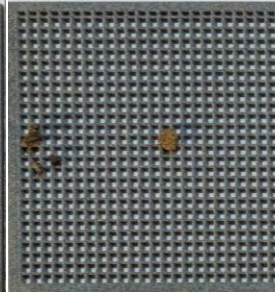
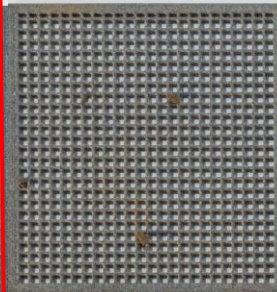
Soil Aggregate Stability Test: Bavois, CH (Slake test)

0.25 mm

2 mm

5 mm

10 mm



Tilled,
Bare

Tilled,
Mulch

No-Till
Cover crop

No-Till
Bare

No-Till
Bare-tilled

Pasture

Forest

Spain
Tilled

Scientific paper: (CH and Spain)

Correlations

1) Surface and soil temperatures

Soil cover

Land management

2) Aggregate stability

Soil temperature

Organic Matter

... add. soil properties

Land management

3) Soil respiration
(Micro-Organism)

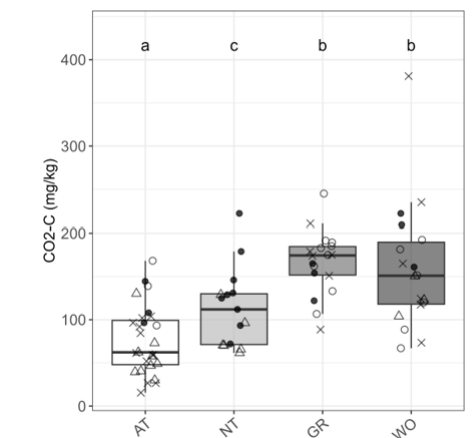
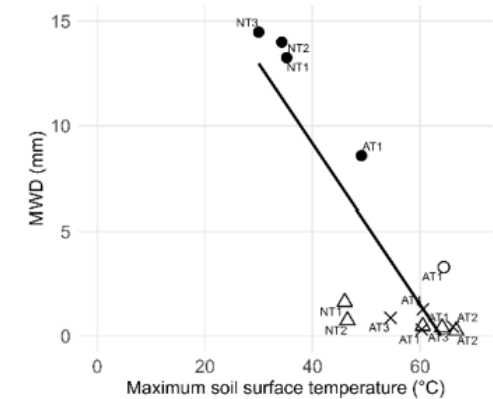
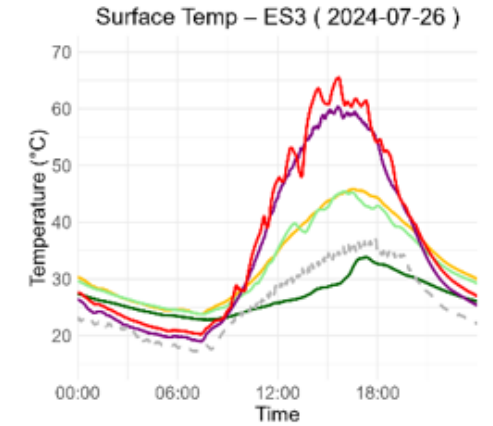
Soil temperature

Organic Matter

Aggregate stability

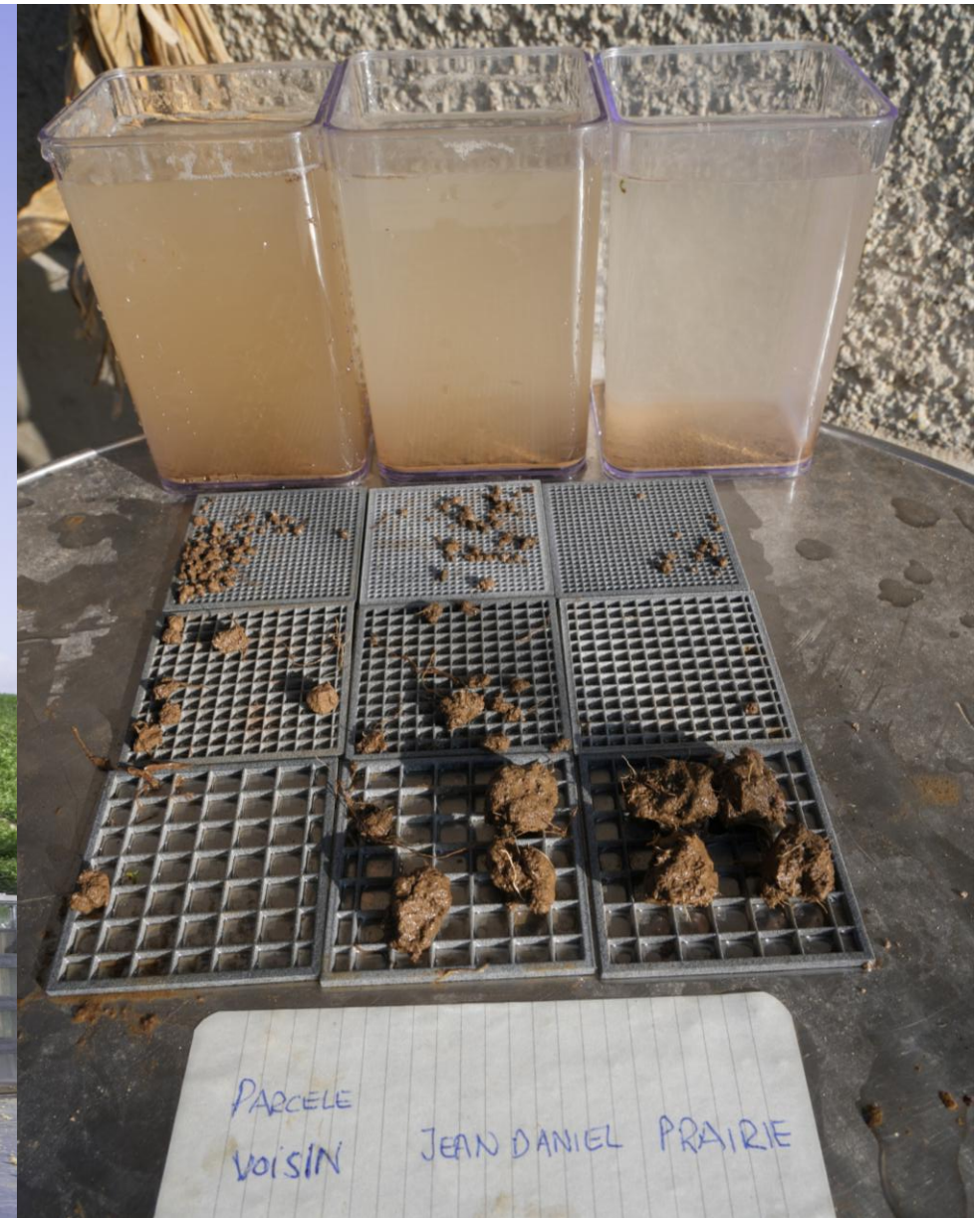
... add. soil properties

Land management



AggStab -Test for farmers and Research

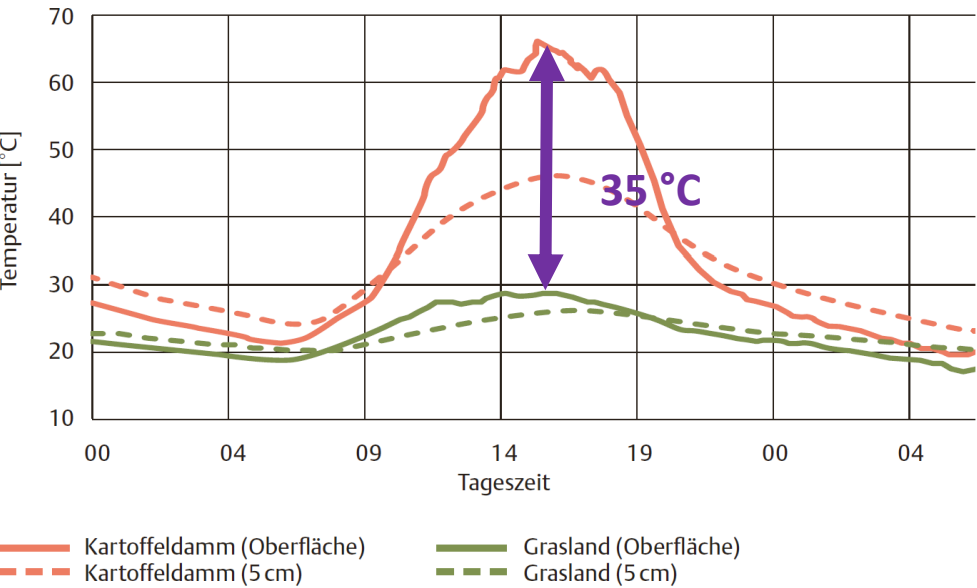
Measurements in the field?



Surface temperatures Witzwil, 20. 8.2023 (around 16:05)

Air temperature: 36 °C

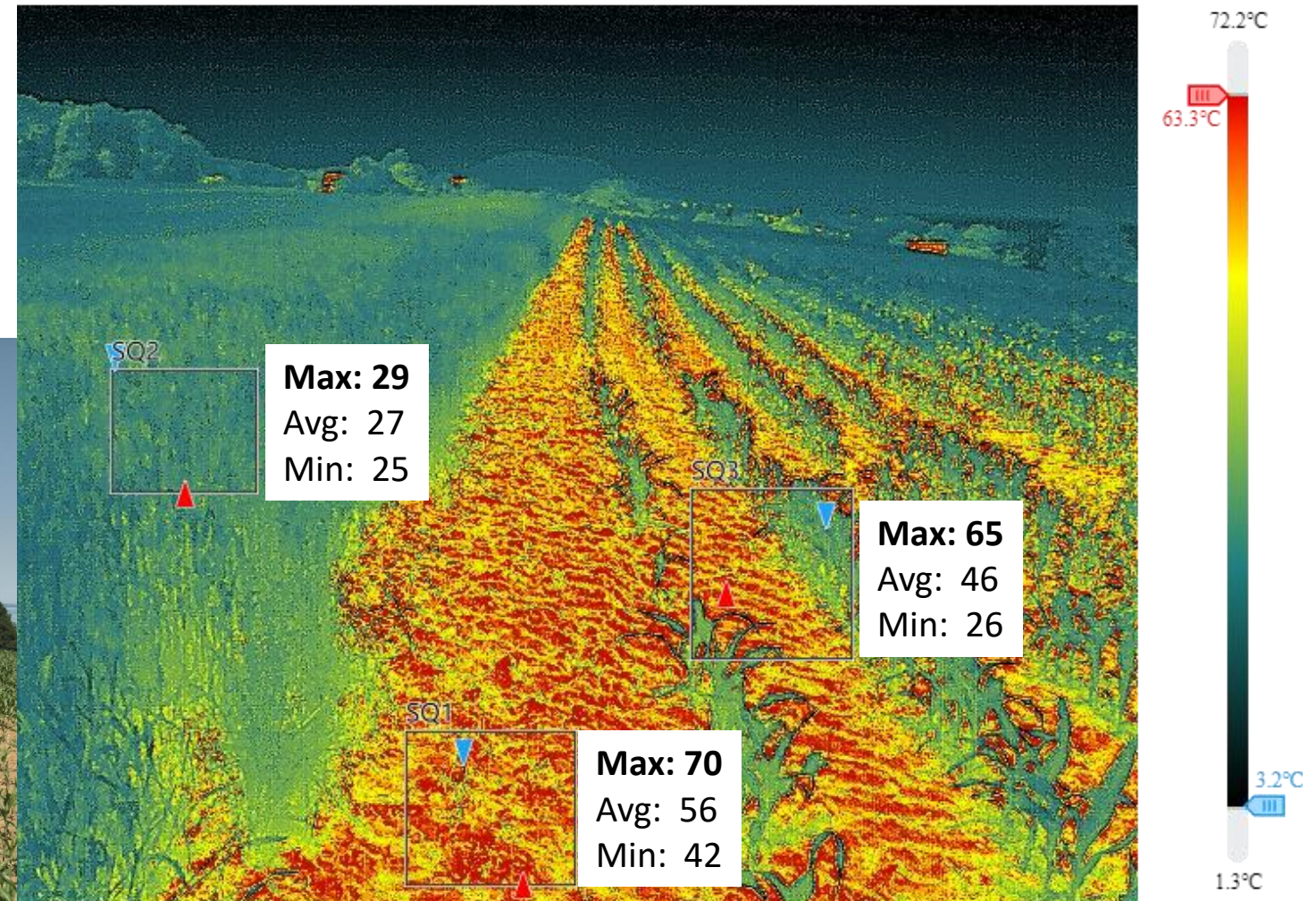
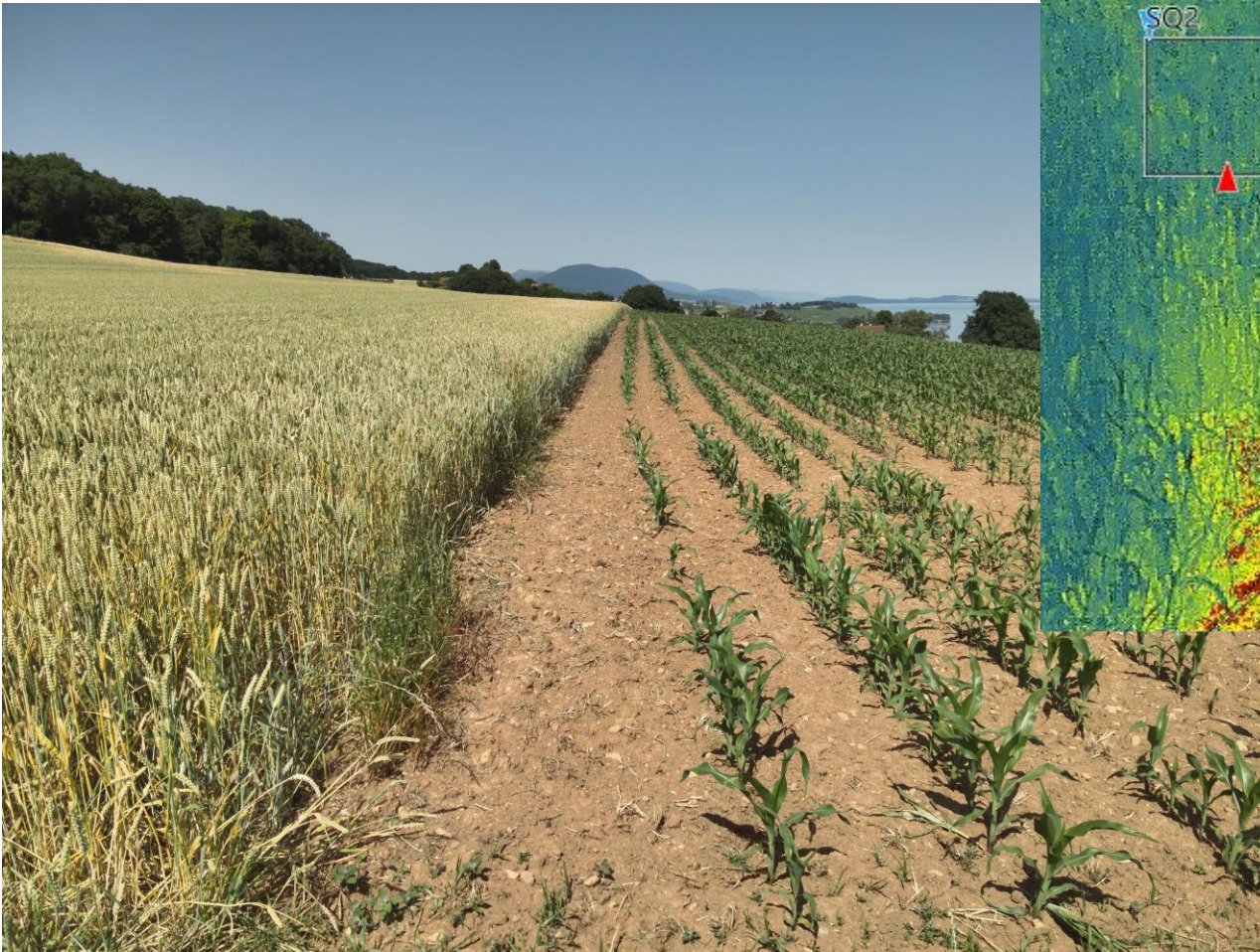
Bodentemperaturen an der Oberfläche und in 5 cm Tiefe in Kartoffel-dämmen und Grasland in Witzwil, August 2023



Hot Earth Campaign Gorgier (NE)

25.06.2025: 15:56

Air Temp: 30 °C

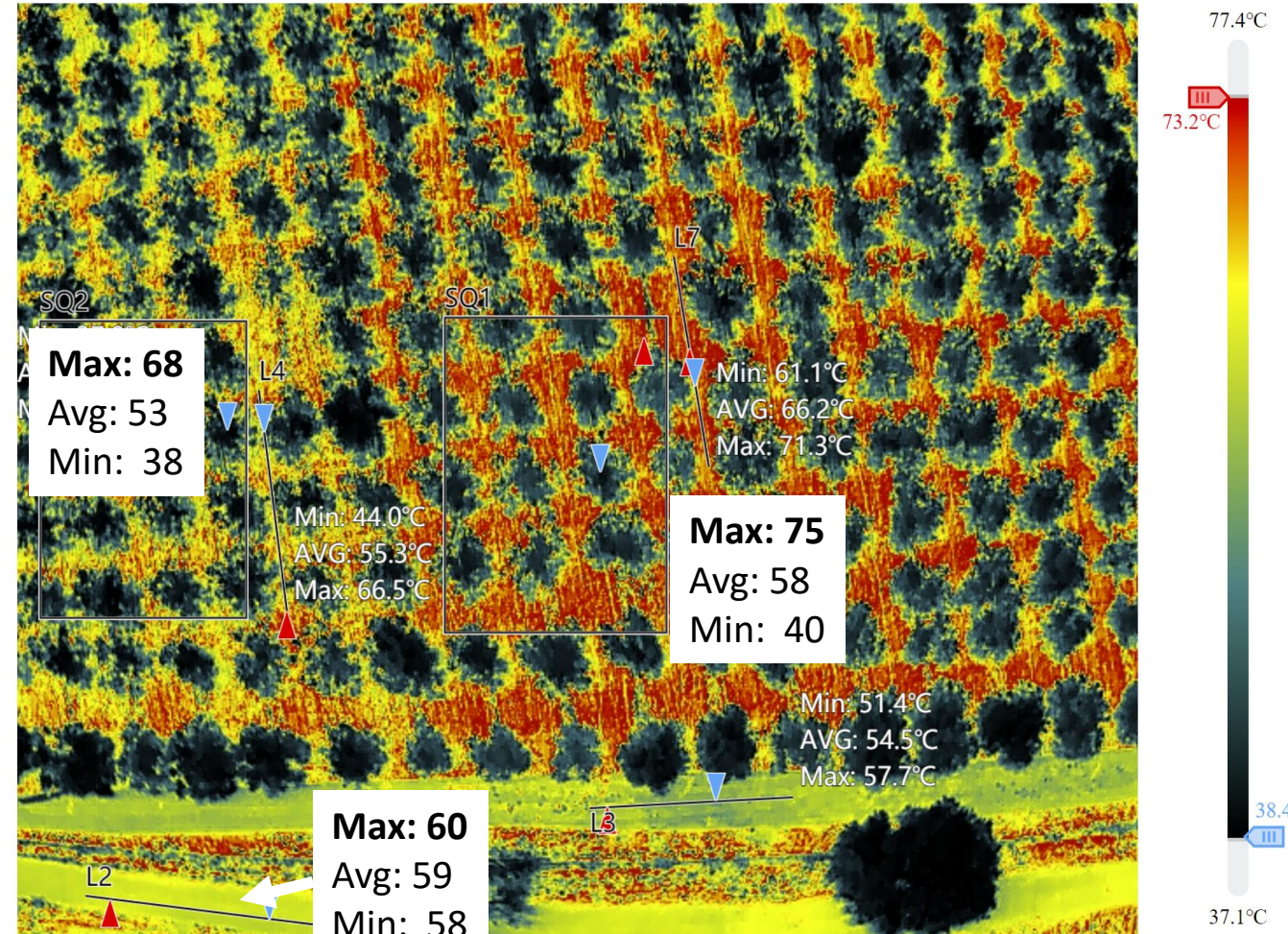


© Hanspeter Liniger

Maize: bare soil between rows gets extremely hot (even hotter than soils of open bare fields)

Hot Earth Campaign Puglia (Italy) : Olive plantations

21.07.2023: 12:25

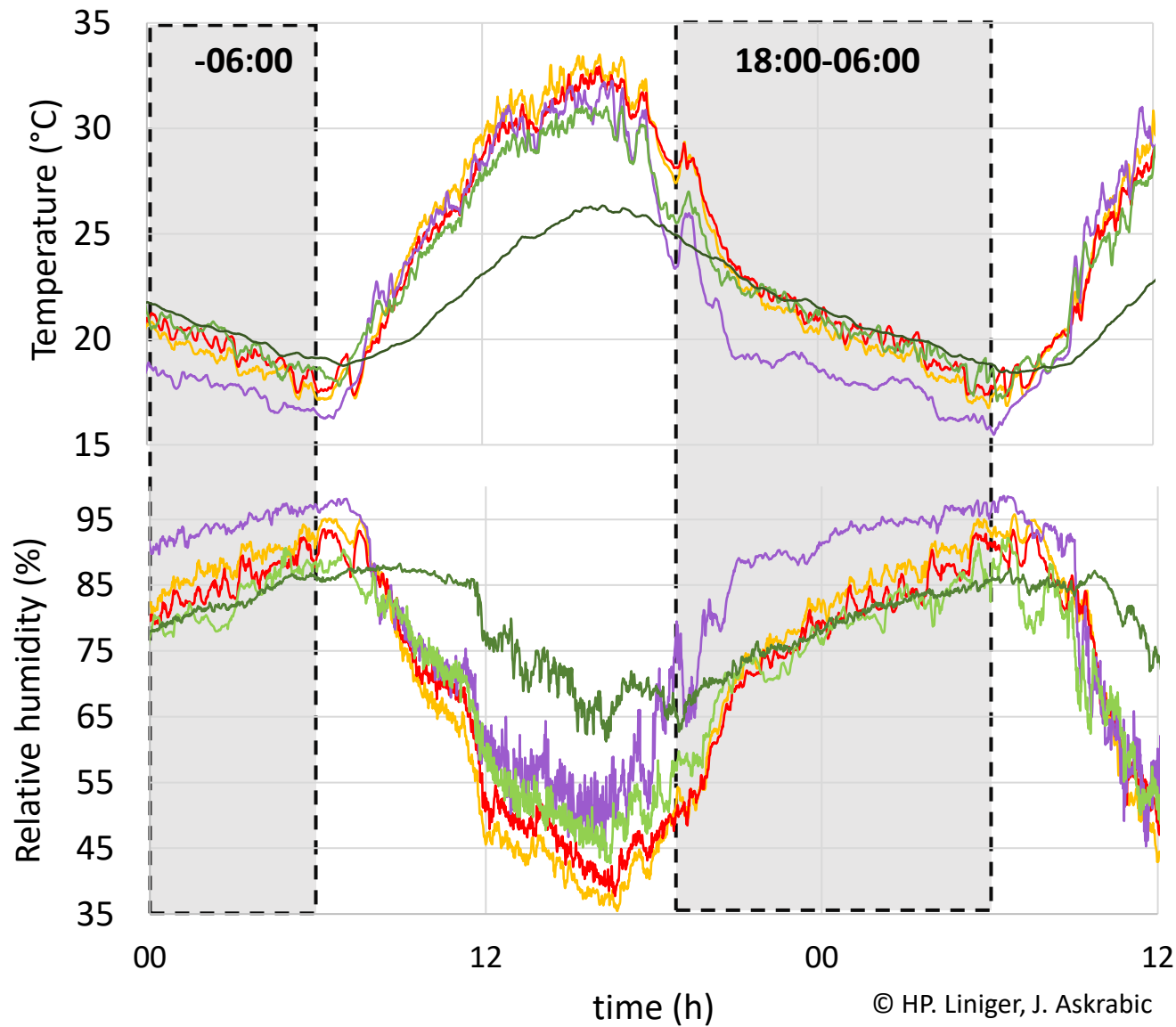


DJI_20230721122537_0112_T.JPG

2023/07/21 12:25:37

© HP. Liniger, J. Askrabic

Air temperature and relative Humidity at 0.6 m in Bavois (VD) 31.8-1.9.24

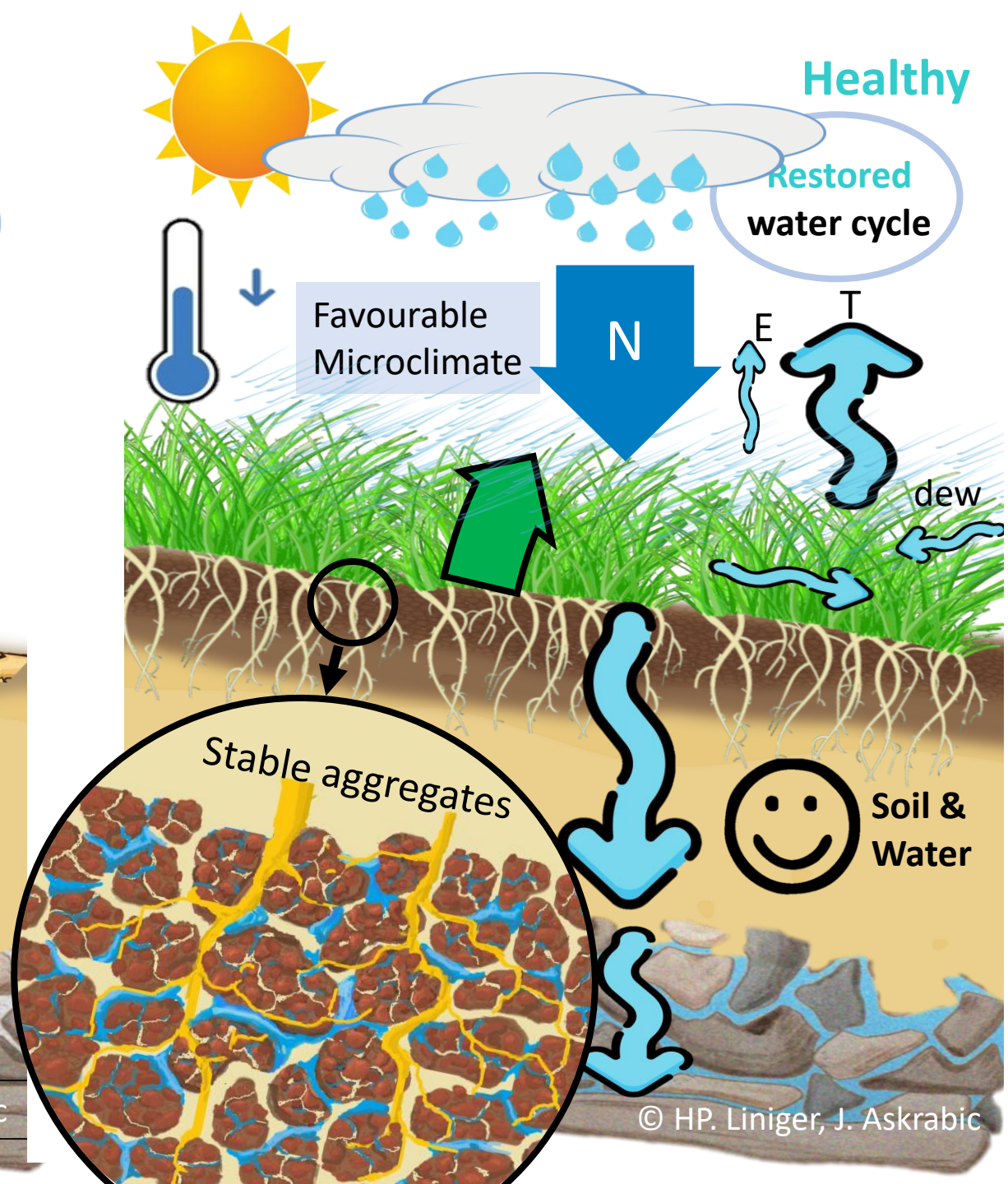
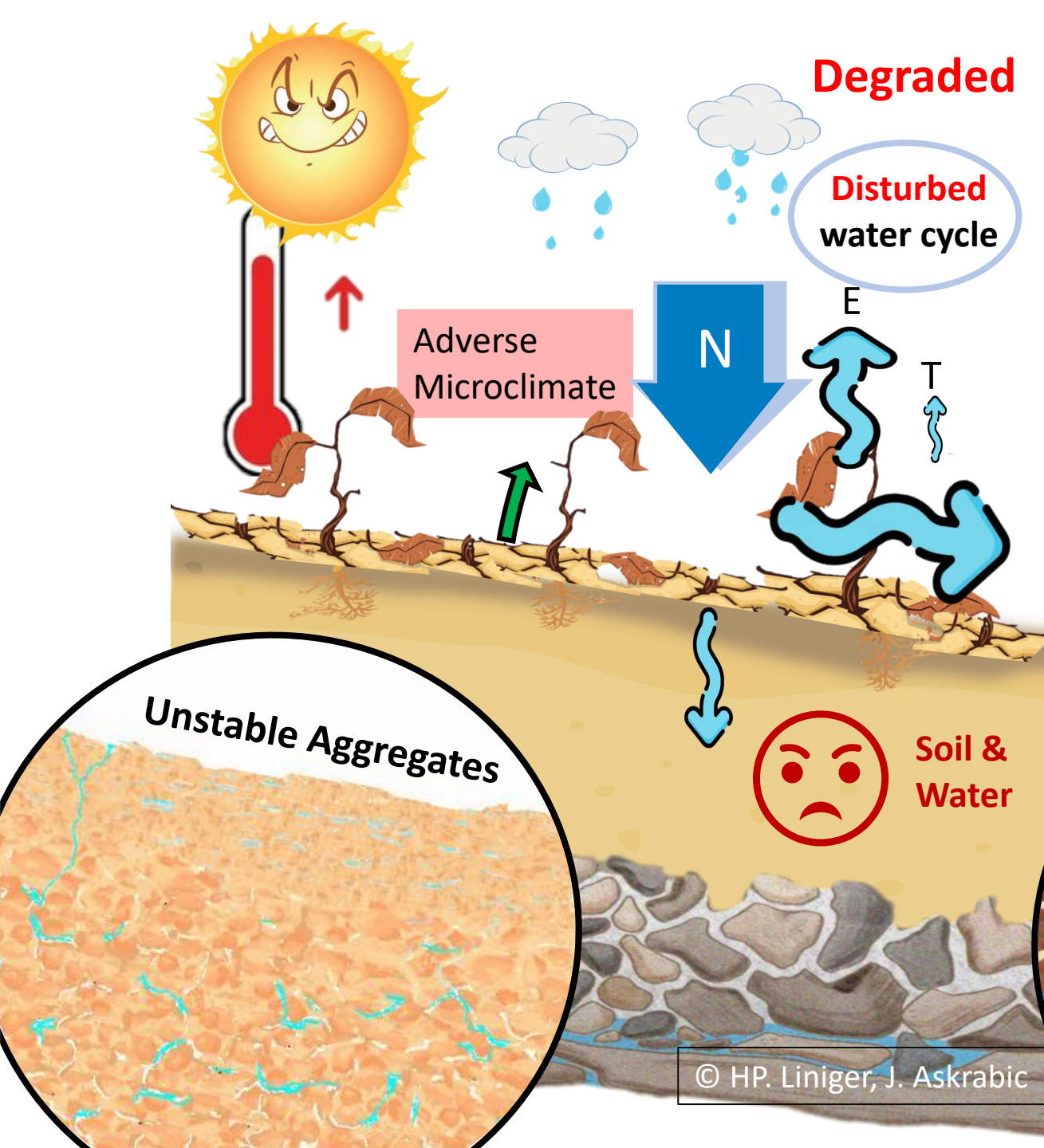


- Tilled Cereal Bare (C1P2)
- No-Till Rapeseed Mulch (C1P1)
- Permanent Pasture (C1P6)
- No-Till Cover Crop (C1P4)
- Forest (C1P7)

In the night: Cover crop

- 2-3 °C cooler than all others (incl. forest!)
- 10-20% higher rel. humidity

→ Collects water: even during heatwaves
e.g. summer 23



The big and small water cycle

How much of the rain is:

- directly from the oceans?
- Recycled water from the land between us and the oceans?

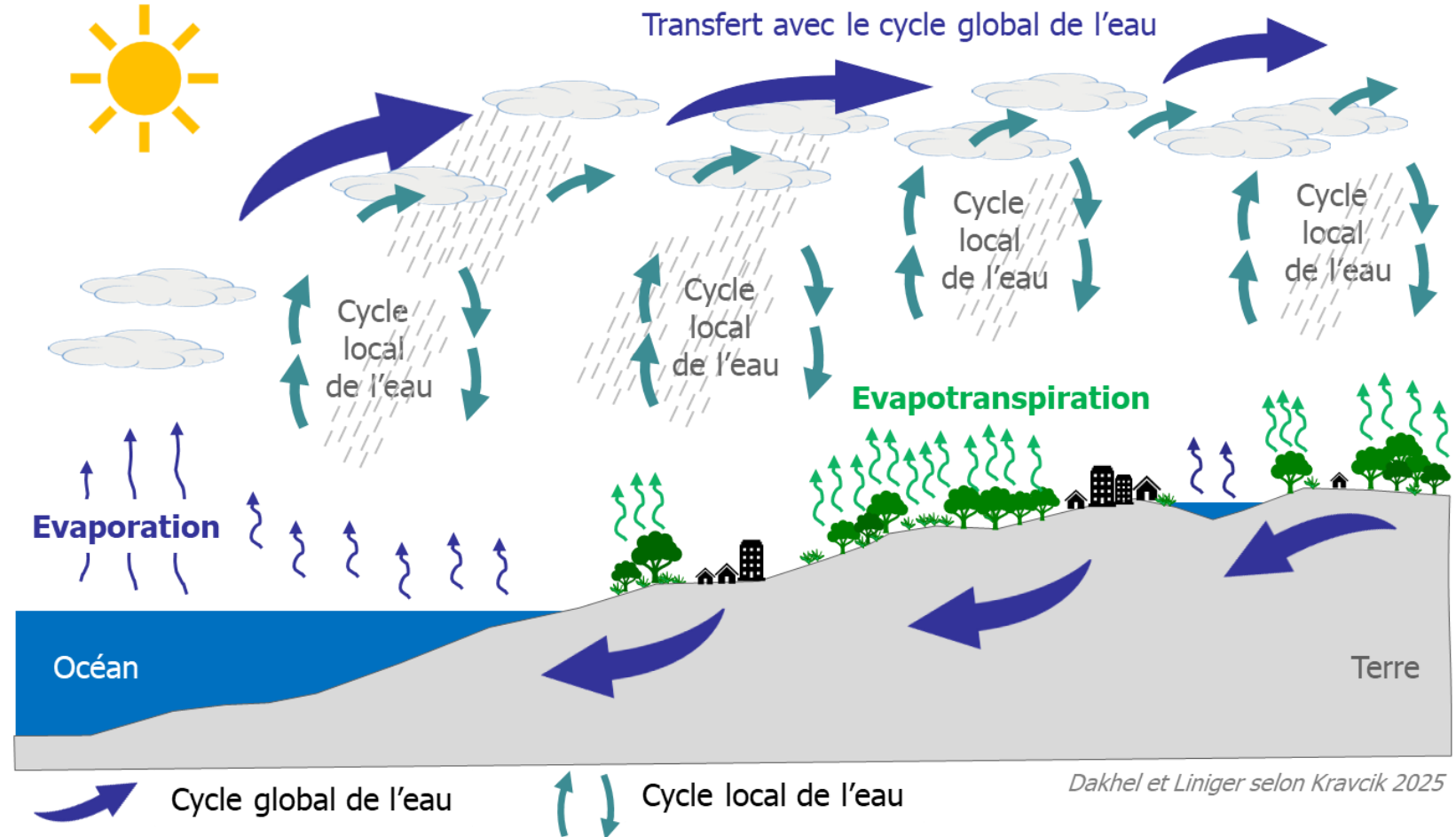
In Switzerland (Alps):

Annual: 80% oceans, 20% land

Summer: 50% oceans; 50% land

In summer every second drop of water comes from the land management of our neighbours

In other places? Depending on wind circulation and distance to the open water



Thus, we should care for our neighbours and their land!

Continental precipitation recycling ratio ρ_c

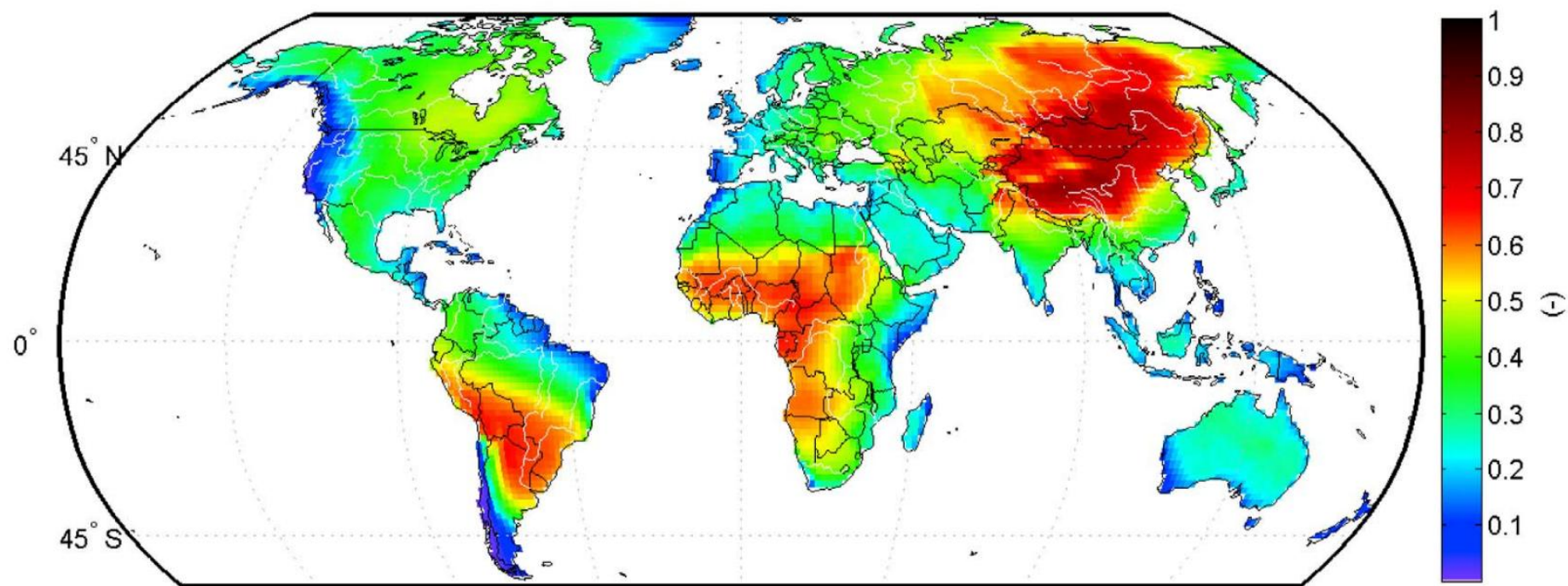


Figure 3. Average continental precipitation recycling ratio ρ_c (1999–2008).

Source: van der Ent, R. J., H. H. G. Savenije, B. Schaefli, and S. C. Steele-Dunne (2010), Origin and fate of atmospheric moisture over continents, *Water Resour. Res.*, 46, W09525, doi:[10.1029/2010WR009127](https://doi.org/10.1029/2010WR009127).

Water losses/ potentials

Surface runoff is visible::

→ floods (role of aggregate stability?)

Evaporation → the hidden disaster

Dew potential is largely overlooked!

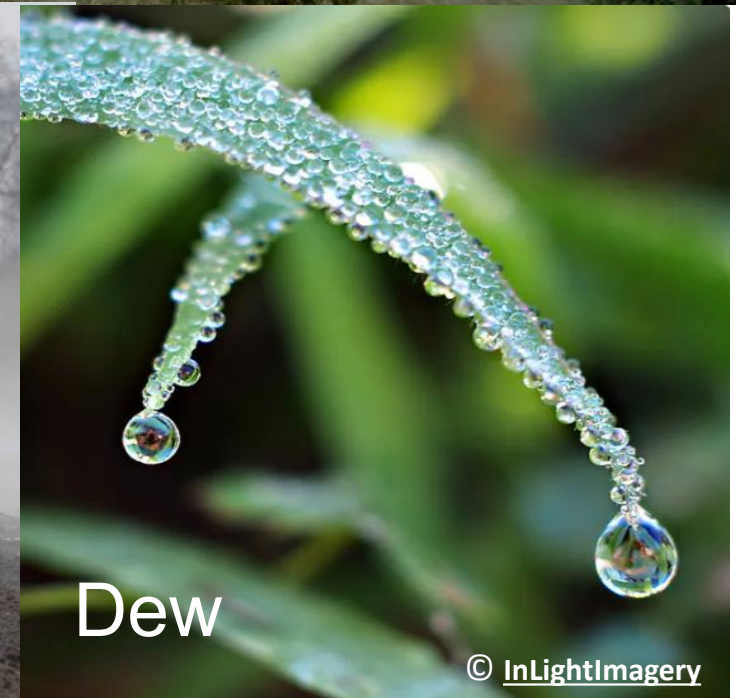
Photos: H.P. Liniger



Aggregate



Evaporation



Dew

Spain 2024: Olives... soils intensive tillage

Water shortage, extremely dry and hot... followed by floods

→ Local / regional disaster → climate change or land management???



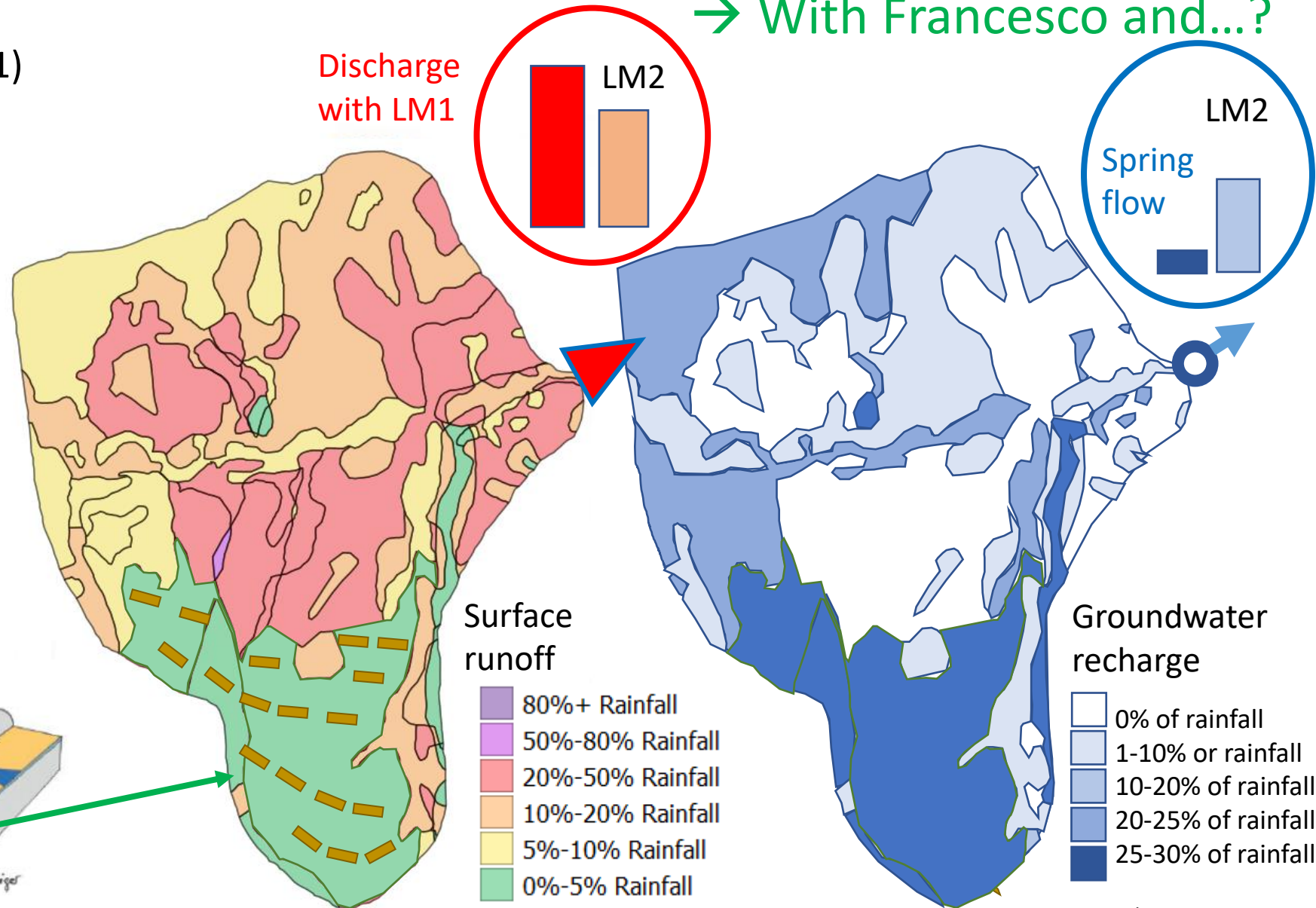
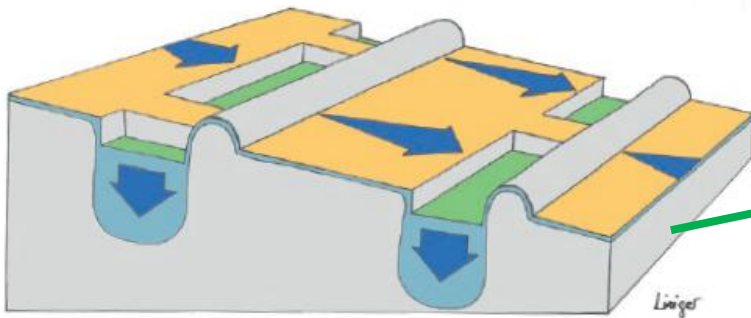
Watershed tool to explore impacts of local Land Management (LM)

→ With Francesco and...?

- Current land management (LM1) determines surface **runoff** and **discharge** from each area ...
- ... and the **GW recharge** from each area...
- ... and the **Spring flow**
- Any land management change (LM1 → LM2) results in a different runoff

and Surface Water Discharge
and GW recharge / Spring flow

Water Harvesting (LM2)



Support to the Swiss Agricultural Advisory service



La Liberté 7 juillet 2026

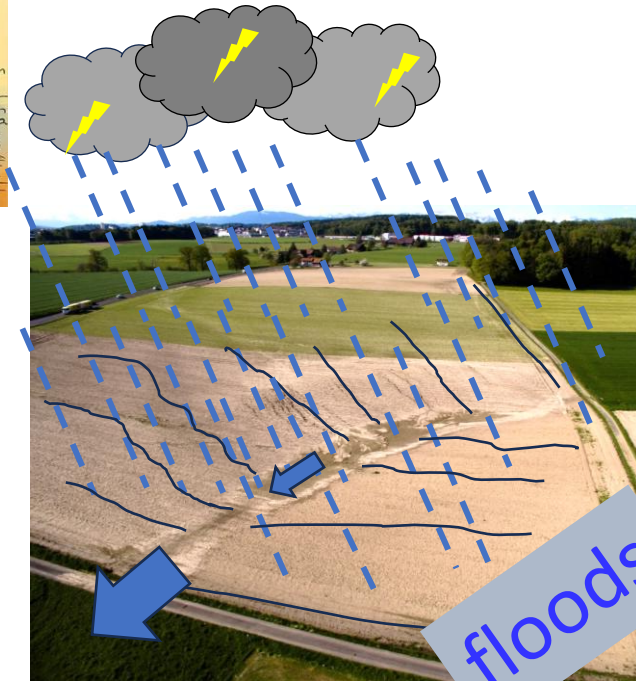
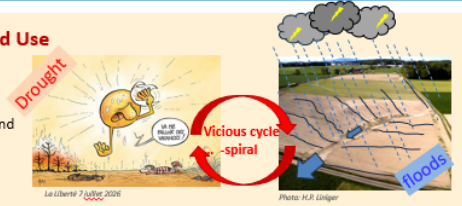


Photo: H.P. Liniger

Improving the Water Cycle and Microclimate in Agriculture

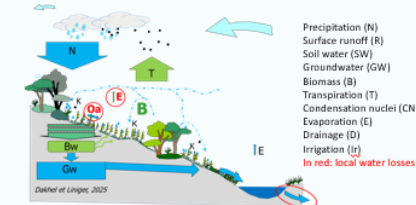
Climate Change... and Changes in Soil and Land Use

- More frequent heatwaves, droughts and heavy rainfall
 - Soils without vegetation or mulch overheat in summer
 - Bare soils degrade and lose rainfall through surface runoff and direct evaporation
 - Large, monotonous landscapes store little water
- The result: water and fodder shortages and low yields



Water cycles

Functioning local water cycle



- Rainwater is primarily used for **plant transpiration (production)** and **storage in soil and groundwater** (which sustains river flow).
- Vegetation transpiration **promotes rainfall and dew formation** (through condensation nuclei).

Disturbed local water cycle



- **Water losses**
 - through surface runoff and rapid drainage (drains, channels)
 - through evaporation from bare soils (limited condensation)
- Unfavourable micro- and regional climate
- Little green vegetation, resulting in low transpiration and condensation

Restore the Local Water Cycle and Improving the Microclimate

Principles

Soil cover

- protects against erosion, heat and drying out

Slowing water flow

- through crop diversity, strips, hedgerows, and vegetation along streams and rivers

Water infiltration

- thanks to porous, vegetation-covered soil with stable aggregates

Water storage

- in the landscape: in soils, groundwater and surface water

Plant transpiration

- feeds the local water cycle (dew, rainfall) and supports cooling and production

Slow Blue Water and Cultivate Green Water

Soil Water
Vegetation / Trees

- Soil cover is key: green vegetation where water is sufficient; otherwise mulch or crop residues
- Water availability can be improved through a combination of agronomic and landscape measures
- Combined with adapted crop varieties and/or irrigation, these measures help secure yields.
- Restoring the local water cycle is central to reducing the impacts of climate change on agriculture and society as a whole, particularly on drinking water supply, cooling and biodiversity





© E. Z'Rotz

Solutions: Summer

- Soil cover!
 - if possible green
 - otherwise mulch

© HP. Liniger



Further Hot Earth Campaigns: 2026, 27, ...

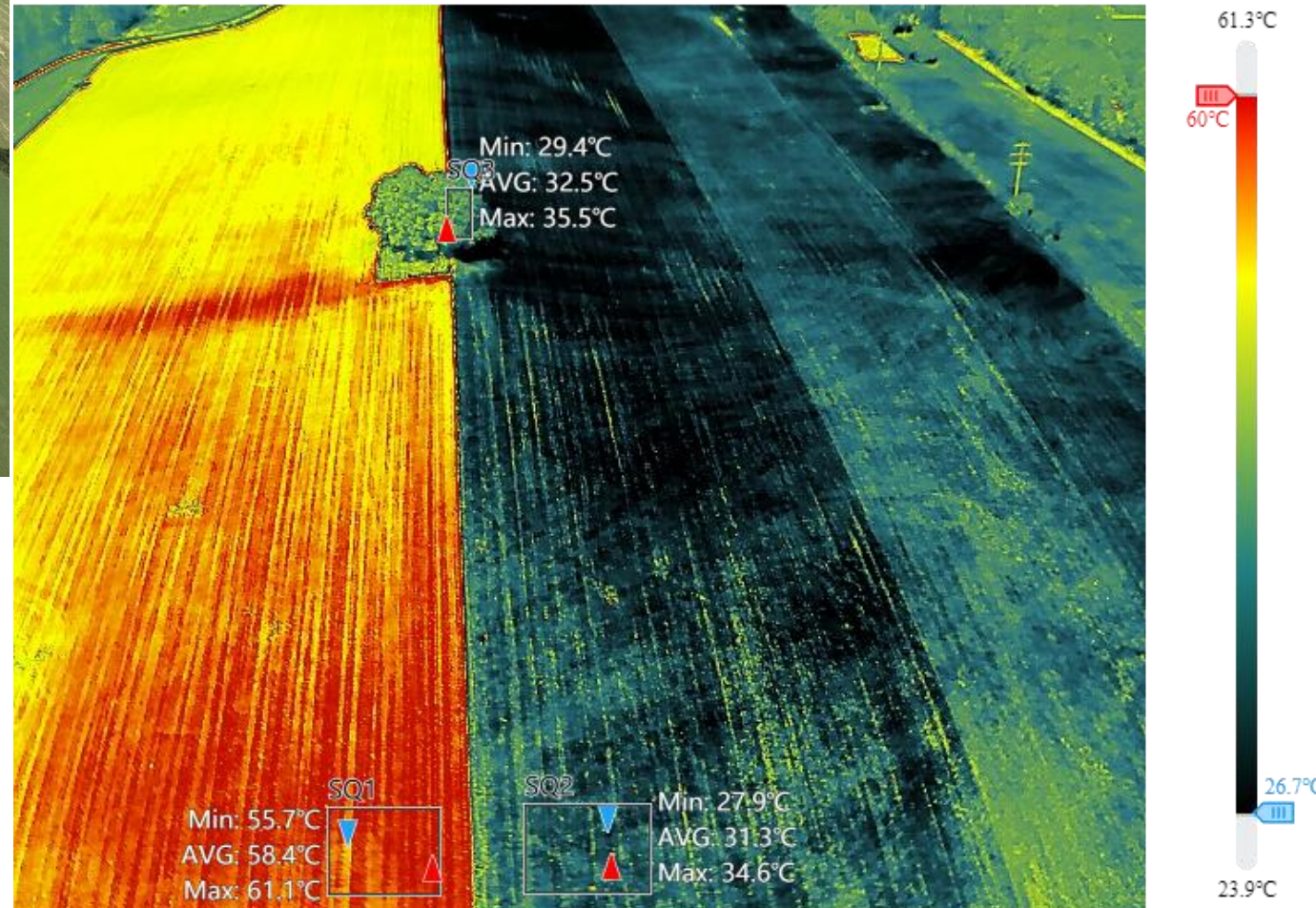
(Gorgier NE: 25.06.2025: 16:04 ...)

Climate Landscapes:

- each m2 green = 20-25-30° cooler (heating plate) immediate contribution
- **Difference in air temperature at 0.6m and 2m???**
- **Importance of dew and local and wind circulation**

Degradation Landscapes

- Soil aggregate stability → **consequences on water cycle local/ regional (watershed)**





Deutsch

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LinkedIn: Hanspeter Liniger

Video: Hot Earth is not cool (CH! + Spain?)

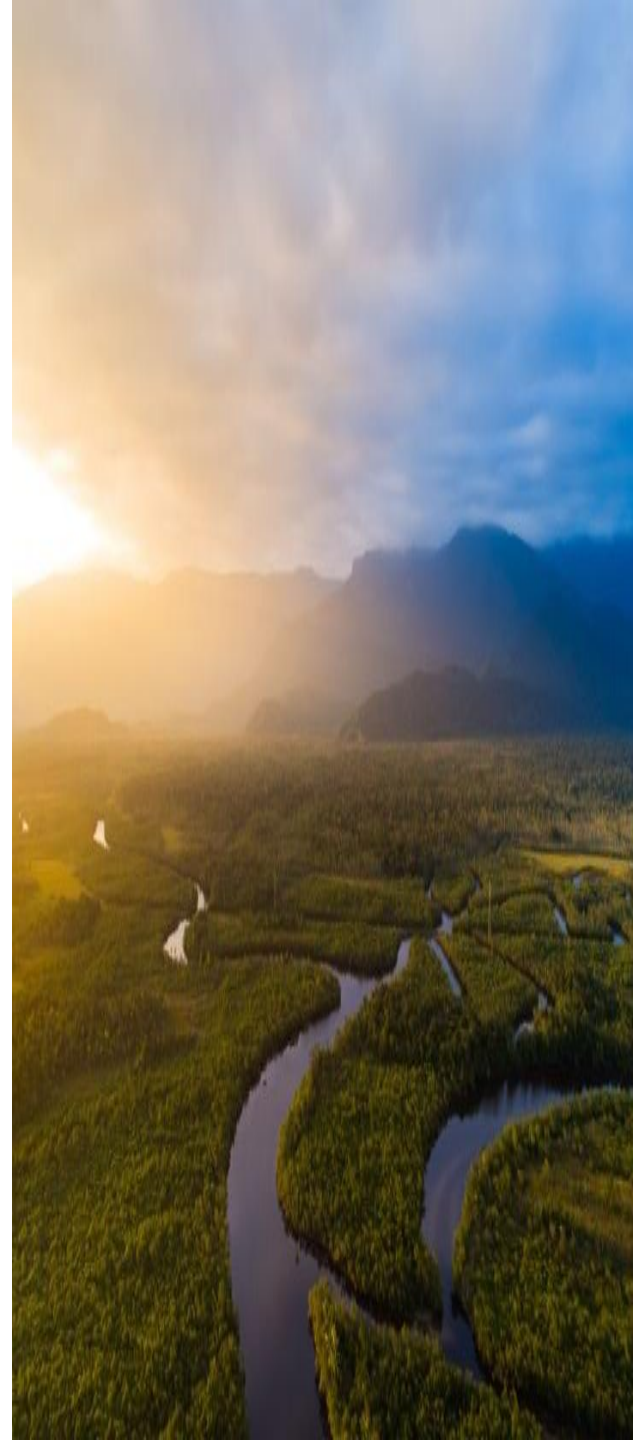


English

04

Henk Ovink

Recap from Stockholm World Water Week, and the knowledge gap
Green Water Flagship Initiative for 2026 UN Water Conference
Global Commission on the Economics of Water



Step 1: the narrative



OPEN QUESTION

Who is willing to write, who will support, and who takes the lead on each of the three?

Where do we tell it?

4-8 October

IWA World Water Congress & Exhibition

Glasgow, UK

6 October

Webinar IAIA (International Association for Impact Assessment)

"Small water cycles & local climate: Integrating Land–Water–Atmosphere Processes into Environmental Assessment"

26-28 October

European Water Technology Week

Leeuwarden, NL

9-20 November

COP31

Antalya, Turkey

8-10 December

UN Water Conference, Abu Dhabi

WUR Session submitted: "Future Flows: Advancing the Green Water Knowledge Agenda"

WHAT WE ARE AFTER

A network that presents itself as a group, rather than five projects turning up separately.

- What else is in your calendar that we should know about?
- Who is already going, and could carry the message?
- Do we go as individuals, or as the network?

A home online

Somewhere the initiatives are findable, and the narrative has a place to live.

FOR DISCUSSION

- What does already exist?
- What do we still need? A standalone site, or a section on a platform that already has traffic?
- What does it hold: a map of initiatives, an evidence library, a member list, or all three?
- Public shop window, or a working space for this group?

POSSIBLE NEXT STEPS

- Inventory the initiatives the group already knows about
- Settle platform and owner before anything gets built
- Publish the first initiatives



Putting the network to work

The community of practice

- Who is in it now, and who is missing? Funders, ministries?
- New people and new ideas: who should be at the 4th roundtable?
- The connector role: making insights travel between contexts
- Do we present as one network rather than as separate projects?

The connection to the ground

- Which pilots are ready to be shown?
- What do practitioners need from science that they are not currently getting?
- Justdiggitt has offered its implementation work as case studies + The Mont Nimba ESIA case (iron ore mining) by NCEA
- A light common protocol: temperature, soil moisture, greenness



THE ROADMAP

Narrative on paper, then share

01

On paper

The scientific paper, the practitioners note, and the policy brief.



02

Circulate

Drafts to this group first, then out to the wider network for comment.



03

Present

Glasgow in October, Leeuwarden in October, UN Water Conference, etc.



04

Integrate

One shared vision and one recognisable network, with new people brought in along the way.