“Traditional and Innovative Water Harvesting for Landscape Change”

Presentation at University of Firenze
10 December 2018

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META Research

3R
MANAGING THE WATER BUFFER

Three Messages

- Power of Water Harvesting
  - Large Scale Transformation of Landscapes = Possible
    - Work intensely
  - Better Buffers = Extending the Chain of Uses
  - More People, More Livestock = More Food Security
  - Innovations = Promise
- New frontiers :
  - Biological System Engineering
  - Micro-Climate
- Reaching Scale
  - Example of using road infrastructure

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Power of water harvesting

UNAVOIDABLE?

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Cases

- Burkina – The Zai Pit Revolution
- Ethiopia – Soil/water Conservation at Scale
- China – Warping Dams
- Thailand – Monkey Cheeks Small Dams
- India – Groundwater Retention Weirs
- Africa – Manual Drilling in Flood Plains
- Yemen – Landscape Dew Harvesting

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Burkina Faso – the Zai Pit Revolution

Ethiopia – Soil/water Conservation at Scale


NG THE WATER


Warping dam, China


Monkey Cheek, Thailand


KT Weir, India


Floodplain (30 M ha in Africa)

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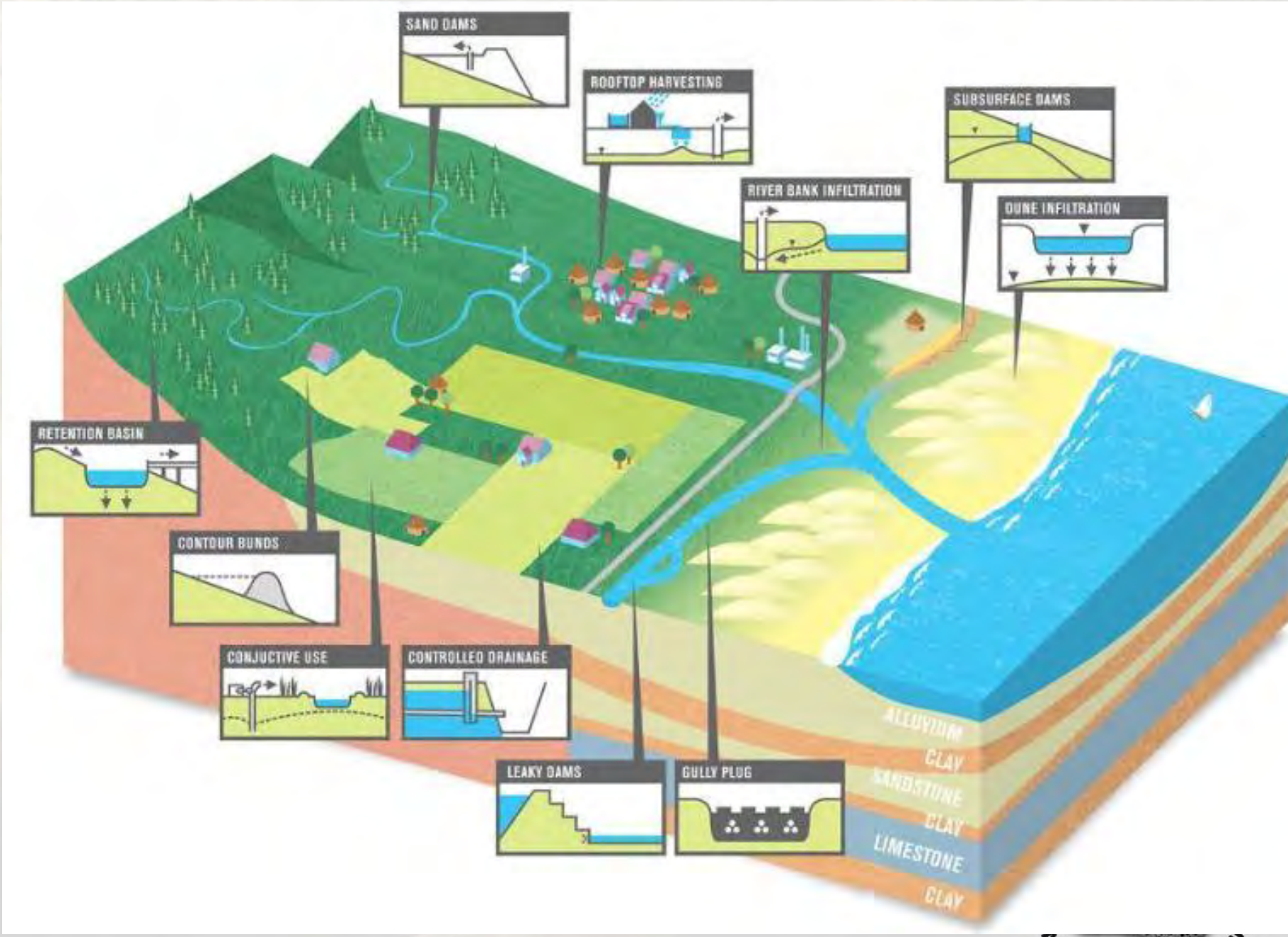
Yemen – Landscape Dew Harvesting



Intensive approaches

Innovations are possible - organizational

- Learning from large scale implementation and intensive approach – landscape change
- Learning from farmer –innovators
- Innovations in financing:
  - Subsidies and safety net
  - Payment for environmental services
  - Long term leases
  - Co-ownership
  - Land development companies
  - Capitalizing on new benefit streams

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2. New Frontiers

- Biological system engineering
- Managing the micro-climate


Biological system engineering:
Vegetation is step
in landscape restoratipm

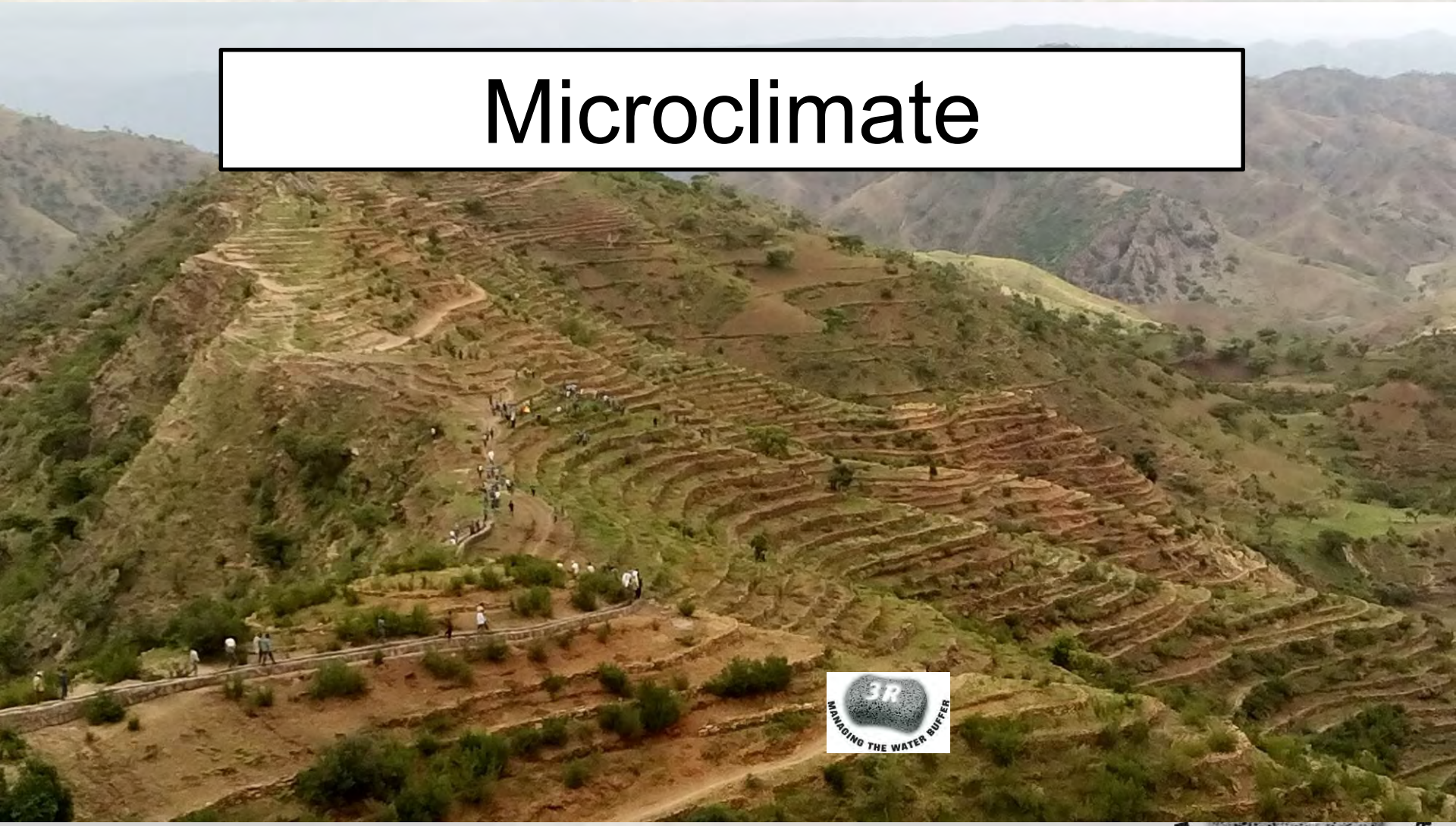

Niger – farmer managed revegetation
2005 03 15

Floodwater spreading and sowbug, Iran

Biological system engineering

- Integrated approaches
- Managed natural regeneration
- Biological engineers

Microclimate



Microclimate and 3R – evidence from fieldwork

"The forest land in the mountains is considered as God's daughter land. Under the shade of trees land is cool (temperature) compared to bare lands".

"We can see now mist on the grass on the conserved area and also observe that moisture retention is higher there."

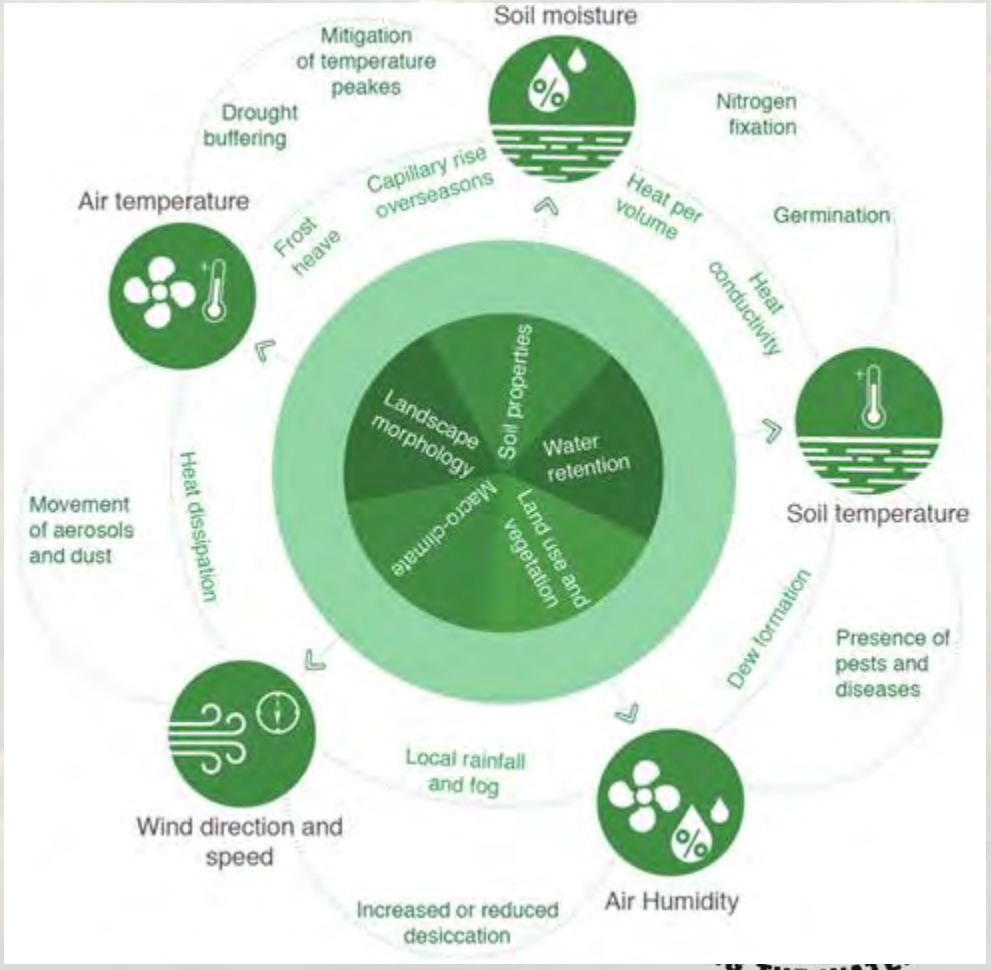
"Due to the intervention the day temperature and night temperature are warmer and is less fluctuating, this is our indication that we will have good summer rainfall."

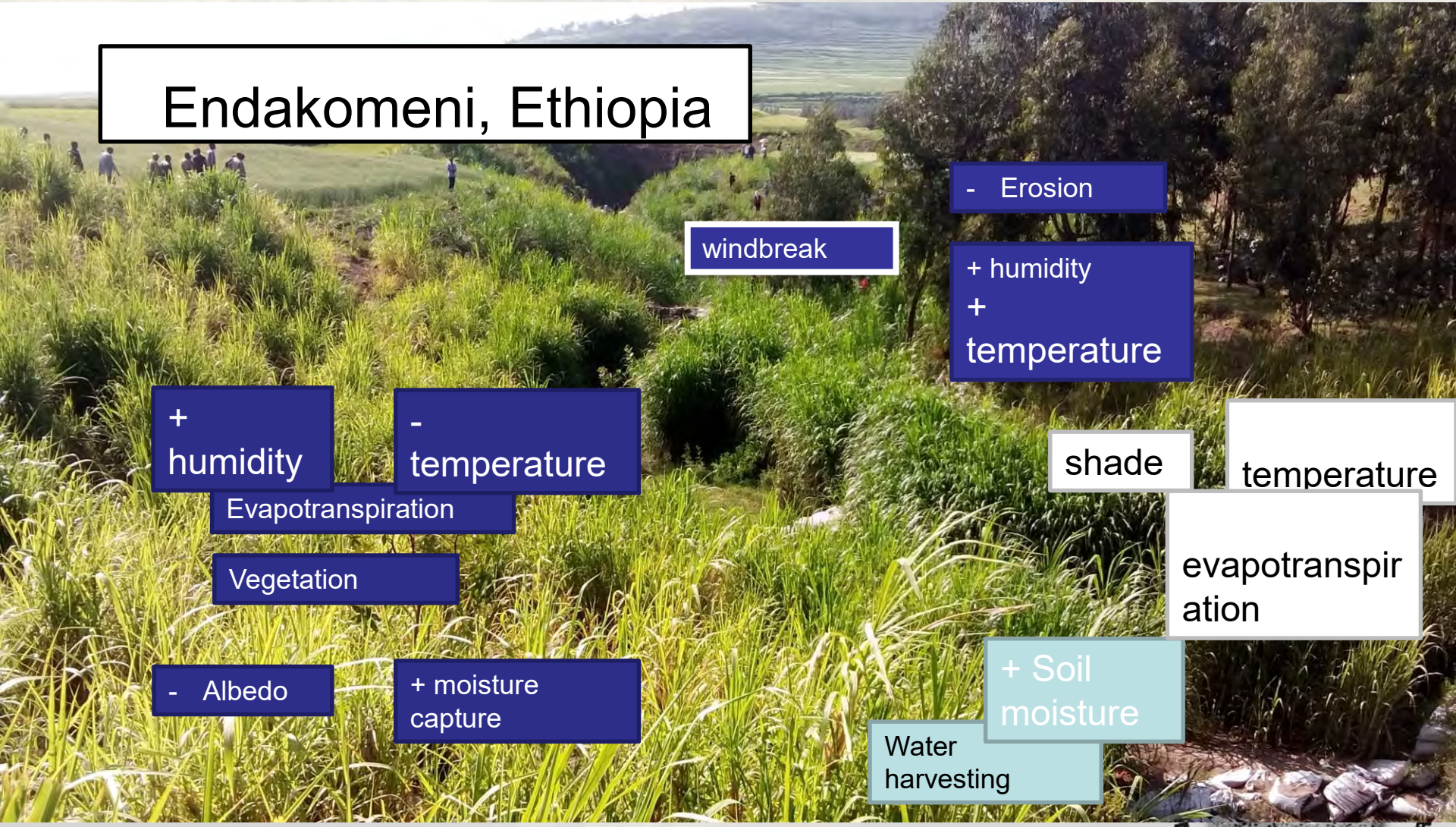
Why microclimate

- Changes to the landscape change the microclimate
- Microclimate changes are now often an ‘unintended’ by-product of other interventions > this should change
- Focusing on the microclimate can uncover methods to increase the resilience of a landscape – third way (next to mitigation and adaptation)
  - Help buffer (global) climate change and climate extremes
  - More productive landscapes
- Understanding of microclimate relationships at landscape level and their impacts in the field is missing – the pieces are there but the jigsaw is a yet not put together

Microclimate factors

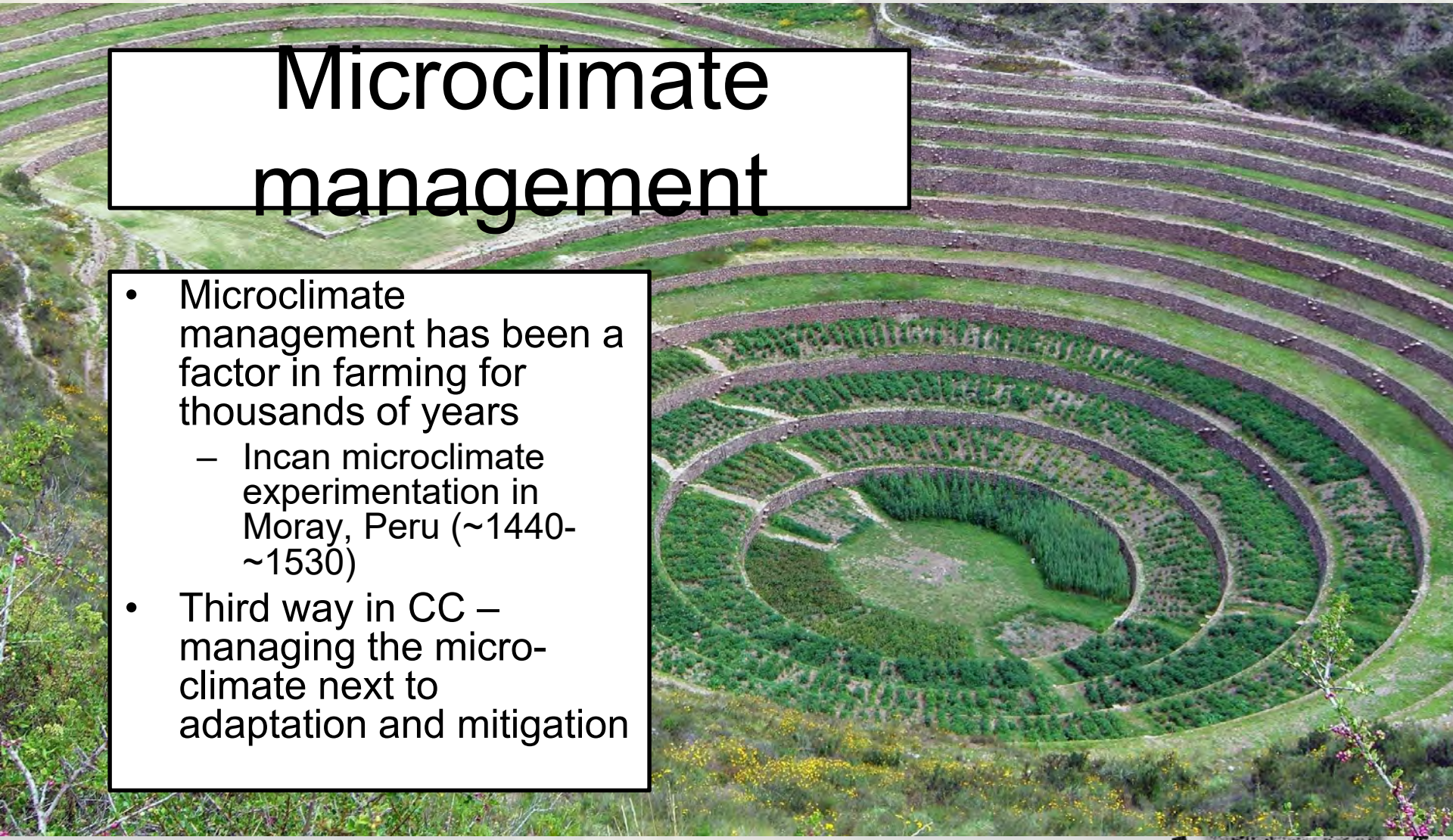
- Soil moisture
- Soil temperature
- Air temperature
- Air humidity
  - Incl dew, white frost
- Wind direction and speed




Endakomeni, Ethiopia
windbreak
- Erosion
+ humidity
+
temperature
+
humidity
-
temperature
Evapotranspiration
Vegetation
shade
temperature
evapotranspir
ation
- Albedo
+ moisture
capture
+ Soil
moisture
Water
harvesting
MANAGING THE WATER BUFFER

Microclimate management

- Microclimate management has been a factor in farming for thousands of years
  - Incan microclimate experimentation in Moray, Peru (~1440-~1530)
- Third way in CC – managing the micro-climate next to adaptation and mitigation



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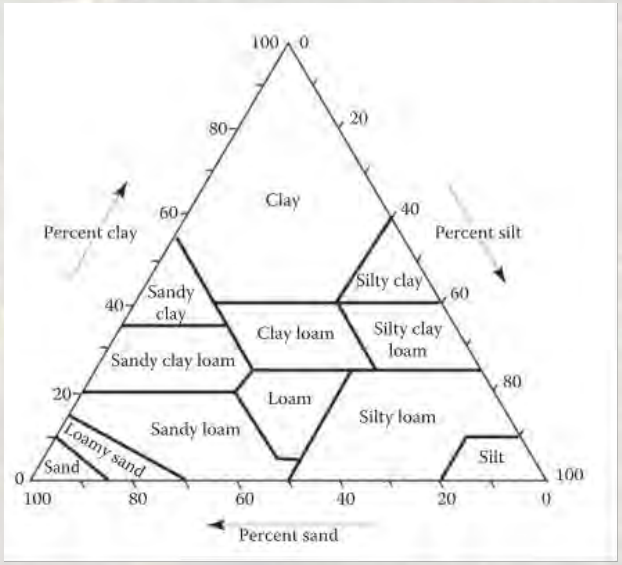
Soil moisture

- Determined by soil's water storage capacity and addition/loss of water
  - Texture, structure, depth, organic matter, biological activity
  - Soil texture influences capillary action
- Areas with available soil moisture have more balanced microclimate and conducive conditions
  - Buffers extreme heat
    - Wet soils take up radiation
  - Buffers frost
    - Wet soils stay warm longer than dry soils
  - More nitrogen fixation in the soil
- Landscape management can have medium term effects
  - Capillary action occurring in cold season (cold nights)



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Waru Waru

- Canals provide moisture during dry conditions
- Water acts as buffer against prevailing night frost
- Drainage prevents water

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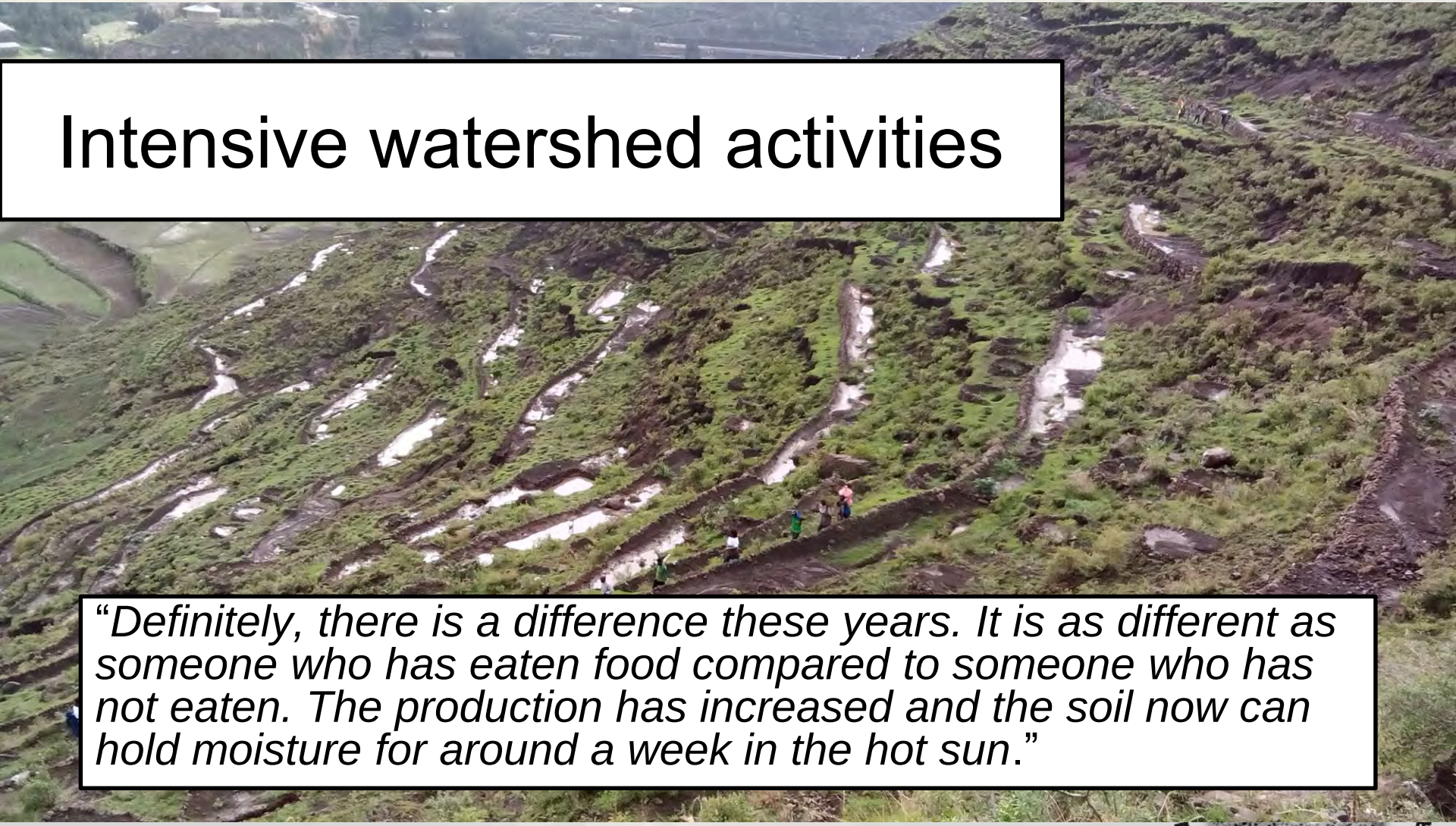
Intensive watershed activities



"*Definitely, there is a difference these years. It is as different as someone who has eaten food compared to someone who has not eaten. The production has increased and the soil now can hold moisture for around a week in the hot sun*."

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Soil temperature

- Incoming radiation, thermal conductivity, heat capacity
- Depending on soil composition, organic material and humidity> can help balance temperature extremes
  - Day: takes up heat from air, lowering temperatures
  - Night: releases heat to surface
- Same process also occurs on longer time scales (summer – winter)
- Moderated soil temperature – helps germination and root development
- High soil temperatures diminish plant growth, biological processes

	Thermal conductivity (W m^{-1} K^{-1})	Heat capacity (MJ m^{-3} K^{-1})
Soil component		
Quartz	8.80	2.13
Clay minerals	2.92	2.38
Organic matter	0.25	2.50
Water	0.57	4.18
Air	0.02	0.0012
Sandy soil (porosity = 0.4)		
0%	0.30	1.28
50%	1.80	2.12
100%	2.20	2.96
Clay soil (porosity = 0.4)		
0%	0.25	1.42
50%	1.18	2.25
100%	1.58	3.10
Peat soil (porosity = 0.8)		
0%	0.06	0.5
50%	0.29	2.18
100%	0.50	3.87

Air temperature

- Radiation
  - Slope, albedo, shading
  - Evapotranspiration
- Conditions within a few meters of the surface change rapidly
- Strong influence from vegetation
  - Shading
  - Evapotranspiration
- Crops have optimum temperature range for growing
- Higher temperatures can aid spread of pests and diseases
- Affects thermic effects - rainfall

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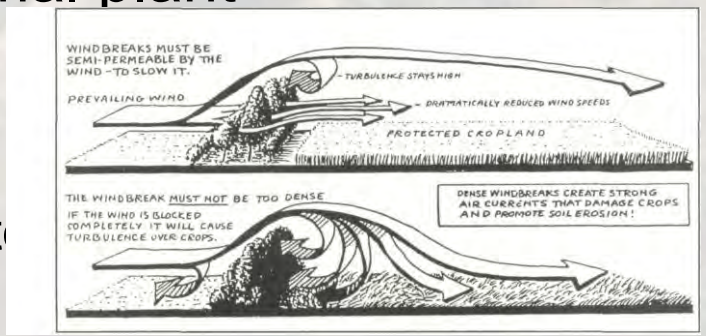
Air humidity

- Result of evapotranspiration from soil and plants, and transport from other areas
  - Temperature determines amount of water vapor air can hold
- High air humidity slows transpiration
- High air humidity helps dew formation
- Dew formation
  - When surfaces cool below the dewpoint, dew can form
  - Triggered by cooling surfaces (stones)
  - Dew can provide significant amounts of moisture in (semi-) arid ecosystems

Wind direction and speed

- Guided by windbreaks and vegetation in general
- Cooling effect
- Increase water ET from plants
- Mixing of the atmosphere for optimal plant growth (humidity and CO2)
- Negative effects
  - Wind erosion (fine soils, organix mett
  - Damage to plants
  - Transport of diseases and pests



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Wind direction and speed

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Towards a microclimate toolkit

3 clusters

- Water buffering
- Re-greening
- Land use planning

From local to regional

- Focusing on microclimates does justice to climate on the ground
  - The effects of global and regional change will be felt at small scales – we need local climate buffers
- Should be an instrument not side effect or second thought
  - For productivity, multi-functionality and climate resilience
  - Third way

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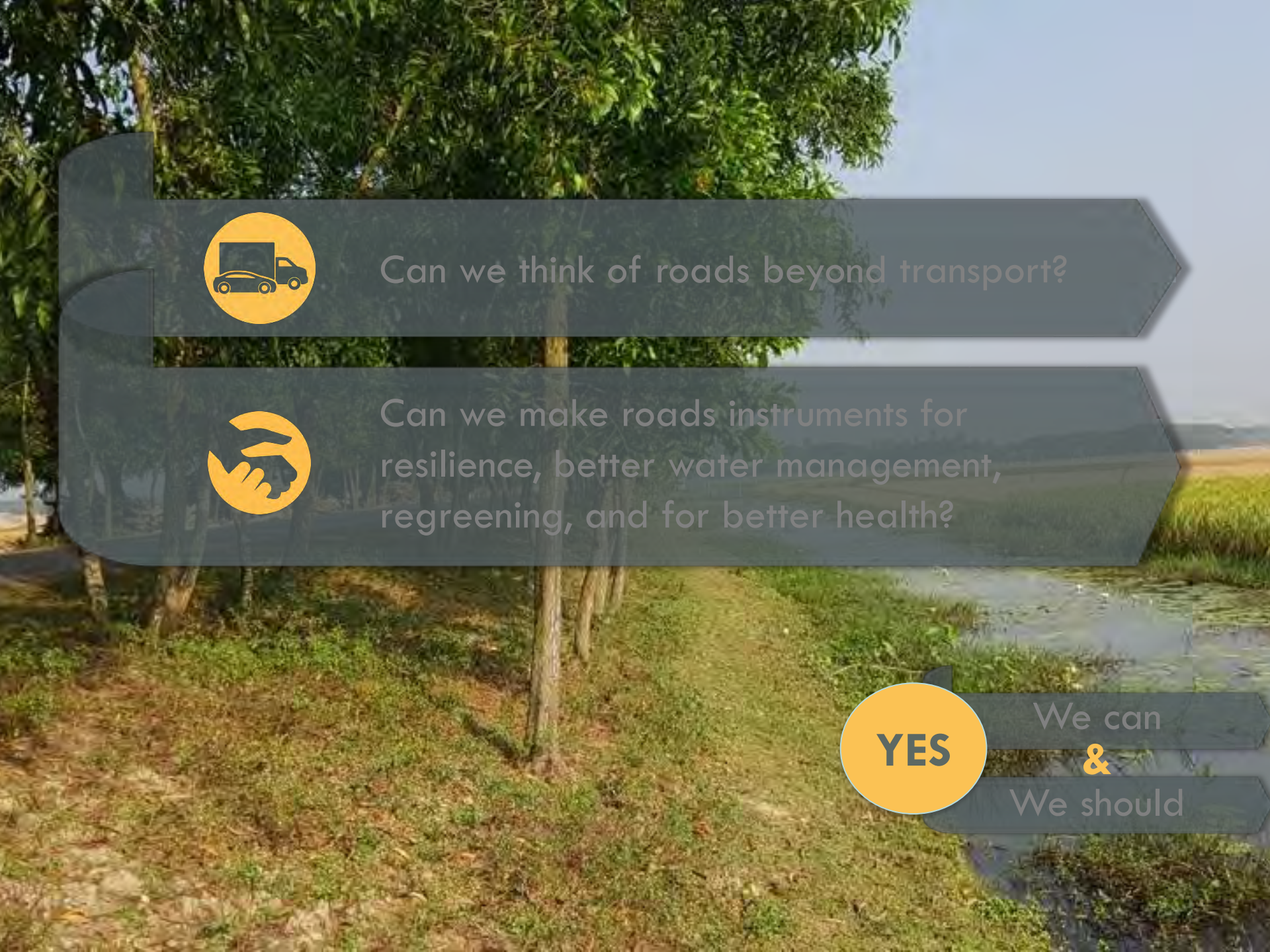
3. Reaching Scale

GREEN ROADS FOR WATER


Can we think of roads beyond transport?
Can we make roads instruments for resilience, better water management, regreening, and for better health?
YES
We can
&
We should

At present, **REALITY** is different...

Erosion and sedimentation

Roads are a major cause of:

Local flooding

Water logging (crop loss and health

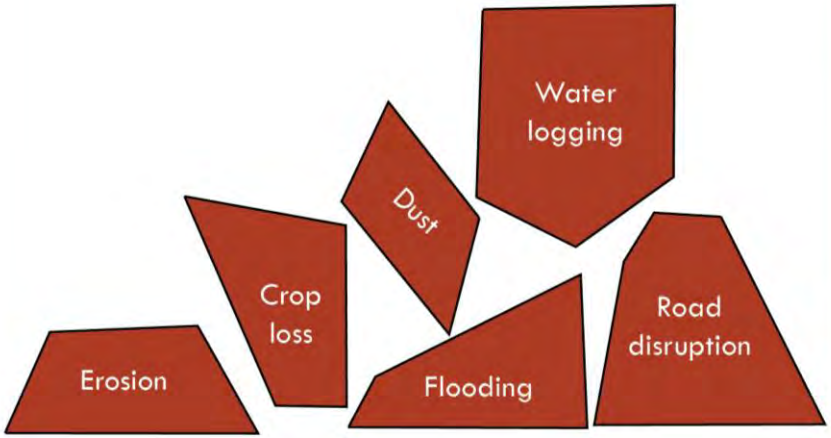
Dust (Health problems and crop


This can be
Turned
around
roads can become
GREEN ROADS

What Are Green Roads?

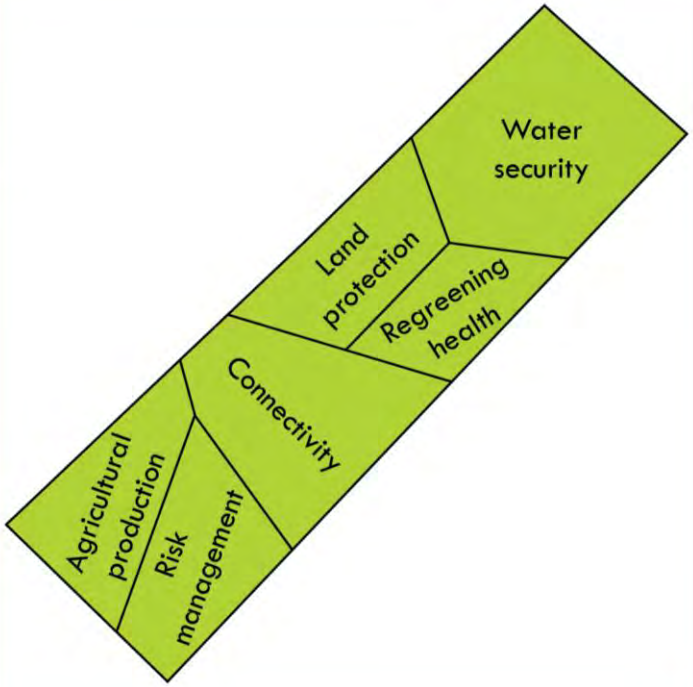
- Roads that have secure transport functions
- Roads that are instruments for water management
- Road that are used for flood protection
- Roads that stem erosion and promote good land management
- Roads side vegetation that controls dust and filters effluents

Conventional road



We need to turn roads into

Green road



Case Load

Why Green Roads:
Big Scale and Big Impact

Roads are major investment globally (1-2 Tr USD/year)

For instance: road network in SSA is to increase to 2.8 million kilometer by 2025 (up 80%)

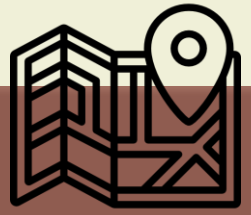
Roads are one of the major impacts on (surface and subsurface) hydrology and flood patterns

At same water causes 35-80% of road damage

Impact now often negative: turn around 'green roads' as instruments for (climate) resilience, beneficial water

Case Load

Why Green Roads:
Big Scale and Big Impact



Many tested Green Roads measures exist, suited to different geographies

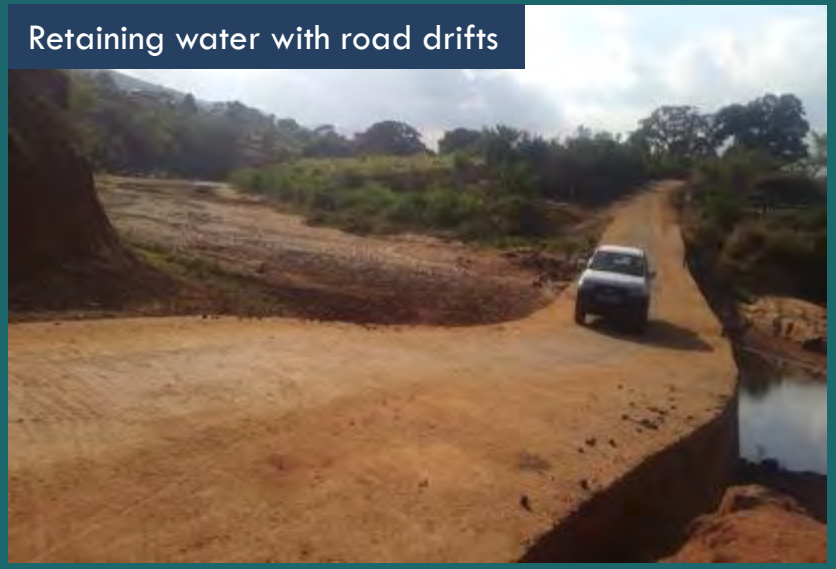
Measures are low cost in comparison to total road investment (<5%) – and often saving cost of

Green Roads can be a main instrument for climate resilience, health and increased agricultural production

Rate of return high (>4 in a year)

Many things can be done

Retaining water with road drifts



Feeding soil moisture with road drainage

Road side tree planting

Gardening with road side wells

Borrow pit converted to water storage

Road embankment creating storage reservoir

Harvesting fodder from culvert run-off

Water from spring opened by road construction

Safeguarding wetland functions with low embankment road

Road side recharge structures

Roads created from storage excavation

Roads leading to flood shelters, roads serving as (post) flood shelters as well

Roads controlling water tables between high and low land

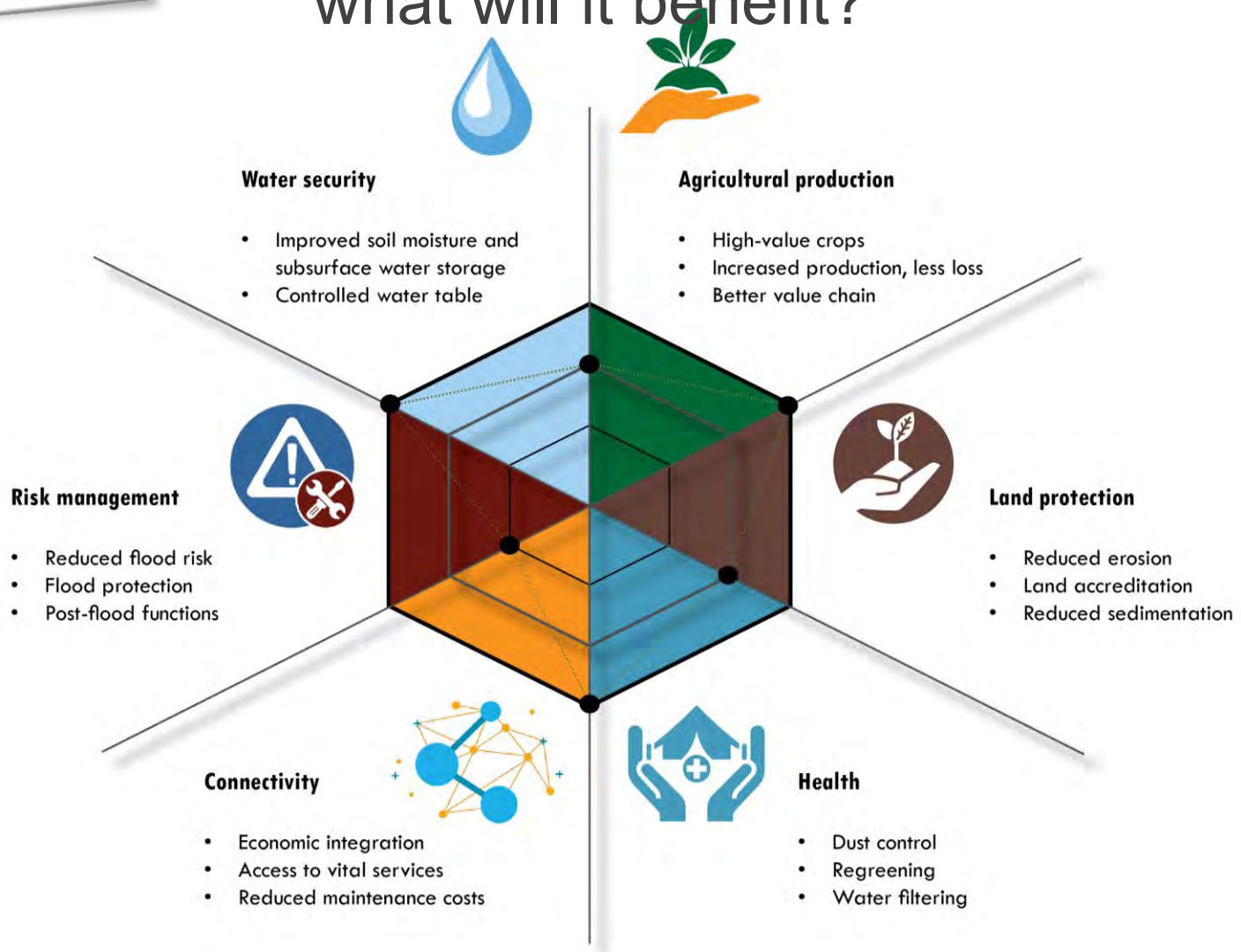
Gated culverts for water management

What are the ambitions?

- To promote Green Roads: to have roads for systematically used for water management, regreening and climate resilience as an industry standard in at least 50% of countries in the world by 2025
- To fast track climate change adaptation by retooling roads for water and regreening and at the same time have more reliable transport connections

Green Roads Initiative

what will it benefit?



Green Roads Initiative

What will be done?

1. Green Road Finance
   - Work with major infrastructure financers
   - Work with Green Bonds for verified Green Road programss
2. Learning alliance
   – Motivational and technical training
   – Monitoring, documentation and learning
   – Introduce industry standards and guidelines
3. Support to roads and water and regreening programs on the ground
   – Continue and expand current country programs
   – Special initiatives
   – Co-operation with infrastructure programs


Road Water harvesting campaigns
> 3 Million people benefitted since 2015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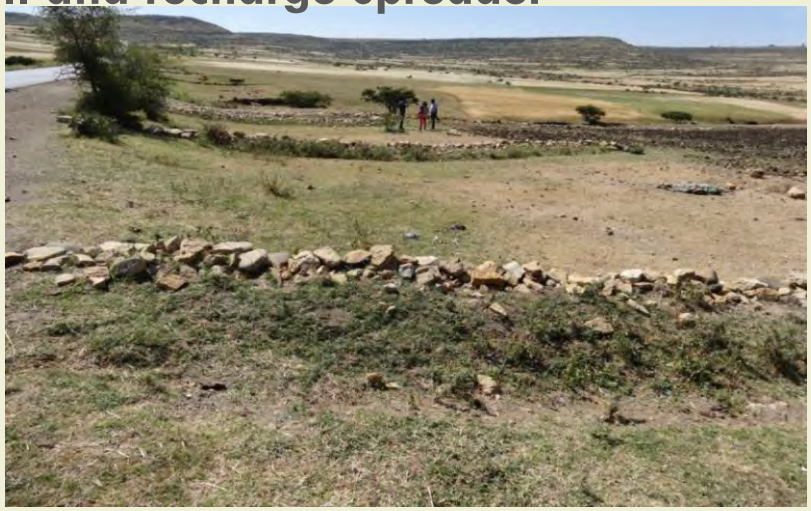
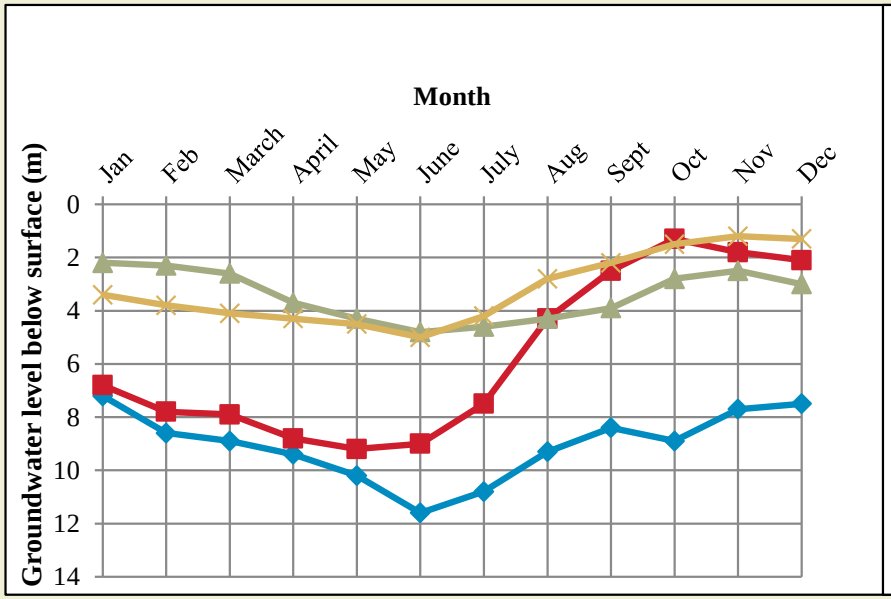
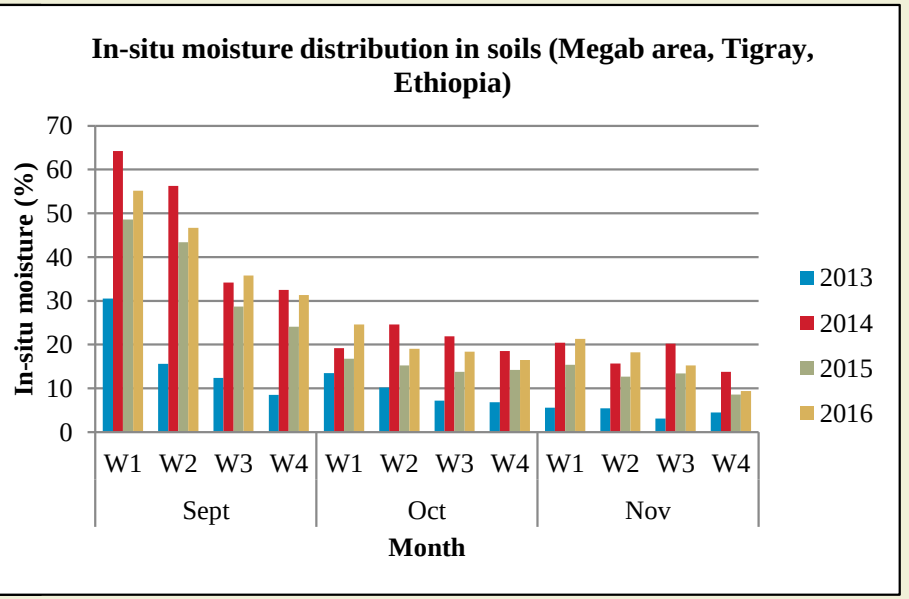
Impacts

Effects on soil moisture from road recharge well and recharge spreader







Multiple Resilience Dividends: recently checked by ITAD

			Roads for Water Approach	Conventional Resilient Roads Approach
Costs		Paved roads	USD 1800	USD 45000[1]
		Unpaved roads	USD 1800	USD 31200
Resilience Dividend				
1	Reduced damage	Reduced cost of road maintenance Unpaved Paved Periodic paved Periodic Unpaved	 USD 1,100 USD 2,200 USD 3,400 USD 1,870 	Comparable
		Reduced damage due to erosion	USD 2,675	Negative: considerably more flooding than in base situation
		Reduced damage due to flooding	USD 1,762	Negative: considerably more flooding than in base situation
		Reduced damage due to sedimentation	USD 180	
2	Unlocking the economic potential	Less down time of roads Reduced impact from climate Change	USD 3,800 USD 550	Comparable Comparable
3	Co-benefits	Beneficial use of water harvested from roads	USD 4,500	0

Link to certification of road projects
(in draft World Bank Global Guidelines)

Road Resilience Class	
Basic	Roads can withstand climate change effects
Plus 1	Road environment modified beneficially contribute to climate resilience
Plus 2	Road bodies and alignments modified to optimally contribute to climate resilience

Please work together

- www.metameta.nl
- www.3r.org
- www.thewaterchannel.tv
- www.roadsforwater.org
- www.spate-irrigation.org