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Science for resilient livelihoods in dry areas

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Regional Initiative on Water Scarcity

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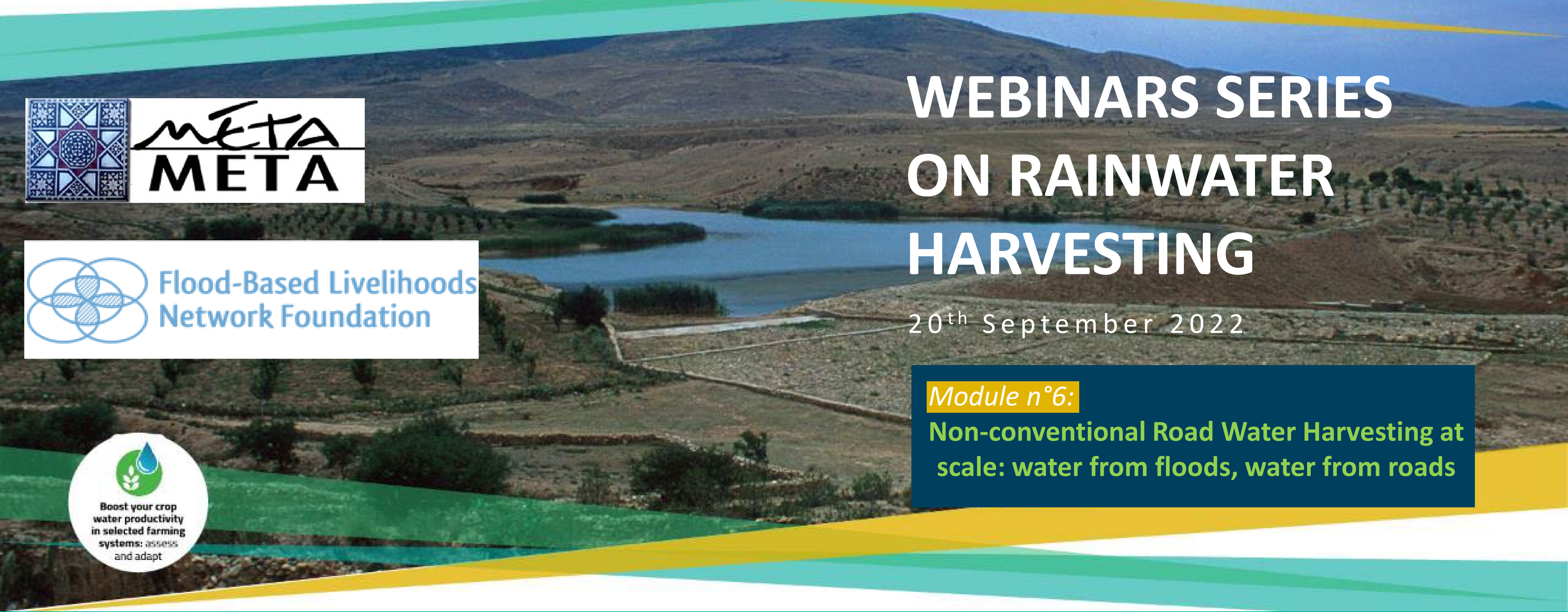


META META

Flood-Based Livelihoods Network Foundation

WEBINARS SERIES ON RAINWATER HARVESTING

20th September 2022

Module n°6:

Non-conventional Road Water Harvesting at scale: water from floods, water from roads

Boost your crop water productivity in selected farming systems: assess and adapt

Green Roads for Water

Non-conventional Road Water Harvesting at scale: water from floods, water from roads

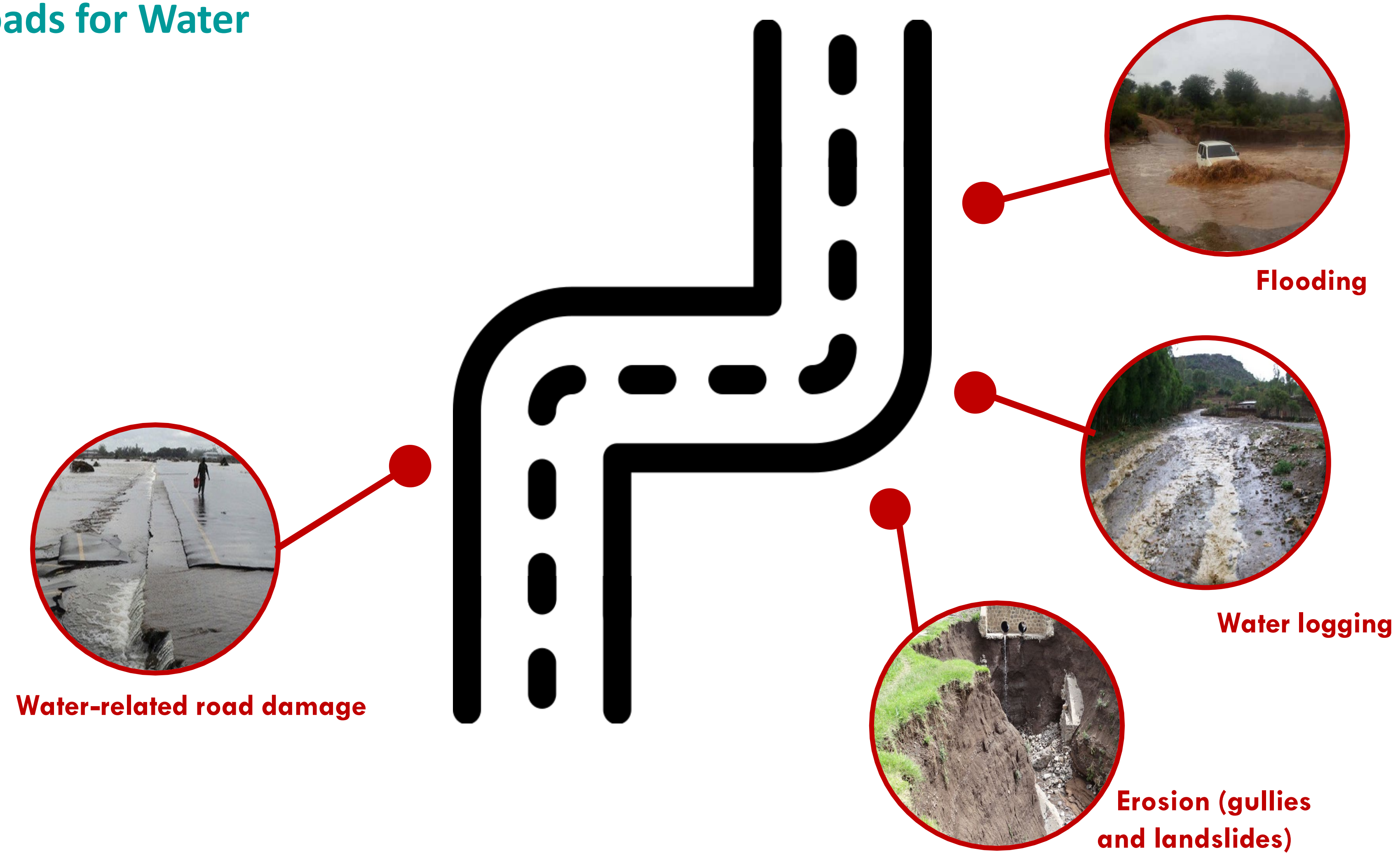
Frank van Steenbergen, Anastasia Delligani, MetaMeta (www.metameta.nl)

September 20, 2022

Introduction to Green Roads for Water

Roads affect the hydrology of entire areas:

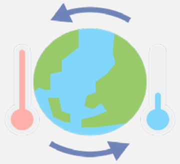
- They block and guide water
- They concentrate runoff
- They interfere with subsurface flows
- They change flooding patterns
- They get damaged in this process



Introduction to Green Roads for Water

Turn the problems into opportunities

Green Roads for Water is a smart way of



meeting climate resilience of roads

collecting and using the road run-off for various purposes

reducing adverse weather impacts on road bodies and the surrounding of the road's environment

Protecting roads and securing transport

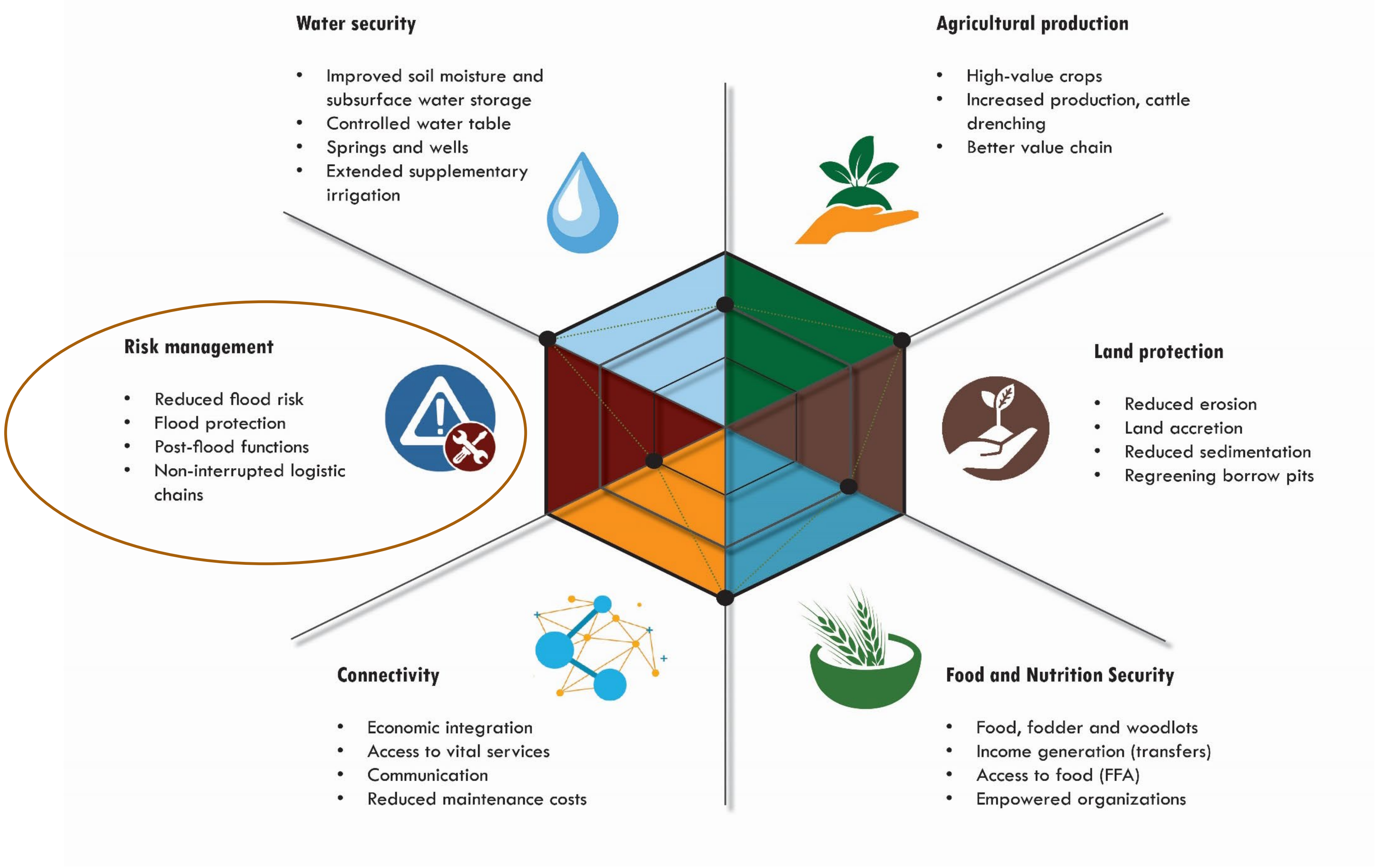
Introduction to Green Roads for Water

Approaches to Resilience

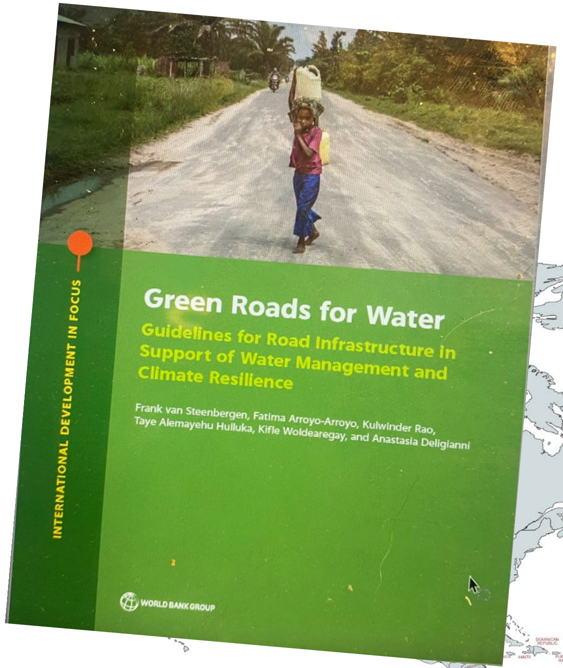
	Regular Roads	Green Roads for Water	
Level of Road Resilience	**Basic Resilience: Protective**	**Resilience Plus 1: Adaptive**	**Resilience Plus 2: Proactive**
Key words	Protecting road infrastructure	Making best use of and adapting to changed hydrology	Redesigning road infrastructure to optimize the area's water management/climate resilience
Geographies			
Semiarid areas	Catchment measures to reduce water damage to roads	Use runoff guided from roads for recharge and storage; upper catchment protection	Design roads and cross- drainage facilities to collect runoff and guide to recharge area
Watersheds and catchments	Catchment protection to protect road infrastructure	Catchment protection to protect road infrastructure	Plan road alignment and drainage structures in support of catchment management
Coastal areas and floodplains	Increase height of flood embankments to deal with higher floods	Convert village roads for water-level management with gated structures	Consider low embankment roads with controlled floodways develop road levees in flood-prone areas; use roads for land accreditation
High- and medium-altitude areas	Have safe road water crossing and protection measures; have adequate road drainage; reconsider road alignment to higher areas; train mountain rivers to reduce exposure of roads to mountain floods	Using water-retention and land-management measures suitable to mountain areas to stabilize mountain catchment and retain moisture and snowmelt; systematic spring management	Use cut and fill instead of cut and throw methods; observe maximum slope and gentle alignments; combine roads with additional storage to and drift for torrent stabilization
Desert areas		Revegetation and dune stabilization using road runoff Develop small roadside oases taking road runoff to depression areas	Adjust road directions to deal with wind directions to control sand dune formation
		During road maintenance and rehabilitation	**During road design and construction**

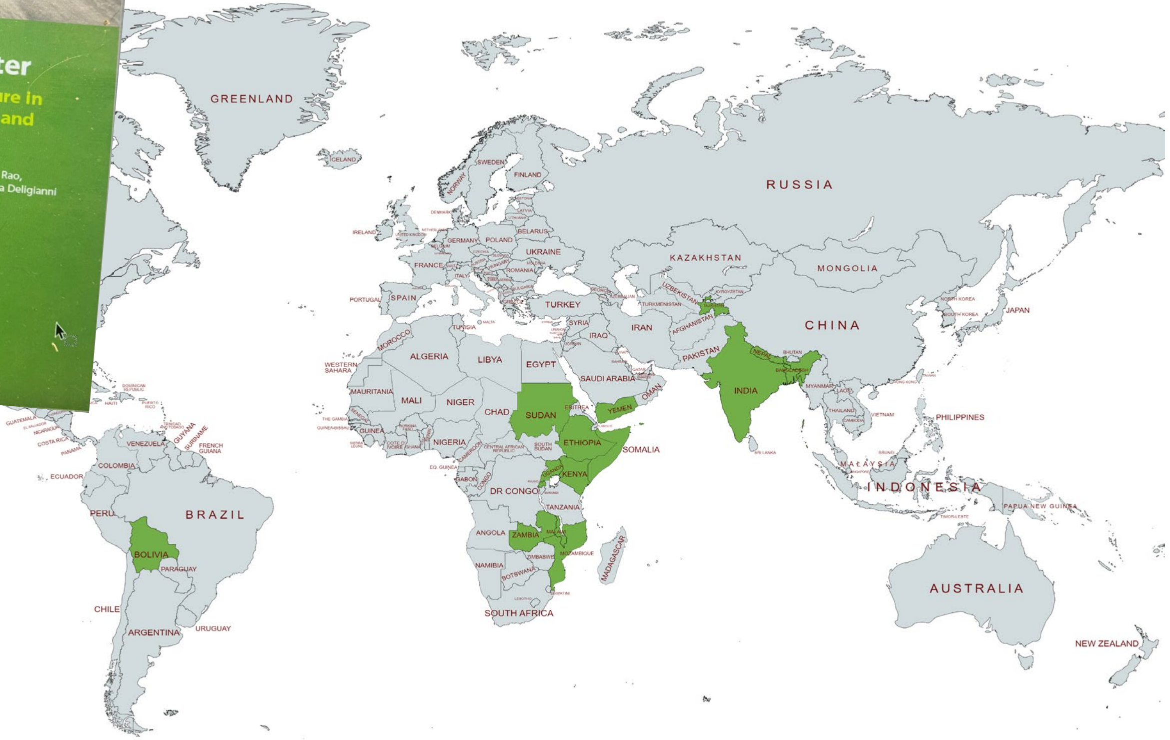
Introduction to Green Roads for Water

Green Roads co-benefits



Introduction to Green Roads for Water





Green Roads for Water work and geographical coverage

- Initiated by MetaMeta in 2015
- Active in more than 14 countries
- Various types of projects: research, capacity building, implementation, policy formulation
- Supported by: The World Bank, GRP (supported by USAID, SIDA and Rockefeller Foundation), IRF, ADB, NWO, NERC, RAP3, IFCD, IFAD, IKEA Foundation, NUFFIC, Welthungerhilfe, IUCN
- Development of Global Guidelines and Guided Learning Packages
- Total funding secured: about USD 3.6 M (2015-2022)

Introduction to Green Roads for Water

Costs & Benefits of Green Roads for Water in Ethiopia

Source: Green Roads for Water: Guidelines for Roads Infrastructure in support of water management and climate resilience

	NO CLIMATE RESILIENCE INTERVENTIONS	GREEN ROADS FOR WATER (ETHIOPIA)[a]	PROTECTIVE RESILIENCE[b]
Costs per kilometer			
Intervention costs:			
Paved roads	US$0.00	US$1,800	US$45,000
Unpaved roads	US$0.00	US$1,800	US$31,200
Benefits per kilometer			
1. Resilience dividend			
Routine maintenance	Costs increase substantially across the network because of climate change impacts that damage the road over the years	Cost savings per year: Paved: US$1,100 Unpaved: US$2,200	Cost savings are generally comparable to those from the roads-for-water technique
Periodic maintenance	Costs increase substantially across the network	Cost savings: Paved: US$3,400 Unpaved: US$1,870	Cost savings are generally comparable to those from the roads-for-water technique
Reduced damage from erosion	Erosion from peak weather events is not mitigated	US$2,675	Erosion often worsens down-stream from protected roads, sometimes severely
Reduced damage from flooding	Flood impacts typically not mitigated upstream or downstream of roads	US$1,762	Road is protected; Flood damage often worsens downstream of improved roads
Reduced damage from sedimentation	Higher levels of sedimentation	US$180	Higher levels of sedimentation, sometimes severe
2. Unlocking economic potential			
Reduced impact from climate change	Climate impacts not mitigated	US$550	Climate impacts are not mitigated and may be exacerbated
Duration of road closures or downtime	More road closures and downtime	US$3,800	Generally comparable to those from the roads-for-water technique
3. Co-benefits			
Beneficial use of water harvested by the road	No opportunities to harvest water beneficially	US$4,500	Opportunities to use water beneficially are forgone

GR4W AND RAINWATER HARVESTING FOR FLOOD MANAGEMENT

Upland: GR4W for upstream storage and retention

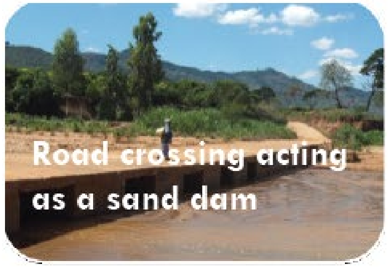
Lowland: GR4W for guided stormwater drainage, controlled flooding and flood response

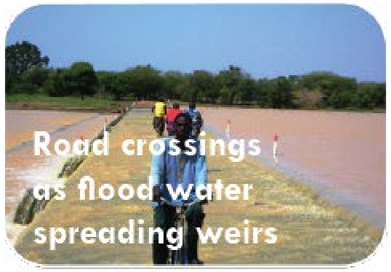
1. GR4W
Road Water Harvesting and water retention

In uplands

Adapting to the road

Adjusting the road





Examples of RWH techniques from different countries

Road Water Harvesting

Successful examples of road water harvesting

Retaining water with road drifts

Feeding soil moisture with road drainage

Roadside tree planting

Road Water Harvesting

Successful examples of road water harvesting

Gardening with roadside wells

Borrow pit converted to water storage

Road embankment creating storage reservoir

Road Water Harvesting

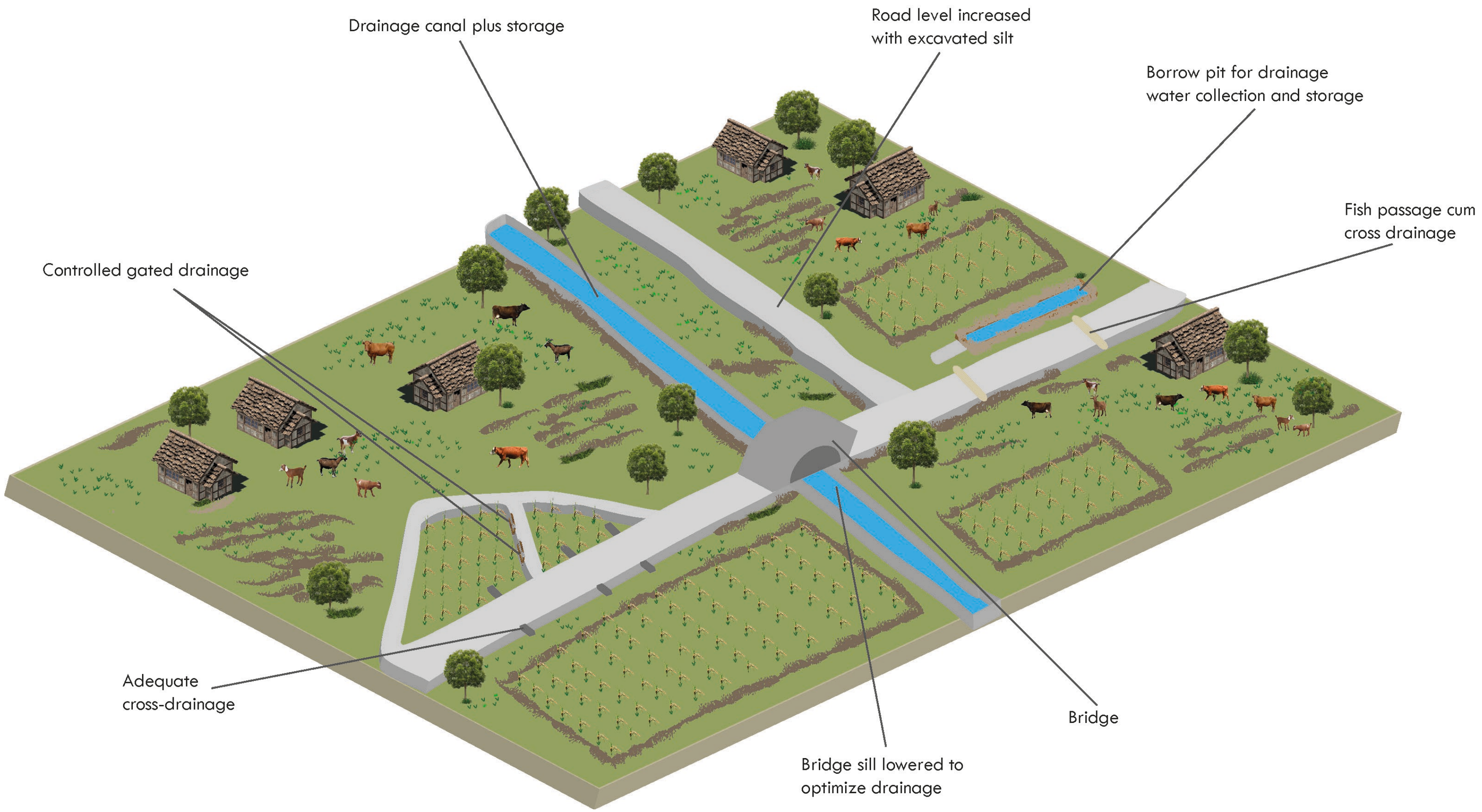
Successful examples of road water harvesting

Converting borrow pits to store water from roadside drains and culverts

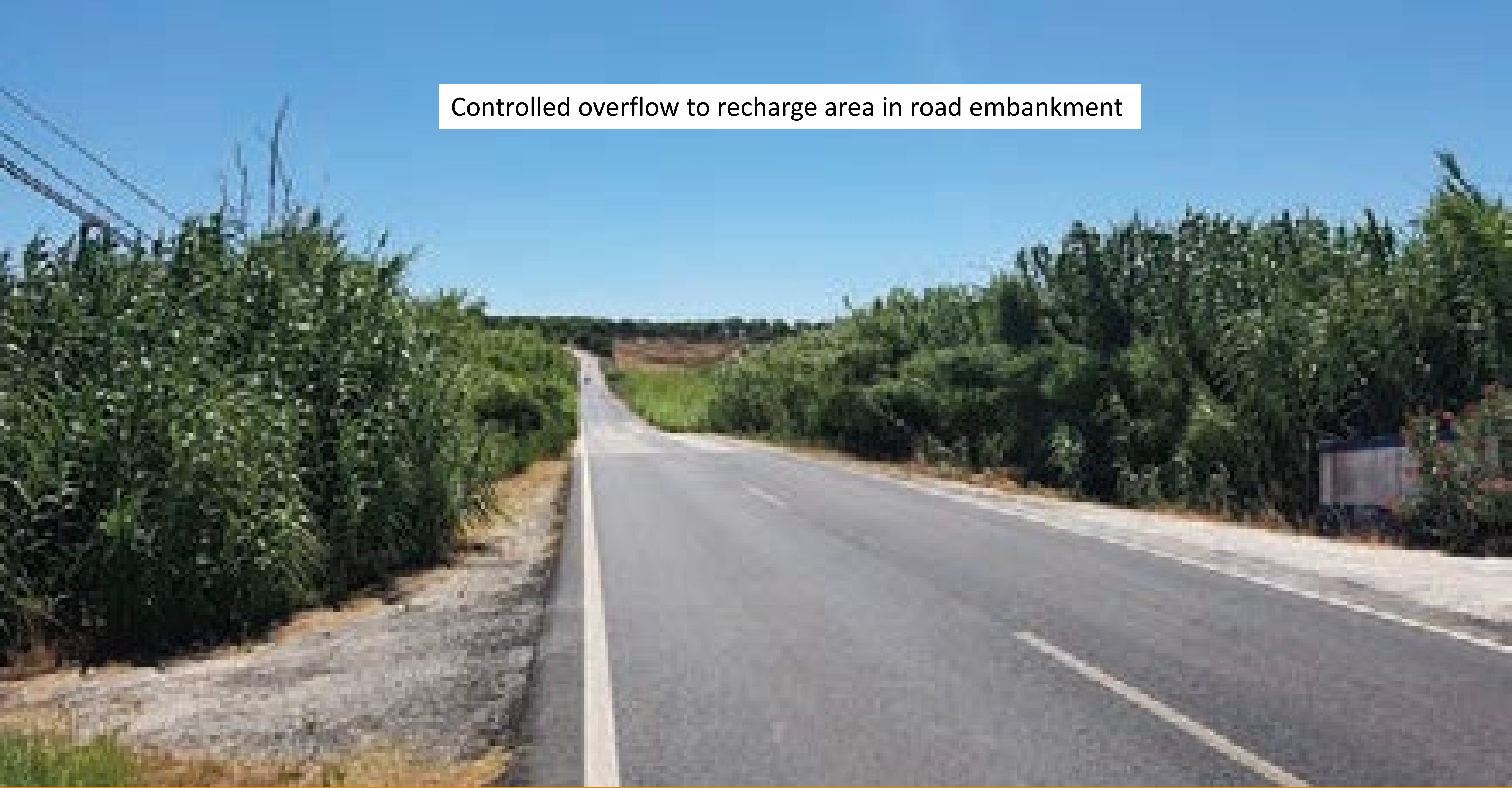
GR4W
Road Water Harvesting for flood protection

In lowlands

Recommended best practices for Road Water Management for lowland areas



Controlled overflow to recharge area in road embankment



Roads to compartimentalize land and retain floods and release excess water in control manner

Gated culverts to control the water levels for productive uses

Roads as flood protection infrastructure and flood shelters

Related resources

- **Green Roads for Water website**
- **Green Roads for Water brochure**
- **Green Roads for Water Guidelines (published by the World Bank)**
- **Videos:**
    - Green Roads for Water: The pitch
    - Making Roads Work for Water: Local Impressions- Mozambique
    - Gender, Rural Roads, and Transport
    - Road Water Harvesting in Tigrai, Ethiopia
    - Kenya- Catching Road Runoff in Ponds
    - Connecting Roads, Water, and Livelihoods in Uganda
    - Roads for Water: Experiences from Malawi
    - Roads for Water: Zambia

Spate Irrigation

Non-conventional Road Water Harvesting at scale: water from floods, water from roads

Spate irrigation – globally

Estimates

Country	Year of Irrigation	Total Irrigated Area (ha)	Spate Irrigated Area(ha)	Spate Irrigation as % of Total Irrigation
Algeria	1992	555,500	110,000	19.8
Eritrea	1993	28,124	15,630	55.6
Libya	1987/1997	470,000	53,000	11.3
Morocco	1989	1,258,200	165,000	13.1
Pakistan	1990	15,729,448	1,402,448	8.9
Somalia	1984	200,000	150,000	75.0
Sudan	1997/1987	1,946,000	280,000	14.4
Tunisia	1991	385,000	30,000	7.8
Yemen	1987/1997	485,000	193,000	39.8

Source: FAO Aquastat; Hadera 2001; Kohler 1999

In addition there is spate irrigation in Ethiopia, Kenya, West Africa, Iran, Latin America


Spate irrigation – upwards and downward trends

In North Africa many spate irrigation systems converted to dam irrigation

In Pakistan several spate irrigation areas 'disturbed' by perennial irrigation systems and spate irrigation (rod kohi) very much neglected in spite of the enormous area

In Yemen combination of groundwater irrigation and spate irrigation system in many areas

In Iran 'flood water spreading' for recharging groundwater combined with spate irrigation

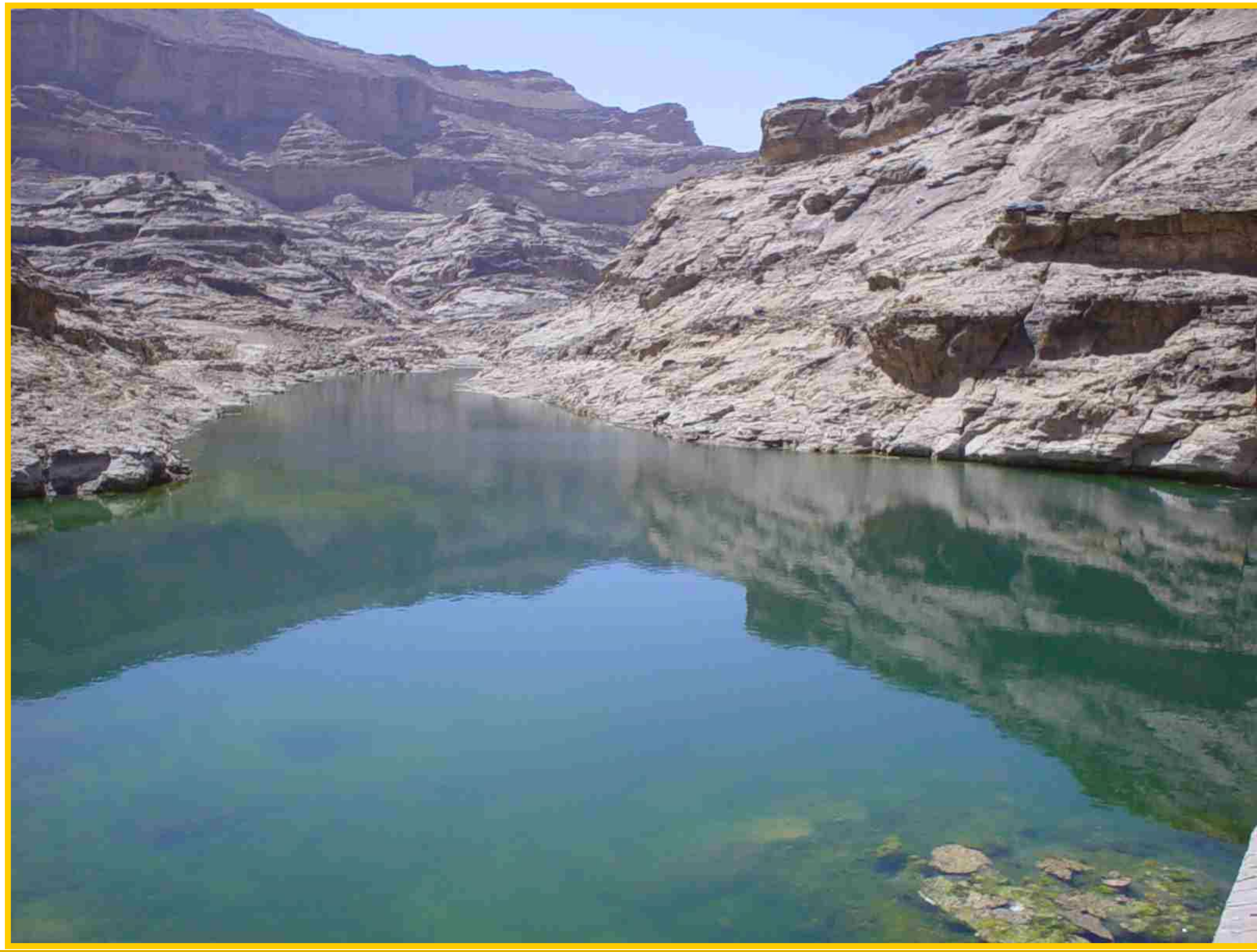
In Eritrea spate irrigation development is preferred strategy

Elsewhere (in Africa)

    small spate irrigation is increasing

Construction of dams

- Has intercepted floods
- In arid areas high evaporation and often no recharge after 2-3 years
- Has changed flood hydrographs (early peak is missing)
- At cost of spate irrigated areal



ONE MAY ARGUE HOWEVER THAT IS BETTER TO STORE FLOOD WATER IN THE SOIL PROFILE THAN IN DAMS AND RESERVOIRS

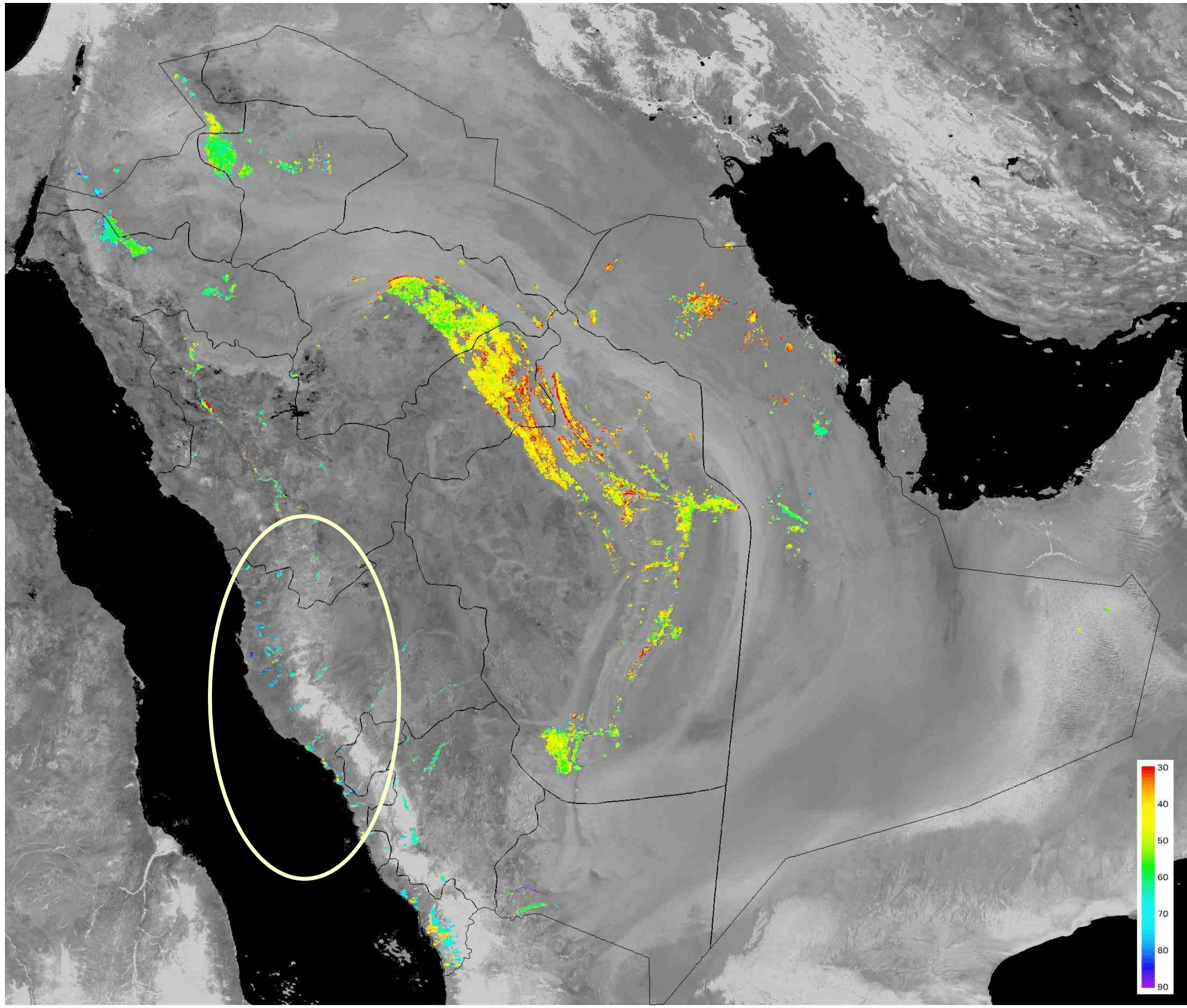
Through spate irrigation and flood water spreading

Cost for creating 1 m3 of storage capacity in soil profile/ shallow aquifer under artificial recharge is USD 0,0008 – and costs of 1 m3 of water actually stored is USD 0,027

Cost for creating 1 m3 storage in reservoir is USD 0,20

Irrigation efficiency (consumption/supply) for all irrigated areas in Saudi Arabia averaged for the period 1975 to 2005. The wheat belt with (badly managed) center pivot irrigation systems have an efficiency of 40%. The highest efficiencies (70%) are obtained at the spate irrigation systems along the Red Sea coast!

Saudi Arabia: Irrigation efficiency can be high



Comparing..

Perennial irrigation (dam based)	**Spate irrigation**
Secure supplies – provided dam has reasonable catchment and manageable sedimentation	Insecure supplies unless combined with groundwater irrigation
In shallow dams high evaporative losses, in deep reservoirs not too much	Water storage in soil profile/ shallow aquifer – low evaporation losses
Investment costs per m3 stored is high	Investment cost per m3 stored is low (if there is a fresh water aquifer)
Sedimentation may cause siltation (and prevents recharge)	Sedimentation contributes to fertility
Can store peak flows	Cannot utilize all peak flows, but shallow reservoirs may be added within command area

Opportunities in spate irrigation..

Can be very productive if combined with groundwater irrigation and recharge (provided aquifers are fresh)

Adequate moisture conservation is key to high production

Often significant productivity increases are possible in main crops, such as sorghum or cotton

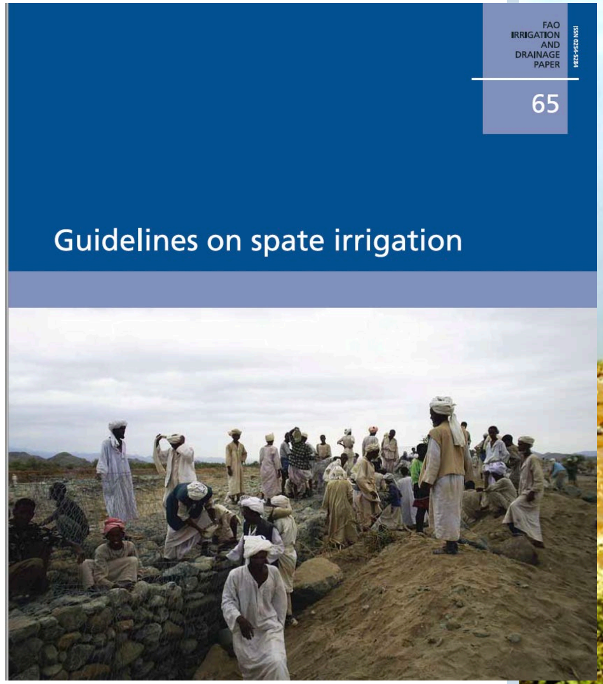
Promising new crops: vegetables, guar (clusterbean)

Can serves many different functions – livestock, wild vegetation, drinking water

Several examples of successful ‘improved’ traditional system – better model than modernized engineered systems

Requires close partnership with spate irrigation farmers and local authorities

www.floodbased.org



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Thank you for your attention

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