Green Roads for Water

Road infrastructure in support of water management and climate resilience

-Introduction and global experience-

GREEN ROADS FOR WATER

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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

Water-related road damage
(water causes 35-80% of road damage)

Flooding

Water logging

Erosion (gullies and landslides)

This can be

roads can become GREEN ROADS

Green Roads present a triple win with very little additional investment:

1. **reduced road maintenance costs**
2. **reduced degradation of the landscape around roads** and
3. **Beneficial use of water for roadside communities**

Levels of road resilience in different geographies

Regular Roads

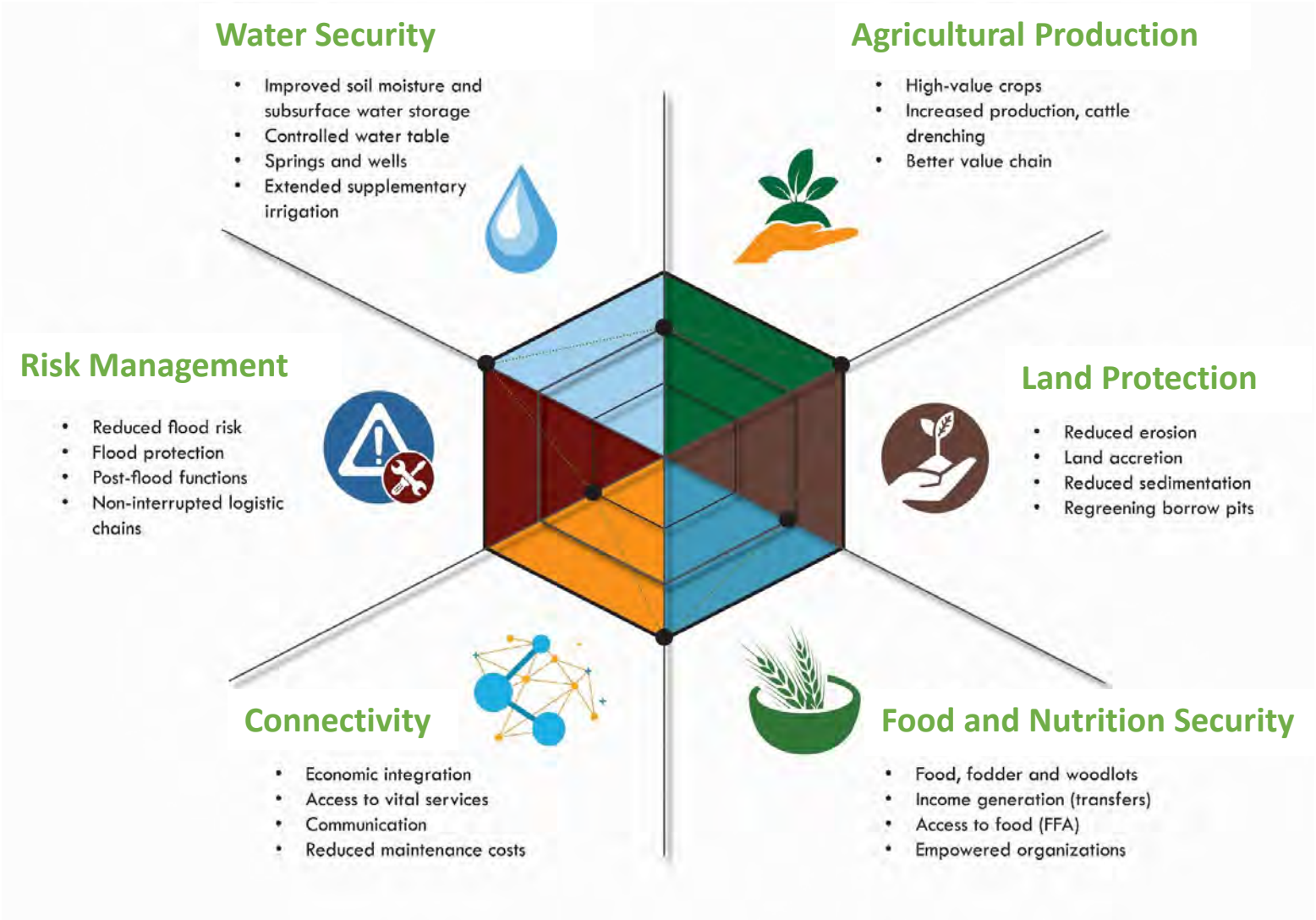
Regular roads support only connectivity and pose negative effects on landscapes and livelihoods

Green Roads

Apart from connectivity – green roads contribute to climate resilience, water security and productive use of natural resources

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

Green Roads co-benefits



Green Roads for climate change adaptation and mitigation

Climate Change adaptation strategies/measures

GR4W provides several measures aiming at reducing the negative impacts of climate change to roads, the surrounding of the roads landscape and the livelihoods of local communities by using roads as instruments for beneficial water management.

Climate Change mitigation strategies/measures

Roadside Tree Planting is a climate mitigation measure. If trees are managed well, they can sequester CO_2 and function as carbon sinks.

Read this Blog on the potential of roadside trees to offset CO_2

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Why Green Roads:
Big Scale and Big Impact: The Trillion USD Gap

Roads are major investment globally

(1-2 Tr USD/year)

Road expansion

(25 million km of paved road-lanes and 335,000 km of rail-track will be added from 2010 to 2050. About 60% increase!)

Water causes 35-80% of road damage

(Road transect surveys in upland Ethiopia and Uganda show that in every 10 km of roads there may be 8 to 25 flash points, such as local erosion, flooding, sedimentation, or waterlogging.)

GR4W measures are low cost in comparison to total road investment (<5%) and bring high returns (>4 in a year)

(Based on C&B Analysis from the GR4W implementation in Ethiopia)

Widespread adoption of GR4W can **leverage investment at a transformative scale** , making road development and maintenance vital tools for climate resilience, water management and productive use of natural resources

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Green Roads for Water program

- Initiated by MetaMeta in **2014**
- **Aim**: To have roads systematically used for water management, regreening and climate resilience and introduce as standard in at **least 50% of countries in the world by 2025**
- Active in more **than 15 countries**
- Various types of projects: **research, capacity building, supporting implementation, policy formulation, mobilizing green funds and investments for green roads**
- Development of **GR4W Guidelines,** Guided Learning packages, Training Material
- Supported by: The World Bank, Asian Development Bank, Global Resilience Partnership, NWO, NERC, RAP3, Blue Gold and more

Green Roads for Water program: Activities

Global level activities

✓ **Introducing the GR4W practice at global level and exploring its incorporation in the transport portfolio of main multilateral players**

Working with IRF, World Bank, Asian Development Bank and have started discussions with several other organizations such as GCF through IFAD, WWF, WFP and GIF

Country level activities

✓ **Scoping studies**

Studying how water is addressed around roads and assessing the issues and opportunities for GR4W in different countries

✓ **Motivational workshops/trainings**

Raising awareness on the GR4W topic, bringing all relevant sectors together and developing synergies, building capacity on how to use roads as instruments for CR and on the roles and responsibilities of each stakeholder

✓ **Supporting the implementation**

Drafting guidelines tailored to specific countries, providing technical assistant to implementers, facilitating the incorporation of GR4W approach into national/regional plans and programs and exploring green funding opportunities

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Green Roads for Water program: Status up today

✓ GR4W has been introduced/ initial assessments have been made/ trainings have been conducted

- **Rwanda, Somaliland, Mozambique, Zambia, Tajikistan, Bolivia, Yemen** – Introduction and scoping studies to explore GR4W opportunities
- **Nepal** – Introduction, scoping studies in several areas, tailor-made training to the Department of Local Infrastructure and a GL has been issued on this topic
- **Sudan** – Introduction and tailor-made training to the relevant stakeholders from road, water and transport sectors

✓ GR4W has been integrated in national/regional programs and implemented at a big scale

- **Ethiopia** - GR4W is incorporated in the water conservation programs and a Guideline has been developed with the Ethiopian Roads Authority
- **Kenya** – GR4W is incorporated in various programs of Makueni county
- **Bangladesh** – GR4W is being implemented (widespread use of gated culverts, joint Recommend Practice by four key organizations)

Green Roads for Water Guideline

- explains the Green Roads for Water concept
- provides strategies to use roads for beneficial water management tailored to diverse landscapes and climates, including **watershed areas, semiarid climates, coastal lowlands, mountainous areas, and floodplains**
- discusses the management of Green Roads for Water interventions (community engagement and governance)
- Discusses the costs & benefits of Green Roads for Water in Ethiopia, Kenya and Bangladesh

Published by: WORLD BANK GROUP

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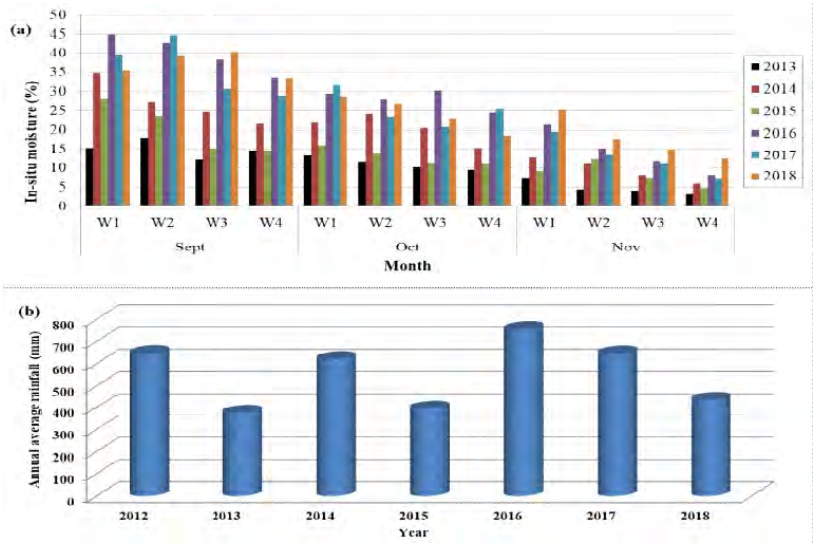
Impacts of Green Roads in Ethiopia

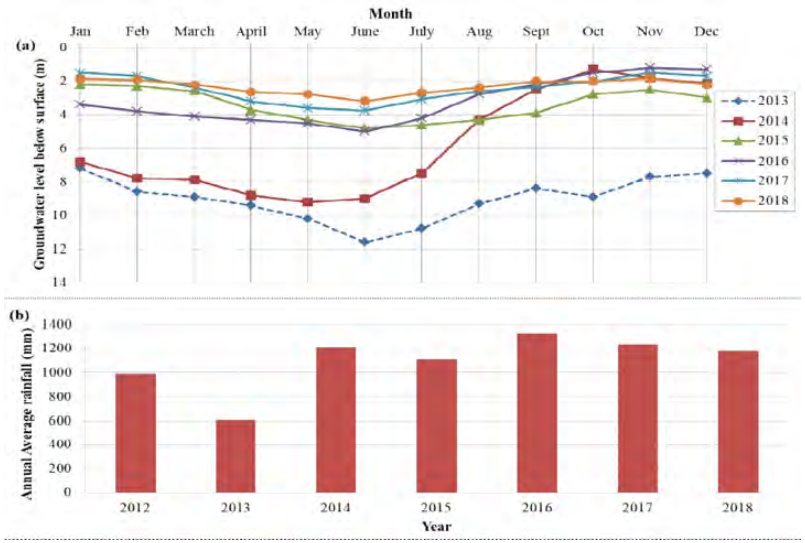
Raised water availability after implementing Green Roads in Ethiopia at a large scale

Additional information on the benefits of GR4W on rural livelihoods. This blog was published by GRP after a site visit at the road-water-harvesting sites implemented in Northern Ethiopia during the GR4W program



(a) In-situ moisture distribution in soils (before and after the construction of structures that divert runoff from culverts into farmlands along the Mekelle road (Kihen), Tigray, Ethiopia. Construction of the diversion structures was done on May-June 2014. Monitoring was done for the period September years 2013 to 2018. (W1= Week one; W2=Week two; W3=Week three and W4=Week four). (b) Rainfall distribution for (ENMSA, 2018).

Source: Kifle et al., 2019



a) Groundwater fluctuation in Selekleka area, Tigray, Ethiopia (at downstream of a check-dam which was constructed in the period January is designed to store improved at downstream of the box culvert b) Rainfall distribution for the year 2012 to 2018 (ENMSA, 2018)

Source: Kifle et al., 2019

Costs and Benefits of Green Roads in Ethiopia

Costs:
~ 1,800 $/km

Benefits:
~ 18,879 $/km

	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

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

Our mission

- **To make Green Roads a standard**: to have roads systematically used for water management, regreening and climate resilience and introduce as standard in at least 50% of countries in the world by 2025

- **To work with other organizations to adopt and support the same practices**

- **To fast-track climate change adaptation** by retooling roads for water and regreening and at the same time have more reliable transport connections

Our services

- ✓ **Road water assessments** – identifying the best options along selected roads
- ✓ Working with engineers and implementers to **design better practice**
- ✓ **Developing guidelines** appropriate to specific countries and situations
- ✓ **Training and coaching** towards a change in culture and governance for green roads for water
- ✓ **Developing strategies** to optimize the wider socio-economic benefits of road development and road construction

Main partners

Connecting with (in progress)

National Programs

Green Finance Initiatives

Academia

United Nations

Bilateral & Multilateral Organizations

Private Sector foundations

Contractors

Main NGOs

Green Roads for Water

Good examples from around the world

Ethiopia

Mozambique

Yemen

Nepal

Kenya

Malawi

Bangladesh

Somaliland

Zambia

Sudan

Rwanda

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Good GR4W examples from around the world

Kenya Experience

Roadside Gully rehabilitation, prevention and reclamation using locally led adaptation methods.

Farming using harvested roadside rainwater (cut-off drains)

Good GR4W examples from around the world

Kenya Experience

Non-vented drift/road crossing

Act as both road crossings and sand harvesting structures for water storage during the dry seasons

Roadside Farm Ponds

Road runoff harvested rainwater stored into farm ponds for farming and tree planting- See the silt-trap used to prevent sedimentation to the pond

Good GR4W examples from around the world

Kenya Experience

Road run-off harvesting from a cross culvert for farming and domestic use.

Roadside tree planting using road runoff for dust control, water retention and roadside land protection

Good GR4W examples from around the world

Mozambique Experience

Converting borrow pit

Upgraded borrow pit with geomembrane for lining and fencing used for domestic water for population on radius of 4m

Connecting roadside drains to farmland

Good GR4W examples from around the world

Mozambique Experience

Road crossing act as sand dam

Good GR4W examples from around the world

Zambia Experience

Use of ponds to store water from mitre drains

Used for drinking water for livestock and wildlife

Use of borrow pits to store water from culverts

Used for livestock drinking water, small scale irrigation and groundwater recharge

Good GR4W examples from around the world

Zambia Experience

Directing water from roadsides to tree plantations along the road

Single woman farmer uses four roadsides, hand dug wells to irrigate her vegetable plot with a bucket

Good GR4W examples from around the world

Malawi Experience

Road runoff distribution trenches

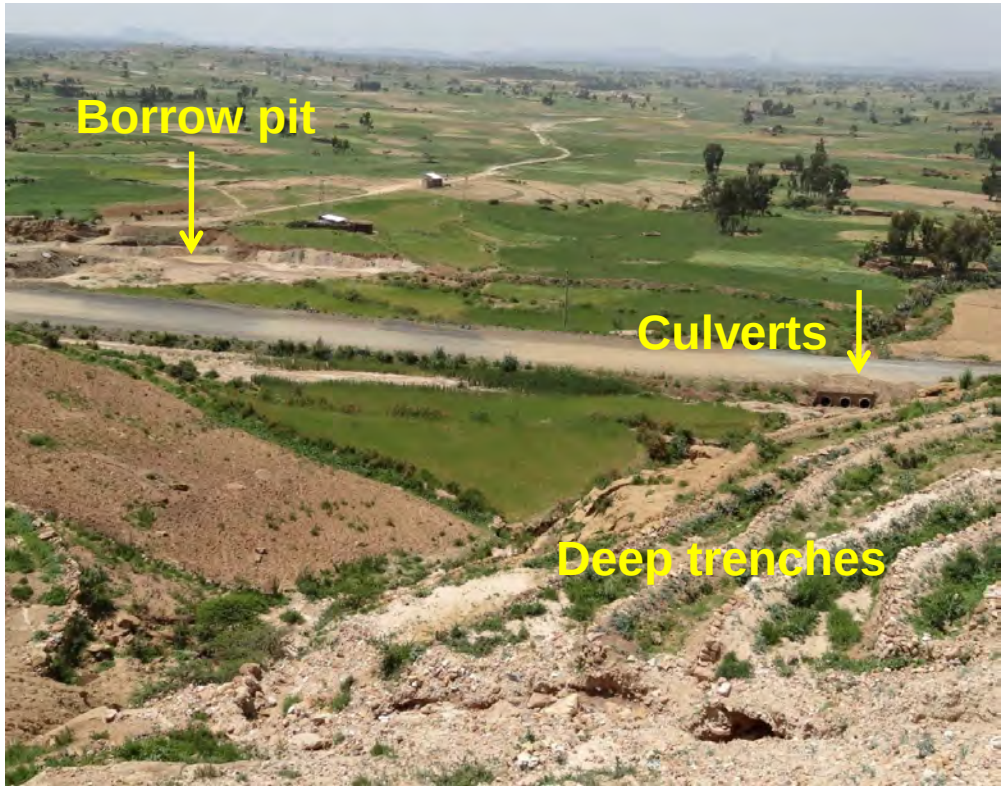
Percolation ponds with water diverted from roads

Good GR4W examples from around the world

Ethiopia Experience

Runoff from a town (Freweign) is managed through a number of options:

- Construction of deep trenches to reduce runoff and enhance groundwater recharge.
- Diverting water from culverts into a borrow pit for surface water storage and groundwater recharge.

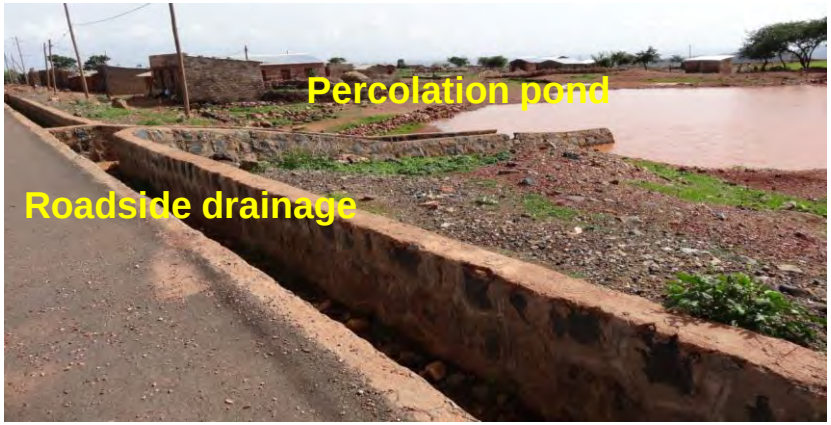


Good GR4W examples from around the world

Ethiopia Experience

Water from a bridge is spread into series of deep trenches and percolation ponds to recharge groundwater

Roadside drainage connected to percolation pond for groundwater recharge.



Good GR4W examples from around the world

Ethiopia Experience

Employment opportunities for rural communities in road construction

Good GR4W examples from around the world

Sudan Experience

Use of bridges or elevated roads for roads crossing over canals in big irrigation schemes (example from Gezira irrigation scheme)

Converting borrow pit to water storage pond (mainly for livestock drinking water)

Good GR4W examples from around the world

Rwanda Experience

Mansory drains at culverts to divert road run-off to tea plantation downstream of the road

Building terraces for slope stabilization around roads in high mountain areas (Sebeya catchment)

Good GR4W examples from around the world

Rwanda Experience

Grass vegetation at the culvert outlet protects the roadside environment from road-induced erosion

Roadside tree planting with indigenous trees for protecting the roads and the roadside environment

Good GR4W examples from around the world

Somaliland Experience

A leaky pond dug over carbonate rock areas on the road to Garbo-Dadar mainly used for livestock drinking water

Roadside tree planting in Garbo-Dadar and along the Borema-Gabiley road

Good GR4W examples from around the world

Yemen Experience

Using the Culverts provided with control gates to facilitate distribute floods in sub-canals

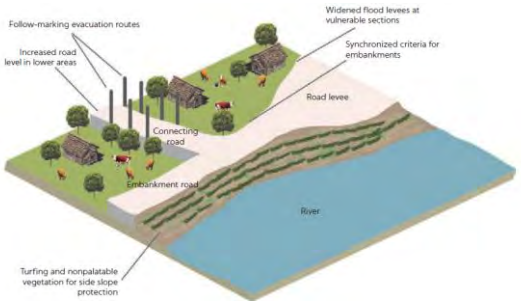
Water from roadside drains used for irrigation

Good GR4W examples from around the world

Bangladesh Experience

Roads as temporary flood shelters and evacuation routes

Roads and embankments as flood defense



Good GR4W examples from around the world

Bangladesh Experience

Use of gated culverts to retain and control water

Roadside tree planting

Good GR4W examples from around the world

Nepal Experience

Protecting and preserving spring water as part or road development practice in mountainous areas

Bio-engineering measures for roadside slope stabilization

Thank you!

For more information visit www.roadsforwater.org

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