

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ



Kabul University

Ministry of Higher Education
Islamic Republic of Afghanistan

Roads for Water and Resilience

Climat Smart Innovations in Water Harvesting

Assoc. Prof. Abdul Qayyum Karim, Ph.D.

aqkarim15@yahoo.com
Kabul, 9 January 2017

Table of Contents

1. Rainwater Harvesting
 2. Water Harvesting History in Afghanistan
 3. What is Road for Water?
 4. Why Road for Water?
 5. Road for Water Techniques
 6. Optimizing Road Design for Multiple Functions
 7. Learning Topics
 8. Recommendations
- References

1. Rainwater Harvesting

- ▶ **Rainwater harvesting** is the accumulation and deposition of rainwater for reuse on-site, rather than allowing it to run off.
- ▶ Rainwater can be collected from **rivers** or **roofs** and mostly redirected to a deep pit (**well, shaft, or borehole**), a reservoir with percolation, or collected from **dew or fog** with nets or other tools.
- ▶
- ▶ **Uses:** **gardens, livestock, irrigation, domestic use, indoor heating for houses, drinking water, and groundwater recharge.**

2. WH History in Afghanistan (Few Examples)

KANDA:

- Northern and Central parts
- Round or rectangular underground reservoir
- Micro Catchments
- Rain and snow melt as source of water
- Built by the herders and rain-fed farmers
- Rainwater is harvested automatically
- Animals, herders and travelers, mainly for drinking purpose.



2. WH History in Afghanistan (Few Examples)

NAWR, NAWOR or Hawz

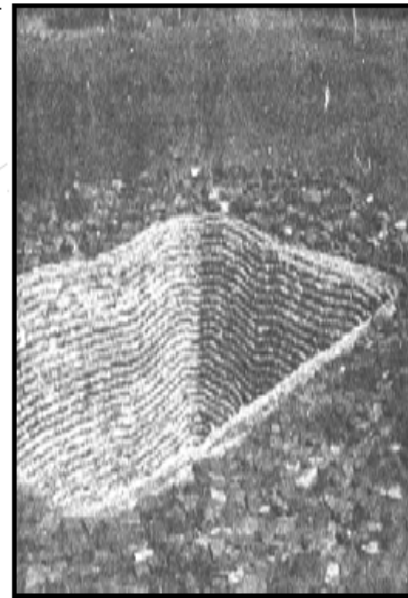
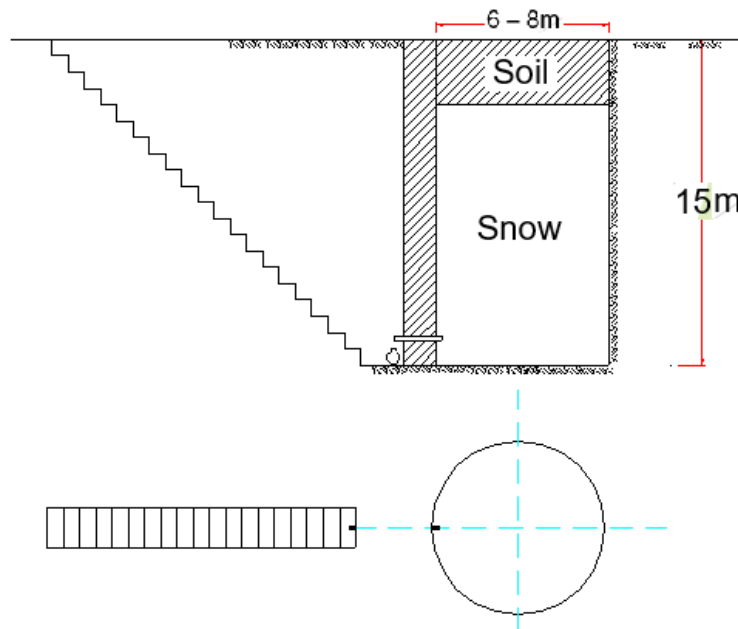
- Northern, Western and Central parts
- Mainly rectangular pond with different dimensions
- Macro catchment areas
- Rain water as source harvested through water channels
- Mainly built by the community/ farmers/herders.
- Used in summer by animals, herders and travelers



2. WH History in Afghanistan (Few Examples)

YAKHDAN/BARFDAN:

- Northern, Western and Central part
- Shallow well with dia. 5-10m and a depths of up to 10m
- Mainly fed from snow melt,
- The water is used in summer
- Users are villagers for drinking purpose and local Ice Cream makers.



2. WH History in Afghanistan (Few Examples). . . .



Roof rainwater harvesting



3. What is Road Water Harvesting

Road Water Harvesting is Rainwater Harvesting from Roads with the following Objectives:

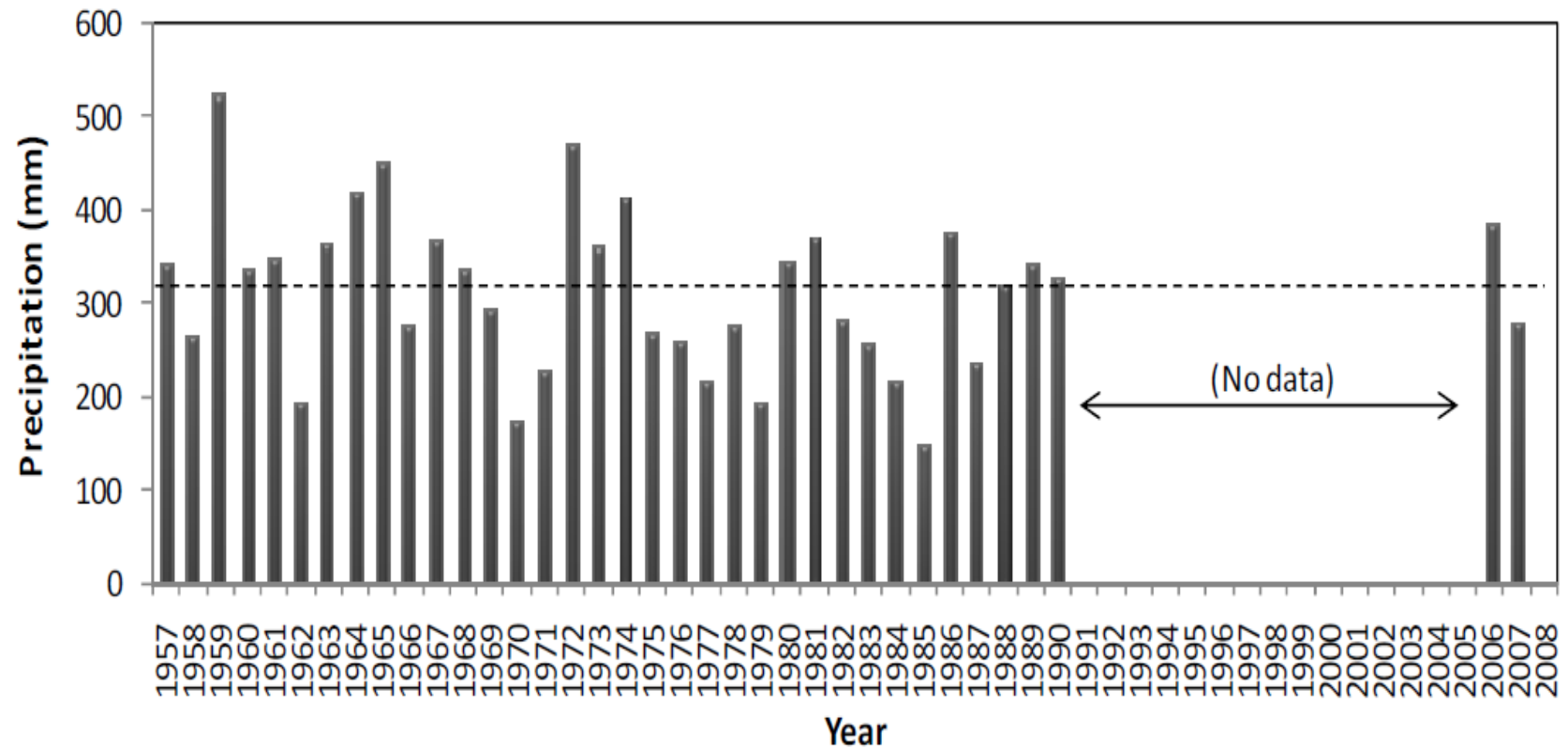
- ▶ To have roads systematically used,
- ▶ To recharge/retention, storage water, and
- ▶ To manage water all over the world, such as Sub Saharan Africa and Asia, including Afghanistan



4. Why Road for Water?

- ▶ Annual investment on Roads USD 1-2 Trillion (40% in developing countries)
- ▶ Increased water stress - 74% in most poor in water stressed areas
- ▶ Water is 35% of damage to paved roads, up to 80% to unpaved roads.
- ▶ Roads change the surface hydrology and have major impacts on run-off, often causing local flooding, water logging and erosion.

4. Why Road for Water?



Simple calculation from Kabul (Afghanistan)

4. Why Road for Water?

- Width of Darul-Aman Road say 40 m
- Total length of Road is 5.5 km or 5500m
- Kabul Average rainfall 300 mm,
- A simple calculations shows that annually 66,000 m³ for the whole length of the road, and $66,000 / 5.5 = 12,000$ m³ per ha. water could be harvested.



4. Why Road for Water?



4. Why Road for Water?

Some Results of Reconnaissance Studies shown that:

I. In 200 kilometers:

- ▶ Erosion and sedimentation: 150 locations
- ▶ Flooding of houses and land: 45 locations
- ▶ Persistent waterlogging: 65 locations

II. Deficiencies in governance process

- ▶ Missing from guidelines,
- ▶ No coordination,
- ▶ No interaction with road-side communities.

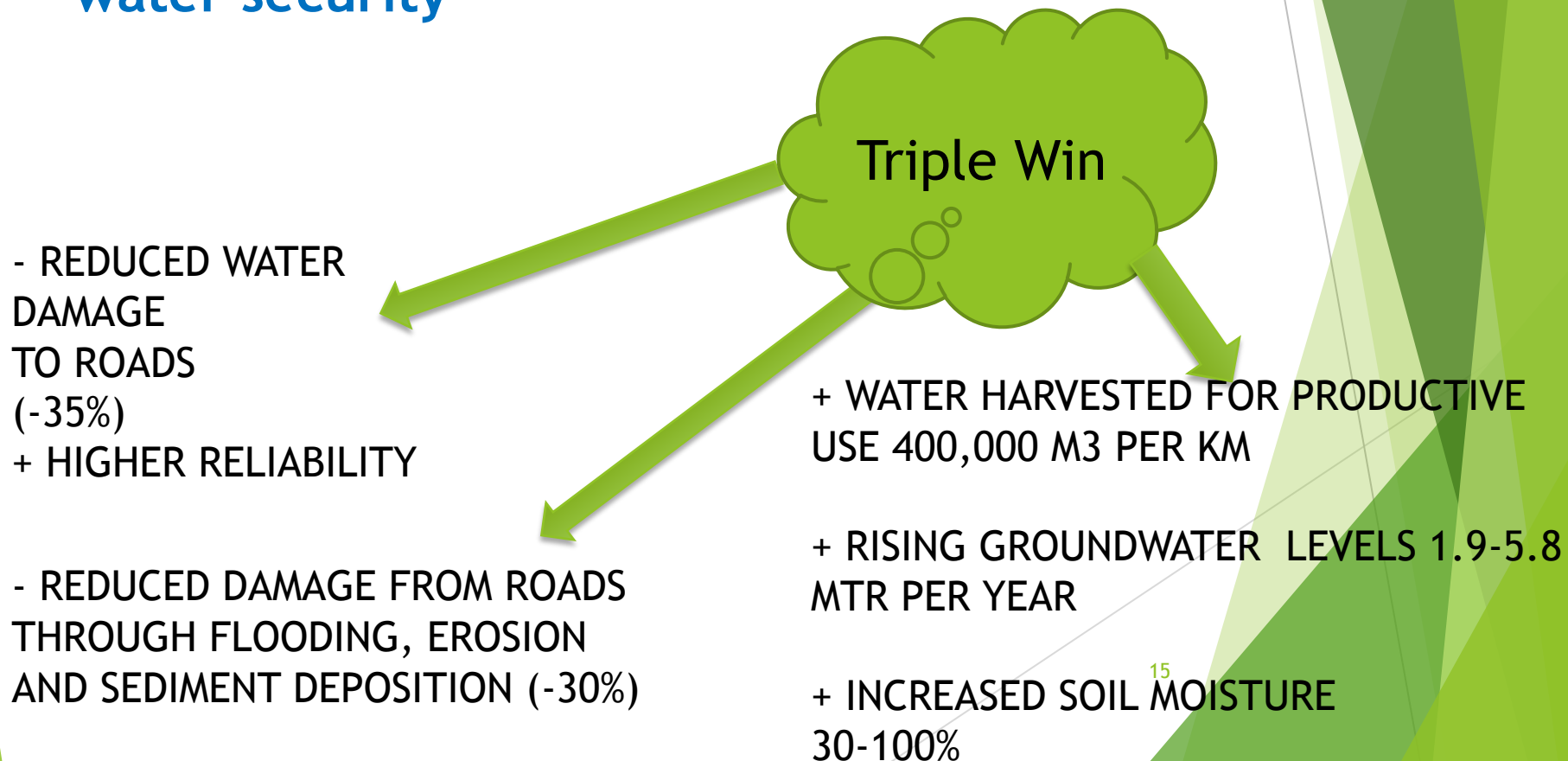
III. Social impacts

- ▶ Damage to land and houses, dust
- ▶ Poor - most vulnerable least access to potential
- ▶ No compensation, indirect litigation



4. Why Road for Water?

“This can be turned around in large potential for water harvesting and water management which will enhance food and water security”



4. Why Road for Water?

Current Road Practice

- Erosion, flooding, water logging
- Dust impact on health
- 35% of road damage by water
- Insecurity and reduced resilience

towards



“Roads for Water”

- Harvest water for productive and social use
- Agriculture, rangeland, fisheries
- Other livelihood opportunities
- Reduce erosion and land loss
- Lower road damage
- Higher ability of people, households, communities to deal and thrive in the face of shocks and stresses

5. Techniques of Road for Water

Adapting to changed road run-off

1. Spreading water from road surface
2. Harvesting water from culverts, side drains and depressions
 - Converted borrow pits
 - Infiltration ponds
 - Infiltration trenches/ pits
 - Diversions/cutoffs/trenches to farm
3. Gully plugging for recharge
4. Spring capture

5. Techniques of Road for Water



The Netherlands: Swallow for Recharge

5. Techniques of Road for Water



Soaking pits along the road for groundwater recharge and increased soil moisture

5. Techniques of Road for Water

Trenches/Soaking pits for groundwater recharge and increased soil moisture

4. Techniques of Road for Water

**Embankment
Erosion**



**Infiltration ponds, downside
drain, mountainous terrain**



5. Techniques of Road for Water

**Ponding water on downside of culvert
Ethiopia, in flat terrain**



Photo: Sept. 01, 2013



Photo: Sept. 23, 2013

5. Techniques of Road for Water

Ponding water on upside of culvert using sluice gates



SE Mali,
flat terrain

5. Techniques of Road for Water

**Roadside pond on downside of culvert
Yemen, in flat terrain**



5. Techniques of Road for Water

Examples of gabion protection



5. Techniques of Road for Water

Borrow pit



Culverts



Deep trenches

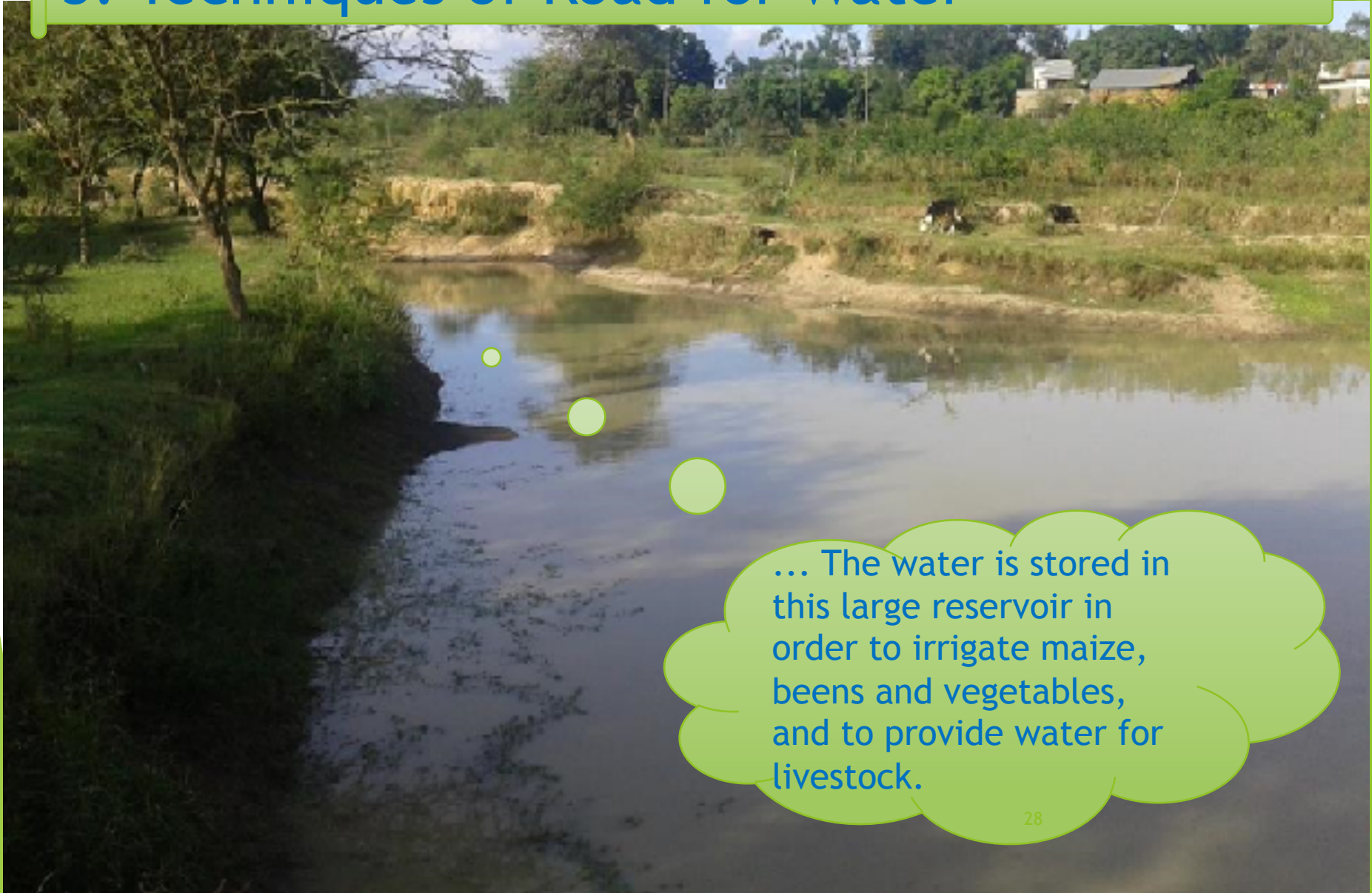
Communities which used to have been affected by flooding are saved from dflooding.

5. Techniques of Road for Water



Stone bunds are used to divert and spread water from a culvert

5. Techniques of Road for Water



... The water is stored in this large reservoir in order to irrigate maize, beans and vegetables, and to provide water for livestock.

5. Techniques of Road for Water



Tigray, Mulegat:
Spring Capture

6. Optimizing Road Design for Mutlipel Functions



The drift acts as a sand dam

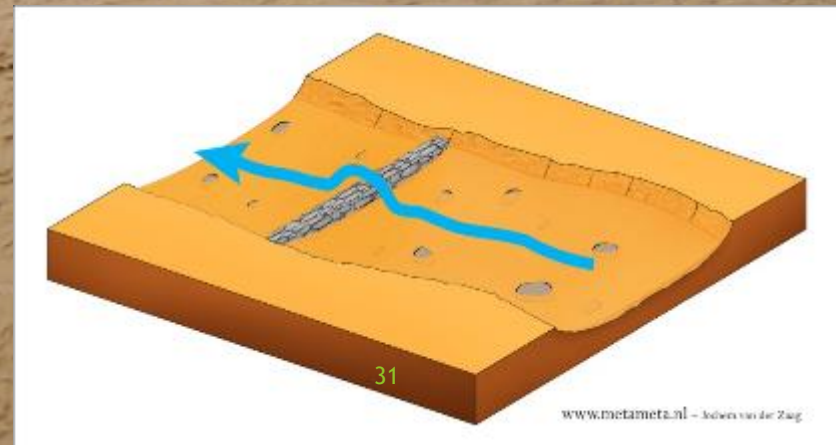


Holding the water upstream

Road crossing acting as sand dam

6. Optimizing Road Design for Mutlipel Functions

Pakistan:
Road =
Spate
Irrigation
Bed
Stabili
zer



6. Optimizing Road Design for Mutlipel Functions

Road
Crossing
acting as
Sand Dam
+ Brick
Making



6. Optimizing Road Design for Mutlipel Functions



Brick making along the oad crossing a sandy river bed.

6. Optimizing Road Design for Mutlipel Functions



Road side
tree
plantation

7. Learning Topics

- ▶ Introduction- Roads for Water, creating resilience
- ▶ Culvert and cross drainage design
- ▶ Drainage from unpaved roads
- ▶ Estimating drainage flows
- ▶ Gully assessment and prevention
- ▶ Landslide related road failures in Ethiopia
- ▶ Rainwater run-off from roads
- ▶ Road for water planing and governance
- ▶ Roads crossing river beds
- ▶ Roads for inclusiveness
- ▶ Roads in flood plains
- ▶ Roadside planting
- ▶ Social engagement processes
- ▶ Social impact of roads for water harvesting
- ▶ Spate irrigation from road run-off
- ▶ Water harvesting from roads: experiences from Tigray
- ▶ Water harvesting from seasonal river crossings
- ▶ Weather proofing and water harvesting
- ▶ Road crossings as sand dams - Kenyan Experience
- ▶ GIS and Remote Sensing application in watershed management
- ▶ Environmental mitigation of impact from road water harvesting

8. Recommendations

- ▶ 1. Integratation of RFW in road and watershed programs
- ▶ 2. Community engagement in the business
- ▶ 3. Change procedures in roads development
 - Manuals/Guidelines and Design
 - Investment budgets
 - Maintenance budgets
 - Cooperation
 - Social interaction and cooperation
- ▶ 4. Capacity building
 - Short courses
 - Tools (run-off models)
 - Training Workshops
 - Research

References

- ▶ Access Exchange International (an NGO promoting accessible public transport for persons with disabilities): <http://www.globalride-sf.org/>
- ▶ Commission for Global Road Safety:
<http://www.fiafoundation.org/commissionforglobalroadsafety/> United States Transportation Research Board: <http://www.trb.org/Main/Home.aspx>
- ▶ Global Road Safety Partnership: <http://www.grsroadsafety.org/>
- ▶ International Road Safety Assessment programme (iRAP): <http://www.irap.org/>
- ▶ The UK Transport Research Laboratory (TRL) produced the Overseas Roadnotes series: <http://www.trl.co.uk/>
- ▶ Rod for Water, Presentation by Luvieke Bosma, Metameta the Netherlands, Spate Irrigation Training Workshop, MAIL, Kabul, Afghanistan Dec. 2016
- ▶ Spate Irrigation, Said Shobair Sharif, Ministry of Energy and Water, Spate Irrigation Training Workshop, MAIL, Kabul, Afghanistan Dec. 2016
- ▶ The International Forum for Rural Transport and Development (IFRTD): <http://www.ifrtd.org/new/index.htm>
- ▶ World Business Council for Sustainable Development (2009) Mobility for Development. 64
- ▶ World Health Organization (WHO) (2004) World Report on Road Traffic Injury Prevention.
- ▶ World Road Association (PIARC): <http://www.piarc.org/en/>



Roads for Water Security
Water for Roads Safety!
Let's travel together 😊

