Water Harvesting from Roads in Ethiopia:

Practices and Techniques

By: Kifle Woldearegay (PhD) (Mekelle University, Ethiopia)

Outline of the Presentation

1. Introduction
2. Hydrological effects of road development
3. Practices of Water Harvesting from roads in Tigray
4. Techniques of Water Harvesting from roads
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1. Introduction

- Water scarcity is a major problem in many parts of Ethiopia.
- Road building constitutes one of the largest and most widespread public investments.
- Estimated spending in road sector in Sub-Saharan Africa: 7 billion USD per year (World Bank, 2010).
  - ➢ This investment is far more for instance than the investment in water resource management.

2. Hydrological effects of road development

- Increase in erosion of local streams causing gullying.
- Sedimentation/siltation.
- Alter sub-surface shallow groundwater flows.
  - Reduced groundwater recharge through altered surface water pathways.
- Water logging in the upstream areas.
- Opening springs in mountain areas.
- Groundwater pollution.

Erosion of side drains.

Gully erosion: water from culvert.

The effects of water from roads affecting farm lands along Mehoni-Hiwane road, Southern Tigray, Ethiopia

Photo: May 30, 2013

Photo: Sept.08, 2013

The effects of water from roads affecting farm lands along Mehoni-Hiwane road, Southern Tigray, Ethiopia.

Ponds filled with flood from roads at Freweign area, Tigray, Ethiopia: Photo: March 22, 2013

Water logging issue:

Ponding of water along the Freweign-Hawzien road, Tigray, Ethiopia; Photo: July 24, 2013

A hand-dug well which is recharged from ponding of water along road.

Photo: March 22, 2013

Photo: Sept. 23, 2013

A culver damaged by flood (overtopping of flood) in Gule area, Klite Awlaelo, Tigray, Ethiopia

Roads retarding surface runoff and sub-surface water flow.

Upstream side of the road is a potential area for shallow groundwater development.

(An example from Shire area, Tigray, Northern Ethiopia)

3. Practices of WH from roads in Tigray

Ponds used to collect water from culverts in Hiwane area, Southern Tigray, Ethiopia.

Series of Percolation ponds along the road, Hiwane, Southern Tigray, Ethiopia

Runoff from culverts contributing to the recharge of a hand-dug well in Wukro area, Tigray, Northern Ethiopia. Note the location of the culvert close to the vehicle.

A pond developed for harvesting concentrated flow from culverts in Shire area, Northern Ethiopia.

Partial view of series of gabion check-dams which are constructed at downstream of a bridge.

Concentrated runoff is channeled to these gabion check-dams in Bizet area, Tigray, Northern Ethiopia.

View of a borrow pit used for harvesting water in Axum area, Tigray, Northern Ethiopia.

The road embankment is now used as an earth dam and borrow pit as a reservoir. The size of the borrow pit that is storing water is 250m long, 80m wide, and with maximum depth of 15. It is used for small-scale irrigation (using pumps) and for shallow groundwater recharge in the area. The communities have strongly resisted closure of this borrow pit. The borrow pit is acting as a reservoir and water is recharged from surface runoff and base flow from the adjacent areas.

Hand-dug wells at upstream of Irish Bridge in Megab area, Tigray, Ethiopia.

Irish Bridge (Photo: Sept. 01, 2013)

Irish Bridge (Photo: July 24, 2013)

Water from roads is being channeled into farm land; later it joins a percolation pond in Adigudom area, Southern Tigray, Ethiopia.

Photo: Sept. 01, 2013

Photo: Sept. 23, 2013

View of percolation ponds designed to collect water from roads mainly from culverts in Zata area, Southern Tigray, Ethiopia. Design and construction was made by MERET, Tigray Bureau of Water Resources, in 2013.

Typical feature of the percolation ponds designed to recharge the groundwater and enhance moisture at downstream of these schemes in Zata area, Southern Tigray. The percolation ponds have average width=5m; length=6m; and depth=2m. Design and construction was made by MERET, Tigray Bureau of Water Resources, in 2013.

Farmers diverting water from roads into their farm in Mekelle area, Tigray, northern Ethiopia.

Farmers diverting water from roads into their farm in Hawzien area, Tigray, northern Ethiopia.

Photo: July 24, 2013

Photo: Sept. 01, 2013

Runoff from culverts is channeled to deep trenches in Megab area, Tigray, Northern Ethiopia.

Typical example of spring capture where roads are made in deep cut and springs are opened up in Megulat area, Tigray, Northern Ethiopia

4. Techniques of WH from roads: General

Some concepts from KUBBINGA (2011):

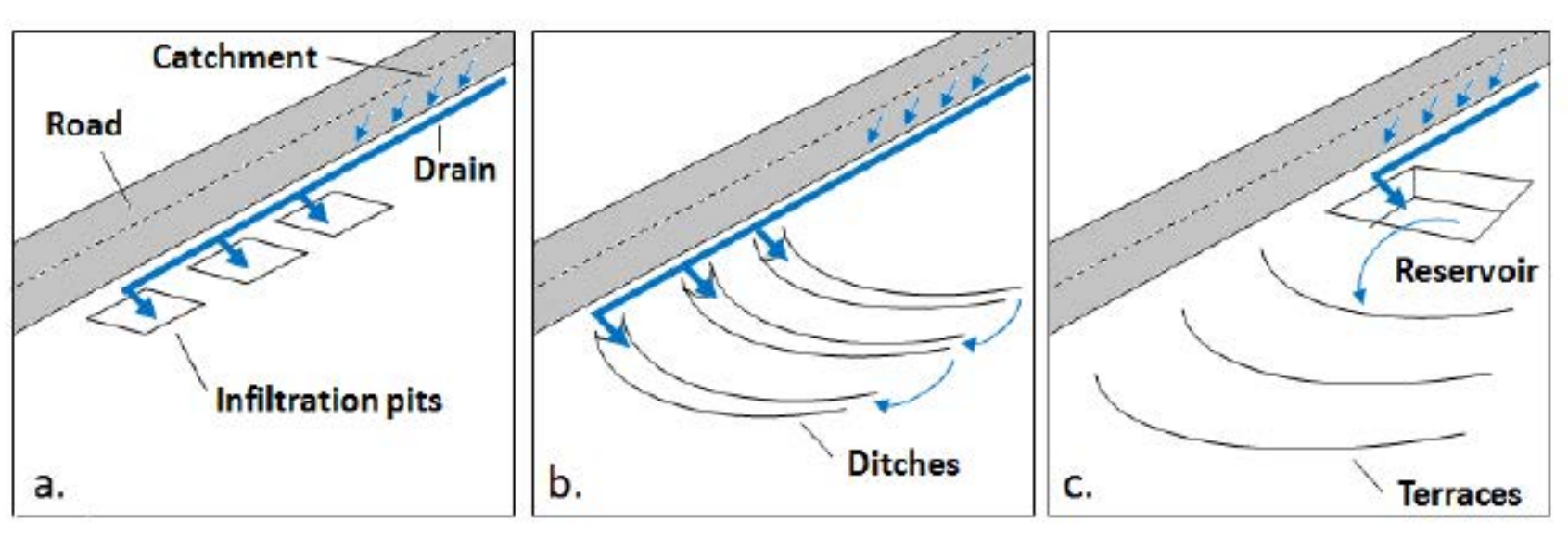
- Roads have a large surface that can collect large amounts of rainwater.
- Rainwater that is not directly ‘absorbed’ by the road and runs off the road, can be collected.
- In the rainy season, smaller roads can become completely inaccessible and turn into small rivers.
- Two major methods:

  (a) Runoff harvesting with roadside drains

  (b) Runoff harvesting through a culvert

(a)Runoff harvesting with roadside drains: three basic forms

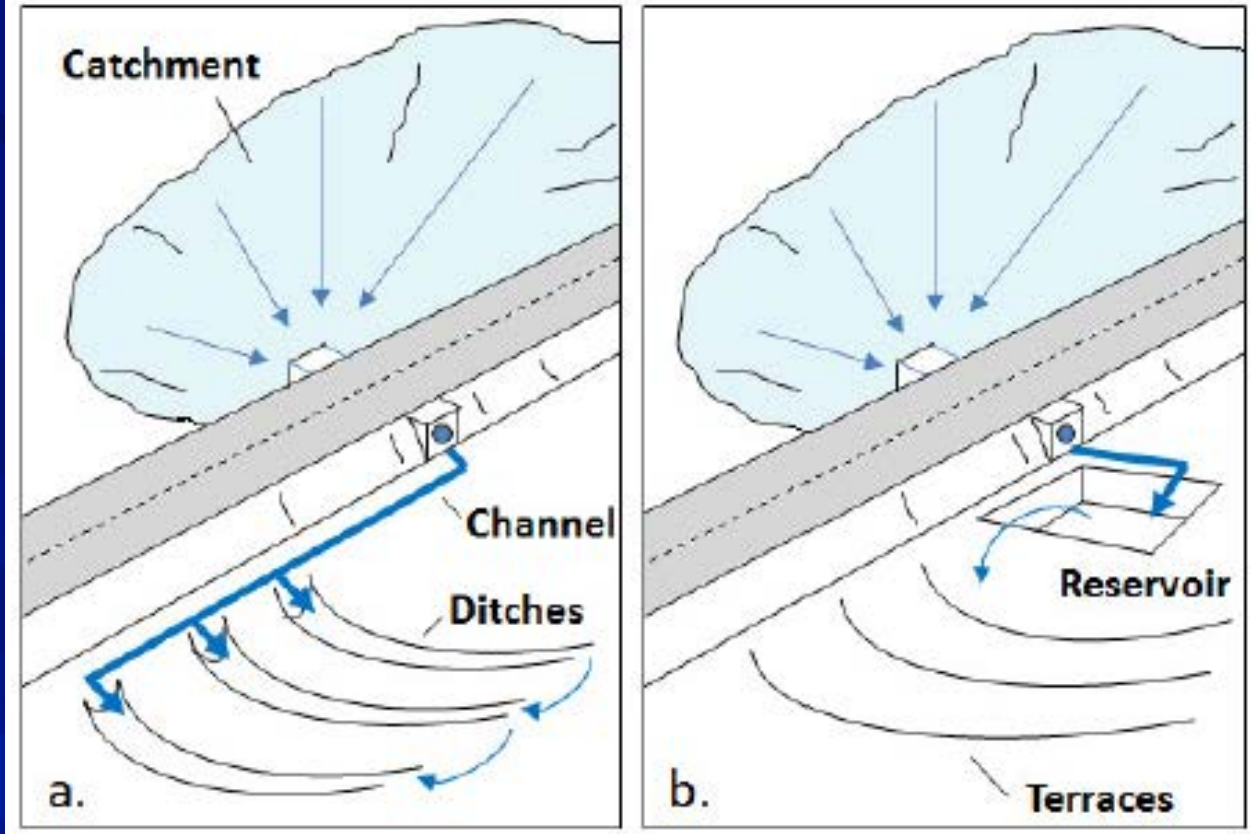
(Kubbinga, 2011)



- Blue arrows indicate the direction of the runoff water. The first form (a.) applies water directly into small, restricted cultivation areas alongside the road.
- The second (b.) guides the water into retention ditches that are built along the contour lines. This form also includes flooding of the cultivation area, which can have contours bunds instead of trenches.
- The third and last form (c.) consists of an intermediate storage facility that is preferably built above the cultivation area (to facilitate irrigation).
- Many variations are possible based on these three general forms.

(b) Runoff harvesting through a culvert: two basic forms

(Kubbinga, 2011)

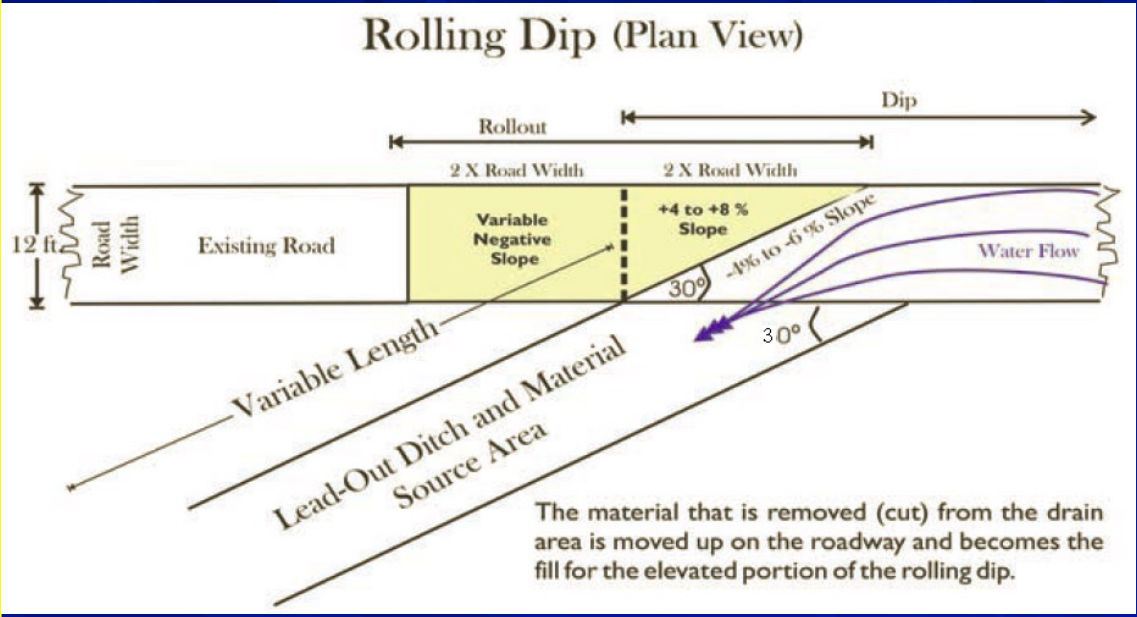


- This figure shows two basic forms of road runoff harvesting based on the water that is discharged by a culvert.
- In the first form (a.), the water is guided directly into retention ditches for use within-field. In this case, spill-ways are essential to prevent waterlogging.
- The other form (b.) makes use of an intermediate water reservoir that can have all forms and shapes (see examples in the text under harvesting with a roadside drain), while the size depends on the amount of runoff water that needs to be stored.

Major techniques of WH from roads

1. Carefully planning road alignments:
affecting the speed of surface run-off as well at the routing of run-off towards specific infiltration and recharge areas.

Road alignment design can take into account drainage of road runoff into infiltration prone areas so as to improve water retention and recharge of ground water.



Schematic rolling dip, from *(Zeedyk 2006)*

2. Planning cross drainage and lateral drains:

- To impede and direct run-off to recharge zones, or to water harvesting systems.
- To prevent gully erosion at downstream areas.

Water harvesting of road runoff, side drains and culvert into small pond, Yemen (REF Abyad 2013)

Water Harvesting cisterns from road side drains, Yemen (from Abyad 2013).

3. Using borrow pits or ponds: Systematically using borrow pits ponds or ponds as recharge or storage systems.

Borrow pit in Axum area

4. Rethinking road foundation design/ compaction so as not to interfere with the base-flow to shallow wells.

Pond in Wukro area

5. Carefully constructing road crossings through low causeways or Irish bridges:

In dry river beds such structures can retain groundwater upstream of the road crossing and increase bank infiltration, serving as proxy sand dams.

6. Harvesting sediment from runoff:

Sediment deposition in road pavement, drainage systems and downstream fields is a common issue, increasing road maintenance costs.

Spring capture where roads are made in deep cut and springs are opened up.

Road side plantation to slow down runoff, capture sediment and fix pollutants.

5. Conclusion and Recommendation

- Water from roads is an important resource for use.
- Shallow groundwater is becoming among the most important resources for irrigation and water supply in many parts of Tigray and Ethiopia.
- In many parts of Tigray and other parts of Ethiopia, the shallow aquifer systems are unconfined which makes it more feasible for groundwater recharge and development.
- Shortage of water is a major problem in arid to semi-arid regions, especially in dry seasons.

- A number of organizations: Bureaus of Agriculture and Rural Development, Bureaus of Water Resources, NGO's (like REST, Wukro Saint Mary College, etc) are involved in natural resources management, water harvesting, and irrigation development.
- The country is undertaking massive road development projects which will continue altering the hydrology along the roads.
- There is a need for optimized road design that takes into consideration water harvesting.

- Different organizations working in water resources development, natural resources management, road design/construction, and research institutes need to collaborate to address the issues.

- Through collaborative research- based development work it is possible to have double advantages with road development: water harvesting and safe road construction.

7. Acknowledgement

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Thank You