## *Case for GRIPP site on Groundwater-based Natural Infrastructure*

**On the road to water management and climate resilience**

Innovative solutions to increase water security and resilience, while protecting roads from flooding

**Roads for Water – What is it?**

There is probably no intervention globally that has more impact on the surface and groundwater hydrology and landscapes than road construction. Roads obstruct the flow of water, channel runoff and concentrate it, make it accelerate, and in the process trigger erosion and sedimentation. In watersheds, roads may rewrite the entire drainage pattern. In floodplains and coastal lowlands, the effect is similar: Road embankments and bridges may cut floodplains in two parts and change the sedimentation and flood pattern – causing waterlogging in one place and drying in others. Representing an estimated global investment of USD 2.0 trillion annually [1], road building has enormous potential, if done properly, to help address – apart from improved access and connectivity – to some of the main challenges of our time, particularly climate resilience and water management [2].

The traditional image of roads and water is that they are enemies. Almost all of the damage to unpaved roads and a large part of that to paved roads is related to water. The higher rainfall and flood peaks accompanying climate change will only make matters worse. Also, there is a knock-on effect. The negative effects of roads on the landscape surrounding them (i.e., erosion, devastating local floods and waterlogging) ultimately will find its way back into the road network as well.

There is a need to turn this around. Studies have established that a 10-km-long stretch of road may have up to 25 major and minor problem spots [3]. In watersheds, typically 10-40% of all sedimentation is triggered by roads, affecting aquatic biodiversity as well as the lifespan of reservoirs [4]. Such a turnaround is possible, and by intelligent, innovative and relatively low-cost solutions, roads, rather than causing environmental damage, can become instruments for climate change resilience. This is the basic concept behind the Roads for Water project, which developed and piloted such approaches in developing countries.

**The solution: Road water management technologies for water harvesting and groundwater recharge**

Many measures can be used to manage the water associated with roads, so that they serve as instruments for water and food security, landscape management and environmental protection. Road bodies and their drainage infrastructure can be used to harvest floodwater in

arid or semi-arid areas by guiding the water naturally intercepted by roads to groundwater recharge basins, surface storage or direct application to the land (Figures 1-4). New roads can be planned and existing roads rehabilitated to manage smaller catchments – controlling the speed of runoff, compartmentalizing and mitigating flood runoff, and influencing sedimentation in the catchments. The approach of the Roads for Water project significantly enhances conventional practices to water management linked to roads by focusing on the managed harvesting and storage of excess flows. Since 2014, it has been successfully implemented in Ethiopia and Kenya, and is now being scaled out to Uganda, Malawi and Bangladesh, primarily through the so-called Roads for Water Learning Alliance.

*Figure 1. Water diverted from culvert to percolation pond for groundwater recharge (photo: K. Woldearegay).*

*Figure 2. Roadside trenches in Ethiopia (photo: MetaMeta).*

## Implementation in Ethiopia

When the idea of managing water associated with roads in a more integrated way was first introduced in Ethiopia in 2014, the uptake was significant. It was quickly incorporated into watershed programs in several regions, where communities are mobilized to implement soil and water conservation measures - improving water availability for more than two million people since 2015 [5]. Numerous measures have been implemented that make beneficial use of the water guided by road infrastructure: floodwater spreaders from culverts, road drainage connected to nearby infiltration pits and storage ponds, and the conversion of borrow pits into minor reservoirs. The capacity of a roadside farm pond depends on the purpose for which water is needed and on the amount of inflow that can be expected in a given period. The seasonal water yield can be estimated using past historical weather data (i.e., mean annual, mean seasonal or certain probability-based rainfall, multiplied by a runoff coefficient, which is usually 0.1 to 0.3, as well as by catchment area). The implementation and funding of the measures were led by the regional bureaus of agriculture. Follow up and maintenance are carried out by the district (*woreda*) authorities in charge of agriculture and water harvesting.


*Figure 3. Check dam downstream of culvert retaining water and recharging hand-dug well (photo: K. Woldearegay).*

## Benefits of road water management

The positive impacts of road water management – increased water availability and access, reduced floodwater damage, and new livelihood opportunities – are typically noticeable after only one rainy season and multiply over the years. If water is captured at higher elevations, with reduced waterlogging in low depressions, crops will benefit from the extra amount of water during the rainy season, and the water harvested aboveground will permit supplemental irrigation during dry spells. Livestock will also benefit from the increased amount of drinking water in the ponds. Besides, groundwater recharge increases, raising groundwater levels and making it easier to extract the resource, even in times of drought.

The hydrological and socioeconomic impacts of integrated road water management have been monitored since 2015 at nine sites in Ethiopia. The data showed an increase of 1.2 to 2.0 m in groundwater levels during the dry period [5]. Soil moisture next to the road increased by up to 100% in some cases, and farm productivity increased by 35%, on average, for 129 farm households, as a result of increases in supplies of water for irrigation [5]. Besides, there was the important co-benefit of protecting the roads from erosion, flooding and sedimentation.

*Figure 4. Road crossing acting as a sand dam retaining water upstream in Kenya (photo: MetaMeta).*

## Opportunities for upscaling

Because of the magnitude of road building programs in developing countries, the scope for implementing the Roads for Water concept on a large scale is enormous. By 2050, there will be an estimated 2,883,905 million roads: 15% paved, 72% unpaved and 13% unknown [6]. To scale up the approach, a systematic introduction of the Roads for Water concept in infrastructure programs is needed, adjusting the design criteria, the budgeting systems and the maintenance arrangements. Implementation of the approach will require close cooperation between road authorities and those responsible for agricultural development, water resources management, disaster risk reduction and local government.

## References

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## Authors

Frank van Steenbergen[1], Marta Agujetas Perez[2] and Kifle Woldearegay[3]

[1] MetaMeta Research, The Netherlands; Email: fvansteenbergen@metameta.nl
[2] MetaMeta Research, The Netherlands
[3] Mekelle University, Mekelle, Ethiopia

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