

# New Roads for Resilience

Optimizing the Hydrological Potential of Roads





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## 1. Refined problem statement

“The flood went through the house, the family had to pack their belongings and run to a higher place until the flood subsided; now every night that there is rain, they need to be prepared to pack their belongings, take their animals and go out to an elevated place.”

“She also lacks the human and social capital that would enable her to restore the productivity of her land and irrigate

“Poorer households with low food security are proportionally more affected by floods than richer households who have more resources to rely on.”

“In Gira Aras, the increased run off from the road had a positive effect on the moisture of grazing land downstream, which had become greener.

The higher quantity of runoff had also increased the recharge of hand dug wells”

“The thin dust, which reduces the visibility to a few meters every time a car or truck passes, makes people sick and dirty, affects crops (especially during harvest time), and decreases the fertility of the fields.”



This problem statement was formulated following a stakeholder workshop <sup>2</sup> and core team meeting from 23-27 March 2015 in Mekelle and subsequent discussion with other organizations it concerns the optimization of the hydrological potential of roads so as to contribute to the ability of people, households, communities and systems to mitigate, adopt to, recover from and thrive in the face of shocks and stresses.

Droughts and floods, rising temperature and changing seasons in the Horn of Africa unsettle lives and rural economies in an area that hosts a large number of very vulnerable people. There have been the dramatic events such as the 2009 and 2011 droughts that affected an estimated 22 million people, but there are also many localized events and changes: local floods, gulying, disturbed micro-climates and droughts. Such local events are in many cases triggered by the development of new road infrastructure. New highways and feeder roads dramatically change water run-off patterns. Under current governance and practice this often has a negative impact on road side communities and reduces rather than improves their resilience.

In preceeding work done by the multi-sectoral team working on this project it was found that in 10 kilometre of roads in Ethiopia there are typically 13 problem spots: be it water logging caused by water being blocked by road alignments (4.5 locations), severe down-slope erosion from culverts (7.5) or road floods affecting houses and land (2). Another concern is the dust from unpaved roads, which affects health and crops yields (especially just before harvest time). A mood board of the impacts of roads, based on rural appraisal in Tigray is given at the start of this section.

Detailed socio-economic monitoring was done In two villages <sup>3</sup> along the newly constructed Freweign-Hawzen highway. In both villages crop yields went down after road construction in period 2012-2013 - see figure 1 for Sinqata village. Though 2013 was a year of good rainfall, the water run-off patterns were severely disturbed by the road: blocking water in some areas and causing concentrated floods in others. These floods caused damage to houses, inundated planted fields and created uncertainty.



*img. 2 erosion caused by road culvert - threatening the road itself*



*img. 3 farmers pointing out road induced flood level*

<sup>2</sup> In the workshop there were representatives from five states in Ethiopia (Tigray, Gambela, Afar, Amhara and Oromyia) as well as a delegation from the Ethiopian Road Authority).

<sup>3</sup> Sinqata and Gra Ares

## Yields qt/ha

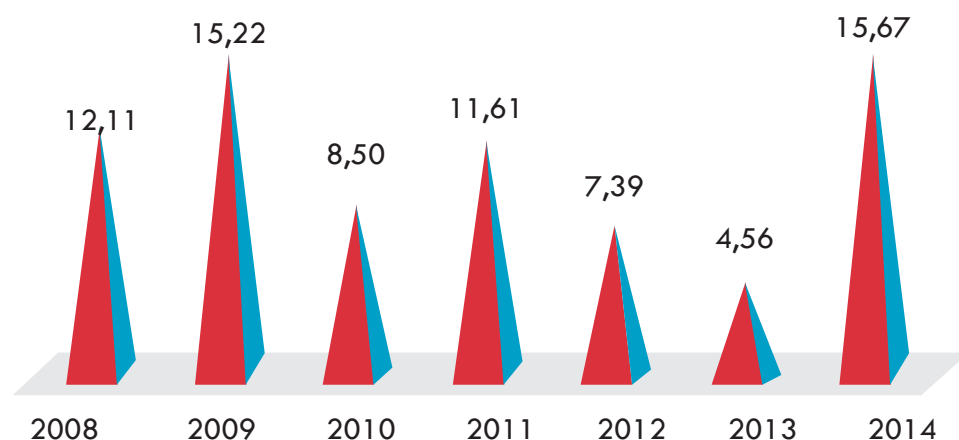


Figure 1: Yield (in quintal) per hectares in Sinqata before and just after the road construction in 2013.

The negative effect in these two villages came down heavily on the more vulnerable population groups. Female-headed households that make up 27% of the population in the two villages (in line with proportion in Tigray) were relatively more affected by the decline in crop yield than male-headed household. Figure 2 makes a comparison between the female and male headed households with regards to access to land, income, engagement in institutions, coping mechanisms and the impact of the road damage on their production. Female headed households in Sinqata and Gra Ares fell almost exclusively in the poorest category and hence make up half of the poor households. Their lands are on average smaller, they have fewer provision to deal with floodwater and are less well connected in local organisations. The damage because of uncontrolled flood from the road affected them as a proportion of their total income more. Their land was less well prepared and they relied more on emergency relief

Figure 2 Gender analysis of flooddamage for Sinqata and Gra Ares

Assets and Income	female headed households	male headed households
Land holding (ha)	0.63	0.84
Income from agriculture (ETB)	9532	13599
Income outside agriculture (ETB)	5672	6073

Access to institutions	female headed households	male headed households
Micro-credit (%)	57	72
Access to extension (%)	11	40
Member of formal/informal organization (%)	14	62

Adaptive and coping measures	female headed households	male headed households
Land preparation (%)	38	62
Selling assets (%)	14	13
Emergency aid (%)	34	5

Impact of road flooding	female headed households	male headed households
Average productive land (ha)	0.30	0.24
Households affected by water logging and siltation (%)	68	45
Income loss (ETB)	1089	1192

The Resilience Consortium aims to turn this around and create multi-functional “roads for resilience”. The construction of roads is the single largest and most widespread intervention in the different landscapes of the Horn of Africa. Run off water is massively affected by road construction with roads creating barriers in the topography, interfering with streams and drainage patterns and concentrating run-off in a limited number of points. This problem however can be turned into a solution by using roads to harvest and retain water. By fine-tuning investment (incl. maintenance) in roads and aligning it with watershed management activities, the hydrological potential of roads can be optimized. An example can be seen in figure 1, where the implementation of roadwater harvesting structures restored productivity in 2014 even though. This was a relatively low rainfall year. There are many road water harvesting options, including several low cost measures, that are currently unused but can contribute importantly to water security and reduce land scape degradation. In addition there are opportunities to harvest sand from the roads and to introduce dust-reducing roadside tree planting. All these would allow roadside communities to better absorb with shocks and stresses of weather events and transform them into opportunities.

The main reason for the link between roads and water not taking place at present is governance. At present road development is largely single-objective. The sole purpose of building roads is that of creating transport corridors. There is no cooperation with other stakeholders for instance in agriculture or water resources nor a culture or practice of consulting roadside communities. There is limited or no concern for the immediate environment of the roads. The designs and guidelines for road development do not take into account the possible beneficial use of water along roads, but are primarily concerned with safeguarding roads from water damage. Among road builders there is generally no consideration of the impact of roads on the environment immediately surrounding them.

To move from ‘roads that cause harm’ to ‘roads for resilience’ requires changes in the technology used, appreciation of the different contexts in which roads are developed; the introduction of consultative processes and importantly changes in governance. Governance needs to be multi-stakeholder and recognize the reduction of risk and the distribution of access to benefits. Gender is an important item: In Tigray female-headed households make up nearly 50% of the poor population: the gender bias hence ensures inclusivity. It requires sensitivity of the impact of different road water harvesting options for male and female livelihoods, better linkages to male/female roles in different socio-economic contexts, ensuring female representation in local consultation processes and consideration of special measures to engage and support female-headed households in better road water harvesting and other opportunities created by roads for resilience.

Figure 3 tries to show the transition from current practice to a vision of “roads for resilience”<sup>4</sup>. There is an important additional selling point to road authorities for the transition: the lack of integration between road development and water development ultimately affects the sustainability of roads as well. The current estimate for Ethiopia for instance is that 35% of all maintenance costs are caused by water-related damage<sup>5</sup> which in itself is related to the lack of water management on and around the roads.. On highways damage from water is, for instance, initially triggered by uncontrolled flooding from culverts. This is forming gullies that ultimate regress and affect the road body themselves. In low volume unpaved feeder roads the linkage is equally pronounced. These unpaved roads are constructed with low budget and extremely limited technical supervision. They in many instances are devoid often of basic drainage facilities (road cross drainage, side drains, short road slopes): this creates heavy erosion of road surfaces and sedimentation. It also foregoes the opportunity of turning unpaved feeder roads into water harvesting structures.

<sup>4</sup> The diagrams are based on the presentation in the Nairobi GRP workshop by CD Glin of Rockefeller Foundation.

<sup>5</sup> The figure may be higher if the landslides are taken into account – there are also water-related: in 80% of cases they are triggered by inadequate drainage in the larger area around the roads.



Figure 3 Transforming practise in road construction and maintenance



## 2. Theory of change and pathway to impact

The consortium intends to work on roads for resilience and optimizing the hydrological potential of roads – a topic that at present is not addressed at all-in spite of the considerable win-wins.

The philosophy is to bring on-board all the stakeholders who could be actors and create a joint endeavor with shared outputs. The different stakeholders have different but large complementary perspectives. For road authorities the safety of the road is paramount, but also the cost of the solutions, the reduction of local litigation and complaints and the challenge to reduce negative impact. For road-side communities there should be no damage farmland and property, engagement in design and planning and the opportunity to make use of water harvesting options. The interest of agricultural offices is largely similar: minimum damage to land and utilizing the opportunities for productive and consumptive use of water. For water resources organization there is the additional interest in reduced sedimentation and avoiding water contamination issues.

The ultimate aim is to transform the majority of roads in Sub Saharan Africa into multi-functional resilience carriers: reducing current insecurity of roadside communities and bringing down negative effects on landscapes, micro-climate and water availability. The aim is to change the negative into the positive by systematically including modifications to technical design and the joint planning of road water harvesting structures (reuse of borrow pits, water harvesting from culverts and side-drain, ford as sand-dams, spring capture, road water spreaders, road bodies as dam walls etc) placed within the different contexts (different landscapes, different climates, different economic systems).

The aim is to optimize the impact from roads by better road water use and considering additional activities (such as productive road side tree plantations and sand harvesting). Reducing risks of erosion and local flooding and developing better water storage alongside road can ultimately make 20 M road side dwellers<sup>6</sup> in the Horn of Africa less vulnerable to shocks and better able to deal and make use of unusual events – such as floods and droughts. A special consideration is that the new opportunities of road water harvesting contribute to fair sharing of the local resilience dividend within the roadside population, with special consideration of providing access to land and water and supporting the livelihoods of female-headed households.

The potential for upscaling of “water harvesting from roads” in Ethiopia, Kenya and the wider Horn of Africa is high. In the coming five years 70,000 km of new roads are planned to be constructed/improved, whereas existing roads are maintained and rehabilitated in the Horn of Africa. In whole Sub-Saharan Africa there is an estimated 5.5 million kilometres of roads. Of this, 2.36 million kilometres are located in dry lands, 1.57 million kilometres in range lands, and 0.80 million kilometres in cultivated areas (Kubbinga, 2012)<sup>7</sup>. In the Horn of Africa road development is the largest distributed investment in the region – affecting local communities in all areas. In Ethiopia 30% of the government development budget is dedicated to road development – ranging from low volume community built roads to new highways. The budget for new road development estimated yearly by IGAD is 4 Billion USD. In addition there is considerable investment in road repair and maintenance. These can also be used for adaptive measures, The challenge is to get the engagement of the main players.

<sup>6</sup> Living within 2 kilometer distance from the road, estimate.

<sup>7</sup> Kubbinga, B. (2012) Road Runoff Harvesting in the Drylands of Sub-Saharan Africa: Its Potential for Assisting Smallholder Farmers in Coping with Water Scarcity and Climate Change, Based on Case Studies in Eastern Province, Kenya, MSc thesis, Amsterdam: Vrije University

Amhara (Ethiopia) and Athi Basin/Makueni County (Kenya)<sup>8</sup> but at the same time start to engage in several other areas and prepare the ground for change there as well<sup>9</sup>. The engagement of other areas will follow the interest and presence of champions.

The ambition in Stage 3 is to create the systems to reach 3 million persons in roadside communities and give them access to larger resilience options, in particular better water harvesting. Ultimately in and beyond the Horn of Africa the innovations in road water harvesting, modified to different contexts (lowland plains, highlands; pastoralist, agriculturalist and fisheries; semi-arid, semi-humid) can reach a far larger proportion of people. Scaling up of the roads for resilience has three dimensions:

- to initiate the process of developing roads for resilience in an ever larger number of regions and socio-economic/bio-physical contexts and co-create new solutions governance wise and in terms of road-water designs, appropriate to the different locations and contexts
- to bring together/ share experiences and designs for road water management and associated features that are effective and efficient in terms of costs-benefits<sup>10</sup>, so that innovations will largely travel on their own as well as to better understand the requirement in different contexts (i.e. highland versus lowlands; pastoralist versus agricultural livelihood systems; different governance systems for different types of roads – low versus high volume roads)
- to safeguard the multi-stakeholders governance process and ensure access to benefits for most vulnerable women and men and appropriate improvement of livelihood systems.

There are reasons to believe that with a positive momentum uptake can be fast:

- the uptake of the program in Tigray in Ethiopia in 2014 was widespread and fast with pilots implemented in all 30 districts (woredas) – these are now being evaluated. Based on the lessons of the first batch the program can be consolidated;
- there are large institutional players in road building that can help create critical mass – road building authorities and financing organizations. These should be linked in through the learning alliance.
- The nature of the road building sector is that the introduction of good practices can be accelerated/supported by mechanisms such as the modification of guidelines, the development of standard designs and providing in-house training
- Many of the measures can be implemented at (below) zero net cost: they will reduce repair costs and at the same time create assets in water harvesting
- Success will depend very much on having a strong starting points: the project is fortunate to have the success of the 2014 Tigray campaign but also the response of the Ethiopian Road Authority (ERA) has been encouraging. ERA moreover has an increasing regional function providing support and training to roads authorities in East Africa Djibouti. Kenya, Somalia). This can be an important mechanism for scaling up. Similar response from other regions in Ethiopia in the stakeholder meeting was encouraging

*8 The geographical focus in Kenya has been changed due to the disturbances in the Tana Basin. The adjacent Athi basin is now chosen – with Makueni County as headquarter. The choice for Makueni County is related to the presence of strong proponents in the road and water sector.*

*9 There is interest from several other regions of Ethiopia: Afar, Gambela, Oromyia as well as from Uganda and Ruanda.*

*10 To be assessed under Value for Money monitoring.*





**20 million** roadside population in Horn of Africa more resilient: Better road water harvesting and other roads for resilience opportunities

**3 million** roadside population in the impact areas more resilient to floods and droughts with special attention to access and livelihoods of female headed households



Create **new road practice** on the ground consolidated in guidelines, designs, working procedures, and implementation.

Co-create roads for resilience solutions

Environment for sharing and co-owning

Build capacity and motivation

Generate evidence to feed practice

Short courses as repository

Monitoring and research

Learning alliance on "new roads"

Support to pilot activities

The Theory of Change is illustrated in figure 4. It aims to put new new road practice on the ground supported design, guidelines, improved governance, working procedures and implementation. It is based on co-creating the new knowledge and creating the stimulating environment to modify road building and water shed management practices by the main direct and indirect stakeholders. The "New Roads for Resilience" programme will stimulate the co-creation of roads for resilience solutions: the development and testing of designs appropriate to different areas and context; the practical multi-stakeholder and consultative governance arrangements to support this and the approaches to support access and designs that are gender-sensitive and supportive of female-headed households. It will:

- Support pilots and novel approaches – by encouraging an supporting different organizations to implement roads for resilience measures, in particular road water harvesting but also road side tree planting, by providing design support and incentives and contributions to start pilot activities
- Create an environment of sharing ideas and progress – motivating and mobilizing positive energy by all working on the set of important and do-able innovations
- Build capacity – by preparing and implementing a tailored short course, that acts as a repository for knowledge sharing but will also provide motivational events. The course material will also be placed in the public domain and the engagement of the educational network will be sought.
- Feed and guide the programs with the generation of evidence on different aspects to stimulate learning.
- Bring on-board all the stakeholders who will be actors in the implementation with clear tasks and responsibilities

Figure 4 theory of change

This will be supported by the implementation of a number of activities:

1. Development of learning alliance. The learning alliance for the program will bring together key stakeholders: implementing organization in the impact areas as well as those interested outside these immediate impact areas, knowledge institutes, community representatives, financial support organizations (donors, credit organizations) as well as specific networks for road development and water harvesting and educational networks. The learning alliance will discuss and design program activities, learn and share results. Importantly, the learning alliance members will be the joint owners and convenors of the innovations in road water harvesting, the ancillary techniques but also the governance and operational arrangement (in construction and maintenance). The mode of operation will be meetings, joint presentations, joint inspections, discussion of monitoring and documentation outcomes (all under shared logos) and ultimately – by key organization the development of joint guidance notes and implementation of improved practices. This will be facilitated by new and local media – a dedicated website and visual documentation. Within the learning alliance local partnership events can take place with research organizations, road authorities, agriculture and rural development bureaus, and water resources bureaus, local communities reviewing case studies with the help of the multi-disciplinary team
2. Development and sharing of short courses. A short course in the name of the Learning Alliance will contribute capacity development, but will also serve to introduce a common approach as well as serve as a repository of emerging knowledge and experiences. The courses as mentioned above when I planned can serve as energizing and motivational events, expanding the group of local champions. Envisaged is a three to five days course at this stage that apart from being provided within the Roads for Resilience program is available in the public domain ([www.roadswater.org](http://www.roadswater.org)) and will be shared through educational networks. Lectures will be taped and shared and can be supported by other educational activities.
3. Joint monitoring and research. This will first serve to explore the opportunities for introducing resilient roads through reconnaissance and participatory appraisal. This is also important to gather evidence on the impact of road construction as well as the value for money of road water harvesting and other measures – see also section 5. The monitoring as undertaken in 2014 needs to be continued – covering hydrological impacts, gender-disaggregated social impact and the effect on road damage or reduction thereof and the cost and benefit of the different interventions. In Tigray the existing monitoring arrangements can be continued whereas in other areas they can be introduced starting with reconnaissance visits and PRA meeting to understand the issues and their magnitude. There will also be a facility to do research – tailored to specific issues technical or social-governance related.
4. Support to pilot activities. This will take the shape of specific support – and can come in many shapes: documentation of current and improved practice, road engineering technical advice, special modelling and specific sessions and trainings.



### 3. Economic and social safeguards

Optimizing the beneficial hydrological potential of roads is an environmental and social impact mitigation strategy itself. The engagement of the project aims to turn this around the now recurrent negative effects of road building. At present road development creates environmental damage and for those next to the roads negative livelihood impacts. The systematic use of roads for water harvesting and greening provides a bundle of benefits for roadside communities and the environment.

Even so, there are several issues that need special attention when planning and implementing road water harvesting. According to the USAID Sector Environmental Guidelines<sup>11</sup> on Small Scale Construction (2014) areas of special concerns are: damage to sensitive or valuable ecosystems, compaction of the soil and grading of the site altering the local drainage patterns, contamination of ground and surface water supplies, sedimentation of surface waters, and spread of diseases. Since a new water source is developed, tension over water resources may arise between community members and would need to be handled. All these issues will be carefully assessed during an Initial Environmental Examination at an early stage, and prevention and mitigation measures will be developed. An overview of possible impacts and mitigation measures is given below. Note that these impacts mostly concern road building as it is currently practiced which could be better mitigated as part of the entire project. The two impacts in *italics* (contamination and safety ponds) are issues that arise particularly because of the more systematic use of roads for water harvesting.

Possible impact	Description	Likely mitigating measures
Damage to Sensitive and Valuable Ecosystems	Roads passing through sensitive areas causing direct damage or damage because of larger access	Promote ancillary measures (now generally absent) including community resource protection
Altered Drainage Patterns due to road construction and compaction	Flooding and erosion triggered by road construction	Turning these altered drainage patterns into opportunities for water harvesting
<i>Contamination of Ground and Surface Water Resources</i>	Around high volume roads polycarbons and oils may pollute adjacent water resources	Measuring these impacts (so far not significant in rural areas) and adjusting guidelines on road water harvesting accordingly
Sedimentation of surface Waters	Triggered by erosion and uncontrolled sediment transport in road drainage water (esp. in unpaved roads)	Watershed activities and special design of road drainage to trap and harvest coarse sediment
Spread of Diseases	Mosquito breeding from water logged areas	Special care for standing water bodies
Dust from unpaved low volume roads	Causing respiratory problems and affecting crop yields	Promote road side tree-planting and appropriate business models to sustain
<i>Safety of water ponds and converted borrow pits</i>	Risk of persons falling in deep ponds	Special care for protection of deep ponds, including proper landscaping
<i>Access to land and (harvested) water along the road</i>	No regulation for who obtains right to use the water from the roads bodies and drainage	Developing adequate social processes for this – with special emphasis for most vulnerable, including female headed households

table 1 Possible environmental issues

<sup>11</sup> [http://www.usaidgems.org/Documents/SectorGuidelines/SectorEnvironmentalGuidelines\\_Construction\\_2014.pdf](http://www.usaidgems.org/Documents/SectorGuidelines/SectorEnvironmentalGuidelines_Construction_2014.pdf)

## 4. Risk matrix and mitigation

The risks concerning the implementation of the GRP grant are given below. The risk matrix assess the impact of the on different activities on the planned program, the likelihood of the risk occurring and the mitigation measures

Risk	Impact	Likelihood	Mitigation measure
Concept of road water harvesting and roads for resilience will not click	High	Low (based on prior experience)	Emphasize the multiple benefits and win-wins, and connect the different stakeholders with the road authorities to give a face to negative and possible positive impacts
No buy-in from key stakeholder, i.e. government	High	Low (based on current experience)	Have key government organizations as part of core team, partner in joint exercise
Difficulty to move from concept (roads for resilience) to action on the ground (real adjustments), measures are too costly	Medium	Medium	Twin track approach – (1) adaptation to current roads with water harvesting structures (which is low cost) and (2) Transformation of road designs to incorporate water harvesting opportunities (more costly in general)
Difficult to introduce program in other areas	Medium	Low	Using positive examples from Tigray (and possibly Amhara) as starter. Emphasize benefits/ tangible solutions and start working in areas where there is strong entry point/ interest Already have positive feedback from other areas
Learning alliance will be loose and will go adrift	Medium	Medium	MoUs defining expectation. Plan regular meetings and exchange, also stimulate each Learning Alliance member to share outcomes and ideas and take joint credit for it
Disarray in coordination team	Medium	Low	Dedicated team managing the activities, observing standard administrative and financial rules, regular reporting and external communication,

table 2 Risk matrix



## 5. Measuring resilience

### Monitoring resilience

In the project measuring resilience and generating evidence on cost and impact as well on process is crucial and very much part of the research activities. It will provide the insights and arguments for the multi-functional development of roads as well guidance on the process: what works well, at what cost (see VFM), what is the likely benefit stream and how it is distributed, how do multi-stakeholder processes (including budgeting, planning, implementation supervision) work in developing roads for resilience. These insights will feed into the learning alliance, the capacity building and can provide the motivation and energy for stakeholders to engage in road for water harvesting activities.

Under the earlier research in Tigray hydrological monitoring was undertaken in ten road-side locations (groundwater levels, soil moisture, sediment loads), whereas participatory appraisals were under taken in six locations followed by (gender-disaggregated) socio-economic monitoring in two locations. These activities will be continued so as to build a long time series. Additional data may be collected on road damage and maintenance costs. The results will also be shared and validated by stakeholders, including the communities directly involved.

In new areas the same will be introduced, so as to set the base-line and better understand impact. In addition the images of Planet Labs will be used from 2016 onwards for measuring resilience especially at road-water crossings to assess impacts in before and after situations, besides better understanding what is happening.

This will be transferred in a set measurable indicators will be developed and assessed to understand and address resilience challenges.

### Value for money (VFM)

The assessment of VFM involves examining the economy, efficiency and effectiveness of the introducing 'roads for resilience'. This touches upon one important business argument: that the costs for the water harvesting and other measures are amply compensated for in the shape of reduced maintenance costs and other benefit streams (reduced erosion, reduced flood damage, productive/social value of harvested road water, other benefits<sup>12</sup> ).

Measuring VFM will concern both the specific road water harvesting measures and the costs of the more inclusive governance and community participation:

1. to measure cost and impact of different technical measures in different context and come with solutions that are cost effective and can be accommodated within existing budgeting systems.
2. to trace (at least qualitatively) the costs and benefits of more inclusive processes (coordination, communication engagement, of road development and maintenance.

Figure 5<sup>13</sup> gives the different important VFM key to be answered. Both technology and process aspects of value for money will feed in the different activities under the GRP grant (learning alliance, short term courses). They will also inform the upscaling so as to have a better idea of the costs of introducing roads for resilience concepts in areas and countries beyond the first 'batch'.

To capture the results of the 200 roads for water pilots undertaken in 2014 by communities and the Bureau of Agriculture and Rural Development, a joint monitoring by the three main government organizations involved in Tigray (Bureau of Construction Roads and Transport), Bureau of Agriculture and Rural Development and Bureau of Water Resources including an assessment of best performance. This learning will also contribute to the 2015/16 campaign in introducing road water harvesting in Tigray.

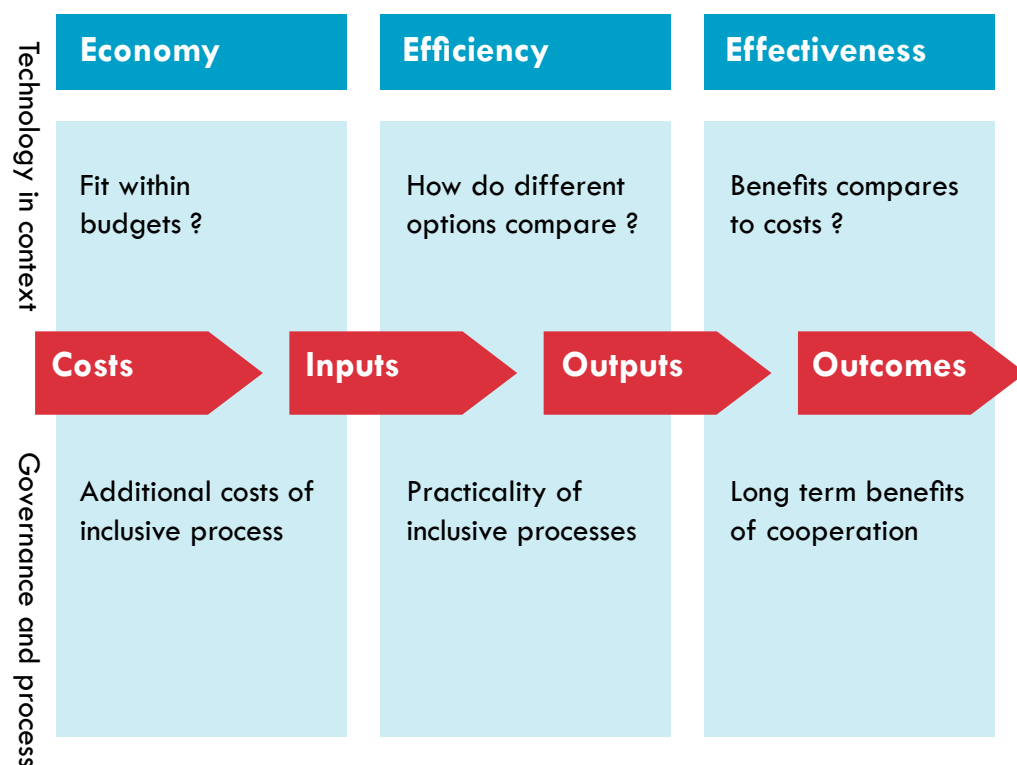


Figure 5 Value for money analysis

<sup>12</sup> Other benefits: reduced sedimentation, systematic harvesting of sands and gravel, reuse of excavation material, benefits related to roadside tree planting for instance

<sup>13</sup> Based on [http://r4d.dfid.gov.uk/pdf/outputs/mis\\_spc/60797\\_itad-vfm-report-dec10.pdf](http://r4d.dfid.gov.uk/pdf/outputs/mis_spc/60797_itad-vfm-report-dec10.pdf)

## 6. Updated plan

The activities of the Stage 2 are part of the pathway to impact. They were modestly refined in the core group discussion from 23-27 March 2015.

- Instead of three meetings have two larger core group/ stakeholder meetings (Mekelle and Mahouni) and in the meantime have members of the core team travel to impact regions (Amhara) and events (Regional Symposium on Water Harvesting), meet main stakeholders and discuss the program
- Inclusion of environmental scientist in core team, shift in staff time depending on availability
- Assignment for exploring interest in other regions (Gambela, Oromyia and Afar)
- Developing the first version of short course including recording of presentations
- Continuation of hydrological and socio-economic monitoring activities and assessment of impact of last years pilot activities



# Problem Analysis

On average in:



- Erosion and sedimentation: 7.5 locations
- Flooding of houses and land: 2 locations
- Persistent waterlogging: 4 locations
- Lost opportunity to capture water 4 M m<sup>3</sup>

