New Roads for Resilience

Connecting Roads, Water and Livelihoods

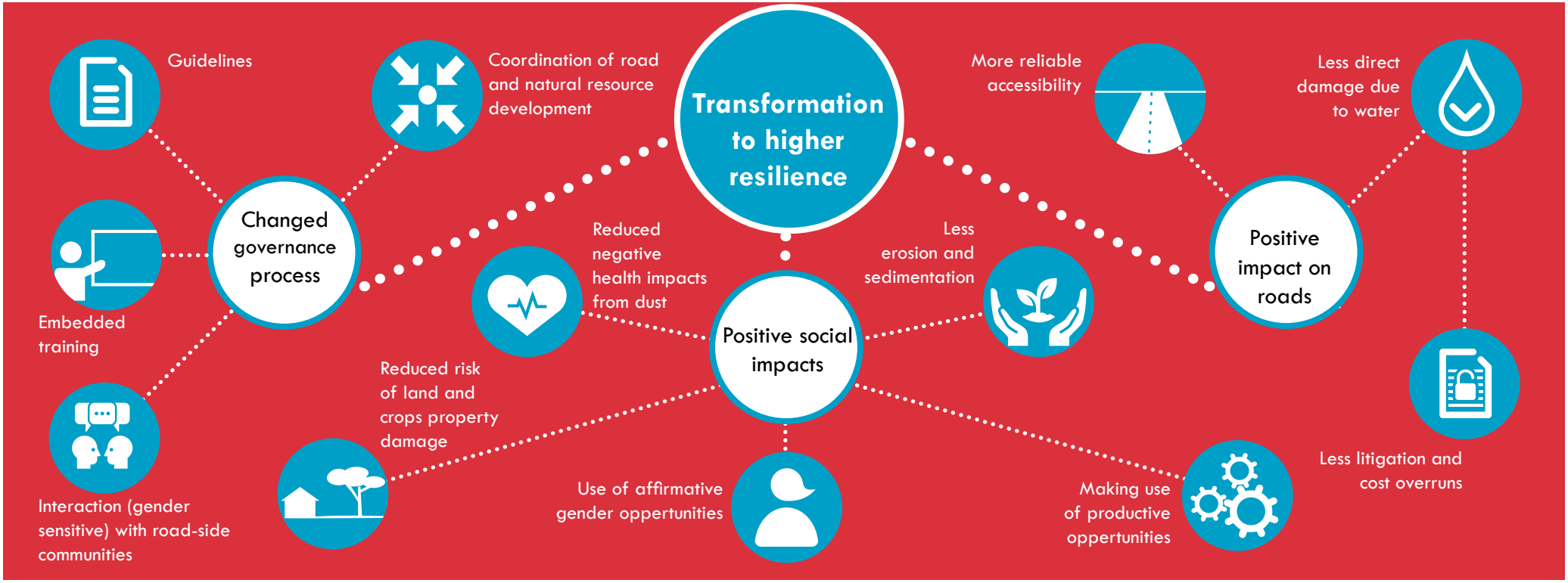
Solution Statement and Implementation Plan

GLOBAL RESILIENCE PARTNERSHIP

Solution Statement

3 million persons

Stage 3	Areas	Population
Impact areas	3	26 M pop.
Start up areas	3	36 M pop.
Transformation	Productive assets	Access and innovation



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Road water harvesting in Amhara El Nino Resilience Campaign 2015 (this photo and cover photo)

1. Project Data

Title:	New Roads for Resilience: Connecting Roads, Water and Livelihoods
Region:	Horn of Africa
Lead organization:	MetaMeta
Dates:	15 September 2015-14 September 2016

This Solution Statement and Solution Implementation Plan follow from the Problem Statement submitted to the GRP on 15 April 2015. The program wants to transform roads into instruments of resilience, to start with promoting harvesting water with roads. The response during Stage 2 has been more than encouraging – with significant support from important organizations, substantial interest from several geographical areas, bridges built with the road building community and importantly several scaling activities started.

With respect to the latter in Tigray Regional State the road water harvesting activities initiated in all districts in 2014 was extended into the June-July 2015 drought resilience campaign with the district offices doing their own assessment of the previous years activities so as to be better equipped for the coming years. In Amhara Regional State in Ethiopia (see cover) similarly road water harvesting was introduced in the El Nino resilience campaign in the eastern districts of the regional state. This mobilized respectively an estimated 0.75 million and 1.5 million people in these two regions and saw measures implemented in manifold places. A clip of the Amhara Campaign is here: http://thewaterchannel.tv/media-gallery/6204-amhara-climate-resilience-campaign. Also in the Stage 2 a communication campaign including a competition on road water harvesting was started by three local radio stations in Makueni in Kenya. Further a pilot on road side tree planting was started in Wukro, Ethiopia with St. Mary College. This rapid uptake gives confidence in the scaling up potential and the scope to innovate.

The composition of the team for the proposed Stage 3 of New Roads for Resilience is given next.

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2. Innovation and Impact Pathway

"Need your help to upscale my skills by giving access to training and capacity building"

"Newly designed roads should incorporate road water harvesting"

"Farmers should be trained on how to divert the road water to their farms"

"Nice to work out a manual for "water wise" road construction"

"We need further evaluation, investigation, monitoring and documentation of road water interventions"

"Need to create critical mass network of professionals through capacity building"

Background photo: Drift with vents closed in order to retain water

2. 1 Solution Statement and Impact Pathway

Roads have a major impact on the landscapes immediately surrounding them – determining the movement of water, sediment, dust and others. Roads have a particular important impact on rain run-off. De facto roads often act either as an embankment or as a drain/conveyance systems and thus bring major changes to the natural hydrology. These modifications now often have negative impacts: roads cause local floods and water logging along the way, whereas the more concentrated discharge from drains and culverts cause erosion and sedimentation. These negative impacts are related to the prevailing practice in road engineering to evacuate water away from the roads as soon as possible rather than making use of the water for beneficial purposes. All this undermines the resilience of roadside communities, who loose crops or property or suffer health effects from road dust. Case studies undertaken in Tigray in Ethiopia as part of Stage 2 activities indicate that the effects somehow come down harder on female headed-households.

This negative however can be turned into a positive and roads can be systematically used as instruments for water harvesting. This has been implemented in Tigray since 2014. It can generate substantial positive impacts: more secure water supply, better soil moisture, reduced erosion and respite from harmful damage. It leads to better returns to land and labour and a higher ability of people, households and communities to deal with and thrive in the face of shocks and stresses. With the investment in roads in many countries exceeding that of any other programme (in Ethiopia it is for instance 30% of the national budget), this is a large opportunity to improve the productive environment and increase the resilience of the population in the vicinity of the road.

Figure 1 gives an updated problem statement as well as solution statement, looking also at the four elements of resilience, i.e. knowledge, context, participation and governance and the present barriers and required transitions on all these fronts.

We want to introduce roads as resilience corridors by innovative designs and improved guidelines on harvesting water with roads with solution adjusting a wide array of context and a culture of innovation and learning created, with better consultation with road side communities inclusive of women and poorer members and multi-sector, multi-actor governance in place. We believe that roads as resilience corridors will make water available for productive and social use and create the basis for other livelihood opportunities, will reduce erosion, land loss and insecurity of those living along the roads, reduce road damage and sedimentation and in general will lead to a higher ability of people, households and communities to deal with and thrive in the face of shocks and stresses. The solutions should give special space to special gender dimension of the concerned transition: in design, in ensuring access of female headed household and women farmers have access to the captured water and moisture and in launching special related measures (see also 3.1).

There is the additional benefit that road water harvesting can also contribute to road longevity and safety. In Ethiopia water typically is the cause of 35% of the damage on paved roads and close to 80% on unpaved roads. Problematic drainage is the most common factor in construction delays. Yet better basic drainage on unpaved feeder roads for example will not only reduce damage and improve all-weather accessibility but it is also the basis to divert water to adjacent farm land or storage reservoirs. Similarly sedimentation from badly drained earthen roads or from road side gullies is a major contributor to sediment releases in catchment. This effects river aquatic life but also adds to the sediment load of rivers. The inconsiderate development of roads in the erosion hotspots in Blue Nile upper catchment in Ethiopia, could thus significantly reduce the life-span of the Grand Ethiopia Renaissance Dam that is currently under construction. The point to be made is that there is a compelling win-win situation in promoting collecting water with roads: many of the measures in fact come at negligible extra cost, on the strength that they preserve road infrastructure and other infrastructure.

The ultimate long term vision of success is to transform the majority of roads in Sub Saharan Africa but elsewhere too into multi-functional corridors for resilience: reducing current insecurity of roadside communities and bringing down negative effects on landscapes, micro-climate and water availability. Above all, the positive impact of road water harvesting in areas where it is introduced is significant (see also 2.5).The dream is that in 2025 in half of the countries in SSA (population wise) roads for resilience is in place with cross-overs to Asia as well. The vision moreover is to also use the momentum that is created, document on-going local innovation and

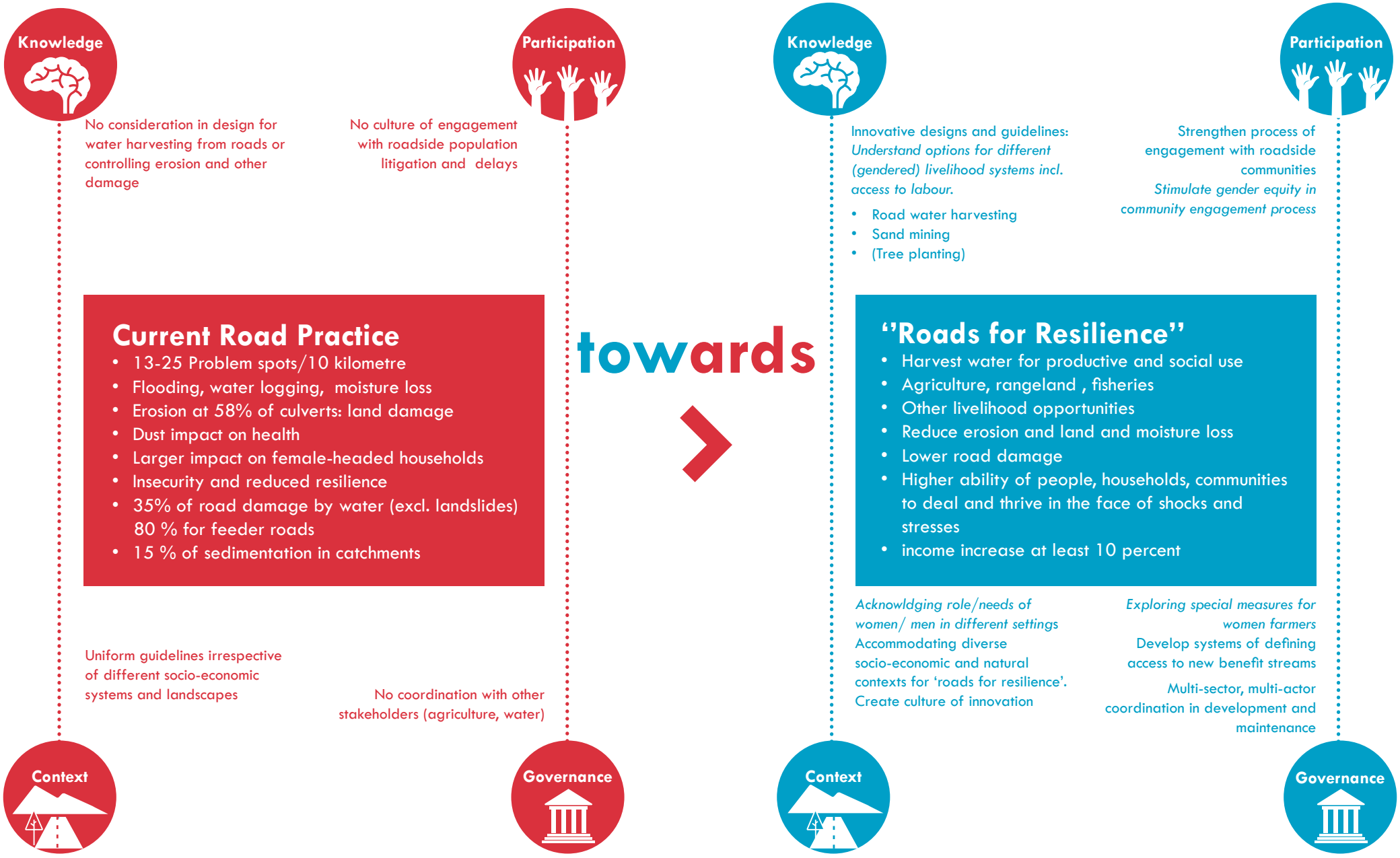


Figure 1 - Transforming a problem into a solution statement

engage with major organizations to introduce additional measures that promote diversity and equity that make better use of the opportunities created. Attached as annex 1, is a more elaborate note on a future vision of the road water harvesting approach.

The overall approach is to:

- Work with implementing organizations (next users) that have a large impact or outreach: road authorities, watershed programs, safety net programs, agriculture and water resources bureaus;
- Engage with educational and professional networks to mainstream the approach and identify more leaders
- Start working in selected impact areas in Ethiopia and Kenya, but at the same time open the door to new impact areas based on interest and identify supporting innovations and improvements that can be introduced in the medium term.

Borrow pits only source of stock water in Guna Mountain

2.2 Theory of change and pathway to impact

The Impact Pathway is given in figure 2. The central aim is to transform current road development practice (including governance, participation and techniques) and contribute to new approach in road development where roads are seen as an important part of the landscape and symbiotic interaction is created on the ground rather than the prevailing practice of removing water away from the roads without consideration of the consequences. This change will set the basis for the beneficial use of water harvested with roads to contribute significantly to resilience: the larger water security moreover is envisaged to catalyze wider change in rural production. Basic building blocks to come to the changed practice are:

- To co-create with the different implementing organizations solutions in 'roads for resilience' and to give recognition and exposure to the different efforts and solutions developed in different contexts and ensure that they are effective and promote equity (in terms of gender and vulnerable groups)
- To create a stimulating environment for sharing and co-owning by having a learning alliance.
- To build capacity and motivation – among others by a courses that are shared and constantly updated and acts as a repository of knowledge.
- To keep generate evidence and new insights to feed practice – from monitoring, documentation of experie nce and research.

With reference to figure 2 there are a number of main underlying activities to these building blocks:

1. Providing support to implementing organizations by internal review and discussion, supporting (in-house) monitoring (to feed into internal training) and documentation (to share) as well as recognizing best efforts (in learning alliance and communication and by engaging successful implementers in training and exchange programs).
2. Preparing guidelines to formalize road water harvesting practices and be the step towards formal changed governance and consultation as well as modified formal designs.
3. Create a learning alliance of implementers, researchers, funders – by regular messages and invitations to events, use of social media (twitter) and updating of website www.roadsforwater.org that contains news, open access training

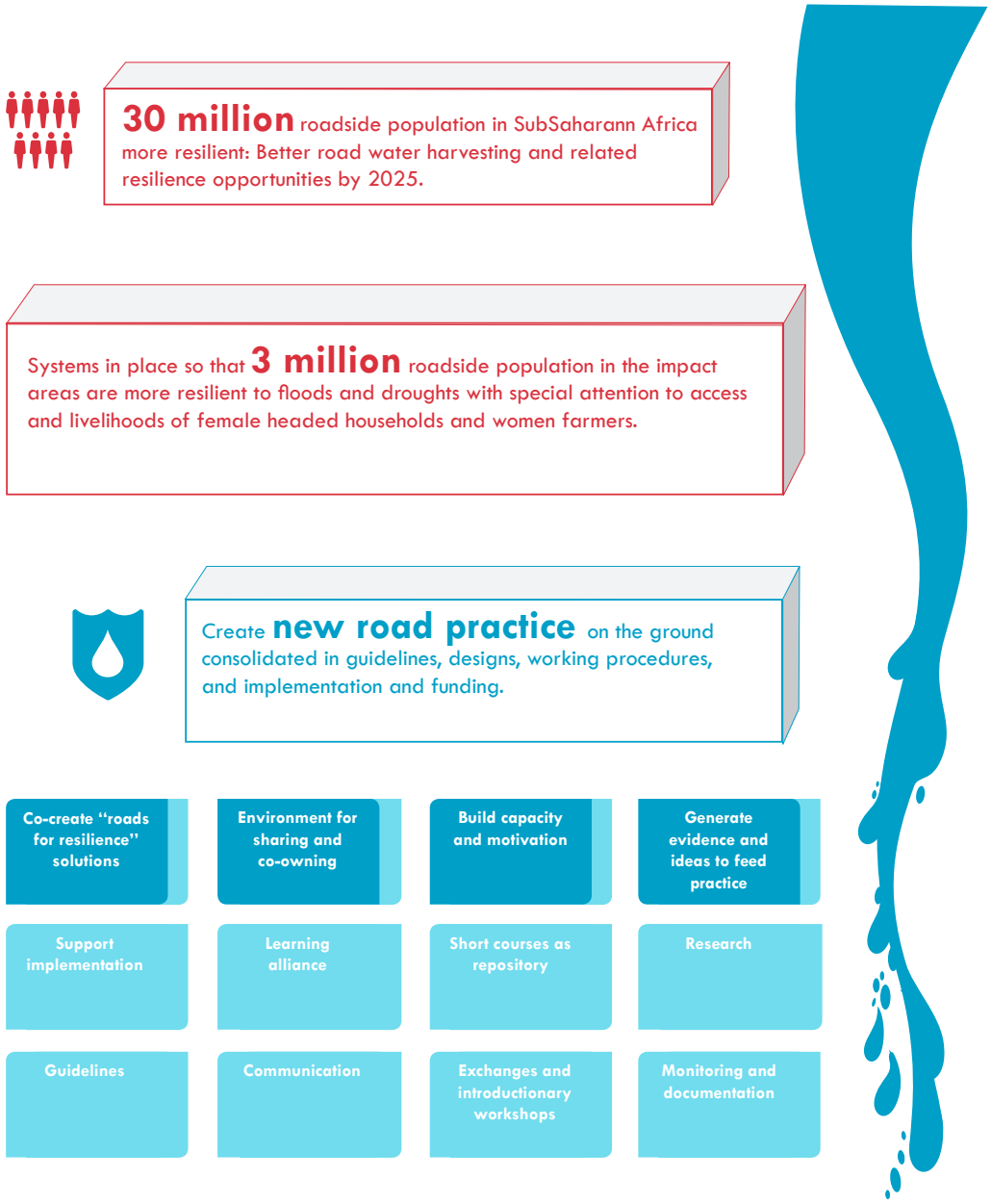


Figure 2: Pathway to impact

4. material, visual tools and source documents and serves to highlight special efforts.
5. Communication that is used strategically (emphasizing the contributions of – through seeking general publicity and publication in professional journal and audio visual including videos and webinars at www.thewaterchannel.tv and webinars with the International Road Federations, and other appropriate communication methods.
6. Having short courses and a guided learning program as a repository of knowledge, but also to provide practical guidance, ideas and confidence. These courses are shared widely in educational networks to expand outreach of the project.
7. Organizing exchanges and motivational workshops in selected new areas so as to introduce the roads for resilience concept in new areas.
8. Monitoring (see also section 2.7) to track progress, generate evidence on physical and socio-economic impact and the VFM and compare against environmental standards – and feed the learning alliance and others with this.
9. Undertake research in different social and technical aspects, with engagement of young recent graduates as capacity building for the future generation. The research results will contribute to the guidelines and training and other activities.

A closely related activity will be to work with funding agencies – for infrastructure or climate change adaptation - to explore the possibility of in-building road water harvesting into road (and railway) investments with the arguments of infrastructure longevity/safety, climate change adaptation, and creating resilience.

2.3 Innovation and impact

For the road water harvesting activities promoted under this project the consortium core was awarded the **Global Road Achievement Award of the International Roads Federation in June 2015 in the category Environmental Mitigation** (www.irfnews.org).

The stage 3 project is expected to create the systems to serve 3 million road side population[1] with a positive bias towards women farmers and vulnerable groups by improving their access to the beneficial use of water generated with roads and/or reduce the risk of damage to their crops, land or property. The targets are based on the planned large scale activities in the three impact areas (Tigray and Amhara regions in Ethiopia, and Makeuni in Kenya) that have been agreed with the implementing organizations for 2015/2016 (see table in section 2.5). Large part of the impact (estimated at 60%) will be immediate as it will result from the watershed campaigns and road water harvesting component planned to be part of this in this period and that will cover two entire regional states in Ethiopia.

Added is the medium term impact. Guidelines on Road Water Harvesting will be prepared with the Ethiopian Roads Authority (with annual budget of USD 1.3 B) as well as with Productivity Safety Net Program in Ethiopia (with annual expenditure of USD 200 M used for a fine-grained network of often low quality village roads) – backed up by training and guided learning. In Kenya similarly guidelines will be discussed and modification in the budget system is to be experimented with consisting of a mark-up to road budgets so as to allow water harvesting measures to be included in road building and maintenance programs. There is also the long term effect of engaging the professional road building network (the International Road Federation) and different important water educational networks to disseminate the approach and skill set. Moreover, in stage 3 a start will be made to introduce the roads for resilience in other geographical areas – most likely Oromya and Gambela Regional States in Ethiopia and Uganda and/or Tanzania.

The new practices to be introduced concern both new governance arrangements, better connection with roads side communities and a range of road water harvesting techniques. Figure 3 showcases some of these techniques: some adapting to the presence of the roads and the changed hydrology, and others going further and adjusting the design of the road and related structures to the potential for harvesting water. What matters is that in every context (landscape, climate, economic and social system) the specific best solutions are developed – it is not only a matter of introducing innovation but also supporting a culture of innovating and making use of local opportunities. The techniques moreover have to balance the impact on hydrology and safeguarding the safety of the road bodies. The innovations moreover do not stop with for water capture: there are several other innovations that can be explored in due time – road-side tree planting, sand harvesting, managing wildlife and even controlling rodents – see annex 1.

As important as road water harvesting techniques are the innovations in stakeholder engagement and in governance – more coordination with other organizations and a structured and gender-sensitive interaction with roadside communities. Examples of such arrangements discussed so far are: different contracting procedures for making borrow pits; budget mark-ups for road water harvesting to regular road construction budgets; coordination committees to align watershed management and road building activities; farmer concessions for road water diversion and maintenance of unpaved roads.

Figure 5 present the result of the impact of road water harvesting based on socio-economic survey and bio-physical monitoring in respectively two and five locations in Tigray, where road water harvesting activities were introduced in 2014. There has – in the two locations where the socio-economic survey was undertaken been a significant change in agricultural productivity. In the concerned area the reduced yields because of road side flooding were turned around after this water was used for recharging the large number of wells. Similarly in the five study areas the different road water harvesting intervention resulted in a strong improvement in soil moisture and groundwater tables.

It is believed that there are a number of reasons why the roads for resilience measures can be up scaled relatively rapidly:

- Road development is increasingly rapid in Sub Saharan Africa with 70,000 kilometres of new roads being built annually and the budget

1 Living within 2 km from a road

Adapting to the road

Adjusting the road

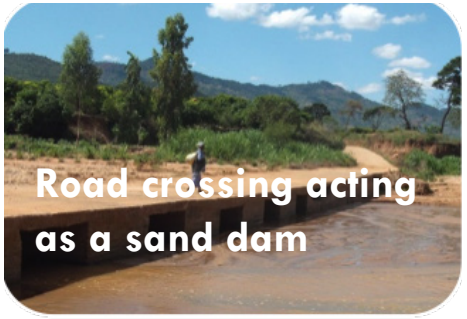


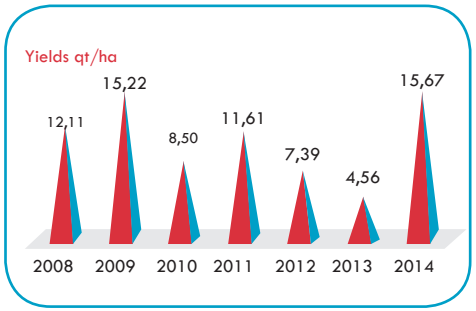
Figure 3 - Examples of collecting water with roads from different countries

on road building for the Horn of Africa at USD 4 B with road development is the largest distributed investment in the region. There is also a sense of urgency to make sure to incorporate the resilience measures from the start in the road-building program and prevent resource degradation and ensure the sustainability of the roads.

- There are large institutional players in road building that can help create critical mass – road authorities – with mechanisms in place to introduce good practices such as the modification of guidelines, the development of standard designs and providing in-house training. The recognition for the novel approach that came with the Global Road Achievement Award 2015 is helpful.
- The interventions come in the different levels of complexity, but many interventions are easy to implement, requiring mainly labour – the threshold to start is low.
- There is additional scope to accelerate, if a link can be made between infrastructure funds, water resources development, watershed programs, and climate financing for additional road water harvesting measures.

There is also the Value for Money (VFM) argument. In the table below points relating to the four aspects of VFM are summarized. In general the cost of not doing is likely to be more than the additional investment in road water harvesting. It is important however to quantify this and to collect evidence. As part of the monitoring (see 2.9) a number of VFM indicators will be measured and analysed. i.e.:

- Cost of road water harvesting program compared to cost of maintenance and depreciation (efficiency)
- Effect of participation on construction progress (effectiveness)
- Differentiated impact of different technologies on women and the poor (equity).



Yields (in quintal) per hectares in Sinqata before and just after the road construction in 2013


Checkdams downstream of culvert: 2 m GW level increase


Percolation pits along road: 20% soil moisture increase


Diverting water into farmland: 30 - 100% soil moisture increase


Water from culvert to trenches: 30% soil moisture increase


Borrow pit used as pond: 1 - 2 m GW level increase

figure 4 - Results of monitoring road water harvesting Tigray 2013-2015

Economy		Efficiency	
Technology in context	Governance and process	Technology in context	Governance and process
- Range of options, starting from low threshold	- Costs of meetings and structured stakeholder dialogue are not insurmountable	- Additional costs very low compared to overall construction and maintenance costs	- Alternative of no coordination and engagement leads to litigation, bad relations and delays
Effectiveness		**Equity**	
Technology in context	Governance and process	Technology in context	Governance and process
- Cost effective way of water harvesting - Most cost-effective way for achieving climate resilience for roads	- Cost of governance less than costs of additional maintenance and construction delays	- Technology can be selected and promoted on inclusiveness and equity and scope for affirmative action	- Structured stakeholder engagement provides opportunity for empowerment of women/ poor

table 1: The Four E's of Value for Money as they apply to governance and technology aspects of road water harvesting

2.4 Outcomes

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 and respite from flooding, water logging and erosion. We expect that this will at least increase their income from farming with 10% compared to the situation prior to the road water harvesting measures and that it will reduce property loss and damage during high seasonal rainfall events also compared to the situation before the intervention.

The Theory of Change and Pathway to Impact (section 2.1 and 2.2) described the causal relationship to come from the project activities and inputs to this intermediate and ultimate outcome (see also the Logical Framework). The expected change for different stakeholder groups is given in table 2.

	Expected change	Support from project
Road authorities (including safety net program)	Road water harvesting included as central concerns – as captured in Guidelines Closer cooperation with other sectors and road side communities – including defining (gender-sensitive) access Reconsidering changes to designs and procedures – including innovative design Develop capacity to include this additional	Development of Guidelines Short Courses and Guided Learning Support to Implementation Learning alliance Communication Research and documentation Monitoring Coordinate and support experience sharing visits
Agricultural department (including NGO allied to it)	More and systematic attention to promote the potential of road water harvesting in programs under implementation Innovation in new techniques and follow-on use of water from female and male farmers Develop internal capacity to learn and integrate lessons on road water harvesting Include access issues	Support to implementation Short Courses and Guided Learning Monitoring Learning alliance Communication Research Coordinate and support experience sharing
Water departments	Support the process of integrating road development and water resources management Develop new techniques and practices	Short Courses and Guided Learning Monitoring Learning alliance Communication Research Coordinate and support experience sharing
Farmers/ road side communties	Engagement in planning and implementation of road development and watershed activities Initiate farm level measures of collecting water with roads	Short Courses (farmer leaders) Learning alliance Communication and experience sharing
Others – outreach partners and interested implementers	Make a start with considering road water harvesting in different programs Contribute ideas and knowledge Consider (climate) financing mechanism for roads for resilience Integrate in educational programs	Learning alliance – access to ongoing evidence Exchanges and Introduction workshops

table 2: Expected change from the project on main stakeholder groups

2.5 Next users and next use

In figure 5 a map of current and envisaged future stakeholder relations is drawn up. At present there is no or limited linkage and no innovation, systematic use of road water or quality standards to prevent degradation. This can change with more coordination and new perspectives.

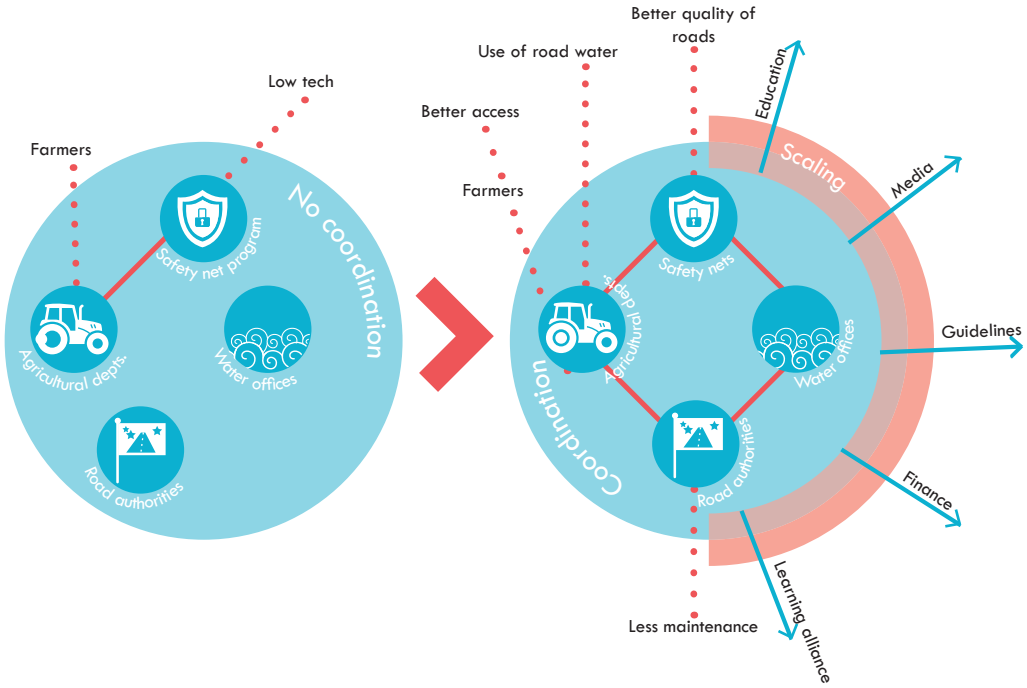


Figure 5 - Current and envisaged stakeholder relations

There are three important categories of next users in the project.

The first group of next users are the implementing organizations in the selected impact areas, in particular Tigray Regional State (Ethiopia) represented by the Bureau of Agriculture and Rural Development, and Bureau of Construction Roads and Transport; Amhara Regional State (Ethiopia) represented by Bureau of Agricultural and Rural Development, and Roads Authority and the Makueni County Government (Kenya) as well as main stakeholders at national level: Ethiopian Roads Authority (Ethiopia), the Productive Safety Net Program (Ethiopia) and the Kenyan Rural Roads Authority (Kenya). All these organizations command considerable clout. With these implementing organizations agreements have been reached on the scope of engagement, in several cases confirmed in support letters and MoUs. These MoUs and support letters are given in Annex 2. Table # is an leverage table that indicates the agreed remit of the different partners under the project, the barriers and incentive and the support provided.

The second group of next users are outreach partners. The program will be working with media, professional networks and educational networks. In addition agreement has been reached with educational networks working in Ethiopia (University Water Sector Partnership), East Africa (Uniwatered and Afhrinet) and globally Cap-Net. This is to make the material available, help mainstream the combination of water development, road development and resilience in education. It may also help to cast the net wide and have new leaders that work on roads and resilience. As a first test UNESCO-IHE that caters for MSc education of 200 students will incorporate the material on road water harvesting in the MSc Programme in Land and Water Development for Food Security. The before-mentioned outreach partners span a large part of the water sector, but agreement has also been reached with the International Roads Federation (IRF) to organize training sessions around major regional and global events, a membership webinar and undertake joint certified training. The engagement of the educational networks and the IRF will help to ensure sustainability and scaling up. Working with media is important with contacts established with The Guardian and agreement to contribute article to different professional journals and webinars to be given with the IRF and TheWaterChannel.

Thirdly, next users concern key implementing organization outside the impact areas. There has been considerable interest in road water harvesting in the past four

Box 1
As a trial the program in Stage 2 worked with three local language radio stations in Makueni (Mbaitu, County and Athiani) to broadcast good farmer practice and have expert views. The three radio station broadcast a competition for the best farmer road water harvester in Makueni County.

table 3: Leverage table >

Core area implementing partners	Leverage	Incentives and barriers	Agreed activities	Specific support	Basis of cooperation –see annex 2
Tigray Bureau of Agriculture and Rural Development	Region-wide soil water conservation program 1.2 M people engaged	Road water harvesting is addition to current watershed management activities	Road water harvesting in 2015/2016 campaigns and in the new five year plan	Self monitoring, documentation and award of best practice, training, serve as best practice area, pilot on road side tree planting	MoU
Tigray Bureau of Construction, Road and Transport	> 7,000 km of low volume roads	Reduce damage to roads and contribute to water security	Coordinating Universal Road Program with watershed activities	Training and documentation, resource for guidelines	Earlier agreement
Amhara Bureau of Agriculture	Region-wide soil water conservation program 5 M people engaged	Road water harvesting is addition to current watershed management activities	Road water harvesting in 2015/2016 campaign, tree planting campaign	Monitoring, self documentation and award of best practice, training, serve as best practice area, pilot on road side tree planting by women groups	MoU
Ethiopian Roads Authority	USD 1.3 B annual budget – projected to increase > 100,000 km road network	Wants to make positive contribution to water security but safeguard safety of road bodies. Has leading role in innovation in the region.	Prepare guidelines – then review designs and procedures. Facilitate training and pilots.	Support guidelines, joint training events, joint research	MoU
Productive Safety Net Program (Ethiopia)	US$ 200 M annually on new village roads 7-8 M rural Ethiopians	Addressing sometimes problematic quality of roads component	Prepare guidelines and organize training	Support development of guidelines on village roads and set up Guided Learning	Correspondence
KeRRA	Road network 177,800 km 10,000 km built during 2014-2017 (USD 3 B)	Wants to build on earlier experience with innovative drift designs	Include road water harvesting – including pilot on budgeting	Support to guidelines, training, research	MoU forwarded
Makueni County Government	Population: approx. 900.000 (2009) > 3,200 Km roads	Wants to accelerate spending after year of delay.	Include road water harvesting in current budget	Support in shape of training and workshops,	MoU
ICRAF	CGIAR Centre on Agroforestry incl. Water Harvesting	Interested to join forces and touch policy level.	Road water harvesting in Makueni under DRYDEV program	Coordination of activities at governance and field level	Letter of support

Education and outreach partners					
International Road Federation	16,000 recipients of newsletter Representatives in 120 countries worldwide	Recognizes the importance of new road concepts esp. for members in developing countries	Webinars and joint certified training	Webinars and joint training, workshops at main meeting	Letter of support
IGAD	Intergovernmental Authority for the Horn of Africa Facilitated Regional Water Policy	Interested to play a role in regional initiatives following its on going work in water management	Explore joint programs	Joint training and debate at policy level	Correspondence
Cap-Net	23 educational networks in 4 continents	Provide educational network with new and relevant material	Introduction of material in educational network - explore training of trainers	Update and make training material available	Letter of support
Afhrinet	4 country partners in SSA Ethiopia, Kenya, Mozambique,	Wants to build up active centres	Introduction in educational centres and book publication	Explore guided learning with educational centres	Letter of support
Uniwatered	4 host universities in Kenya, Tanzania, Nigeria and Canada	Improve quality and relevance of university education in water	Introduction of material in educational network	Update and make training material available, share research	Letter of support
University Water Sector Partnership	8 partner universities in Ethiopia	Building on earlier work on integrated basin management and irrigation	Introduction of material in educational network	Update and make training material available, share research	Long term partner
New area implementation partners					
Oromiya Roads Authority	Carry out road development > 50,000 km rural roads	Interest to make positive use of roads and avoid damage through erosion	Support to research activities, promotion of the approach and disseminating outcomes	Training and program development	Letter of support
Gambella Regional State Water Resources Bureau	Water resources management	Realization that borrow pits for instance	Support to research activities, promotion of the approach and disseminating outcomes	Training and program development	Letter of support
Uganda Ministry of Water and Environment	Setting national policies and standards and initiating water resources and water supply projects	Realization that roads are cause of considerable landscape damage	Integrated in own operation and provide links to road programs	Training and program development	Letter of support
IFAD – international	Design and implementation of over 240 projects in approx. 100 countries	Interested to redefine road investment in context of climate change adaptation	Discuss opportunities for integrating and identify selected projects (Tanzania, Uganda, Botswana) as 'Pathways to Impact'	Identify projects as pathway to impact and prepare proposals	Letter of support under preparation
RAIN Foundation	Knowledge network on rain water harvesting for food security	Looking to expand the range of options with	Provide links to water harvesting organizations	Sharing material and outcomes within their network	Long-term partner
Rwanda Environmental Conservation Organization (RECOR)	Environmental NGO working with 10 partners including Ministry of Natural Resources		Facilitate documentation of practices and research activities	Sharing material	Letter of support

months, also spurred by the development of the learning alliance, various media messages and the news that came with the Global Road Achievement Award. There has been very clear interest from different regions – in particular Oromia Regional State in Ethiopia, Gambela Regional State in Ethiopia, Uganda and Ruanda (with letters of Interest in annex 2) as well as several other areas (Ghana, India, Tanzania). It is planned to make an introduction in at least four of these areas.

Apart from the direct engagement in specific activities with the next users, the next users will also be part of a Learning Alliance – the start of which was made in Stage 2 (it has 160 members now). The Learning Alliance will also incorporate other persons that are interested. It will serve to disseminate material and experience as well as collect feedback and new examples Figure 6 shows the learning alliance, as envisaged:.

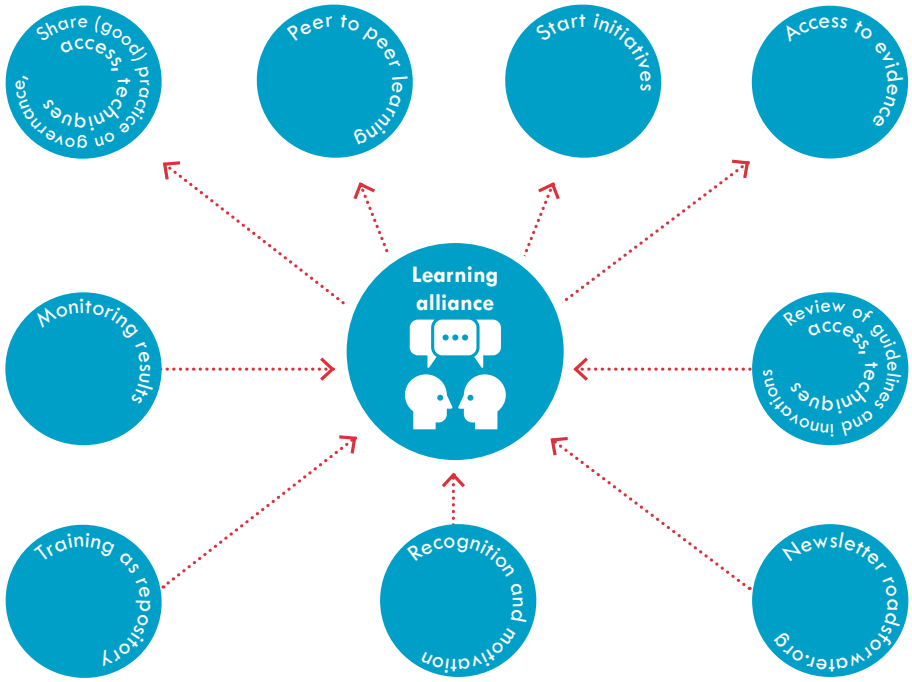


Figure 6 - Learning alliance

2.6 Outputs

The programme in the Stage 3 will deliver different outputs for uptake by next users, and these outputs will also be made available in the public domain. (on www.roadsforwater.org) The following outputs are foreseen in Stage 3.

Data and research	Monitoring data (hydrological impact, socio-economic impact, VFM) Research on specific topics by recent graduates, such as:
Training	Short course package – including taped presentations – for one week course Guided learning package on roads water harvesting for field staff/engineers
Communication	www.roadsforwater.org newsletters for learning alliance video four professional publications - Civil Engineer (outreach 60,000), - World Water: Stormwater Management (outreach 23,400), - Farming Matters (outreach 9,000) - Highway News (outreach 16,000) two popular publications contribution to standard book on Rainwater Harvesting, Irrigation and Resilience
Guidelines	Guidelines on Road Water Harvesting Contribution to Safety Net Program Guidelines to incorporate road water harvesting

Table 4 - "Tangible" outputs

2.7 Work plan and Timeline

The Solution Statement and Solution Implementation Plan are based training/ workshop sin Mekelle (22-27 March), Woreta (9-10 May), Dire Dawa (10-11 June) and Kibwezi (22-25 June), smaller meeting, fact-finding and additional monitoring.

The activities selected derive from the Pathway to Impact (section 2.2) and are clustered in the following groups:

(1) Support to implementing organizations
The program will work closely with implementing organizations (see 2.5) – such as the Tigray Government, Amhara Government and Makueni Government, who all have committed substantial resources to implement road water harvesting program. The program will provide training, encourage monitoring by the implementers, document and distil good practices. The program will also work together to develop special packages – especially measures that promote equity and agricultural development

(2) Prepare guidelines
The program will work with the Ethiopian Roads Authority, the Productive Safety Net Program and the Kenyan Rural Roads Authority, all commanding substantial budgets, to prepare Guidelines on Road Water Harvesting – to next be translated into revised designs and working procedures. A joint team of the Ethiopian Roads Authority and the Roads for Resilience Team has been formed and the draft content of the Guidelines has been agreed (see annex 6). The preparation of the Guidelines involve expert meetings with the regions, so as to make a strong connection with on-going practices and experiences.

(3) Develop learning alliance and communication
The different stakeholders will be connected through a learning alliance. The alliance will share experiences and discuss results (see figure 6). A start with more than 150 members has been made. The learning alliance will be supported by roadsforwater. org and regular newsflashes and access to training and the video to be made. Communication will be used to bind the stakeholders together and give credit to path-breaking initiatives and also use of general interest and specialist media. The program will also prepare a Guided Learning on Road Water Harvesting Package aimed particularly at field workers that have often little guidance and no coaching as in the PSNP. The short course (that will be further developed) and the guided learning will be disseminated through many educational networks and certified training with the International Road Federation.

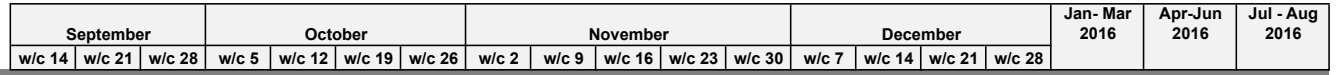
(4) Short courses, exchanges and introduction workshops
The flagship will be the short course developed at Mekelle University, serving people from the region as a repository of evolving practice. Abridged version of the training including field visits and exchanges will be given in the current and in selected future impact areas and in IRF meetings so as to identify and equip new champions.

(5) Monitoring, research and documentation
The monitoring activities to track progress assess impact in resilience and establish VFM as described in more detail in section 2.9. A research program especially for recent graduates and BSc and MSc students will be started on practical governance and technical aspects. If additional resources are available an additional program on managing road dust is proposed (see annex 4).

The timing of activities is given in Gantt chart of table 4 Priorities in the start of Stage 3 are mobilization and completion of an IEE, engaging with the large scale implementation programs that will undertake their activities (at least in Ethiopia) in the lean season for agriculture (January/ February), prepare communication material and get base line data collection on-going. Annex 3a gives a further detail of the workplan.

Project name: New Roads for Resilience: Connecting Roads, Water and Livelihoods

Gantt chart



Task	Responsible	Status
1. Mobilisation , planning and coordination		
1.1 Mobilisation	Frank van Steenbergen	
1.2 Coordination and reporting	Marta Agujetas	
1.3 Supervision	Kifle/ van Steenbergen	
1.4 Forward planning	Frank van Steenbergen	
2. Initial Environment Examination (IEE)		
2.1 Prepare IEE	Marta Agujetas	
2.2 Plan additional measures after review	Marta Agujetas	
3. Support to implementation		
3.1 Review and training sessions	Kifle/ van Steenbergen	
3.2 Develop special gender programs	Likie Nigussie	
3.3 Discuss financial packages	Frank van Steenbergen	
3.4 Identify additional measures	Getachew/ Haftu	
4. Prepare guidelines		
4.1 Coordinate ERA Guidelines	Taye Alemayehu	
4.2 Assist ERA Guidelines	Consultants	
4.3 Prepare PSNP Guidelines	Taye Alemayehu	
4.4 Regional and national meetings	Assefa Kumsa	
4.5 Assist in KERRA Guidelines	Benson Masila	
5. Learning alliance and communication		
5.1 Social media, www and newsletter	Lenneke Knoop	
5.2 Prepara video	Lenneke Knoop	
5.3 Prepare Guided Learning package	Ian Neal	
5.4 Coaching Guided Learning	Likie Nigussie	
5.5 Cooperate with educational networks	Lenneke Knoop	
5.6 Special campaigns	Erik Nissen Petersen	
6. Short courses, exchanges and introductionary workshop		
6.1 Workshop at IRF global/ regional meeting	Frank van Steenbergen	
6.2 Review workshop Tigray program	Berhane Grum	
6.3 Review workshop Amhara program	Kifle Woldearegay	
6.4 Workshops/ training Makueni	Benson Masila	
6.5 Workshops Oromya	Assefa Kumsa	
6.6 Workshops Gambela	Taye Alemayehu	
6.8 Workshop Tanzania	Frank van Steenbergen	
6.8 Workshop Uganda	Ian Neal	
6.9 Governnance workshops	Taye Alemayehu/Masila	
6.10 Short term course Mekelle	Kifle Woldearegay	
7. Monitoring, research and documentation		
7.1 Design research program/ call	Kifle/ van Steenbergen	
7.2 Evaluate research	Kifle Wolderegay	
7.3 Coaching graduate research Ethiopia	Berhane Grum	
7.4 Coaching graduate research Kenya	Nathon Musimba	
7.5 Consolidate physical monitoring Ethiopia	Kifle Wolderegay	
7.6 Consolidate socio-ec monitoring Ethiopia	Kebede Manjur	
7.7 Set up/ implement monitoring Amhara	Kifle Wolderegay	

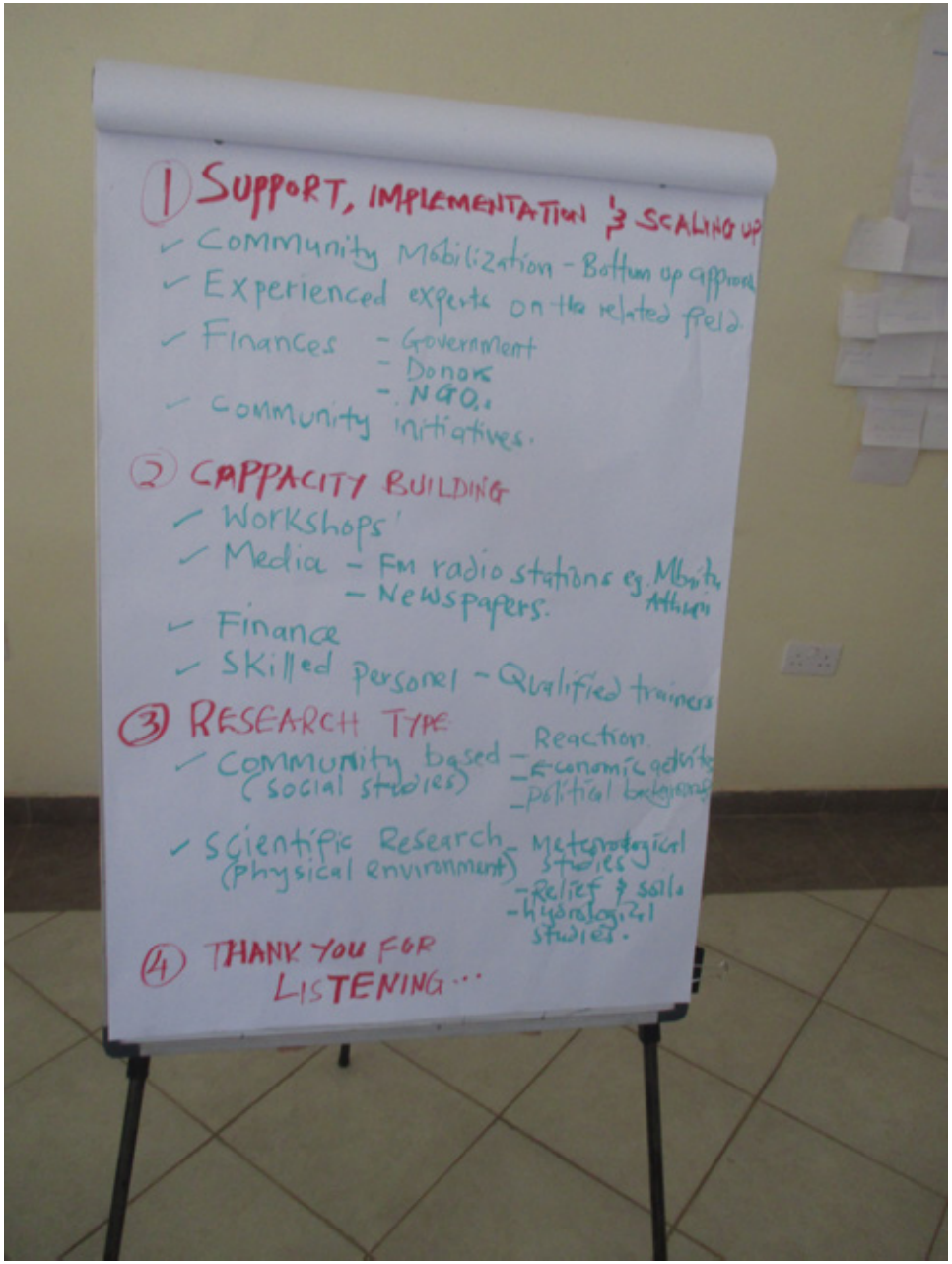
table 4 - Gantt chart

2.8 Questions to be answered

In trying to introduce the practice of collecting water with roads the following questions will be answered:

- What governance mechanisms work to better connect roads and water for resilience– in terms of budgeting, contracting, coordination mechanisms and maintenance systems?
- How to engage roadside communities, during planning, road development and maintenance and how to ensure that the interests of women farmers and vulnerable groups are safeguarded?
- What are appropriate techniques and how can they be scaled up in different contexts? What are minimum quality and safety requirements? Which interventions work best for different purposes (recharge, productive use, fisheries, livestock) and how does this relate to the opportunities for women and vulnerable groups? How to modify designs?
- What supporting measures are possible to improve usage of the additional water and moisture and improve livelihood systems? How to deal with other constraints such as access to labour or credit (see also 3.1)?

The project approach is inspired by the 'Golden Circle of Sinek'. The main entry is having partners' buy-in into the why of road water harvesting and then motivating and encouraging the different implementers to start work with it (how) and discover best techniques and improved governance (what) under the guidance and sharing of the project. The improvements are reviewed, assessed and discussed during trainings and experience sharing meetings. Evidence is collected by research, fact-finding and monitoring. By working with the implementing organizations and outreach partners, it is hoped that uptake by those interested is encouraged and the creativity of a large number of persons – farmers, road engineers, water resources experts and natural resource management specialists is engaged.



Narrative summary	Indicators	Data sources	Assumptions
Project goal: Roads as resilience corridors for road side population widely introduced in Sub Saharan Africa	30 M benefitting from roads for resilience in 2025 Practice introduced in 50% of SSA countries (population-wise) in 2025	Reconnaissance surveys Surveys among IRF membership and agriculture/ water programs	
Project purpose (intended impact): Roads as resilience corridors for roadside population in three key impact areas in Horn of Africa (Tigray, Amhara, Makueni) Roads as resilience corridors introduced in at least five more areas based on expressed interest (see short list)	3 M benefitting by end 2016 from: • Road water harvesting for agriculture and reduced damage from floods and erosion – avg at least 10% income increase • Additional livelihood opportunities created (in sand mining and tree management) • Access of female headed households/ women farmers/ vulnerable group safeguarded	Hydrological and socio-economic monitoring in sample sites (extrapolated) Baseline field checks/ monitoring of extend of road water harvesting activities	Concept ready to be introduced in other regions and countries Capacity to deliver at scale available in other areas Conducive environment at least 50% of SSA countries Space for introducing additional measures Consortium and learning alliance active and supported from 2016
Outputs: Change practice and process of road development introduced on the ground in three areas Roads for water and resilience communicated through media and networks	On the ground implementation in three impact areas (pop 24 M) by 2016 Guidelines and related governance arrangements accepted in 2016 Roads for water and resilience course material integrated in 3 larger educational programs by 2016	Records and photo documentation Published joint guidance notes and discussion notes Information/ correspondence with IRF, CAPNET, Afrhinet, UWSP and Uniwatered	Buy-inn and coordination of main stakeholders/ next users Investment in roads and road side water harvesting made by main implementers Measures to ensure equity integrated
Inputs: Implementing programs supported Guidelines preparation Learning alliance created Communication activities Short course and guided learning Exchanges Roads for resilience meeting Research, monitoring, documentation	3 implementation programs supported Guidelines with two main partners Learning alliance with 300 key persons Five impact publications Short course for 80 persons Guided learning program ready in 2016 2 exchange events, 5 introductionary meeting (can be combined) At least 4 joint MSc/graduate researches and 6 documentations	Project progress reporting Published guideline versions Website and correspondence list Course records Updates of course packages Reports and records on events MSc proposals, documentations Monitoring records Goodwill as recorded in official communication	Concept of road water harvesting and roads for resilience clicks Active engagement in learning alliance Progam well managed

Table 5 - Logical Framework

2.9. Measuring Progress towards Outcomes

In the project measuring resilience and generating evidence on cost and impact as well on process is crucial. The evidence thus created will feed into the learning alliance but also the training and the development of guidelines. It will also provide the material to approach other organizations interested to undertake roads for resilience activities, such as implementing organizations in other countries or national or international funding agencies. Monitoring is important for scaling up. 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.

As a bonus, the images of Planet Labs will be used for tracking the impact on resilience in terms of vegetation change especially at road-water crossings, both in areas with and without road water harvesting. In addition the day-to-day images of Planet Labs will help to have a better visual understanding of what is happening in the rainy season. The Planet Labs scanner is about to be opened up in Ethiopia and Kenya and the density of images is being built up.

2.9.1. Indicators

The indicators measured will assess the progress in adapting road water harvesting measures, the impacts in terms of resilience (separating female and male headed households), some of the specific environmental concerns and the Value for Money indicators (see also section 2.3). In addition reporting on
The indicators that are tracked and are reported relate to the inputs and outputs as given in the log gram. A semi-annual report will be prepared with the achievements at the level of inputs and outputs.

Indicator	Methods	Performance (baseline)	Performance (Year 1)
1. Implementation of road water harvesting - Use of road water harvesting	Detailed field reconnaissance on 150 kilometres of roads (three stretches)	Problem spots in 13-25 locations per 10 kilometer in Tigray Same to be assessed in Amhara and Makueni	Increase in number of facilities that make beneficial use of rain water
2. Impact on livelihoods - basic household information (incl female-headed; male-headed) - household income - food expenditure - participation in institutions - impact of water from road	Questionnaire survey as used before in two locations in Tigray, to be finetined used in two locations in Amhara and Makueni too	Current income and food expenditure	Increase from better management of water from roads
3. Impact on local hydrology: - soil moisture - groundwater levels	Forth nightly measurement of groundwater levels (piezometer) and moisture levels (probe)	Moisture leveld to Existing five measurement sites in Tigray Similar measurement in three selected sites in Amhara and Makueni	Positive increase in moisture over time period and increase in shallow groundwater levels where it exists
4. **Impact of different types of water collection** systems on livelihood for women and vulnerable persons; access and engagement	Participatory appraisal	Current situation	Measure to differentiate effect of different measures
5. Run off water quality	Water quality analysis (oil contents)	Content of oil	Content of oil not to exceed safe limits

Table 6 - Resilience indicators

2.9.2 Baselines

The project is building on an earlier completed research activity under the NERD funded UPGRO program in 2013/4 that looked at the opportunity of water harvesting from roads, as well as the current situation of road induced damage. Work on the hydrological impact was followed in five locations and gender-

disaggregated socio-economic change in two locations in Tigray, one of the three impact areas for Stage 3. These data can serve as a long term data sets: data collection was continued in 2015.

Moreover, In Makueni in Kenya an extensive base line study in 2014 was done as part of the DRYDEV program by Qomon – which will introduce regreening and water harvesting measures in the county. In Makueni two areas were singled out for data studies: Kalawi and Mtito Andei. Though the data in this base line are not entirely compatible the use of these areas as impact monitoring sites will be explored.

For the current situation on the beneficial or detrimental use of water along roads the base line can be collected in the early part of Stage 3 as will be done for the socio-economic situation.

Explaining the design of roadcrossings to retain water

2.9.3 Value for money

The overview of the value for money is given in section 2.3. Three indicators will be assessed, as below:

- Cost of road water harvesting program compared to cost of maintenance and depreciation (efficiency)
- Effect of participation on construction progress (effectiveness)
- Differentiated impact of different technologies on women and the poor (equity).

Indicator	Explanation	Method
Comparative costs of road water harvesting vis a vis maintenance and depreciation	Investment costs and estimated maintenance costs in road water harvesting systems in comparison with cost of with/without maintenance and estimated (accelerated) depreciation	Records (incl. valued contracts) and interview with staff of regional and national road authorities – combined with selected road stretches (indicator 1)
Effect of participation on construction progress	Comparing ; comparing with general data base of	Interviews with supervising staff and community leaders as well as project records in with/without participation
Gender-differentiated impact of different road water harvesting techniques	Comparison of different benefits and social costs of different water harvesting options (surface storage, groundwater recharge, moisture increase)	Structured participatory appraisal in three locations (see also indicator 4)

Table 7 - VFM indicators

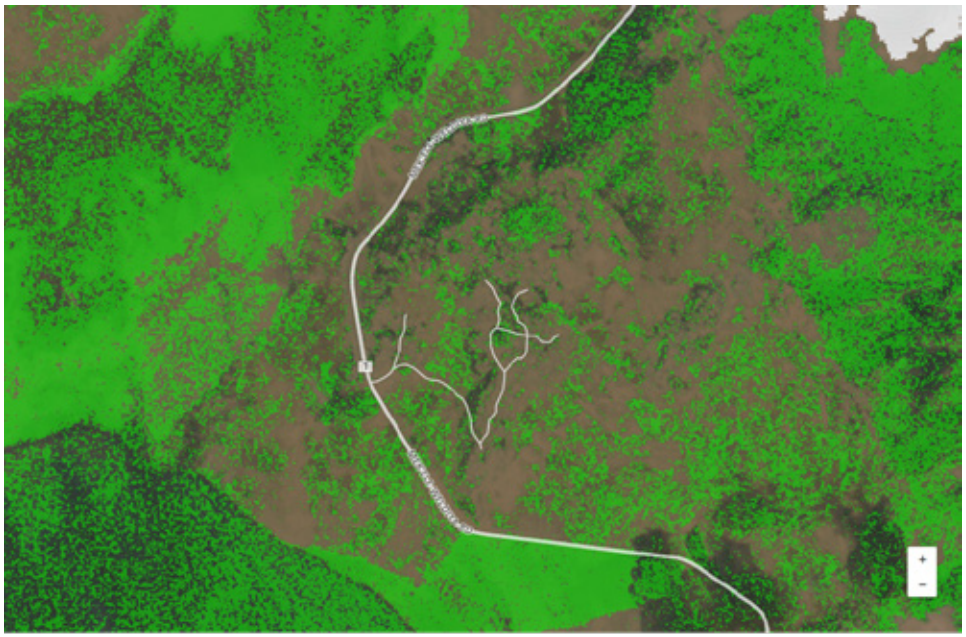
2.9.4 Using Planet Labs to monitor resilience

Planet Labs provides daily Earth imagery by using earth-imaging satellites that act like a line scanner for the planet. These images can be used to monitor changes over time in an area. The program provides useful tools to monitor change, such as the Triangular Greenness Index (TGI) that shows leaf chlorophyll content and the Change Detection tool that shows changes in physical structures in an area over a period of time.

The tools and imagery of Planet Labs may be used to detect variations in roadside areas where road water harvesting is happening or where damage occurs as a result of uncontrolled road flooding. We would like to use Planet Labs imagery and tools in our project to:

- Detect vegetation cover change over distance from roads after rain events using the Triangular Greenness Index (TGI) tool (Figure 1). Images from before and after rain events will be compared to determine the impact of the (controlled or uncontrolled) water from road drainage.
- Compare vegetation cover before and after the construction of water harvesting structures using the TGI tool
- Detect water collection in water harvesting ponds connected to culverts and monitor the amount of time that the pond remains with water
- Monitor roadside planting pilots over time using TGI tool
- Detect increase on road water harvesting structures over time with the Change Detection tool
- Comparative analysis with Landsat images

To monitor impact a number of representative road stretches will be selected in Ethiopia and Kenya where road water harvesting is taking place – preferably close to the area selected for indicator 1. The data would be validated on the field by the project team.



Screenshot of Planet Labs tool "Triangular Greenness Index"

2.9.5 Monitoring and Evaluation Plan

Within the project team one person is dedicated to coordinate the monitoring activities and ensure that results are quality-assured, compiled and shared. Overall responsibility and implementation for monitoring is with Mekelle University and in Makueni with South East Kenya University – with supervision by Mekelle.

With reference to section 2.2. and 2.3 the main data to be collected over the period are:

	Q1	Q2	Q3	Q4
1. Implementation of road water harvesting systems	Additional base line		Overview of implementation	
2. Impact on livelihoods	Complementary base line		Impact over 2015/6	
3. Impact on local hydrology	On-going Set up in two additional impact areas	On-going	On-going	On-going
4. Impact of different water harvesting systems			Special study	
5. Road water quality		Dry season Ethiopia Wet season Kenya	Wet season Ethiopia Dry season Kenya	
6. Comparative costs		Record keeping	Record keeping	
7. Effect of participation on construction process			Special study	

Table 8 - Monitoring plan

Building pond to collect roadwater

3. Achieving the Resilience Challenge

3.1 Gender

In the proposed project gender is a mainstream equity issue. Women farmers in Makueni, Kenya, are the 70-80% majority. In Tigray, Ethiopia, female-headed households amount to 27% and most of them are classified as poor: in fact approximately half of all below poverty households are female-headed. Female-headed households in Tigray Women in are also on average less well connected and more reliant on emergency aid. They are more vulnerable and hence resilience is a larger issue for them. An overview of issues is given in table 9.

The opportunities that come with better use of roads for water can be used to improve the livelihoods of women farmers and increase their resilience. Also with reference to Figure 1 this requires that special care is taken to:

- Ensure that in consultation and discussing water harvesting option women and women's interests are strongly represented.
- Better understanding of the gender implication of the different techniques – during the reviews assessing what are the relative merits of different water harvesting techniques in different socio-economic topics to allow gender-sensitive interventions.
- Ensuring that access to the opportunities of water harvesting is fair.

There is also need for special measures that take into account the special needs of women farmers.

In the fact finding undertaken in Stage 2 it was observed that a major bottleneck for women is access to labour, particularly in land preparation. In Tigray there is a taboo on women ploughing, whereas external hiring labour is expensive. In Makueni there is an overall shortage of labour. Though women plough, part of the land remains unprepared. There is a need to complement the water harvesting program with measures that allow to move to more diversified farming. Given the shortage of land preparation capacity one opportunity to be explored is the

	Main situation	Specific conditions	Opportunities
Ethiopia (Tigray)	27% of farm households are female-headed	Equal access to road water harvesting opportunities More affected by damage (+23%) Inadequate access to labour for land preparation (-24%) Lesser access to institutions (-29%) and local organizations (-48%) Higher dependence on emergency aid (+29%)	Connect with affirmative programs (land distribution to women; women employment programs; women banks) Promote tree-based and horticultural livelihood systems Develop support model (medium term credit for ponds and trees)
Kenya (Makueni)	70% of farmers are female	Equal access to road water harvesting opportunities Insufficient labour for land preparation Concerns on reduced tree cover Self help groups widespread (88%) High dependence on assistance from government (98%) or NGO (85%)	Link road water harvesting to on-going assistance programs Promote through self help groups and barazza's Promote tree-based livelihood systems Develop support model (medium term credit for ponds and trees)

Table 9 - Gender assessment

use of tree crops, though these have specific challenges, in particular the delayed returns. With the implementing agencies/ next users in Stage 3 such special follow on activities will be identified, also making use of the momentum created by road water harvesting programs.

3.2 Resilience

At present current road building practice reduces resilience of road side population. In updated research it was found that in 100 kilometres of roads there may be 13 to 25 problem spots – from flooding, water logging, erosion or uncontrolled sand deposition. Apart from direct loss of resources and assets this also creates uncertainty. Most of these problem spots can be converted into a solution/ opportunity. Often better water management and road water harvesting preserves rural roads as well. As these roads are vital for productivity and have been linked to for instance nutrition in Ethiopia, their preservation is important in its own right.

Though relatively forgotten and underutilized, capturing water from road side drains, culverts or along road embankments is in many cases is the easiest way to capture run off. The network of roads is fine-grained and in many areas fast increasing. The ability to better retain water will help farmers to tidy over drought periods and increase their capacity to deal with shocks and even make use of them, especially when the rain water that is guided by the roads is stored as shallow groundwater, as in large parts of Tigray and several areas of Amhara region, Ethiopia. The ability to store run off as groundwater in Makueni though not absent is relatively less widely available, given the area's geohydrology. The larger water retention in a landscape that comes with water harvesting also contributes to a number of other important phenomenon: in general the increased soil moisture improves soil fertility as soil biota that fix nitrogen are more active. Water buffering also stabilizes the micro-climate and prevents larger temperature spikes because there is more moisture in the landscape.

The project also tries to redefine the concept of resilience as it has been applied to (road) infrastructure so far. A number of studies undertaken to improve the resilience of roads argued for heavier standards to allow the road itself to deal with flood peaks or heat waves. The proposed adjustments increased the costs of infrastructure, meaning that less can be built. The concepts proposed to the contrary in the current project takes a different angle on infrastructure resilience and suggests that a climate resilient road is a road that is integrated with the environment around it and with solutions that are environmentally friendly. The proposed adjustments then come at zero or low extra net cost.

3.3 Sustainability

The aim is not to introduce roads for resilience on an incidental basis but to make it a standard practice and make the knowledge and capacity to do this widely available among the different parties from farmers to road engineers. There are strong financial arguments that carry the approach– as with limited additional effort productive assets can be created – that repay themselves quickly largely because of reduced costs of road maintenance or gully repair or restoration of flood damage.

So far there has been strong buy-in from the major government players as demonstrated from the MoUs and the efforts from Tigray and Amhara Government to already start with road water harvesting program during Stage 2. Similarly, the Makueni County Government made a pledge to implement road water harvesting in the coming financial year (also making use of the fact that last years budget was unspent). The Ethiopian Roads Authority signed a MoU in one day committing to engagement in guidelines and pilots.

The project aims to work along a number of lines to make road water harvesting a standard practice. First is the development of official guidelines on road water harvesting in Ethiopia. This will be a joint activity with the Ethiopian Roads Authority for which a group of eight experts has been identified, with backgrounds in road engineering, water resources management and social science. The same is proposed for Kenya. Following the development of the Guidelines in Stage 3 the Ethiopian Roads Authority intends to mainstream road water harvesting and modify standard design. The Guidelines and standard designs will apply to the national highways and to the feeder roads programs (under the Universal Rural Roads Access Program), managed by the regional roads authorities. The third category of

roads in Ethiopia are the most basic village roads, constructed with the assistance of the Productive Safety Net Program (PSNP): these are low design roads yet causing disproportionally much sedimentation and gullying. In Stage 3 the Project will work together with the PSNP and (1) contribute to their road development guidelines (these are not covered by ERA guidelines) and (2) develop a guided learning program for the many experts working in the PSNP program (see box)

Box 2: Guided learning

Guided learning program are based on the principle of 'doing by learning' – and essentially coaching field staff in their daily activities. Learning packages are provided with instruction and exercises that are implemented in the field. The training in this way to reach field level staff who often are very little coached or stimulated. The effect of doing the assessment exercises is often that staff solve the problem they are analysing. After doing a round of exercises the trainees are invited for a joint training preferably coordinated by a local vocational centre. This training bring people together from different districts and the sharing of experiences creates a peer effect – of learning from others, sharing joint problems but also not wanting to be outdone by others. After the first cycle a second cycle is undertaken. In Stage 3 this guided learning program will be developed and tested for uptake within the PSNP program. It then becomes an asset that can be used in other counties.

The element of sustainability is to create 'motivated capacity' to implement road water harvesting program. This is embedded in the approach of engaging many centres of innovation and change and recognizing and reinforcing the achievements undertaken by the different implementers. The program also want to reinforce the effort by making strong linkages to education and financing mechanisms.

4. Risk Management

This section presents the risk matrix and a preliminary social and environmental impact assessment.
The main implementation risks are summarized in table# and also partly reflected in Logical Framework. All risks are manageable, provided the current approach are manageable.

Table # is an assessment of the social and environmental risks. The points relate to road building in general as it is currently practiced. These in fact will be better mitigated as part of the entire project. In fact the proposed activities by turning roads into water collecting structures transform a number of negative effects, as identified in USAID Sector Environmental Guidelines on Small Scale Construction (2014), into a positive, engaging with different infrastructure programs.

There are a number of specific issues that are related to the beneficial use of run-off water with roads. First, since a new water source is developed, tension over water resources may arise between community members and would need to be handled. An assessment done in Stage 2 indicates that at present access is mainly ruled by access to the land and that in the impact areas there is enough run-off to go by and the bigger challenge is making use of the additional moisture. Even though at present no conflicts occur, the definition of access (including that of gender and vulnerable groups) should be carefully monitored and turned into a positive, particularly if the program would move to very arid areas, where competition may be larger. The same vigilance applies to the effect of polycarbons running of road bodies. This issue was measured in the past and found to be negligible, particularly as most water is captured from the run-off of a large catchment with direct road-off being a minor portion. Nevertheless this issue will be traced and as other areas of concern addressed in the promoted improved practice, as cast in guidelines, training and other activities. All these issues will be further assessed during an Initial Environmental Examination planned early in Stage 3, so that prevention and mitigation measures will be developed. An overview of possible impacts and mitigation measures is given at the next page.

Risk	Impact	Probability	Mitigation measure
Concept of road water harvesting and roads for resilience will not click with main stakeholder groups, and limited buy-in	High	Low (based on prior experience)	Emphasize the multiple benefits and win-wins and major contribution road builders can make (emphasize the 'why') – so far extremely positive response. Have key government organizations as part of core team, and have MoUs and support letters. Can you use encouraging examples that already exist.
Program is ambitious – but key people overstretched	Medium	Medium	As program rolls out more persons can serve as resource persons. Actively build up capacity of graduates and next generation professionals. Recognize prime effort of implementing organizations.
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 but still cost saving)
Difficult to give shape to gender issues	High	Low	Women farmers are more than significant part of the target group. Positive outcomes will benefit them too esp. if additional measures are safeguarded. Scope for special activities to be utilized. Team has one person dedicated.
Disarray in coordination. Learning alliance will be loose and will go adrift.	Medium	Medium	Dedicated support team managing the activities, observing standard administrative/financial rules, regular reporting, monitoring and external communication Plan exchange of ideas, also stimulate and acknowledge members that share outcomes and ideas and take joint credit for it. Continuous updates on innovations would keep the learning alliance strong.
Other initiatives take on board road water harvesting but cause reputational damage	Medium	Medium	Other initiatives are welcomed and cooperation and integration should be sought. Track record of program will keep it in the lead

table 10 - Risk Matrix

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 and creating of safe passage and watering places
Altered Drainage Patterns due to road construction and compaction	Flooding and erosion triggered by road construction	Turning these altered drainage patterns into main opportunities for water harvesting and mitigate flood and erosion risk
Contamination of Ground and Surface Water Resources	Around high volume roads polycarbons and oils from direct run-off may pollute adjacent water resources	Measuring these impacts (so far not significant in rural areas) and adjusting guidelines on road water harvesting accordingly. Note that most road water harvesting comes from the entire catchment and not from road surface
Sedimentation of surface waters	Triggered by erosion and uncontrolled sediment transport in road drainage water (especially in unpaved roads)	Water harvesting combined with road drainage can contribute to reduced erosion from gullies and unpaved road run-off and also trap and harvest coarse sediment
Spread of diseases	Mosquito breeding from water logged areas	Water logging will be generally reduced by road water harvesting. Special care for standing water bodies. Also introduction of sand filters where surface water is only local option for drinking water.
Dust from unpaved low volume roads	Causing respiratory problems for humans and livestock. Also affecting crop yields especially in irrigated areas	Promote road side tree-planting and appropriate business models to sustain these in pilots
Safety of water ponds and converted borrow pits	Risk of persons falling in deep ponds	Special care for protection of deep ponds, including proper landscaping in guidelines and design
Access to land and (harvested) water along the road	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 and women farmers
Possible pollution from road surface	Direct road run-off may contaminate water sources	Vigilance (monitoring) Recommending water collection primarily from rural areas not in urban centres Most water collected with roads (not directly from roads) from large catchments

Table 11 - Screening of environmental and social impacts

6. Team Composition and Changes

6.1 Modification to the team

In comparison to Stage 1 and 2 of the GRP program a number of changes have been made. During the problem statement formulation Dr. Kifle Woldearegay and Marta Agujetas Perez were added. Dr. Kifle has been leading the roads for water activities since 2013 and is an Engineering Geologist by background with extensive experience in water management and groundwater as well as in site investigations for various civil engineering projects including roads. Dr. Kifle is the co-lead – following from the cooperation started in 2013 on the roads for water program under the UPGRP research program. Marta Agujetas is environmentalist and supports the coordination of the program.

For stage 3 we add the following team members – Haftu Kiros (agriculturalist) from the Bureau of Agriculture and Benson Masila (road engineer) from the Kenyan Rural Roads Authority. Benson Masila has also been leading the development of drifts (river crossings) as water retention structures. The two members serve also as the contact with the main.

The coordination will be done by core group. In the Stage 2 this actively consisted of Frank van Steenbergen, Kifle Woldearegay and Marta Agujetas. This core team will be expanded with three persons: Taye Alemayehu will take the lead in the development of the Guidelines, Lenneke Knoop who will take care of the communication activities and Matthijs Kool who was designated to do the project reporting and oversee the monitoring.

6.2 Group strengths and relevant experience

As such the expanded consortium brings together a support team and representatives of the core implementing organizations. The team members represent a mixture of person with an engineering, water resource management and social science background. The project team 'Roads for Water and Resilience' consist of members of MetaMeta Research, MetaMeta Ethiopia, Mekelle University and the Institute for Development Studies (research institutes), the Tigray Construction, Road and Transport Bureau (TCRTB) and Amhara Regional Bureau of Agriculture (two regional governments), the Institute of Development Studies, the South East Kenya University and ASAL Consultants.

The core of the consortium cooperated earlier in the UPGro catalyst grant research 'Optimizing Road Development for Groundwater Recharge and Retention' implemented by MetaMeta, Mekelle University, IDS and The Tigray Bureau of Agriculture and Rural Development. This project was the basis of the current program and was acknowledged in the 2015 award of the Global Road Achievement Award, for Environmental Mitigation as mentioned earlier. Furthermore, Mekelle University and MetaMeta are core partners in the international Spate Irrigation Network (www.spate-irrigation.org), which promotes flood based farming systems globally and work together in the WAHARA research program (funded under EU FP-7) that introduces new water harvesting techniques for agriculture. MetaMeta, Mekelle University and IDS also collaborate in a recent research project under the NWO (Netherlands Scientific Council) that studies the broad inclusive growth aspects of feeder roads in Ethiopia – looking at market access and employment creation. ASAL consultants and MetaMeta has been already for years each other's knowledge partners in projects related to water harvesting. The aim is to reinforce each others' complementary capacities. In addition each consortium member has its own individual strength in research and development, as described below.

<u>MetaMeta</u>
MetaMeta is a private research and development organization. Its mode of work is to adopt relevant themes and ensure these get higher on the agenda – through policy work, program development, training and research. The multi-functional road is an important theme, alongside for instance salinity management, groundwater governance and flood based farming systems. Its affiliate MetaMeta Communications operates www.thewaterchannel.tv that is one of the best visited water portals, hosting water videos and webinars.

<u>Mekelle University</u>
Mekelle University (MU) is one of the public higher education institutions in Ethiopia.

MU has proved to be one of the fastest growing Universities in Ethiopia with international reputation for teaching, research and community services. At present, the University has seven faculties, with over 25,000 students in the regular and continuing education both at undergraduate and postgraduate levels. MU has been active in applied and development oriented researches of regional, national and international dimensions. The university has been running several research projects in collaboration with national and international similar institutions. Based on research MU has been at the forefront in influencing policy issues nationally.

Amhara Regional Bureau of Agriculture

The Amhara Regional Bureau of Agriculture is responsible for agricultural and rural development programs in Ethiopia's second largest state. It steers the extension services and importantly coordinates the intensive water shed programs using mass mobilization campaigns and safety net programs. In the last five years these program have transformed the landscape in large part of Amhara and brought erosion to a halt

Tigray Bureau of Agriculture and Rural Development Amhara

The Tigray Bureau of Agriculture and Rural Development Amhara is the equivalent of the Amhara Bureau of Agriculture with a similar remit. It has pioneered the watershed movement in Tigray that is now seen as a role model for many other areas.

Tigray Construction, Road and Transport Bureau

The Tigray Construction, Road and Transport Bureau is responsible for the planning, management and implementation of the development and maintenance of road networks in Tigray region. The personnel provide technical and administrative support, as well as supervision and monitoring for the woreda- and kebele-level road offices.

KeRRA

KeRRA (Kenyan Rural Roads Authority) is a national institution that coordinates the development of rural roads in Kenya in cooperation with the newly formed county government. KERRA has major share in the two year target of developing 10,000 kilometer of roads.

ASAL Consultants Ltd.

ASAL Consultants Ltd. is a privately owned consultancy firm based in Makueni in Kenya. It has more than three decades of on the ground experience in arid zone water management and has been one of the pioneers in road water harvesting.

Institute of Development Studies

The Institute of Development Studies (IDS) is a leading global organisation for social science research and teaching. Its expertise covers poverty studies, water, sanitation and livelihoods and includes socioeconomic research on road building. Active programs include the 'Water Justice Programme' and the 'Integrated Water Resources Management in Africa'

South East Kenya University

South East Kenya University (SEKU) based in Kitui (Kenya) is a relatively young University (but with experienced staff) with a strong programmatic focus on the management of arid and semi arid lands. It operates an undergraduate course on soil and water management, the students and graduates of which will form a pool of young experts.

Annex 1 - Vision on Future for Roads for Resilience (Stage 4)

Vision

The ultimate aim of the Roads for Resilience Group is that collecting water with roads is mainstreamed in at least 50% of the countries in Sub Saharan Africa by 2025 and in at least several 10 countries outside SSA.

So far a number of development have augured well for the spread of the concept of roads for resilience and have been helpful in transformation of the concept of roads from that of self standing infrastructure to being part of the productive landscape.

The encouraging developments are:

- There is much response from different organizations from different locations
- Several important implementing organizations are taking the lead – most have not taken long to start activities
- The new roads for water practice is embraced by the International Roads Federation, which is significant
- Important outputs will be produced that can make the introduction in other areas relatively easy: guidelines, guided learning package, evidence from monitoring (VFM) and research
- There is scope to innovate more – in the field of collecting water with roads in different bio-physical contexts but also in looking at additional cross-over such the connection between roads and flood embankment; the use of roads to compartimentalise a landscape and hence reduce flood run-off, innovation in tree planting, controlling rodents with amplified vibration from road traffic, controlled water retention and reduction of water logging in flood plains (which are extensive in SSA) (see figure A.1)

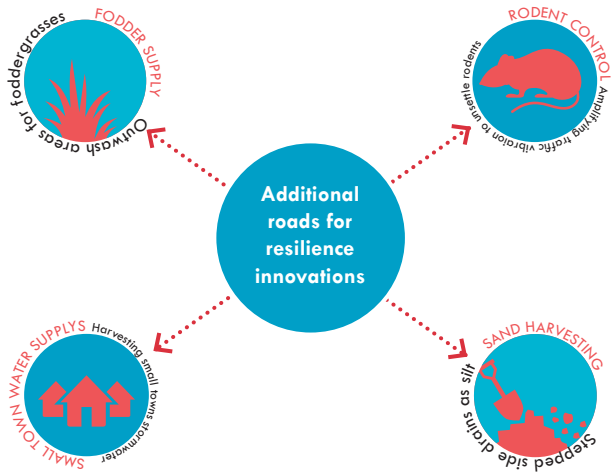


Figure A.1 Future road for resilience innovations

The strategy is to keep momentum being build up – especially with the use of media, educational network, the contacts of the IRF and the learning alliance – and to make sure that the implementing organizations (road departments, local governments, agricultural and water offices, safety net programs) are in the lead and the limelight. The map shows tareas where there is interest and opportunity to introduce the program. As the program develops more such entry points may arise.

The momentum/ goodwill thus created, the contacts made (and engagement of large organizations) and the water resource made available also creates the basis for more new practices, especially in the field of productive agriculture. In the impact areas it was noticed that there is substantial scope for improved agricultural livelihood systems – such as more diversified farming systems, investment in long term assets (tree crops provided the maturity is overcome), better storage and

Box 1: Possible follow on – a 'Tree Bank"

An idea that came up during the field work in Amhara was that of a Tree Bank. At the moment farming in the drier part of Amhara is dominated by the cultivation of maize and teff with no horticultural or tree crops in the system with the exception of eucalyptus. The main benefit of eucalyptus is the short time it takes to mature and generate income. It is also one of the trees that rapidly converts water into biomass, but at the same time can create local water storage (as it acts as a biological pump). The leaf litter of eucalyptus moreover cause a degradation of soil quality and this is one reason why once eucalyptus is introduced it has to spread to other areas.

To overcome the longer maturity/ no income period of other useful tree species the idea of a Tree Bank was put forward – local micro-credit organization giving multi-year loan payment to (women) farmers to look after their trees and sharing in the profit of the tree at maturity. Part of the loan would also be access to good seedlings and advise. The Amhara Bureau of Agriculture is willing to test the idea in one kebelle.

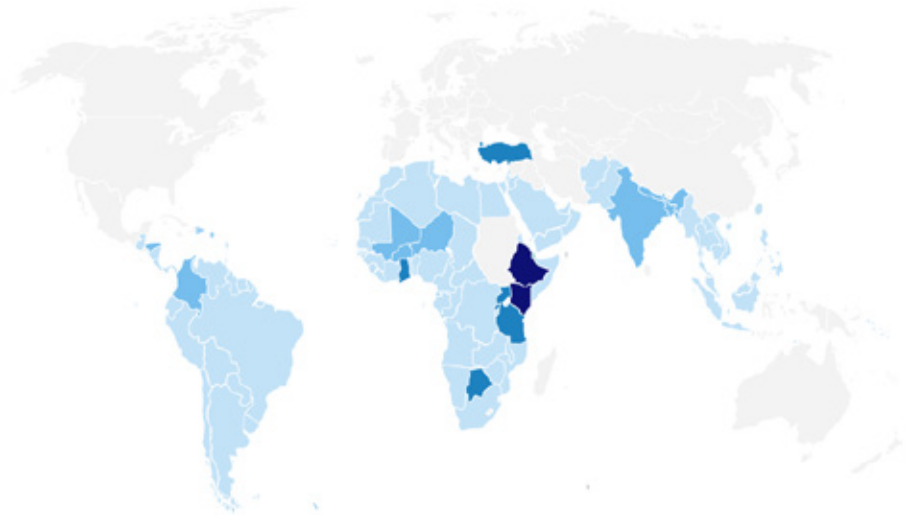


Figure A.2 Areas of current and future interest

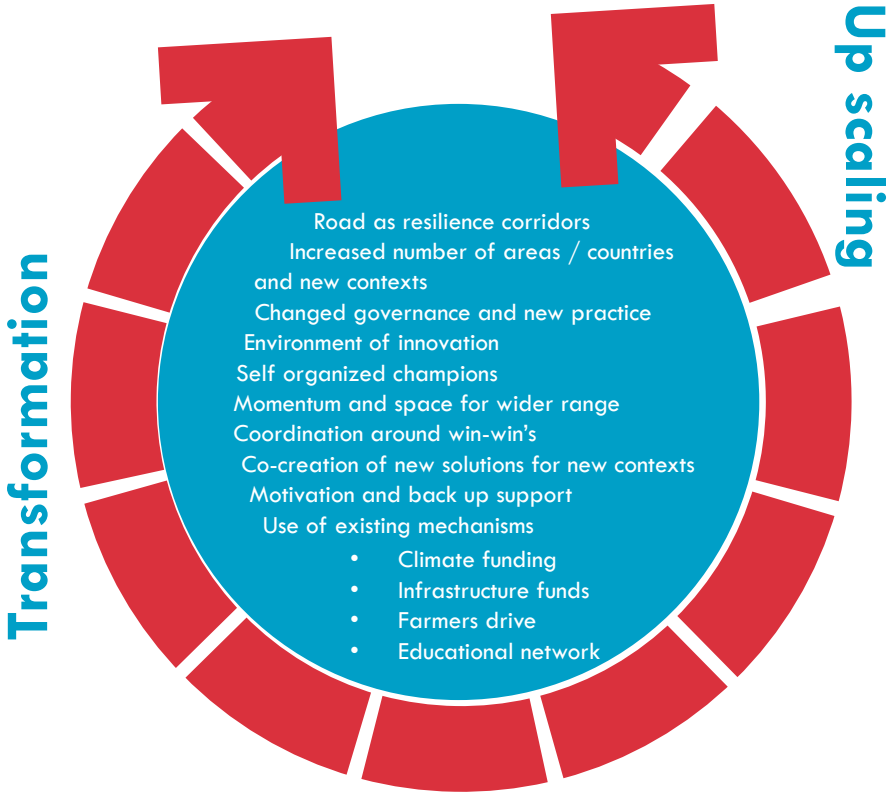


Figure A.3 Transformation and upscaling

marketing. There is in general a good receptiveness to work on these downward linkages and several of these can contribute to promote larger equity and strengthening of the position of women. A downstream idea that come up in (but needs to be strengthened) is a Tree Bank. We would expect that some of the resilience solution developed in other groups can be contemplated too.

Concept for Stage 4

Below is a graphic on how the road for resilience initiative could develop beyond the proposed Stage 3, building on a culture of transformation and critical mass .

The project in Stage 4 could and should move in new geographical territories – there is demand and interest for instance from Ghana, Uganda, Tanzania, Ruanda and Botswana. Outside SSA there is also interest from Turkey, India, Bangladesh and Nepal. There are likely to be more starting points. Though there are many unknowns, the introduction in new areas will be helped by having more 'assets' (as mentioned guidelines and guided learning packages that can be tailored; but also more champion and leaders from the different regions who can be engaged in promotion and sharing; more examples to show). New financing mechanisms can be developed by combining infrastructure development with climate financing – the latter paying for supplementary road water harvesting measures and other roads for resilience. Activities in Stage 4 would also consolidate the activities set in motion in Stage 2 and 3 of the GRP Program.
In addition a set number of 'workable new practices' (may be a better word than innovation) could be introduced that would transform the agricultural production system. In the impact areas in Ethiopia there is a relatively well functioning extension service but it is in search for new practices – in diversified farming, better post-harvest practice etc. Similarly in Kenya it was observed that basic opportunities toward more productive farming were not used. The program could feed such ideas and work with the implementing partners on this.

In the table below an overview is given of what Stage 4 could look like.

	Stage 3		Stage 4		Beyond
Scaling up	Linear	Accelerated	Linear	Accelerated	
Impact areas	3	3	6	9	
Start up areas	3	6	3	6	
Innovations Transformation	Road water harvesting options		Different contexts		Production systems
	Road side tree planting incl management		Sediment harvesting		
			Town storm water reuse		
			Roads as flood protection		
			Storage pond liners		
	Roadside tree planting				
	Productive assets		Diversification		Others (value chain?)
	Access to land and water		Access to medium term finance		

table A.1 - Stage 3 and 4

Outline for Phase 4 activities and estimated budget

As a step for phase 4 the following activities can be thought of with the overall volume of activities depending on whether a linear or accelerated model is chosen

As the program expands the core team has to expand too and champions from different areas will be more actively involved. The outreach in terms of population reached would continue but the remit would broaden to include follow on agricultural improved practices and special measures aimed at gender and equity.

The budget required for a Stage 4 is to be determined, but a first estimate would place it in the vicinity of the budget for Stage 2 and 3 combined, i.e. close to USD 1.2 M.

Support implementing organizations	In first core areas, move towards improved follow on (agricultural) practices – incl road side tree planting
	In new core areas, inspire with practice and evidence from other
Guidelines	Tailored guidelines to different countries/ programs
Learning alliance	Develop strong core support team as
	Making more linkages
	Considering competition for best practice so as to promote exchange and peer learning
Communication	Continuation
Training and guided learning	Tailoring guided learning package to demand of new areas/ new implementing organizations
	Short course to become pivot of new practice
Research	Ensure good sharing of existing research
	Engage students/ graduates in earlier and new core areas – more exchange
Monitoring	Continue in first core areas – time series
	Start in existing areas

table A.2 Stage 4 activities

Annex 5 - Additional CVs and Letters of Commitment

- Kifle Woldearegay - Deputy Team leader
- Marta Agujetas Perez – Environmental Expert
- Haftu Kiros Zegeye – Natural Resources Management Expert
- Lenneke Knoop – Communication Expert
- Taye Alemayehu – Water Resources Management Expert
- Beson Masila – Road Engineer
- Matthijs Kool – Monitoring and Evaluation Expert
- Prof. Nashon Musimba – Rangeland Management Expert

Dr. Kifle Woldearegay Woldemariam
Faculty staff at Department of Earth Sciences, and Institute for Water and Environment
Mekelle University
P.O Box 203
Mekelle, Ethiopia
Date: July 01, 2015

Dr. Frank van Steenbergen
MetaMeta Research
Paardskerkhofweg 14
5223 AJ Den Bosch
The Netherlands

Re: Letter of Commitment

Dear Dr. Frank van Steenbergen,

With this letter I want to declare my availability to take part as national PI and Water harvesting expert in the Project "Connecting Roads, Groundwater and Livelihoods" that is being developed by the consortium led by MetaMeta Research under the Global Resilience Partnership Program.

The proposed research and development activities will enable our University to systematically explore and understand how to make multifunctional use of roads - and in particular to utilize roads for water harvesting, groundwater recharge and retention and productive use and to prevent landscape degradation, while building resilience.

Specifically my organization interests' and concerns' are: Optimizing road water harvesting in order to make livelihoods more resilient against droughts and flooding. In our case we intend to contribute to the project by investigating on best techniques of road water harvesting and developing guidelines and technical designs.

For all my personal details, skills and relevant work experience I would like to refer to my C.V. As requested by the Global Resilience Program my details are in short:

Full name: Kifle Woldearegay Woldemariam
Position: Assistant Professor of Engineering Geology focusing on water harvesting, site investigation for different civil engineering and environmental projects, and on mitigation of water related road failures including landslides.
Organization: Mekelle University
Nationality: Ethiopian
Principle place of Business: Public University

With kind regards,

Dr. Kifle Woldearegay Woldemariam Organization's stamp:

Marta Agujetas Perez
MetaMeta Research
Paardskerkhofweg 14
5223 AJ Den Bosch
The Netherlands
July 10th, 2015

Dr. Frank van Steenbergen
MetaMeta Research
Paardskerkhofweg 14
5223 AJ Den Bosch
The Netherlands

Re: Letter of Commitment

Dear Dr. Frank van Steenbergen,

With this letter I want to declare my availability to take part as Environmental Expert in the Project 'Connecting Roads, Water and Livelihoods' that is being developed by the consortium led by MetaMeta Research under the Global Resilience Partnership Program.

The proposed research and development activities will enable my organization to systematically explore and understand how to make multifunctional use of roads - and in particular to utilize roads for water harvesting, groundwater recharge and retention and productive use and to prevent landscape degradation, while building resilience.

Specifically my organization's interests and concerns are: Optimizing road water harvesting in order to make livelihoods more resilient against droughts and flooding. In our case we intend to contribute to the project by investigating on best techniques of road water harvesting and their impacts in livelihoods, and developing guidelines and technical designs.

For all my personal details, skills and relevant work experience I would like to refer to my C.V. As requested by the Global Resilience Program my details are in short:

Full name: Marta Agujetas Perez
Position: Environmental Expert
Organization: MetaMeta Research
Nationality: Spanish
Principle place of Business: The Netherlands

With kind regards,

Marta Agujetas Perez

Signature:

Mr. Haftu Kiros Zegeye
Tigray Regional Bureau of Agriculture and Rural Development
Tigray,
Ethiopia
July 14th, 2015

Dr. Frank van Steenbergen
MetaMeta Research
Paardskerkhofweg 14
5223 AJ Den Bosch
The Netherlands

Re: Letter of Commitment

Dear Dr. Frank van Steenbergen,

With this letter I want to declare my availability to take part as water harvesting and rural development Expert in the Project 'Connecting Roads, Water and Livelihoods' that is being developed by the consortium led by MetaMeta Research under the Global Resilience Partnership Program.

The proposed research and development activities will enable my organization to systematically explore and understand how to make multifunctional use of roads - and in particular to utilize roads for water harvesting, groundwater recharge and retention and productive use and to prevent landscape degradation, while building resilience.

Specifically my organization's interests and concerns are: Optimizing road water harvesting in order to make livelihoods more resilient against droughts and flooding. The Project will help greatly the ongoing soil and water conservation efforts in Tigray Region.

In our case we intend to contribute to the project by investigating on best techniques of road water harvesting to improve the livelihoods of local communities.

For all my personal details, skills and relevant work experience I would like to refer to my C.V. As requested by the Global Resilience Program my details are in short:

Full name: Haftu Kiros Zegeye
Position: NRM core process
Organization: Tigray Regional Bureau of Agriculture and Rural Development
Nationality: Ethiopian
Principle place of Business: Ethiopia

With kind regards,

Lenneke Knoop
MetaMeta Communications
Stationstraat 1
6701 AM Wageningen
The Netherlands
July 10th, 2015

Dr. Frank van Steenbergen
MetaMeta Research
Paardskerkhofweg 14
5223 AJ Den Bosch
The Netherlands

Re: Letter of Commitment

Dear Dr. Frank van Steenbergen,

With this letter I want to declare my availability to take part as Communications Expert in the Project 'Connecting Roads, Groundwater and Livelihoods' that is being developed by the consortium led by MetaMeta Research under the Global Resilience Partnership Program.

The proposed research and development activities will enable my organization to systematically explore and understand how to make multifunctional use of roads - and in particular to utilize roads for water harvesting, groundwater recharge and retention and productive use and to prevent landscape degradation, while building resilience.

Specifically my organization's interests and concerns are: Optimizing road water harvesting in order to make livelihoods more resilient against droughts and flooding. In our case we intend to contribute to the project by investigating on best techniques of road water harvesting and their impacts in livelihoods, promoting and disseminating the approach and producing communication materials.

For all my personal details, skills and relevant work experience I would like to refer to my C.V. As requested by the Global Resilience Program my details are in short:

Full name: Lenneke Knoop
Position: Communications Expert
Organization: MetaMeta Communications
Nationality: Dutch
Principle place of Business: The Netherlands

With kind regards,

Lenneke Knoop

Organization's stamp:

Signature:

META Ethiopia Branch

Mr. Taye Alemayehu
MetaMeta Ethiopia
CMC Road
Addis Ababa
Ethiopia
Date: 01/07/2015

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www.metameta.nl

Dr. Frank van Steenbergen
MetaMeta Research
Paardskerkhofweg 14
5223 AJ Den Bosch
The Netherlands

Re: Letter of Commitment

Dear Dr. Frank van Steenbergen,

With this letter I want to declare my availability to take part as Hydrogeology Expert in the Project 'Connecting Roads, Groundwater and Livelihoods' that is being developed by the consortium led by MetaMeta Research under the Global Resilience Partnership Program.

The proposed research and development activities will enable my organization to systematically explore and understand how to make multifunctional use of roads - and in particular to utilize roads for water harvesting, groundwater recharge and retention and productive use and to prevent landscape degradation, while building resilience.

Specifically my organization interests' and concerns' are: Optimizing road water harvesting in order to make livelihoods more resilient against droughts and flooding. In our case we intend to contribute to the project by investigating on best techniques of road water harvesting and developing guidelines and technical designs.

For all my personal details, skills and relevant work experience I would like to refer to my C.V. As requested by the Global Resilience Program my details are in short:

Full name: Taye Alemayehu
Position: Researcher
Organization: MetaMeta Ethiopia
Nationality: Ethiopian
Principle place of Business: Ethiopia

With kind regards,

Taye Alemayehu

Signature:

Organization's stamp:

META

KENYA RURAL ROADS AUTHORITY

KILIFI REGIONAL OFFICE

Tel. 041-7522162
Fax. 041-7522054
Email: kilifi.rm@kerra.go.ke
Website: www.kerra.go.ke

KIBAONI – PRISON ROAD
P.O. BOX 27-80108
KILIFI, KENYA

Wednesday, July 01, 2015

OUR REF. NO: KeRRA/KFI/RM/VOL 7-001

Dr. Frank van Steenbergen
MetaMeta Research
Paardskerkhofweg 14
5223 AJ Den Bosch
The Netherlands

RE: LETTER OF COMMITMENT

Dear Dr. Frank van Steenbergen,

With this letter I want to declare my availability to take part as Rural Roads Expert in the Project 'Connecting Roads, Groundwater and Livelihoods' Project that is being developed by the consortium led by MetaMeta Research under the Global Resilience Partnership Program.

The proposed research and development activities will enable my organization to systematically explore, understand and how to make multifunctional use of roads - and in particular to utilize roads for water harvesting, groundwater recharge and retention and productive use and to prevent landscape degradation, while building resilience.

Specifically my organization interests' and concerns' are: Optimizing road water harvesting in order to make livelihoods more resilient against droughts and flooding, while reducing road maintenance costs.

In our case we intend to contribute to the project by making investigations on best techniques on developing water from roads so as to make them part of the road design and construction. We are also planning to contribute to the development of guidelines and technical designs for road water harvesting.

For all my personal details, skills and relevant work experience I would like to refer to my C.V. As requested by the Global Resilience Program my details are in short:

Full name: **Benson Muteti Masila**
Position: **Regional Manager**
Organization: **Kenya Rural Roads Authority**
Nationality: **Kenyan**
Principle place of Business: **KILIFI**

With kind regards,
Eng. Benson M. Masila
Signature:

Organization's stamp:

KENYA RURAL ROADS AUTHORITY
01 JUL 2015

Matthijs Kool
MetaMeta Research
Paardskerkhofweg 14
5223 AJ Den Bosch
The Netherlands
July 10th, 2015

Dr. Frank van Steenbergen
MetaMeta Research
Paardskerkhofweg 14
5223 AJ Den Bosch
The Netherlands

Re: Letter of Commitment

Dear Dr. Frank van Steenbergen,

With this letter I want to declare my availability to take part as Monitoring and Evaluation Officer in the Project 'Connecting Roads, Groundwater and Livelihoods' that is being developed by the consortium led by MetaMeta Research under the Global Resilience Partnership Program.

The proposed research and development activities will enable my organization to systematically explore and understand how to make multifunctional use of roads - and in particular to utilize roads for water harvesting, groundwater recharge and retention and productive use and to prevent landscape degradation, while building resilience.

Specifically my organization's interests and concerns are: Optimizing road water harvesting in order to make livelihoods more resilient against droughts and flooding. In our case we intend to contribute to the project by investigating on best techniques of road water harvesting and their impacts in livelihoods, and developing guidelines and technical designs.

For all my personal details, skills and relevant work experience I would like to refer to my C.V. As requested by the Global Resilience Program my details are in short:

Full name: Matthijs Kool
Position: Monitoring and Evaluation Officer
Organization: MetaMeta Research
Nationality: Dutch
Principle place of Business: The Netherlands

With kind regards,

Matthijs Kool

Signature:

Organization's stamp:

PROF. NASHON K R MUSIMBA
SOUTH EASTERN KENYA UNIVERSITY
P.O BOX 170- 90200-KITUI, KENYA

Dr. Frank van Steenbergen
MetaMeta Research
Paardskerkhofweg 14
5223 AJ Den Bosch
The Netherlands

Re: Letter of Commitment

Dear Dr. Frank van Steenbergen,

With this letter I want to declare my availability to take part as Rangeland Management Expert in the Project 'Connecting Roads, Water and Livelihoods' that is being developed by the consortium led by MetaMeta Research under the Global Resilience Partnership Program.

The proposed research and development activities will enable our University to systematically explore and understand how to make multifunctional use of roads - and in particular to utilize roads for water harvesting for irrigation, livestock , groundwater recharge and retention and other productive use to prevent landscape degradation, while building resilience.

Specifically my University's interests and concerns are: optimizing road water harvesting in order to make livelihoods more resilient against droughts and flooding and increase the food security. In our case we intend to contribute to the project by investigating best techniques of road water harvesting to improve the livelihoods of local communities. More specifically, to understand how both men and women are affected (both positively and negatively) by the water from roads in their efforts towards alleviating poverty.

For all my personal details, skills and relevant work experience I would like to refer to my C.V. As requested by the Global Resilience Program my details are in short:

Full name: Nashon K.R. Musimba
Principle place of Business: South Eastern Kenya University, Kitui.
Position: Professor
Organization: South Eastern Kenya University
Nationality: Kenyan
With kind regards,
Nashon K.R. Musimba

Signature:

Annex 6 - Agreed Table of Contents

ERA Guidelines for Road Water Harvesting

1. Introduction
   - Importance of multi-functional road development to create resilience
   - Characterization of road water harvesting in different types of catchments roads and type of settings (lowland, highland/ agriculture, forest, pastoralist areas)
   - Calculating catchment run-off and direct-road run-off (ready reckoners)
   - General guidelines for road development
   - General guidelines for road maintenance

2. Planning high volume roads
   - Road location and water harvesting
   - Road foundation
   - Placing of drains and drain outlets
   - Flood water spreaders
   - Reinforced road embankments for upstream storage

3. Planning low volume roads
   - Road location
   - Alternating of slopes
   - Reducing erosion
   - Placing of cross drains and water bars
   - Using outflow

4. Drainage design and road surfaces
   - Water harvesting from drains
   - Sand harvesting from drains

5. Design of culverts and associated structures
   - Culvert placement (concentrated or distributed road drainage)
   - Culvert design
   - Culvert size
   - Fish passage from culverts
   - Downstream erosion control
   - Water spreading from culverts

6. Road side water harvesting structures
   - Storage ponds (location and dimensions)
   - Infiltration ponds (location and dimensions)
   - Deep trenches (location and dimensions)
   - Soak pits

7. River crossings
   - Using fords and low causeways as sand dams
   - Using fords and low causeways as river bed stabilizer or flood water spreaders

8. Spring capture and protection
   - Safe access

   - Dimension upstream or downstream

9. Reusing borrow pits and quarries for water storage

- Preferred location of borrow pits
- Landscaping and protection of borrow pits
- Use of spill ways
- Special cases: dug out ponds

10. Developing road side vegetation
    - Dust capture and sediment control by trees and grasses
    - Selection of trees
    - Selection of grasses and other vegetation
    - Management of road side tree plantation
    - Engaging women and youth groups

11. Landscape management around roads
    - Erosion and run-off control
    - Avoiding and preventing landslides
    - Avoiding sand dune management

12. Roads and flood management
    - Contribution of roads to flood control
    - Roads as embankments and evacuation areas
    - Roads in low lying flood plains – managing water retention

13. Defining access to road water harvesting benefits
    - Access to land and water
    - Gender considerations

14. Community and stakeholder engagement in road water harvesting
    - Community resource planning
    - Coordination with watershed programs

Farmers stories

My name is Ataklti and I live in Tigray, Ethiopia. I have 2 hectares of land in which I cultivate rainfed crops. I realized that the water from the culvert was causing erosion because it was all concentrated in one point. It was eroding my brothers' land. I decided to divert the water from the culvert to my farmland to help my brother and utilize that water. The productivity of my farmland has doubled since I divert the water from the road, combined with the use of fertilizers and improved seeds. Usually at the end of August there is not enough rainfall and that is when the crops need it the most because is the crop maturity period. Is at that moment when the water from the road is crucial. I am happy to have my land next to the road because I have extra water.

My name is Tsedkan and I live in Tigray, Northern Ethiopia. I have one hectare of land where I cultivate teff, sorghum and wheat. I have been diverting the water from the road to my land for several years. This is a very dry area, so the water coming from the road is very useful. Usually at the end of August there is not enough rainfall and that is when the crops need it the most because is the crop maturity period. Is at that moment when the road run off is crucial. The quantity and quality of the crops increases thanks to the water. The hay also becomes larger and stronger and is use it the rest of the year to feed my cattle. The extra water in August also allows me to apply fertilizers and thus my crops are even more productive. I am happy to have my farmland next to the road and benefit from the extra water.

My name is Margaret and I live in Makueni County, Kenya. I have a tree plantation with 6000 trees where I am planting Melia Volkensii for timber production. In 2009 I started diverting water from the road passing next to my farm because I saw other farmers doing it. I can see a difference: where there is extra water from the road the trees grow faster and stronger. The grass also grows faster, and I use it to fatten my livestock. This extra water is very useful.

Roads for Water