Case Study

Exploring the cost-benefit of Roads for Water in Ethiopia

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Results in development

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List of acronyms

CBA	Cost-benefit analysis
FAO	Food and Agriculture Organisation of the United Nations
GRP	Global Resilience Partnership
MEL	Monitoring, Evaluation and Learning
MM	Meta Meta
MU	Mekelle University
NERC	National Engineering Research Council
NWO-WOTRO	The Netherlands Organisation for Scientific Research (NWO)–WOTRO Science for Global Development
RfW	Roads for Water
ToC	Theory of Change

1 Introduction

The Roads for Water (RfW) project has been implemented by Meta Meta (MM) with Mekelle University (MU), together with regional and federal government organizations in Ethiopia since 2014. It has enabled farmers to use water from roads that previously would likely cause flood damage, by intercepting the water and guiding it to recharge areas, surface storage places or directly onto pieces of land. The project has brought together government stakeholders from the agriculture, water and roads sectors and used extensive training of trainers to enable government to scale this approach to millions of farmers in Tigray, Amhara and Oromia.

RfW began as a catalyst research project in 2014 in Tigray region with the UK's National Engineering Research Council (NERC) funding (£142,855), was further partially supported by The Netherlands Organisation for Scientific Research (NWO)–WOTRO Science for Global Development[1] in Tigray region with scaling supported by the Global Resilience Partnership (GRP) from 2015 in different parts of Ethiopia. GRP provided grant funding in two investment rounds: US$249,450 in round 1 and US$998,664 in round 2.

Itad has supported GRP in its programme monitoring, evaluation and learning, including providing grantees with guidance notes and webinars. Dr Gil Yaron has been closely involved in this work and following discussion with the project team, he was asked to spend four days with project staff, government partners and target communities to (1) verify the evidence used to report on key GRP indicators, and (2) strengthen project cost–benefit analysis (CBA). This case study report addresses these tasks.

Data sources accessed

Three sources of evidence have been used to address these questions:

(a) Review of project reporting and documents provided by the project team.[2]

(b) Key informant interviews with government stakeholders and project staff and partners.

(c) Focus group discussions with farmers in three communities that had taken part in road water harvesting activities. The discussion covered the history of the activities undertaken and the difference these had made to production.

2 Verification of GRP reporting

GRP 1: Total number of people supported by GRP

The Meta Meta final project report for GRP provides the following:

GRP 1 (Total number of people supported by GRP) = 3,006,000 in Ethiopia

This is based on the following narrative:

> *"In Ethiopia road water harvesting is a vital part of the mass mobilization campaigns (in Feb-March) and water harvesting campaigns (June–July) in Amhara and Tigray. This last campaign (Feb–March 2018) has been also implemented in both regions. Moreover, following a training in Oromia, road water harvesting was also part of the*

[1] As one aspect of the project: 'Ethiopia: Feeder road development for inclusive productive employment' led by the University of Utrecht, the Netherlands.

[2] Gregg Smith provided helpful research assistance to review project reporting

Mass Mobilization in the region in 2017. In total, since 2015 (including 6 campaigns), 6,679,696 people have benefited in Ethiopia due to the inclusion of road water harvesting in the mass mobilization and the efforts on road side planting. Considering that several people will be addressed in subsequent moving campaigns, the "net" number is estimated to be 3,006,000 or 45% of total."

Interviews with two senior Bureau of Agriculture staff – the project focal persons in Tigray and Oromia – were the principal means of verifying these numbers although interviews with project staff were also used.

The key conclusion is that the estimate of people reached reflects important, if relatively small scale, work done with NERC funding prior to GRP funding.[3] Attributing the number of people reached solely through GRP will overstate the role of GRP.

Figures on citizen participation in the mass mobilization campaigns have come from Bureau of Agriculture and Rural Development offices in the regional states and are likely to be accurate as it is a legal requirement for citizens to participate in these campaigns unless specific criteria for exemption are met. Those who do not participate (or contract a substitute to do the work) are subject to fines. Identifying mass mobilization participants that have undertaken RfW activities as a result of the project is more difficult and has to be estimated. No one interviewed was able to explain exactly how the 45% estimate was arrived at. However, the project focal person in Tigray thought that this would capture the proportion participating in mass mobilizations who had been exposed to training enabled by the project. A smaller proportion would have actually undertaken RfW activities as part of the mass mobilization.

Some evidence on what this lower figure might be is provided by the narrative to GRP indicator EG.11-4 (Investments for climate change adaptation mobilized). Here, an estimated 10 days of per capita mass mobilization participant time are attributed to RfW from a total of "30–50 days"[4]. Taking a 10/40 day share and applying it to the total number participating in mass mobilizations would give:

Table 1: Estimates for GRP 1

Participants	No. of participants
Participants in mass mobilization in Tigray, Amhara and Oromia	6,679,696
Participants benefiting from project training (45%)	3,005,863
Participants based on a 10/40 mobilization day for RfW share	1,669,924

Note that all the figures in **Table 1** should be multiplied by the appropriate share of GRP funding from GRP plus NERC funding for the RfW work in Ethiopia. This will require GRP to identify the proportion of their funding for RfW used specifically for Ethiopia.

EG.11-4: Investments for climate change adaptation mobilized

The Meta Meta final project report for GRP provides the following:

EG.11-4 (Investments for climate change adaptation mobilized) = US$35,000,000

This is based on the following narrative:

[3] NWO/WOTRO funding was also obtained but this was for a research program implemented by Utrecht University on the inclusive development of roads. It primarily looked at jobs created with different types of road construction and did not promote or support Roads for Water programs.

[4] Although the required participation in mass mobilisations had fallen from 40 days to 20 days by the end of the project.

> *"Rough first estimate – based on labor days in mass mobilization campaign (2.75 M people * 10 days) and tree planting. Further info provided over email: Under the mass mobilization campaigns in Ethiopia community members will provide labor – between 30–50 days a year. In addition, persons entitled to the Productive Safety Net Program are engaged in the mass mobilization campaigns.*
>
> *According to estimates by the Bureau of Agriculture and Rural Development in Amhara and the Bureau of Agriculture and Rural Development in Tigray respectively 1.2 M and 0.55 M were engaged in the spring campaign, and 0.7 M and 0.3 M persons in the summer campaign. The summer campaign has a strong focus on road water harvesting – it is more field oriented. The spring campaign is more on upper catchment protection but includes a substantial element of road protection and road water harvesting too. The estimate is that people were employed for 10 days on road water harvesting related activities – other activities were more on catchment protection. We took a low value of a day labor USD 1.2/day (ETB 25) – actually labor costs are higher in rural Ethiopia. To this we added the estimated value of the tree planting campaign."*

The EG.11-4 estimate is likely to be an understatement for the following reasons:

- It excludes mass mobilization participants in Oromia (the biggest region with 3.9m of those in Table 1).
- It excludes government contributions of machinery and expert time.

Nonetheless, there is an assumption that *all* mass mobilization participants spend an average of 10 days on RfW activities. **If the average of 10 days per participant is too high, it will tend to overstate EG.11-4**.

On balance, it seems likely that the figure currently given for EG.11-4 is too conservative as it could be obtained by adding in the participants from Oromia and assuming an average of only four days per participant (across all regions) is spent on RfW activities – without adding in any contributions from government.[5] Field interviews confirmed that farmers in the three communities visited spent a minimum of five days per year on RfW activities even after the project had ended.

3 Evidence for cost–benefit analysis (CBA)

In order for the RfW team to present a credible CBA, the benefits produced by the project need to be quantified and compared with costs. These benefits and costs include those seen in the project lifetime and those we can be confident in seeing in years following interventions, as RfW structures continue to do their job with maintenance by community members. There is a straightforward and accepted method for converting these cost and benefit streams into net present values[6] and so this case study report focuses on the benefits and costs that need to go into this calculation.

Van Steenbergen *et al*. (2018) set out a large number of potential benefits[7] from RfW investments. In order to add some value to the existing body of knowledge, this case study report focuses on identifying the strength of the evidence available for each major benefit and cost and suggesting how gaps might be filled (see Table 2). Recommendations are given as part of the narrative in the third column of Table 2.

[5] It is beyond the scope of this case study report to estimate government contributions of machinery and expert time, but this could be done fairly easily by MM project staff in discussion with government partners.
[6] Set out in GRP guidance notes and the literature referenced in the guidance notes.
[7] These are stated as costs resulting from not following a RfW approach. Here they are restated as benefits from following a RfW approach in order to distinguish them from costs of project implementation.

Table 2: Benefits and evidence sources

Avoided cost/benefit	Source of evidence	Validity in the Ethiopian context and suggestions for improvement
Avoiding gullying and erosion: loss of land for farming	Gullies created and farmland lost as a result (Addisu 2011; Woldearegay *et al*. 2014)	This is based on primary research in Ethiopia. The RfW team have clarified that this is separate from farmer crop yield improvements reported by the project,[8] i.e. farmers that had lost land were downstream of the sample area or had dropped out of the sample due to loss of land. Hence it can be added to the reported yield increase by farmers in the CBA.
	Value of lost crop yield (FAO 2017)	An average across sub-Saharan Africa is used. The RfW team should make this specific to project areas using existing project case study farm data.
Avoiding gullying and erosion: loss of soil moisture adjacent to gullies	Hydrological monitoring from sample plots (Woldearegay *et al*. 2015)	This is based on primary research in Ethiopia. It is likely to be captured by farmers reporting improved crop yields. Hence including this benefit separately leads to double counting. If gulleys and farmland loss extend beyond the area sampled by Woldearegay *et al*. (2015), there would be a separate effect but further research would be needed to identify this.
	Value of lost crop yield (FAO 2017)	If it can be shown there is no double counting, this benefit should be made specific to project sites as noted above.
Avoiding gullying and erosion: loss of nutrient-rich soil	Benefit transfer from research by Ayele *et al*. (2015) with farmers in highland Ethiopia. They estimate the cost of replacing nutrients in soil lost from farmland due to erosion. Their methods section explains this is an alternative to estimating the loss of productivity change or yield loss from erosion.	There is a strong case that these research findings can be transferred to the project context. However, yield increases reported by project farmers who benefit from RfW already capture the reduction in loss of nutrient-rich soil, i.e. it is effectively the productivity change from reducing soil loss. Including this benefit separately is double counting.

[8] Frank van Steenbergen, October 2018 (personal communication).

Avoiding gullying and erosion: value of lost land	Gullies created and farmland lost as a result (Addisu 2011; Woldearegay *et al*. 2014)	See note on 'loss of land for farming' above.
	Value placed on land lost (Oruonye 2015)	The value of annual lost agricultural yield is a 'flow' in economic terms. This can be amortised into a capital value ('stock') per hectare over many years – as done by Oruonye (2015). What the RfW team should not do is include both measures of the same benefit. As all other benefits are expressed as flows (US$/ha/year), the value placed on lost land that is currently farmed should be dropped.
Avoiding cost of sedimentation (silting up of water infrastructure, effect on aquatic life, sand deposits on agricultural land)	Transect survey looking at a 67km stretch of road from the highlands in Tigray and cost of re-digging ponds and shallow wells that had been silted up (Woldearegay et al., 2014).	This is a highly conservative figure as the authors make clear that many other types of cost reported in other countries have not been quantified in the Ethiopian context. Further research at the watershed level in Ethiopia is needed to produce the full range of avoided sedimentation costs (such as impacts on hydropower).
Avoiding the cost of flooding: loss of animals due to floods	Benefit transfer from research by Ayele *et al*. (2015) with farmers in highland Ethiopia	There is a strong case that these research findings can be transferred to the project context. For some reason, this benefit does not appear in the van Steenbergen *et al*. (2018) paper. It should be added to a CBA.
Avoiding the cost of flooding: damage to houses and public infrastructure	Transect survey looking at a 67km stretch of road from the highlands in Tigray, socioeconomic survey and cost of rebuilding (Woldearegay *et al*. 2014)	This is valid as it stands but research on additional sites in other areas of Ethiopia would be useful to make CBA estimates more representative.
Avoiding the cost of flooding: flooding and waterlogging of agricultural land – loss of crops	Transect survey looking at a 67km stretch of road from the highlands in Tigray and socioeconomic survey to calculate yield loss. Value of lost yield is calculated from farmer responses.	Yield increases reported by project farmers should already capture benefits of avoiding regular flooding that happened prior to RfW. Hence including this benefit alongside reported yield increases would lead to double counting. However, this is backwards looking, and climate change is predicted to increase the severity of flooding in future. The additional cost from predicted climate change should be estimated if possible.

Avoiding increased costs of road maintenance	Benefit transfer of findings from Cervigni *et al*. (2016) on down time of roads in sub-Saharan Africa with climate change predictions.	This could be made more specific to Ethiopia by multiplying by the GDP ratio for Ethiopia to the average for the Cervigni *et al*. (2016) sample.
Additional farmer income from use of harvested water from roads	Evidence on increased soil moisture from 10 project sample sites. Field observations suggest increased moisture benefits approximately 10ha/km road. The value of *all* crop production based on the FAO (2017) productivity estimate of 1ha = 13.1 quintiles wheat and local prices is attributed to the intervention based on the loss of this production in the 2015 drought.	It is possible to improve this estimate in a number of ways: 1. Droughts occur from time to time and so a CBA should only include the total value of production in drought years. Climate modelling data can be used to include a probability of drought in each year. 2. The van Steenbergen et al. (2018) paper refers to actual data on average yield increases collected by Mekelle University: 'Wheat increased by 22%/186kg per ha, barley increased by 8%/ 75kg per ha, *teff* increased by 30%/145kg per ha and maize increased 81%/75kg per ha'. Our field visits suggest these are averages across farmers who benefited from RfW *and* those who did not, i.e. yield increases for those who benefited are much higher – in the region of 75%–100%. This is actually confirmed by the literature cited by van Steenbergen *et al*. (2018). The RfW team should (continue to) use the value of the average yield increase across all farmers for non-drought years in any CBA. 3. Our community discussions suggest that RfW has also enabled new livelihood activities in many cases, e.g. growing of fruit trees or forage for livestock. The value of this production is significant and should be added in any CBA for a representative sample of farmers in drought and non-drought years.

For the CBA, we also need to consider the costs associated with the RfW project. Van Steenbergen *et al*. (2018) use an average RfW investment cost of US$1,800/km based on the experience in Ethiopia. This would appear to include the labor costs of farmers involved in RfW activities as part of the mass mobilization. As government staff are already allocated to support community development, we can make the case that RfW does not involve additional government labor costs. However, the RfW team should identify and include:

1. Additional government spending on machinery use for RfW. This can be done by calculating the capital depreciation for representative types of machinery and allocating a share of this life to the RfW work. Operational costs such as fuel should also be added.

2. NERC and GRP costs that have been spent on the Ethiopia project.

It is reasonable to assume that benefits from the project intervention will continue to flow for the lifetime of the structures put in place (provided maintenance is carried out). This would allow the net present value of benefits and costs to be calculated over, say, a 10-year period with a suitable discount rate. A 1.5%–5% 'social discount rate' is typically used for climate resilience benefits.[9]

[9] The choice of appropriate discount rate for climate programmes is a source of controversy in the economics literature but, for a project intervention with something like a 10-year time horizon, this is unlikely to make an important difference in practice.

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