Monitoring and assessment guidelines and options towards land restoration and water resources management in agricultural landscapes

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1. Introduction

Historically, agroecosystems the world over have responded rather resiliently to the increasing pressure for producing food for an expanding human population[1]. As a result, it is not surprising that recent years have witnessed a gradual but steady increase in urbanization and prominent rise in incomes of emerging economies[2], with shifting of human diets toward higher consumption of calories, fats, and animal products[3]. This therefore calls for exploring novel and sustainable ways of intensifying agro-ecosystems to ensure higher crop and forage productivity that reduces competition between man and livestock for food and feed respectively. This is more pertinent than ever because climate change is among the plethora of factors affecting crop and livestock productivity resulting in negative impacts on livelihoods in various areas within Eastern and Southern Africa.

Subsistence farmers suffer not only from depleted soils but from challenges with water: too little water, too much water, and erosion from water. There are always strong links between measures for soil conservation and measures for water conservation, and this applies to smallholder farming systems. Many measures are directed primarily to one or the other, but most contain an element of both. Reduction of surface run-off through modified soil physical properties such as tillage practices or by changes in land management help to reduce soil runoff and erosion that would result in substantial water and sediment losses. Similarly, reducing erosion will usually involve preventing splash, rills and gullies, or formation of crusts, or breakdown of structure through tillage practices to increase infiltration, and so help the water conservation. In this guide, we refer to a landscape as consisting of the visible features of an area of land, including mountains, hills, water bodies; plants and animals; and human elements including people, farms, houses, roads, mines, other structures and institutions and their cultural and spiritual values[4].

In order to increase resilience and adaptive capacity of farming communities, qualitative and quantitative aspects are considered in this guidance document. Climatological data, scientific papers and field experiment formed valid quantitative information to support the soil and water conservation narrative. This simple field guide draws upon existing frameworks and lessons learned from partners and scientific literature as well as other internationally accepted methodologies. The guide serves as a go-to reference for a scientist working with a landscape approach[5] in small holder agricultural settings. The concepts, information and practices in the guide help support management decisions for risk reduction in relation to landscape management. In addition, the guide can be used as a tool for approaches in landscape analysis to help scientists with viable interventions that address a specific problem pertinent for farming communities. In this guide we present:

1. General guidelines towards soil and water resources management
2. Complementary case for the Upper Tana Basin in Kenya
3. Complementary case for Bungoma county in Kenya

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1 Robertson et al. 2014

2 Cohen 2006

3 Nair 2014

4 Author

5 A landscape approach takes both a spatial and socio-economic approach to managing land, water, and forest resources and the ecosystem services they provide' *Adapted from World Bank, 2011*

1.1 General guidelines towards soil and water resources management

1.1.1 How to get started with soil and water conservation techniques

There are no universal conservation practices that work everywhere. Planning soil and water conservation is like having a large array of techniques and practices. The object of planning soil and water conservation is to make up a system by selecting a set of individual items which are each relevant to the conditions, and which can be combined into a workable system. Looking at the large choice of mechanical works, the main factor in deciding which to select must be to define the objective. The way that different mechanical terraces will help meet different objectives depends on why the terrace is being constructed for example in order to modify the soil slope; to influence the surface run-off or to allow the agricultural use of steep slopes. The top soil layer contains mostly organic matter and nutrients which are very useful for plant growth. In order to get better plant growth, the top soil layer must be protected from wind and water erosion. Measures taken for protecting the top soil layer are called soil conservation measures. These measures protect top soil either through reducing the impact of erosive agents (water and wind) or by improving the soil aggregate stability or surface roughness. The soil conservation measures can be broadly grouped into three categories namely, biological, mechanical and bio-engineering. All these measures need to be focused to the actual needs of the people. Biological methods include mulching, agroforestry, crop rotation, reforestation/afforestation, mixed- or intercropping, cover cropping and strip cropping. Mechanical practices are engineering measures used to control soil erosion from sloping land surface e.g. terraces and graded bunds. The purpose of constructing the mechanical structures is to (1) increase infiltration time and reduce run-off, (2) to break the land slope, thus reducing the velocity of the runoff water. Biotechnical methods using willows and other woody plants are especially appropriate for constructing several soil conservation structures. These structure stabilizes the soil, reduce the movement speed of running water, and thus reduce the surface erosion.

1.1.2. Optimal spacing of soil and water conservation measures on hilly landscapes:

A study was conducted by CIAT in 2016 and 2017 in Babati district and compared the extent of erosion from varying slope gradients and lengths across three agro-ecological zones. We proposed two conservative threshold limits for slope gradients and lengths to be ≤5% length and ≤20 m. If the slope gradients and length thresholds are above these limits (with no soil and water conservation interventions in place), this would result in significant soil losses and runoff. This in turn results in nutrient losses and reduced crop productivity. Based on these two threshold limits; we classified the slopes into 3 categories and these were shared with the District extension agents:

- Flat to gentle undulations (0 to < 5%; less than 20 m slope length); constitute the first domain of sheet erosion.
- Moderate to steep slopes (> 5% to < 20% gradient; > 20 m but <50 m slope length): potential domains of active gully erosion and with potential expansion;

- Very steep slopes (> 20% to < 40% gradient; > 50 m slope length): are prone to mass movement, severe rain splash and sheet erosion.

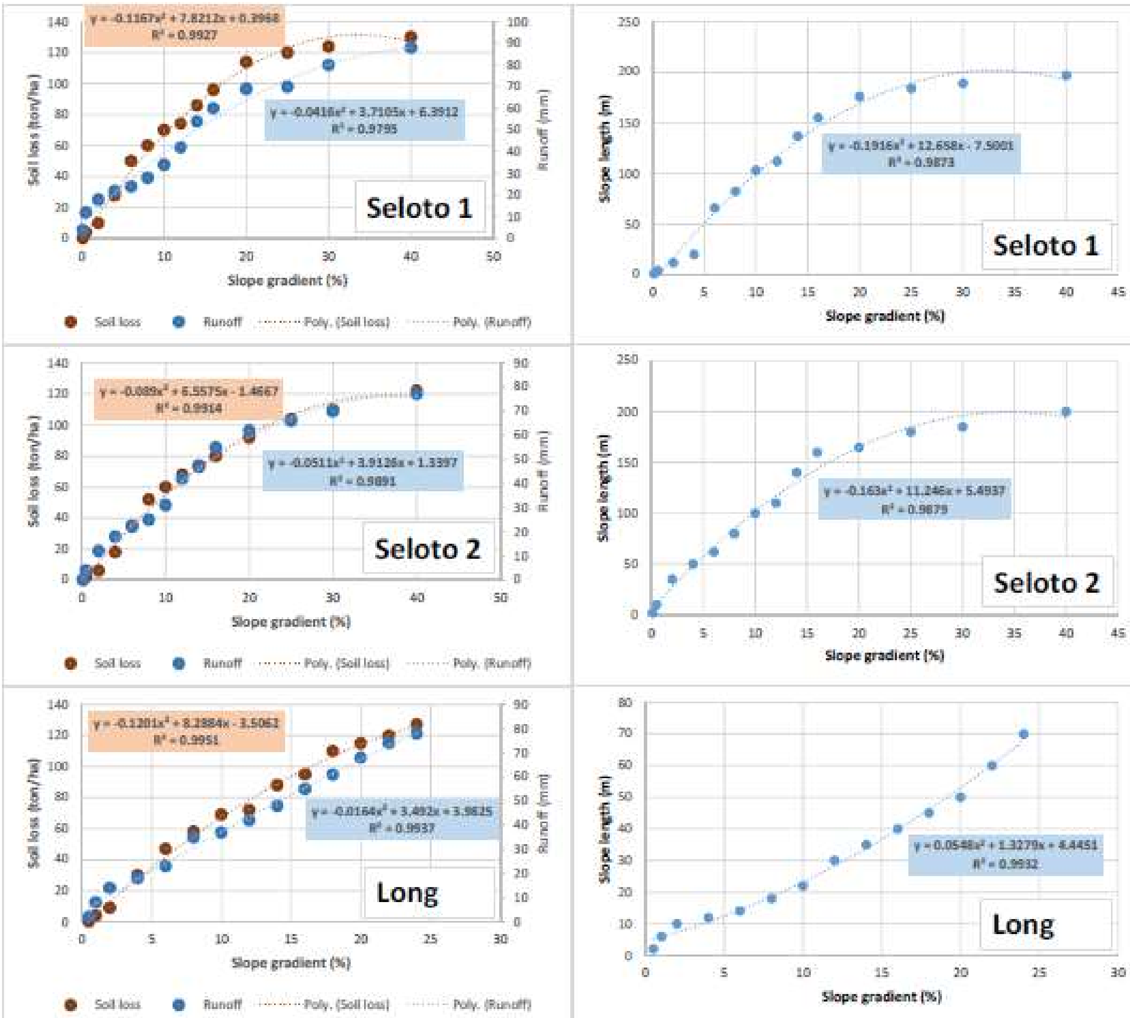

Figure 1. Illustration of optimal spacing interventions for terraces from farm scale to watershed scale interactions in association with sediment discharge and other landscape management options (Author data under preparation for publication).

The proposed thresholds are very helpful in farm decision making especially for landscapes that are in high altitude areas and cropping is conducted on steep slopes such as Lushoto and Babati in Tanzania.

1.2. Benefits associated with soil and water conservation technologies

There are numerous benefits[6] associated with soil and water conservation measures including increased crop water uptake for dry matter production hence increased yields; an increase in the infiltration rate of the soil which allows the use of as much rainwater as possible to fill the soil reservoir thereby reducing runoff; reduced evaporation rates while

6 FAO, 1987, 2016 http://www.fao.org/3/T0321E/t0321e-10.htm

ensuring soil is kept in place through reduced erosion and reduced impact from raindrops, runoff or wind; it helps to reduce soil compaction and crusting while preserving soil structure and increases soil moisture availability.

1.3. Challenges associated with soil and water conservation technologies

The use of mechanical works and structures in soil conservation programs need to be coupled with increasing awareness of soil and water conservation that includes the full support of the people. Subsistence farmers cannot afford to respond to emotional appeals to care for the soil, and this means that conservation measures must have visible short-term benefits. Yield benefits would be most appreciated by farmers or greater productivity per unit of labour, or reduced yield variability. Soil conservation must be cost- effective to be acceptable to the farmer, hence for smallholder farmers, only cheap and simple solutions are appropriate. On a fertile soil with good rainfall it may be advisable to invest more money in sophisticated schemes for controlling the runoff or in water harvesting, but not in settings with low and unreliable yields. Attempts to eliminate soil erosion completely may be unrealistic and some degrees of erosion might be acceptable if soil conservation measures are not 100% effective. Many conservation programmes have failed because the technology was inappropriate or wrongly established. Often the social situation of people has not been taken into account. While contour ridges, soil bunds, hedgerows, vetiver grass or forage strips are effective a single technologies, it is more effective to provide a basket of options to farmers, researchers and extension agents which all have to decide and choose which techniques best suits their situations. The costs of a specific soil and water conservation measures can sometimes be prohibitive and these deserve a thorough pre-assessment.

2. In-situ water harvesting

In-situ rain water harvesting (IRWH), involves the use of methods that increase the amount of water stored in the soil by ensuring that every single rain drop available during the cropping season is well captured where it falls. The amount of water stored as a result of IRWH to a large extent is determined by the action taken on cropland during manipulation of soil physical condition prior to crop establishment. Primarily, IRWH techniques, improve soil moisture retention by enhancing infiltration and reducing the water which is lost through surface runoff[7]. The IRWH technologies namely tied ridging and ripping techniques hold water long enough due to ponding through micro-basins and rip lines created in the field respectively. The soil moisture conserved under IRWH techniques has a potential to delay crop moisture stress. The extra water made available to plants contributes significantly to the biomass accumulation which translates to increased crop yield. The application of tied ridging technique in particular works better in areas with a slope gradient less than 7%. For smallholder farmers, in Eastern and Southern Africa, tied ridging and ripping IRWH techniques are viable option for optimizing soil moisture retention in an area with annual rainfall of 300-800 mm per annum.

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7 Vohland K, Barry B (2009). A review of in situ rainwater harvesting (RWH) practices modifying landscape functions in African dry lands. Agri Ecosyst Environ 131:119–127

2.1. Benefits associated with tied ridges

There are many benefits associated with the use of *in-situ* rainwater harvesting technologies (IRWT) such as tied ridging and ripping in the semi-arid areas of Eastern and Southern Africa. The IRWT improve soil moisture retention by increasing the ponding time, infiltration and reduced surface runoff. The extra water conserved in the soil helps in overcoming dry spells and improving crop yields. The ultimate benefit of IRWHT is enhanced yield stability which will ensures household food security for smallholder farmers. For example, use of an oxen drawn ridge plough and ripper increased sorghum grain yield in semi-arid areas by two to three folds as compared to conventional tillage[8].

2.2. Challenges associated with tied ridges

- The tied ridging technology works better in area with less than 7 % slope. Above, 7 % slope, ridges can fail due to overflowing and when this occurs, greater soil losses occur.
- In case of annually made ridges high labour may be required, however, in case no-till tied ridging is adopted the labour requirement for reinforcement is much lower.
- In case farmers have no access to sources of draft power or tractor drawn tillage implement there is high labour requirement amounting to 25-35 labours days ha^{-1}.
- The tied ridging technology may not be appropriate for well drained soils e.g. sandy soil. Some ridges and ties may be restored but could vary depend on soil type and rainfall intensity.

Figure 2: The cross ties retain rainwater by allowing longer time for infiltration.

2.3. How to get started on use of tied ridging technology

The procedure for tied ridging preparation entails a series of steps:

1. Conduct training on the use of ox-ridger drawn tillage implement to equip the farmers with the technical knowhow on the proper handling of draught animal and equipment.

8 Majule et al., 2013

2. Ridging using readily available sources of power and inter-row spacing relies entirely on the crop variety to be grown and specific agro-ecology recommendations.
3. Ridges should be installed across the slope and the height of ridges may vary depending on the soil type and source of available power.
4. Ridges of about 25 - 45 cm height can be made in the field to maximize the amount of water that can be retained following a big rain storm.
5. Install cross ties along the ridges by scraping up soil from the bottom of the furrows using available implement (hand hoe/animal drawn implement/tractor powered implement) at an interval between 1 m to 2 m apart.
6. Install cross ties a half to two thirds the height of the ridges to allow excess accumulated runoff to drain away smoothly following a big storm.
7. Within the growing season, maintain the ridges and ties to restore it to their original geometry particularly following a big rainstorm. The frequency of maintenance for the ridges will depend on the soil texture. For instance, sandy soils may require two to three maintenances and clay soils might need only one.

2.4. Opportunities for application of technology

In the fragile ecosystem of Eastern and Southern Africa characterized by inadequate and erratic rainfall, a wider application of IRWH is feasible. Increasingly, IRWH for smallholder farmers is tailored to the use of oxen/donkey ridger/ripper drawn tillage implements to save labor. The advantages of these implements, employed in the formation of ridges and preparation of rip lines, is that they are fabricated locally within the region. Secondly, both the ridger and ripper attachments can be interchangeably mounted on the same frame which reduces costs for the farmer.

2.5. Potential intervention impact

Within the scope of this guidance, the potential intervention impact describes the benefit of soil and water conservation but would depend on the indicators one chooses. For landscape soil and water resources management, the potential intervention impact is the result of the comparison between the baseline scenario and the project scenario. The anticipated impact is successively expressed as an outcome indicator when a plausible relationship with a given process indicator is presented e.g.

1. Loss of top soil is prevented (%)
2. Quantity of soil moisture captured that results in increased yields (%)
3. Percentage soil cover for reduced evaporation losses (%)
4. Other landscape assets or household assets are protected (USD)

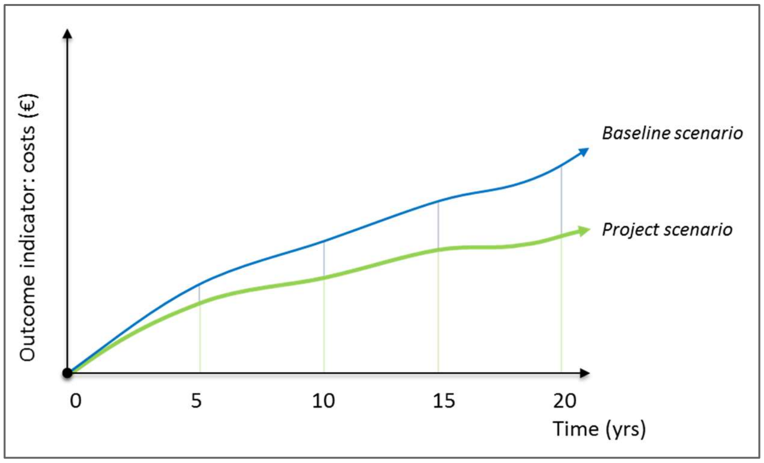


Figure 3. Benefits from the implementation of a proposed landscape intervention

3. Complementary case for the Upper Tana Basin in Kenya

Groups of farmers and extension agents within the Thika-Chania and Sagana-Gura watersheds were trained on water quality monitoring, measurement of infiltration, capturing of surface runoff and erosion prevention. The training consisted of a total of 80 people with 46 males and 34 females. The farmers were given a farmer scorecard that helps with evaluating landscape health

Figure 4. Training on watershed monitoring in the Tana Basin

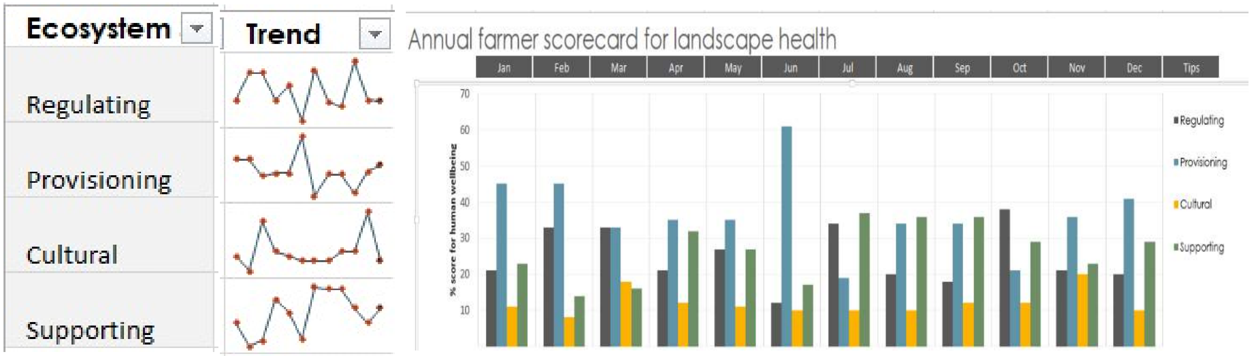


Figure 5. Annual farmer rating with a scorecard for landscape health with the ecosystem services for regulating, provisioning, cultural and supporting.

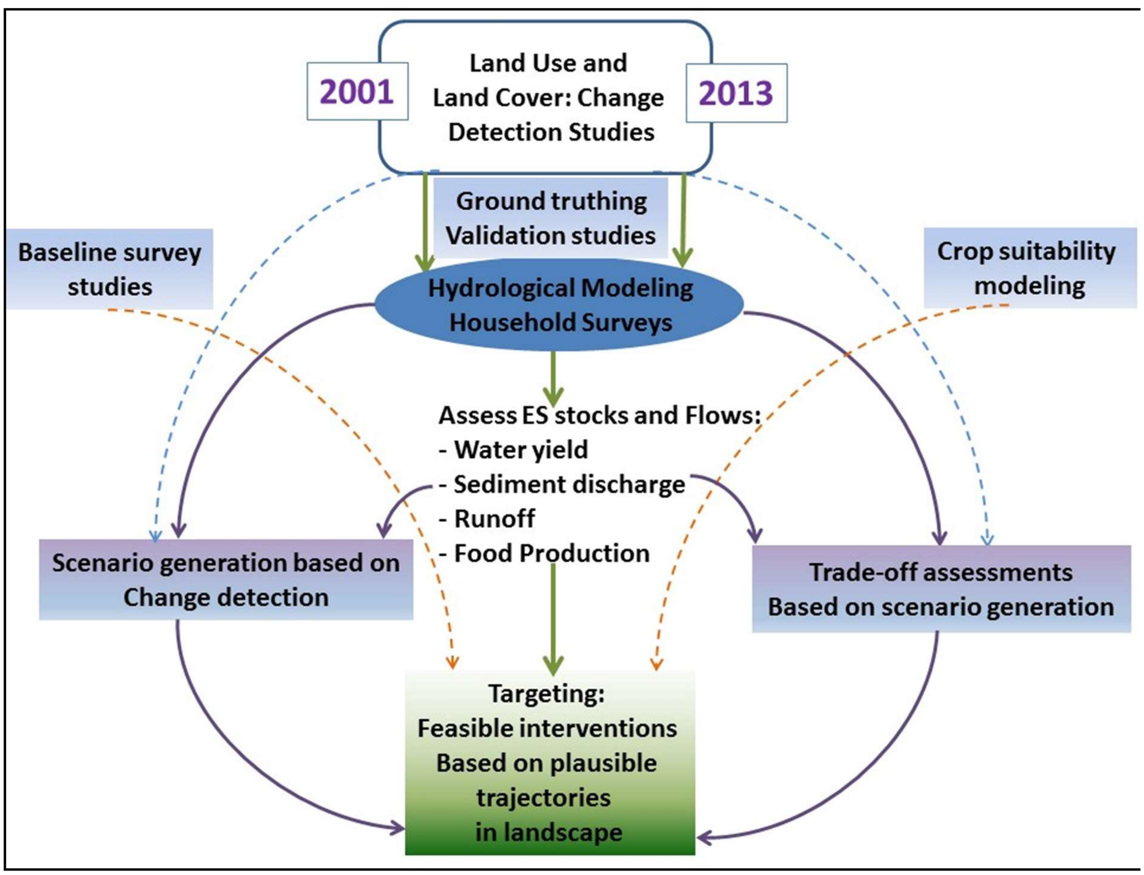


Figure 6: Conceptual representation of the methodology

Agricultural landscapes face the challenge of increasing food production for an ever increasing population while simultaneously reducing the use of inputs and delivering on other ecosystem services. In the upper Tana Basin of Kenya, landscapes are undergoing rapid changes as a result of land use transitions and this calls for rethinking management options with a multidimensional ecosystem-based lens in order to ensure that transitions are sustainable and beneficial for livelihoods and the environment in the long term. This study revealed both gains and losses from the different land cover categories in the Upper Tana Basin of Kenya (Sagana-Gura and Thika-Chania watersheds) during the 2001 – 2013 period. This study quantified changes in soil and water-related ecosystem services (specifically sediment retention/erosion prevention and water yield) as a result of the land use transitions. The most significant net change in acreage showed that for the Sagana-Gura watershed, there was a 70% transition of grasslands to cereals with forests transitioning to tea and cereals with 11% and 16% changes respectively. For the Thika-Chania watershed, the most significant net change in acreage showed that 77% of grasslands were transitioning to coffee zones while 43% of forests changed to tea and 14% forests changed to vegetables. Crop suitability assessments revealed that areas will become increasingly suitable for both maize and beans, specifically the mid-west of the two watersheds in the Upper Tana in the area currently covered by tea. We used the Soil Water Assessment Tool (SWAT) as a hydrological model to assess sediment yields in the landscape. Models results revealed that consideration of point sources outside of agriculture, specifically quarries is critical to assessing overall landscape contribution of sediment within streams. For this study, quarries contributed to 25% extra sediment supply to the overall load. SWAT was used in combination with land use change detection and crop suitability assessments to develop potential feasible future scenarios of sediment and water yields in the two watersheds.

Scenario generation revealed that the conversion of 60% tea lands to coffee zones would generate higher sediment loads in the Sagana-Gura and Thika-Chania watershed by 8% and 17% increments respectively. This would be more pronounced if there was 60% conversion of tea lands was to agriculture (cereals and vegetables) and would generate even higher sediment loads in the Sagana-Gura and Thika-Chania watershed by 23% and 27% increments respectively. The reverse is true if 40% of the agricultural areas were replaced by tea, it would result in a 21% and 17% reduction in sediment loads for both the Sagana-Gura and Thika-Chania watersheds respectively. Quantitative assessments and scenario generation revealed numerous tradeoffs between environmental integrity and livelihood needs (income and food security). Under all scenarios, appropriate agricultural management practices are critical to realizing the multiple benefits of ecosystem services and reducing disservices from agricultural activities. There is need to conduct further detailed studies in order to provide sustainable intervention options for landscape management in order to realize both on-site and off-site benefits within the target agroecosystems.

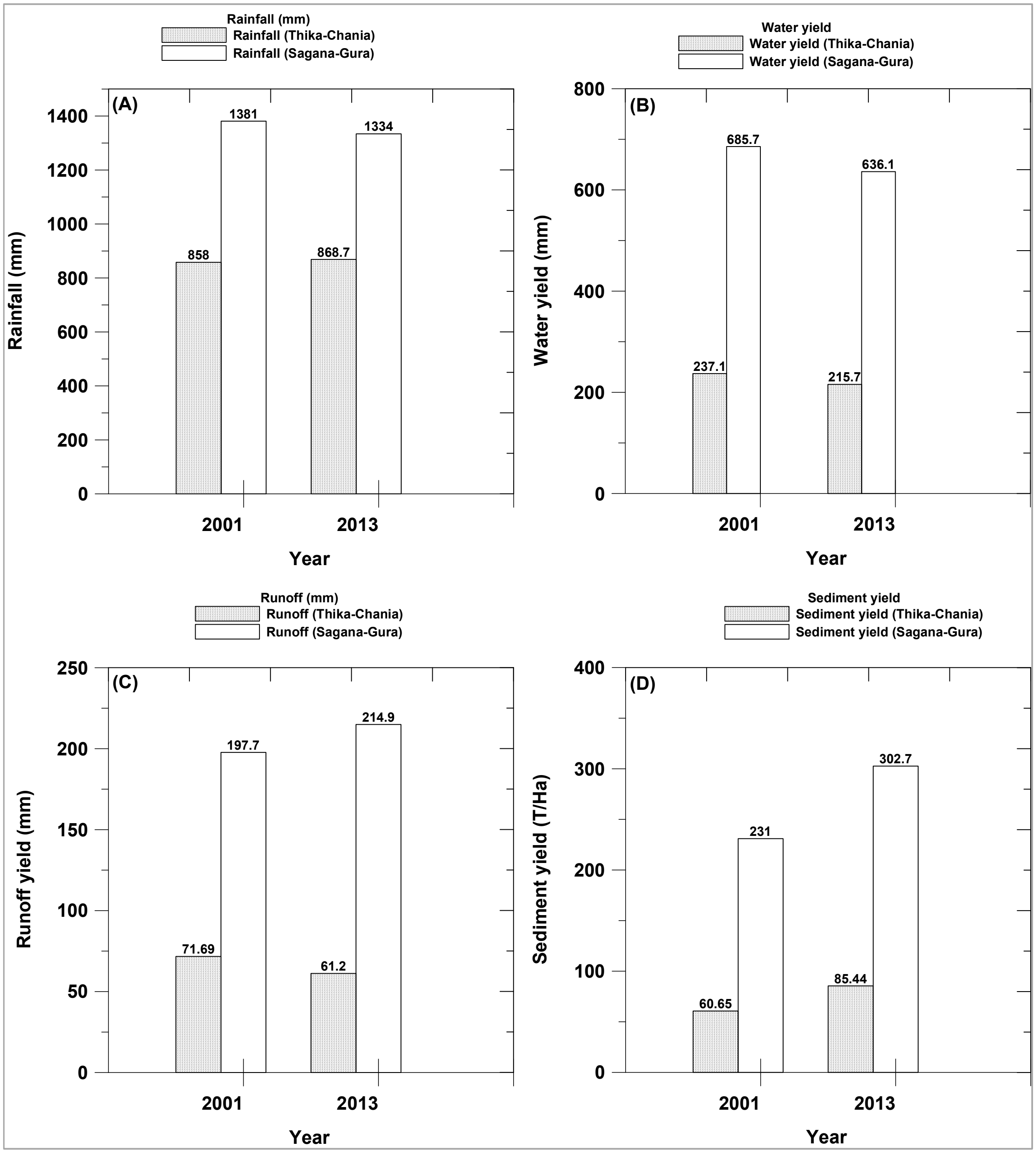


Figure 7. Comparisons of rainfall, water yield, runoff and sediment yield between 2001 and 2013 for the Thika-Chania and Sagana-Gura watersheds

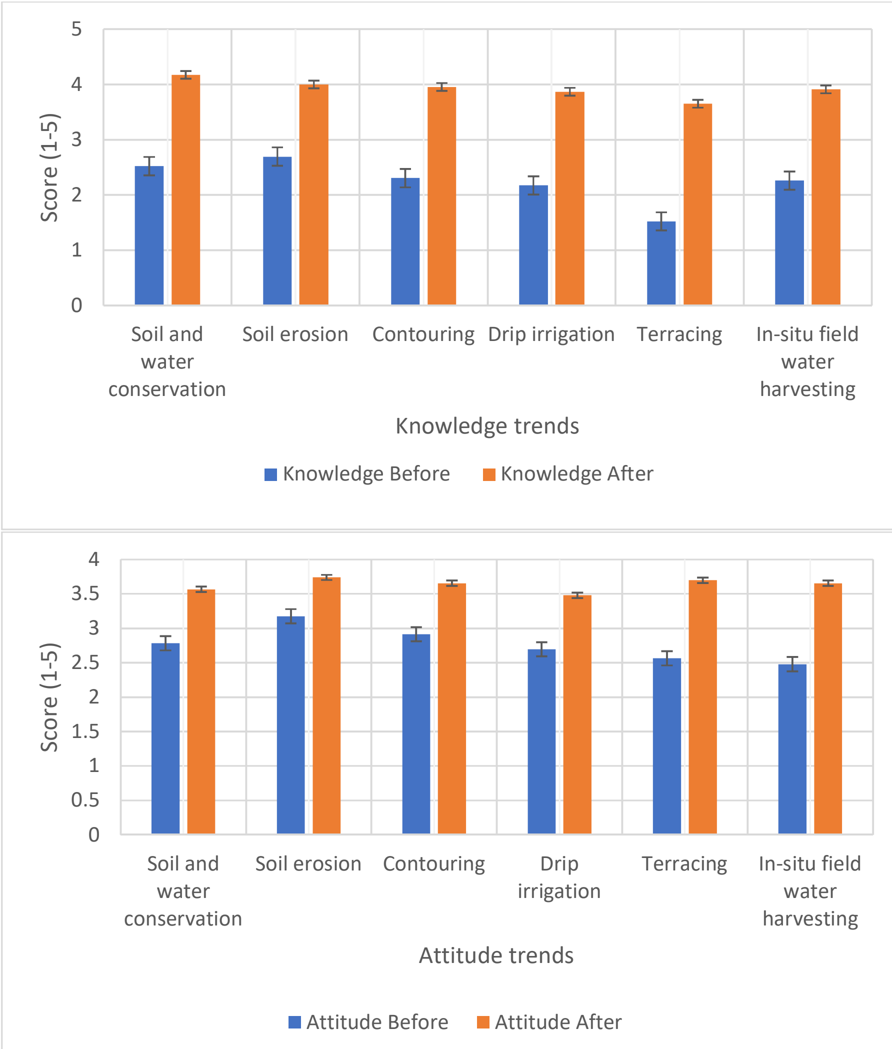


Figure 8. Training assessment for farmers on their knowledge and attitude trends for soil and water conservation measures.

You can read more about a related study at:

https://wle.cgiar.org/thrive/2018/10/09/erosion-eating-away-african-farms-here%E2%80%99s-why-measuring-damage-so-important

4. Complementary case for scenario building with hydrological models for landscape restoration: The case for Bungoma County in Kenya

We share a policy brief aims to give an overview of land degradation hotspots in Bungoma County and the policy options for land restoration. In this assessment, land degradation is referred to as the persistent loss of ecosystem function and productivity caused by disturbances from which the land cannot recover without human intervention (unaided). Hotspots are defined as places that experience high land degradation and if left unattended, will negatively affect both human wellbeing and the environment. The spatial location of hotspots was identified through a methodology combining modeling, participatory stakeholder consultations and field validation. Understanding the spatial locations helps identify hotspot areas and target them as priority intervention sites with relevant management options. This county policy brief is complemented by detailed National comprehensive assessment report which can be accessed at this link: https://cgspace.cgiar.org/handle/10568/97165

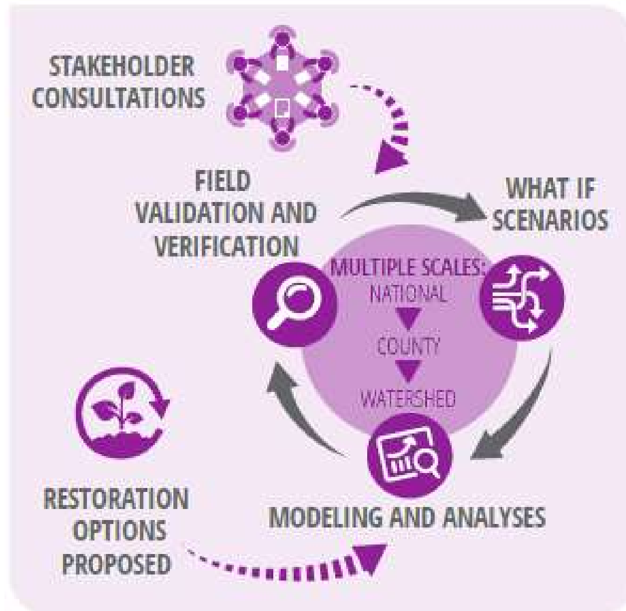


Figure 9: Land degradation assessment approaches

The methods conducted in this land degradation assessment were hierarchical (covering three different scales: national, province and watershed) and involved stakeholder consultations for field validation evidences (See Figure 9)

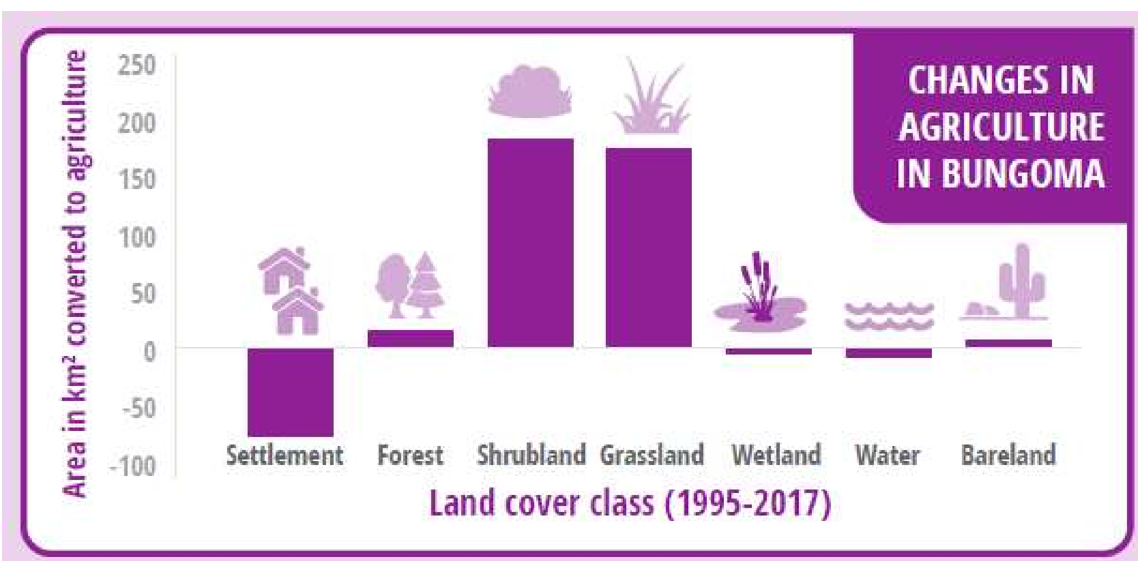


Figure 10: Land use changes in the context of agricultural land (gains and losses)

To account for the role of differences in land use/cover on land degradation, we used land use/cover data generated from Landsat satellite image analysis. This figure exemplifies the land use and land cover changes in Bungoma County. Since agriculture is most predominant, the figure portrays values above zero which are areas in square kilometers converting into agriculture in relation to other classes. Values below zero are areas in square kilometers for agriculture converting into another land use class. Land use conversions and transitions for Bungoma County show that the most pronounced changes were in the agriculture land use category.

Figure 11 depicts an overall degradation risk map. The areas most affected by degradation (brown patches) are in the Southern parts of Bungoma specifically around Nzoia, Chwele, South of Bungoma, Mayanja and South of Webuye as well as Sirisia. The land degradation map highlights areas with high risk. This is more pertinent in the southern parts of Bungoma specifically around Nzoia, Chwele, South of Bungoma, Mayanja and South of Webuye. There are areas with the light green to brown patches. The green areas are areas with moderate to no degradation risk.

Key Messages towards land restoration in Bungoma:

KEY MESSAGE 1: Soil erosion and land degradation risks are eminent in the Southern parts of Bungoma County specifically around Nzoia, Chwele, South of Bungoma, Mayanja and South of Webuye and deserve tailored management interventions to prevent a downward spiral

KEY MESSAGE 2: Food insecurity within Bungoma county is specific to the Southern parts of Bungoma specifically around Nzoia, Chwele, South of Bungoma, Mayanja and South of Webuye and to the North East of Webuye areas and deserves tailored management interventions

KEY MESSAGE 3: Land use changes in Bungoma County have greatly contributed to land degradation highlighting the need for policy reforms in land use decisions

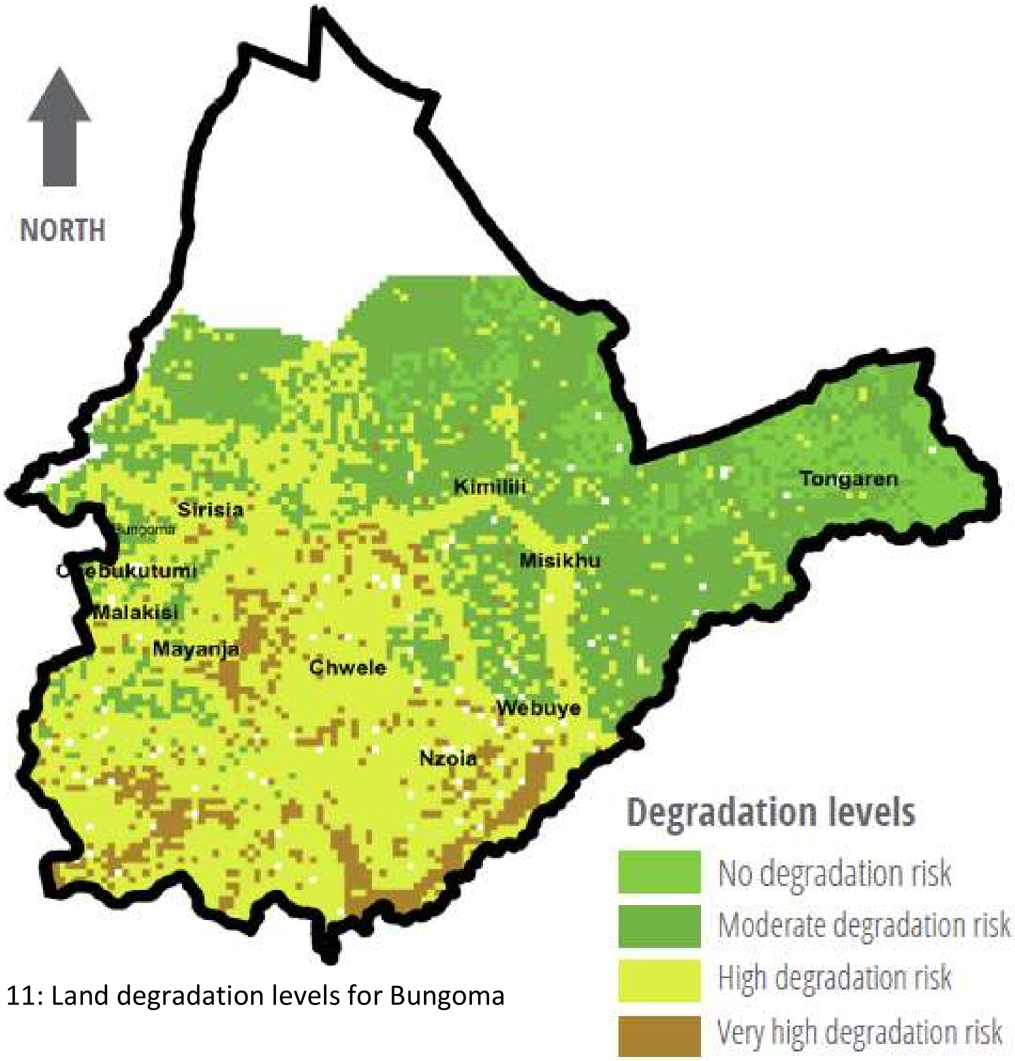


Figure 11: Land degradation levels for Bungoma

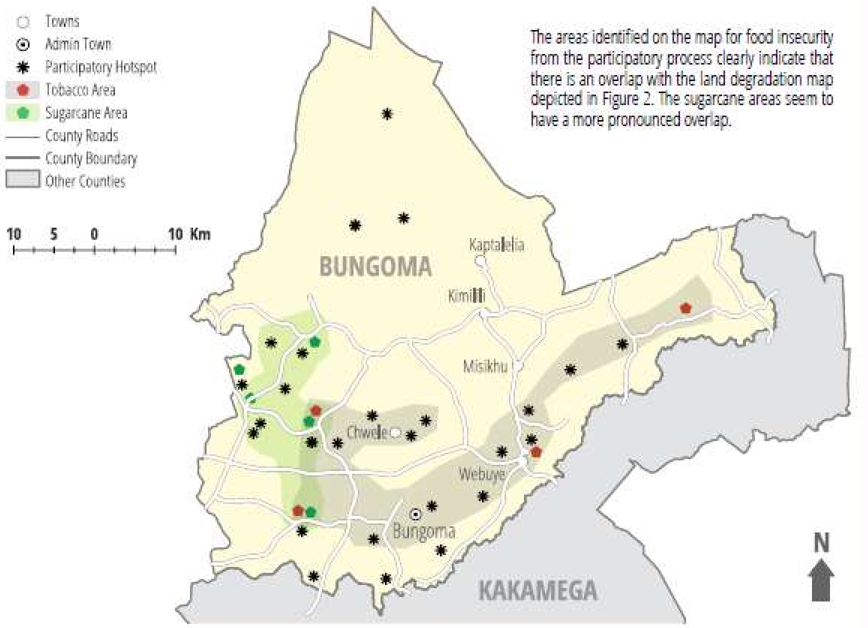
DEGRADATION RISK LEVELS IN BUNGOMA

10%	of the land area is under **very high risk** and is classified as degraded	10% human and livestock population
40%	of the land area is under **high risk** of land degradation	45% human and livestock population
35%	of the land area is under **medium risk** of land degradation	35% human and livestock population
15%	of the land area is under **none to low risk** of land degradation	10% human and livestock population

NOTE: The percentages in the light purple rectangles (on the right) imply that this is the percentage distribution of both human and livestock populations in the degraded portion that is highlighted in the dark purple circles to the left.

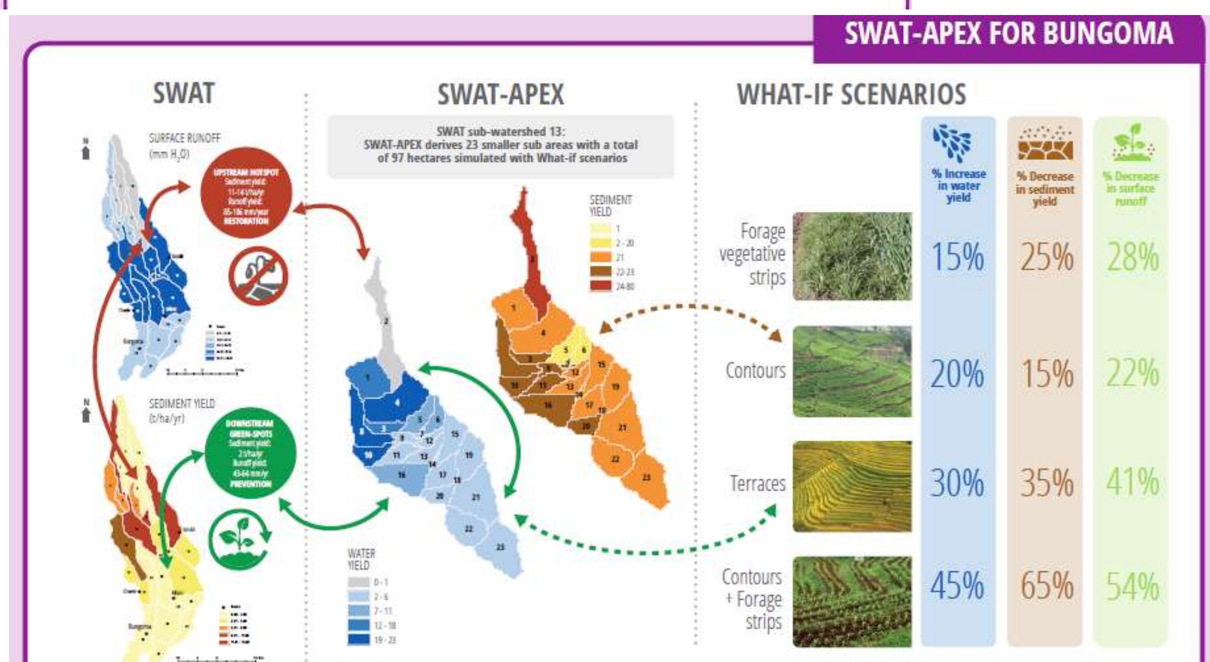
This study further analyzed both sediment and runoff load reductions obtained from simulated scenarios for current (business as usual) and proposed best management practices within a selected watershed of Bungoma. This served as a means to explore possible intervention options that can be promoted by decision makers for implementation by local communities. We describe the identification of dominant sediment and runoff delivery mechanisms in the watershed with readily available tools consisting of SWAT and Agricultural Policy and Environmental

ZONE	FOOD INSECURITY REASONS
Sugarcane belt	Striga weed infestation; low soil fertility; mono-cropping of sugarcane all year.
Tobacco zone	Low soil pH; encroachment on community agricultural lands by tobacco & paper companies; population pressure
Extended tobacco zone	Intense deforestation; encroachment on catchments between hills and Saboti Land Defense Forces (SLDF) ; squatter displacement



The areas identified on the map for food insecurity from the participatory process clearly indicate that there is an overlap with the land degradation map depicted in Figure 2. The sugarcane areas seem to have a more pronounced overlap.

Extender (SWAT-APEX) models for conducting the "What-if" scenarios. These tools also developed multiple regression equations to estimate the sediment and runoff ratios for the sub-watersheds. The models used 35 years of weather data from 1981 to 2016. The "What if" scenarios that were conducted in the SWAT-APEX interface were selected based on stakeholder workshop feedback and quantitative data on the current status quo or business as usual in case no interventions are done.



The combination of contours and forage strips yielded the greatest percentage of water and biggest decrease in both sediment and surface runoff. The performance of the terraces was also quite good. The sole implementation of forage vegetative strips or the contours did not perform as well as the combination of the interventions.

APPENDIX A: Sample Case study for stocking of land restoration

There is currently an enormous political demand and a range of commitments on landscape restoration (Bonn Challenge, GPFLR, AFR100, NY declaration on Forests, UNCCD LDN, Great Green Wall etc..), and a range of institutions working on the issue. However, beyond some success stories, landscape restoration is not happening at scale. Why so?

We adopt here a broad definition of restoration as "***efforts to secure recovery of ecological functions allowing the long term productive use of land***".

We propose a sample case study for restoration efforts in the Tana Basin. This was conducted through support from the WLE CRP.

Title: Biophysical and socio-economic synthesis of the effectiveness of land restoration towards enhancing food security and livelihoods in smallholder communities
Starting year: **2016**
Ending year: **2018/19**
Place: **Tana Basin, Kenya**

1a) Scale:
From farm to landscape

1b) Driver of degradation addressed/reversed
Land use changes/habitat transition. Since the 1970s, forests on steep hillsides and areas of wetlands in the Tana Basin have been converted to agriculture. As a result, sedimentation is becoming a serious problem, reducing the capacity of reservoirs and increasing the costs for water treatment. Today, 60% of Nairobi's residents are water insecure.

1c) Stage of the forest transition curve
It is a mix of Agriculture for the most part and Agroforestry for the other parts.

1d) Entry point:
1. Governance, institutions
2. Biophysical (soil, vegetation)
3. Economics, livelihoods

2) Short description of the project
The project is located in the Upper Tana Basin of Kenya. It is a public-private partnership that includes the Nature Conservancy and CIAT. Forests and wetlands in the Upper Tana play an important role in maintaining water quality and quantity, providing areas where runoff water and sediment can be stored and filtered naturally. The challenges to water security will likely grow as climate change brings increasingly unpredictable rainfall. The impact of landscape restoration on incomes and livelihoods of farmers was previously not well understood. This project endeavors to translate biophysical data into socio-economic metrics with specific indicators under consideration.

3) Results

Impacts: positive, failure, unexpected impacts (positive or negative)

Results from our monitoring data in relation to soil erosion and the associated intervention measures indicated that there was an order of magnitude of increase in runoff for areas without sustainable land management with about 40% increases in sediment losses. This underpins the importance of landscape stewardship at the farm level which translates to wider influences at the landscape scale.

3.1. What has helped?

The existence of a functional partnership with the water resources users association and the private sector have been very critical to the success of ongoing efforts to control upstream soil erosion from the Tana Basin to downstream areas.

3.2. Main constraints?

There are several challenges associated with the management of partnerships that involve the public and private sector entities. Currently, there are challenges associated with funding upstream activities and interventions that reduce erosion that involve the smallholder communities.

4) Evidence of impact

Results from our monitoring data in relation to soil erosion and the associated intervention measures indicated that there was an order of magnitude of increase in runoff for areas without sustainable land management with about 40% increases in sediment losses. This underpins the importance of landscape stewardship at the farm level which translates to wider influences at the landscape scale. The areas that had interventions specifically grass strips & terraces indicated better sedimentation retention and water yields of 30% and 45% respectively.

5) Relevant further reading

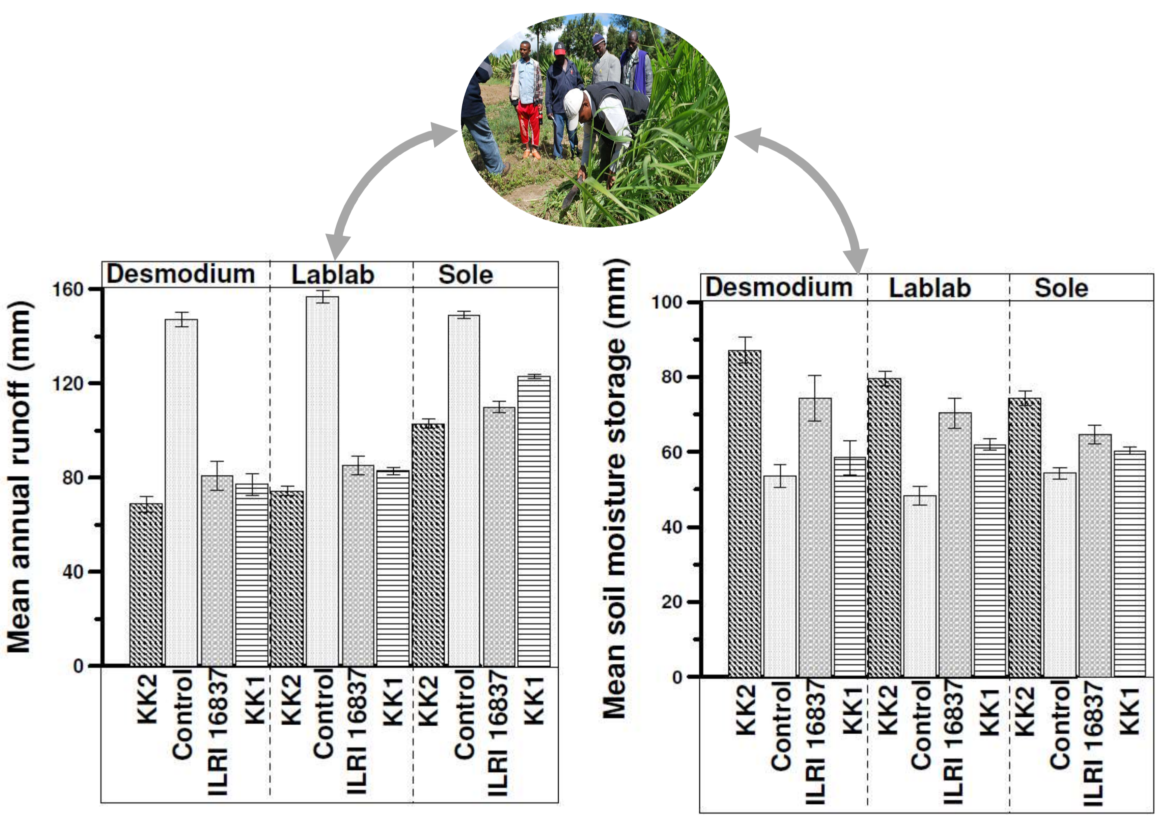
- http://www.ciatnews.cgiar.org/wp-content/uploads/2014/11/WLE-Innovation-Fund_Final-Report.pdf

- https://wle.cgiar.org/thrive/2018/10/09/erosion-eating-away-african-farms-here%E2%80%99s-why-measuring-damage-so-important

APPENDIX B: Soil and water conservation with forages within smallholder agricultural systems in Babati District, Tanzania

Cover and fodder crops are known for high nitrogen fixation. Africa RISING Scientists introduced soil and water conservation on terraces for sloping fields in Babati District. We demonstrated that runoff levels were reduced in areas with forage grass-legume intercrops (40-60% lower runoff); there was higher soil moisture storage (on average of about 25 mm of moisture over a depth of 50 cm (30% higher)) in areas with forage-legumes than the control areas.

Associated benefits: Perennial forages reduced overall erosion and served as soil amendments through nitrogen fixation resulting in improved sustainability of farming systems in addition to contributing towards feed resources. These combinations allow for providing livestock feed, household nutritional needs, fodder legumes for sale while playing a critical role in risk reduction against pest and diseases (push-pull system) as a co-benefit.



Mean annual runoff and mean soil moisture storage trends among forage grass-forage legume combinations over two years 2014 and 2015.

Link to further information:

- *Book Chapter:* http://www.springer.com/gp/book/9783319412368
- *Infographic for integrated systems:* https://cgspace.cgiar.org/handle/10568/76339