Tamera

Healing Biotope I

Global Ecology Institute

Report of Kenya visit

Goal of the visit

Review of Watershed Management Plan of the Muvitha Kathemboni watershed

Table of content

Summary

The current land-use within the catchment of the Musosya dam has lead to a full siltation of the dam over the last 10 years. This means that the local population currently does not have access to water from the dam. The first step that has to be taken is to change the land-use. We recommend to form a watershed community involving all stakeholders. In each parts of the catchment different measures have to be taken for restoring the catchment. As a general line we recommend to increase vegetation cover so that all earth is covered and rooted. To achieve this we propose a common livestock grazing management. In addition mainly small earth works should be undertaken, which are already widely known by the community members. On the slopes the natural bushland/forest vegetation should be restored. We propose to build an open well in the silted dam to get water accesses. Furthermore other wells should be constructed in the valleys for decentralized access to water.

Reservoir in Kitui Town

Places and issues assessed during the Kitui visit

31.08.2013 Kitui Town

- Arrival in Kitui town
- Study of Rainwater Harvesting techniques and agriculture practices
- Visit of earth dam near Kitui town
- Piped and hand fetched (potable) water supply of Kitui town

01.09.2013 Kitui Town

- Study of rainwater harvesting techniques and agriculture practices
- Waste water infrastructure of Kitui town
- Dried up riverbeds around Kitui town
- Visit of unfinished building site of concrete dam

02.09.2013 Kitui Town, **Nthongoni**, Kitui County

- Field trip to Muvitha Kathemboni Watershed
- Assessment of silted Musosya earth dam
- Study of earth work like terraces and swales

03.09.2013 **Nthongoni**, Kitui County

- Determination of watershed size
- Erosion on roads
- Influence of animal traffic and grazing
- Study of grassland vegetation,
- Insecure agriculture production due to regular floods
- Deforestation

04.09.2013 Kitui town

- Review field visits
- Mapping of watershed
- Vegetation cover, mulch, grazing, maps

05.09.2013 **Nthongoni**, Kitui County

- Sand Dam
- Wells
- Upper Catchment

06.09.2013 **Nthongoni**, Kitui County, Kitui town

- Retention ponds along road site
- Meeting with watershed community members

Sustainable Water Management as the basis for rural and urban planning

Introduction to the principles of a Water Retention Landscape

Desertification, droughts and floods have a common reason: the damage of the hydrological balance by deforestation, industrial agriculture and sealed surfaces in urban areas. Naked soil becomes hot and looses the ability to absorb water. Rain erodes the topsoil. The earth body dries out, global groundwater reserves and soil fertility decreases. For food sovereignty we need a proper water balance.
A Water Retention Landscape is a model for natural and decentralized water management and restoration of damaged ecosystems. It is a basis for reforestation, horticulture and agriculture in regions threatened by desertification, and is part of a comprehensive model for sustainability on a large scale including water, food, energy and community building.

In short the basic principles of the Water Retention Landscape are:

No rainwater should run over the earth surface but rather be infiltrated into the soil where it falls. Taking a certain territory into the focus the goal would be that no more rainwater and waste water leaves the territory but rather all water flowing away comes from springs.
If the aquifer is recharged water is available from springs and from wells in sufficient quantities for all human usage. In most cases the soil and the earth body is not capable to infiltrate the rainwater immediately due to mismanagement. Therefore different methods are applied within the Water Retention Landscape to restore the water balance. This includes: building of retention reservoirs (ponds, earth and sand dams), terraces, low proportion of sealed surfaces, road water infiltration, swales, permanent vegetation cover, mulching, adequate grazing management, afforestation…
If the principles are understood and integrated in the planning and management, water is available all through the year, erosion is stopped, landslides are avoided, vegetation grows vigorously, rivers are constantly flowing, floods are moderate, risk of fire is low, decentralized biological agricultures enables local food security…
Therefore we stress the importance of sustainable water management. In countries which have a low development of infrastructure there is a large potential to implement it in the right manner and not repeating the mistakes of the past and current management.

A detailed description of the Water Retention Landscape is published in the brochure “The Secret of Water” by Bernd Walter Mueller:
http://www.tamera.org/fileadmin/PDF/2.2_The_Secret_of_Water.pdf

Description of ecological and hydrological situation of the watershed

The Muvitha Kathemboni Watershed area is a typical site in the western part of the Kitui Province.
The catchment has a size of approx 300 ha; the upper part is situated on a plateau on around 1140 mamsl, while the dam is situated at around 1010 mamsl. The flat plateau area is mainly used for agriculture and grazing around the family settlements. At the edge of the plateau steep to medium steep slopes descend which are mainly stocked with natural trees and bushes. Also some terraced parts occur and most of this bushland is grazed. In the lower parts of the catchment the inclination is softer and much land is terraced for agriculture use. Here houses of the landowners, infrastructure for livestock and grazing areas are situated.
There is access from a larger public road to the plateau area, and a smaller earth road leads to the dam area. A partly very steep earth road runs downhill from the plateau to the dam area.
All land is in private ownership, except the dam area which is public. There are around 30 private owned territories in the watershed area.
The annual rainfall for the area is not precisely known, values range from 300-1000mm/y.
The map shows a satellite image of the area with estimated watershed borders (page 7).
The area shows serious degradation of vegetation and soil. Everywhere erosion occurs as a result of heavy rainwater runoff. Small and large gullies have formed and the eroded material has silted the dam within the short period of 10 years. The vegetation cover of the soil is very little, often the ground is bare. The missing anchoring roots and the compacted soils lead to low infiltration and massive runoff.

The main factors for this ongoing degradation process can be summarized by:

Low vegetation cover and low soil vitality

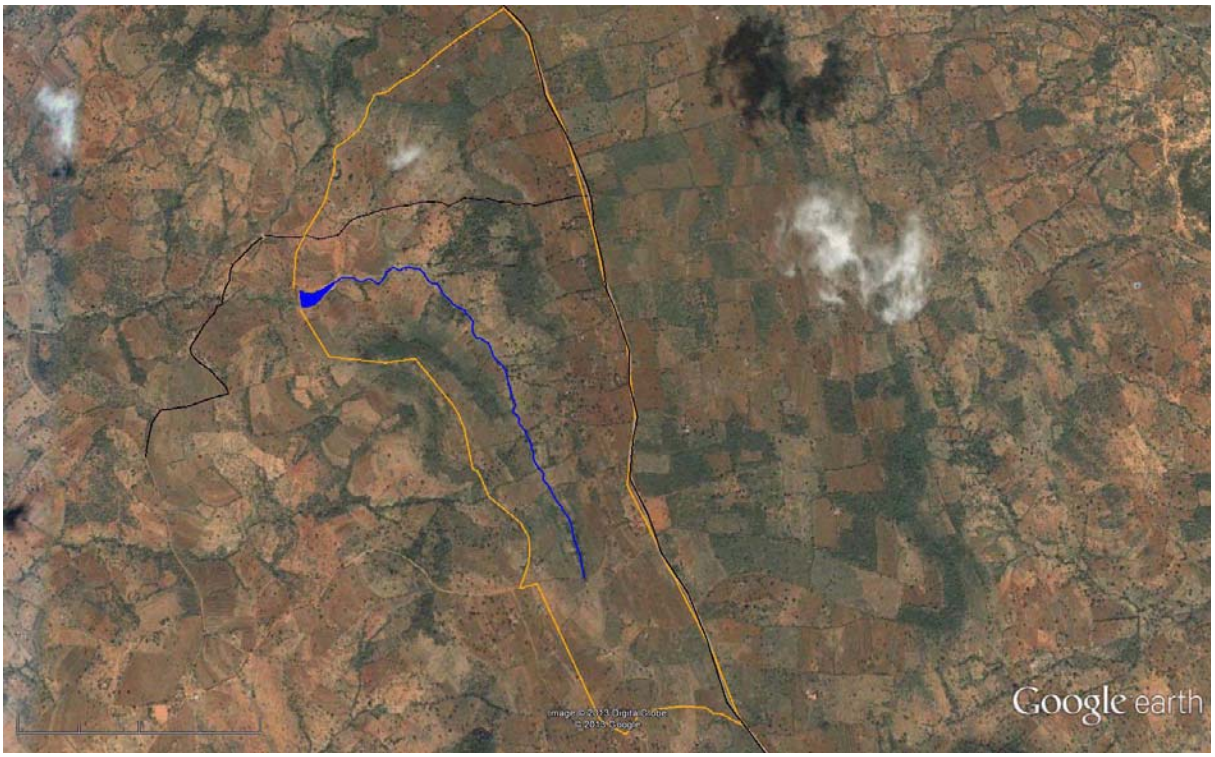
The main interlinked factors of the land-use techniques are:

- Low vegetation cover on agriculture terraces (during dry season)
- Unmanaged grazing, animal trampling
- Deforestation for charcoal production, clay brick production and domestic use

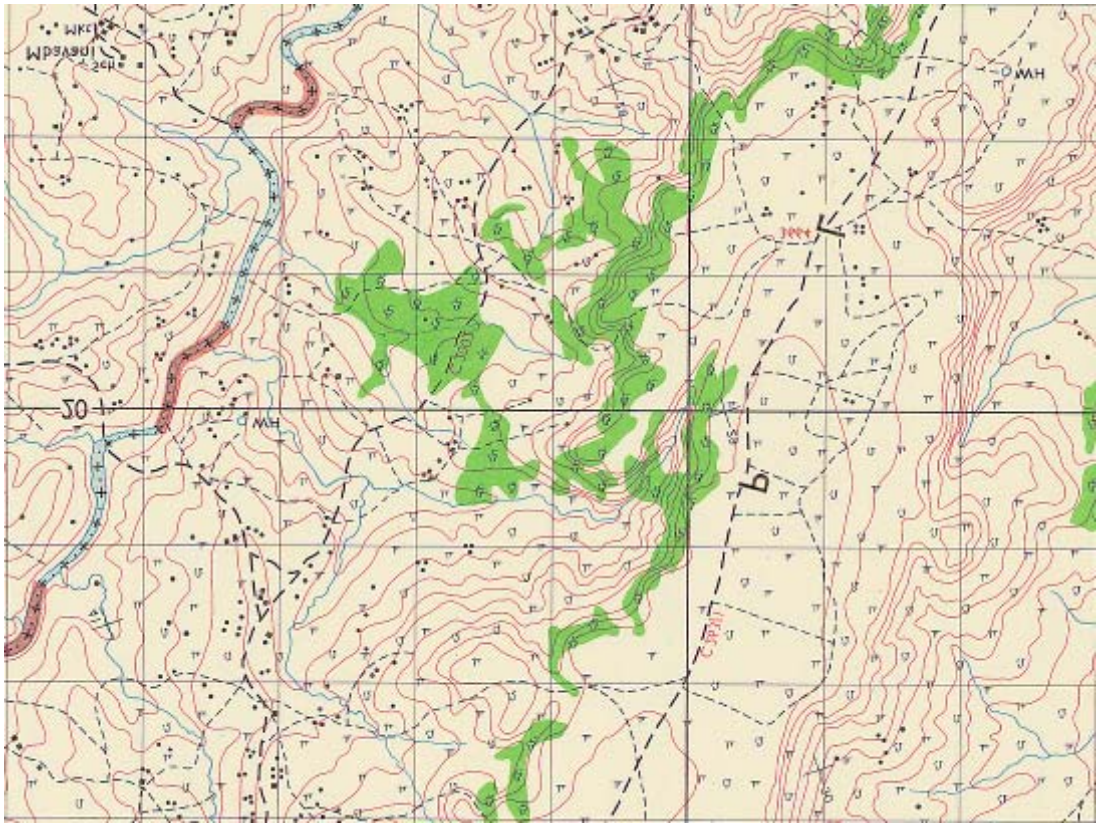
All of these land-use methods lead to high erosion

- Low infiltration leads to high runoff
- Unstable soil conditions by lack of vegetation and roots
- Roads and pathways produce high runoff…
- Compacted soils (livestock)
- Gullies
- Siltation of dam
-

Therefore the goal should be the full restoration of the catchment area. Soil and water conservation must work hand in hand to stop the process of degradation and lead to a regenerative state of the catchment.



Satellite picture from Google earth showing estimated catchment border (orange), Main valley and dam (blue) and roads (black)



Sample showing the watershed area from topographic map, Kenya Survey

Landscape restoration

We emphasize that the main goal is landscape restoration for the whole catchment to secure water supply and livelihood from agriculture and other natural resources. This can only be achieved if all owners participate in a watershed management committee.
We propose to formulate goals on which the landowners communally agree, like:

- **Zero runoff** of rainwater (full infiltration of rainwater to recharge the aquifer)
- **Permanent vegetation covers of the soil**
- **Permanent running watercourses in main valley**
- **Decentralized drinking water access:** Wells close to the valleys and the settlements

To restore the dam reservoir (by removing the silted material) before avoiding further erosion is not sustainable. The general proposal is to redirect the work and training to the other proposed measures.
In addition we want to emphasize some points that have not been addressed in accordance to their significance. This is the role of vegetation cover, livestock management and the maintenance and use of roads and pathways for a full infiltration and recharge of the aquifer.

During the field visits of the consultation we reviewed the proposed measures for soil and water conservation, mainly aiming in the prevention of erosion.

Recharge of aquifer

With regard to hydrology the main goal of the restoration of the watershed is the recharge of the (upper) aquifer. The rainwater is retained (not stored) in the soil and rock of the whole catchment area. After a period of water saturating the upper soil layers and first rock layers the aquifer will refill. This allows extraction of water all the year through from wells in a depth of around 2 -5 meters. Plant and tree growth is prolonged over the dry periods and irrigation becomes possible.
Retaining water in earth dams or sand dams are good means if the soil and earth body can not hold the water during the restoration phase. In the long run the largest and best retention space is the soil and the different layers of the aquifer. The now dried out water flows and river will start to flow permanently again if the soil is recharged with rainwater.

Vegetation

A large part of the area shows very little vegetation and/or leaf cover (living or dead mulch). Farming on terraces without cover crops as well as terrace or bench slopes without vegetation is one reason. Another is a continuous deforestation for fuel uses. Livestock is probably the strongest factor. Grazing of animals as well as trampling an access paths to water sources with animals result in many areas with bare ground. A sustainable livestock management seems to be the key to a successful restoration.

Livestock management

The watershed needs a grazing management plan. This should include the areas for grazing, either privately or communally. Especially the roads and pathways to the settlements and the water sources should be carefully designed. The main access road show strong influence of animal trampling which results in bare and compacted soil. This leads to further erosion and destruction of the terraced land. The steep slopes should be managed to allow natural vegetation growth. Grazing rhythms which support the natural dynamic of this bush and grassland may be applied. Heavy and unmanaged grazing without rotation leads to high runoff which the lower part of the catchment can not cope with.
There are numerous grazing management approaches known in eastern Africa.
We strongly recommend taking local consultation and training for the involved landowners.

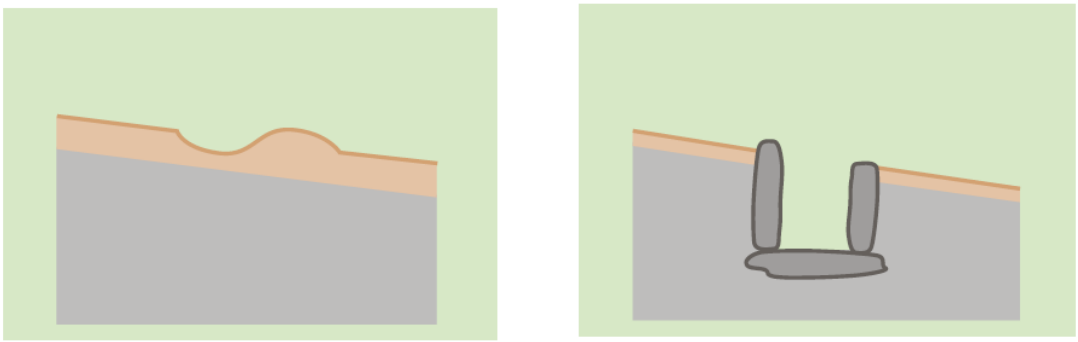
Earth works

Smaller structures

Different methods are proposed and already applied in the project. Farmers are trained in terracing, infiltration ditches (swales), stone berms…
All this solutions are suitable to infiltrate water thereby reduce runoff and erosion. And these methods are already applied and culturally accepted in the area.
Nevertheless they can only be of sustainable value if combined with **permanent vegetation cover.**

Roads and pathways

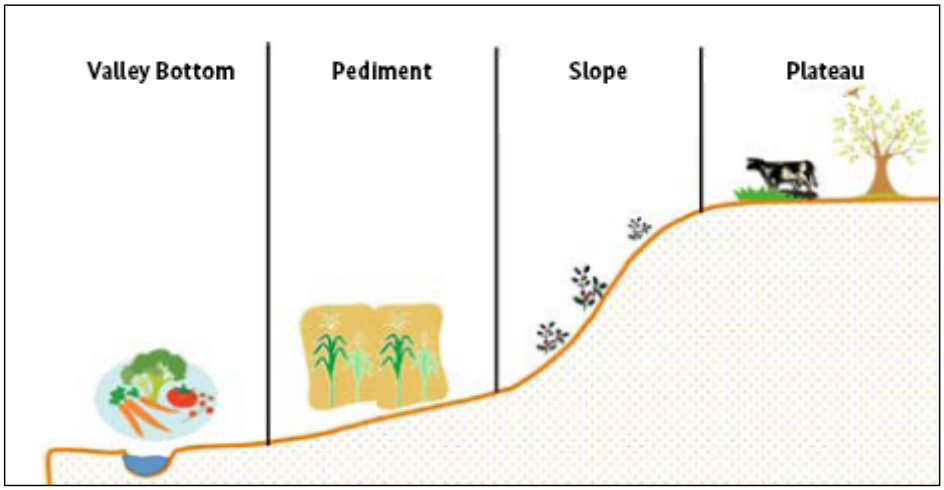
These features need special attendance. They are compacted and act as drainage and runoff channel. Especially the larger access road (see map page 7) must be repaired and regular cutoff drains must be established and the water can be redirected into swales on contour. The water from the roads pathway can act as a rainwater harvesting source, for example irrigation of trees or bananas in pits (see picture below). Most of these works can be done by hand, nevertheless if machinery will be part of the later implementation in the project some repair work of the roads could be effectively done by a caterpillar.



Sidewise (diagonal) direction of water on roads to cut of trenches or swales

Check dams
For the restoration of the gullies check dams are identified as the right measure. It is necessary to start with small structures where the force of the water is small. Stones, or brush berms or living cuttings of trees/bushes, help to anchor the soil.
Larger check dams can be built in the lower parts of the catchment and stop the continuous siltation of the dam reservoir. Nevertheless a serious of small structures will help to stop the erosion where it starts and thereby help to infiltrate the water on a higher altitude. The smaller the amount of runoff which reaches the downhill part, the lower is the force of the water and the simpler the structures can be.
For example: A check dam build in one of the main gullies close to the dam reservoir, must be build from concrete or gabions. Once the erosion is stopped upstream/upslope also these structures can be built from stone, plant material or from earth.
In some places the construction of check dams in the way a sand dam is build can be useful.

Sand dams
Sand dams are constructed within the area to store water in a sand aquifer that forms behind a concrete wall in a riverbed or gully. Hereby we can combine restoration and access to drinking water. Integrating concrete rings (or plastic pipes) before the process of siltation can allow access to water from a well kind of take off and in addition monitor the status of the upper aquifer.



Simplified relief and recommended uses

Plateau: Grazing, farming, trees
Slope: Natural bush and forest vegetation mixed with grassland
Pediment: agriculture on terraces
Valley bottom: Agriculture on terraces, with irrigation

Recommendations

Before the start of the rain season

Spillway restoration

The spillway (overflow) of the Musosya earth dam needs urgent repair. As shown in the picture **(**page 20**)** the dimension of the overflow is no longer adequate for the amount of the through flow. Therefore part of the dam is already eroded. If this continues dam failure can occur. The overflow should be expanded (enlarged in width) on the outer side of the spillway (away from the earth dam). If runoff is reduced the spillway can be fully restored in future.

Exploration of upper aquifer

Determine the level of the upper aquifer by at least three sample diggings: close to the dam, main valley upstream and in one of the larger site gullies. If possible apply concrete rings or plastic pipes in the hand dug holes. This will allow monitoring the level of the upper aquifer 0-5 meters before the rain and from there on. Aquifer levels can be measured with simple means as ropes or measuring tape. This will give the local community a connection to the water retained in their watershed aquifer.

Construction of a well in the silted dam

For immediate water access a well can be easily constructed in the silted dam reservoir, close to the dam wall on the opposite site of the spillway.

Installation of rain gauge

To get precise rain fall data a rain gauge should be set up within the catchment. Besides the total amount of rainfall, especially the rainfall distribution and the maxima are of special interest for the future management.

Rainwater Management

In the current situation of the catchment the next rainfalls will cause more erosion. The full infiltration of the rainwater into the soil will start to recharge the aquifer.

Start on the top and work downhill

If the rainwater runoff of the plateau area is stopped, landowners of the lower catchment only have to deal with the water that falls on their land. This will allow simplified restoration measures and avoid failure of these structures.

Start where the erosion begins

Small mitigation measure at roads, pathways or on bare soil parts can change the runoff drastically. On these spots working with a hoe, some brush material and stones can make a huge difference.

Next steps

Precise mapping of area by land-use category and ownership
The catchment border should be precisely identified and made public to all landowners. The management team should get access to all available maps and aerial photographs. A topographic map has been purchased and given to the project leaders. Working with Google earth can be sufficient; example maps are included in this report. Involving a GIS expert may be considered. For working with the landowners a simplified hand drawn map should be used . Especially in the upper north part of the watershed the borders could not be identified during the consultation field visits. The whole plateau needs special attention for identifying the precise watershed borders. This area is more or less flat, but rainwater uses paths and roads to flow into the catchment.

The mapping should include:

- Catchment border
- Borders of individual territories
- Main valleys
- Side valleys
- Roads, pathways
- Land-use
- Hot spots of erosion

Involvement of all landowners in the catchment
The current land-use and future needs of each landowner must be assessed and mapped (number of animals, grazing area, area of agriculture land, access to firewood…)
The best practices of the area should be determined and shown to all landowners. The hot spots of erosion should be known by all watershed committee members and worked on in communal effort (e.g. roads, pathways)

Training on conservation farming
In addition to the proposed training in terrace making of the landowners additional training should be considered:

- Training in organic farming using existing regional examples, focus on cover crops and mulching
- Experts on sustainable grazing techniques should be consulted

Cooperation with local experts
Local expertise should be used for the implementation. Local NGO foster sand dams and well building. They also have long term experience in the formation of watershed management committees.

Distribution of seeds and plant material
The role of vegetation is essential for a full restoration of the catchment. Especially after earthworks and on agriculture terraces immediate seeding and/or planting is required.
The project outline includes setting up a tree nursery and supplying seed for a demo farm. We think that this subject should be expanded. Farmers should be trained in using and collecting seeds and given a significant amount and variety of seeds to

start with. For the restoration of the gullies special local plants and tree cuttings should be used to anchor the embankments.

Monitoring of water patterns
Wells and other water offtake situations can be used by the landowners and the watershed committee to monitor the status of the upper aquifer. In addition the rainfall data should be measured from now on, using a simple rain gauge. Runoff and erosion patterns and success of restoration methods should be monitored to have a measurement for success and failure.

Decentralized access to drinking water
One major goal of the project is to allow local and easy access to water for all community members. To guarantee this we propose the following measures:
Decentralized drinking water access through the installation of wells next to the valleys and in the silted dam reservoir
Combination of gully restoration by check-dams and sand-dams combined with water off takes (hand pump, well)

Deforestation
Ongoing cutting of trees, branches and bushes reduces the presence of trees and anchoring roots in the soil. In combination with unmanaged grazing this can lead to bare ground, with rock outcrops and absence of grasses. This bares a risk of more erosion on steep slopes and even landslides.
Therefore the steeper slopes should be vegetated with the natural bushland vegetation. Probably in most areas a rest of cutting and grazing will allow natural regeneration, as it can be observed on fenced or abandoned territories in the area (see picture). Nevertheless in some areas planting and seeding of natural vegetation is necessary. Sustainable grazing and firewood cutting can still be part of the future land-use after restoration.
For sustainable charcoal burning, brick making and domestic firewood agroforestry principles should be introduced.
To stabilize the slopes of the terraces, berms and other earth structures rows of trees can be planted. These can be used for firewood and fodder for animals.
Other sources for energy should be strongly considered especially the use of biogas digester and the use of direct sun use **(**Scheffler mirror, photovoltaic and solar thermal collector)

Demonstrate best practices
Identifying best practices which are already applied within the catchment area will allow to educate other landowners and to show the examples to the wider community.
On the public land around the dam a model site could be chosen, to create a showcase model at a place which has easy access. Demonstration of some of the applied techniques in local schools will be of high educational value. This can be combined with the proposed WASH sessions and health education.

Use the watershed as a model for a full restoration and holistic management
We recommend a prolongation of the project running time. Taking a 5 year period the project will allow to fully restore the catchment and to show the results on aquifer recharge, water availability for drinking and irrigation use.

Proposal for long term engagement, models and regenerative water management

The proposal is to set up a model for a future settlement in one country where aid organisations and their partners have a continuous engagement.
This model should encompass all the successful components of the different works of aid organisations and its partner organisation. It should be placed in a community setting in cooperation with local partners. The sustainable management of water, soil and energy form the material foundation of this model.
The goal of the model is to showcase sustainable long-term solutions for settlements, both rural and urban and the livelihood of the inhabitants. The model is replicable and serves in addition as a training and education centre.
Water is the basis of life and essential to all human settlement and livelihood. There are simple, yet sophisticated ways, in the design of settlements. Ecological design allows sustainable access to clean water and healthy food. The knowledge is available but rarely implemented. Every new settlement, be it preliminary or permanent should recognize the aspect of water. Floods are avoided and the groundwater is recharged by harvesting all rainwater. The aspect of water is best regarded if all infrastructures are designed to serve the maximum for the restoration of water and soil. This includes houses, roads, paths, a master plan for the side that takes recognition of the larger watershed and the areas downstream. Water for irrigation and livestock can be directly harvested and used from the rain. Drinking water can be obtained from wells or springs.
All temporary camps can already include sustainable components, which will be replicated in the reconstruction process. Some shelters in Haiti already included rainwater harvesting and solar panels for electricity. If the camps are erected including the knowledge of sustainable water management and restoration of soils they can in the first year deliver water and food to the people.
Every catastrophe offers also opportunities, the opportunity for change. Most of the natural catastrophes and the consequences to humans are man made. Floods are the consequence of loss of vegetation and soil as a result of unsustainable land use practises. It is possible to reverse the mistakes and restore the environments and natural functions of ecosystems globally.

Large scale landscape restoration project in China documented by John D. Liu
http://eempc.org
Decentralized settlements: “Tamera A Model for the Future” by Leila Dregger
http://www.verlag-meiga.org/node/229

Education programs for sustainable and community based infrastructure and land use

Global Ecovillage Network (GEN)
http://gen.ecovillage.org/
http://www.gen-europe.org/

Ecovillage Design Education (EDE), UN endorsed
http://www.gaiaeducation.net/

Permaculture Design Certificate (PDC)
http://www.permaculture.org.uk/education
http://www.permacultureglobal.com/projects

Education and knowledge transfer on solar and water issues
http://www.barefootcollege.org/

Landscape Restoration and regenerative water management
http://www.tamera.org/what-is-tamera/visitors3/events/water-landscape-training-2014/

Links

Rainwater Harvesting
MetaMeta,
www.bebuffered.com
http://www.sasolfoundation.co.ke
www.thewaterchannel.tv
www.samsamwater.com

Landscape Restoration
Sustainable land-use in Ethiopia
http://www.slmethiopia.info.et/

Water pumping
Water Pump
www.kickstart.org

Permaculture
Permaculture Research Institute Kenya
http://www.pri-kenya.org/

Farming
The organic farmer magazine
http://www.theorganicfarmer.org/

Grazing Management
Africa Centre for Holistic Management
http://achmonline.squarespace.com/

Energy supply

Solar
Scheffler reflectors and other low tech solar technology (cookers, dryers
http://www.solare-bruecke.org/index.php?lang=en
Scheffler reflectors build by Alec Gagneux, solar export for community kitchens in Haiti
http://solarcooking.wikia.com/wiki/Alec_Gagneux
Solar electrical systems
http://self.org/

Biogas
Biogas digester from Kenya
http://www.biogas.co.ke/
http://www.charitywater.org/

Biogas construction manual
http://www.tamera.org/fileadmin/PDF/biogas_digester.pdf
Biogas expert for urban areas and developing countries: T.H. Culhane
http://solarcities.blogspot.pt/

Compost Toilets
http://www.tamera.org/fileadmin/PDF/SV_CompostToilet.pdf

Photos

Bare ground as a result of grazing and animal trampling, compacted soil leads to increased runoff and low infiltration

Erosion as a result of animal traffic towards lake

Spillway of Musosya earth dam, increased runoff starts to erode the dam, this has to be immediately repaired to avoid a total dam failure

Grazing animals on silted Musosya dam reservoir, the growing vegetation shows the presence of water in the silted material

Hand dug swale for the avoidance of runoff and erosion, benefiting infiltration

Hand dug water hole 200 m upstream from Musosya dam, water in approx. 1.5m depth

Bucket irrigated fields close to hand dug water hole

Gully development in two phases, sign of increase of runoff and eroding forces
Secondary gully eroding the terraced land

Gully in lowland 200 m from dam site

Soil profile in gully, layer of rock and gravel acts as a strong drainage to the soil

Uprooted tree in developing gully, note also the increased stability of the banks by deeply rooting trees and bushes

Grassland vegetation cover at the end of the dry season, anchoring the soil with its roots, low runoff and high infiltration

Grassland vegetation and litter (mulch) covering the soil, avoiding erosion and immediate re-evaporation after rainfall, allowing infiltration, healthy grassland can absorb most (if not all) of the rainfall even in heavy rain events

Bare soil on terrace (left) and grassland vegetation (right) covering the soil, soil should always be covered with vegetation and litter (mulch), seed cover crops on terraces

Green vegetation at the end of the dry season, a sign that vegetation growth is possible in the dry season, leguminous species covering the soil, anchoring soil and fixing nitrogen, leads to humus accumulation, fodder for livestock

Vegetation grooving on slope of older bench terrace, slopes should always be covered with vegetation and well rooted with perennial vegetation, grassland, bushes trees, the slopes can produce animal fodder or fruit trees

Newly established bench terrace (“Fanya juu terrace”), steep slopes will erode immediately with the first rainfall, seed and/or mulch to establish anchoring vegetation

Nearly bare ground on harvested corn field, no anchoring roots left in soil, so that the first rain will result into erosion. Seek for permanent vegetation cover, animals can graze on the terraces but avoid uprooting of plants

Nearly bare ground on plateau ridge, soil is still anchored by the roots of trees and bushes but ground cover vegetation is missing so erosion continuously occurs, managed grazing is necessary

Erosion and forming of gully on access road 100m downhill from plateau

Heavy erosion on steeper part of same road

Water finds an unmanaged path away from the road causing erosion on downhill agricultural terraces

Animal traffic on road

Pits harvesting rainwater directly or by redirected road runoff for Banana, Papaya or other plants

Bananas growing in pits

Stone berms for controlling runoff, partly vegetated, stabilizing the slope and terrace foot

First swale on plateau ridge avoids runoff downhill

Second swale downhill from plateau