Biogas, Water Quality, and Wildlife Corridors:

A Feasibility study for Mang'ula Villages

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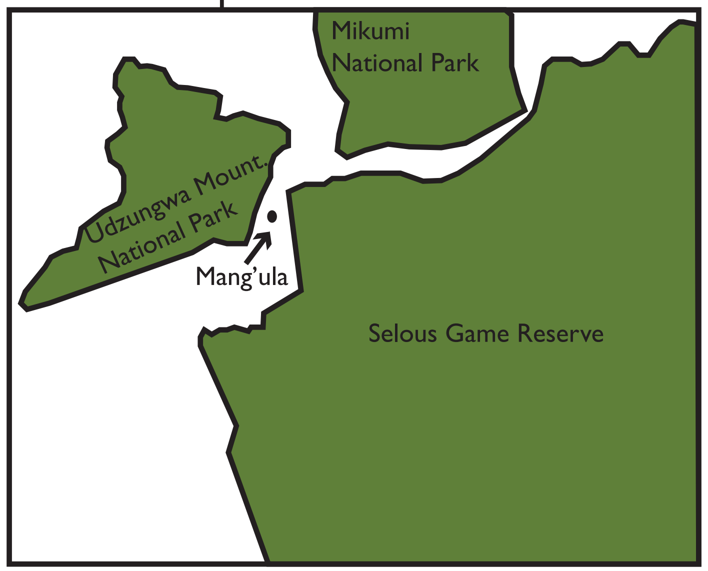


Not to Scale

Opening Remarks

Udzungwa Mountains National Park in the Eastern Arc Mountains is one of the world's most important biodiversity hotspots. It is filled with rare and endemic wildlife such as the red colobus monkey; in fact the mountain range has been comparable to the Galapagos Islands due to its high rates of endemism and beauty. However, unlike the Galapagos Islands, Udzungwa Mountains National Park is surrounded by villages, predominately characterized by agricultural lifestyles. The villages of Mang'ula A and B, for example, are home to many farmers surrounding the national park. The relationship between the natural park and the surrounding villages has been shown to be of a complex nature.

In May and June of 2012, we visited the villages of Mang'ula A and B while the villages were experiencing three crises. The villagers in Mang'ula simultaneously face challenges in the provision of clean water for their families, protection of their crops from losses to wildlife, and supplying fuel for cooking. In response to these problems, we investigated an integrated land use solution to simultaneously address these three needs. Firstly, in hopes to alleviate the local dependency on forest firewood, we researched the feasibility of increasing the use of biogas through methane digestion as a sustainable, alternative energy source in the villages of Mang'ula A and B. To concurrently feed the livestock required to produce the methane gas and improve water quality, we investigated the possibility to integrate vegetated buffer strips along streams and wetlands. As a response to the conflicts faced between Mang'ulans and the invading wildlife from Udzungwa Mountains National Park, the vegetated buffers were also investigated in their function as a wildlife corridor.

It is with great hope that the research that has been developed can be utilized in further decision-making for the villages of Mang'ula A and B, such that the results of this research will help contribute to solving pertinent issues: sustainable fuel sources to replace the need for park firewood, cleaner water through natural vegetation treatments, and greater security for crops. Through this research, we hope to attempt to alleviate the pressures between Udzungwa Mountains National Park and villages of Mang'ula A and B.

Biogas

Current Energy Crisis

As of 2006, 95% of the villages surrounding Udzungwa Mountains National Park relied upon firewood as the main source for energy for cooking. The park accounted for 66% of the wood used to fuel local households (Nyundo et al, 2006). On July 1, 2011, villagers were banned from collecting firewood from the park. Currently, wood still remains the number one fuel source despite the ban. These communities are living on a finite resource and will need to make the switch to an alternative energy source in order to survive.

Biogas Background

Biogas technology replicates the natural process of converting organic material, such as manure from cattle, into the gases methane and carbon dioxide and biol by bacteria when oxygen is not present. Biol a clean and effective fertilizer than can improve crop yield by as much as 30 to 50% when compared to non-fertilized fields. The biogas is a mixture of 50-70% methane, a gas that acts much like propane, which can be burned without producing smoke.

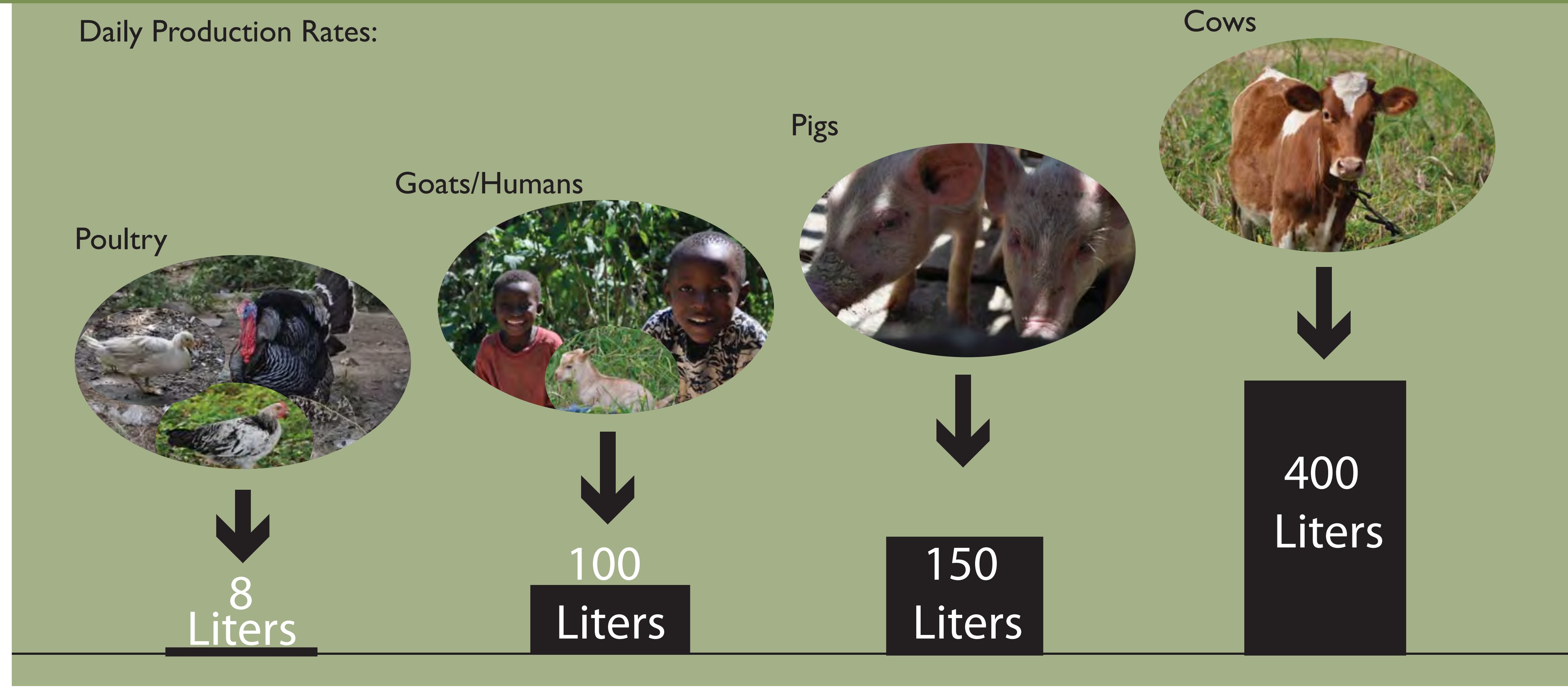
A family biogas digester produces around 700 liters of gas per day, enough to cook for about three hours, although this available time would decrease if used in combination with lighting:

- A biogas stove uses 200 liters of gas per hour
- A biogas lamp uses 120 liters of gas per hour

In tropical climates a family sized biogas digester costs approximately $150, or 240,000 Tsh, however this does not include the cost of fencing, which is highly recommended around the delicate tubular plastic biogas digester. A biogas stove must also be bought and installed at the price of $50 or 80,000 Tsh.

Benefits (Faida)

- Improves Sanitation
- Reduces Indoor Smoke
- Produces Better Lighting
- Reduces Labor
- Generates Employment
- Improves Water Quality
- Conserves Natural Resources
- Reduces Greenhouse Gas Emissions



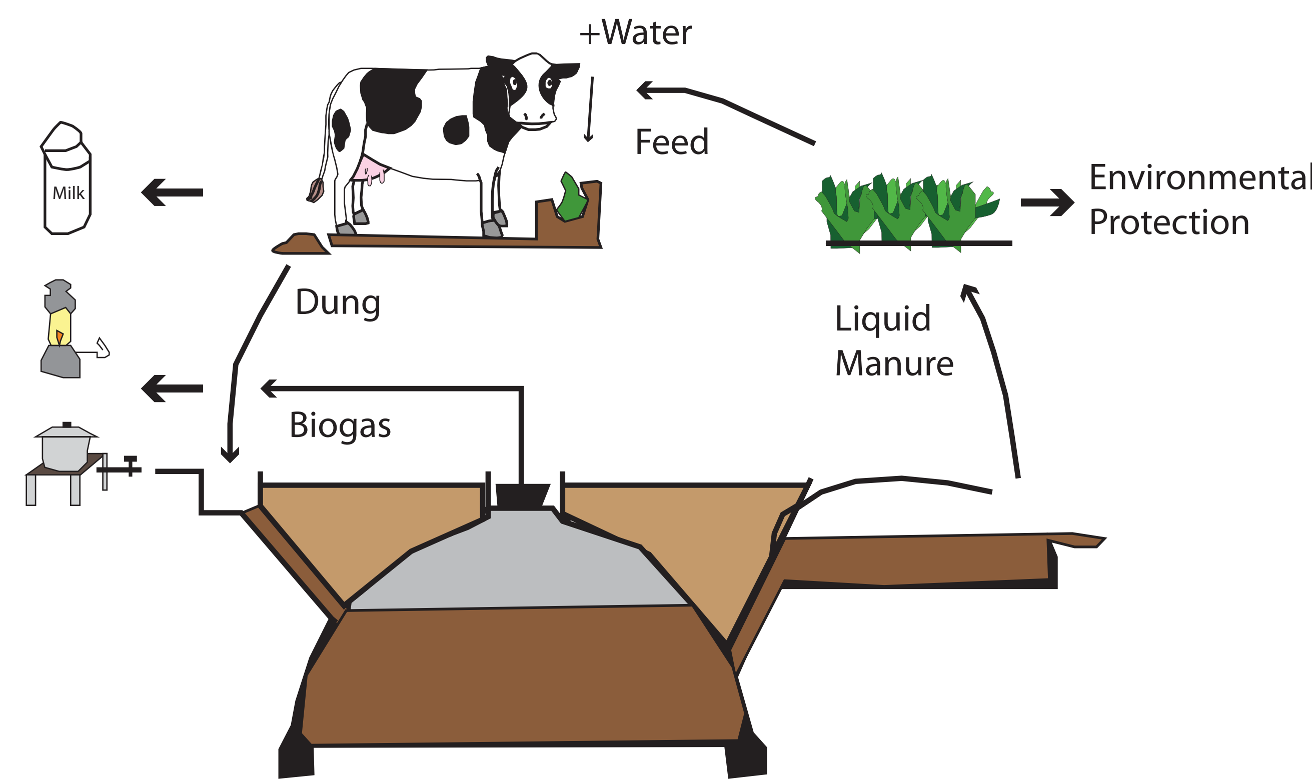
Foreign Case Studies

Ethiopia

- Same energy demands suffering from rapid deforestation.
- Used biogas as a solution for energy.
- The National Biogas Programme Ethiopia (NBPE) subsidized cost, Farmers paid 65% for digestors.

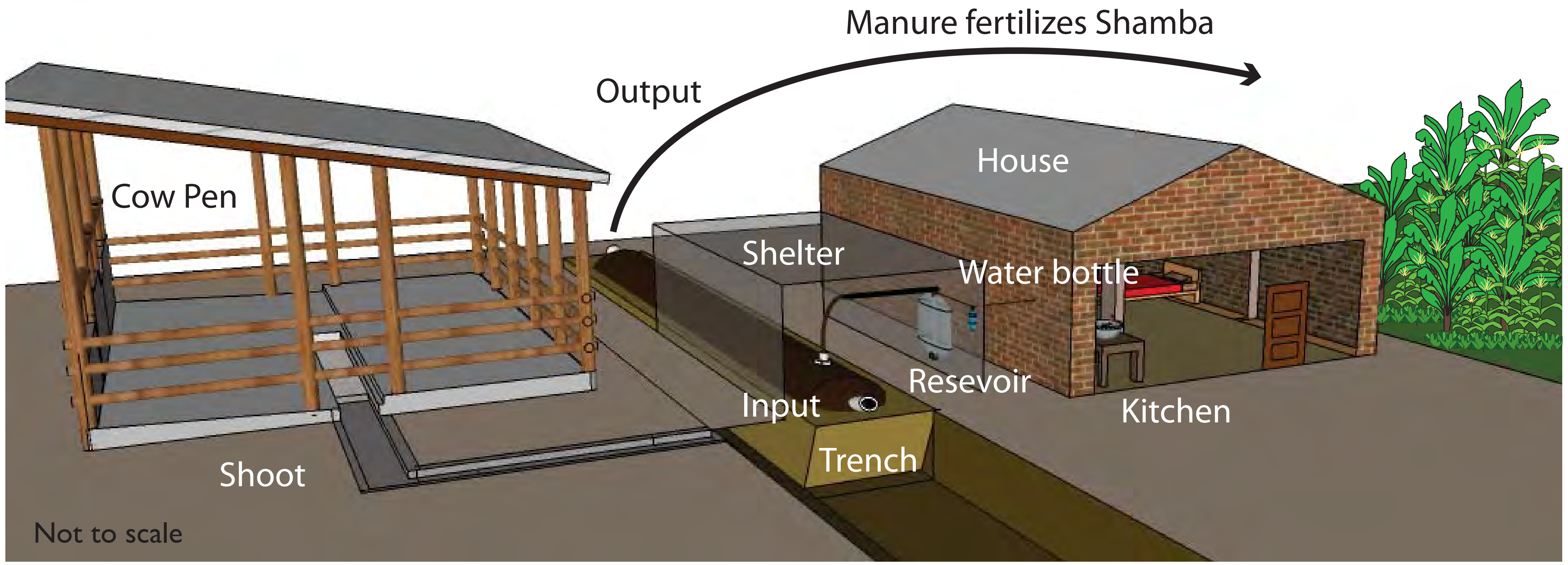
Ghana

- Average of 87% of households use fuelwood
- November 2010: 100 biogas plants implemented to relieve reliance on wood
- Generated 148 full time Biogas technicians

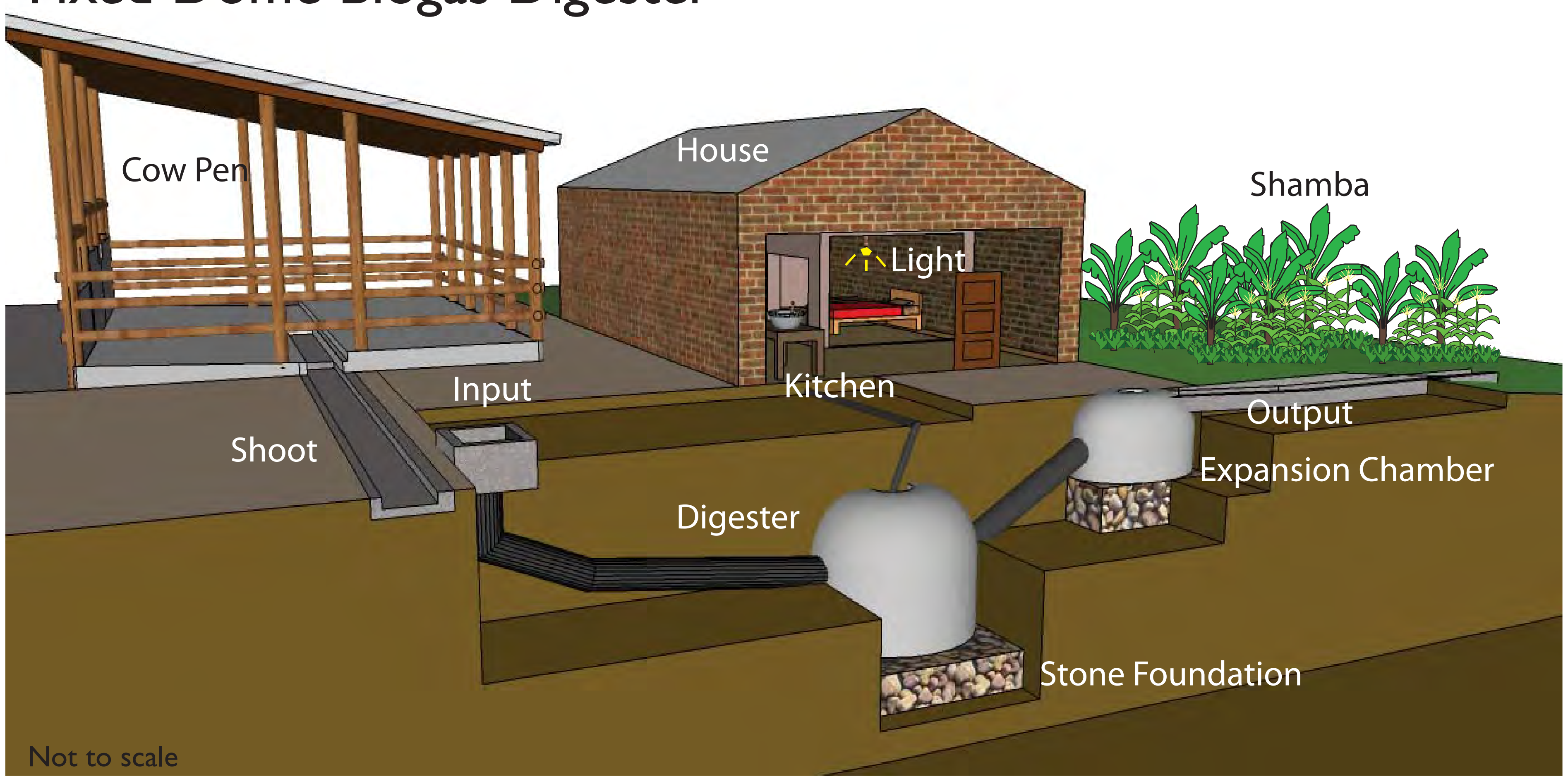


Biogas Models (Biogas Aina)

Tubular Plastic Biogas Digester

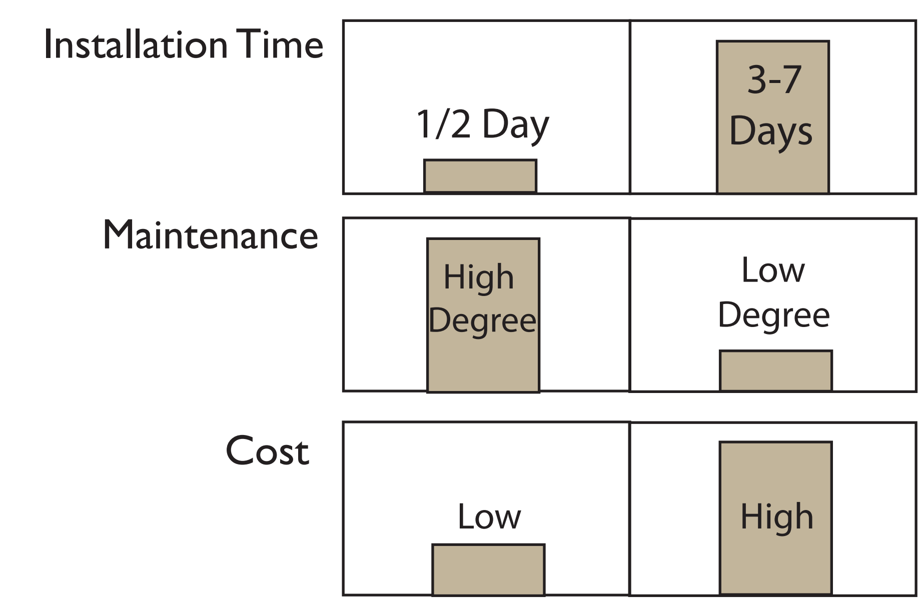


Fixed Dome Biogas Digester



Cost Comparison

Amounts in TSH	Tubular Plastic Biogas Digester	Fixed Dome Biogas Digester
General Costs of Materials	240,000	1,920,000
1 Burner Biogas Stove	80,000	80,000
2 Cattle	1,400,000	1,400,000
Annual Public Standpipe Use	600	600
Annual Veterinary Care (2 Cattle)	20,000	20,000
First Year Cost	1,740,600	3,420,600
Annual Firewood Expenditure (6 Bundles/Month)	144,000	144,000
Annual Charcoal Expenditure (1 Bag/Month)	816,000	816,000
Annual Costs	20,600	20,600
Total Annual Savings	939,400	939,400
Years Until Return	1.85	3.64



Biogas Suitability (Yenyekufaa)

Land Use

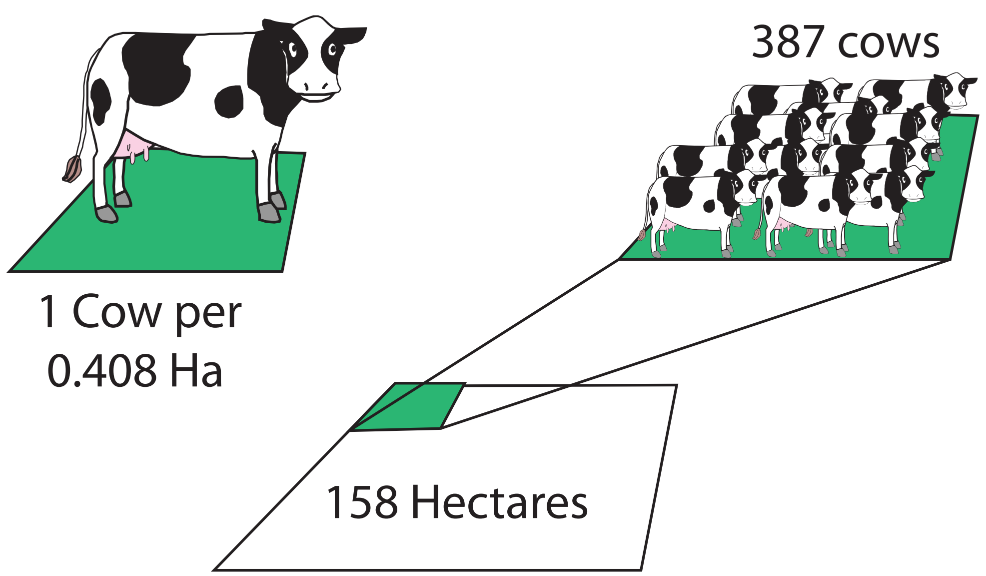
Population increasing statistic! With the population steadily increasing in the Mang'ula Villages, land is often difficult to occupy. In order to implement biogas as an alternative energy source, we need to know the land's maximum capacity to support a certain number of cattle.

Feed Sources

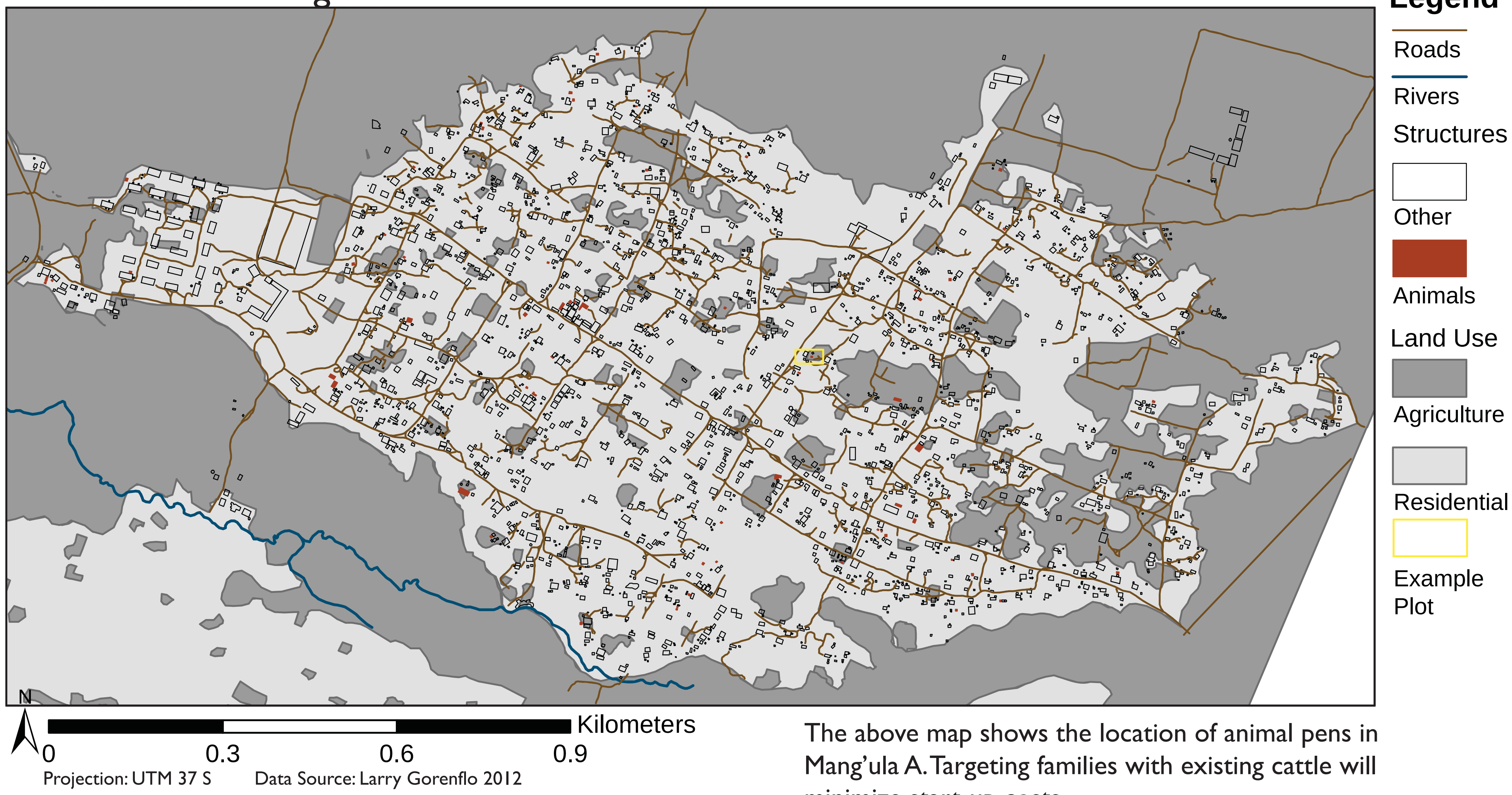
People tend to gather feed from anywhere and everywhere. Although some dairy farmers do purchase maize husks as feed, the overwhelming majority of Mang'ulans gather grasses based on convenience. These areas include along streams and roadsides, inbetween shambas and structures, and any bushland areas.

Available Land for Feed

The total available land was calculated by taking the existing land uses such as cultivation, residential and potential buffer in Mang'ula A, and finding their total area and subtracting it from the area of the overall village. The cow carrying capacity for the158 Hectares in Mang'ula A is 387 cows.

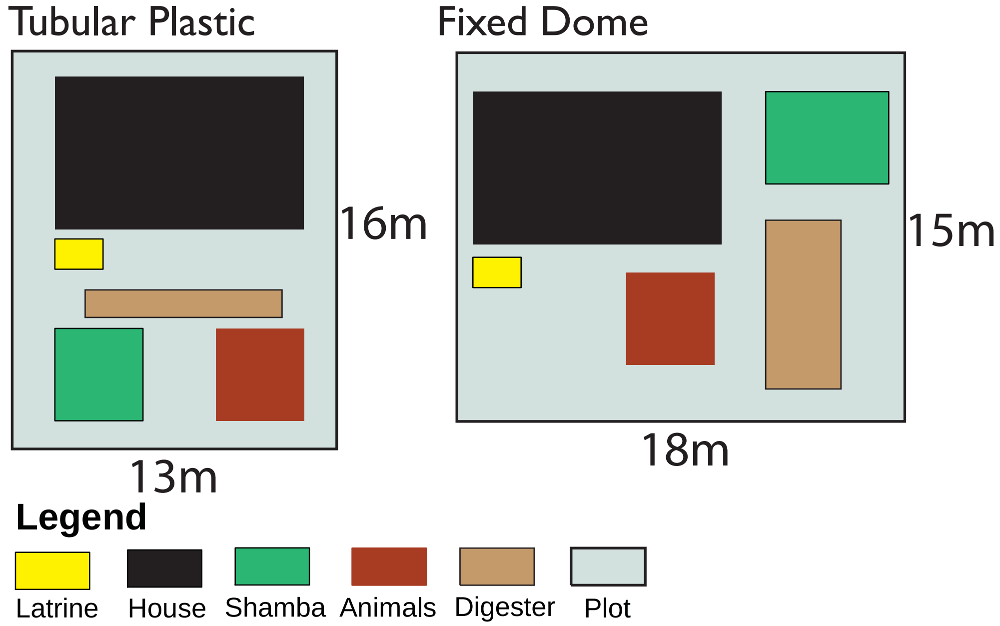


Animal Pens in Mang'ula A

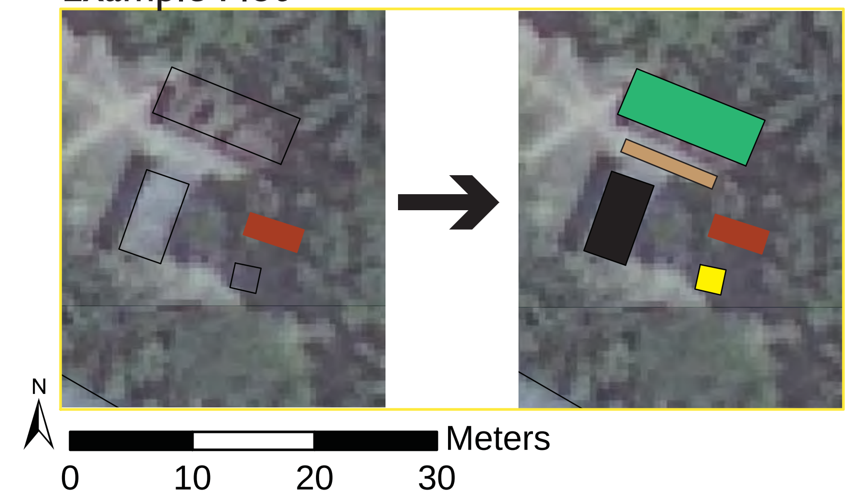


The above map shows the location of animal pens in Mang'ula A. Targeting families with existing cattle will minimize start-up costs.

Digester Footprints



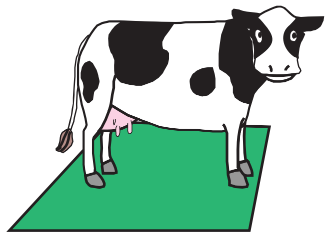
Example Plot



The example above shows how existing plots easily have the space requirements to implement a biogas digester.

Incentive Package (Mishahara Mizuri)

Land-Cow Carrying Capacity



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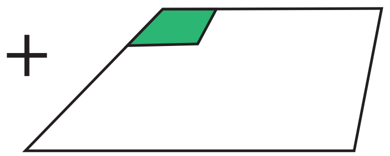
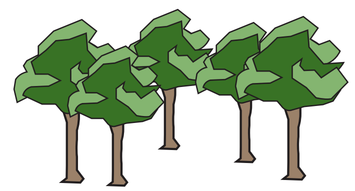


1 Cow per 0.408 Ha

158 Hectares

= 1,570,000 TSH Income

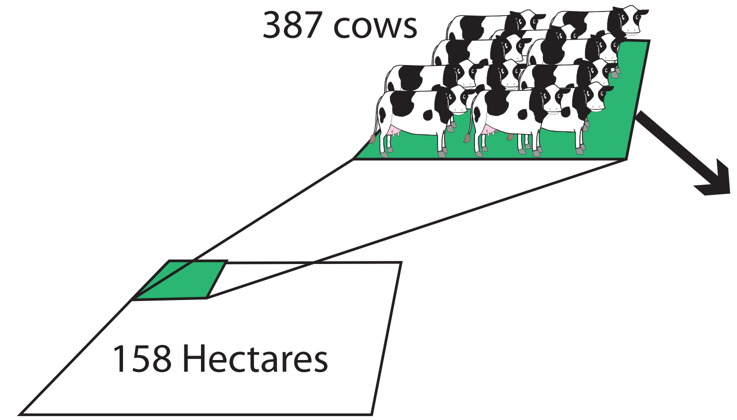
+ 40% Biogas



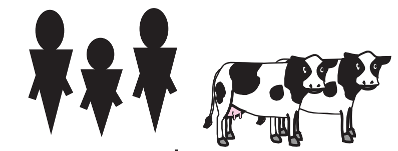
8.8 Trees Saved Annually

Village-wide Savings

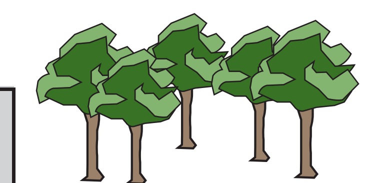
387 cows



158 Hectares



193 Families, 21.8% of Mang'ula A to 100% Biogas



4,256 Trees Saved Annually

Incentive Package

Due to the locality of the materials for both a tubular plastic biogas digester and a fixed-dome biogas digester, it is noted that the largest deterrent for a dairy farmer in biogas production is the initial investment of 4 cattle to produce enough initial dung. It is therefore proposed that a non-government organization such as Heifer International provide a loan of 2 cattle during the initial filling phase of the digester for dairy farmers with at least 2 cattle and the materials for biogas production. Because only 2 cattle are required to produce the daily the necessity of manure for a small household, Heifer International would be able to recollect the loaner cattle after a few months.

Considerations for Biogas Technology:
A biogas digester requires input of at least 20 liters of manure and 40 liters of water (wastewater is encouraged to be used) everyday to continue to produce sufficient energy. If a digester only receives sufficient input 2-3 times a week, then biogas may only be produced to supply 2 meals a day. After installation, biogas will be produced after about 2 weeks with the manure production of 2-3 cows.

Space Demand:

o Tubular Plastic Biodigester = lasts for five years
- 8 – 10 meters long
- 0.65 meters wide on top
- 0.50 meters wide on bottom
- 0.65 meters deep

o Fixed Dome Biodgester = lasts for ten to fifteen years
- 12 cubic meters (small family)
- 16 cubic meters (big family)
- 1 meter between inlet and slurry chamber

Tubular Plastic Biodigester Materials:
- transparent tubular polyethylene (also used for greenhouses).
  - diameter: 80-125 cm
  - circumference: 2,5-4 m.
  - caliber (thickness): 800-1000 gauge = 200-250 micron
  - length: 10+1 m for 8 pigs or cows.
- 2 pvc or ceramic tubes
  - internal diameter (i.d.): 15 cm
  - length: 75-100 cm
- plastic (pvc) hosepipe
  - i.d.: 12 mm
  - length: determined by the distance to the kitchen
- two PVC adapter (male and female)
  - i.d.: 12,5 mm
- two rubber washers (from inner tubes of cars) with a 12,5 mm diameter central hole.
  - diameter: 7 cm
  - thickness: 1 mm
- two rigid plastic (perspex) washers
  - diameter: 10 cm (center hole diameter: 12.5mm)
- PVC or PE pipe
  - i.d.: 12,5 mm
  - length: 2 m
- four used inner tubes cut into 5 cm wide strips
- one transparent plastic bottle (capacity 1,5 liters).
- one PVC elbow
  - i.d. 12,5 mm

Fixed Dome Digester Materials:
- Metal Guide Pipe
  - Length: 4.2 meters
  - Diameter: 40 mm
- Stone, Concrete, Steel Bars, Brick
- PVC Inlet Pipe.
  - Length: 3.6 meter
  - Diameter: 100 mm
- PVC Outlet Pipe
  - Length: determined through distance to the kitchen
  - Diameter: 100 mm
- Sheet Metal
  - Thickness: 2 – 4 mm
- Galvanized Steel T-junction
  - Diameter: 12.5 mm
- Galvanized Steel Elbow-junction
  - Diameter: 12.5 mm
- Galvanized Steel tap (stopcock)
  - Diameter: 12.5 mm
- Galvanized Steel nipple
  - Diameter: 12.5 mm
- Clamps
- PVC class B hose
  - Diameter: 37.5 mm
- Water hose transparent
  - Diameter: 12.5 mm
- Galvanized Steel bush reducer
  - Diameter: 12.5mm
- 12.5mm to internal diameter water hose
- Sealing Tape

	Tubular Plastic Biogas Digester	Fixed Dome Biogas Digester	Tubular Plastic Biogas Digester	Fixed Dome Biogas Digester
General Costs of Materials	240,000	1,920,000	240,000	1,920,000
1 Burner Biogas Stove	80,000	80,000	80,000	80,000
2 Cattle	1,400,000	1,400,000		
4 Cattle			2,800,000	2,800,000
Annual Public Standpipe Use	600	600	600	600
Annual Veterinary Care (2 Cattle)	40,000	40,000		
Annual Veterinary Care (4 Cattle)			80,000	80,000
First Year Cost	1,760,600	3,440,600	3,200,600	4,880,600
Annual Firewood Expenditure (6 Bundles /Month)	144,000	144,000	144,000	144,000
Annual Income through Milk / Sold Calves (2 Cattle)	1,570,000	1,570,000		
Annual Income through Milk / Sold Calves (4 Cattle)			3,140,000	3,140,000
Annual Costs (2 Cattle)	40,600	40,600		
Annual Costs (4 Cattle)			81,200	81,200
Total Savings	1,673,400	1,673,400	3,202,800	3,202,800
Years Until Return	1.05	2.06	1.00	1.52

Market Assumptions

Current Market Price of Adult Cow: 700,000 Tsh
- Reproduction Rate of 1 Calf / Year
  - Breeding Age 3 – 11 years
  - Potential Number of Offspring: 8
    - *Assumed Calf Mortality/Infertility Rate of 12.5%
  - Surviving Number of Offspring: 7
  - Return of Current Investment: 2
  - Estimated Production of Retained Calves: 5

Current Market Price of Calf: 500,000 Tsh
- *Assumed Slaughter Rate of 7.5%
- Average Production of Mature Cow Every Year: 0.55 Calves

Current Market Price of Milk: 1,000 Tsh / liter
- Average Daily Milk Production: 10 liter
- *Assumed Sell Rate: 70%
- Approximate Days in Milking: 185

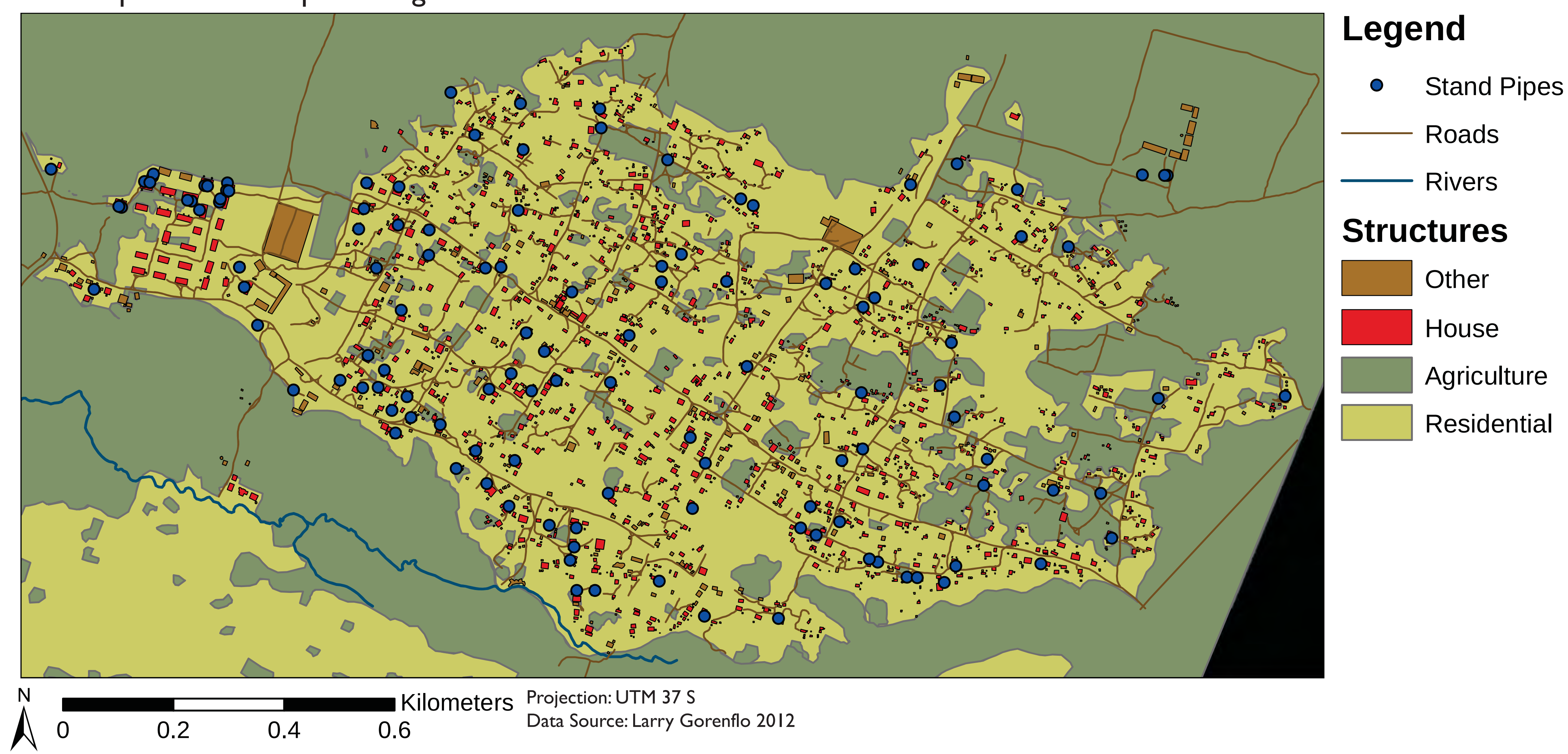
Improving Water Quality (Kuboresha Maji Ubora)

Issues

Water Quality Downstream

According to the 2008 Household Budgets Survey 48% of all Tanzanian households and 60% of people living in rural Tanzania rely on unmanaged sources of drinking water (Nkonya N.D., 27). The map to the right indicates the location of the water standpipes in the village of Mang'ula A. The high number and adequate dispersal of the pipes suggests that the residents have equal access to obtain water from these locations. Although relatively few people living in the Mang'ula villages use streams and open surface water for consumption, the less fortunate people downstream do. Since they do not have an abundance of standpipes flowing with drinkable water straight from the Udzungwa Mountains, they most likely depend on the natural waterways for their daily water needs. In order to keep this water clean as it flows downstream, protective measures should be taken as soon as possible.

Stand Pipe Locater Map of Mang'ula A

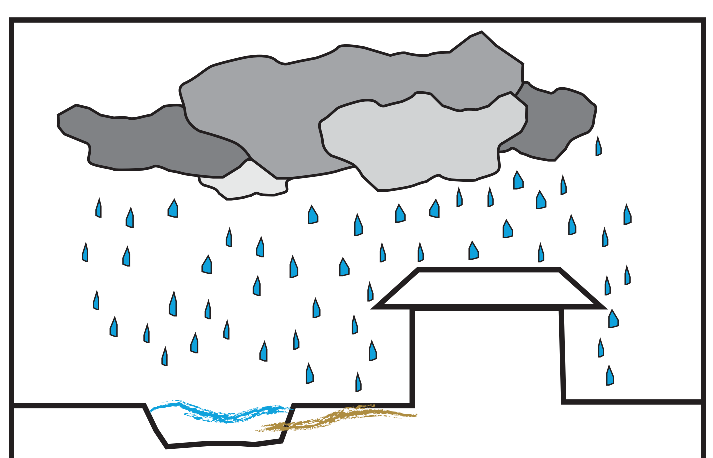


Projection: UTM 37 S
Data Source: Larry Gorenflo 2012

Soil Erosion and Contamination

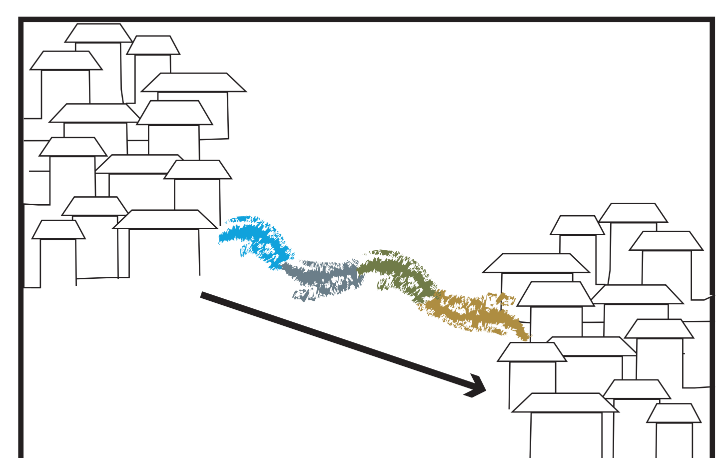
The rainy season contributes to the overall issue of soil erosion in unplanted areas. An influx of water rushes down from the sky, flooding the landscape. The fast moving liquid carries loose sediment from the unvegetated ground and deposits the dirt into the closest body of water. The extra soil contaminants and surface runoff ultimately degrade the water quality in rural areas (Nkonya N.D., 27). In areas of agriculture, pesticides also contribute to poor water quality. The polluted mixture flows along, transporting sediment and disease to the local communities downstream.

Erosion



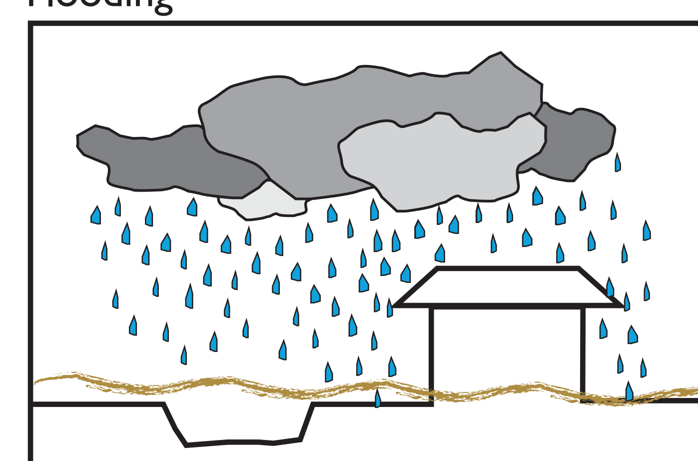
Rain water rushes along the ground, collects loose sediments and deposits them into the nearest stream. Soil erosion, especially along river banks damages the overvall water quality as well as the livelyhood of the stream's ecosystem.

Downstream Effects



Polluted water flows downstream,to communities dependent on natural water bodies for drinking water. The poor quality contributes to overall village health. Precautionalry measures upstream would greatly benefit all villages nestled against running streams.

Flooding



During the rainy season, the heavy downpours raise the water level, resulting in floods that pickup all sorts of pollutants. Flooding also damages houses, dirt roads and other structures. By building on slopes, water is directed away from structures, keeping them drier.

Stream Buffer Suitability (Vijito Tahadhari Yenyekufaa)

Vegetated Buffers

The polluted sources such as rivers, lakes and streams, would greatly benefit from natural treatments through vegetative filtering processes. By implementing vegetated buffer strips, the root systems will provide increased bank stabilization ultimately decreasing soil erosion. Over time, with buffers around streams and other wetlands, the overall quality of water and soil profile will greatly improve.

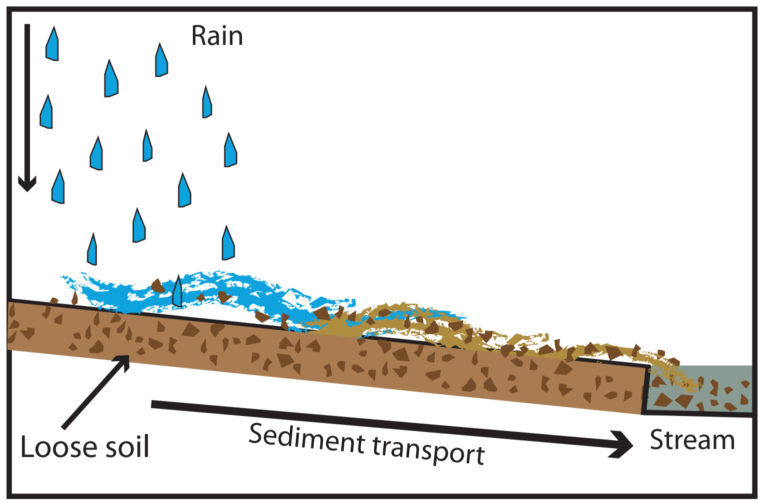
Implementation

The vegetated buffer strip model can be implemented upon evaluation of a given area. In future land use planning along streams, the minimum buffer width is 100 meters surrounding the water source. This zone should be free of animal pens, latrines, houses, and agricultural activities (Madrigal et al, 2010).

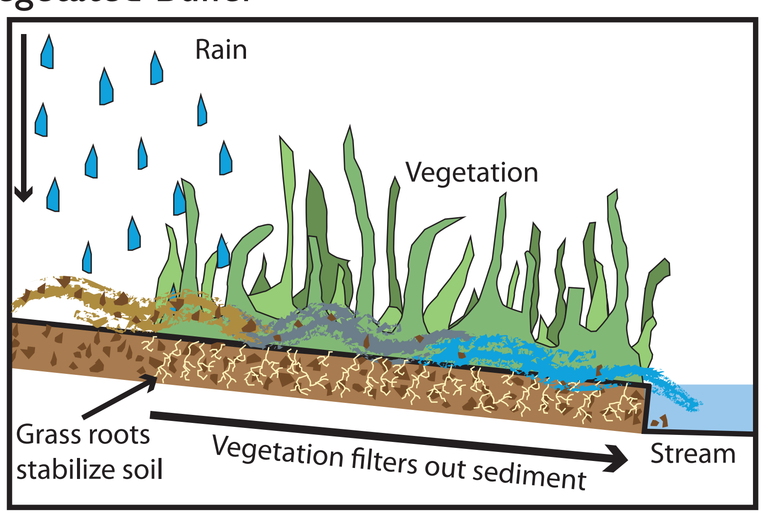
Ideal Plant Species

By planting the right vegetation can maximize soil stabilization along stream banks, efficiently filter stormwater runoff, and can even serve as a feed source for livestock. Monto vetiver grass (Chrysopogon zizanioides) is recommended vegetation in the buffer strips. It is noninvasive has a high tolerance to handle varying soil pH and the pollution of heavy metals. It is known to withstand floods, droughts and pests. This grass can be harvested for fodder after 2 years (Carey, 2006). Having the potential to serve as a feed source for cattle, these buffers help suppliment the available land to support an increased animal population for biogas production purposes.

No Buffer

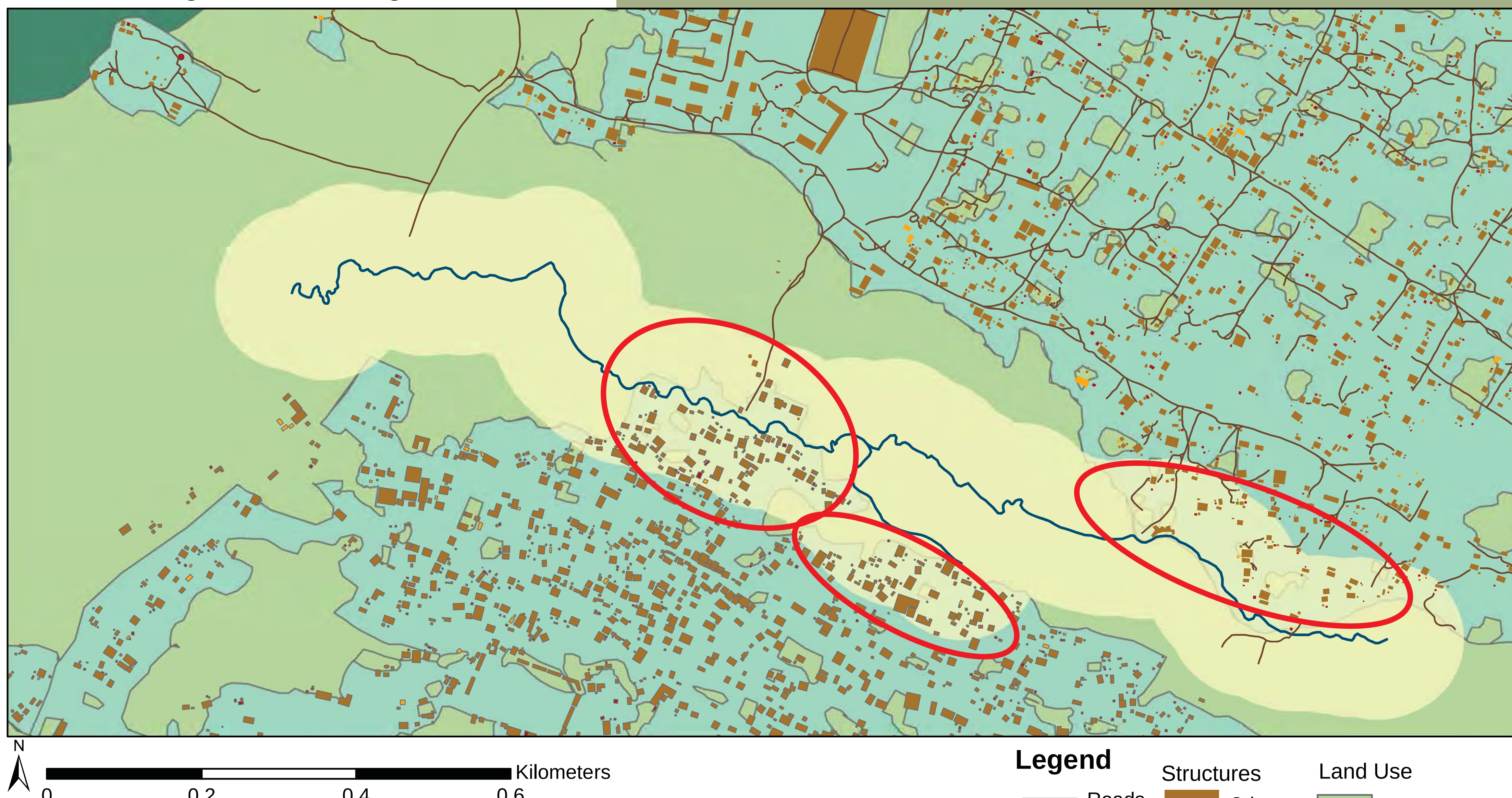


Vegetated Buffer



The above diagrams illustrate the effects of buffering streams with vegetation. Using grass root systems, water has the ability to filter out sediments before entering bodies of water.

Ideal Buffer Along Streams In Mang'ula



Projection: UTM 37 S
Data Source: Larry Gorenflo 2012

The map above indicates the 100m buffer plan along the streams of Mang'ula. The circled conflict areas are where the buffer would disturb people and structures.

Legend

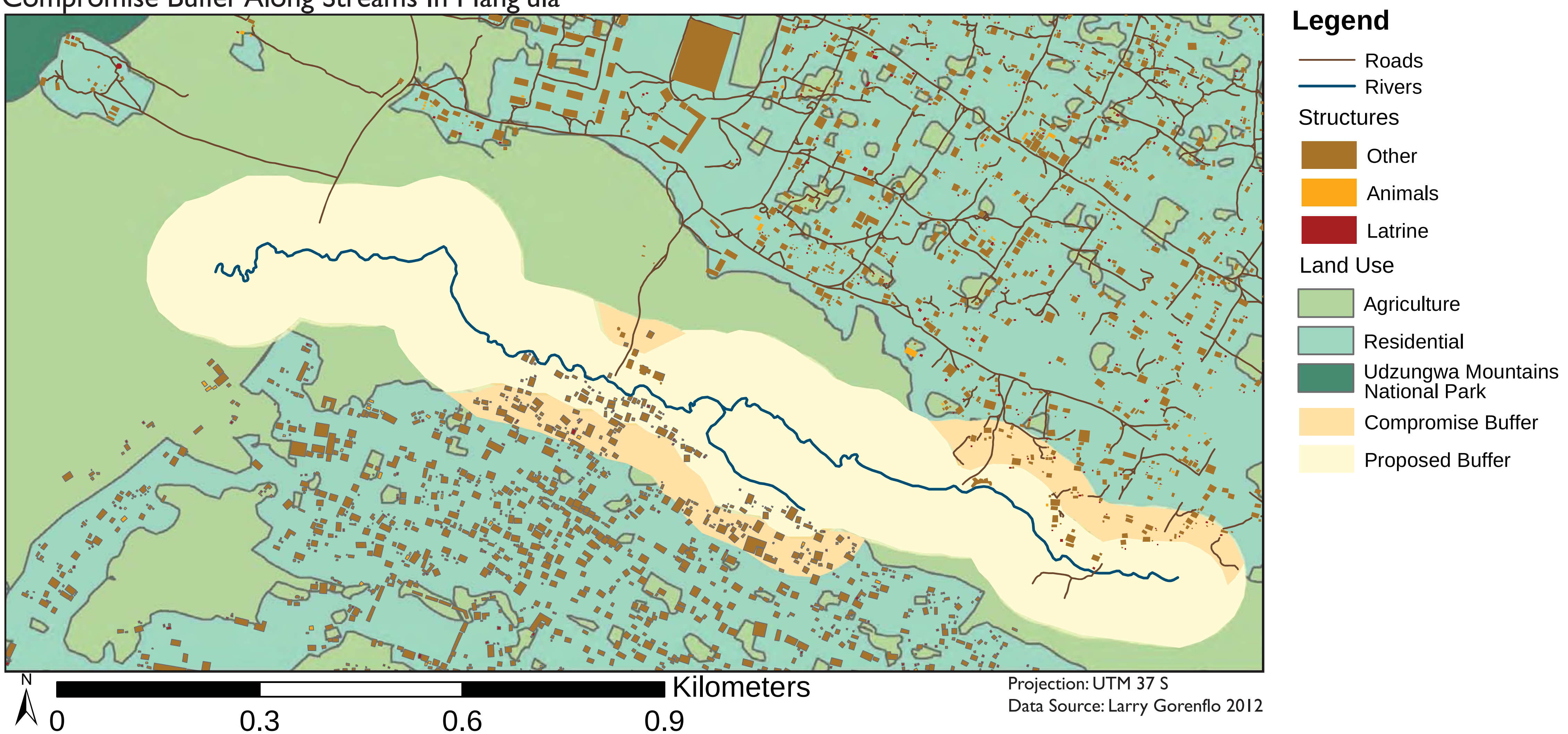
- Roads
- Rivers
- Conflict Areas

Structures
- Other
- Animals
- Latrine

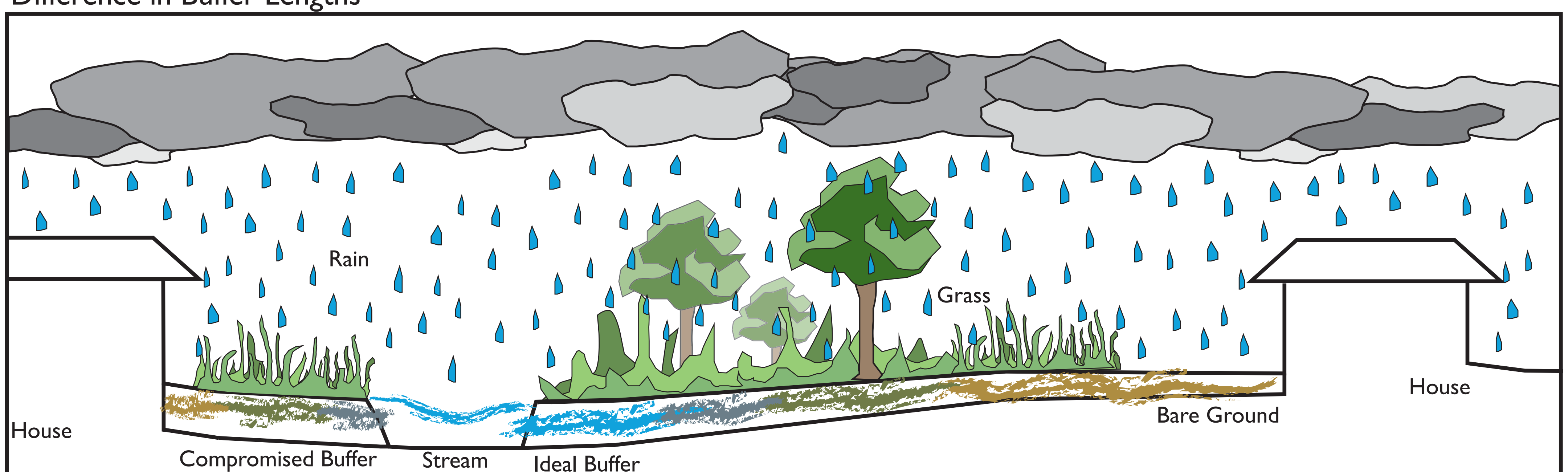
Land Use
- Agriculture
- Residential
- Udzungwa Mountains National Park
- Proposed Buffer

Implications (Athari) & Compromises

Compromise Buffer Along Streams In Mang'ula



Difference in Buffer Lengths



Short buffers help cleanse water before returning it to a bigger source but they are not as effective as long buffers.

Conflict Chart

Structure Lost	50m Buffer	100m Buffer
Animal Pen	2	8
Brick Kiln	1	1
Foundation	8	14
Graveyard	0	1
House	48	127
Kitchen	14	36
Latrine	21	42
Septic Tank	6	17
Shop	5	5
Stand Pipe	7	14
Warehouse	0	1
Workshop	0	1
Total Structures	112	267

Implications

By implementing a 100 meter buffer, 25.51 hectares would be generated as available cattle feed. They would also produce cleaner water downstream by filtering out sediment and pesticides from surrounding agriculture.

However, the 100m buffer also results in the displacement of people and structures. As seen in the chart above, through compromising a few select areas and reducing the buffer zone to 50 meters, the number of affected structures would be reduced by more than half.

It is important to remember that even a small buffer is better than no buffer.

Human-Wildlife Conflicts (Mtu-Wanyamapori)

Background

The villagers of Mang'ula A and B not only face problems with the land, but also problems with the local fauna. The human - wildlife conflicts existing between the Udzungwa Mountains National Park and the surrounding villages has been escalating in recent years. One major problem surfaced in 2007 due to the increase of elephant population that started in the park in 1992 (Kabepele 2012).

Since the park is not fenced and village populations encroach upon park boundaries through agricultural development, elephants have begun to use local crops as an additional feed source. Wildlife accounts for approximately 40% of crop loss of all that are planted (Nahonyo 2012). Elephants, in particular, cause much destruction for farmlands as they eat and trample most, if not all, of a cropland that they venture into. Such destruction devastates the income of affected farmers, as there is no compensation for lost crops by Udzungwa Mountains National Park.

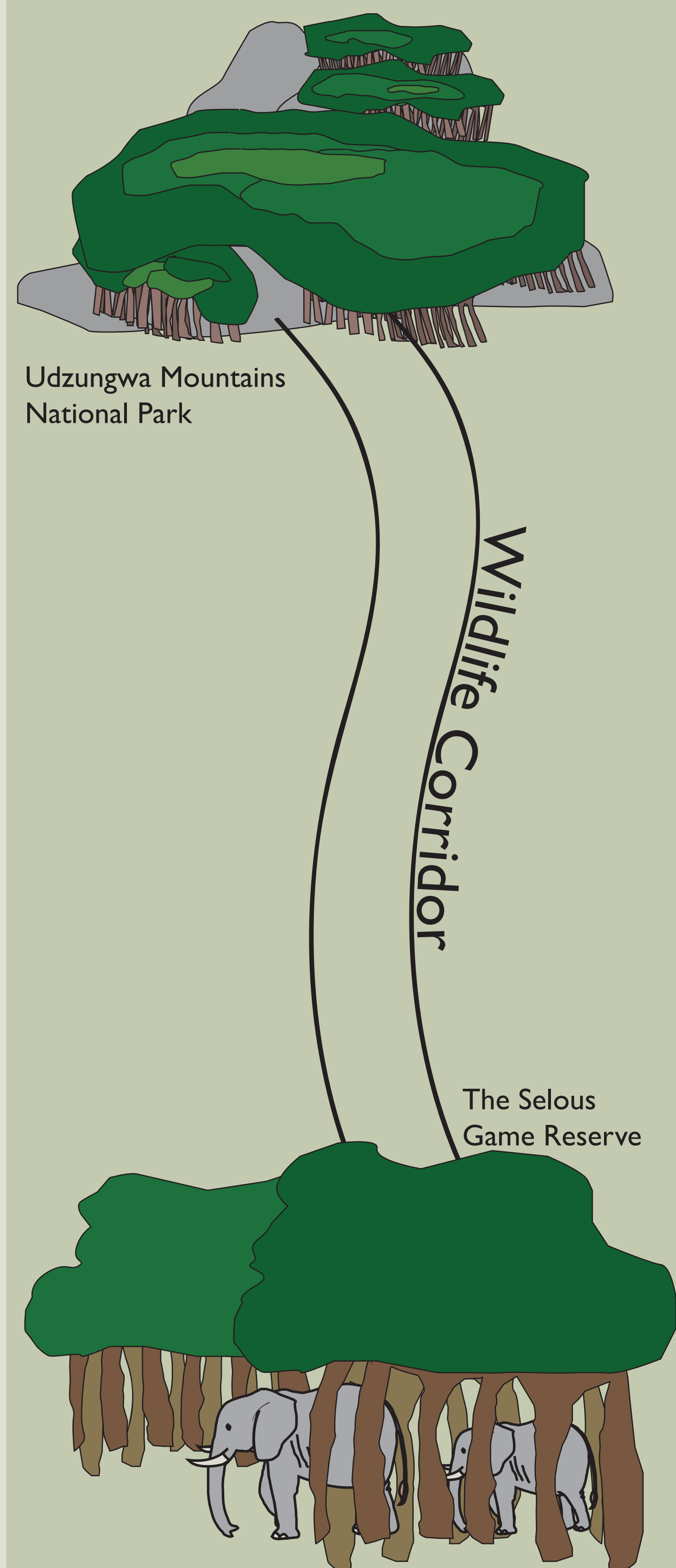
Village Response

Residents victim to crop loss caused by elephants often resort to:

- Planting crops elephants do not favor
- Use noises (loud banging, simulation gun shots, etc.) to scare elephants away
- Protect shambas by implementing fences
- Use fire or smoke
- Poison elephant favored crops
- Shooting the elephants (Nahonyo, 2012).

Long-term Solution

"Elephants typically require large areas to roam, especially if they need to migrate to seasonal feeding sites" (HEC BMP). Long-term solutions, such as developing a wildlife corridor, would help guide these destructive giants to appropriate grazing locations. Implementing these paths could significantly decrease the conflict between humans and elephants in the Udzungwa Mountains National Park region.



Wildlife Corridors

Background

A wildlife corridor is a strip of habitable land that serves as a link between two or more larger patches of habitat. These corridors, often dictated by existing migration routes, have been implemented as a conservation strategy since the early1900s (Hess, 2000).

Benefits (Faida)

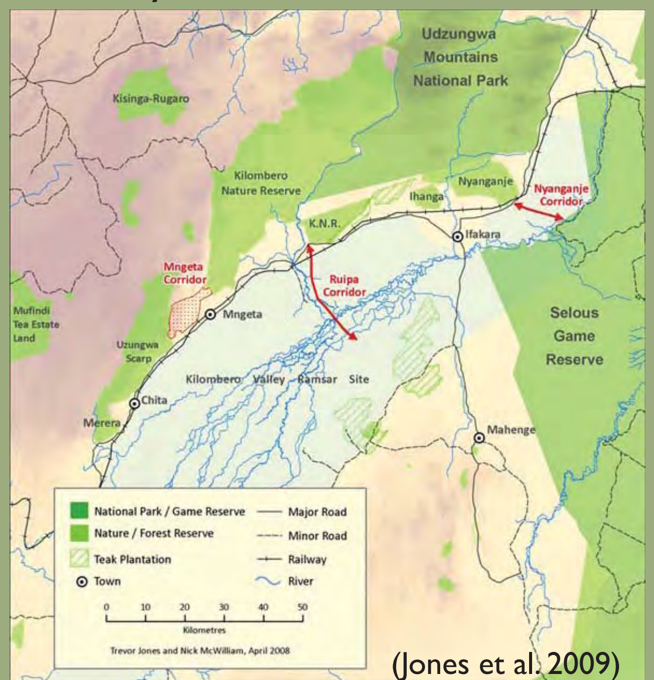
Corridors provide wildlife with:

- Seasonal migration routes to other patches of habitat for grazing
- Greater genetic variation, especially among isolated populations
- Increased habitat diversity
- Safety routes to new habitat should the old one become compromised
- A broad range of ecosystems to meet requirements for certain species
- Further expansion and dispersal of wildlife (Jones et al. 2009).

Conditions

Effective corridors usually follow existing wildlife migration routes. In addition, elephant corridors may require fencing or other methods to delineate the corridor boundaries from the surrounding landscape. As long as these paths provide adequate habitat and are wide enough, corridors can be placed along streams. Keeping agrculture as far away from the corridor can decrease elephant temptation to stray from the path (Fui et al, 2005).

Local Study

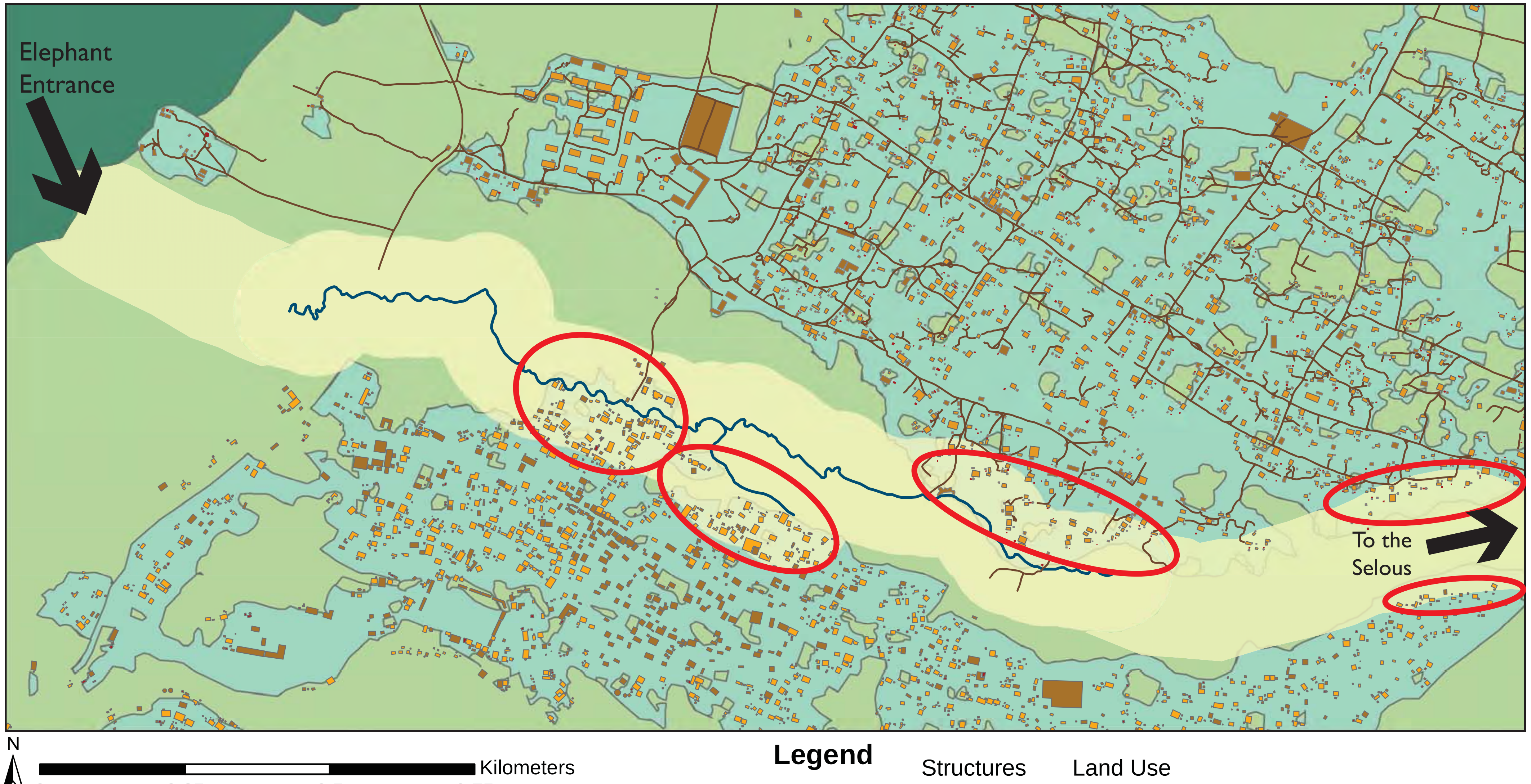


(Jones et al. 2009)

The map above shows the Kilombero Valley, outlining corridors between Udzungwa Mountains National Park and the Selous (Nyangange and Ruipa) and other corridors that connect to UMNP. Due to human immigration the increase in agriculture in the twentieth century, these migration routes are being blocked off (Jones et al. 2009). Two routes were identified that still show signs of wildlife activity, the Nyanganje and Ruipa Corridors (Jones et al. 2009). Without protection, these paths will too become completely inactive, negatively affecting the integrity of the parks. The corridor widths vary from 0.5-6km wide. They are still used by elephants and buffalo (among other wildlife) to migrate between the two parks (Jones et al. 2009).

Wildlife Corridors (Korido za Wanyamapori): Mang'ula Suitability (Yenyekufaa)

Ideal Corridor



Projection: UTM 37 S
Data Source: Larry Gorenflo 2012

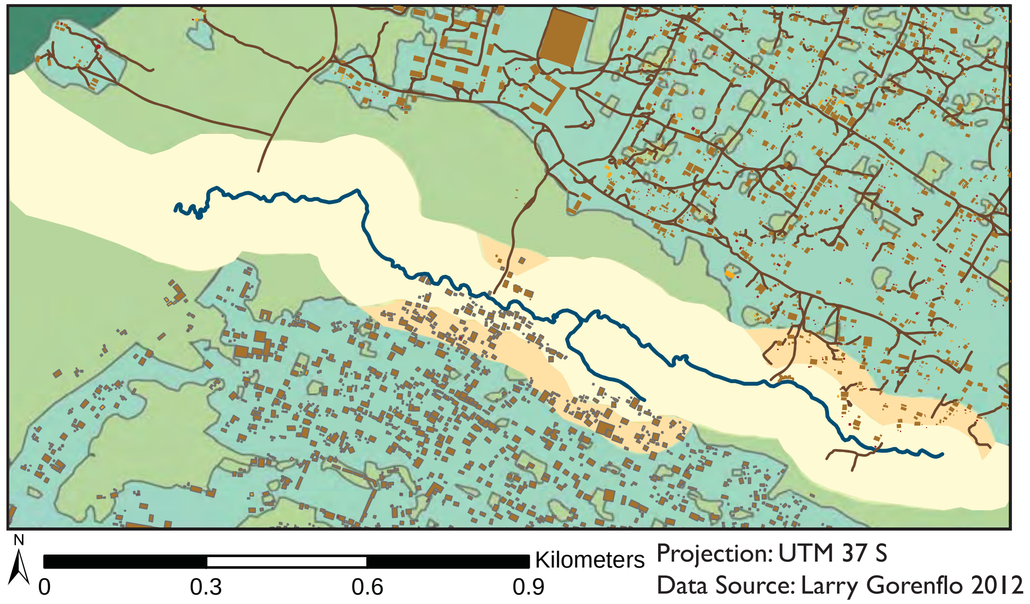
Legend

Roads
Rivers
Conflict Areas

Structures
Other
House
Latrine

Land Use
Agriculture
Residential
Udzungwa Mountains National Park
Compromise Corridor
Proposed Corridor

Corridor Compromise



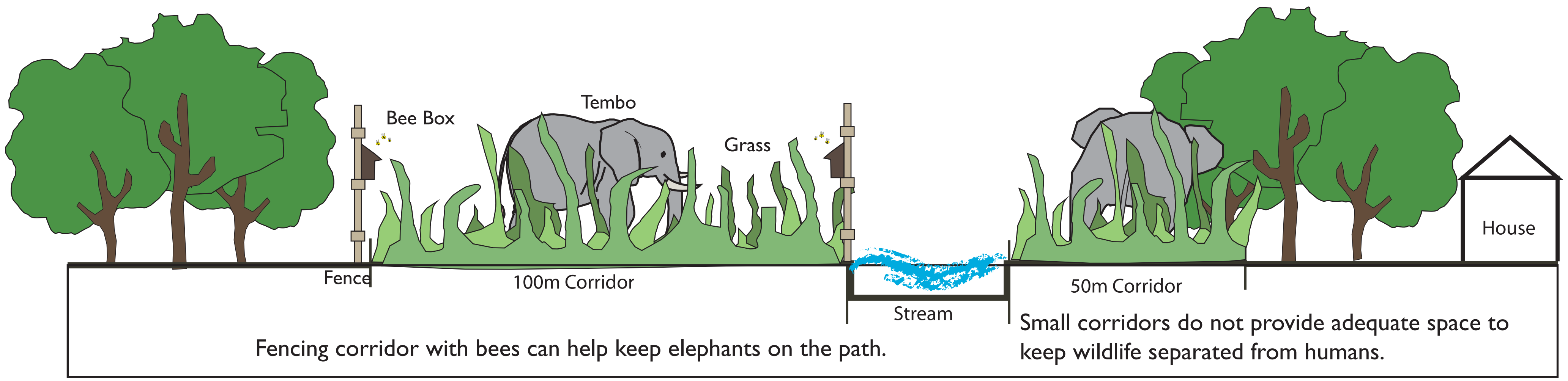
Projection: UTM 37 S
Data Source: Larry Gorenflo 2012

Implications

Implementing this 100m wildlife corridor would provide the beginnings of migration route connecting Udzungwa Mountains National Park to the Selous Game Reserve. Beyond the sugarcane fields, the rest of the corridor will need to be identified in order to link to the Selous. Since wildlife corridors work better if they have already been identified as existing migration routes, it would be best to define those movement patterns first and develop the corridor along them. Be it buffer and corridor this planned path still displaces many people and structures.

Based on the studied corridor widths, 100m is only one tenth of an appropriate size to accommodate large fauna, such as elephants or buffalo. If a corridor was to be implemented immediately, the compromise for a 50m corridor may not be in the locals best interest.

By implementing the 100m wide path, there would be a greater chance to decrease the conflict between humans and wildlife. As is, the passing wildlife may wander off the designated path into the surrounding crops. Elephants in particular may not remain enroute if there are tasty crops bordering the corridor.



Fencing corridor with bees can help keep elephants on the path.

Small corridors do not provide adequate space to keep wildlife separated from humans.

Conclusions

During the week of June 8, 2012 to June 15, 2012, we had researched potential solutions to three critical problems that Mang'ulans face: the provision of clean water for their families, protection of their crops from losses to wildlife, and supplying fuel for cooking. In order to alleviate all problems simultaneously, the practicalities of increasing biogas use through increasing the number of cattle in the villages, while using vegetated buffers as a feed source for the increased number of cattle, increasing water quality for drinking safety as a natural filter, and for the potential use as a wildlife corridor were explored.

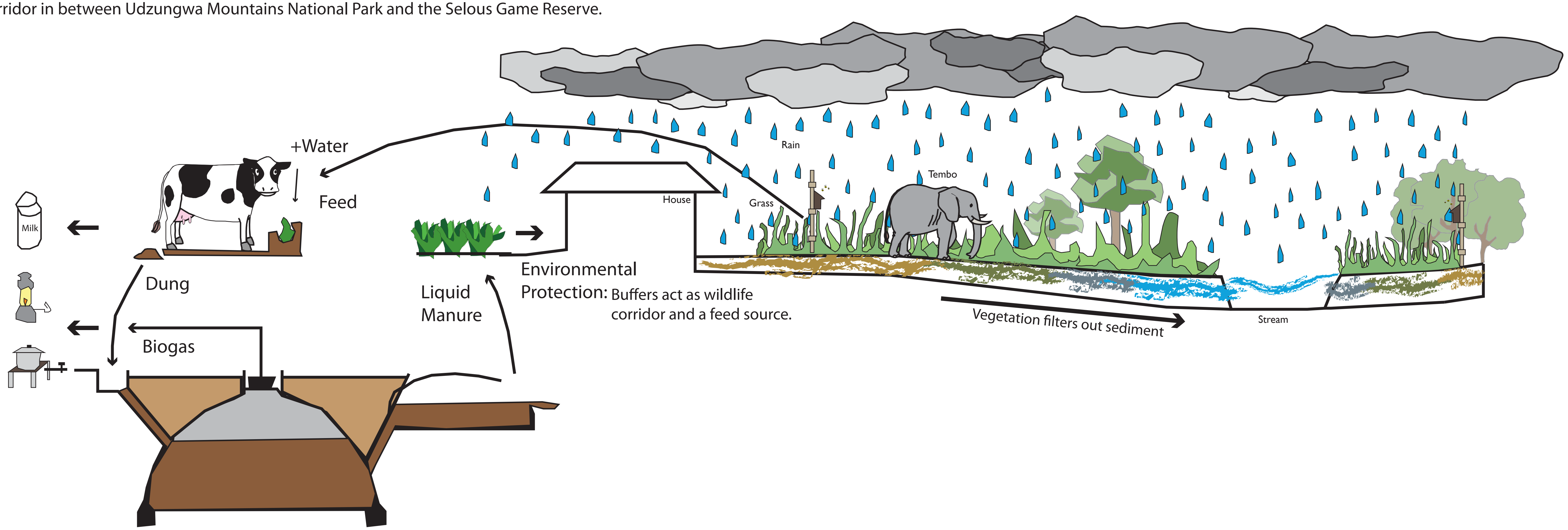
The use of vegetated buffer strips around streams and wetlands was investigated in relation to water purification properties. It was found that in order to create an adequate buffer of 100 meters, 25.51 hectares in area, surrounding the stream in between Mang'ula A and B, 267 structures, including houses, kitchens, latrines, animal pens, and other structures were affected, requiring relocation. While the implementation of vegetated buffers affected homes and other structures, the buffers using the monto vativer grass will improve soil integrity through decreased soil erosion and acting as a filter for pesticide runoff. It is predicted that a large amount of these benefits will fall upon those who are downstream, especially if there are limited amounts of standpipes from which water can be taken.

As a response to the 1 July 2011 ban on firewood collection through Udzungwa Mountains National Park, a sustainable alternative energy source is desperately needed. Because "[d]ead wood was a major source of energy used for domestic purposes such as cooking and heating by more than 95 percent of the population" in the surrounding villages (Nyundo et al 2006, 29), the alternative energy source must provide for a great portion of the village. A potential alternative energy source is the production of biofuel. "Biofuel is what you can extract from biomass and can apply to solid, liquid, or gaseous fuel" (Berg 2008, 6). Biogas was researched as an alternative energy source because of the relatively large amounts of cattle currently present in the villages. Biogas is a mixture of methane and carbon dioxide gas that originates from organic waste, such as animal dung and vegetable waste. Through anaerobic processes microorganisms present in urine and manure of cattle produce the combination of gases (Kuijpers 2003, 1). This potential alternative is praised as a "'sustainable' alternative" by Ninna Berg in her 2008 thesis titled "Biofuels as a Necessary Evil? Report from a Minor Field Study in Kipo, Tanzania."

Through cost – benefit analysis of biogas digestion, it was discovered that the overwhelming majority of materials for a tubular plastic biogas digester can be found locally, potentially lowering the costs of installation. Through this observation, the most expensive component for implementing a biogas digester is expected to be cattle. Because 4 cattle are required to begin the process of biogas production, yet only 2 cattle to continue production, an incentive package around this cost was formulated. It has been proposed to non-governmental organizations, such as Heifer International, to initiate a loaning program of 2 cattle to households which have both 2 heads of cattle and capable of producing the materials needed for a biogas digester.

By random sampling of hectares with high residential areas in Mang'ula A, accounting for unused land and additional land generated by the proposed buffer strip, there was an estimated total of 158 hectares available for feed areas for cattle in biogas production. Under the assumptions made in American models, it was proposed that for each head of cattle 0.408 hectares of grass land must be collected each year. A carrying capacity of 387 cattle is then proposed, which can be used in 193 family sized biogas digesters. Under 2006 calculations, if a family is consuming 22 trees annually for firewood, approximately 4,246 trees can be saved each year.

Wildlife corridors have been labeled as a feasible long-term solution for the wildlife conflicts currently faced for the villagers in Mang'ula A and B. The implementation of a 100 meter buffer in between Mang'ula A and B to act as a wildlife corridor has limitations. Fencing through the corridor may be required due to the high agricultural influence in the area. There may be potential for this proposed wildlife corridor as the beginning of a more complete corridor in between Udzungwa Mountains National Park and the Selous Game Reserve.



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