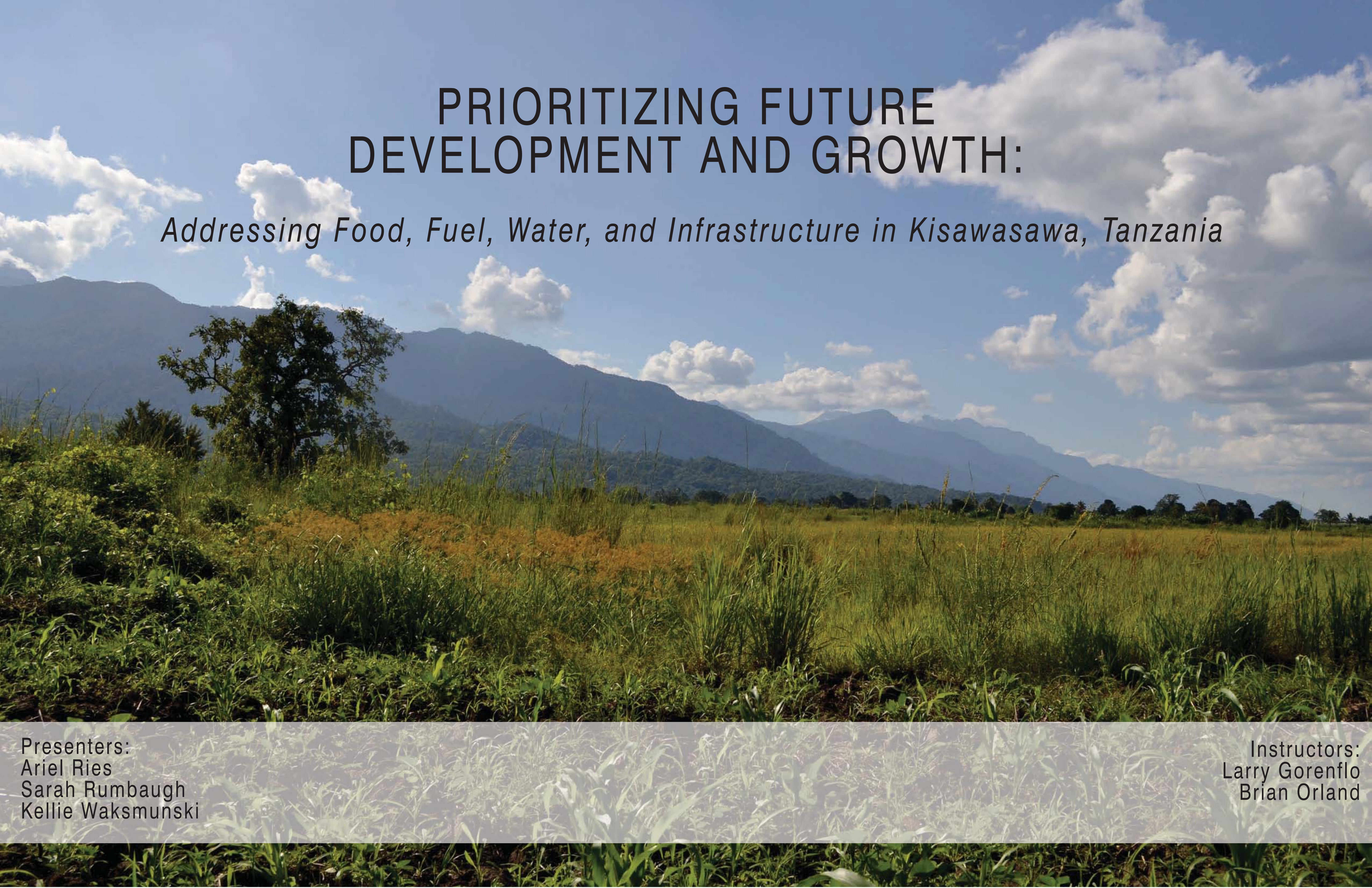

PRIORITIZING FUTURE DEVELOPMENT AND GROWTH:

Addressing Food, Fuel, Water, and Infrastructure in Kisawasawa, Tanzania

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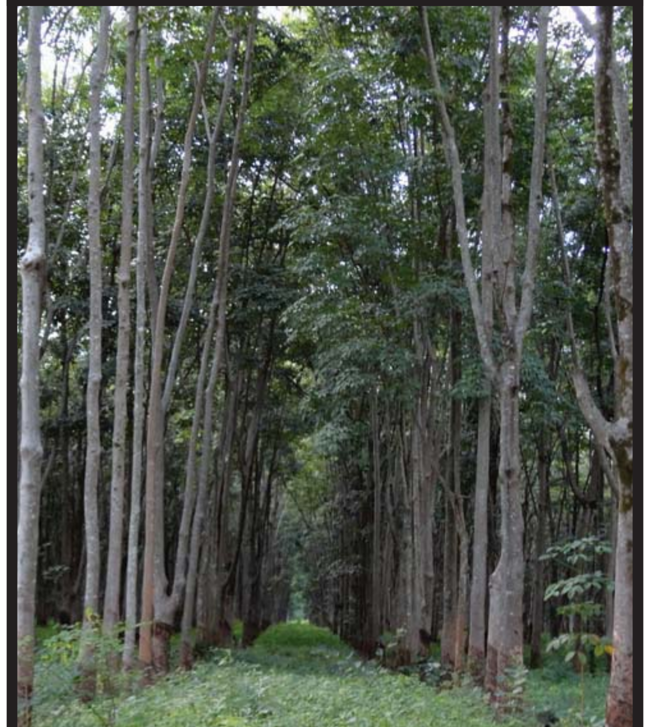

PRIORITIZING FUTURE DEVELOPMENT AND GROWTH

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INTRODUCTION

Setting and Context of Kisawasawa, Tanzania

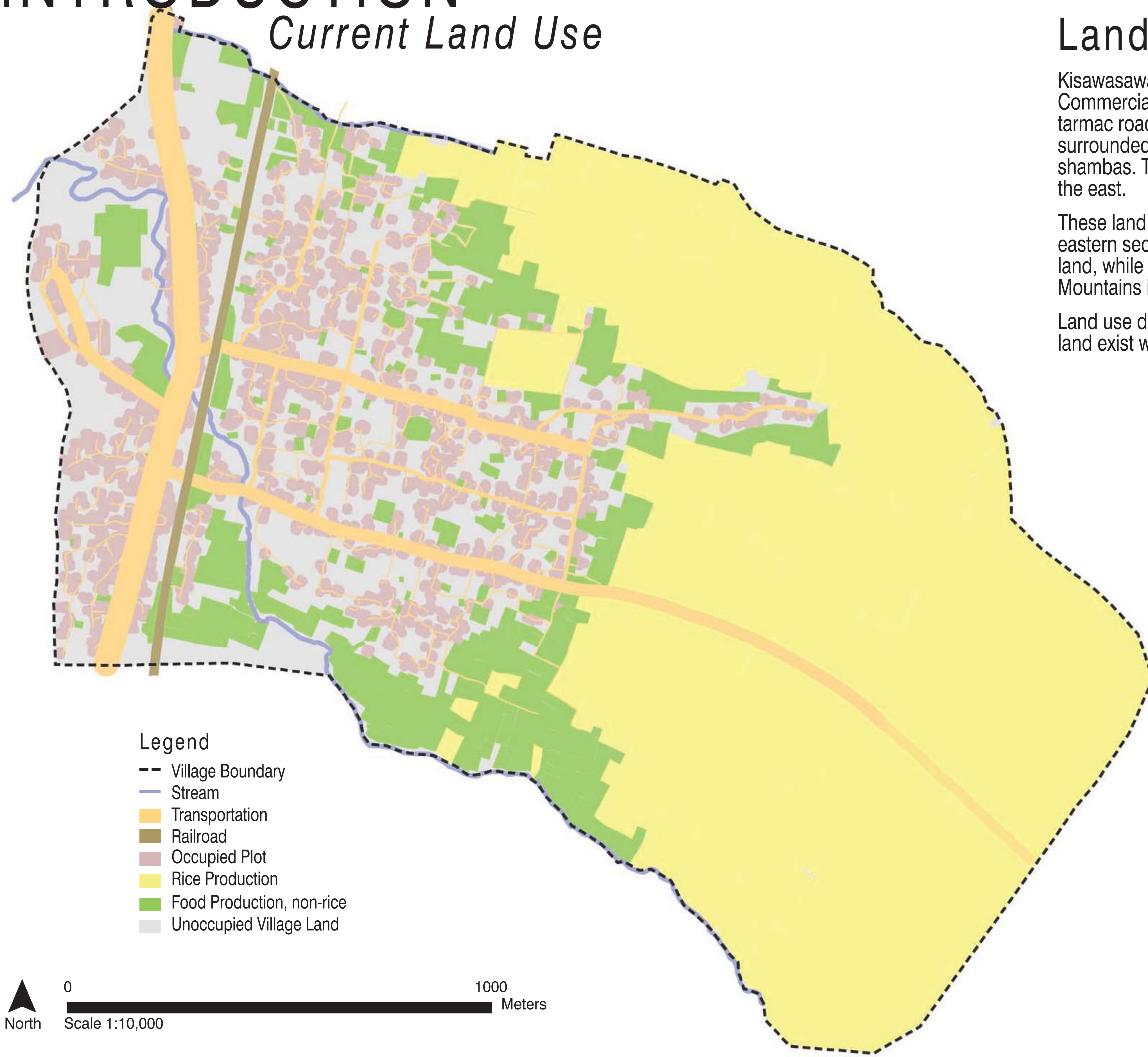
United Republic of Tanzania

Setting

The village of Kisawasawa is located in the Kisawasawa Ward, Mang'ula Division, and Kilombero District of the Morogoro Region of Tanzania (Harrison 2006b). In the 2002 Census, the village's population was recorded as 2,437 persons (Harrison 2006b). However, within the district, population is estimated to be increasing at a rate of 3.4 percent a year, with the current population at 3,404 persons and growing each year (Harrison 2006b). Kisawasawa's location, at the edge of the fertile Kilombero Valley and bordered to the west by the UMNP, has long allowed inhabitants to rely on the park's natural resources for their livelihood (Harrison 2006b). Presently, land to the east of the village is used for subsistence and small scale commercial rice production. With increasing population, the need to both expand the village's residential areas and expand the village's agricultural fields to the east has been identified. With the limiting border of the National Park to the west and the seasonally wet and swampy fields to the east, future expansion will require careful and thoughtful planning. This planning will need to address food, fuel, and water securities for the growing village in a multitude of ways and for a variety of reasons.

INTRODUCTION

Current Land Use



Land in Kisawasawa

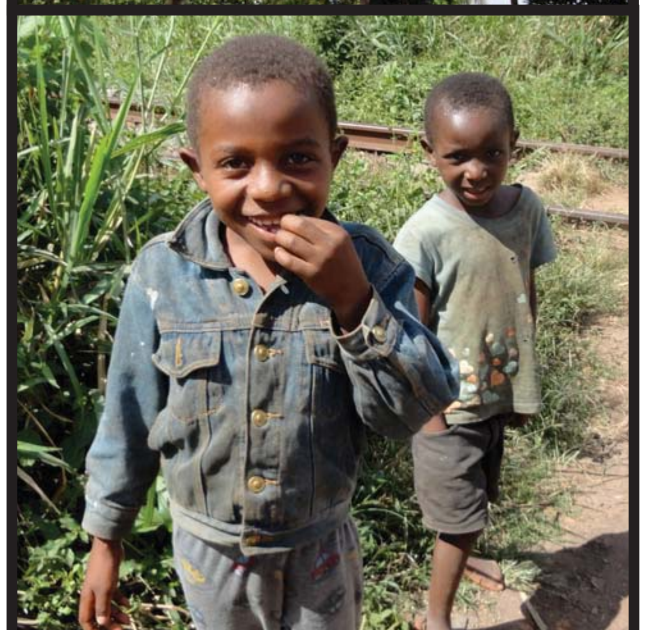
Kisawasawa is organized according to a north-south, east-west grid. Commercial and residential land uses are centered around the main tarmac road and railroad and extend east. This occupied area is surrounded by a ring of small scale agricultural fields and private shambas. This ring is surrounded by a ring of rice fields extending to the east.

These land uses correspond with characteristics of the land. The eastern section of the village consists of low-lying, seasonally wet flat land, while the western section at the base of the Udzungwa Mountains is drier and more suitable for construction.

Land use density within the village is low, and many plots of village land exist within the western section.

Statistics

69.7 ha	Occupied Plots & Roads
179.4 ha	Rice Production
61.0 ha	Food Production, non-rice
48.7 ha	Unoccupied Village Land
358.8 ha	Total Area



INTRODUCTION

Issues and Project Goals

The future expansion and development of Kisawasawa is certain; yet how this development will be approached is not as clear. For the expansion of Kisawasawa to be sustainable, security in food, fuel, and water each must be achieved. This project will look at options and specific approaches for Kisawasawa to obtain security in each of these areas. Acknowledging that actual solutions will be a complex integration of food, fuel, and water securities, the project will then combine these issues into a set of priorities and development models for the village. By strategically and spatially combining the approaches to obtaining these securities, this project will leave Kisawasawa's Village Council with a guide to help them achieve cohesive and coherent expansion, while enhancing sustainable resource consumption, appropriate land use, and quality of life. Ultimately, it will be a way to help Kisawasawa maintain its vibrant community into the future.

These three securities do not exist in isolation. Food is impacted by fuel which is impacted by water, while water is impacted by fuel which is impacted by food. Infrastructure, in particular access to transportation, electricity, and water sources, is affected by the quantity and quality of these necessities. It is impossible to approach any of these issues without addressing the others. In Kisawasawa's agriculturally dominated society, food production directly corresponds with the availability or lack of water (Harrison 2006b). Additionally, with the current absence of electricity, other types of fuel are required to cook food. Fuel production is often dictated by water levels. And water quality is impacted by food and fuel production and consumption. The connections are seemingly infinite. Additionally, the issues of human health and well being are also tightly connected to this triage of food, fuel, and water. The individual issues are interwoven into a complex network that influences every aspect of the village's community, from its members, to its form, to its quality of life.

This project will entail two phases. The first involves addressing the issues of food, fuel, and water securities individually. The second phase involves combining these findings into an integrated model and a set of priorities that can guide future development and expansion in Kisawasawa. The first phase will be undertaken by individual group members each with a particular focus. However, communication between members will be high, and all will contribute towards each issue. Ultimately, each focus will result in specific design solutions for direct implementation and possible connections and concepts to carry into phase two. The second phase will involve a synthesis of the former phase. In this way, the findings of each issue will be combined into a spatial and strategic model for the village of Kisawasawa. Spatially, development recommendations will be made based on the most efficient ways to increase food, fuel, and water efficiencies. Strategically, priority areas and projects will be identified. The result, in essence a master plan to guide the growth of Kisawasawa, will in fact not be a planning document but an approach for the village to start thinking about their expansion. In this way, we will not create a formal plan for Kisawasawa, but a way for the residents of Kisawasawa to create their own plan for the future of their village.

FOOD SECURITY

Inventory & Analysis

Food Security is...

regular access to sufficient foods for a healthy and productive life

a multidisciplinary process that involves the application of science to produce, preserve and store food

applying strategic planning to achieve productions and distribution of products

Issues in Kilombero District

Natural Population + Attractive Land = 3.4% Annual Population

In 10 Years... Population = 55.47%

55.47% Population + 55.47% Food Production = Available Land

Possible Design Solutions

Current Rice Fields → Food Production Fields

Conversion of Rice Fields + Under used Land = Food Production = Food Security

FOOD SECURITY

Inventory & Analysis - Current Food Production

Kisawasawa Crop Production

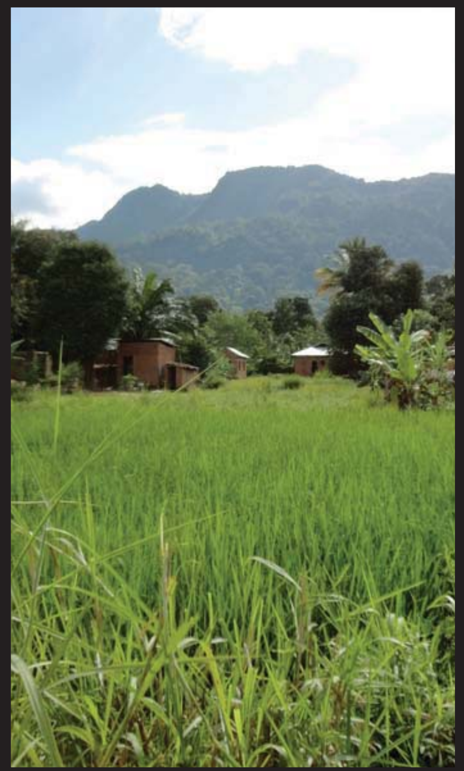
The extent of the agricultural fields in Kisawasawa consist of the production of rice which extend into the east. For food security to succeed in the village in the future, an increase in food production needs to be concurrent with the population increase. The amount of land used for cash crop growing, such as rice, needs to be converted into food production for the village in order to achieve food security for the estimated population growth.

Food Efficiency

The combination of both the population increase and the lack of available land urges an increase food efficiency. To produce a sufficient amount of food with a possible surplus requires a more effective way to farm on the same or only slightly more land. The under utilized land in the village center allows for production to increase through infill instead of resorting to eastern agricultural sprawl.

Food Storage & Marketing

Storing and marketing food production allows for a more successful food security. In Kisawasawa, there is no definite market place to sell surplus crops. Initiating commercial districts along main roads improves the cash inflow for the village. Storing crops also helps eliminate the corruption in selling crops at low prices. Simple storage facilities can help alleviate the issues of weather and animal degradation.



FOOD SECURITY

Inventory & Analysis - Current Food Production

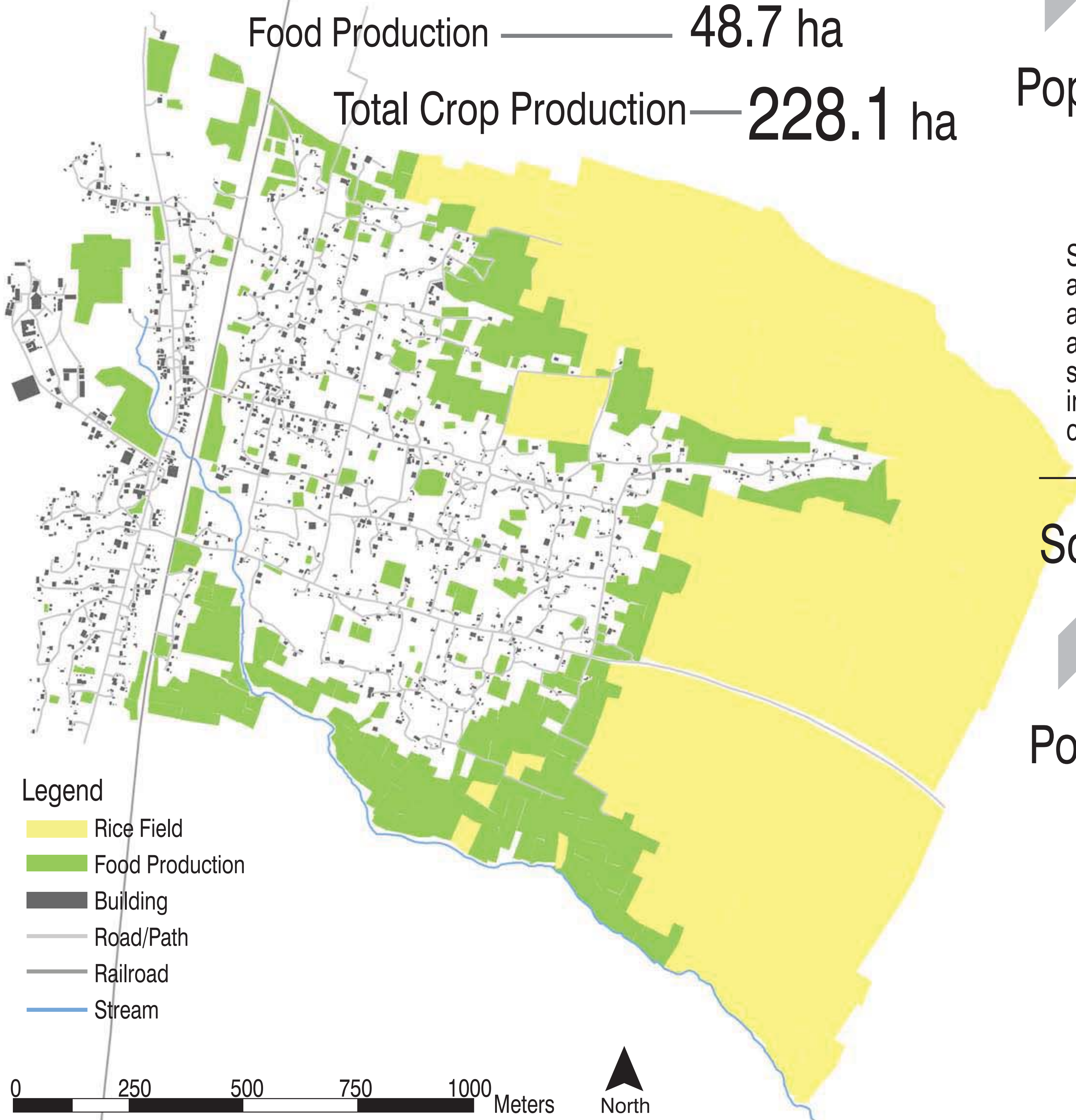
Current Food Production in Kisawasawa

The present land use for agriculture is dominated by rice production. The rice fields are also close to the village center, which will become a commodity when population increases. Since the available land will always be decreasing, the pressure for land to be used for food production instead of for cash crops will increase.

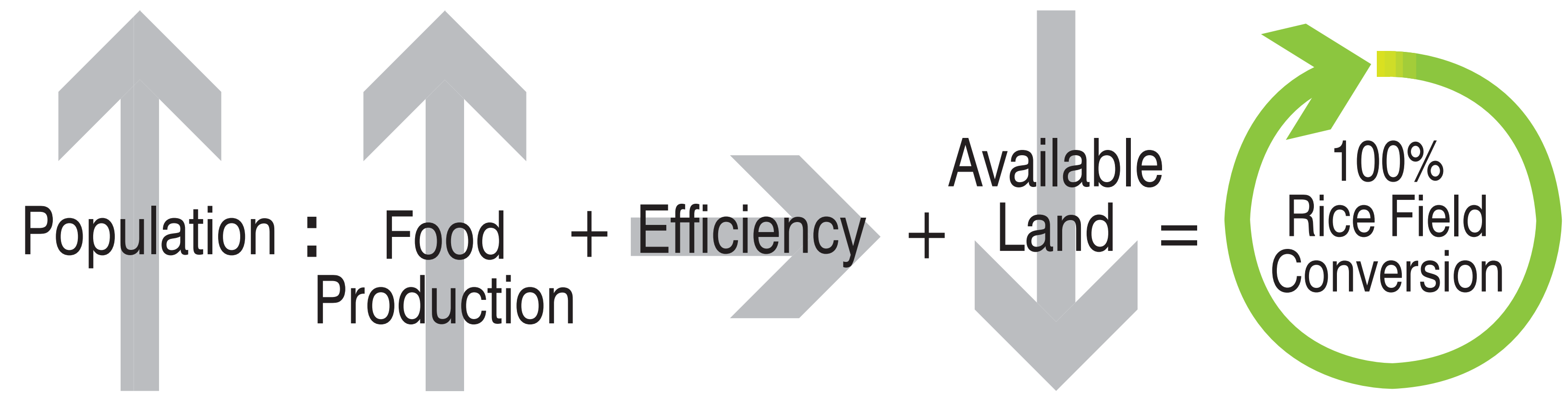
Rice Production — 179.4 ha

Food Production — 48.7 ha

Total Crop Production — 228.1 ha

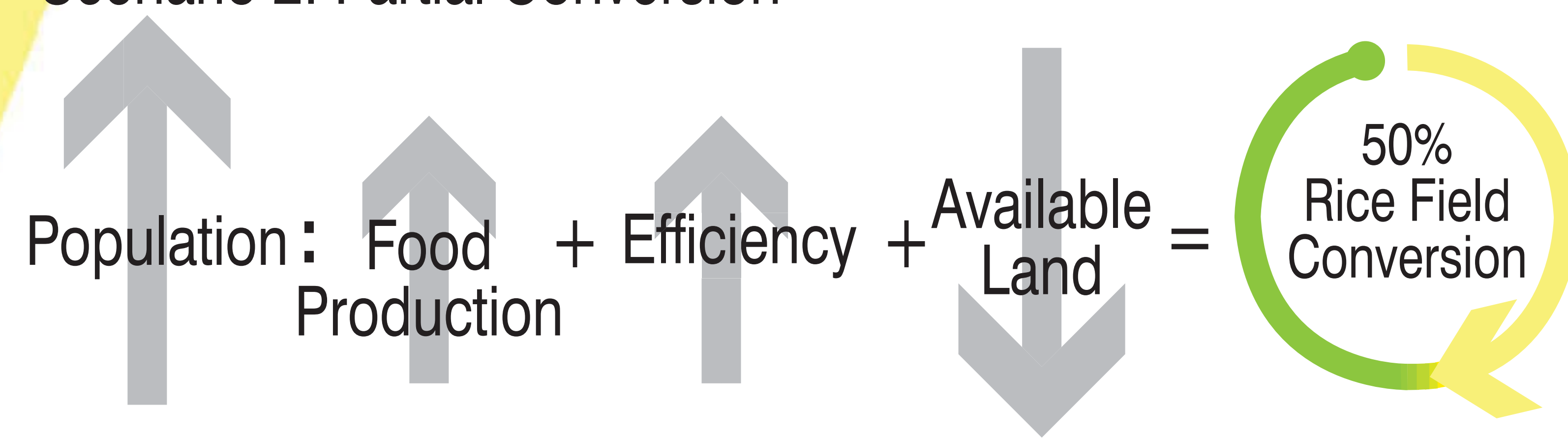


Scenario 1: Complete Conversion



Scenario 1 illustrates how Kisawasawa will look in 10 years when the population increases by 55.47% and does not increase their efficiency in food production. If the population increases by a certain amount, that means the food production will need to also increase by that certain amount, whether in additional land used or increased in efficient production with the current amount of land. This scenario shows that if Kisawasawa does not increase their efficiency in food production but the population increases, then the amount of rice fields needed to fill the void left by the ill-efficient production will cause a 100% conversion of their rice fields to food production to make up for the increased population

Scenario 2: Partial Conversion



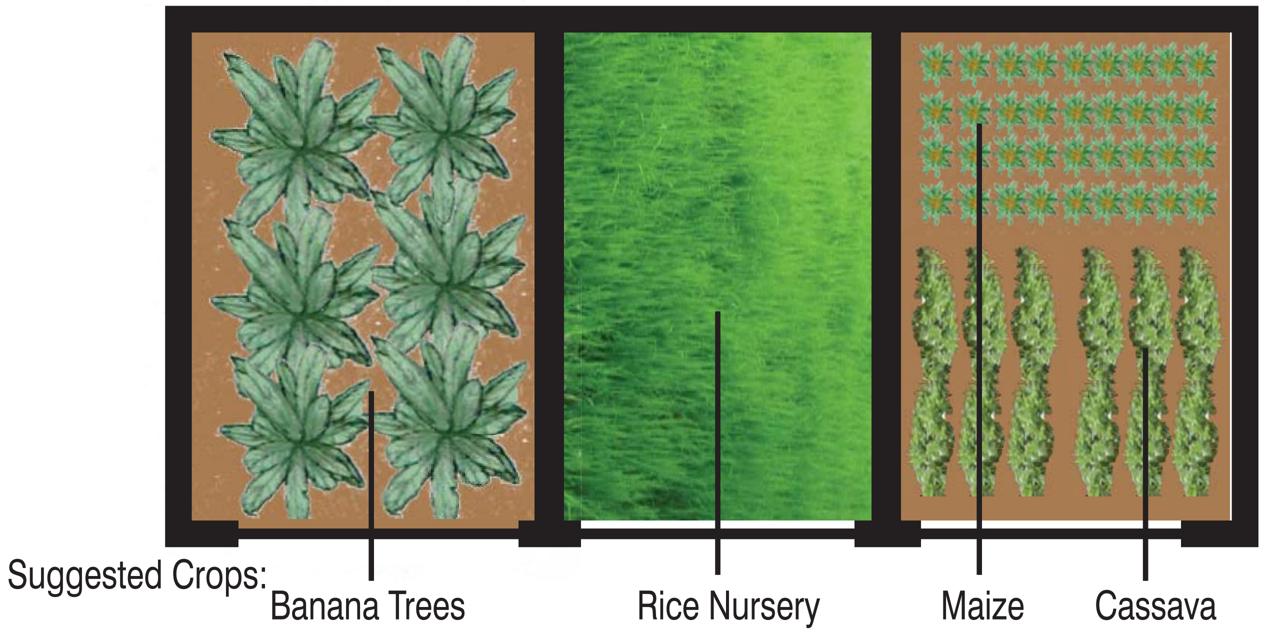
Scenario 2 illustrates how Kisawasawa will look in 10 years when the population increases by 55.47% and does increase their efficiency in food production. If the village can increase the efficiency by half, then the food production that needs extra land will also be only half. This results in the conversion of the rice fields near the village center to only be 50%, which allows for the farmers to still access their cash crop and food with ease. This scenario brings about an issue as to how to

FOOD SECURITY
Design Solutions - Minimizing Land Use Pressure

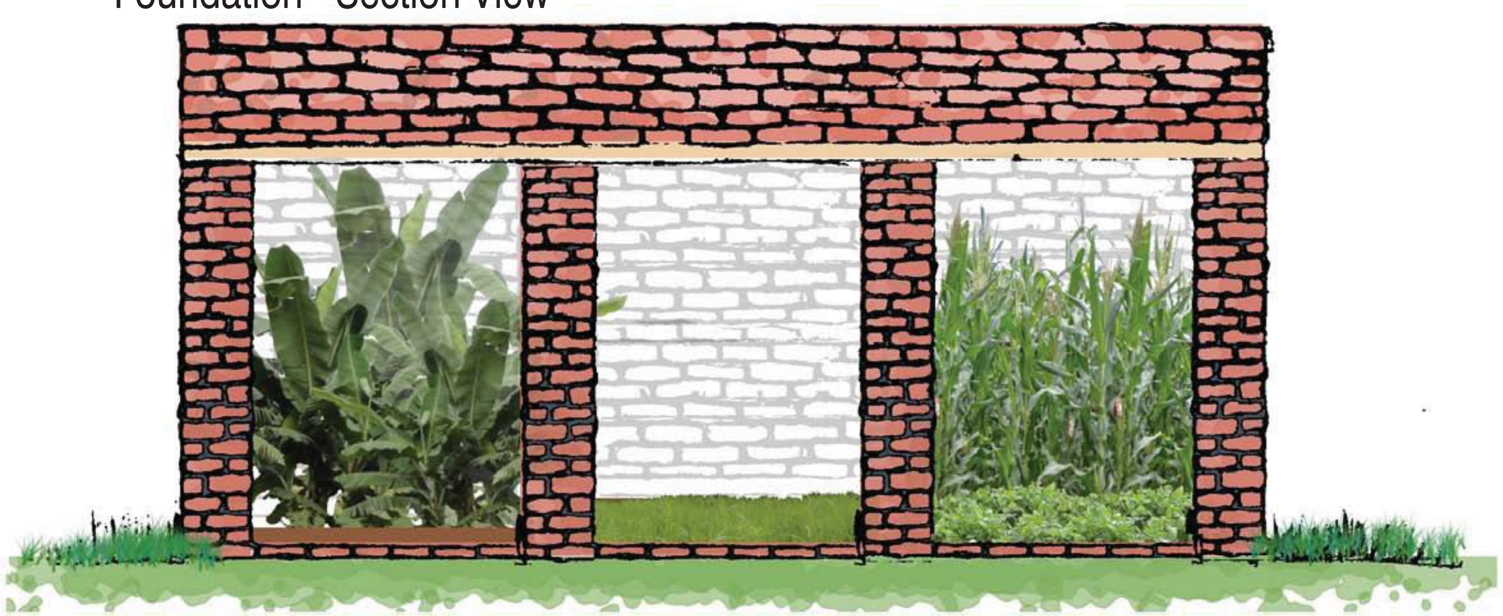
Utilizing Unused Land within the Village

Under utilized land in the village has caused exploitation of land further out for crop production, causing the availability of land for agriculture to decrease. The spacing of houses and their relative builidings through large dirt plazas and overgrown vegetation creates an opportunity for small scale farming in the under utilized spaces. Foundations that have been overgrown also prove to be a viable option for land utilized for crop production. This small scale solution for increasing efficiency in food production can allow for multiple crops to grow in the open roof foundations. Kisawasawa has many abandoned foundations that can be used by either one family or multiple families in the surrounding area.

Foundation - Plan View

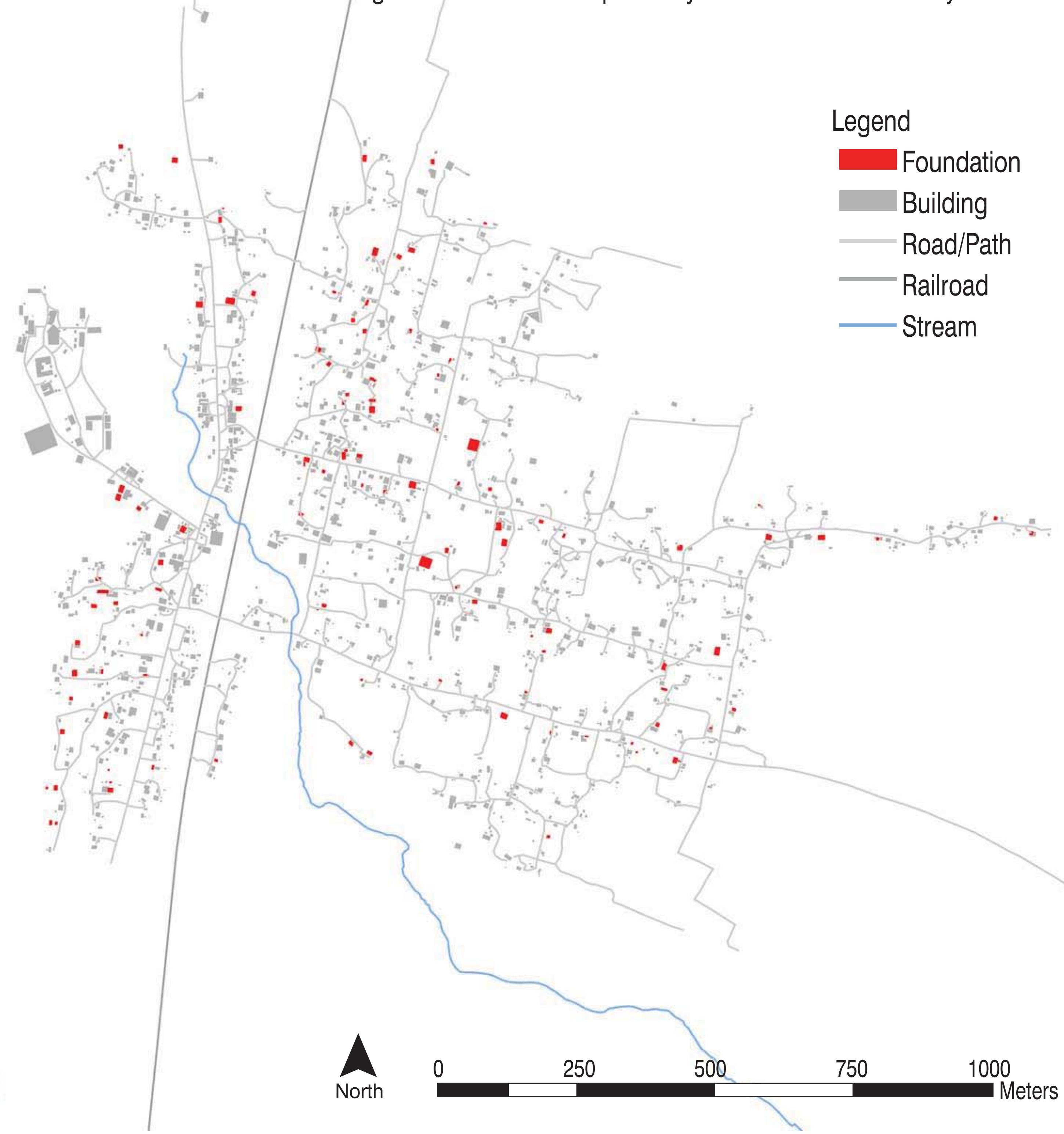


Foundation - Section View



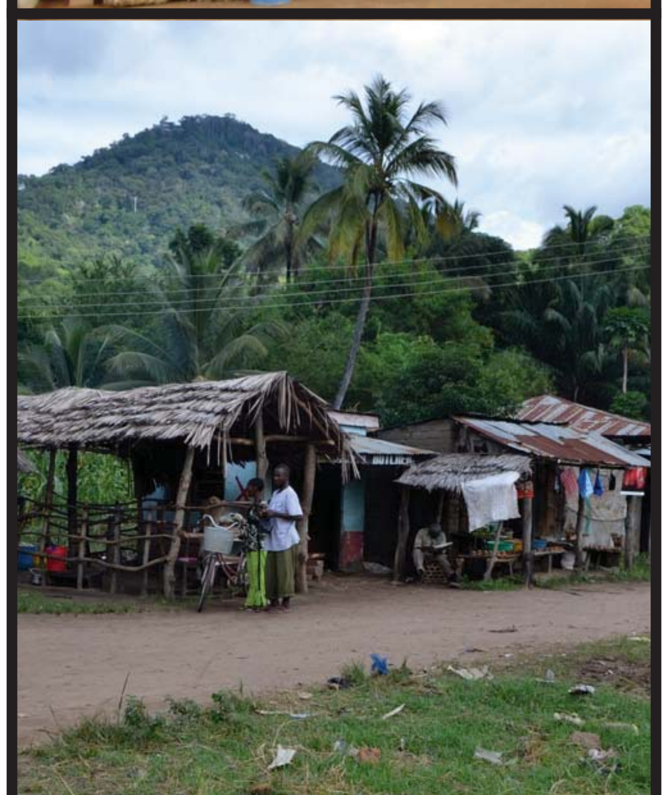
Location of Foundations in Kisawasawa

The amount of foundations in Kisawasawa shows the potential for the land use to be turned into both rice nurseries and crop gardens. Though the amount of land is small, the foundations provide adequate sunlight as well as a close proximity to the house for security.



FOOD SECURITY

Design Solutions - Storage & Marketing



Storage

The storing of crops currently in Kisawasawa is an issue that can greatly improve food security. If surplus cash crops are stored as well as food production, the farmer can sell the product at a higher price when the demand is high. Storage from weather and animal degradation for the purpose of selling can facilitate a market district.

Marketing

To increase food security, the production of a surplus of crops is necessary. Kisawasawa currently has no distinct market for the sale of cash crops. Marketing the enormous rice production in the village would help bring in extra income for the farmers, which in turn can help them buy ways to increase efficiency in farming.

Communal or Individual Storage Facility

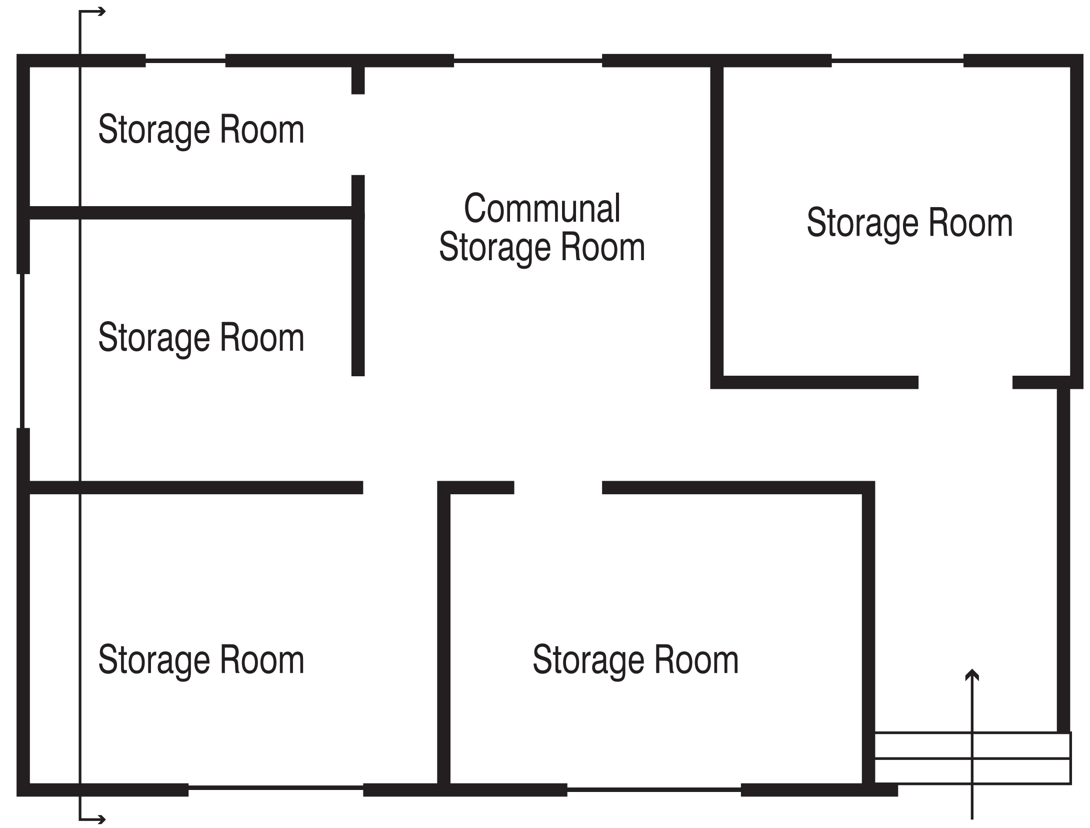
The design for the storage facility can function as both a community facility and an individual family's facility. The multi-roomed facility allows for 5 people to either rent a room, or 5 rooms to be used for the farmer's crops. The structure allows for damage from weather ad animals to be minimal.

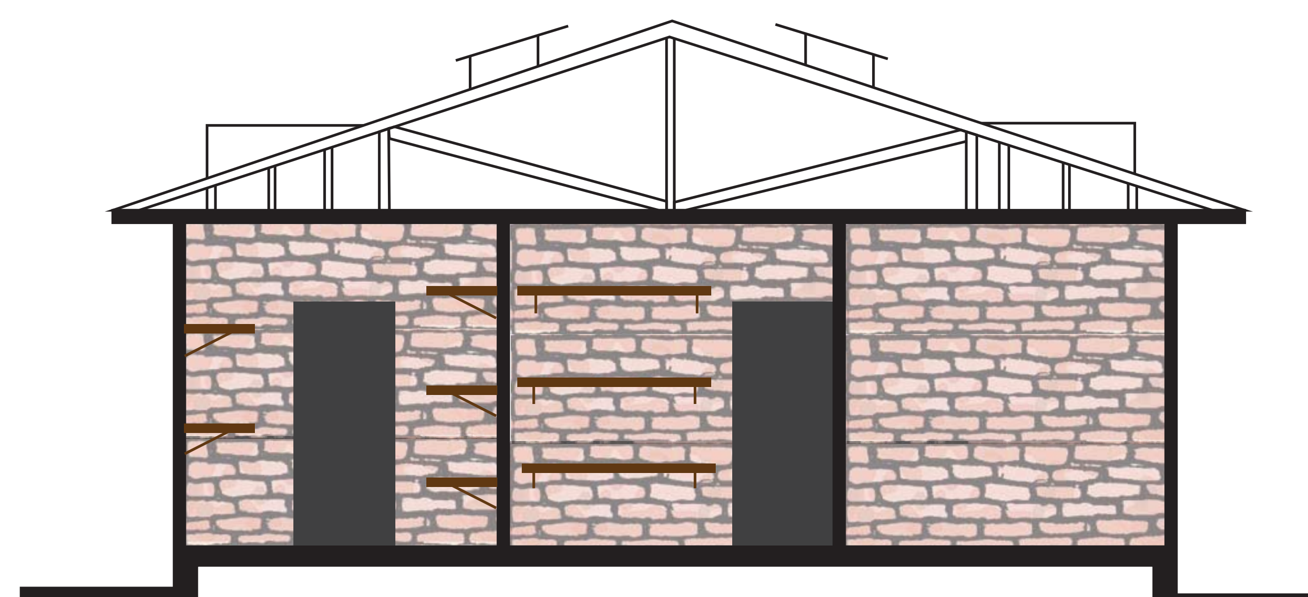
Location Options for Facility:
- Adjacent to Fields
- Adjacent to House/ Shamba
- Community Market

Reasons for Community Storage:
- High level of security
- Located on community land
- Multi-family storage capability

Reasons for Individual Storage:
- Less chance of stolen goods
- Larger area for food storage
- Located on private land

Items for Storage:
- Cash Crops (bagged rice)
- Rice Husks
- Food (cassava, maize, beans)
- Fuelwood
- Farming Tools





FOOD SECURITY

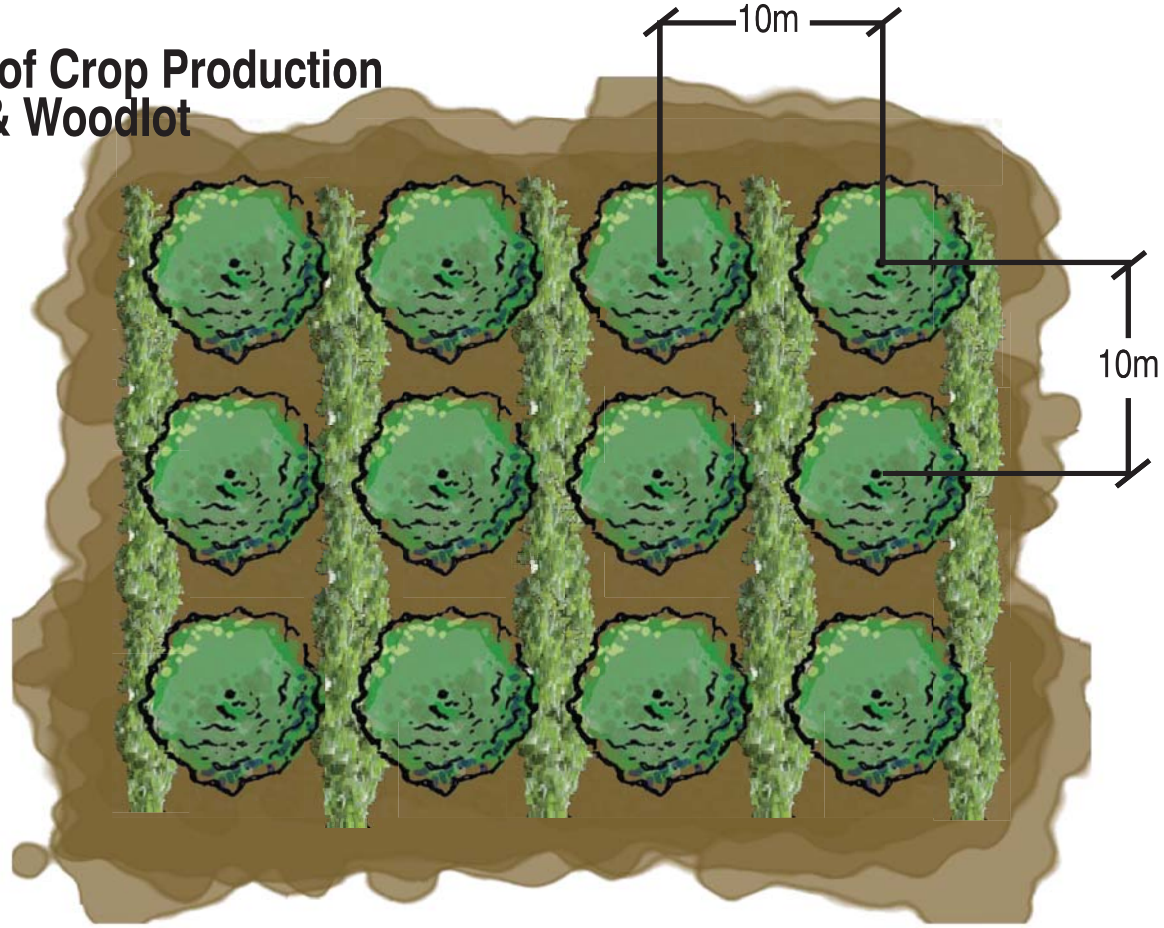
Design Solutions - Crop Production & Woodlots

Initiating Woodlots through Crop Production

The use of woodlots in Kisawasawa will be necessary in the future for fuel. The initial set-up of the lots may seem like a wasted space to many in the village since the trees will be too young to cultivate, and so a combinated of crop production and woodlots can be used. To maximize land efficiency for both the woodlot and food production, the combination can benefit the farmer and the community through the duel uses.

Combining both crop production and woodlot design allows for root vegetables to be grown between the spaced trees. The canopy will never be full and closed since the villagers will be cutting and utilizing the woodlot for fuel. NGO's such as WWF or government programs such as TANAPA can be options for assistance and funding for the set-up of the combined woodlots.

Plan View of Crop Production & Woodlot



Section View of Crop Production & Woodlot

The 10m spacing between the trees allows for ample light to reach the crops

Woodlot outside of the village of Mwaya

Home located next to rice fields

Tree nursery at a local primary school - the nursery must be fenced in and shaded

Man cooking with a rice husk stove

FUEL SECURITY

Inventory & Analysis

Fuel Shortage

73% of households in the villages surrounding the Udzungwa Mountains National Park depend on fuelwood for cooking and heating. About 66% of this wood is collected from the National Park (Nyundo et al. 2006). Starting 30 June 2011 people will be forced to find alternative fuel sources as they will no longer be able to access fuelwood from the Park (Nyundo et al. 2006).

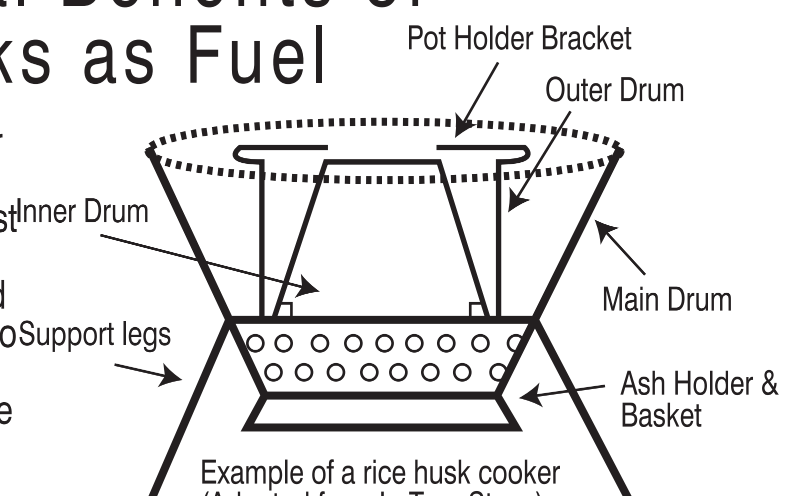
Rice Husks as an Alternative Fuel Source

Rice husks are the outer shell of the paddy grain. The husks form about 20% of the weight of the paddy. Before husking the paddies are dried to have a 14% moisture content. This drying process is important to ensure that the husks can be used effectively as fuel, since husks with a high moisture content do not burn easily. During the milling process the husk is separated from the grain in a husker. These huskers produce either whole or ground husks, with whole husks being preferable for burning in rice husk stoves.

Rice husks are usually discarded in large piles or they are burned, as they are regarded as a waste material in most circumstances (Belonio 2005). However, the dominance of rice agriculture in Kisawasawa ensures that if rice husk stoves were available to households and people were educated on how to use them effectively, rice husks could prove to be a viable energy alternative to fuelwood.

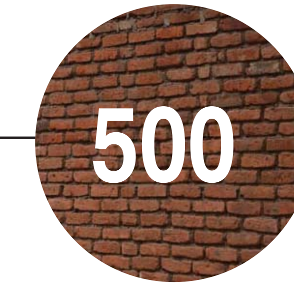
Ecological Benefits of Rice Husks as Fuel

By using rice husks for fuel instead of deadwood the existing forest is preserved as less trees are cut down and deadwood is allowed to decay naturally, contributing to the valuable soil organic matter (Belonio 2005).

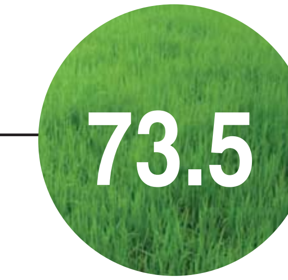


Example of a rice husk cooker (Adapted from LoTrau Stove)

Percent mass of rice paddy that is the rice husk



Approximate number of households in Kisawasawa



Bags of rice produced per hectare per growing season

Household Information

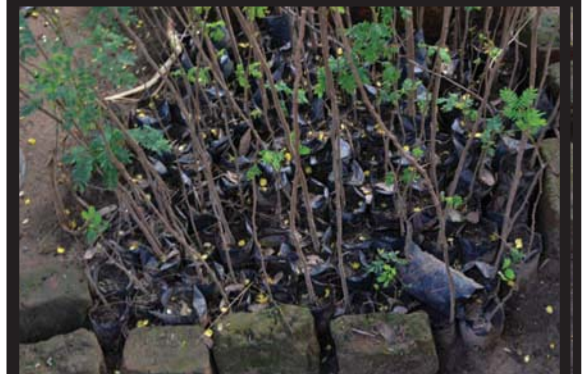
Kisawasawa's population: 2,437 people
Average household size: 5 people
2,437 / 5 = Approximate number of households
Approximate number of households: 487.4 households

Rice Husks for Fuel

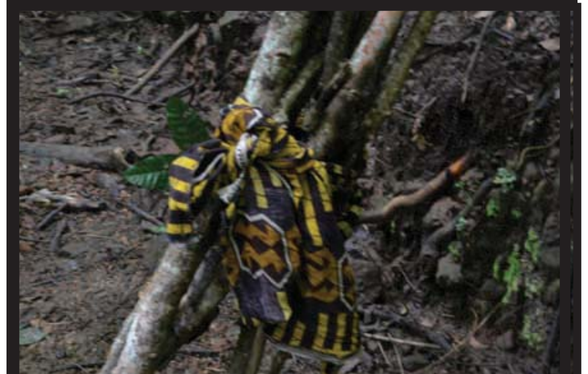
Total hectares of rice fields in Kisawasawa: 121.125 ha
Bags of rice produced per hectare per growing season: 73.5 bags
Each bag of rice is 100 kg
Mass of rice husks: 20% the mass of a bag (20 kg)

Rice Husks per Hectare

Bags of rice produced per hectare per growing season: 73.5 bags
Each bag of rice is 100 kg
73.5 bags x 100 kg = kg of rice per hectare
Kg of rice per hectare = 7,350 kg
Mass of rice husks: 20% the mass of a bag (20 kg)
7,350kg of rice x 0.20 = kg rice husks per hectare
Kg rice husks per hectare = 1,470 kg
Total hectares of rice fields in Kisawasawa: 121.125 ha
1,470 kg of rice husks x 121.125 ha = Amount of rice husks
Amount of rice husks from Kisawasawa's rice fields per year: 178,053.8



Saplings growing at school nursery

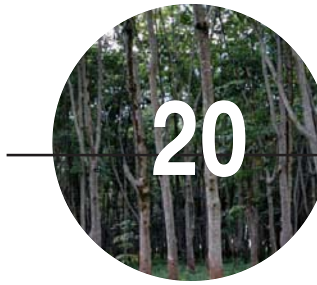


Wood collected from the National Park on a Thursday - the day residents are permitted tc collect deadwood from the forest

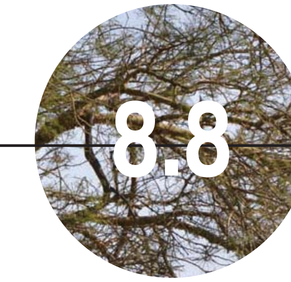
Homes are located directly adjacent to the National Park

Kisawasawa has an abundance of vegetation and canopy coverage within the village

FUEL SECURITY
Inventory & Analysis



Trees needed per year per household with inefficient stoves



Trees needed per year with efficient wood stoves

Percent of fuel needs that could be met with rice husks

Dependence on Deadwood for Fuel

In the Kilombero Valley the average household of five people consumes one to two bundles of firewood per week for domestic use (Harrison 2006b). A bundle of firewood sells for about TSh. 600 (Harrison 2006b). If people resorted to buying the firewood, which currently they are collecting for free, this would impose a cost of between TSh. 30,000 and TSh. 60,000 on households annually - making this source of energy cost prohibitive for most families. While rice husks can provide about one month's worth of fuel for residents of Kisawasawa, the fuel efficient woods stoves are the best possibility for drastically decreasing Kisawasawa's energy demands.

Woodlots must be established in Kisawasawa in order to provide fuelwood for residents after the closure of Udzungwa Mountaions National Park's borders for deadwood collection on 30 June 2011. Saplings for the woodlots should be grown in nurseries run by the schools and other community groups in order to produce healthy trees in the woodlots

Deadwood for Fuel

Trees needed per year per household: 20-medium sized trees (6 m high)
Wood used per household annually with inefficient wood stoves: 3486.6 kg
Trees needed per year per household with fuel efficient stove: 8.8 trees
Trees produced per hectare of woodlot: 400 trees
Approximate number of households: 487.4 households
Wood (kg) x 1.18 = Rice husk energy equivalent (kg)

Annual Deadwood Consumption for Kisawasawa

Trees needed per year per household: 20-medium sized trees (6m high)
20 trees x 487.4 households = Trees needed for Kisawasawa annually
Trees needed for Kisawasawa annually: 9,748 medium sized trees
Trees produced per hectare of woodlot: 400 trees
9,748 trees / 400 trees = Hectares of woodlot needed annually
Hectares of woodlot needed annually for Kisawasawa = 24.37 hectares

Annual Deadwood Consumption for Kisawasawa with Energy Efficient Wood Stoves

Trees needed per year per household with fuel efficient stove: 8.8 trees
8.8 trees x 487.4 households = Trees needed for Kisawasawa annually
Trees needed for Kisawasawa annually with fuel efficient stove: 4,289.12 trees
Trees produced per hectare of woodlot: 400 trees
4,289.12 trees / 400 trees = Hectares of woodlot needed annually
Hectares of woodlot needed annually for Kisawasawa = 10.72 hectares

Rice Husk Contribution to Fuel Needs

Wood utilized per household per year: 3,486.6 kg
3,486.6 kg x 487.4 households = Wood utilized by Kisawasawa annually
Wood utilized annually by Kisawasawa: 1,699,368.84 kg
Wood (kg) x 1.18 = Rice husk energy equivalent (kg)
1,699,368.84kg x 1.18 = Rice husk energy equivalent
Equivalent energy in rice husks: 2,005,255 kg
Amount of rice husks from Kisawasawa's rice fields per year: 178,053.8
178,053kg / 2,005,255 kg = percent of Kisawasawa's fuel needs met by rice husks
Percent of Kisawasawa's fuel needs met by rice husks: 8.9%
2,005,255kg - 178,053kg = Difference between fuel needed and fuel available in rice husks
Difference between fuel needed and fuel available: 1,827,201 kg rice husks
Wood (kg) x 1.18 = Rice husk energy equivalent (kg)
1,827,201 kg / 1.18 = Wood energy equivalent
Equivalent energy in wood= 1,548,475.8 kg
Wood utilized annually by Kisawasawa: 1,699,368.84 kg
1,699,368.84 kg - 1,548,475.8 kg = Energy obtained by rice husks

Hectares of woodlot needed annually for Kisawasawa = 24.37 hectares
Percent of Kisawasawa's fuel needs met by rice husks: 8.9%
24.37 - (24.37 ha x .089) = Hectares of woodlot needed if with rice husk stoves are utilized
Hectares of woodlot needed if with rice husk stoves are utilized: 22.2 ha

FUEL SECURITY
Design Solutions

Land Use Development Model: Woodlots

Woodlots will be located in many areas around Kisawasawa to increase resilience. If pests, animals, or poachers negatively impact one woodlot, the community will not lose all of its trees. This will also be helpful in determining which areas of village land are most productive and most secure.

1. Woodlots will be established as a buffer between the National Park and the village. These lots will decrease the edge effects of the forest, and trees here will thrive in soil that is suitable for their growth.

2. Woodlots will be planted in areas of the village with important significance to villagers, especially near institutions such as churches, mosques, schools, and medical centers in hopes that these institutions will serve as guards against people attempting to steal from the woodlots.

3. Woodlots will be planted in areas near existing homes, where space permits, as villagers will help to police this asset to their community. These lots may or may not be for the residents surrounding the lots.

4. These large continuous woodlots are designated as the major fuel source for the village. These contiguous plots also provide habitat for birds and small mammals. Because of the size and juxtaposition to the village boundary, these woodlots are more vulnerable, therefore these lots will need to be protected by a hired guard.

5. As residential development occurs eastward, woodlots will be incorporated into the village expansion. The woodlots will be surrounded by homes, similar to the woodlots established within the village center, so trees can be protected by the villagers surrounding them.

6. Access road through the woodlot used primarily for maintenance purposes and for planting and harvesting trees

100 hectares | **400 trees per hectare** | **40,000 trees**

FUEL SECURITY
Design Solutions

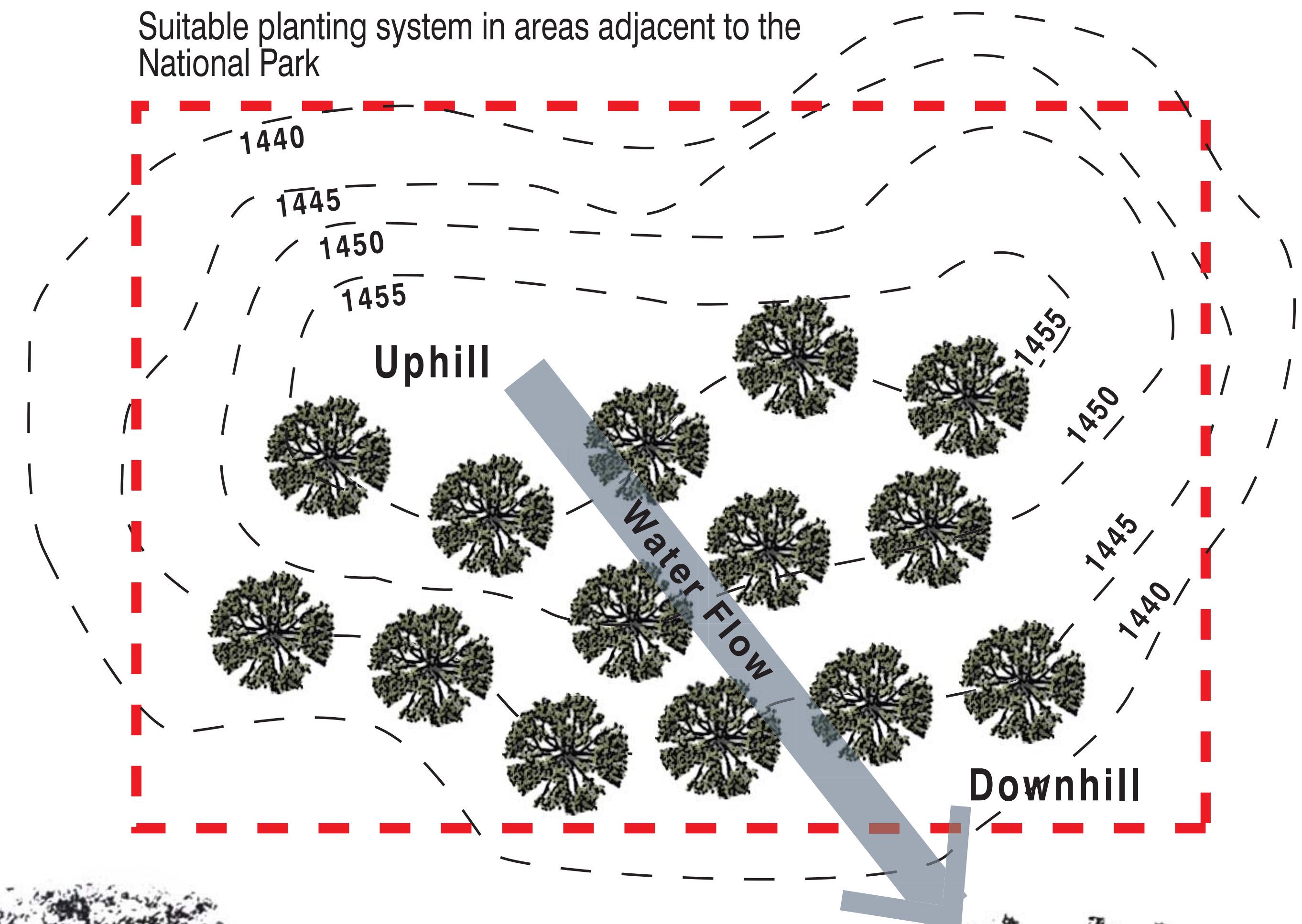
Planting the Woodlot

To establish a woodlot the existing land must first be cleared of vegetation and the soil should be tilled. Seedlings must be grown from a high quality seed bank and should be purchased from a seed distributor. The saplings should be planted when they are between 15 and 30 cm tall.

Trees will be planted on a 5 meter by 5 meter grid. Woodlots established on hillsides in Kisawasawa should be planted along contour lines rather than on a grid. Planting along contour lines helps to stabilize the sloping land, prevents erosion. Trees will not be as evenly spaced on the hillsides, however all trees should remain a minimum of 5 meters apart.

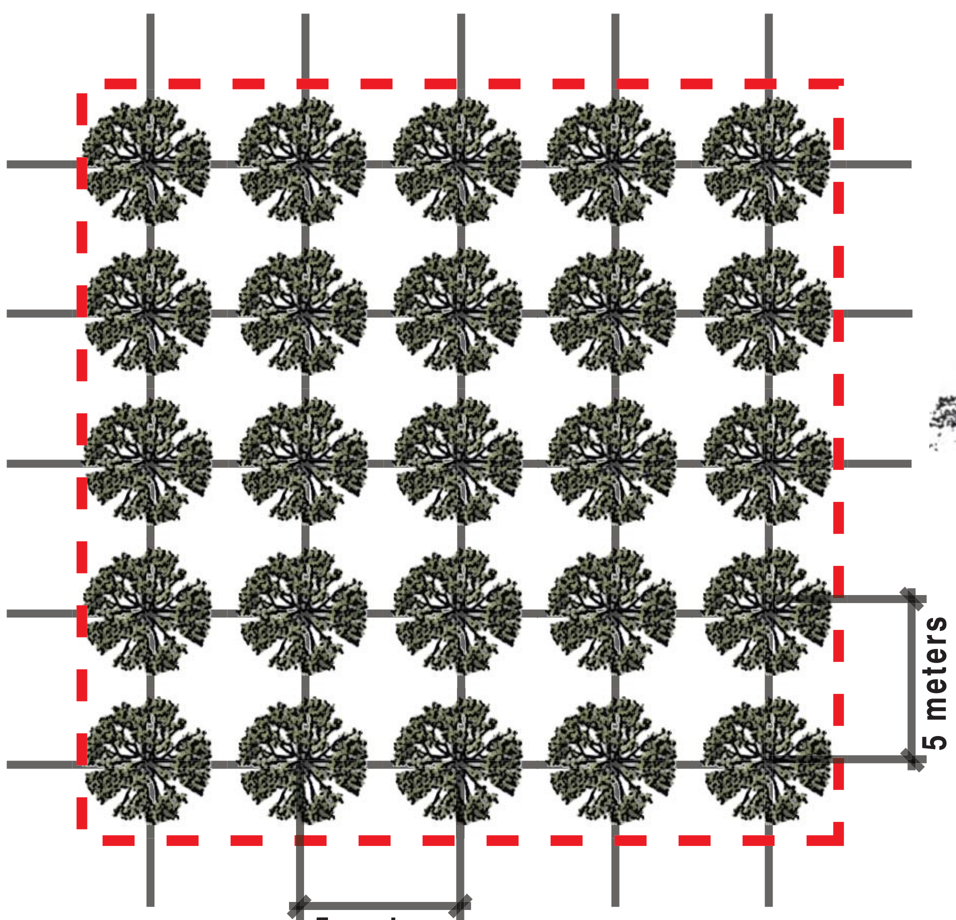
Hillside Woodlot

Suitable planting system in areas adjacent to the National Park



Woodlot on Flat Land

Suitable planting system in areas except for the area adjacent to the National Park



Trees which will be planted for future firewood purposes include *Albizia gummifera, Brachystegia spiciformis, Khaya nyasica, and Maesopsis eminii* (Mbuya et al. 1994; 46, 88, 136, 310, 326). These native tree species are fast growing and suitable for fuelwood harvesting. *Acacia albida* will be recommended for planting near shambas, as its tap root does not interfere with food crops (Mbuya 1994, 46).

Brachystegia spiciformis
Indigenous, deciduous
Uses: firewood, charcoal, timber
Height: up to 8-15 m

Khaya nyasica
Indigenous, semi-evergreen
Uses: firewood, timber, medicine
Height: up to 60 m
Fast growing

Acacia albida
Indigenous, semi-evergreen
Uses: firewood, timber, medicine
Height: up to 60 m
Fast growing

Maesopsis eminii
Indigenous, semi-deciduous
Uses: firewood, timber, poles
Height: 10-30 m
Fast growing

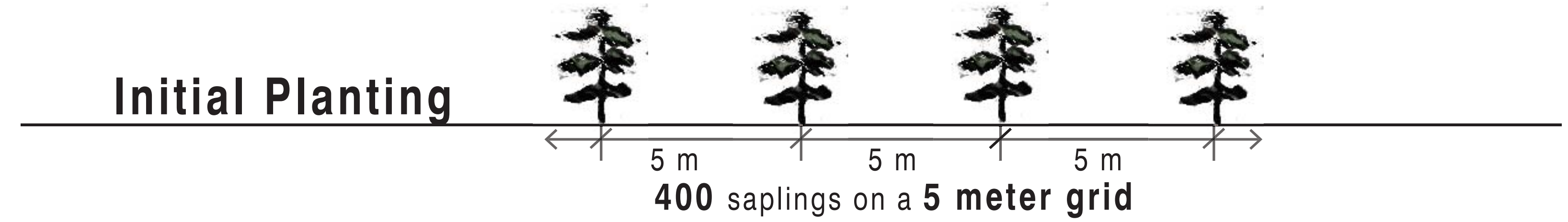
(Mbuya 1994; 46, 137, 311, 327)

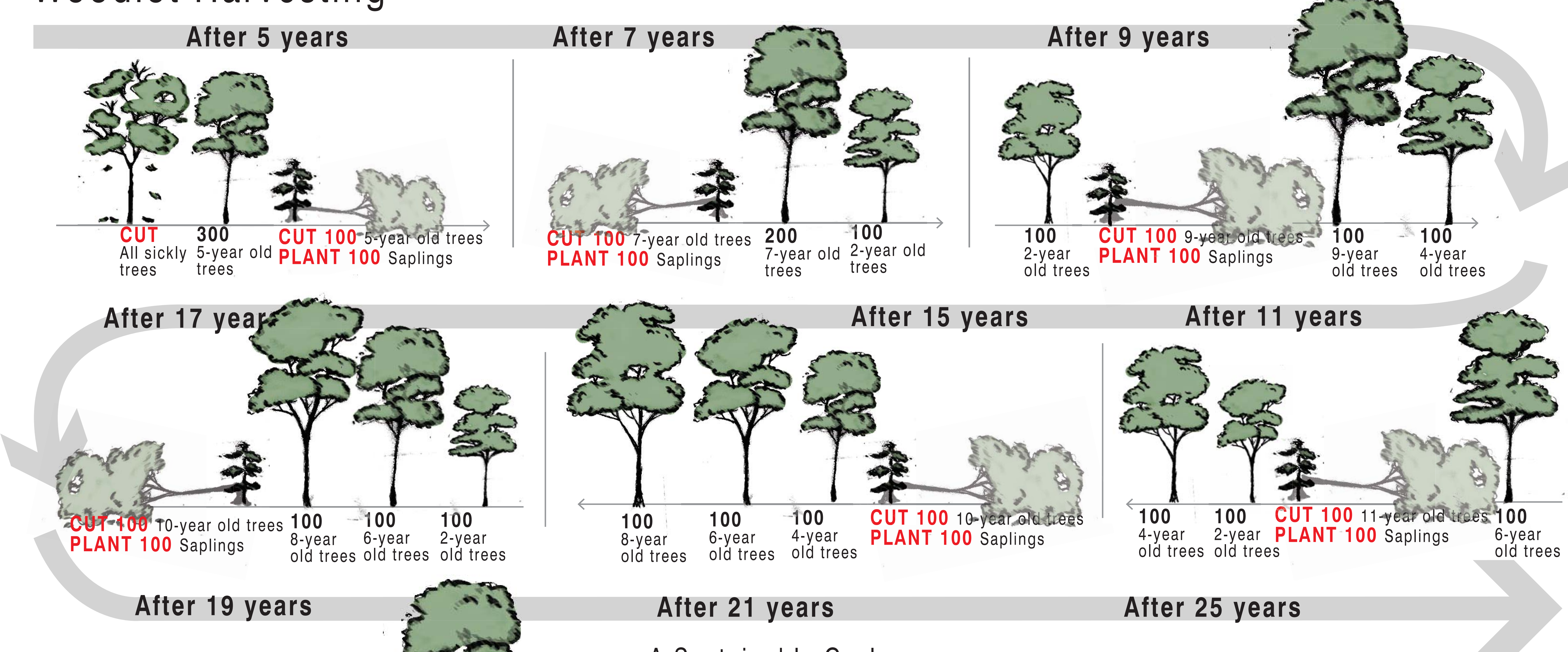
100 hectares **400 trees per hectare** **40,000 trees**

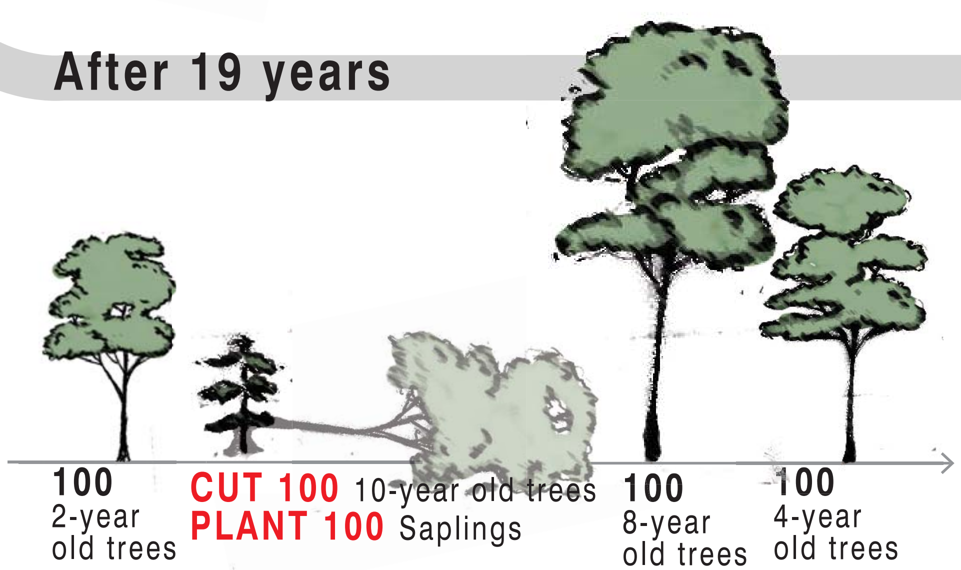
FUEL SECURITY

Design Solutions

Woodlot Harvesting







A Sustainable Cycle

The phasing for Kisawasawa's 100-hectare woodlots will provide fuel for the village's current population However as the population increases more woodlots will be needed in order to accommodate for increasing fuel needs. As the trees grow their roots require more space and therefore a larger distance between trees is necessary. The woodlot will be thinned according to a specific schedule beginning after the first 5 years. Trees which are unhealthy or weak should be the priority for harvesting, especially for the first harvest in year 5. Thinning is done to accommodate for the growth needs of the trees and provide the village with 10 to 11 year old trees after the initial 10 establishment period. After the trees are cut they are replaced with 15-30 cm saplings so that the cycle continues. The cycle, diagrammed above, illustrates one method of phasing that will allow the village to harvest medium-sized trees that will provide adequate amounts of wood after the first 10 years.

WATER SECURITY
Inventory & Analysis

Importance of Water

Water impacts all forms of life (Mittermeier et al. 2010). It forms the foundation for nearly every human activity and all rely on it (Mittermeier et al. 2010). It impacts human health, livelihood, and wellbeing. It is used in food preparation, construction, and industry. Ensuring water security should be a primary goal of any group or locality. The main factors involved in obtaining water security are: access to water, water quality, rate of consumption, and flooding and standing water.

Water in Kisawasawa

The combination of two rainy seasons, numerous mountain springs, and abundant groundwater provide Kisawasawa with plentiful amounts of water for much of the year. Villagers typically have access to water in the form of streams, stand pipes, and water pumps (Harrison 2006b). Water quality appears to be high, however potential contaminants from roads and latrines may be polluting ground and surface water. Consumption rates have currently not exceeded demand, but changes in precipitation or increased abstraction from groundwater could change that. Flooding is a concern in the relatively flat village, where depressions also store standing water, creating breeding grounds for mosquitoes and other insects.

Recommendations

Access

- Additional water abstraction sites, in the form of stand pipes or water pumps, should be constructed to ensure equal access to water for all.

Consumption

- Sustainable consumption should be encouraged. While water is an abundant resource now, care should be taken to use minimal water to ensure its abundance in the future.

Quality

- Water quality should be monitored. Care should be taken to locate sources of contamination and pollution away from water sources and abstraction points.

Stormwater Management

- To prevent flooding, measures should be taken to slope land away from structures and into a network that safely takes water to streams. Similarly, care should be taken to not direct water into dead end locations, causing stagnation.

Implications

Kisawasawa's successful future development and growth will require a heightened water security, both within the western developed portion and for new development in the east. Water security will directly impact food and fuel security, and also have impacts on transportation infrastructure and road quality.

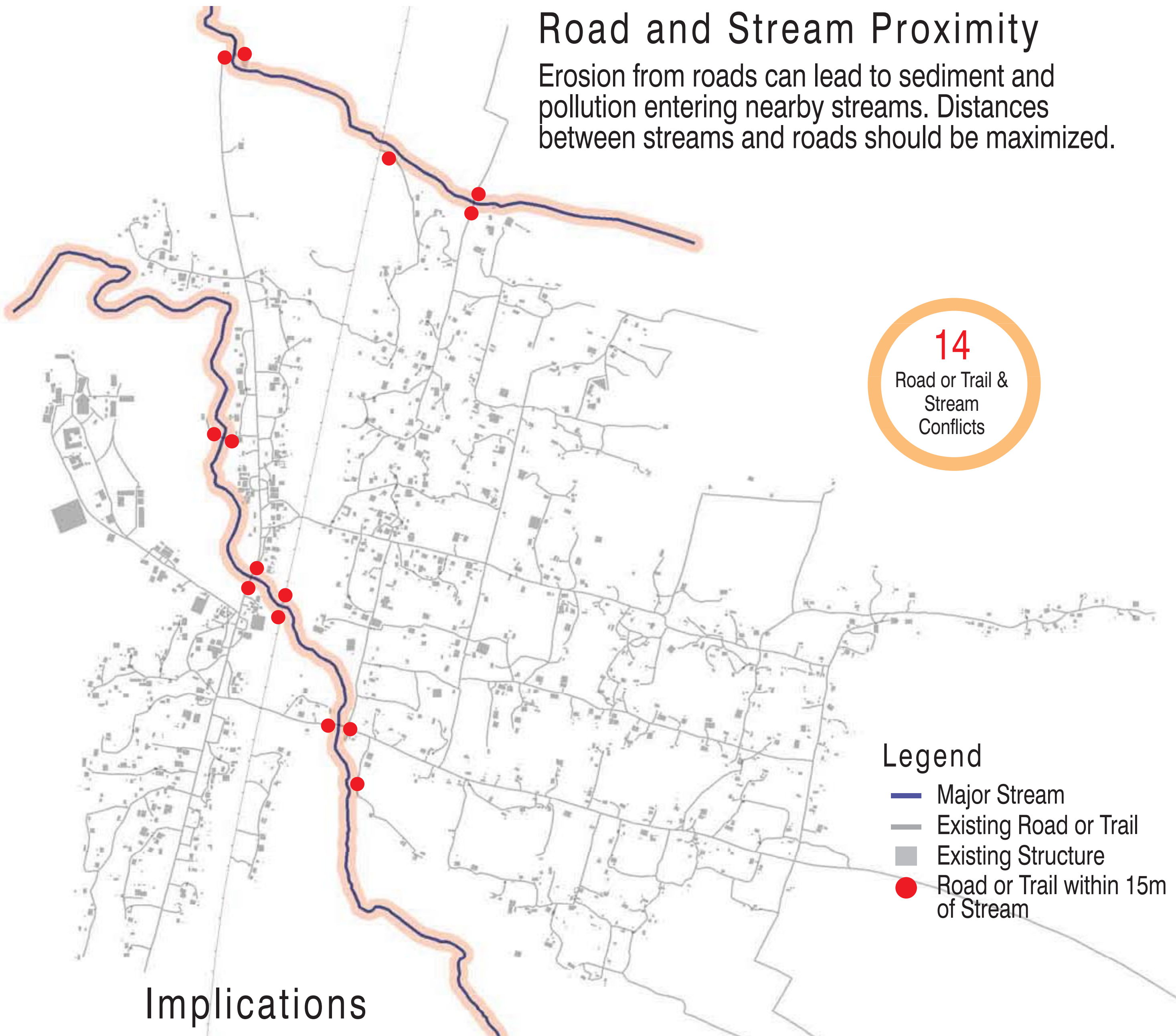
WATER SECURITY
Inventory & Analysis

Water Quality

Two of the main impacts on water quality in Kisawasawa are the proximity of roads to streams and the proximity of pit latrines to water abstraction points. Both can cause pollutants and contaminants to enter the water source (WHO 1992).

Road and Stream Proximity

Erosion from roads can lead to sediment and pollution entering nearby streams. Distances between streams and roads should be maximized.

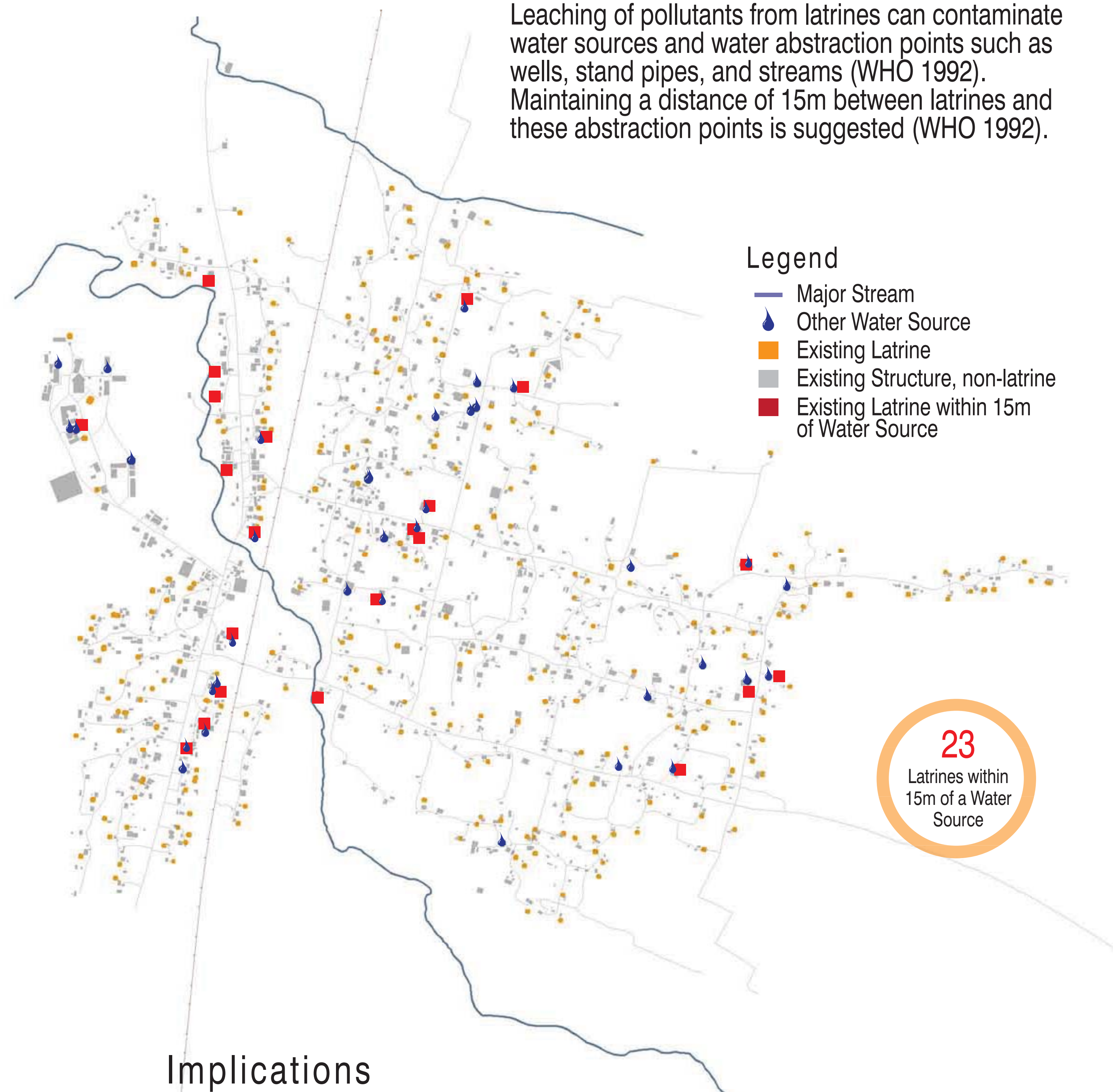


Implications

Several existing roads could be negatively impacting water quality. Vegetated buffers and sloping land away from streams can minimize these impacts (PSU 2006). New road construction should maintain a 15m distance from streams.

Latrines and Water Abstraction

Leaching of pollutants from latrines can contaminate water sources and water abstraction points such as wells, stand pipes, and streams (WHO 1992). Maintaining a distance of 15m between latrines and these abstraction points is suggested (WHO 1992).



Implications

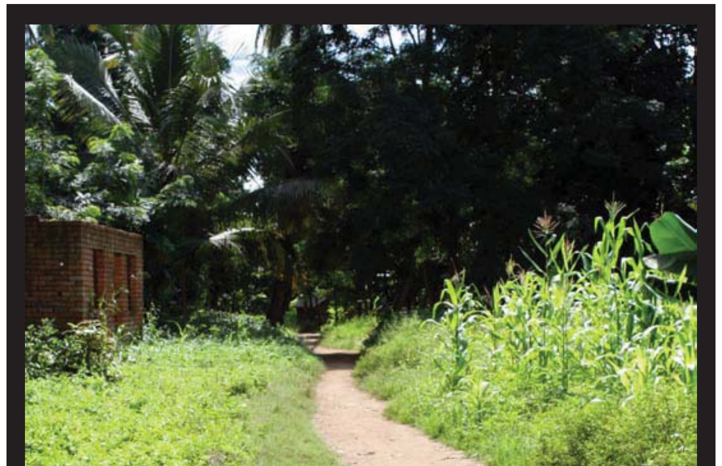
Latrine distribution varies widely within Kisawasawa. Approximately 23 latrines currently are within 15m of water abstraction points. Additional undocumented latrines may also pose a risk. Future latrine construction should be confined to areas further than 15m from abstraction points. The gradual implementation of septic tanks is also suggested to replace pit latrines. Septic tanks cause less contamination than pit latrines (WHO 1992).

North
0 1000 Meters
Scale 1:10,000

WATER SECURITY
Design Solutions

Stormwater Management

Stormwater Management, safely and efficiently managing rainfall, is one of the primary solutions to ensuring water security. It has implications for water quality, flooding, velocity, and pooling.



Maintain Vegetated Cover

Vegetation, such as trees and shrubs, absorbs water and slows its speed, helping to prevent flooding and erosion.

Buffer Streams

Streams are a source of freshwater for all. By maintaining a vegetated, unused buffer strip of around 15m on either side of a stream, pollutants and sediments can be prevented from entering the water supply.

Prevent Standing Water

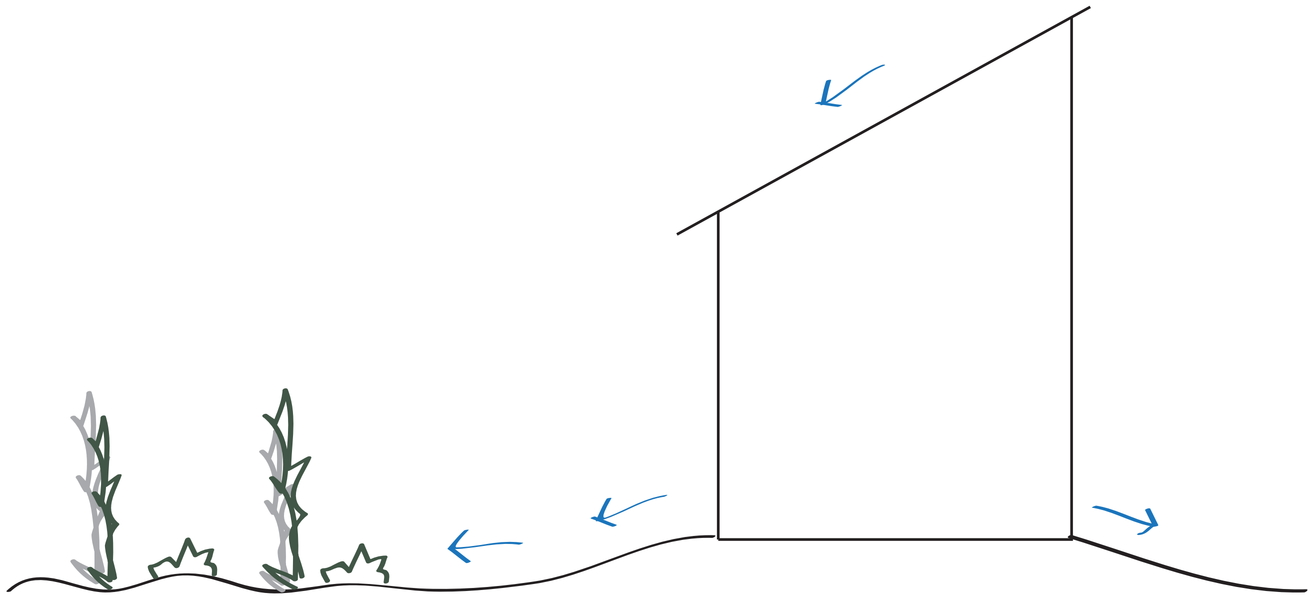
Standing water is a breeding ground for mosquitoes, other insects, and bacteria that can cause illness or disease. Standing water should be prevented within the village. Brick pits such as this can be filled or planted with vegetation.

Direct Water Away from Structures

The ground outside of structures should slope away from the structure to ensure water does not enter. The grade should be steep enough to allow positive drainage but level enough to prevent erosion.

Divert Water for Reuse

Water directed away from structures or transportation networks can be channeled into agricultural fields, nurseries, or tree lots to use as irrigation water.



Water that falls on building roofs falls to the ground, then is directed away off-site or towards shambas.

INFRASTRUCTURE

Transportation: Inventory & Analysis

Transportation and Right of Ways

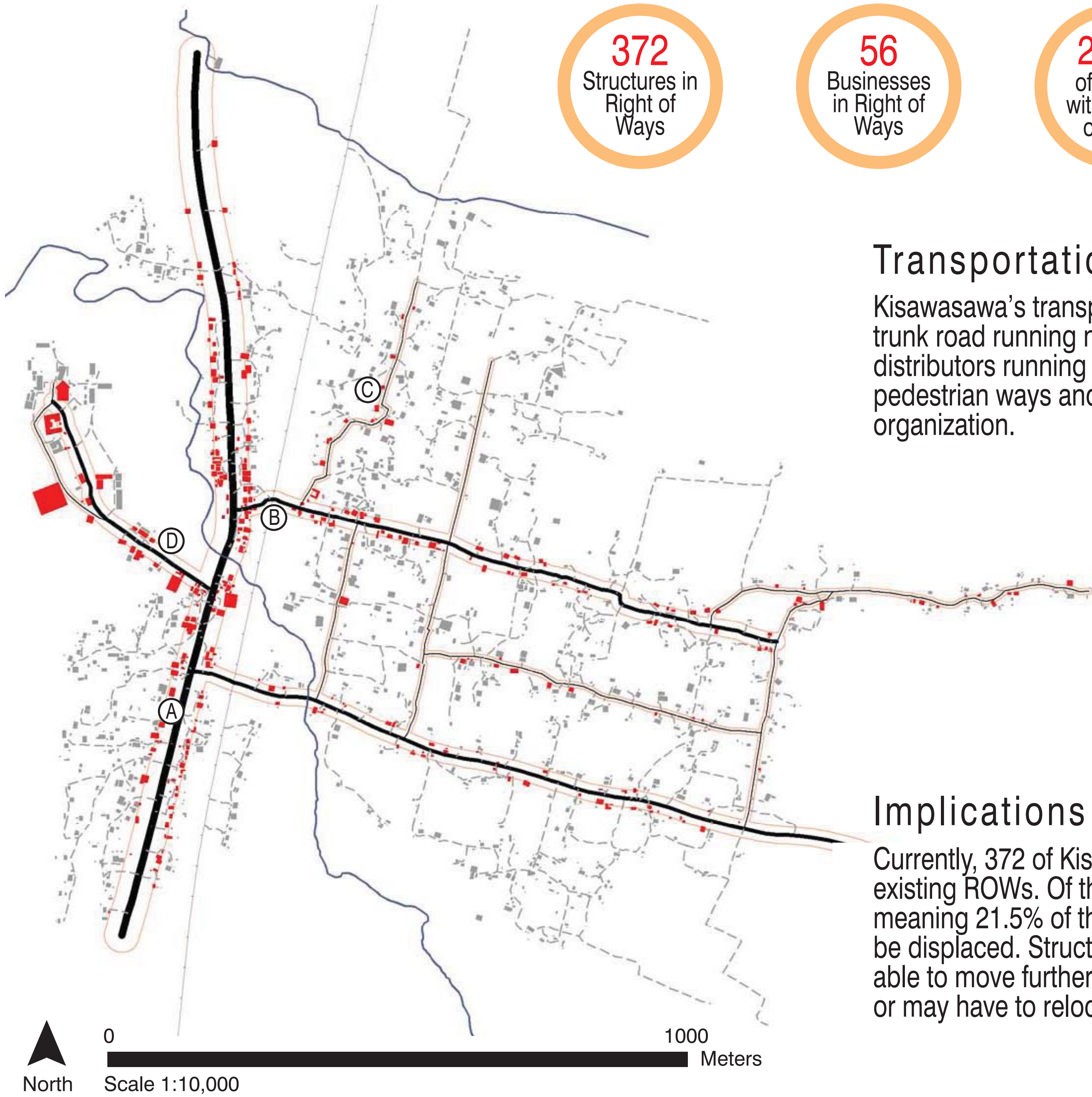
Defining and establishing a transportation infrastructure is one of the first steps in development and expansion. To allow for this expansion, Tanzanian Planning Guidelines suggest a 60m Right of Way (ROW) for a Trunk Road, 30m for a Primary Distributor, and 10m for a Pedestrian access (Tanzanian Planning Commission 1997). If enforced, these ROWs will prevent development within them and require existing structures to be displaced.

372 Structures in Right of Ways

56 Businesses in Right of Ways

21.5% of Homes within Right of Ways

880 Potential Persons Displaced



Transportation in Kisawasawa

Kisawasawa's transportation network consists of a trunk road running north to south, two primary distributors running east to west, and numerous pedestrian ways and footpaths based on this gridded organization.

Legend
- Trunk Road
- Primary Distributor
- Pedestrian Access
- Footpath
- Road Right of Way
- Structure in Right of Way
- Other Structure

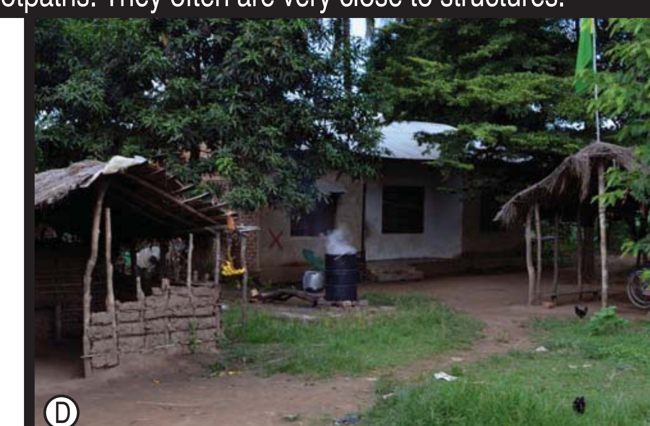
Implications of Right of Ways

Currently, 372 of Kisawasawa's structures lie in existing ROWs. Of these structures, 176 are houses- meaning 21.5% of the homes in Kisawasawa could be displaced. Structures in Right of Ways may be able to move further from the road on their own plot, or may have to relocate to another plot.

Connecting Mikumi and Ifakara, the main road of Kisawasawa is lined with shops, businesses, and homes.

One of two primary distributors that run east-west through the village is flanked by a small commercial district.

Pedestrian trails are generally wider and more defined than footpaths. They often are very close to structures.



An X on a building can signify that it was built within the road Right of Way and is against the law.

INFRASTRUCTURE

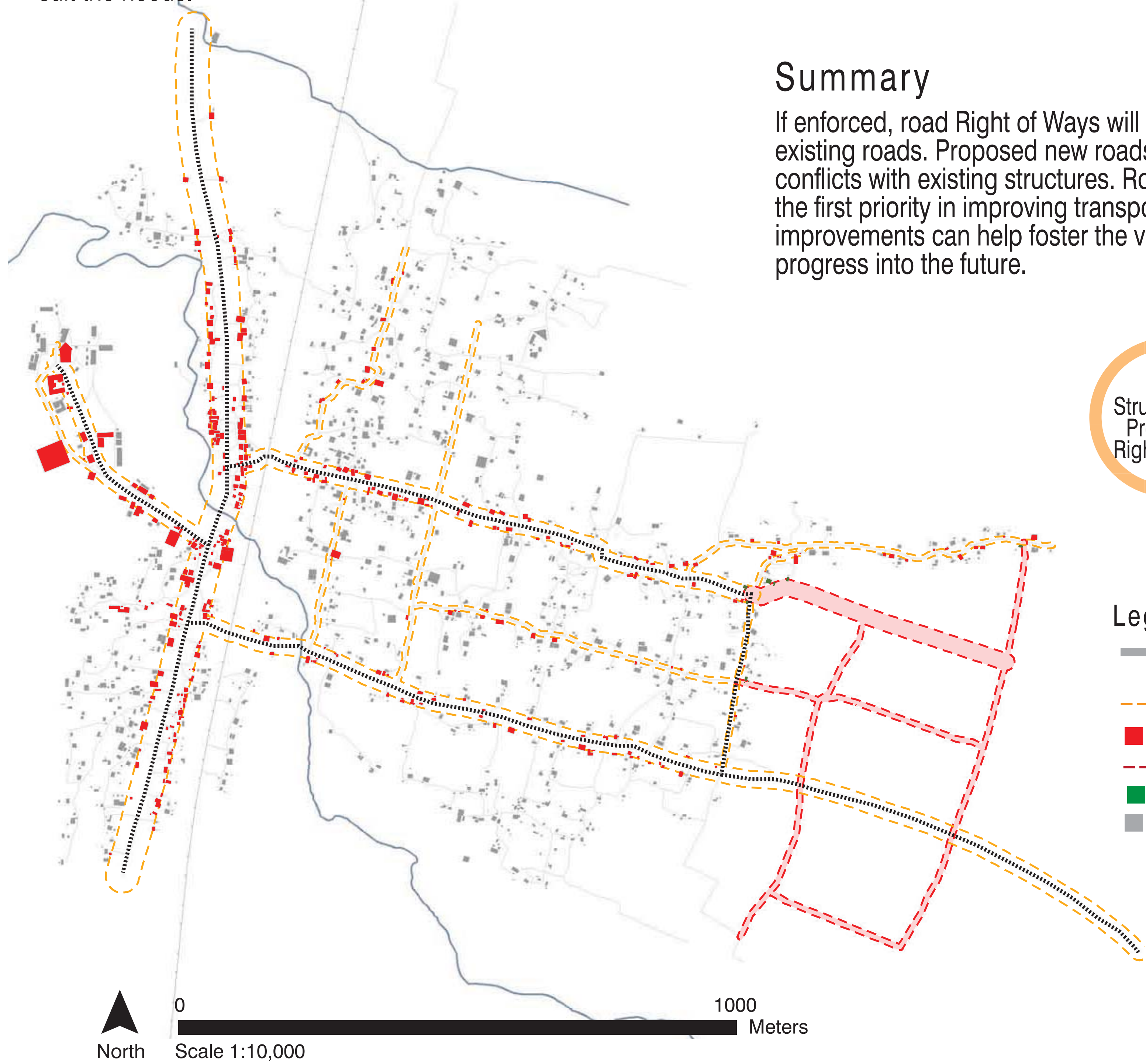
Transportation: Design Solutions

Road Improvements and Establishing New Roads

Kisawasawa's gridded organization already has a hierarchy of roads and trails. The main roads serve as an excellent foundation to begin road improvements. If funds become available, any of these 5 roads could be improved through resurfacing and drainage. These improvements will be important for use by the growing population in the future. With future development, establishing new roads can lay the organization for the growth. The suggested roads follow the existing organization of the village, and can be modified and moved to suit the needs.

Summary

If enforced, road Right of Ways will have the most impact around existing roads. Proposed new roads should be placed to avoid conflicts with existing structures. Road improvements should be the first priority in improving transportation infrastructure. Subtle improvements can help foster the village's development and progress into the future.



11 Structures in Proposed Right of Way

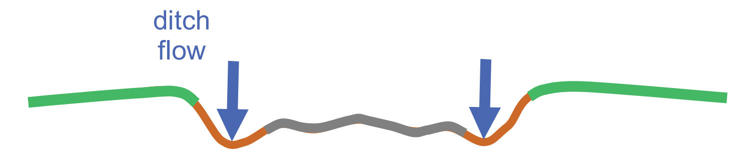
5 Roads Prioritized for Improvement

Legend

- Existing Road
- Proposed Road Improvements
- Existing Road Right of Way
- Structure in Right of Way
- Proposed Road Right of Way
- Structure in Proposed Right of Way
- Other Structure

Road Improvement Suggestion: Raising the Road

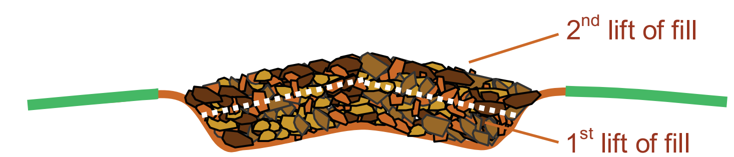
Before: An entrenched road traps road drainage on the road in parallel ditches. This is a situation that requires constant maintenance. Raising the road eliminates the persistent maintenance associated with a road that is lower than the surrounding terrain.



Cross-section #1

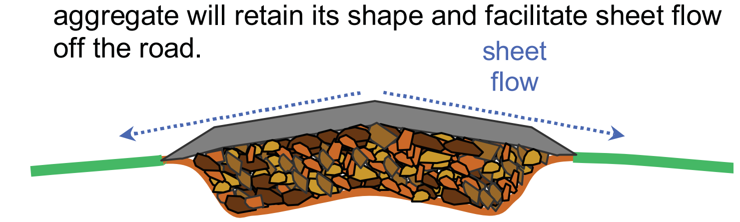
During: Prep the existing road base with proper crown before adding fill material. Place fill material in the road profile in 8" to 12" lifts. Each lift of material should be placed with proper crown of ½" to ¾" per foot. Compact each lift of material to ensure a solid road base. Geo-textile fabric can be used in between lifts of material to add strength to the road base. Whenever possible, add enough fill material to raise the elevation of the road to restore natural drainage patterns.

Cross-section #2: The existing road base is re-shaped with proper crown. The first lift of fill material is placed, crowned and compacted.



Cross-section #3: The second lift of fill material is laid on top of the first lift, crowned and compacted.

After: Place aggregate on the fill material. Because the fill has been crowned or shaped properly, the aggregate will retain its shape and facilitate sheet flow off the road.



Cross-section #4

Diagram from PSU (2006)

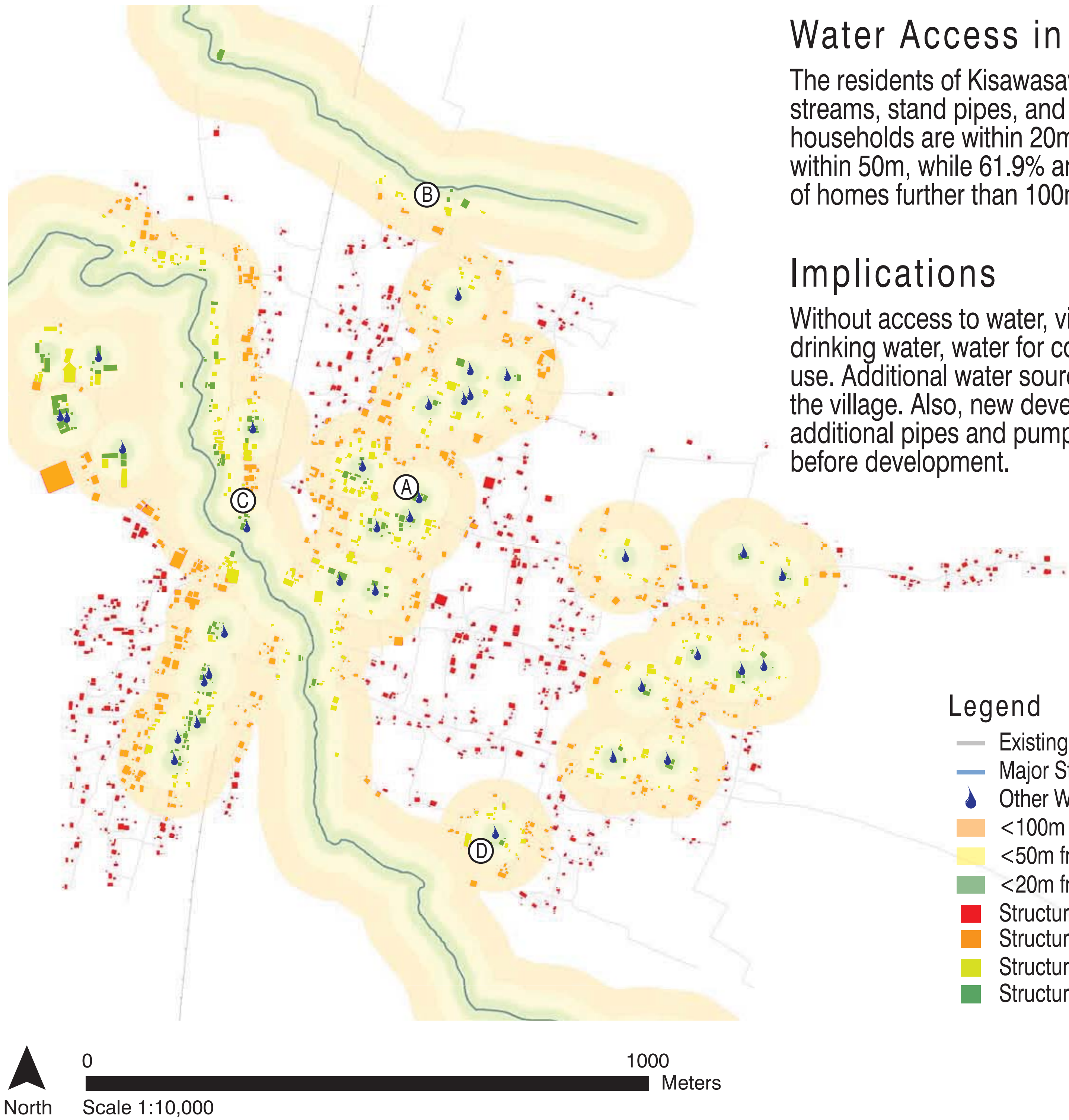
*Design solutions are based on the land use recommendations outlined in the Future Development Section of this document.

INFRASTRUCTURE

Water: Inventory & Analysis

Water Access

Access to water is one of the primary components of a water infrastructure. In this region of Tanzania, water is plentiful during much of the year (Nyundo 2006). Residents get water from both natural and man modified sources (Harrison 2006b). The availability of water within a reasonable proximity can directly impact development.



Water Access in Kisawasawa

The residents of Kisawasawa primarily get their water from streams, stand pipes, and water pumps. Only 9.5% of households are within 20m of a water source. 31.9% are within 50m, while 61.9% are within 100m. This leaves 38.1% of homes further than 100m from a source of water.

Implications

Without access to water, villagers will suffer from a lack of drinking water, water for cooking, and water for household use. Additional water sources should be constructed within the village. Also, new development to the east will require additional pipes and pumps. These can be constructed before development.

38.1%
of Homes >100m from Water Source

Legend

- Existing Road or Trail
- Major Stream
- Other Water Source
- <100m from Water Source
- <50m from Water Source
- <20m from Water Source
- Structure >100m from Water Source
- Structure <100m from Water Source
- Structure <50m from Water Source
- Structure <20m from Water Source

Stand Pipes are a primary water source for many villagers. The pipes bring water from springs and streams into the village.

Many in Kisawasawa also use streams as source of water. The stream above forms the northern border of the village.

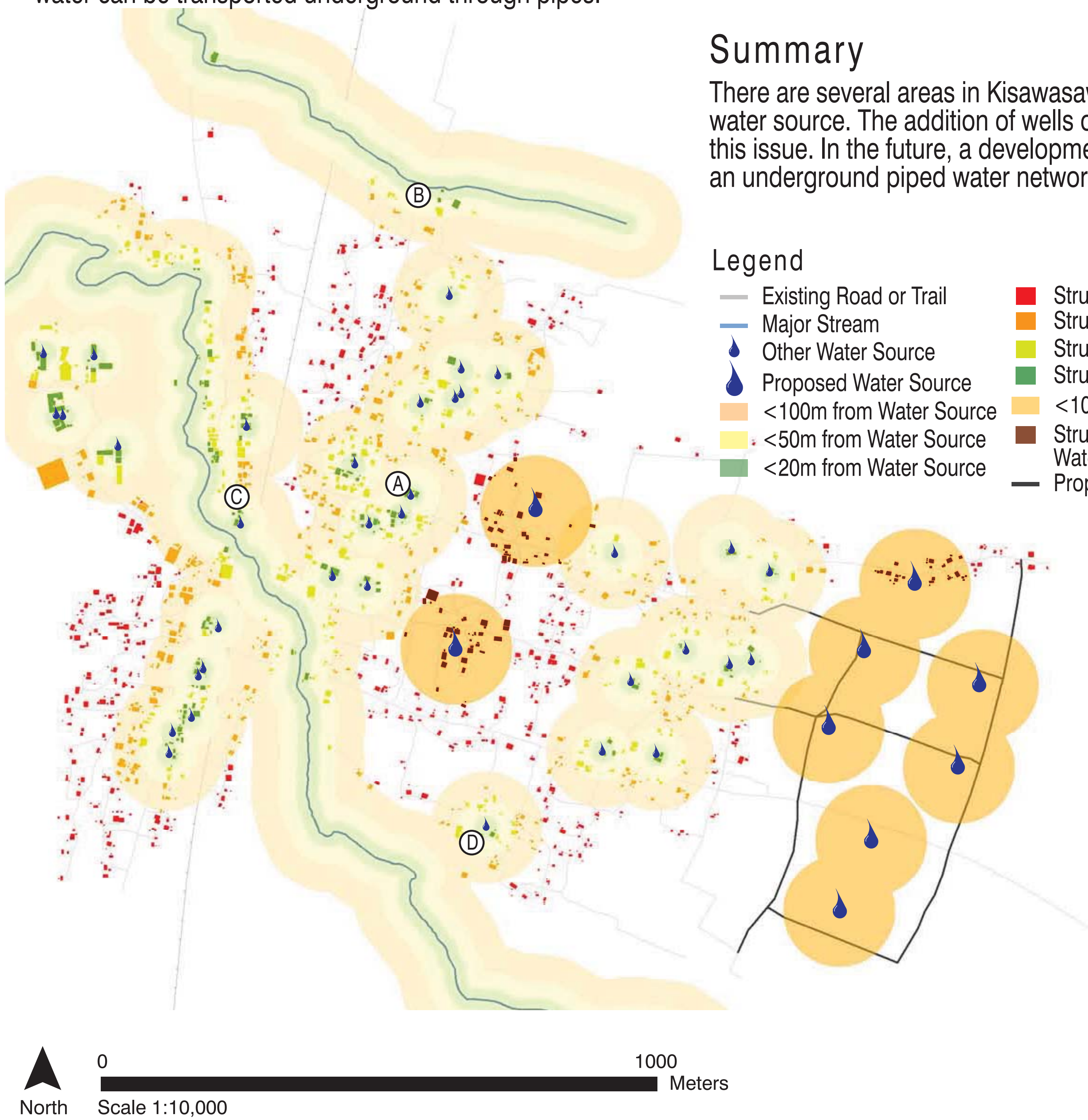
Water pumps are a third source of water for residents of Kisawasawa; they bring groundwater to the surface.

Currently water sources in Kisawasawa have plentiful water, however may not always be so abundant in the future.

INFRASTRUCTURE
Water: Design Solutions

Constructing New Water Access Points

Since water quantity is not a primary issue in Kisawasawa, access to their water supplies is then a primary issue for infrastructure. A water infrastructure including new access points in the form of stand pipes and wells is suggested. Toward future development, water can be transported underground through pipes.



Summary

There are several areas in Kisawasawa that lack access to a close water source. The addition of wells or new stand pipes can solve this issue. In the future, a development goal should be to establish an underground piped water network.

Legend

- Existing Road or Trail
- Major Stream
- Other Water Source
- Proposed Water Source
- <100m from Water Source
- <50m from Water Source
- <20m from Water Source
- Structure >100m from Water Source
- Structure <100m from Water Source
- Structure <50m from Water Source
- Structure <20m from Water Source
- <100m from Proposed Water Source
- Structure <100m from Proposed Water Source
- Proposed Road or Trail

9 New Access Points

107 Existing Structures would gain Access

Establishing a Pipe Infrastructure

The exact locations of existing water pipes in Kisawasawa are not all known. A planned water infrastructure that runs under or alongside roadways is suggested. The diagram below suggests some design guidelines for this construction.

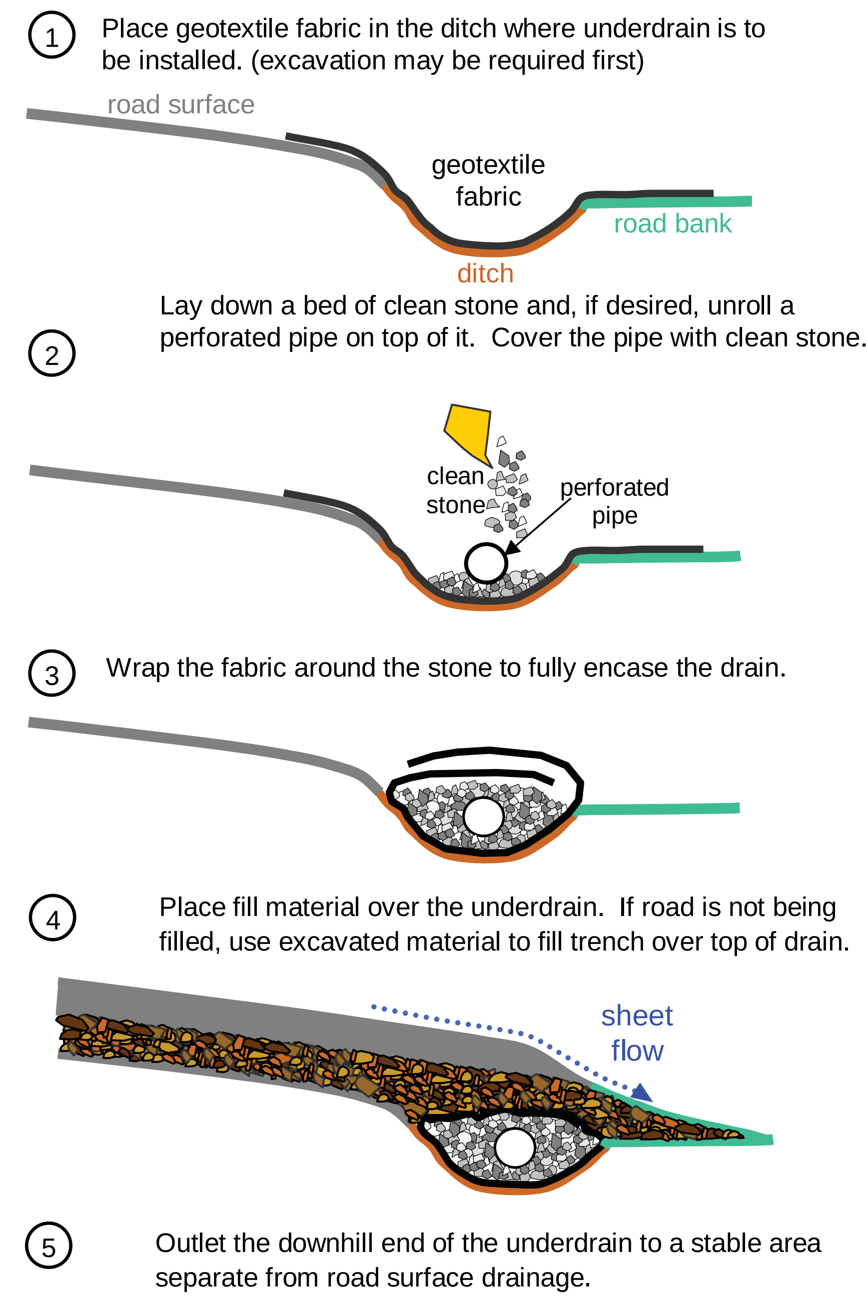


Diagram from PSU (2006)

*Design solutions are based on the land use recommendations outlined in the Future Development Section of this document.

INFRASTRUCTURE

Electricity: Inventory & Analysis

Electric Access

Access to electricity varies widely within Tanzania and the region (Harrison 2006b). Though not widely available presently, it presents opportunities as an alternative fuel and energy source in the future.

Electric Access in Kisawasawa

Existing electric lines in Kisawasawa could potentially provide 12.8% of the village's structures, those within 30m of the lines, with electricity. However, the actual percentage of structures with electric hookups is much lower.

Legend

- Existing Road or Trail
- Major Stream
- Existing Electric Line
- Existing Structure
- Existing Structure within 30m of Electric Line

12.8% of Structures with Electric Access

93 Houses within 30m of Electric Line

Implications

Extending additional electric lines in Kisawasawa is one option to meet its energy demands. Though not feasible on a large scale presently, with future development and growth Kisawasawa could implement an electric infrastructure to grow upon.

Electric lines run along the east side of Kisawasawa's main road, the primary connector between Mikumi and Ifakara.

Household electric use in Kisawasawa is limited, however there are several home with electric hookups.

Electric poles are within road right-of-ways but land below them is still traditionally used for agriculture and other uses.

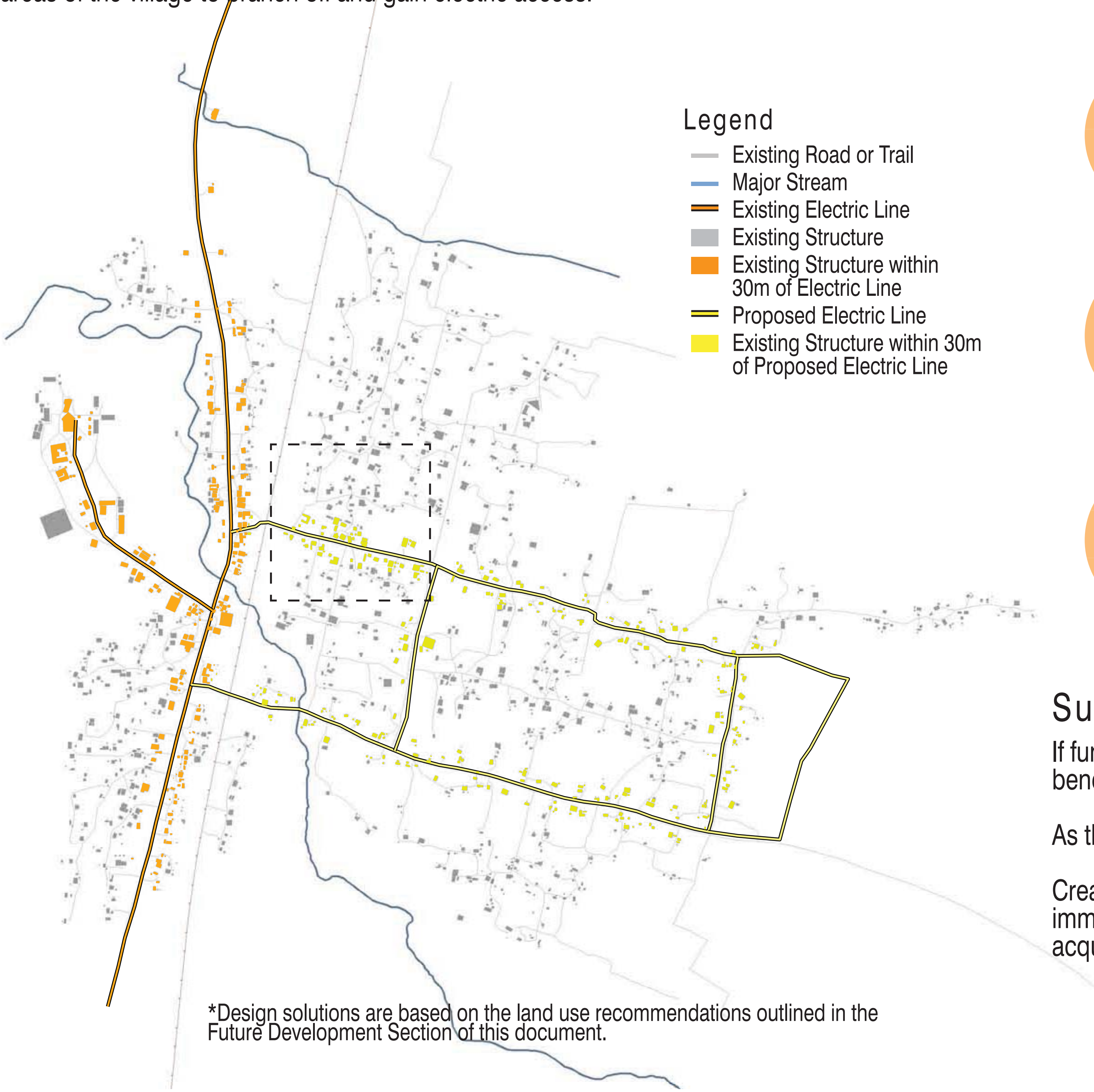
One secondary line extends west from the main road, to the church and school complex.

INFRASTRUCTURE

Electricity: Design Solutions

Constructing New Power Lines

Though a very large investment, constructing new power lines in Kisawasawa would bring access to electricity to an additional 352 structures. And this is just those able to connect to the main line without additional support poles. This infrastructure forms a ring through the village, and its central location would make it easy and less expensive for additional areas of the village to branch off and gain electric access.

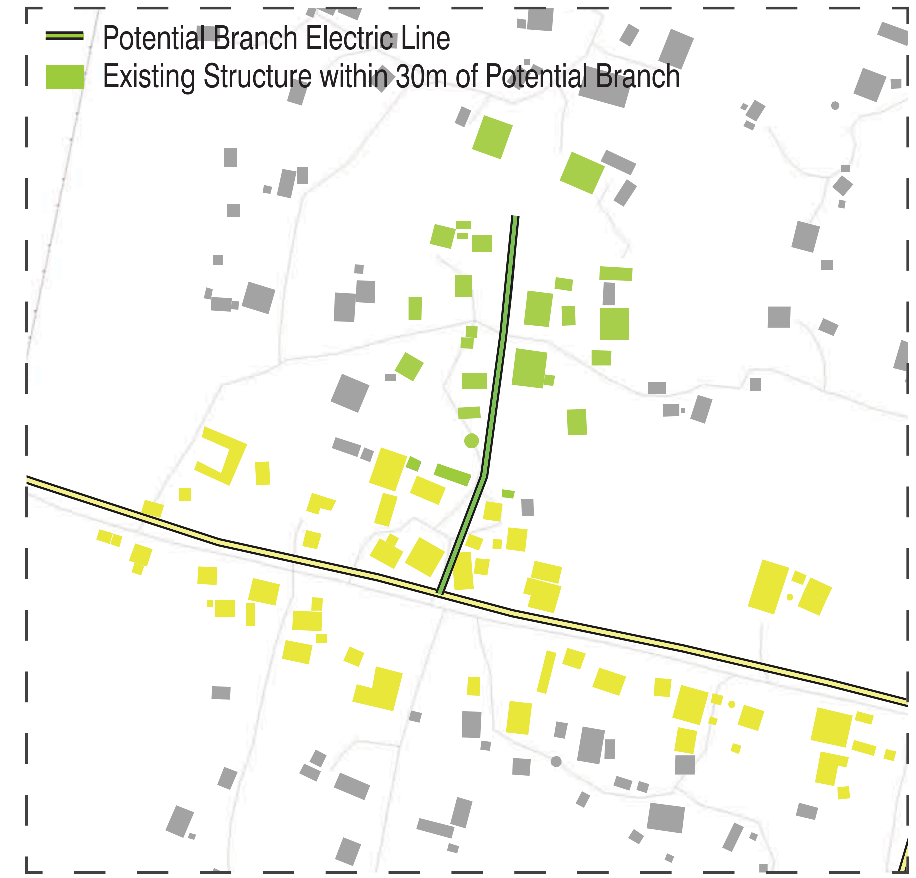


*Design solutions are based on the land use recommendations outlined in the Future Development Section of this document.

352 Existing Structures would gain Access

32.5% of Structures with Electric Access

+154% Electric Accessibility



Facilitation for the Future

Once the infrastructure is constructed, residents further than 30m from the line could band together to bring another power line to their homes. The green line shown above would only require 3 additional poles from the main line and would allow 27 structures to have access to electricity.

Summary

If funds become available, establishing an electrical line infrastructure would be a great benefit to residents and the village as a whole.

As the village develops, this infrastructure will help ensure its success.

Creating this infrastructure along a central loop following primary roads would ensure immediate access to the greatest number of people and ease the process of others acquiring access.

North

0 1000 Meters

Scale 1:10,000

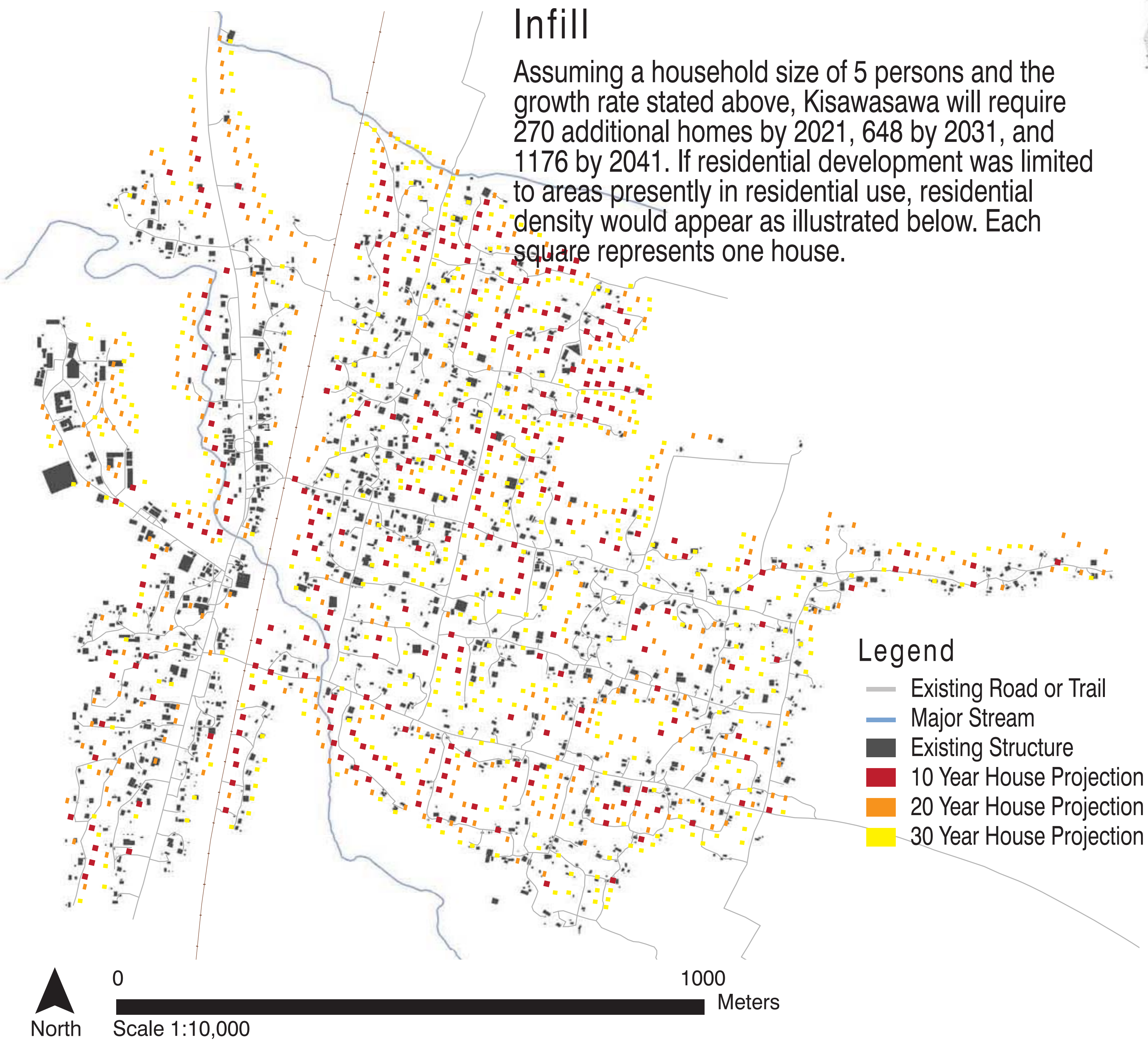
FUTURE DEVELOPMENT
Growth Projections

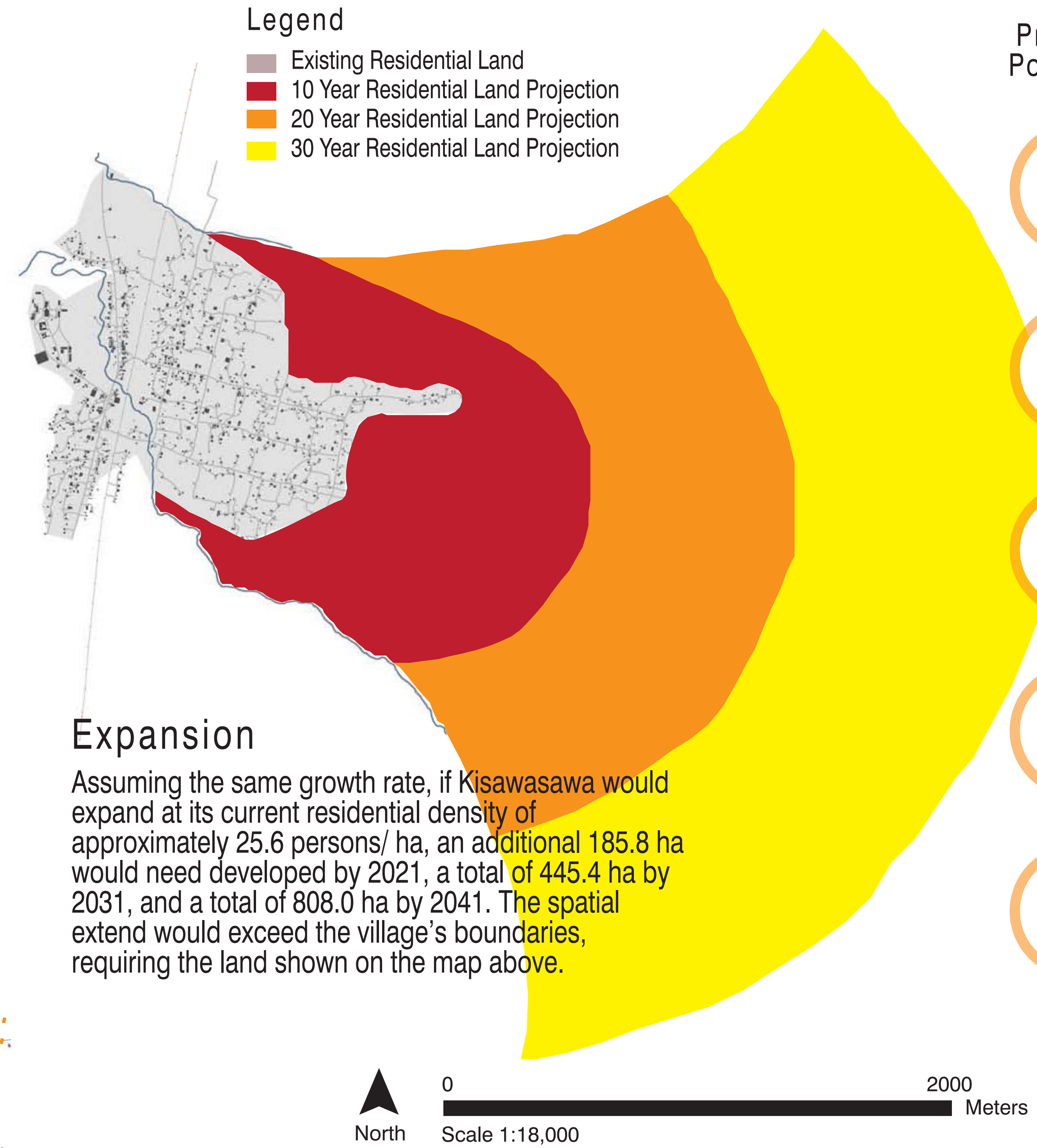
Population Increase

Population in the Kilombero District is predicted to increase at a rate of 3.4% a year (Harrison 2006b). With Kisawasawa's population at the 2002 Census at 2437 persons, population will double by 2021 (Harrison 2006b). Infill, expansion, or a combination of the two will be necessary for Kisawasawa to absorb this population influx.

Infill

Assuming a household size of 5 persons and the growth rate stated above, Kisawasawa will require 270 additional homes by 2021, 648 by 2031, and 1176 by 2041. If residential development was limited to areas presently in residential use, residential density would appear as illustrated below. Each square represents one house.





Expansion

Assuming the same growth rate, if Kisawasawa would expand at its current residential density of approximately 25.6 persons/ ha, an additional 185.8 ha would need developed by 2021, a total of 445.4 ha by 2031, and a total of 808.0 ha by 2041. The spatial extend would exceed the village's boundaries, requiring the land shown on the map above.

Projected Population

2002 2437

2011 3404

2021 4756

2031 6645

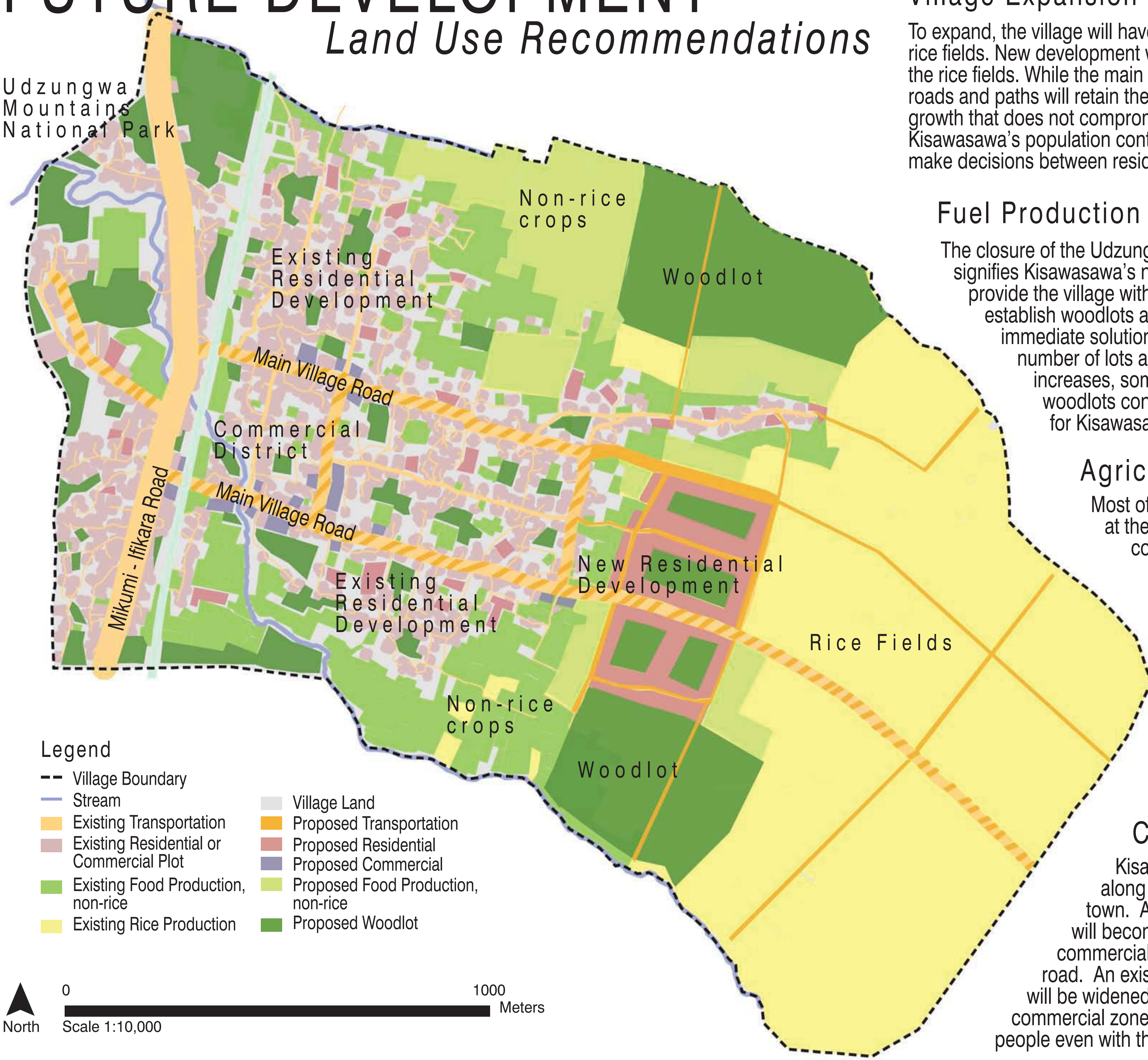
2041 9283

Implications

While development through infill requires no additional land, the village may be negatively affected through loss of vegetation, limited privacy, and congestion. Development through expansion allows for these, but also may negatively affect the village through costly transportation networks, loss of agricultural fields, and less unity. A combination of infill and expansion is suggested for the future of Kisawasawa.

FUTURE DEVELOPMENT

Land Use Recommendations



Village Expansion

To expand, the village will have to extend its residential limits outward onto what is now rice fields. New development will be ordered along two existing roads that extend out into the rice fields. While the main roads will be in a grid organizational system, the local roads and paths will retain their organic integrity. This system should allow for orderly growth that does not compromise Kisawasawa's unique spatial character. However if Kisawasawa's population continues to increase at the same rate the village will have to make decisions between residents, food, and fuel.

Fuel Production

The closure of the Udzungwa Mountains National Park's gates to deadwood collection signifies Kisawasawa's new self-reliance for fuel supplies. Although rice husks could provide the village with a small amount of fuel, Kisawasawa urgently needs to establish woodlots as part of a long-term energy plan. Woodlots are not an immediate solution to Kisawasawa's energy woes, however, if the appropriate number of lots are planted and villagers' use of energy efficient stoves increases, some of Kisawasawa's energy needs could be met. These woodlots constitute only about half the woodlots that would be necessary for Kisawasawa to be totally reliant on its own fuel.

Agriculture Area

Most of Kisawasawa's agricultural output is rice. The village's location at the base of the Udzungwa Mountains allows the soil to be conducive for growing rice. Rice is likely to continue to be the primary crop and cash crop in years to come, as it remains the dominant source of many villagers' incomes. With the increase in population will be a mix of infill and new residential housing on the outskirts of town converting existing paddies. While these paddies will be reestablished at the edge of the current fields, eventually there may not be enough fields to sustain the number of households in Kisawasawa. Other crops are grown in Kisawasawa as well, most of them in fields located between the residential land and rice paddies. This land is also threatened by the expansion of residential area.

Commercial Area

Kisawasawa's commercial area is currently primarily located along the Mikumi-Ifakara road and on the two main roads within town. As Kisawasawa's population increases the two main roads will become more heavily trafficked creating an opportunity for commercial growth, especially in the area closest to the Mikumi-Ifakara road. An existing local road running perpendicular to the two main roads will be widened to create a loop between the commercial areas. Forming a commercial zone, in the village core will allow businesses to be accessible to people even with the inevitable expansion of the residential zone.

FUTURE DEVELOPMENT
Priorities, Phasing, & Management Suggestions

Priorities & Phasing

The possible future land use plan on the preceding page was created to illustrate some of the many ways Kisawasawa can proceed with its growth and development. Though not an official planning document, it does suggest areas and ways for the village to start thinking about its development. The following priorities should be the first issues addressed.

Establish Woodlots and Popularize Alternative Fuel

WIth access to the major source of fuel ending on 30 June, Kisawasawa needs to begin implementing woodlots to harvest as fuel. The limited area of the village will not be able to provide wood for a growing population, however. The use of alternative fuels should be popularized.

Improve & Establish Infrastructure

If population continues to grow and land is further developed, existing infrastructure will need to be enhanced. By focusing on a few primary roads, water sources, and considering electric lines, this infrastructure can be implemented in stages gradually over time.

Increase Food Production and Storage

If agricultural land in the east is converted into residential land or woodlots, additional areas will need to be converted into agricultural use to support the growing population. Maximizing crop outputs will also increase food production.

Management Suggestions

The successful growth and expansion of Kisawasawa will require management and organization on a variety of levels. On the individual level, villagers will have to be informed about their land. On the community level, village leaders will have to drive new ideas and methods. And on a wider scale, if funds become available for particular services, they need to be managed appropriately.

Community WIde Approaches

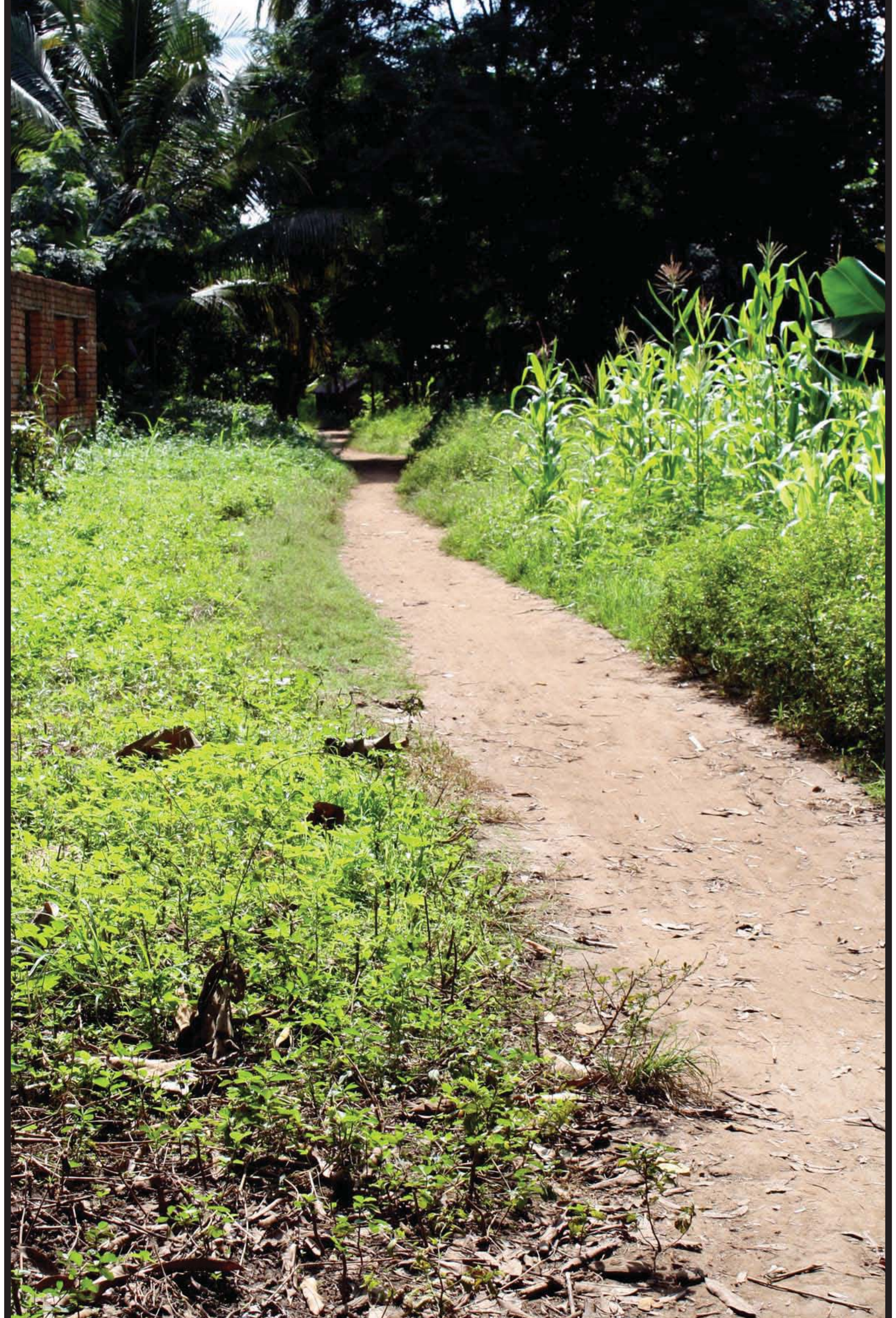
Implementing land use changes requires a variety of scales. Community wide approaches are needed to establish infrastructures, permanent woodlots, and agricultural production areas.

Individual Approaches

Individual approaches for residents to implement are also needed. These approaches allow villagers to improve their own quality of life, while contributing to the larger goal of food, fuel, and water security.

Create Records

By recording the locations of utilities such as wells, pipes, and latrines, and mapping new plots, woodlots, and fields, a permanent record can be started, so future residents leaders will have access to it.



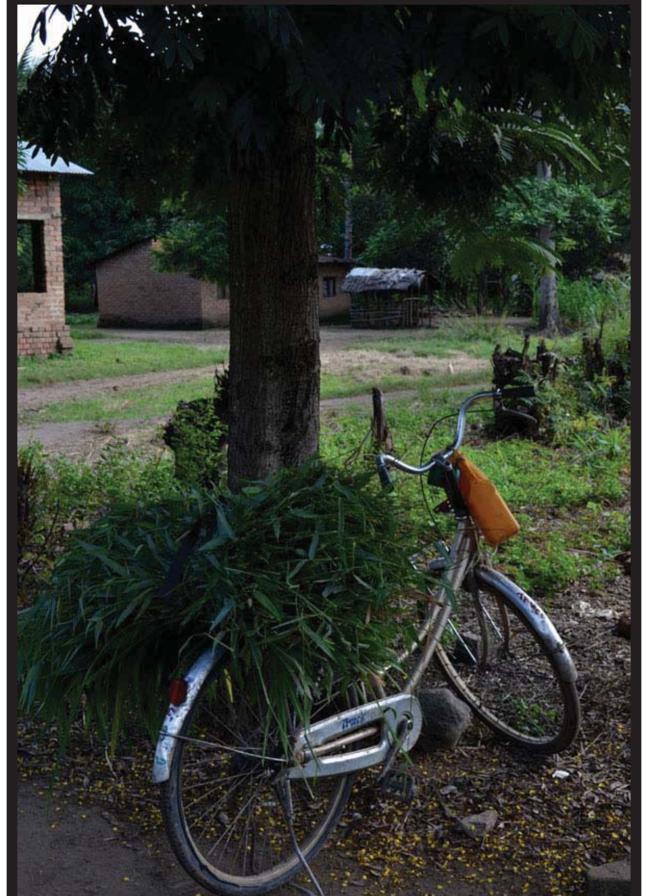
PROJECT IMPLICATIONS

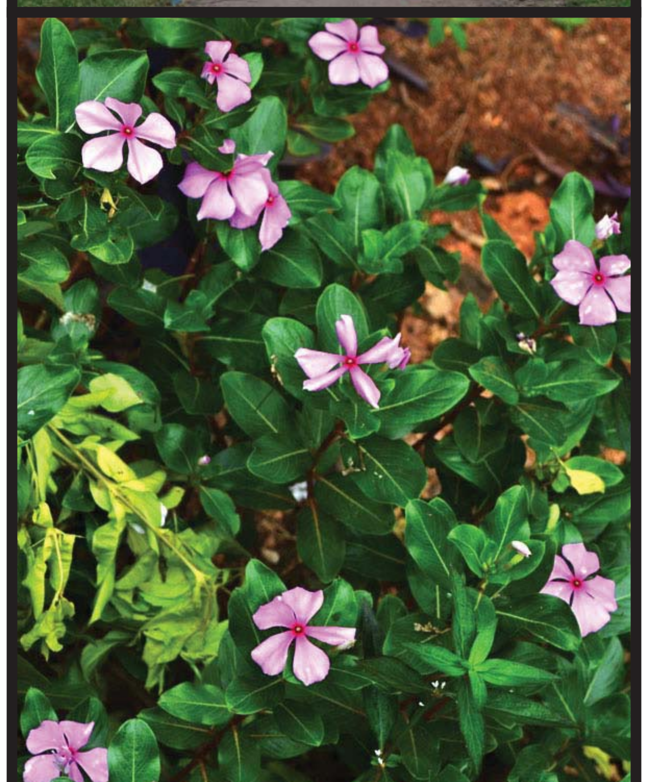
Conclusions

This development project hopes to contribute to the enhanced security of Kisawasawa's necessities - food, fuel, and water. It has attempted to outline ways to ensure the village's vital needs are accounted for in years to come by providing design recommendations, development ideas, and individual options for community members.

Believing that Kisawasawa's residents are in control of their own future, this project attempted to guide residents on choices about food production, energy sources, and water accessibility and quality, while not making strict plans that must be followed. The results are many options and opportunities for Kisawasawa's growth. By prioritizing and combining Kisawasawa's immediate needs, conceptual ideas for the future growth of the village are realized and a model for the future development of the village is formed.

As populations in this agriculture-dominated valley continue to increase, land will be at a premium and plans for responsible development will be of indispensable value to villages. This development model hopes to not only benefit Kisawasawa but also serve as inspiration for other communities in the Kilombero Valley that face similar resource challenges.





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