I SOFTENING THE EDGE I

I UDZUNGWA MOUNTAINS PRODUCTIVE BUFFER I

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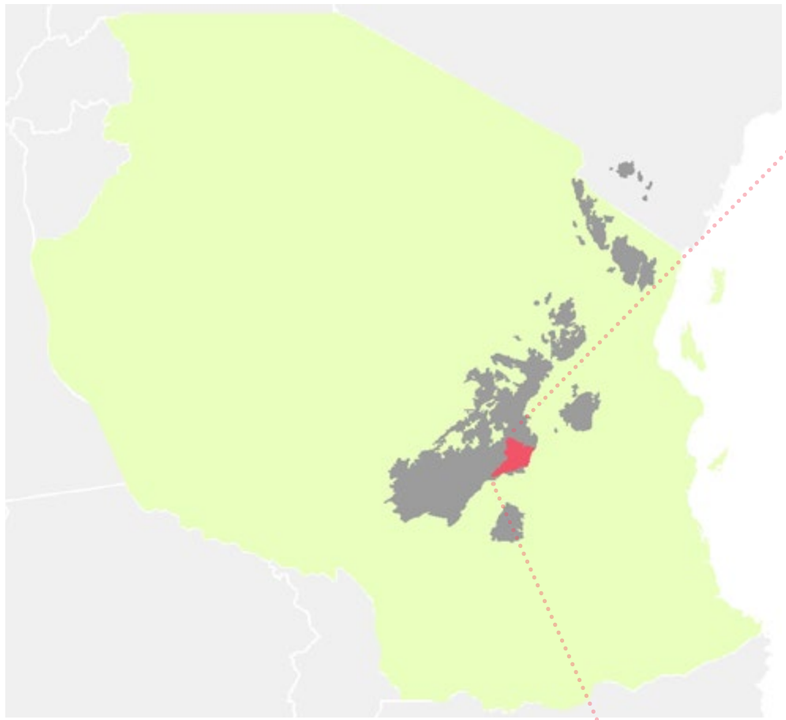


UNITED REPUBLIC OF TANZANIA

EASTERN ARC MOUNTAINS

UDZUNGWA MOUNTAINS NATIONAL PARK

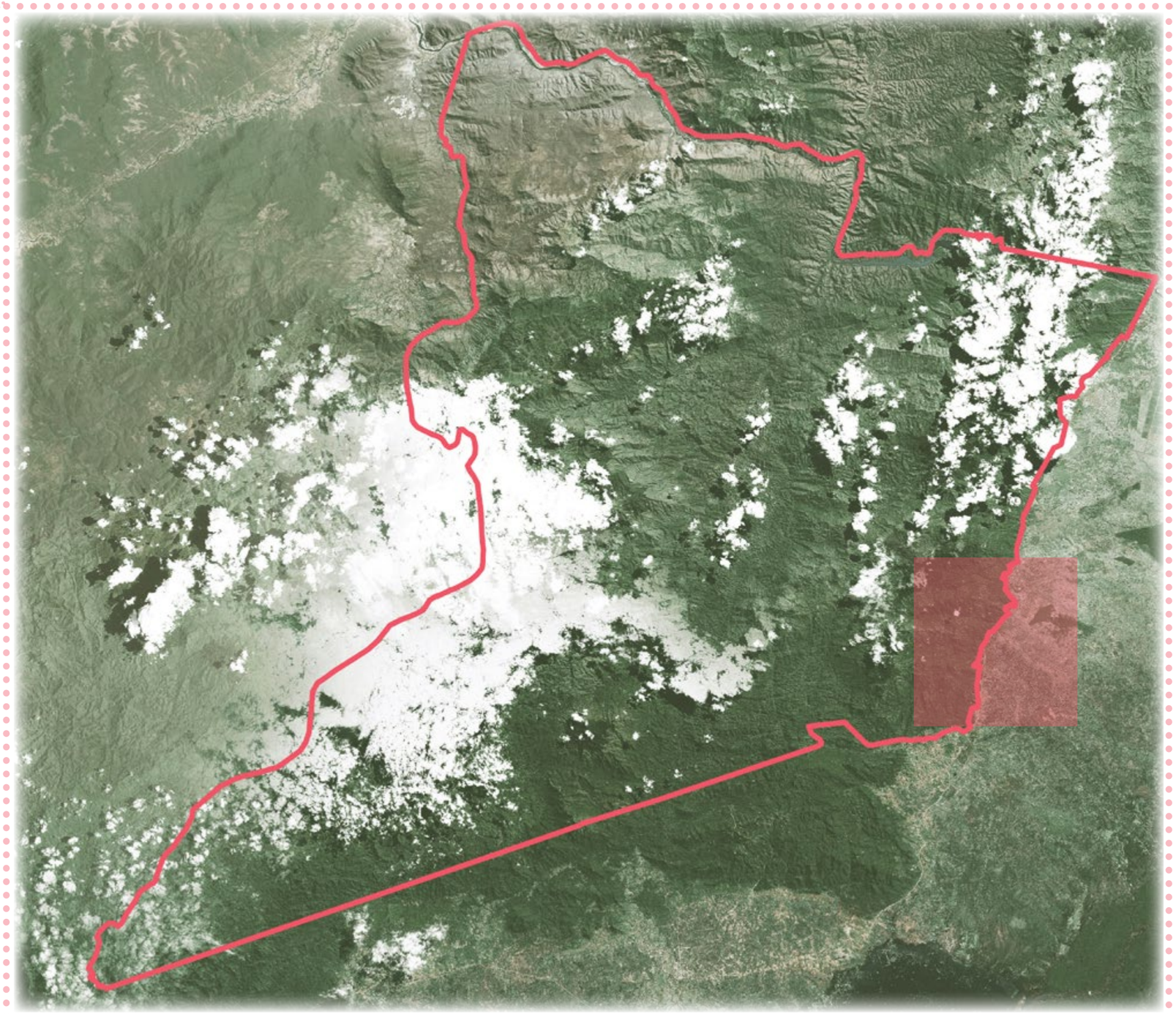
0 KM 600 KM

NORTH

IMPORTANCE OF UMNP

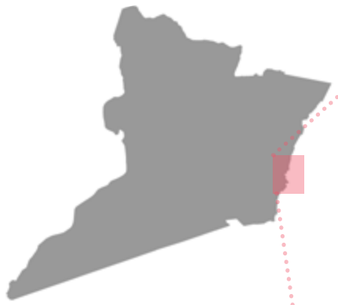
The Eastern Arc Mountians are part of one of the worlds most important hot spots, and are home to a number of endemic plant and animal species. UMNP contains many species endemic to the Udzungwa Mountains alone, and is one of the most biologically important blocks of the Eastern Arc.

Information from Burgess et. al. (2007)



0 KM 20 KM

NORTH



LAND USE

- AGRICULTURE (SUGARCANE)
- PLANTATION FOREST (RUBBER)
- WOODLAND
- HUMAN SETTLEMENT
- PRIMARY FOREST
- UMNP BORDER
- CONFLICT AREA

0 KM 1.5 KM 3 KM 4.5 KM NORTH

LAND USE CONFLICTS

Population in the Kilombero region near the southeastern part of UMNP has been increasing steadily by a rate of 10% annually, as well as shifting demographically, with the population consisting of nearly 70% immigrants

Wood products provide 90% of the energy requirements for local households, and 75% of those households acquire those wood products from UMNP

Harvesting of natural resources negatively affects the ecological composition of Udzungwa Mountains National Park

Since the establishment of the park in 1992, people have gradually lost all permitted access to the park, and the natural resources within

The red line to the left shows conflict areas along a portion of the eastern edge of UMNP, at many places here agriculture and human settlement occur directly adjacent to the park boundary.

Information from Nyundo et. al. (2006) and Trento (2007)

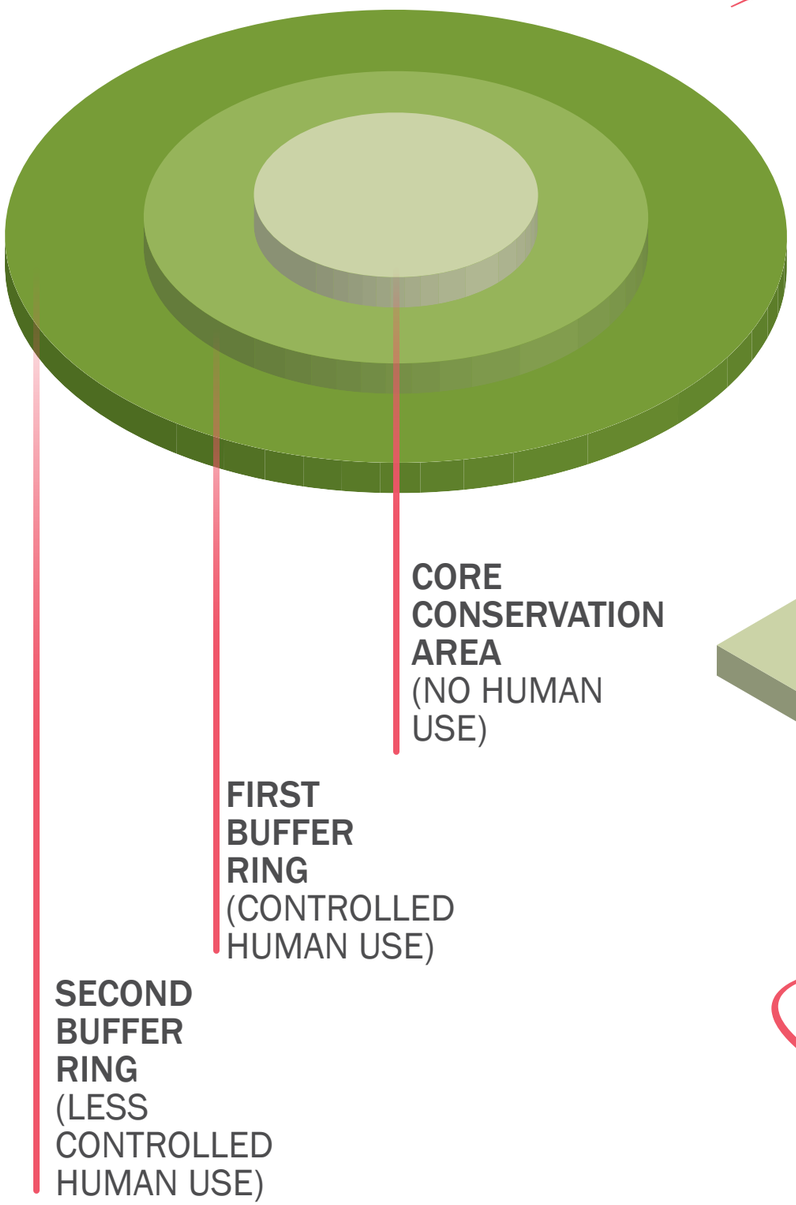
Create zones of decreasing human use to soften the edge of Udzungwa Mountains National Park and prevent future issues involving loss of access to natural resources

Create a buffer that improves the economic situation of the local population around the eastern edge of the Udzungwa Mountains National Park

Extend ecosytem services from the park out into the surrounding human use areas by adding increased ecological value to the lands between Udzungwa Mountains National Park and human use areas

Develop a model for buffer design that can be manipulated to fit existing land uses and allow for implementation around Udzungwa Mountains National Park as well as other protected areas elsewhere

BIOSPHERE RESERVE

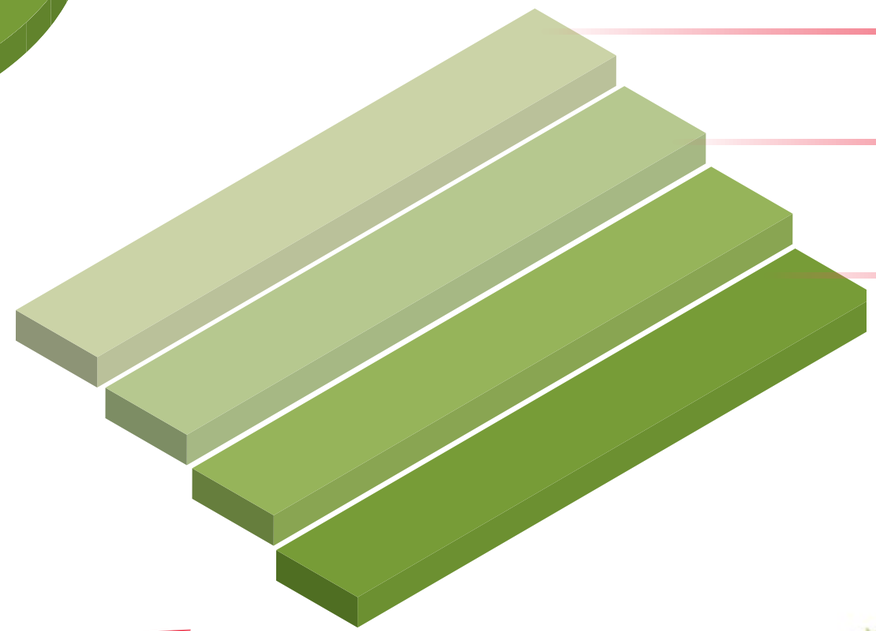


CORE CONSERVATION AREA (NO HUMAN USE)

FIRST BUFFER RING (CONTROLLED HUMAN USE)

SECOND BUFFER RING (LESS CONTROLLED HUMAN USE)

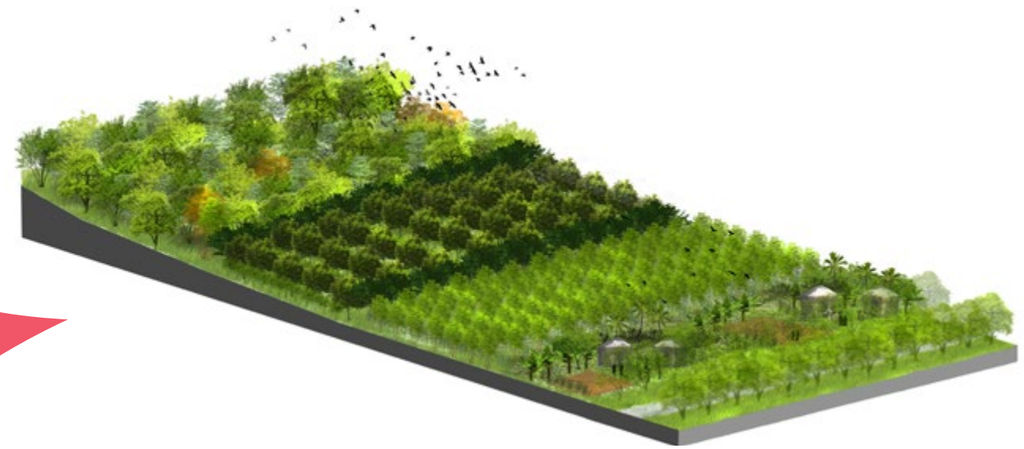
MODIFIED DIAGRAM



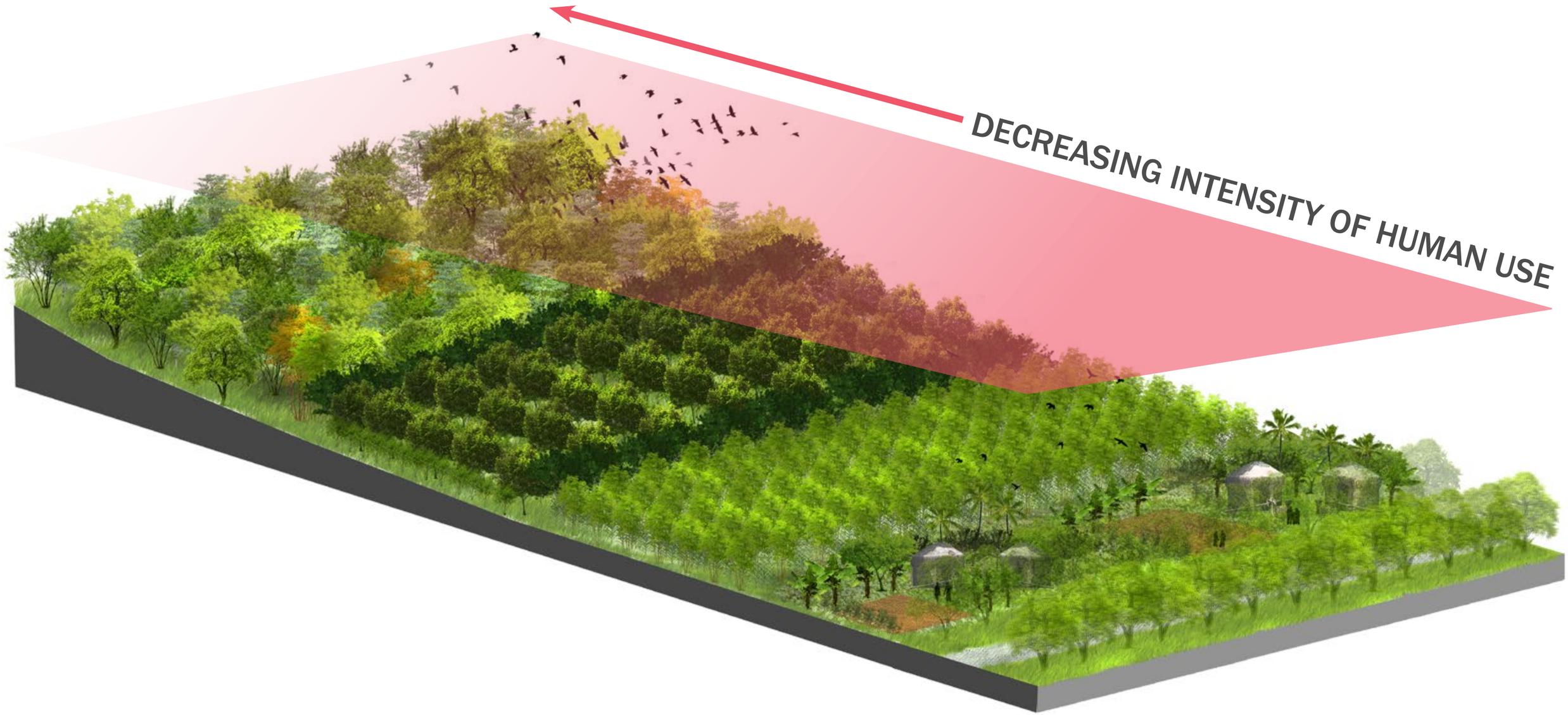
CONSERVATION AREA EDGE (NO HUMAN USE)

INNER BUFFER STRIPS (INCREASING HUMAN USE)

OUTER BUFFER STRIP (HEAVIEST HUMAN USE)



Biosphere diagram based off of Batisse (1982)


DECREASING INTENSITY OF HUMAN USE

NUTRIENT CYCLING

CARBON SEQUESTRATION

AIR QUALITY REGULATION

EROSION REGULATION

SENSE OF PLACE

CULTURAL VALUES

SOIL FORMATION

FIBER

GENETIC RESOURCES

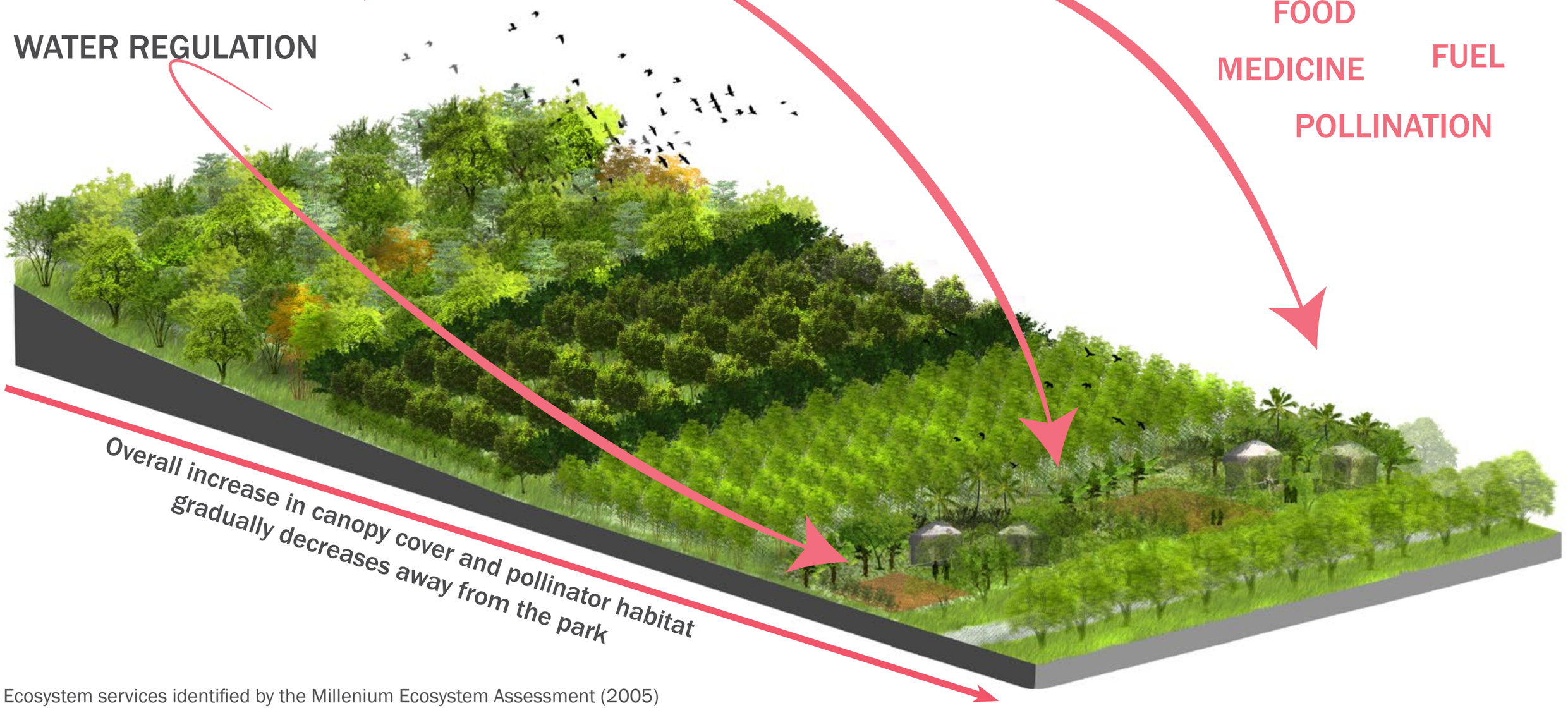
FOOD

WATER REGULATION

MEDICINE

FUEL

POLLINATION



Ecosystem services identified by the Millenium Ecosystem Assessment (2005)

EXISTING FOREST

ZONE 1 MANAGED FOREST EXPANSION

WILDLIFE BARRIER

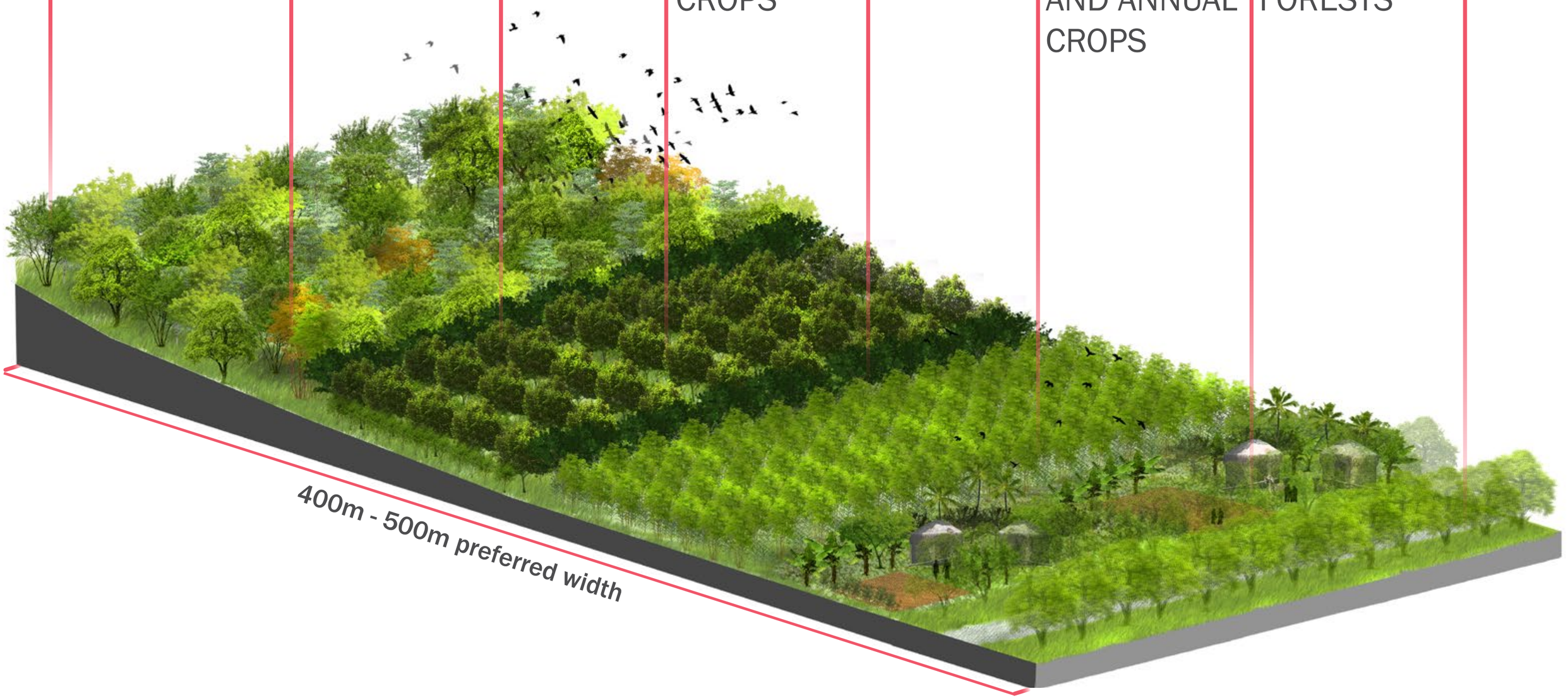
ZONE 2 ROTATIONAL TIMBER AND SHADE CROPS

WILDLIFE BARRIER

ZONE 3 ALLEY CROPPING OF FUELWOOD AND ANNUAL CROPS

ZONE 4 ENHANCED GARDENING PRACTICES AND FOOD FORESTS

ROAD BUFFER

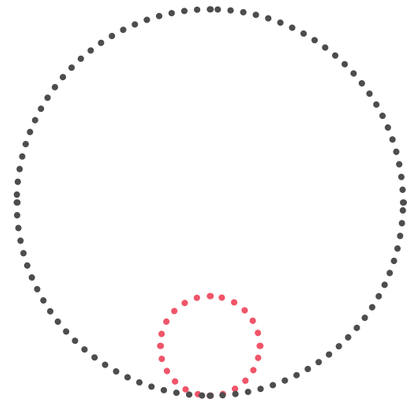


PRODUCTIVE INDIGENOUS SPECIES (NTFP VALUE)

Albizia gummifera
Anthocleista grandiflora
Bersama abyssinica
Bridelia micanthra
Grewia bicolor
Ficus spp.
Lonchocarpus capassa
Parinari curatellifolia
Sclerocarya birrea
Strychnos cocculoides
Tamarindus indica
Uapaca kirkiana
Vitex spp.

HUMAN USE

Community - managed deadwood harvest
Community - managed NTFP harvest
Recreation

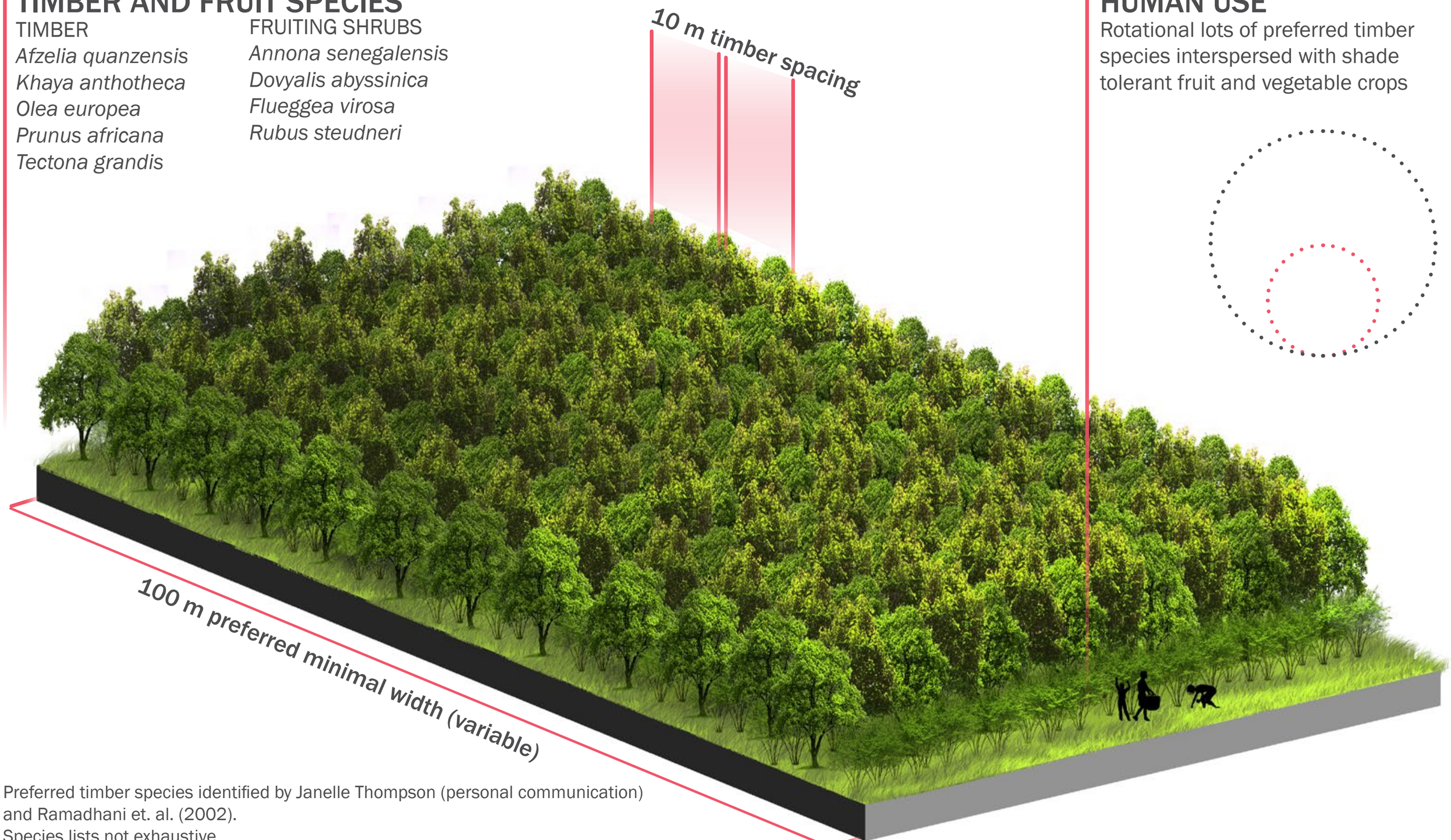


NTFP = Non-timber forest products (food, medicines, dyes, etc.)
Preferred species identified by Msuya et. al. (2010) Ndangalasi et. al. (2007)
Species lists not exhaustive

TIMBER AND FRUIT SPECIES

TIMBER
Afzelia quanzensis
Khaya anthotheca
Olea europea
Prunus africana
Tectona grandis

FRUITING SHRUBS
Annona senegalensis
Dovyalis abyssinica
Flueggea virosa
Rubus steudneri



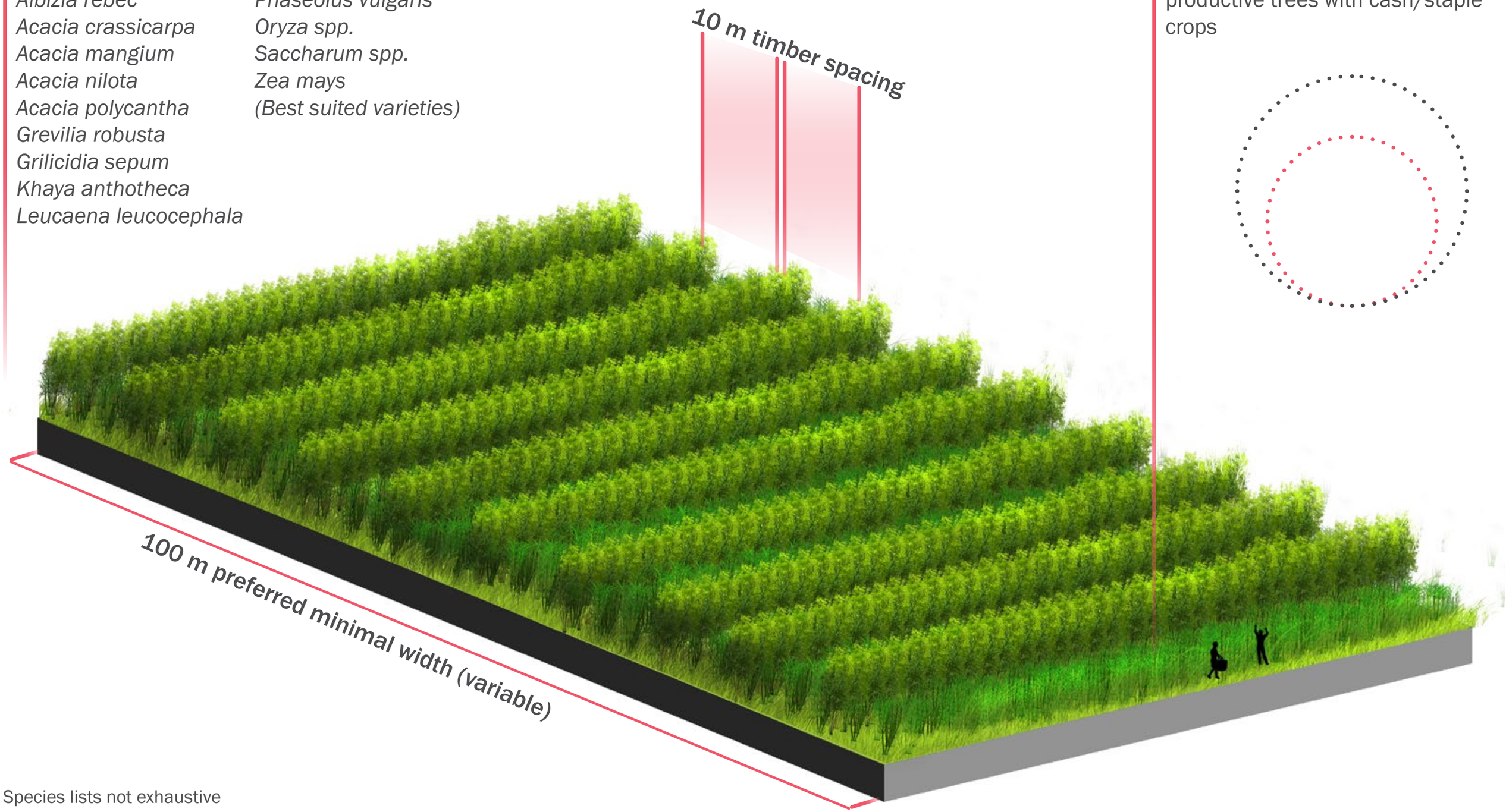
HUMAN USE

Rotational lots of preferred timber species interspersed with shade tolerant fruit and vegetable crops

Preferred timber species identified by Janelle Thompson (personal communication) and Ramadhani et. al. (2002).
Species lists not exhaustive

ALLEY CROPPING SPECIES

MULTIPURPOSE TREES	STAPLE CROPS
Albizia rebec	*Phaseolus vulgaris*
Acacia crassicarpa	*Oryza spp.*
Acacia mangium	*Saccharum spp.*
Acacia nilota	*Zea mays*
Acacia polycantha	*(Best suited varieties)*
Grevilia robusta	
Grilicidia sepum	
Khaya anthotheca	
Leucaena leucocephala	



HUMAN USE

Alley cropping of multipurpose productive trees with cash/staple crops

Species lists not exhaustive

FOOD FOREST SPECIES

Ananas comosus
Carica papaya
Colocasia esculenta
Manihot esculenta
Mangifera spp.
Psidium guajava
Tamarindus indica
Zingiber officinale

Food forests both communal and individual

Biointensive gardening plots in every household

HUMAN USE

Enhanced land use practices on village edges in the form of biointensive agriculture and food forests

Concept of biointensive gardening from John Jeavons (2012)
Food forest species identified by Moorsom (2015)
Species lists not exhaustive

DISSECTING THE ZONES

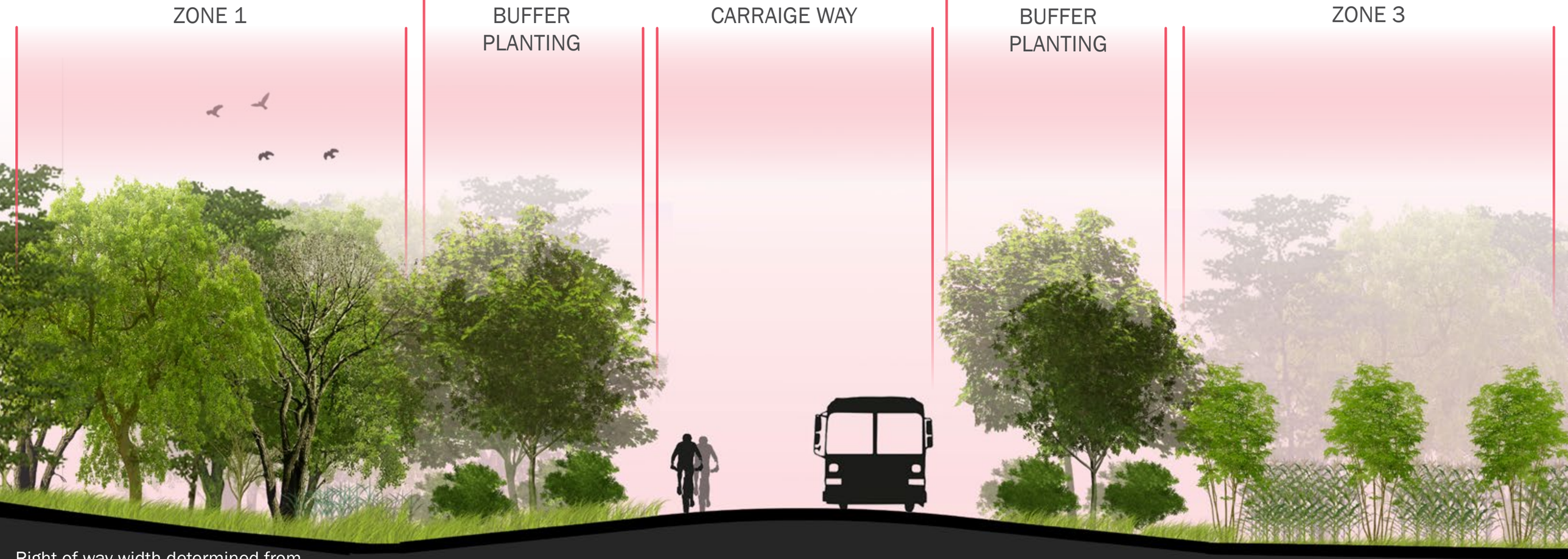
With the planned improvement, the Mikumi-Ifakara road will dissect the Udzungwa Productive buffer in a number of locations. The diagram below shows a an example of what the buffer might look like with a right of way width of 40 meters. The situation shown is where the road might dissect zones 1 and 3 of the buffer.

INTENT

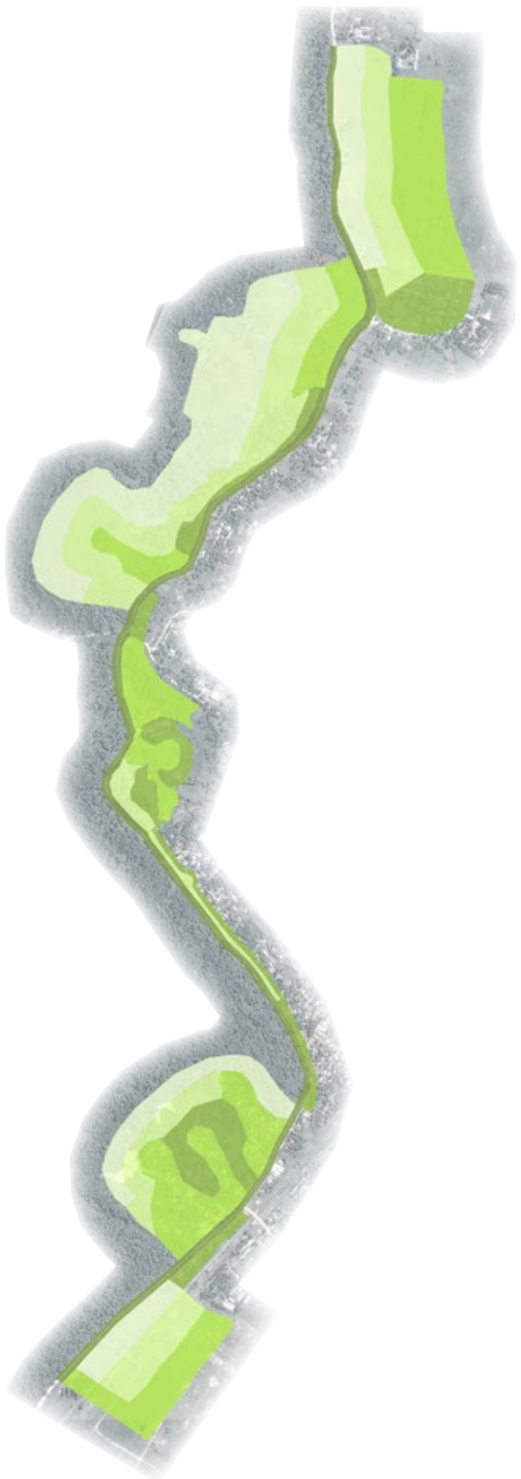
Reduce soil erosion around the road
Enhance road drainage
Increase canopy cover and shade along road
Provide increased planting area for fuelwood trees
Provide increased habitat opportunities for wildlife

BUFFER PLANTING SPECIES

Annona senegalensis
Dovyalis abyssinica
Flueggea virosa
Ficus spp.
Khaya anthotheca
Mangifera spp.
Psidium guajava
Rubus steudneri

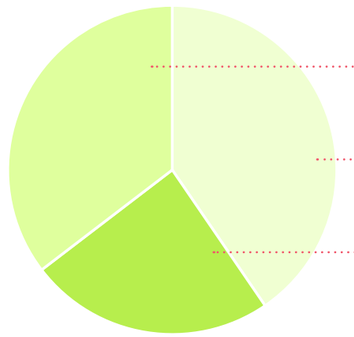


Right of way width determined from Tanzanian Ministry of Works (2011)



AREA BREAKDOWN

VILLAGE LAND

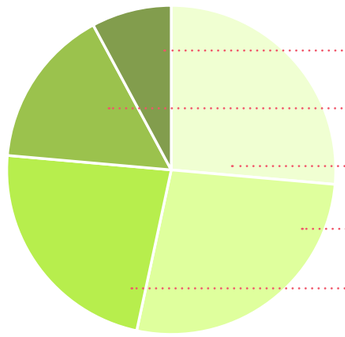


MWAYA I 63 HA

MANG'ULA A I 72 HA

MANG'ULA B I 43 HA

ZONES



ROAD BUFFER I 14 HA

ZONE 4 I 28 HA

ZONE 1 I 47 HA

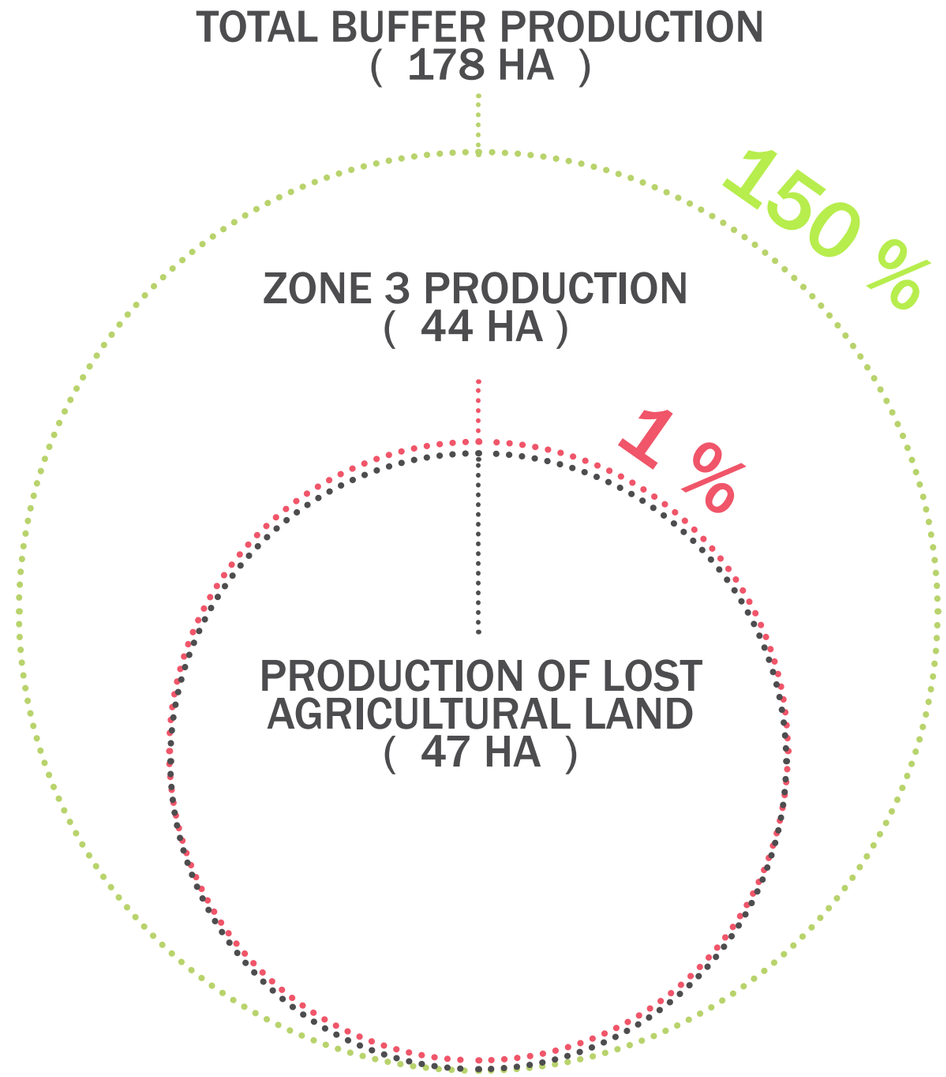
ZONE 2 I 48 HA

ZONE 3 I 41 HA

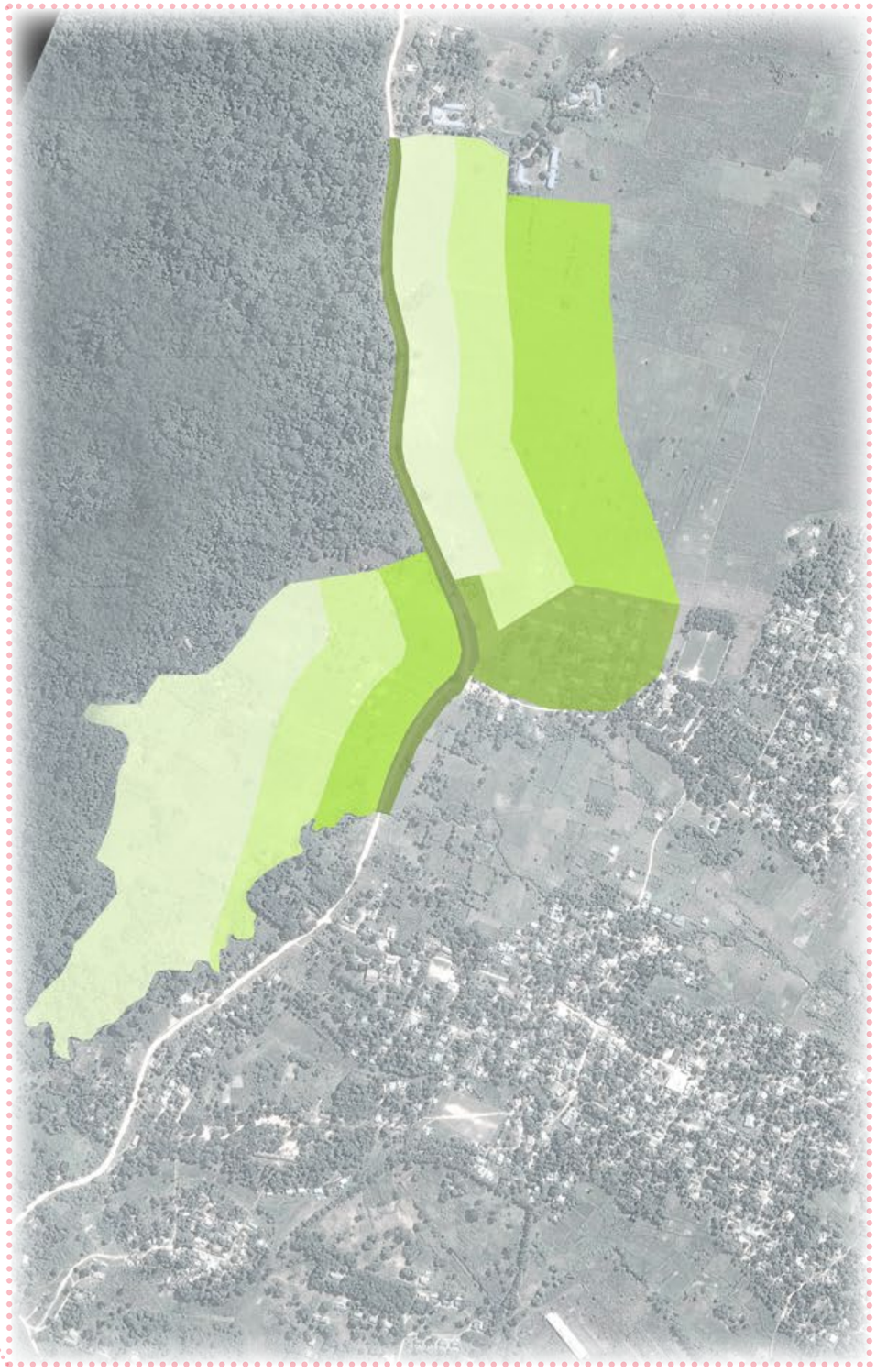
PRODUCTION FACTS

SUGARCANE	
Production rate	1,260,000 Tsh/ha/yr
Area in Buffer	47 hectares
Total Production (7 Years)	**414,540,000 Tsh**
ALLEY CROPPING	
Production rate (Sugarcane)	1,188,000 Tsh/ha/yr
Production rate (Charcoal)	1,170,560 Tsh/ha/yr
Area	44 hectares
Total production (7 Years)	**417,408,640 Tsh**

ECONOMIC VIABILITY



Equations assume average productivity of both the existing systems and the new systems. Total buffer production is an estimate of the profits from entire buffer as compared to the agricultural land lost. Small-holder agriculture lost is not taken into account as the buffer assumes that existing systems will be improved upon.
Prices and production rates identified by Chase Weaver (2016)



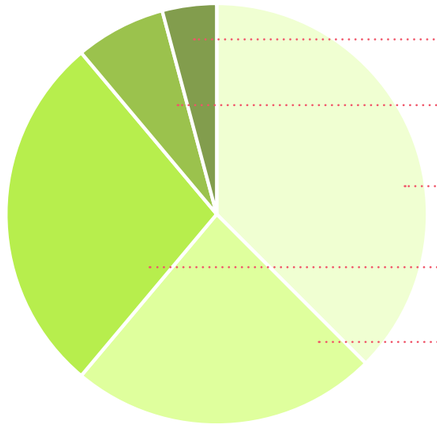
BUFFER ZONES

- ZONE1 I MANAGED FOREST
- ZONE 2 I TIMBER AND SHADE CROPS
- ZONE 3 I ALLEY CROPPING
- ZONE 4 I INTENSIFIED GARDENING
- ROAD BUFFER ZONE

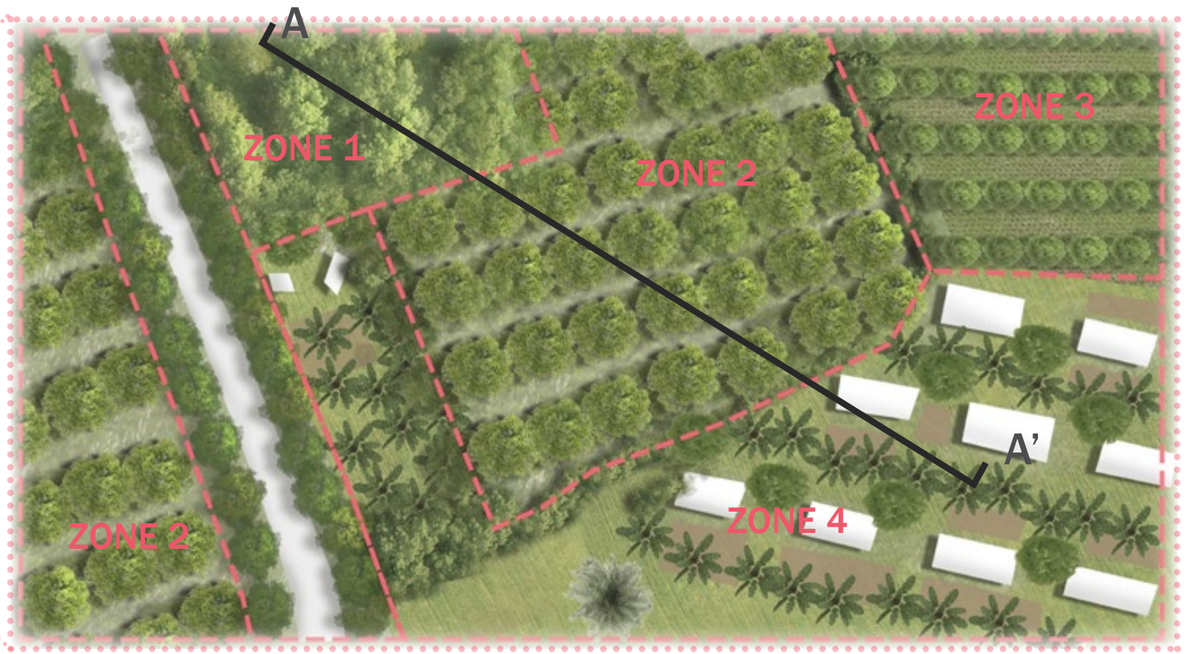
0 M 200 M 600 M

NORTH

AREA BREAKDOWN



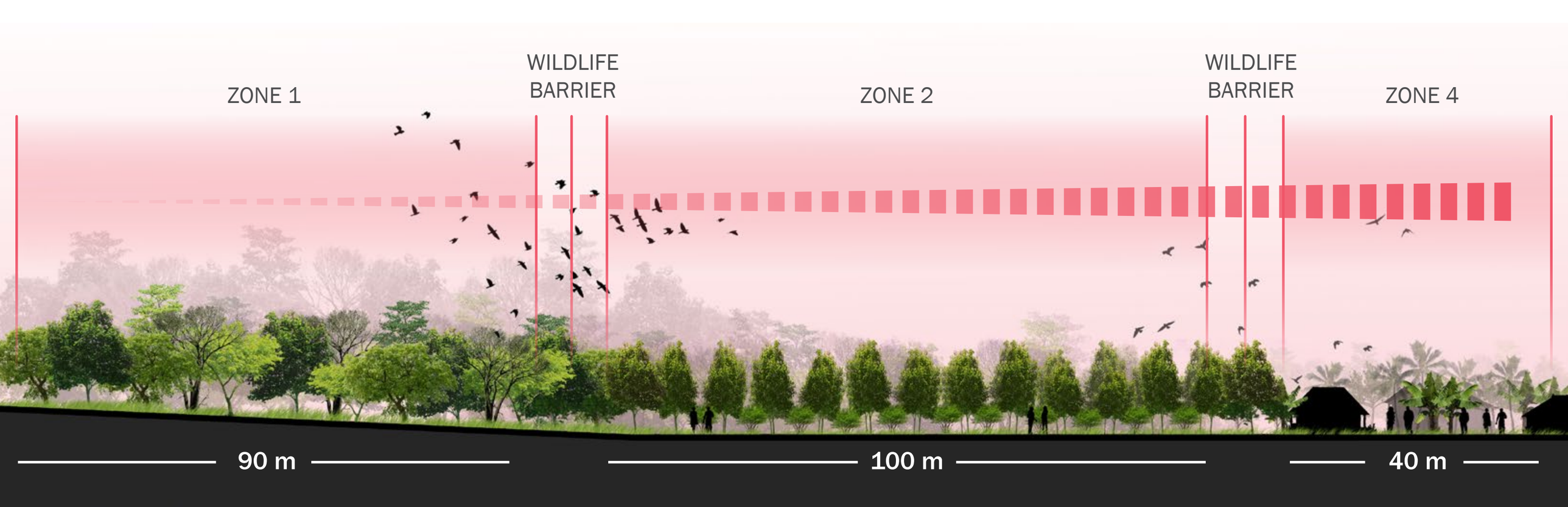
- 3 HA I 4.2%
- 5 HA I 6.9%
- 27 HA I 37.5%
- 20 HA I 27.8 %
- 17 HA I 23.6 %

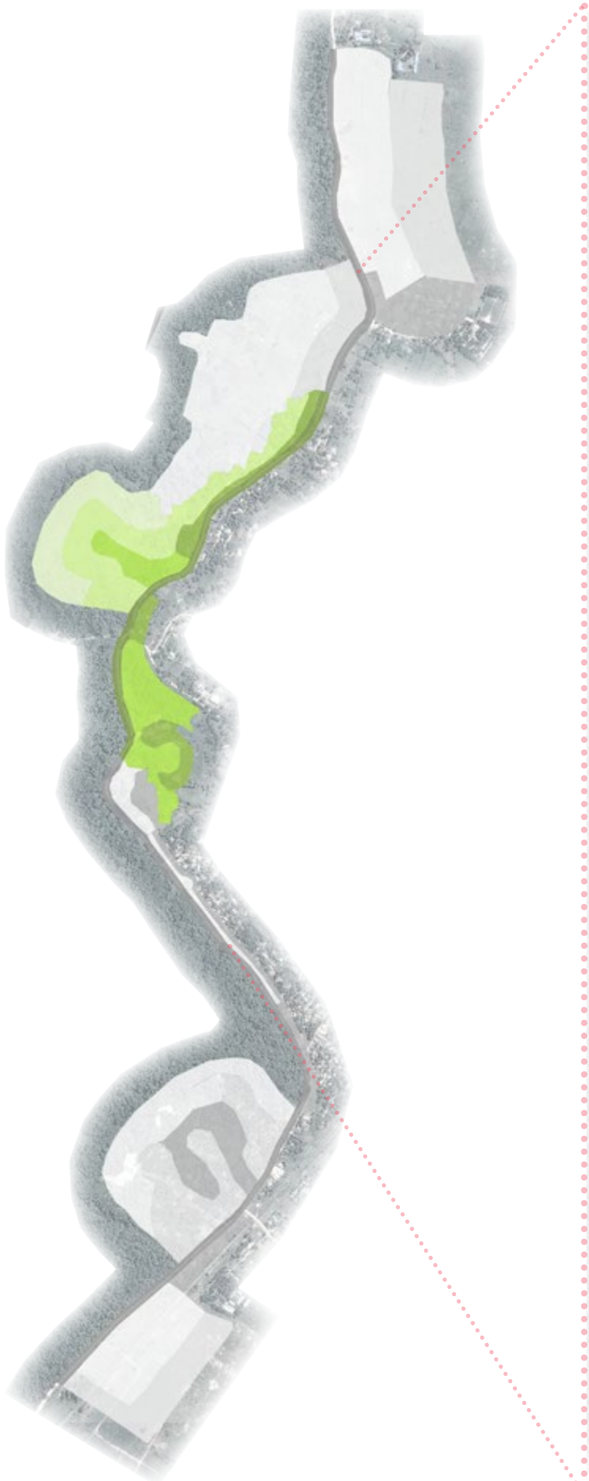


MIXED CONDITIONS

This snapshot shows a situation that involves all of the zones, but in a pattern that is not consistent with the linear buffer design. The majority of the buffer here lies east of the road (an area with heavier human use), meaning that the decrease of human use towards the park is upset. The zones here interlock in a pattern based off of the existing residential area, which has adopted enhanced land use and gardening practices.

0 M 40 M NORTH





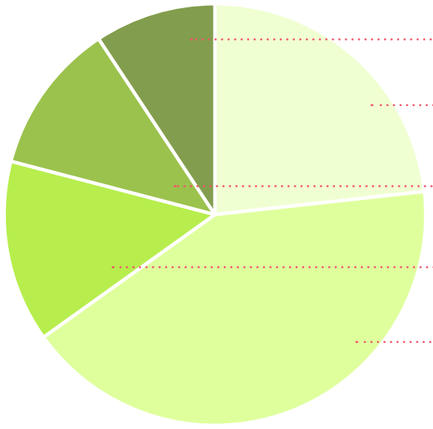
BUFFER ZONES

- ZONE1 I MANAGED FOREST
- ZONE 2 I TIMBER AND SHADE CROPS
- ZONE 3 I ALLEY CROPPING
- ZONE 4 I INTENSIFIED GARDENING
- ROAD BUFFER ZONE

0 M 200 M 600 M

NORTH

AREA BREAKDOWN



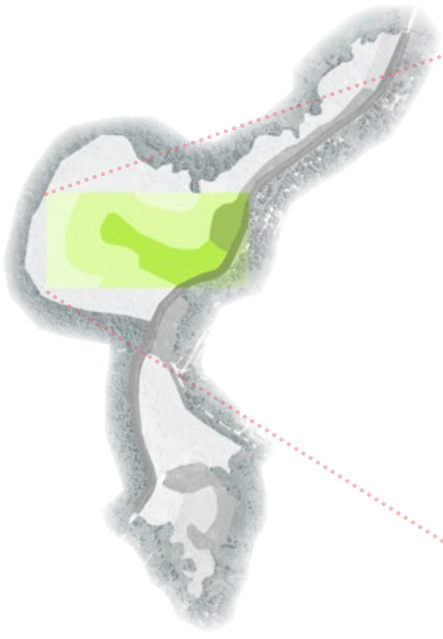
4 HA I 9.4%

10 HA I 23.3%

5 HA I 11.6%

6 HA I 14.0 %

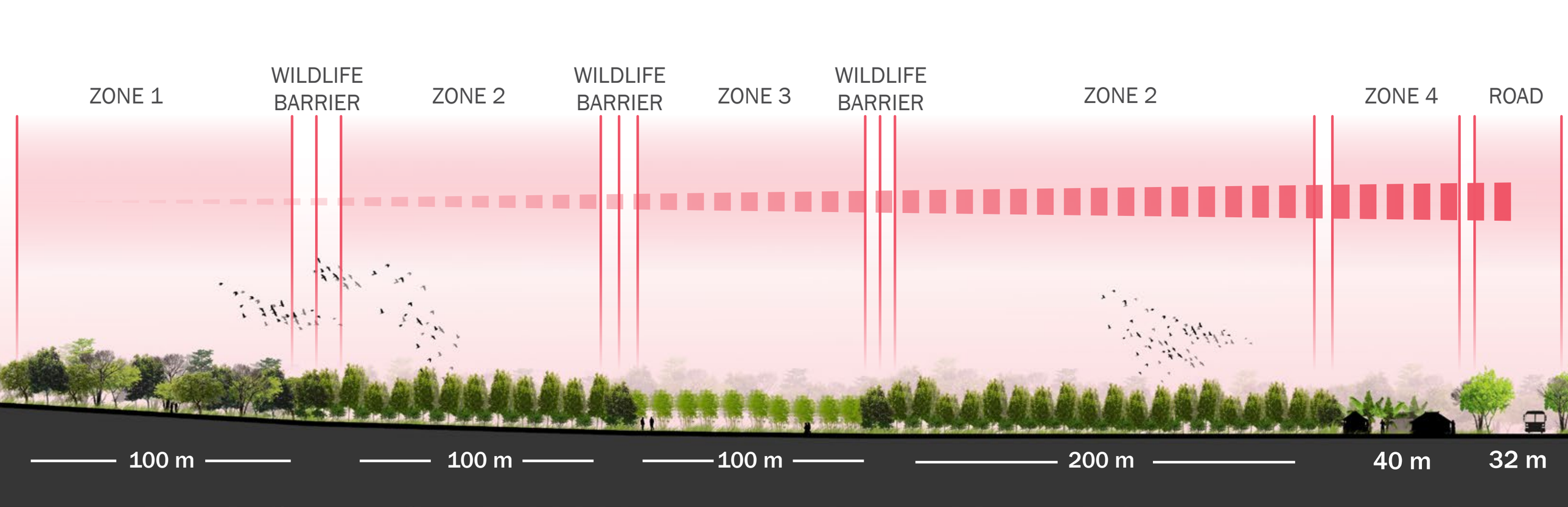
18 HA I 41.9 %



GOOD CONDITIONS

This snapshot shows a situation that is close to the ideal conditions. The entirety of the buffer is on the western side of the road, between the heaviest existing human use and the park. The buffer here fills the existing agricultural and degraded land and molds to the shape of the park. All zones are present and the decrease of human use is clear.

0 M 100 M NORTH



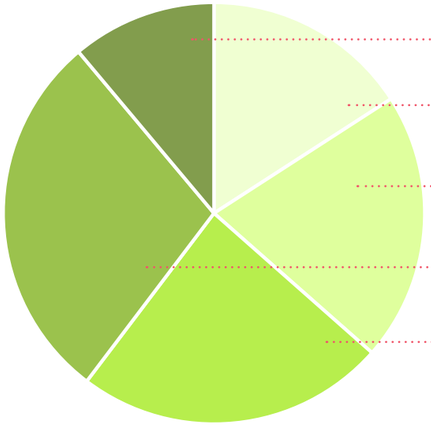
BUFFER ZONES

- ZONE1 I MANAGED FOREST
- ZONE 2 I TIMBER AND SHADE CROPS
- ZONE 3 I ALLEY CROPPING
- ZONE 4 I INTENSIFIED GARDENING
- ROAD BUFFER ZONE

0 M 200 M 600 M

NORTH

AREA BREAKDOWN



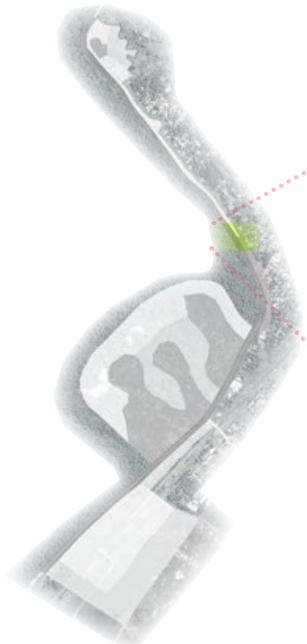
7 HA I 11.1%

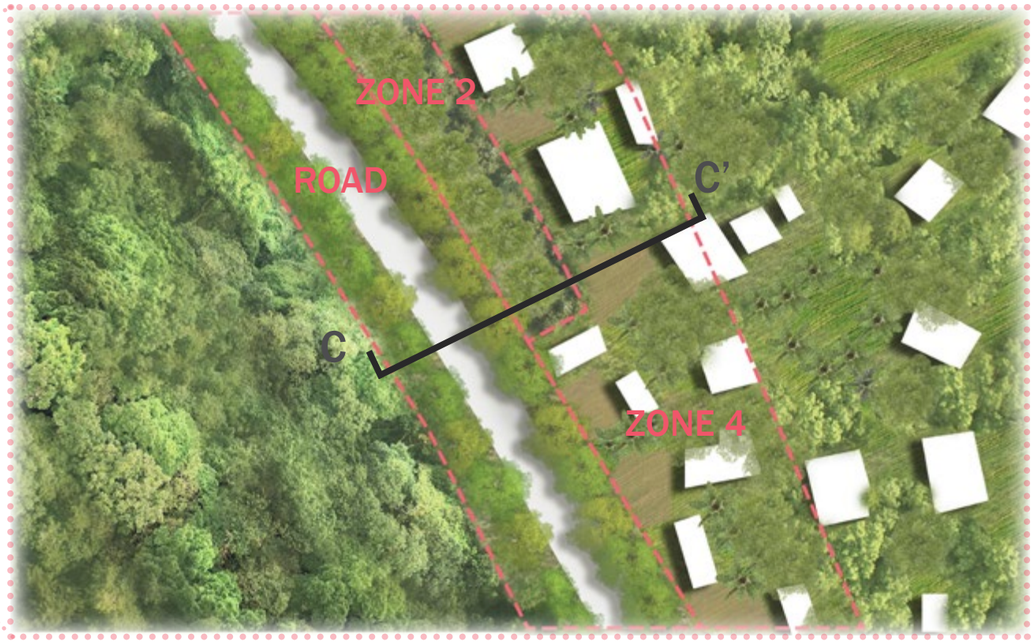
10 HA I 15.9%

13 HA I 20.6%

18 HA I 28.6 %

15 HA I 23.8 %

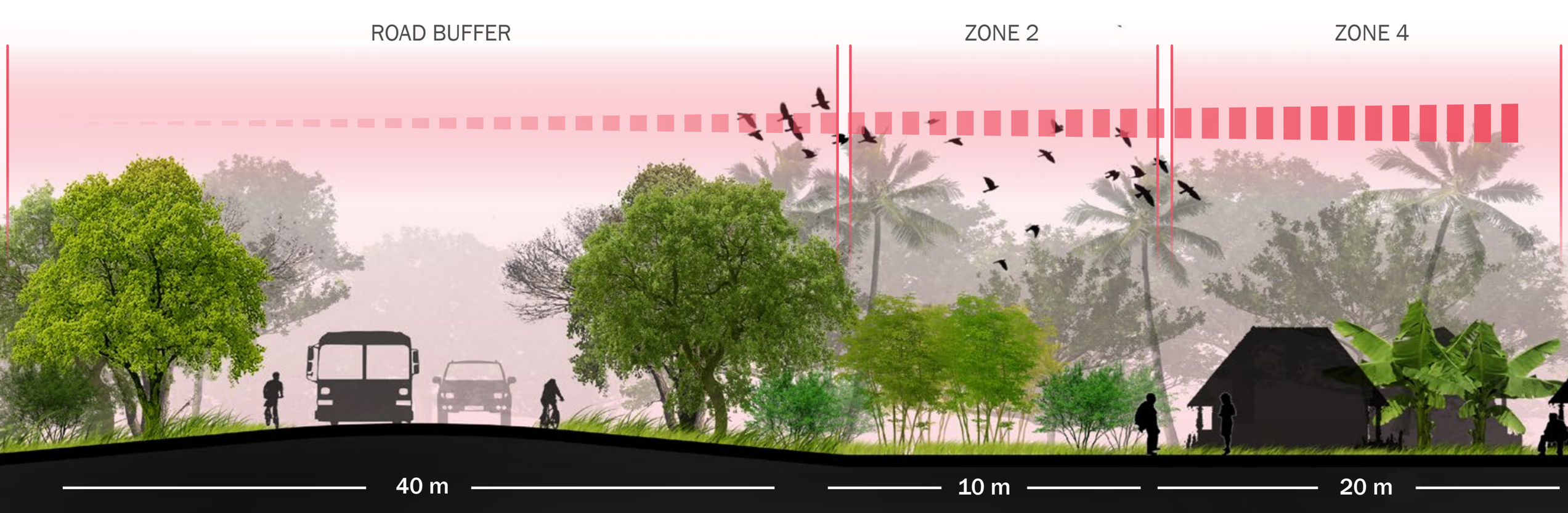




MINIMAL CONDITIONS

This snapshot depicts an area where there is minimal space available for the implementation of the buffer. The park border meets the road right of way, leaving no space on the western side of the road, and residential settlement meets the road on the majority of the eastern side. Here there is only room for the road buffer area, a 10 m wide strip of rotational timber lots for residential use, and the final zone of residential intensification. The woodlot ends when there is no longer room as the residential area expands along the southern portion of this section of the road.

0 M 20 M NORTH



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