

A research programme co-funded by DFID, NERC & ESRC and accredited by LWEC

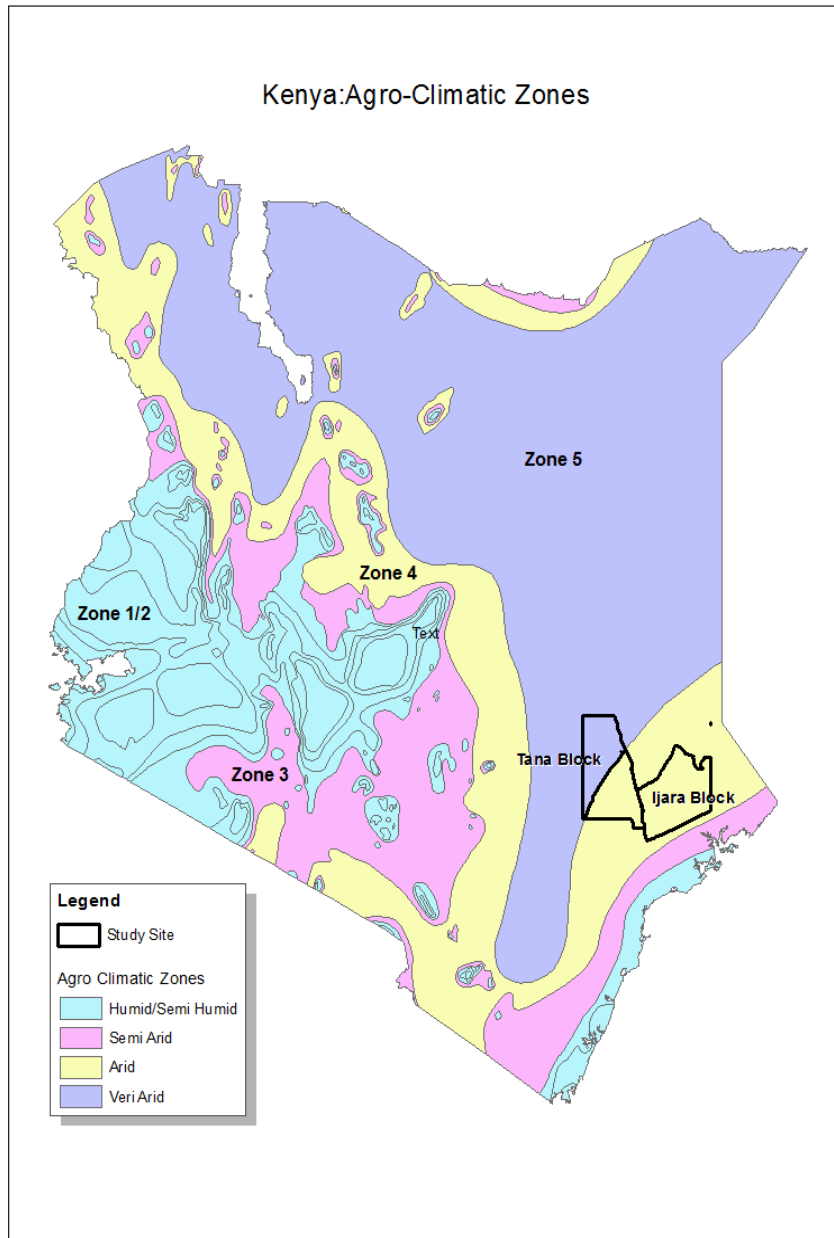


Mapping ecosystem services and trade-offs

Mohammed Said, Shem Kifugo, Tom Otieno, Enoch Ontiri and Bernard Bett
International Livestock Research Institute

Workshop on Dynamics Drivers of Diseases in
Africa, Naivasha 24th – 26th June 2014

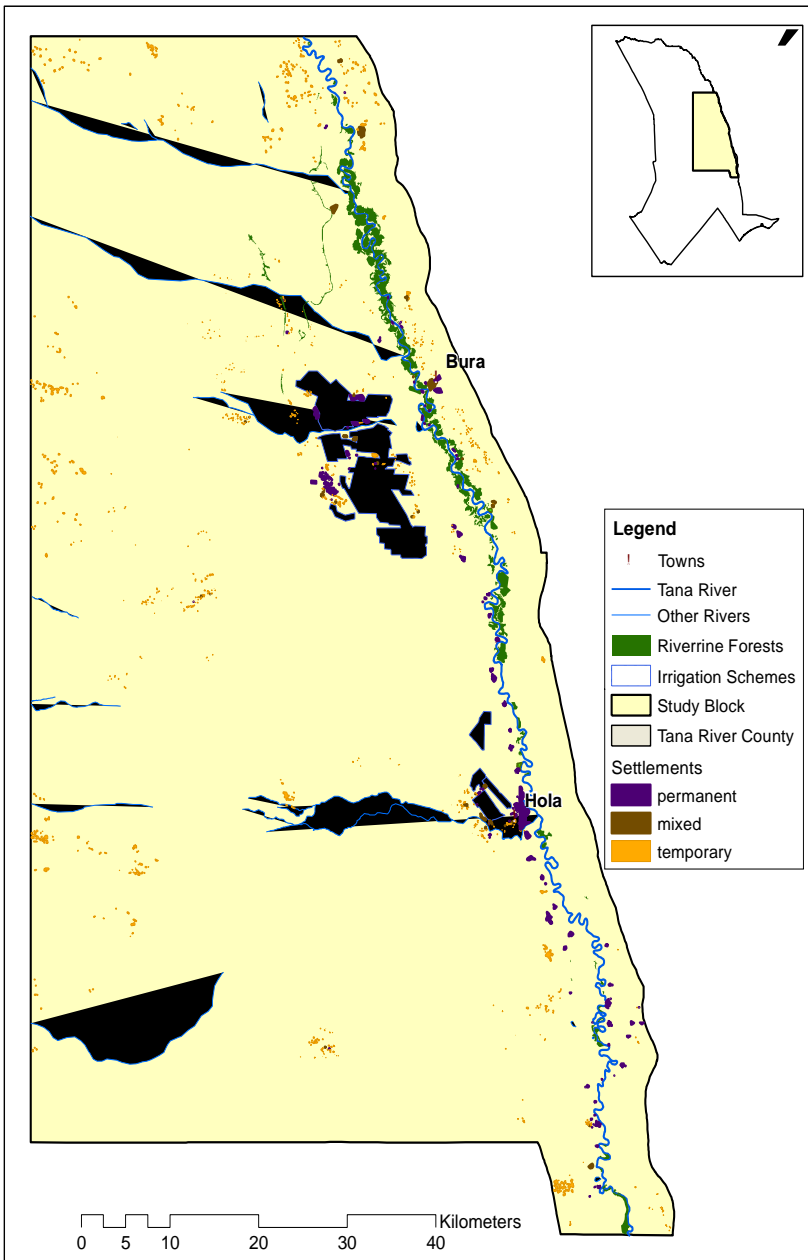
Study Area



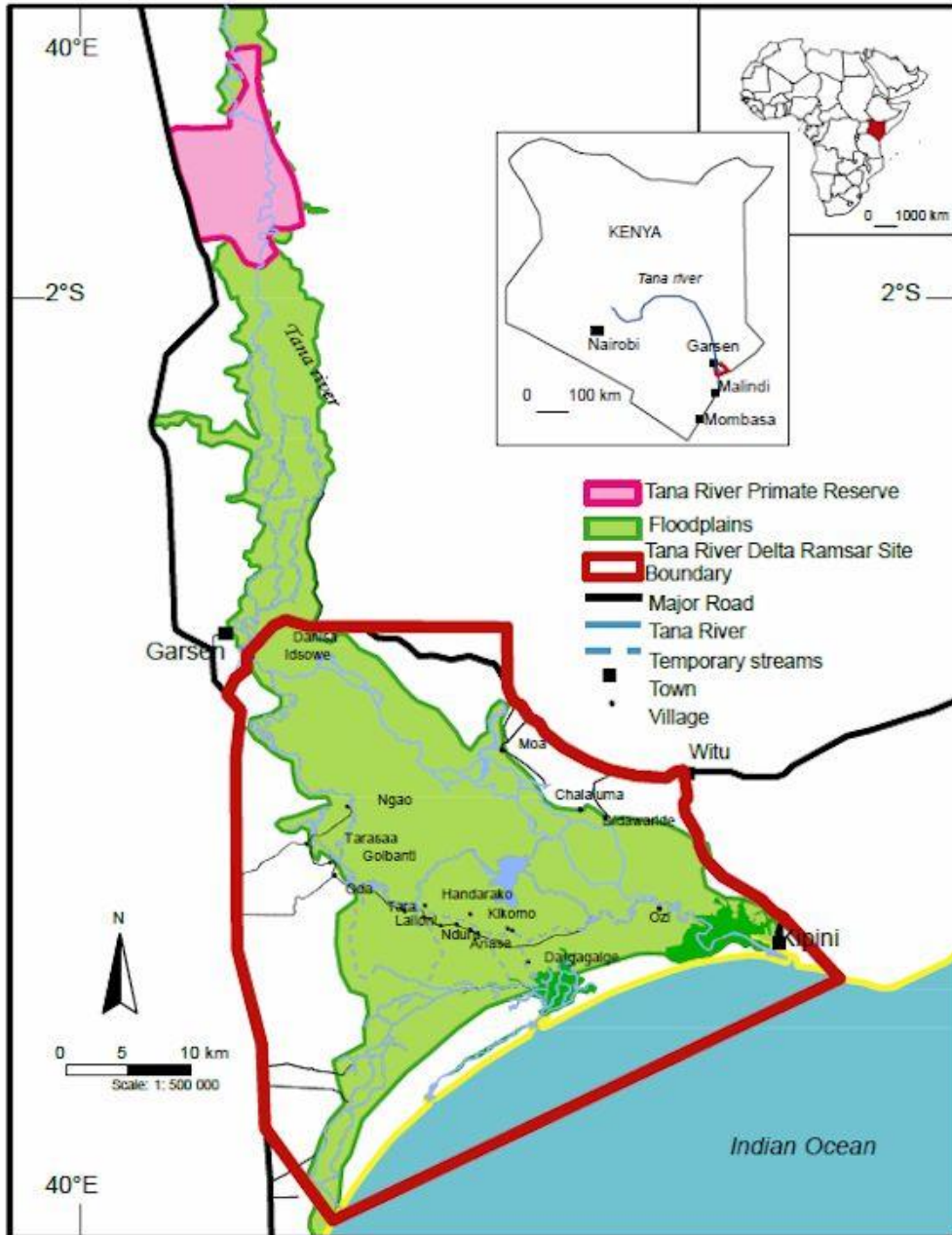
The study site has been identified as a biodiversity hotspot

- supporting a unique plant taxonomy and a recorded 262 bird species and 57 mammal species
- including two highly endangered primates: the Red Colobus (*Colobus badius rufomitatus*) and the Crested Mangabey (*Cercocebus galeritus galeritus*)
- The Tana River delta site was officially declared a Ramsar site, under the Ramsar Convention, in October 2012
- About 5000 birds use the delta for breeding

Study Site Tana River

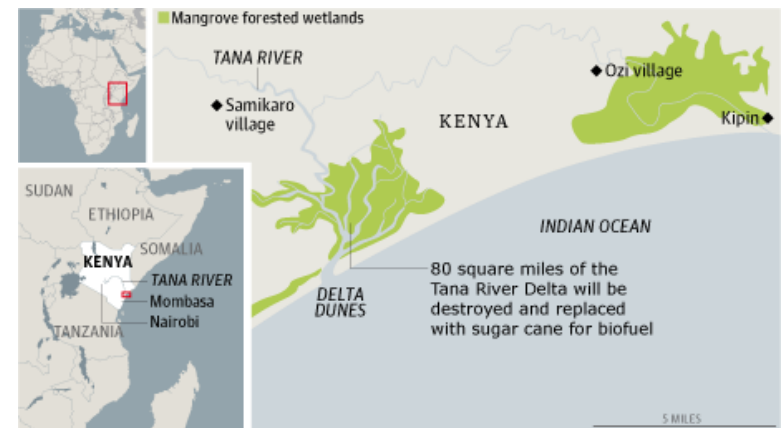


MAP OF TANA RIVER DELTA RAMSAR SITE



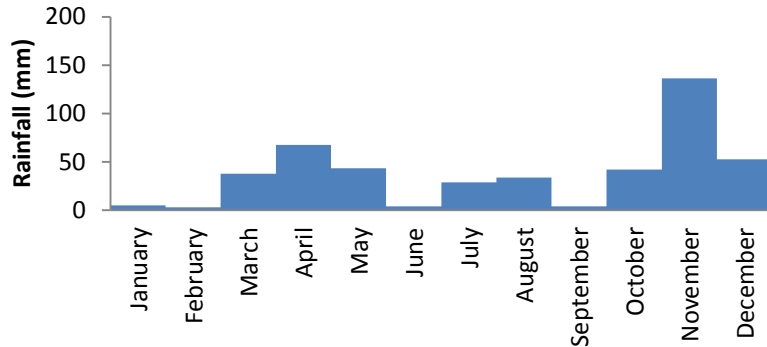
Source: KWS

Importance Floodplains, Primate Reserve and Ramsar Site

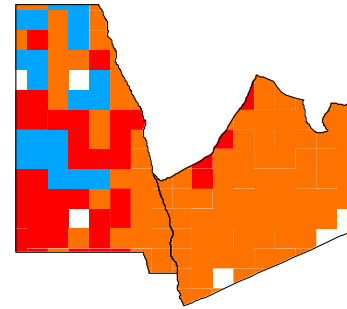


Rainfall and climate

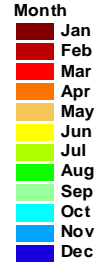
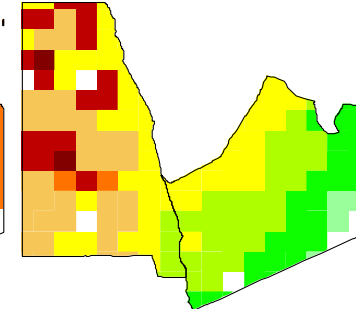
Bura



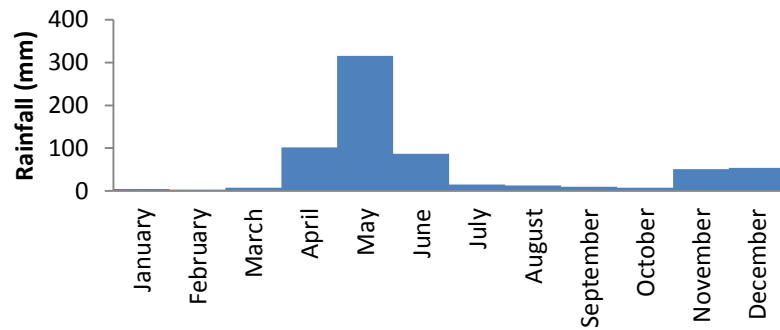
a) Start of the growing season



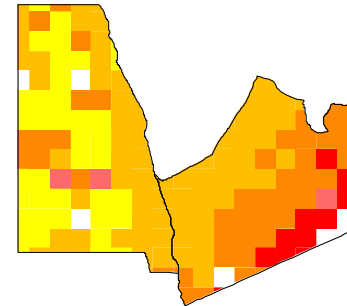
b) End of the growing season



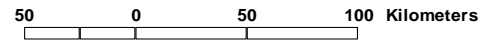
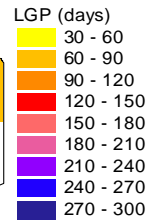
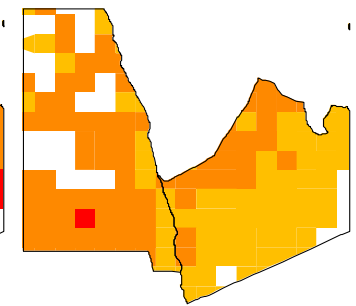
Ijara



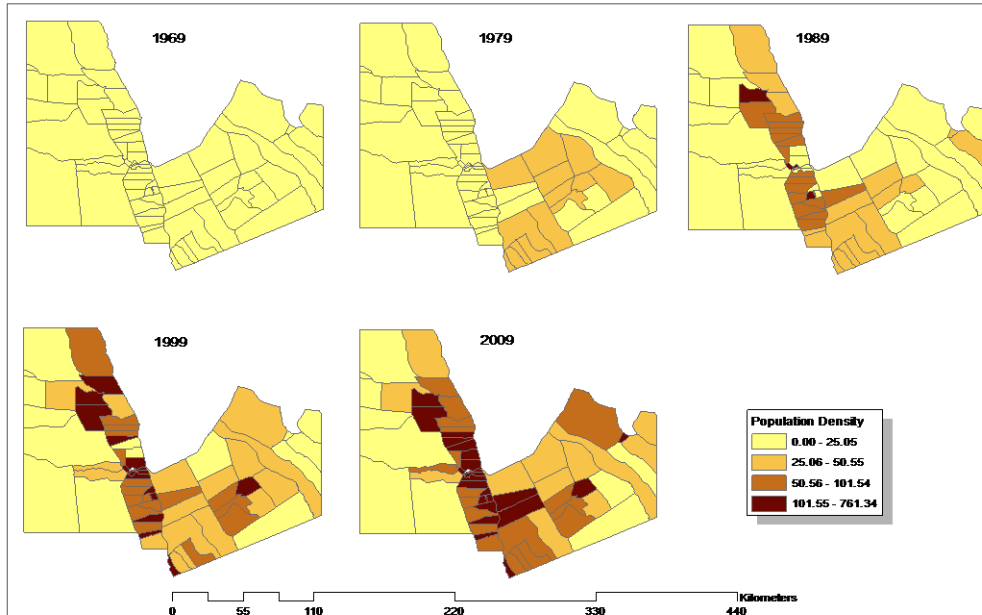
c) LGP - 1st Season



d) LGP - 2nd Season

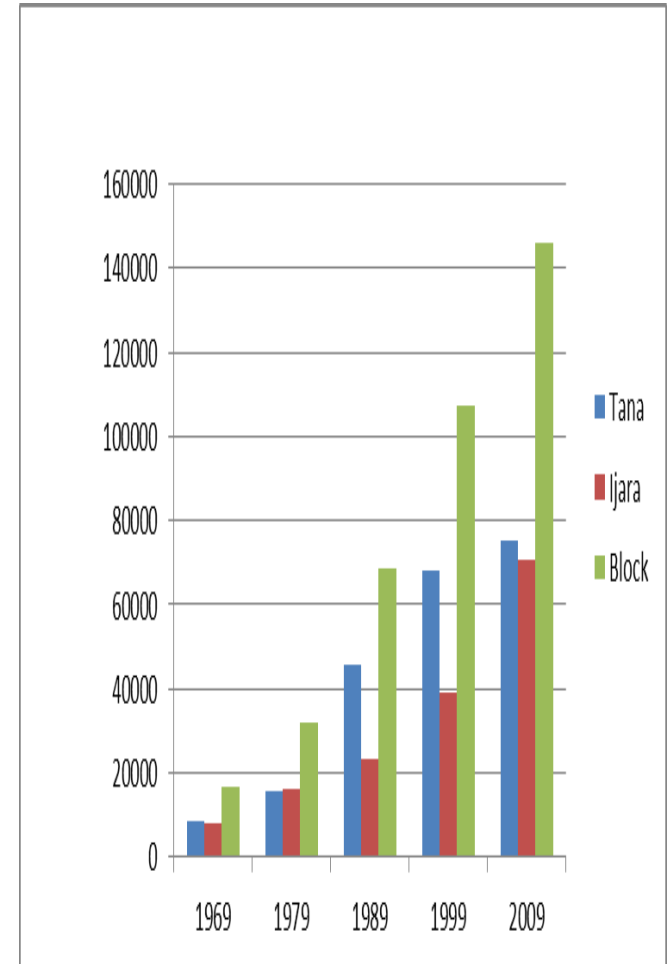


Human population changes

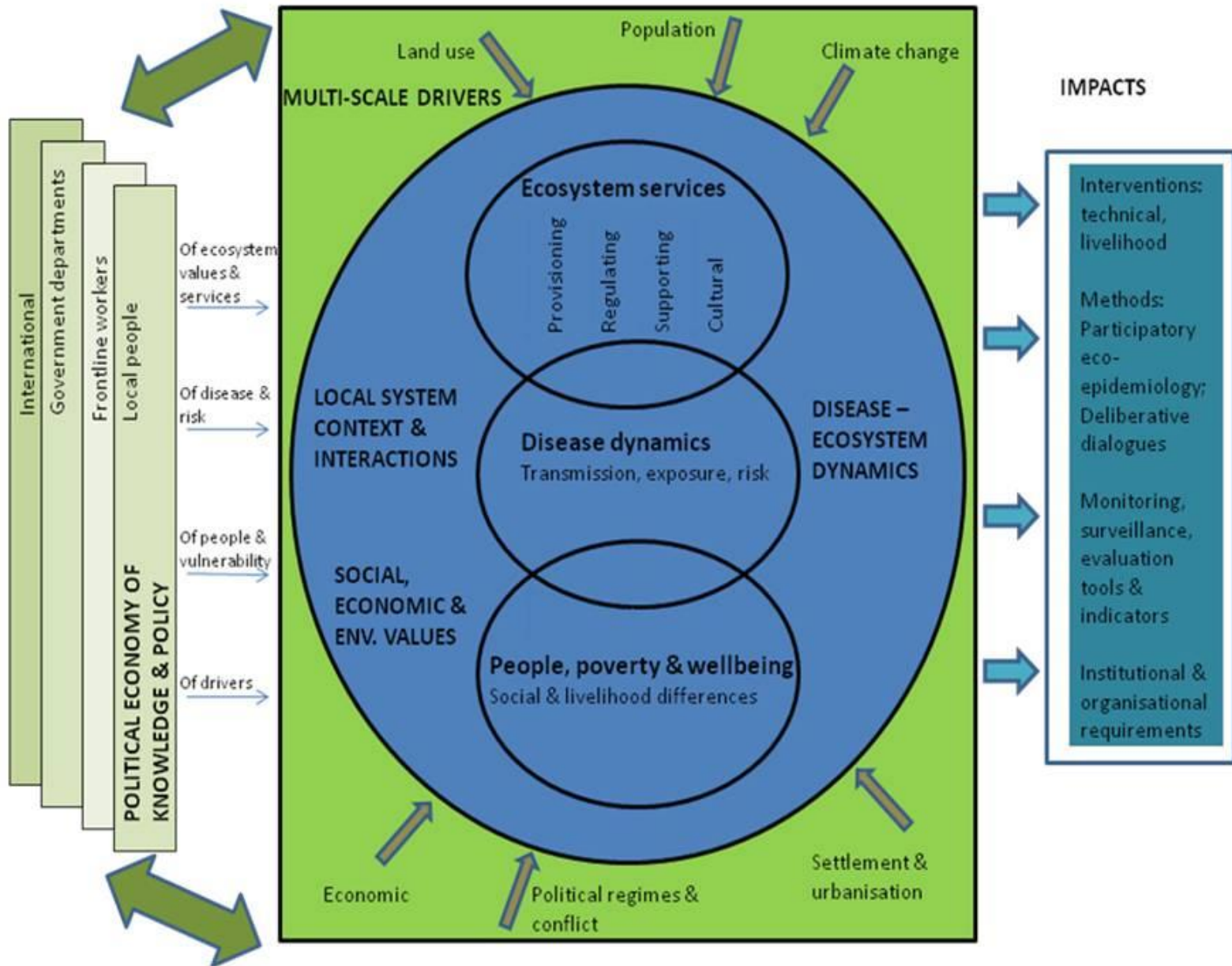


FACTS

- There are two major irrigation schemes– Bura and Hola.
- Bura Irrigation Scheme was started in 1978 to settle landless farmers. It covers an area of 2500 Ha with a tenant population of 2245 farmers settled in 10 villages
- Hola Irrigation Scheme started in 1953. It has a gazetted area of 4,800 hectares of which only 900 hectares are under cultivation.



Mapping Ecosystem Service



Ecosystem services, wellbeing and disease dynamics: a conceptual framework

Storyline

- Ecosystem changes have great implications on human health and wellbeing; these relationships are complex and might vary from system to systems.
- In general, ecological changes degrade disease regulatory services or increase the vulnerability of human and animal populations to infectious diseases.
- For instance, irrigation increases food production in a given area but standing water pools in farms and watersheds provide good breeding grounds for the development of diverse species of arthropod vectors.
- These drainages also serve as valuable watering points for both livestock and wildlife, particularly in the dry season, enabling faster transmission of infectious diseases.

InVEST

Staging

Scenarios

(A Management, Climate, Population)

Models

| Biodiversity | Provisioning | Regulating | Cultural | Supporting |
|--------------|--------------|------------|------------|-------------|
| Species | Food | Climate | Recreation | Pollination |
| Habitats | Timber | Stability | Tradition | |
| | Fresh Water | | Community | |
| | | Flood | | |
| | | Control | | |

Outputs ~ Biophysical, Economic, Cultural

Maps

**Trade-off
Curves**

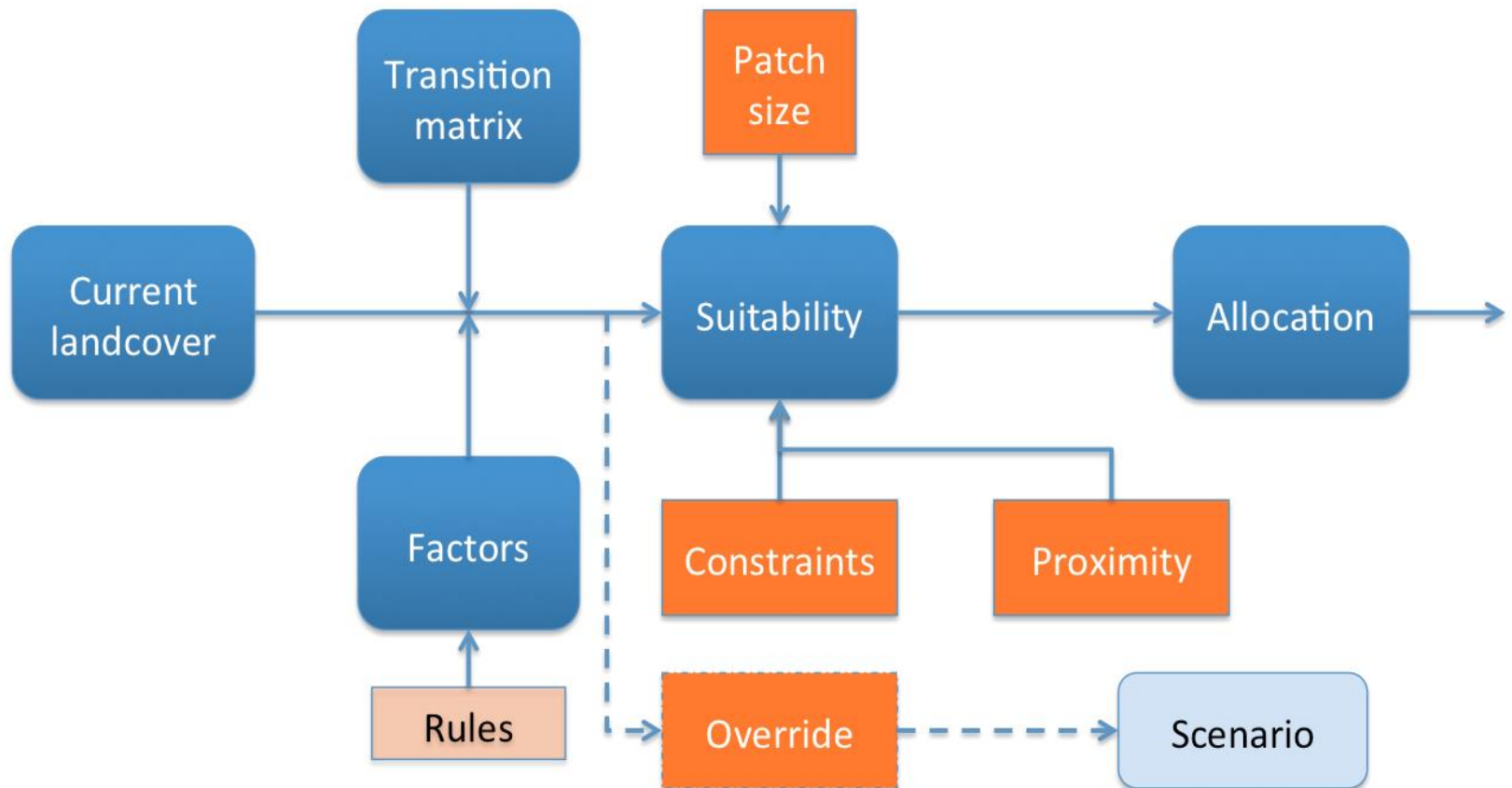
**Balance
Sheets**

Stakeholder Engagement

Example - Biodiversity

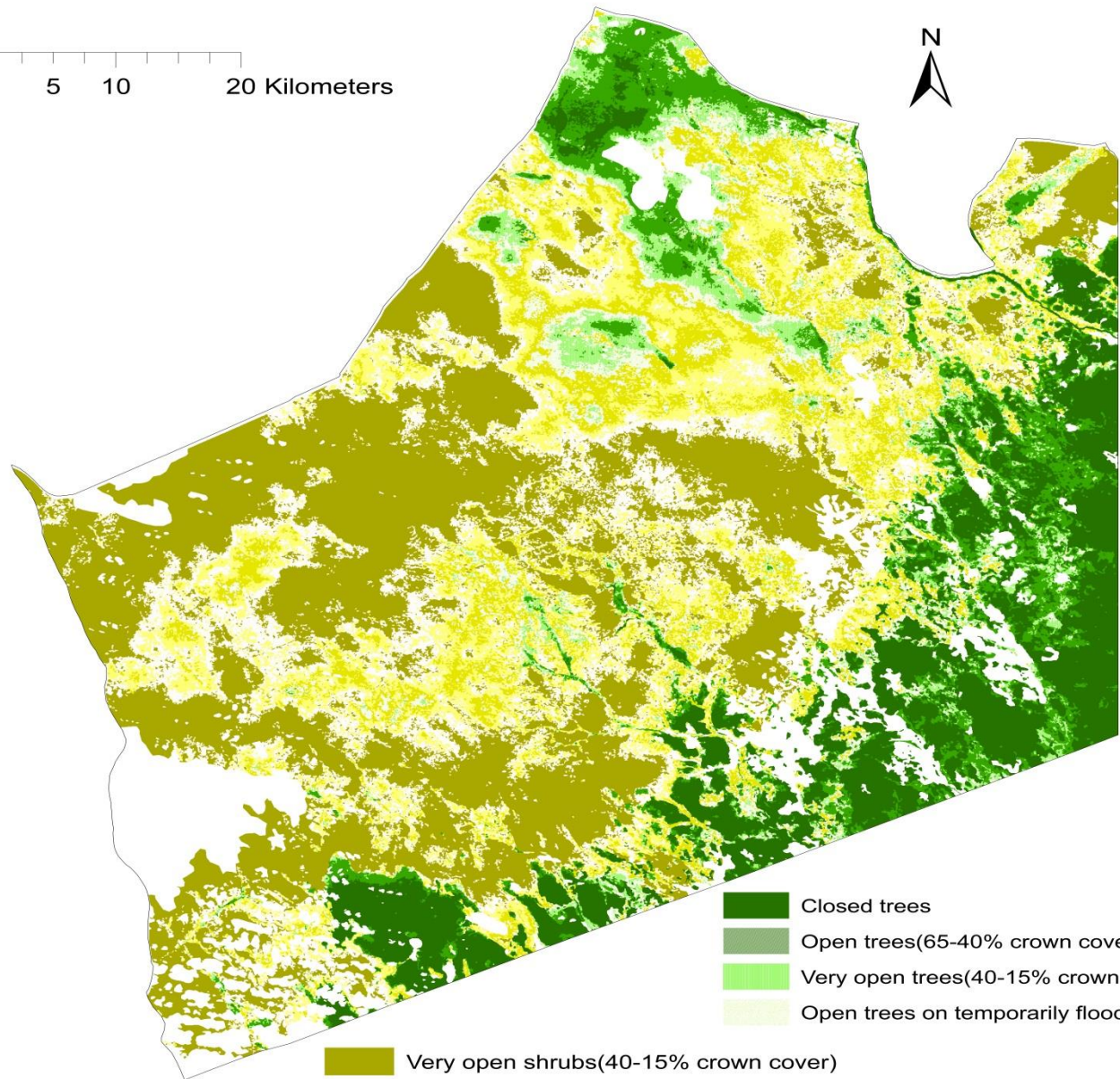
| InVEST Data and Model Inventory | | | | |
|--|---------------|--|---|---|
| | Step | Data requirements | Process | Outputs |
| Biodiversity: Habitat Quality and Rarity (Tier 0) | | | | |
| Required | Supply | Current Land use/land cover | Calculate habitat quality and degradation based on threat intensity and sensitivity | Habitat degradation index; Habitat quality index |
| | | Threat impact distance | | |
| | | Relative threat impact weights | | |
| | | Form of threat decay function | | |
| | | Threat maps | | |
| | | Habitat suitability (optional: by species group) | | |
| | | Habitat sensitivity to threats | | |
| | | Half saturation constant | | |
| | | Protected status | | |
| Optional | Supply | Baseline land use/land cover | Calculates rarity of current and/or future habitat types relative to baseline; calculates quality and degradation of baseline based on threat intensity and sensitivity | Relative habitat rarity index for current and/or future land use/land cover; Degradation and quality for baseline |
| | | Future land use/land cover | Calculates quality and degradation of future scenario based on threat intensity and sensitivity; optionally calculates habitat rarity relative to baseline | Habitat degradation, quality and optionally rarity for future scenario |





InVEST information flow and integration of the model







Land cover changes
and
Transition matrix

0 5 10 20 Kilometers

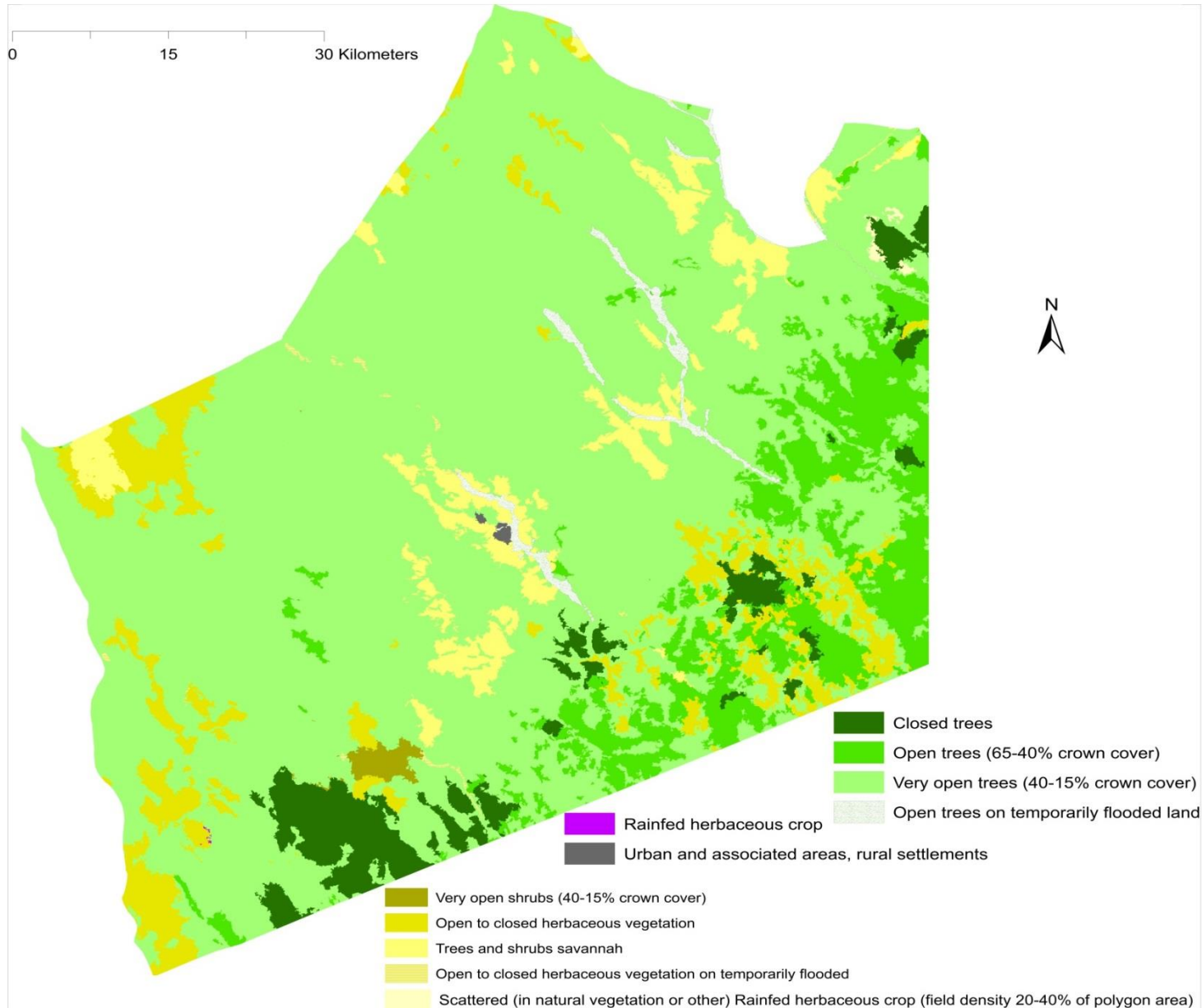


-  Closed trees
-  Open trees(65-40% crown cover)
-  Very open trees(40-15% crown cover)
-  Open trees on temporarily flooded land

-  Very open shrubs(40-15% crown cover)
-  Open to closed herbaceous vegetaion
-  Open to close herbaceous vegetation on temporarily flooded land
-  Trees and shrub savanah

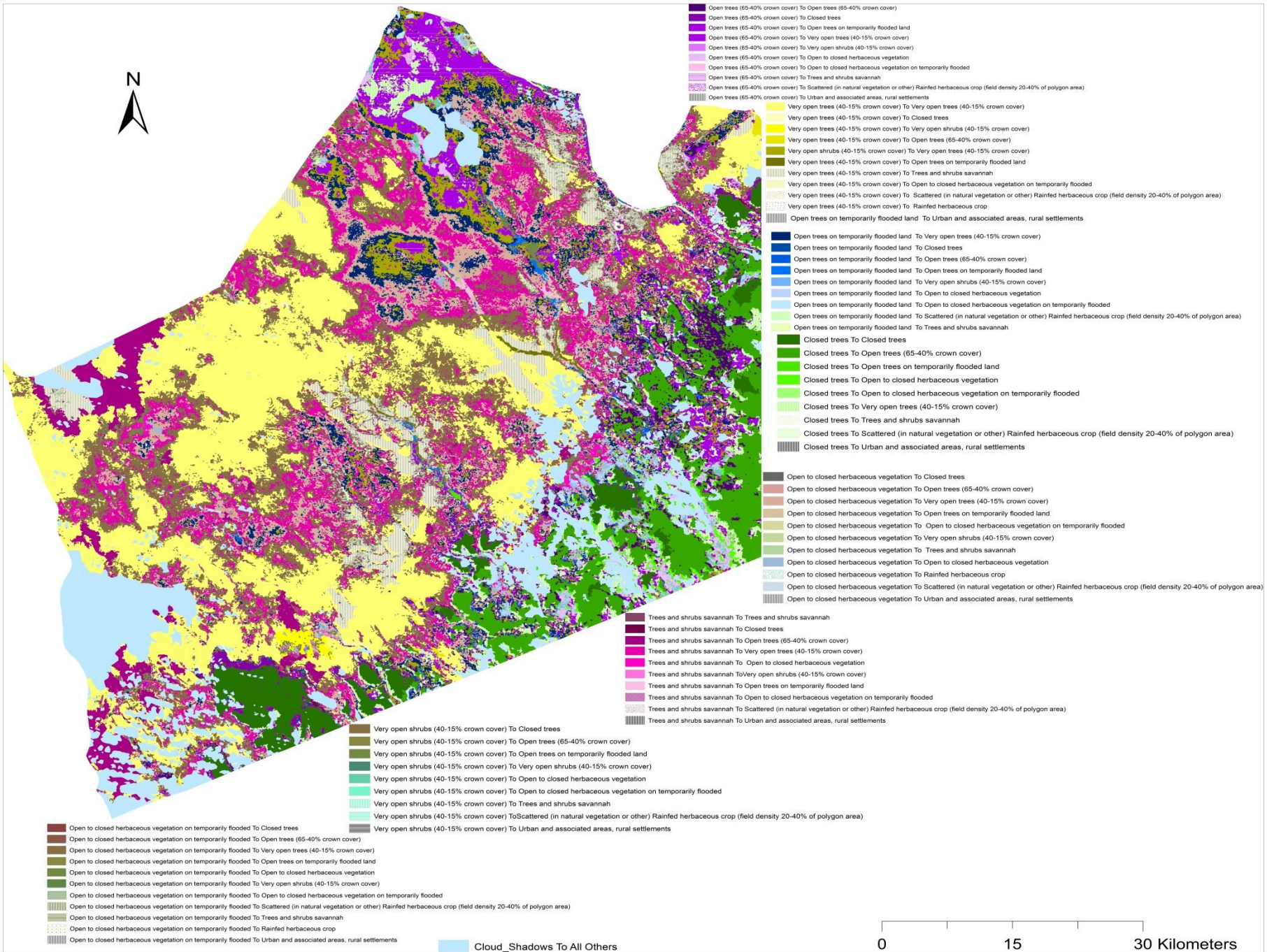
Land Cover Map for Ijara

1985



Land Cover Map for Ijara

2008



0 15 30 Kilometers

Summary Statistics

| Land cover | 1985 (sq km) | 2008 (sq km) | % change |
|---|-----------------|-----------------|----------|
| Very open shrubs(40-15% crown cover) | 1576 | 4097 | 160 |
| Open to close herbaceous vegetation on temporarily flooded land | 733 | 7 | -99 |
| Trees and shrub savanah | 662 | 288 | -56 |
| Open to closed herbaceous vegetaion | 457 | 394 | -14 |
| Open trees on temporarily flooded land | 296 | 63 | -79 |
| Very open trees(40-15% crown cover) | 221 | 23 | -90 |
| Open trees(65-40% crown cover | 420 | 539 | 28 |
| Closed trees | 694 | 244 | -65 |
| Scattered (in natural vegetation or other) Rainfed herbaceous crop (field density 20-40% of polygon area) | 0 | 6 | |
| Urban and associated areas, rural settlements | 0 | 4 | |

Transition Matrix- Ijara

| | Closed trees | Open trees (65-40% crown cover) | Very open trees (40-15% crown cover) | Open trees on temporarily flooded land | Trees and shrubs savannah | Very open shrubs (40-15% crown cover) | Open to closed herbaceous vegetation on temporarily flooded | Open to closed herbaceous vegetation | Closed trees To Urban and associated areas, rural settlements change | Priority | Proximate |
|---|--------------|---------------------------------|--------------------------------------|--|---------------------------|---------------------------------------|---|--------------------------------------|--|----------|-----------|
| Closed trees | 0 | 23 | 0 | 17 | 12 | 0 | 2 | 22 | 0 | | |
| Open trees (65-40% crown cover) | 11 | 0 | 15 | 11 | 11 | 8 | 8 | 13 | 9 | | |
| Very open trees (40-15% crown cover) | 35 | 9 | 0 | 11 | 18 | 17 | 5 | 0 | 0 | | |
| Open trees on temporarily flooded land | 0 | 16 | 10 | 0 | 15 | 11 | 13 | 11 | 9 | | |
| Trees and shrubs savannah | 13 | 0 | 16 | 13 | 0 | 9 | 12 | 13 | 11 | | |
| Very open shrubs (40-15% crown cover) | 3 | 22 | 22 | 13 | 8 | 0 | 4 | 21 | 4 | | |
| Open to closed herbaceous vegetation on temporarily flooded | 12 | 5 | 7 | 18 | 19 | 5 | 0 | 0 | 3 | | |
| Open to closed herbaceous vegetation | 10 | 11 | 17 | 10 | 11 | 9 | 8 | 15 | 0 | | |

Relationship between land cover and RVF risk

| Land cover | RVF | | Total | % positive | OR | P |
|--|------------|------------|--------------|------------|------|---------|
| | Negative | Positive | | | | |
| Artificial areas | 0 | 1 | 1 | | 1.00 | omitted |
| Bare areas | 95 | 3 | 98 | 3.1% | 0.11 | 0.00 |
| Closed broadleaved deciduous forest | 13 | 7 | 20 | 35.0% | 2.16 | 0.11 |
| Closed to open broadleaved evergreen or semi-deciduous forest | 18 | 9 | 27 | 33.3% | 2.01 | 0.09 |
| Closed to open broadleaved forest regularly flooded (fresh-brackish water) | 10 | 7 | 17 | 41.2% | 2.82 | 0.04 |
| Closed to open grassland | 2 | 0 | 2 | 0.0% | 0.00 | omitted |
| Closed to open shrubland | 27 | 16 | 43 | 37.2% | 2.44 | 0.01 |
| Mosaic Croplands/Vegetation | 76 | 22 | 98 | 22.4% | 1.16 | 0.57 |
| Mosaic Forest-Shrubland/Grassland | 170 | 43 | 213 | 20.2% | 1.00 | 0.99 |
| Mosaic Grassland/Forest-Shrubland | 6 | 2 | 8 | 25.0% | 1.32 | 0.73 |
| Mosaic Vegetation/Croplands | 134 | 39 | 173 | 22.5% | 1.18 | 0.41 |
| Open needle leaved deciduous or evergr.. | 1 | 0 | 1 | 0.0% | 0.00 | omitted |
| Rainfed croplands | 23 | 2 | 25 | 8.0% | 0.34 | 0.14 |
| Sparse vegetation | 69 | 12 | 81 | 14.8% | 0.67 | 0.21 |
| Water bodies | 20 | 1 | 21 | 4.8% | 0.19 | 0.11 |
| Total | 872 | 221 | 1,093 | | | |

RVF was less likely to occur in areas with sparse vegetation, water bodies, rainfed crop lands, and in bare areas (significant at alpha 0.05)

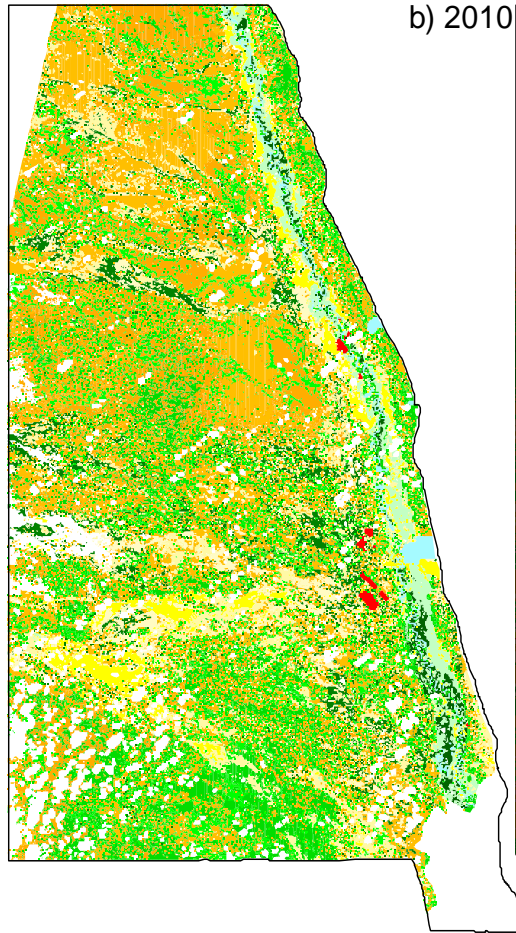
Tana River – land cover changes



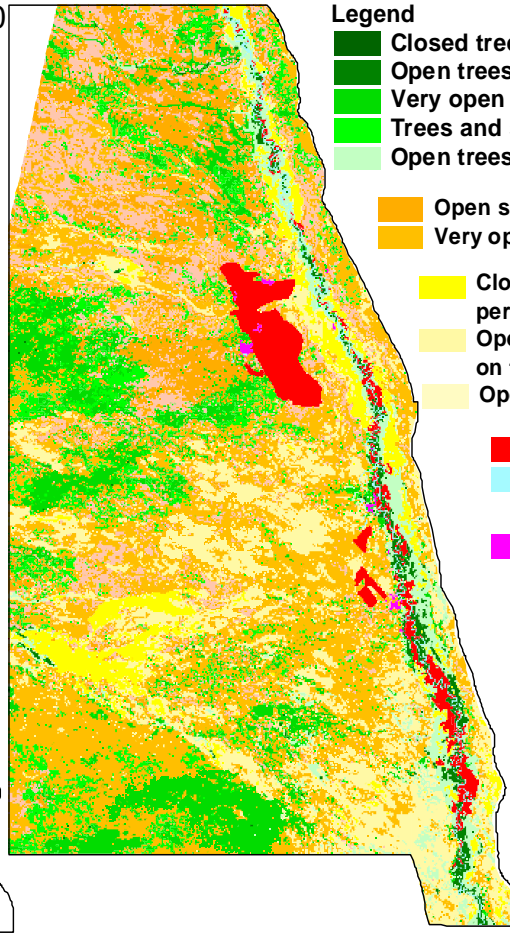
Dynamic Drivers of Disease in Africa

Land cover changes

a) 1975

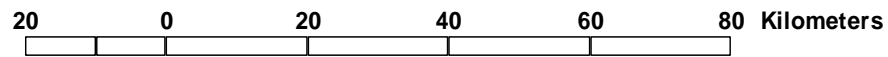


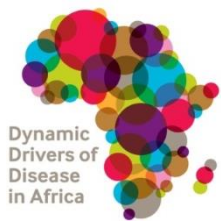
b) 2010



Legend

- Closed trees
- Open trees (65-40% crown cover)
- Very open trees (40-15% crown cover)
- Trees and shrubs savannah
- Open trees on temporarily flooded land
- Open shrubs (65-40% crown cover)
- Very open shrubs (40-15% crown cover)
- Closed herbaceous vegetation on permanently flooded land
- Open to closed herbaceous vegetation on temporarily flooded
- Open to closed herbaceous vegetation
- Irrigated land / Cropland
- Tana River-Waterbodies
- Clouds
- Urban and Rural Settements





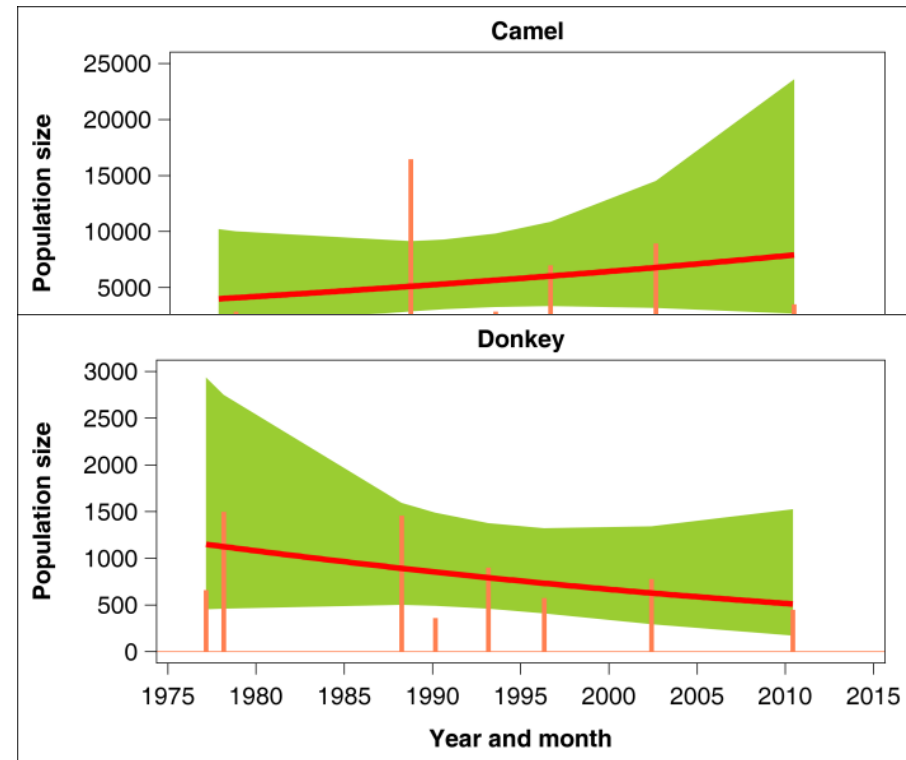
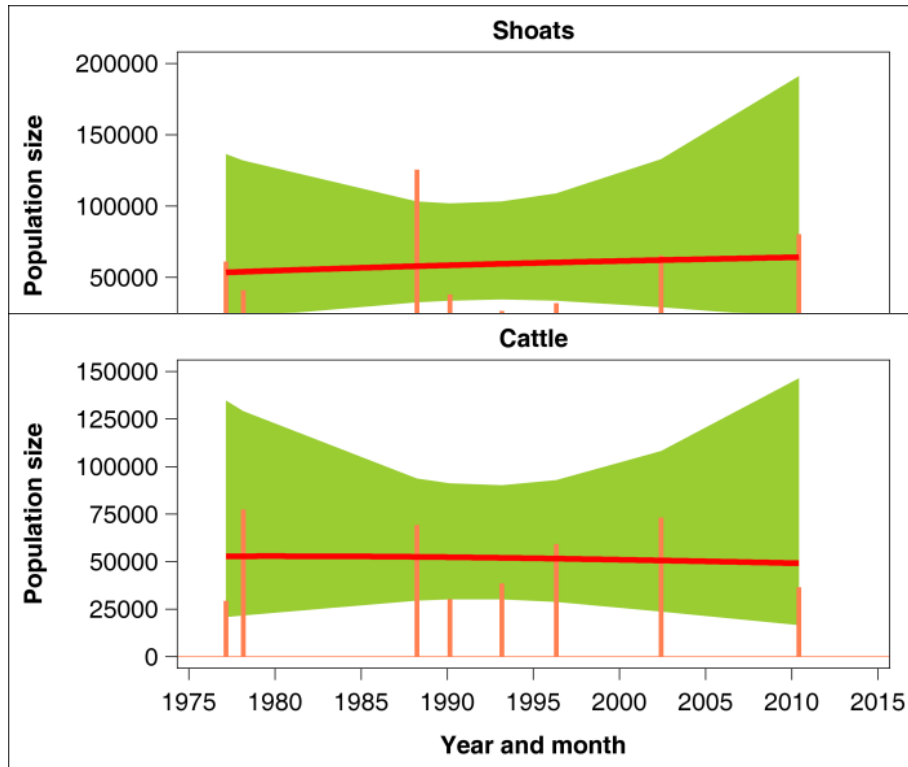
Land cover changes statistics

| Land cover | 1975 | | 2010 | | Area Change (%) |
|---|-------------------------|----------|-------------------------|----------|-----------------|
| | Area (km ²) | Area (%) | Area (km ²) | Area (%) | |
| Closed trees | 62 | 1 | 0 | 0 | -100 |
| Open trees (65-40% crown cover) | 370 | 7 | 68 | 1 | -81 |
| Very open trees (40-15% crown cover) | 741 | 13 | 636 | 11 | -14 |
| Trees and shrubs savannah | 744 | 13 | 439 | 8 | -41 |
| Open trees on temporarily flooded land | 169 | 3 | 199 | 4 | 18 |
| Open shrubs (65-40% crown cover) | 836 | 15 | 699 | 12 | -16 |
| Very open shrubs (40-15% crown cover) | 1516 | 27 | 1604 | 29 | 6 |
| Sparse Shrubs | 0 | 0 | 642 | 11 | 11 |
| Open to closed herbaceous vegetation | 244 | 4 | 0 | 0 | -100 |
| Closed herbaceous vegetation on permanently flooded land | 181 | 3 | 244 | 4 | 35 |
| Open to closed herbaceous vegetation on temporarily flooded | 675 | 12 | 811 | 14 | 20 |
| Cropland//irrigated | 14 | 0 | 209 | 4 | 1359 |
| Tana river-water bodies | 50 | 1 | 42 | 1 | -18 |
| Urban and associated areas, rural settlements | 0 | 0 | 9 | 1 | 1 |

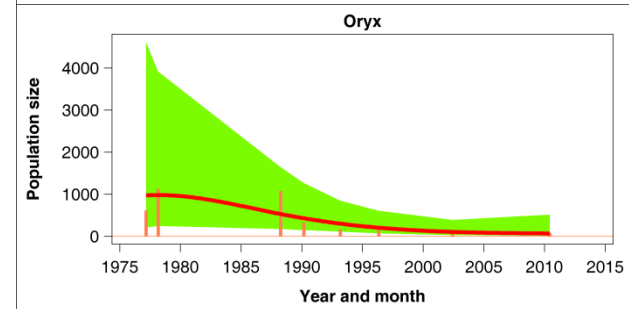
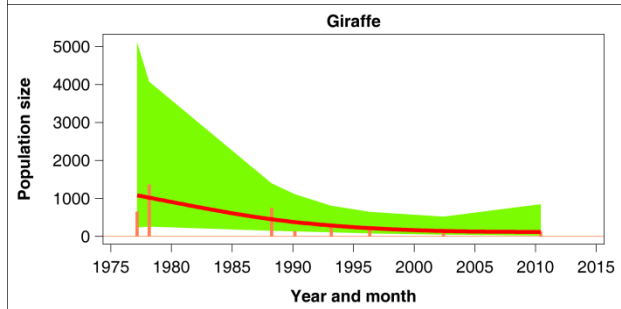
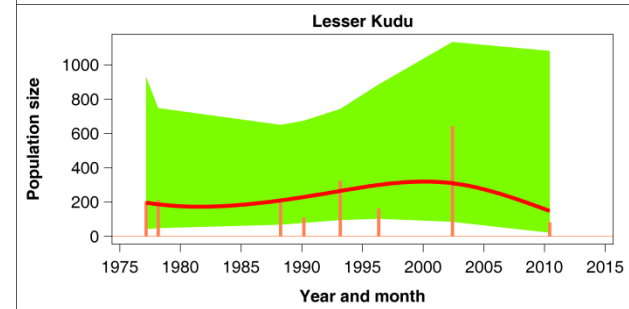
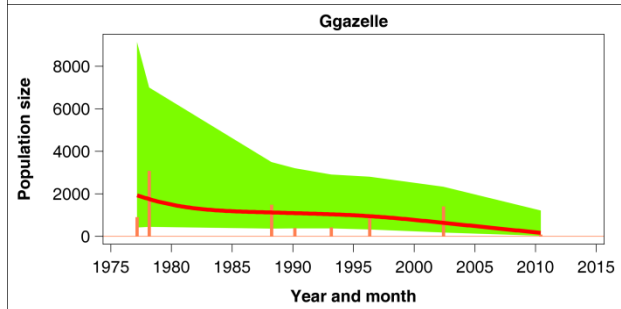
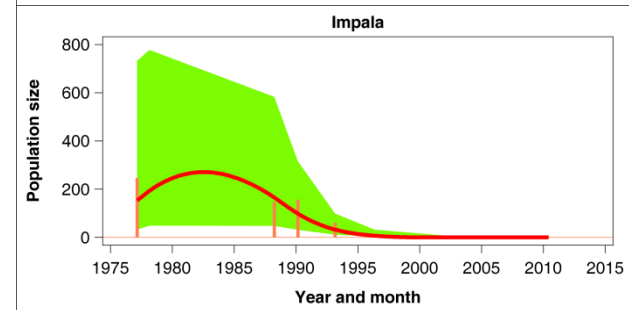
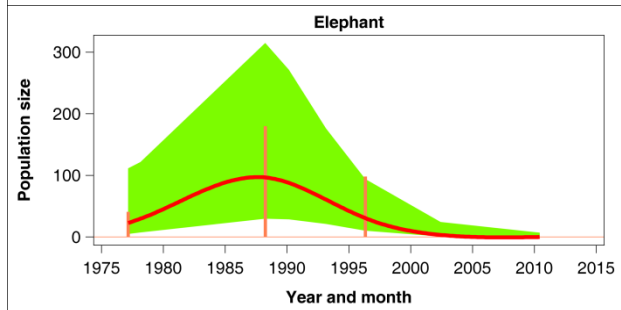
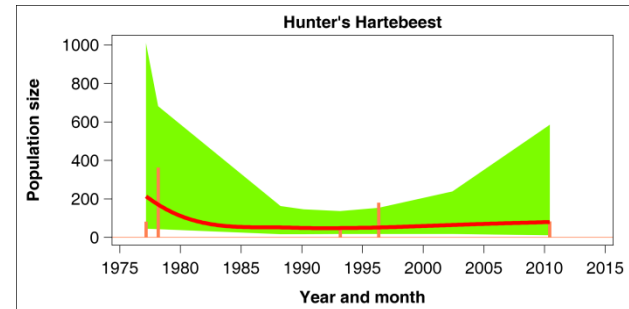
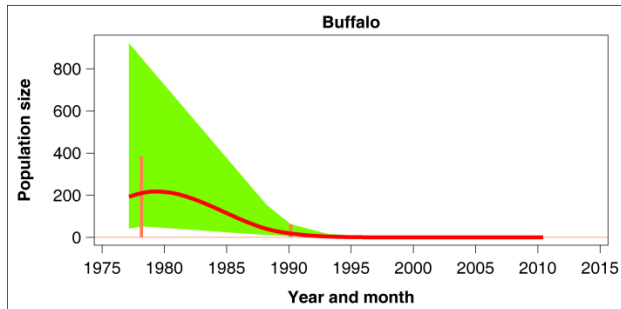
Source: Said, Kifugo et al. (in prep)

Livestock and wildlife trends 1977 - 2011

Livestock trends



Wildlife trends

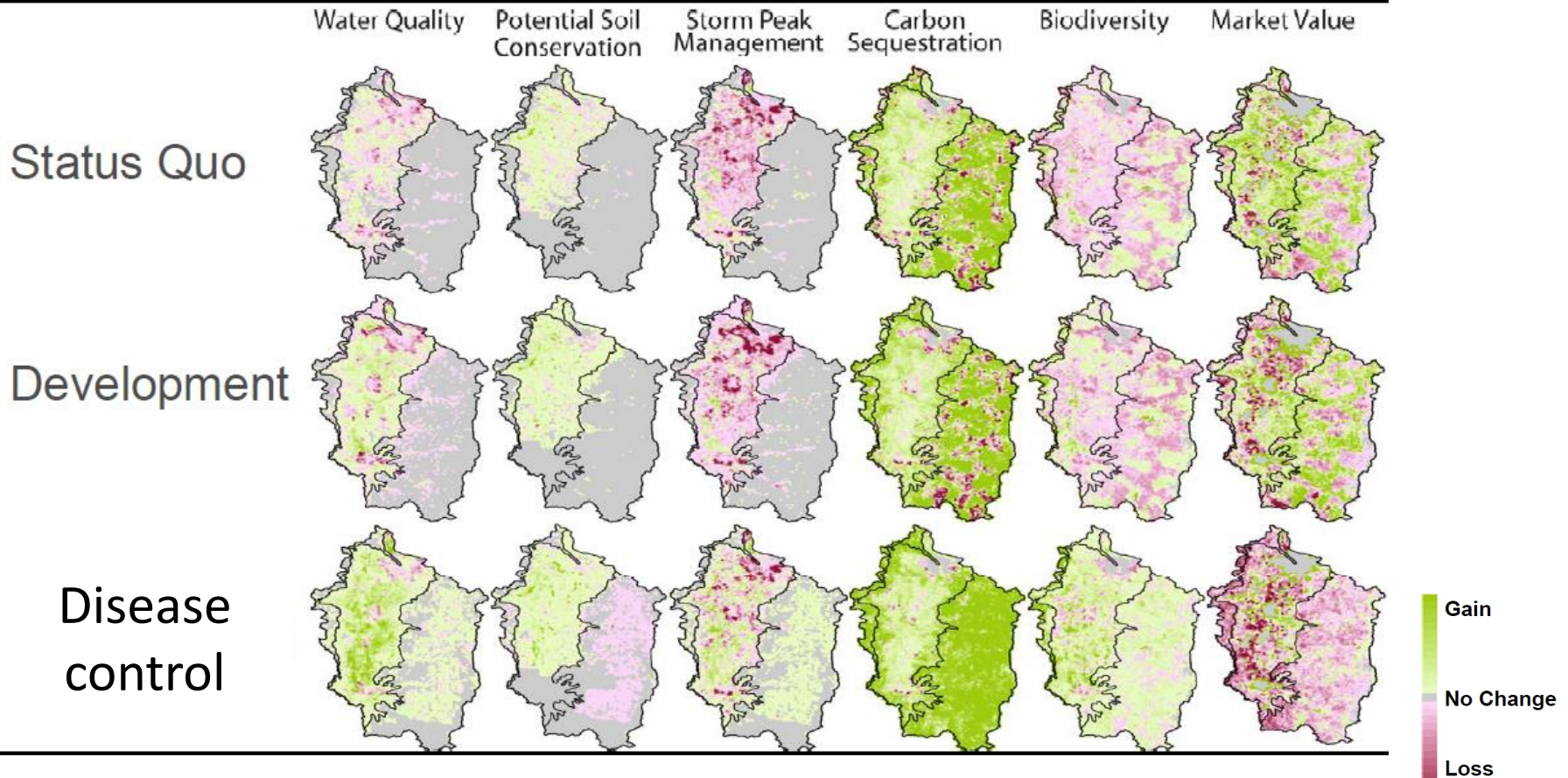


Trade-off Analysis - next steps

Ecosystem services and diseases

Ecosystem Services and
biodiversity

And multiple scenarios can be lined up to find the best options for the future



Source: 2008 Natural Capital Project

Thank you