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TOWARDS REGENERATIVE LANDSCAPE DESIGN: GUIDING LAND USE PLANNING BY INTEGRATING LANDSCAPE PATTERNS AND PROCESSES

Outline

Regenerative Landscape Design

A new concept to bridge farm to global approaches for farmer resilience



Landscape Scale Vignettes (Narok, Kenya)

Water pans

Diet

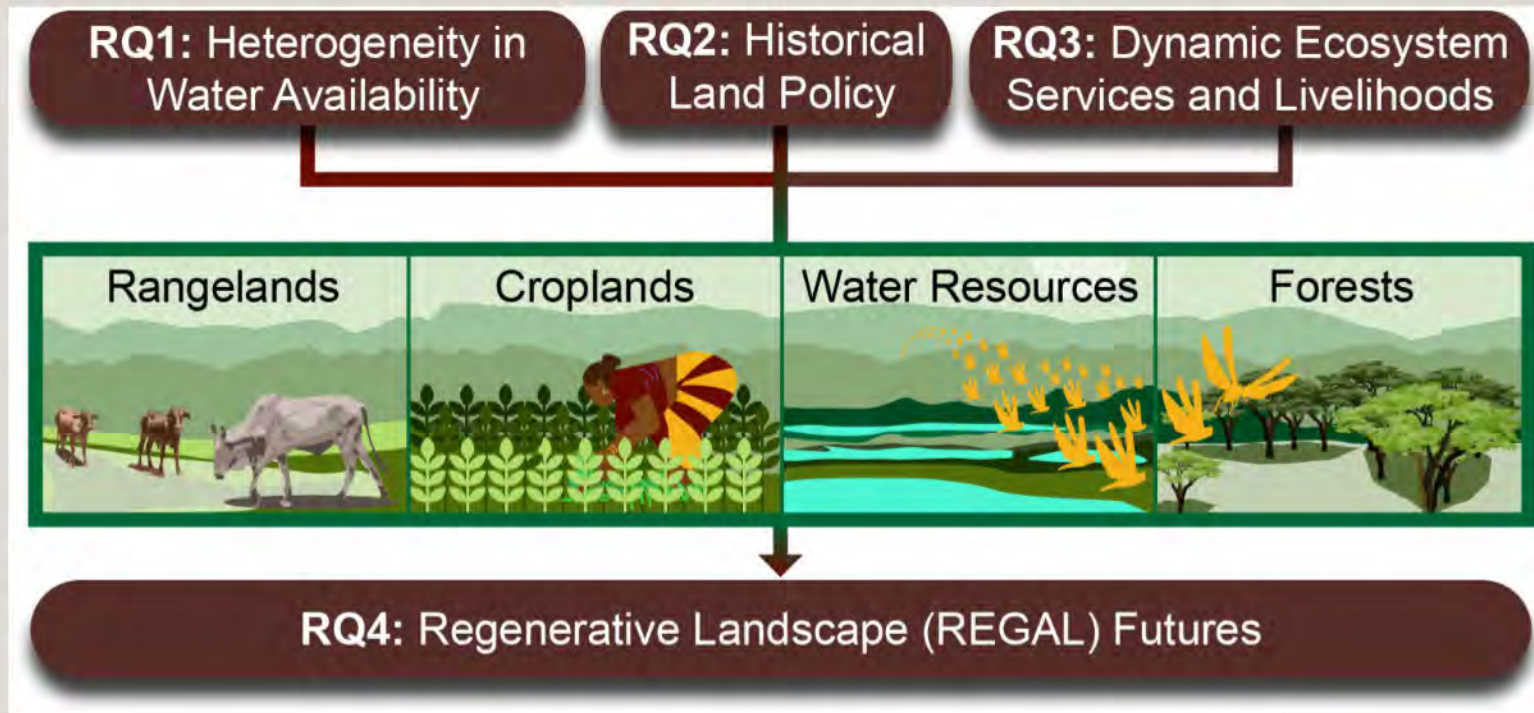
Productivity



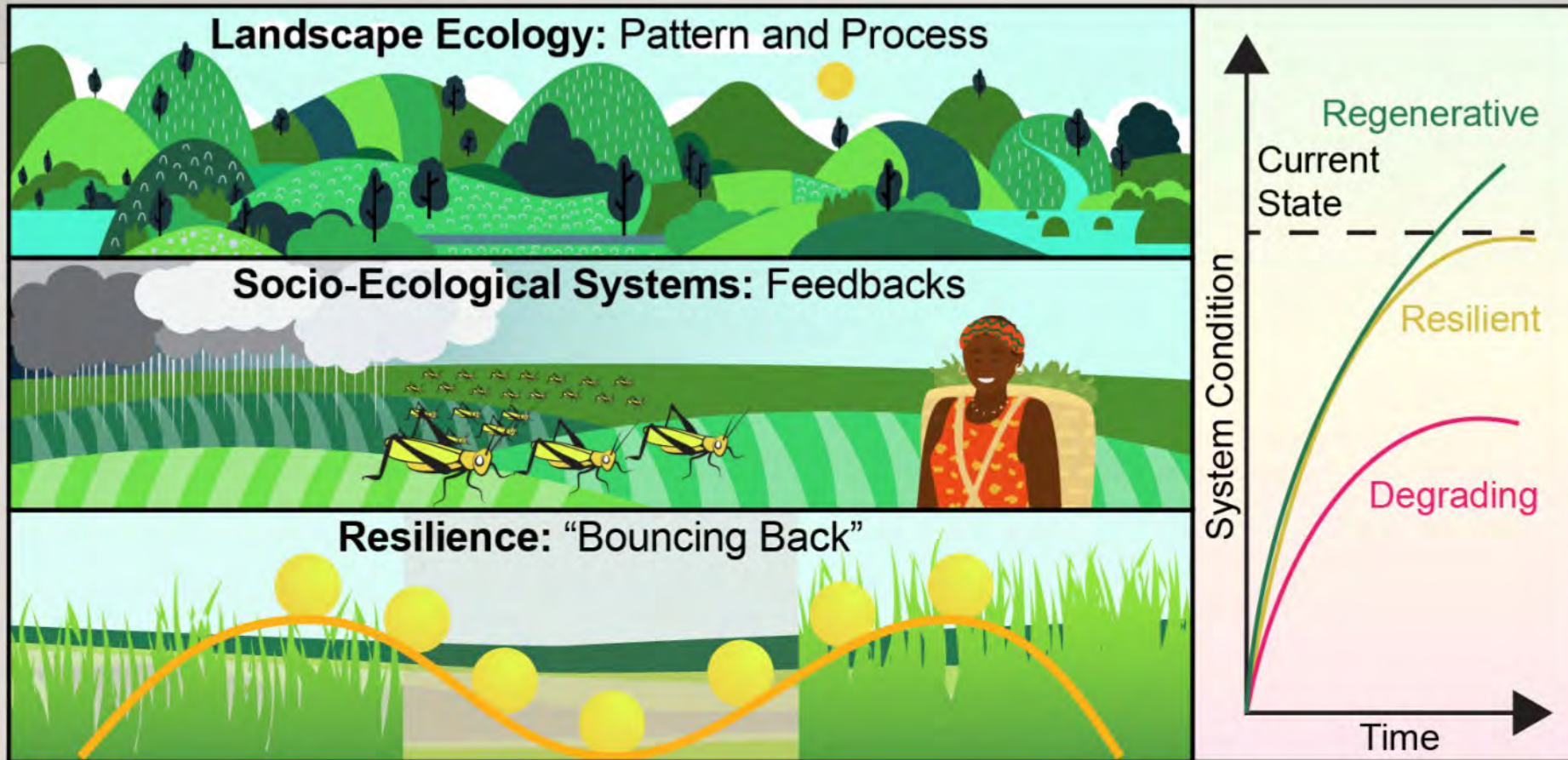
The future: Decision-support tools for designing regenerative landscapes in semi-arid landscapes

REGAL: REGENERATIVE LANDSCAPE FUTURES

NSF #2149244 BCS: Human-Environment and Geographical Sciences : Towards regenerative landscape futures: the role of policy legacies, environmental stress, and landscape change, 06/01/2022-5/29/2025



REGENERATIVE LANDSCAPE DESIGN



The goal is to purposely design landscape structures that promote **THRIVING** agro-pastoral landscapes

Landscape as a Bridging Concept

The Landscape Approach emphasizes:

Composition – What's there

Configuration – How it's arranged

Connectivity – How things move

➔ Explores the interactions between pattern and process

Can guide questions such as:

- How does landscape structure intensify or diminish landscape regenerative capacity and ecosystem services of multi-functional landscapes?
- What are the main drivers of these landscape designs?
- How can we better design regenerative systems?

Example: Narok agro-pastoral landscape, Kenya

- **Livelihoods:** Representative of agro-pastoralists landscapes globally
- **Limited Agricultural land:** 20% arable in Kenya (*Syagga, 2006*)
- **Climate change:** Agriculture and food security
 - 12-40 % maize yield reduction by 2050 (*Rippke et al., 2016, Ramirez-Villegas et al., 2015*)
 - Disease vectors, pests and diseases
- **Restrictive land use policies & adaptive land management** (*Williams and Blois, 2018*)


Requires deeper understanding of local landscape processes and spatial dynamics



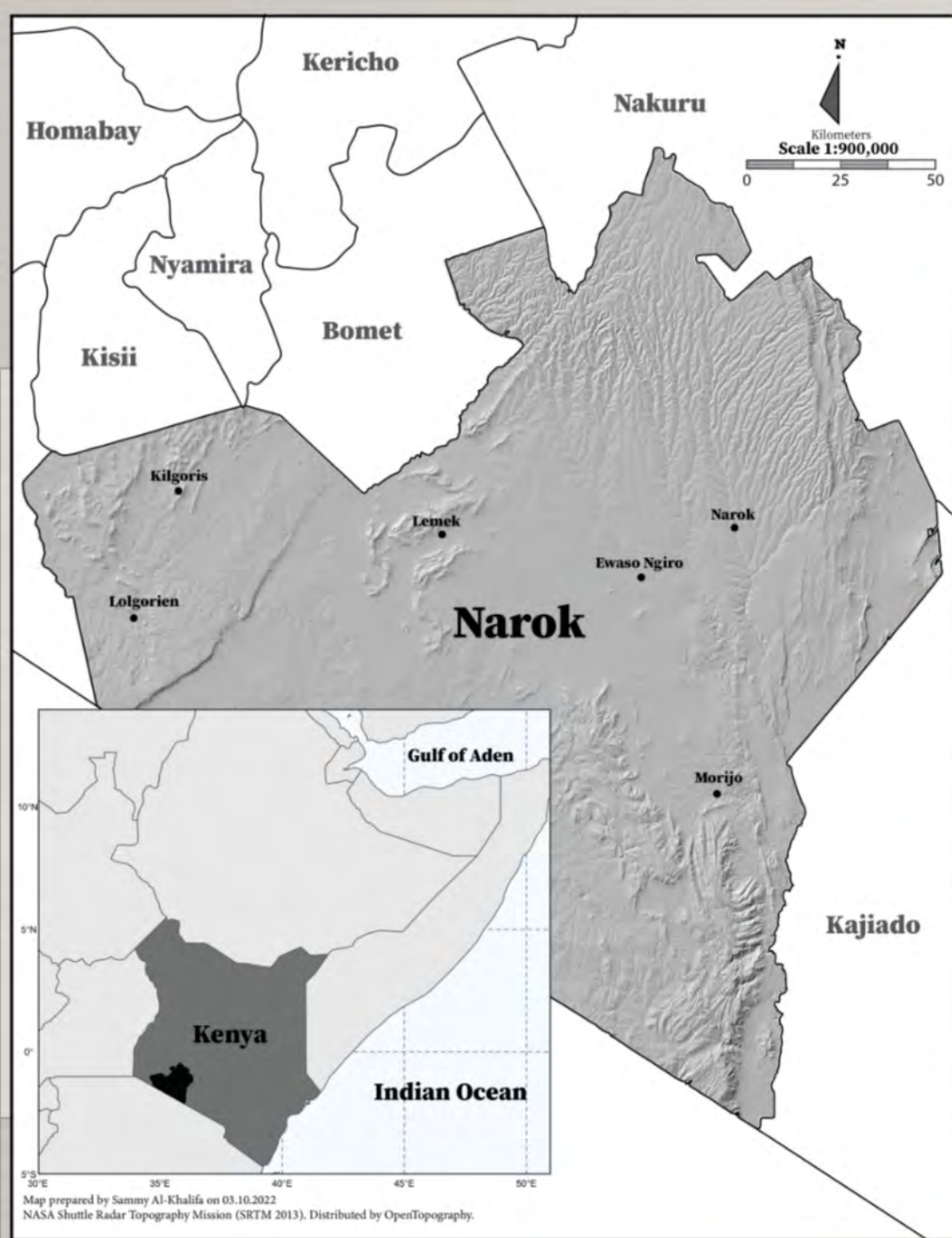


LANDSCAPE VIGNETTES

WATER PANS



Narok: Assessing the Vulnerability of Water-Pans Using High Spatial Resolution Remote Sensing



Photos taken by the Maasai Mara University



Tracking Changes in Water Availability Across the Landscape



Satellite imagery

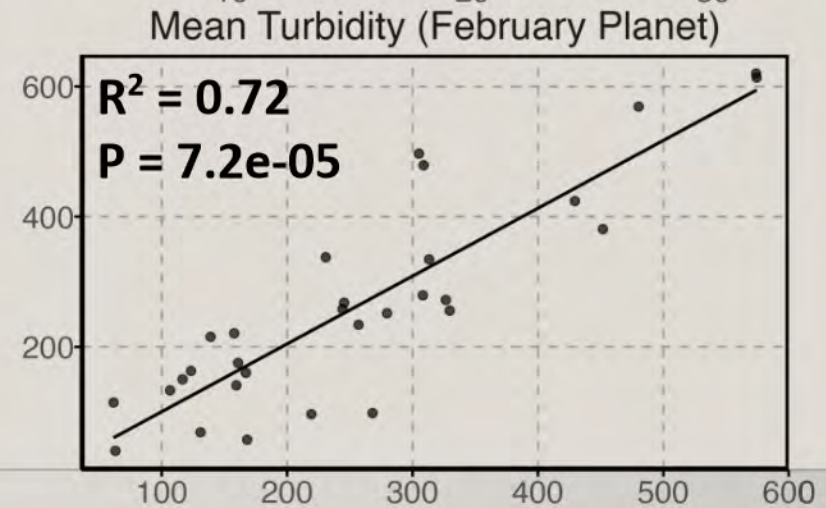
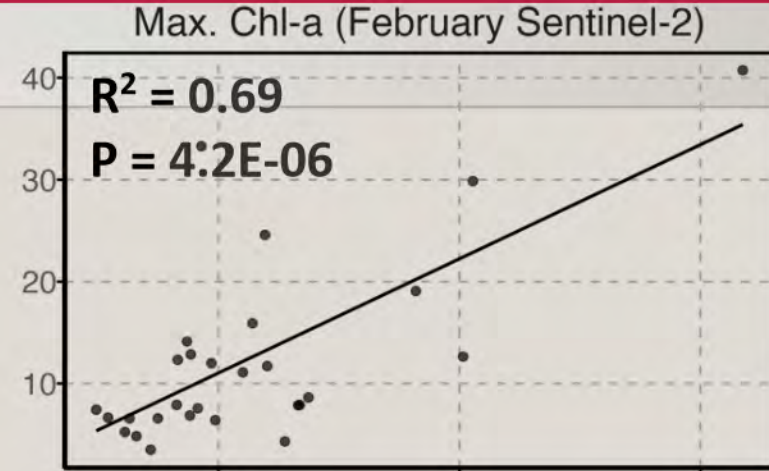
Satellite Imagery of Water Resources in Narok



Field Measurements
(n = 30 water-pans)

MMU collaborators: Dr Romulus Abila (right), Dr Samson Mabwoga (left) and Simo Raphael (not pictured)

In Situ Chl-a (RFU) and Turbidity (NTU) Samples



Model-Derived Water Quality Estimates

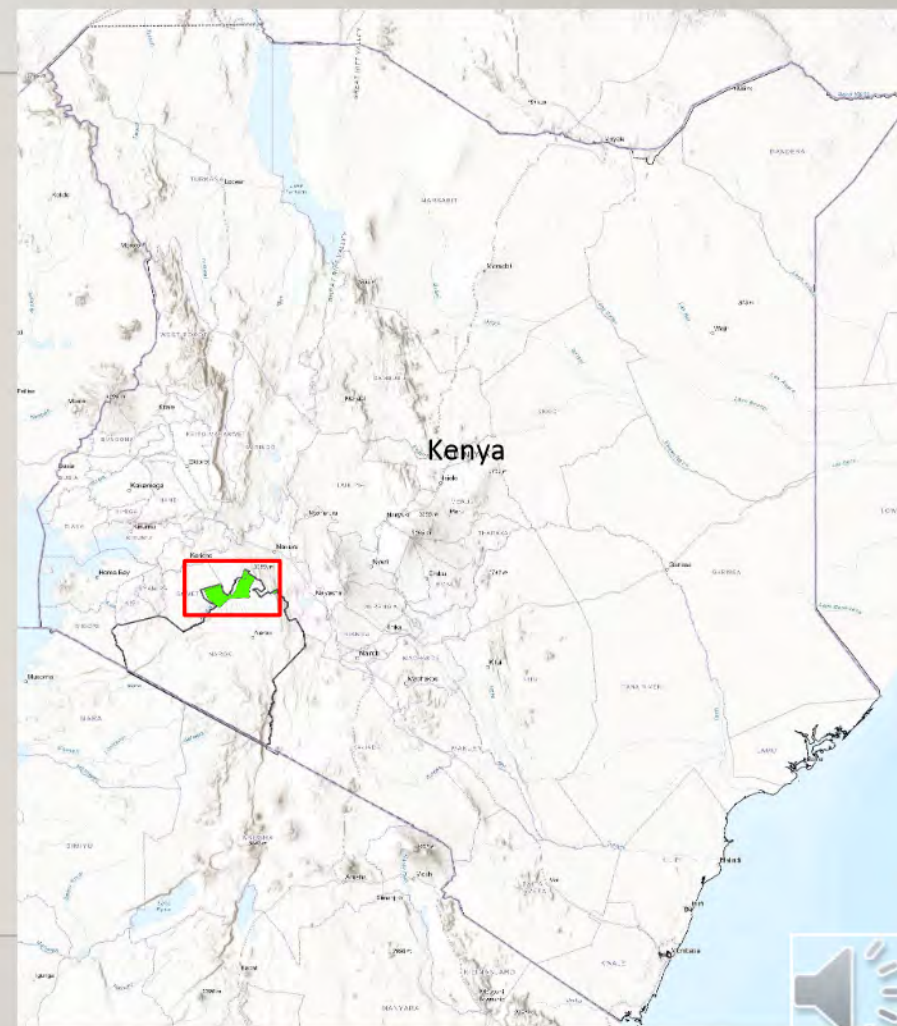


LANDSCAPE VIGNETTES

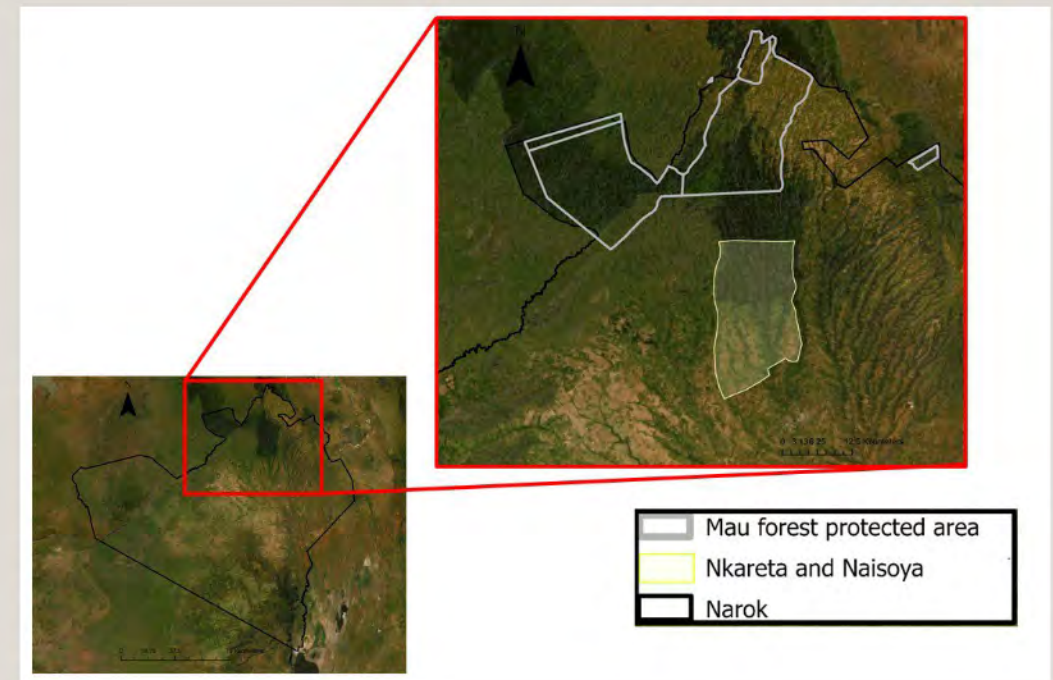
DIET AND LANDSCAPE STRUCTURE

FORESTS SUPPORT LOCAL FOOD SECURITY AND NUTRITION

How does forest fragmentation impact the collection of forest foods?



TRACKING FOREST FRUIT COLLECTION



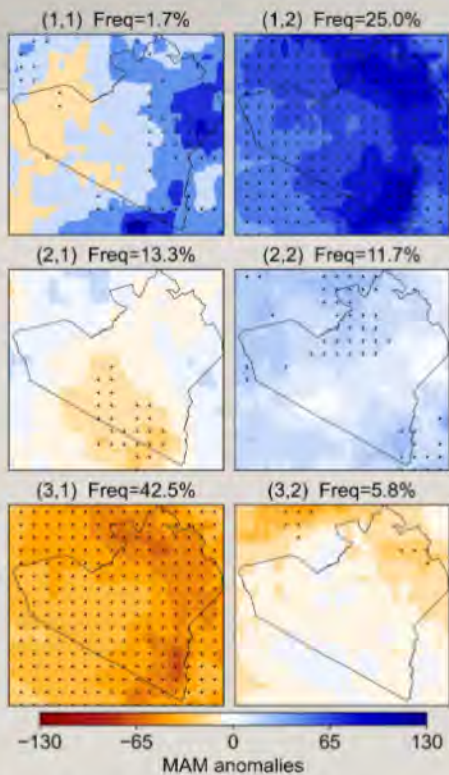
LANDSCAPE VIGNETTES

PRODUCTIVITY PATTERNS & HOUSEHOLD RESPONSE

THE FUTURE: DECISION-SUPPORT TOOLS FOR DESIGNING REGENERATIVE LANDSCAPES IN SEMI-ARID LANDSCAPES

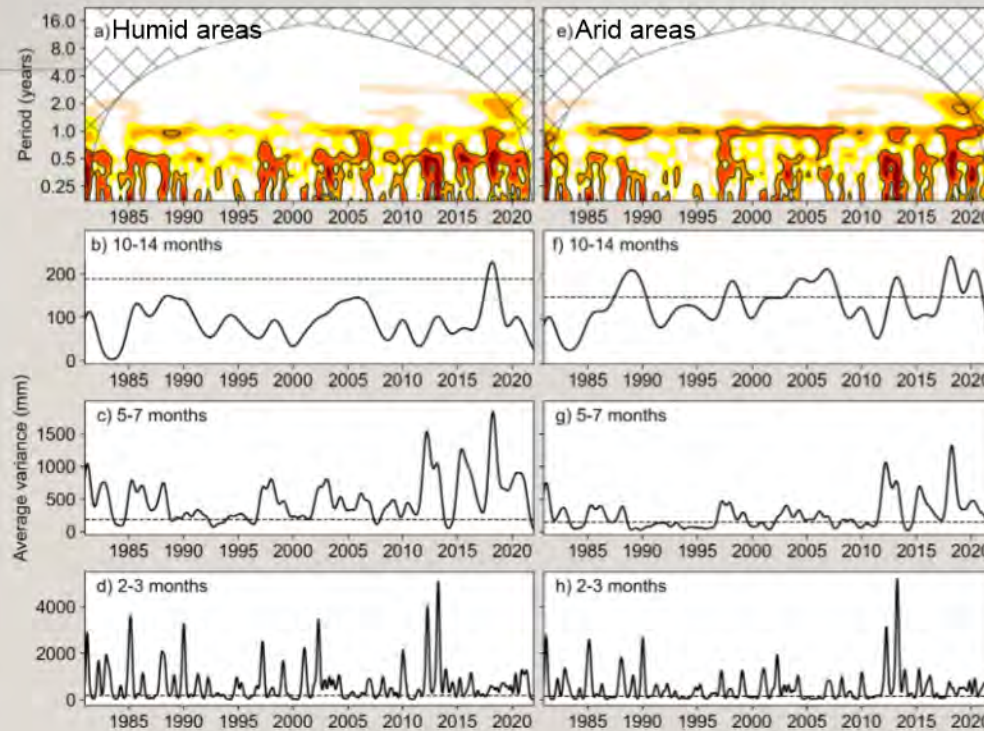
DYNA-CLUE MODELING APPROACH

Localized rainfall assessments highlight farmer and herder vulnerability to climate change



Self Organized Maps:

Showing spatial patterns of rainfall anomalies.



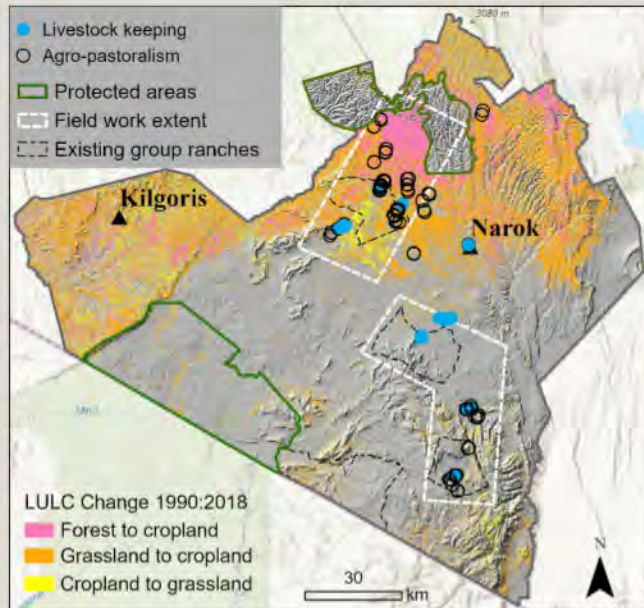
Wavelet power spectrum:

Showing variability at multiple time scales

- There are localized, spatial patterns in rainfall anomalies, relevant to the scale of agropastoral livelihoods
- Patterns are driven by multi-scalar climate processes
- Variability at intra-seasonal, inter-seasonal and inter-annual time scales.

Changing productivity and impacts on livelihood strategies

119 Household surveys.



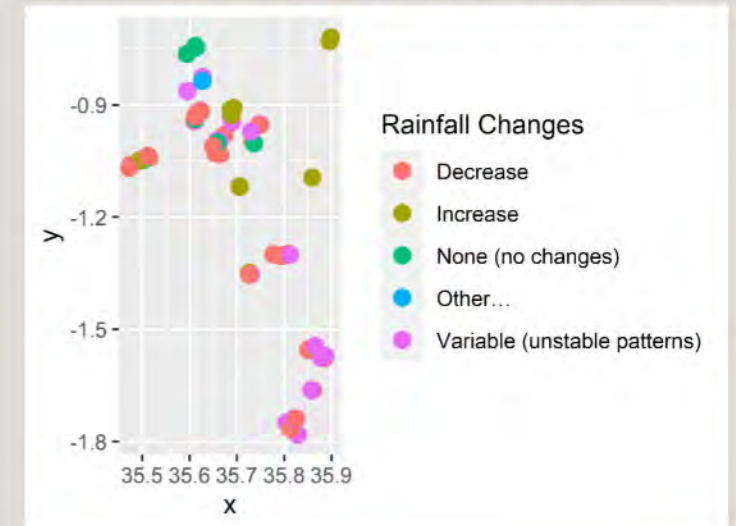
Environmental challenges

- Changing rainfall patterns
- Drought
- Increased crop pests

Impacts

- Pasture degradation
- Yield reduction
- Water resources

Variations in perceived changes



Dynamic Conversion of Land Use and its Effects modelling framework: Dyna-CLUE

How suitable is that land use type for that environment?

How likely is it to convert to another land use type?

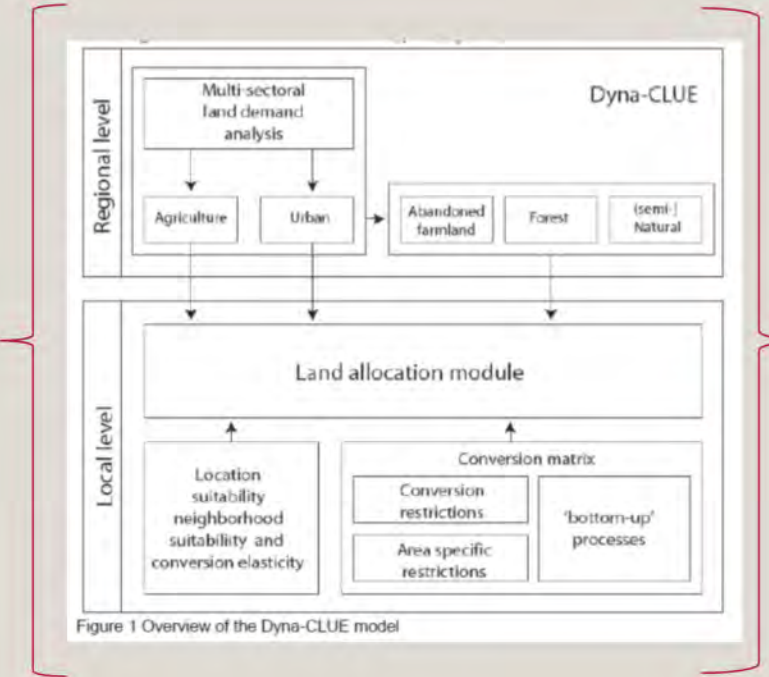


Figure 1 Overview of the Dyna-CLUE model

- Neighborhood Suitability Spatial adjacencies
- Land Cover
- Forest
- Agriculture
- Conservation
- Pasture

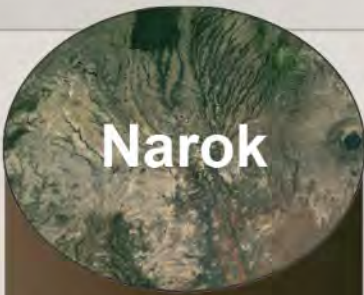
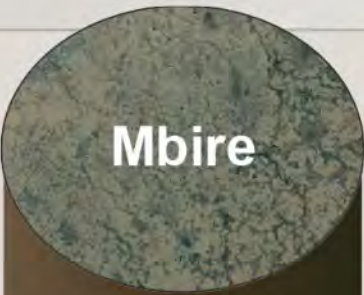



Conversion Elasticity
Commodification, tourism, distance to market & roads

Suitability & Competitive Advantage
Agro-ecological zone, soil, elevation, climate



Modeling Case Studies: Narok + Mbire + Arsi Negele

 Narok	 Mbire	 Arsi Negele
Deforestation	Deforestation	Localized reforestation
Maize, Wheat ↑	Cotton ↓	Wheat ↑
Conservancies ↑	CAMPFIRE ↓	NA
Group Ranch ↓	Non-regulated ↑	Communal

Need Top-Down and Bottom-Up Drivers of Land use change in each region?

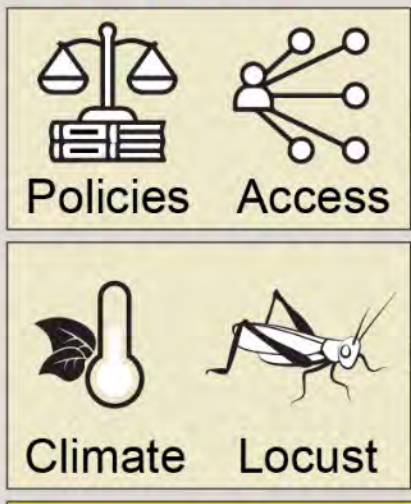
How do they differ across these landscapes?



Quantify Ecosystem Services

- Quantify LULC patterns and Ecosystem Services across model runs

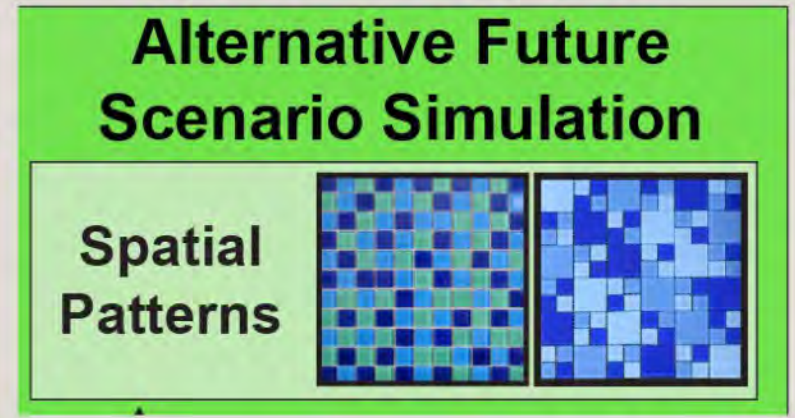
Drivers



Policies Access

Climate Locust

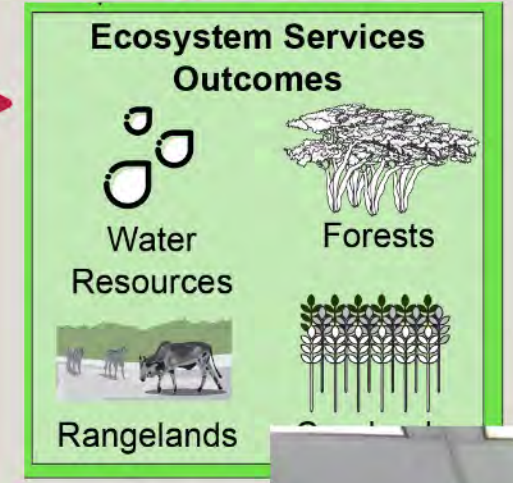
Spatial Land Use Outcomes



Alternative Future Scenario Simulation

Spatial Patterns

Ecosystem Services



Ecosystem Services Outcomes

Water Resources

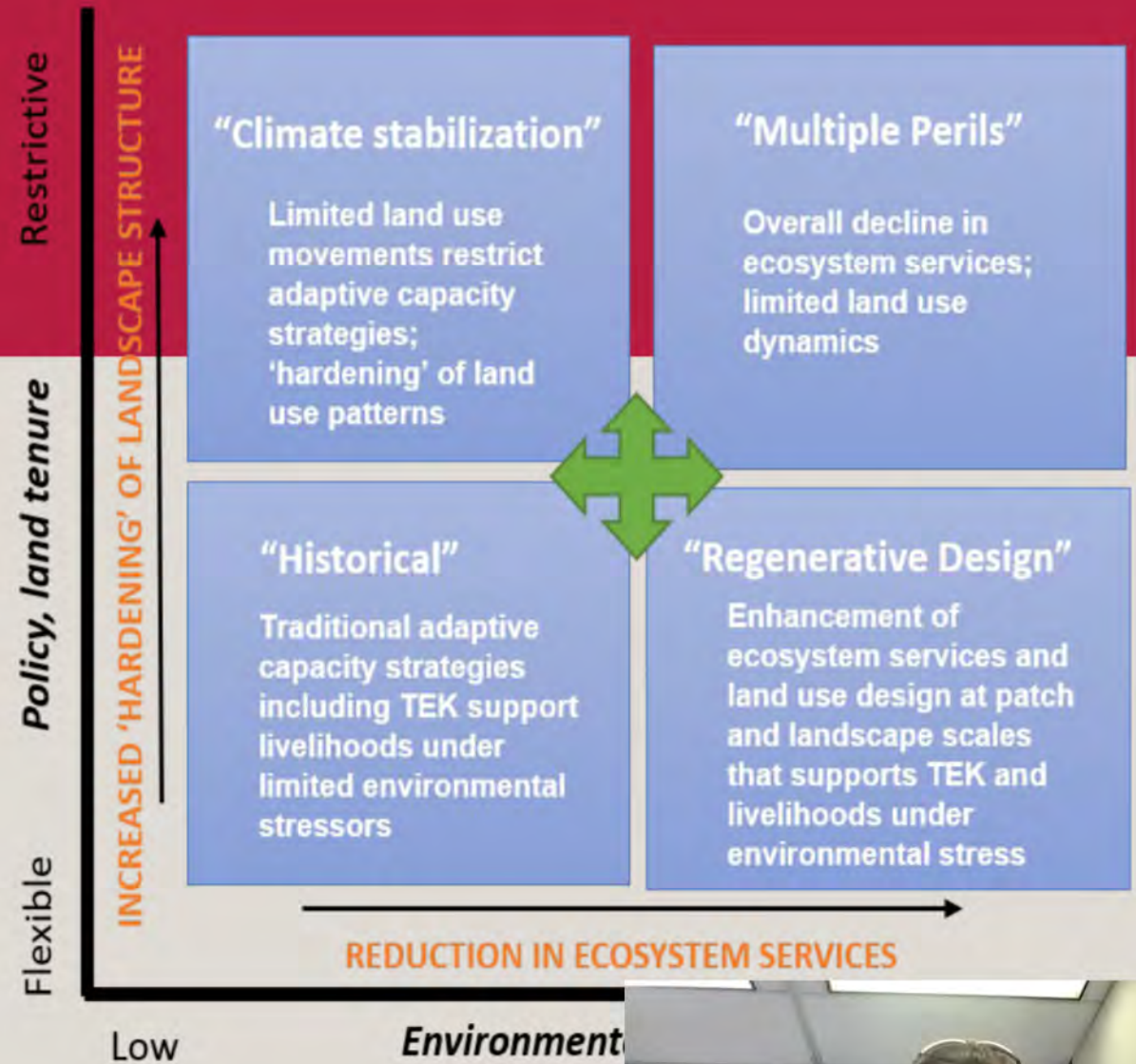
Forests

Rangelands



FUTURE MODEL SCENARIOS ACROSS CASE STUDY AREAS

- Simulation scenarios:
 - Land and resource use policies
 - Climate change - Projected changes in precipitation
 - Adaptive land management strategies



FOR DISCUSSION

- **Top-down landscape drivers:**
 - What policies most influence land use change (in each region)?
 - What are likely land use transitions in each region?
 - What are biophysical constraints to land use transition?
 - What data might be useful?
- **Bottom-up landscape drivers:**
 - What household factors determine land use transitions?
 - What are current and future constraints to land use persistence (consider farmers and herders)?

ACKNOWLEDGEMENTS

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- **PlantVillage.psu.edu**



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