



Mapping re-greening in West Africa: A GIS sample-based approach

Esri Conference, June 29th, 2016

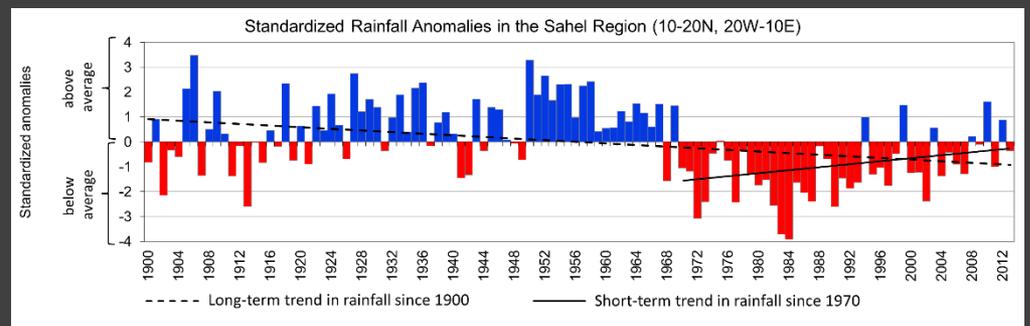
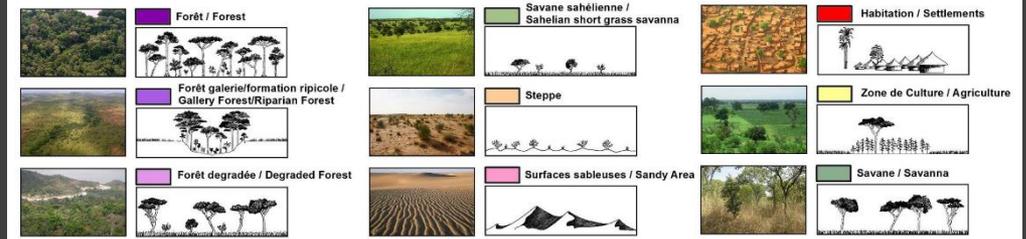
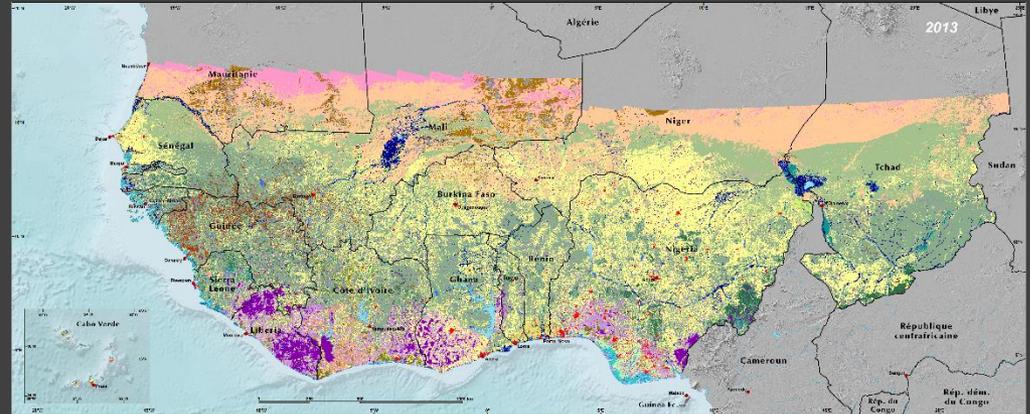
Suzanne Cotillon¹, Melissa Mathis¹

¹ SGT, contractor to the U.S. Geological Survey (USGS) Earth Resources Observation and Science (EROS) Center, Sioux Falls, South Dakota

¹ Work performed under contract G15PC00012

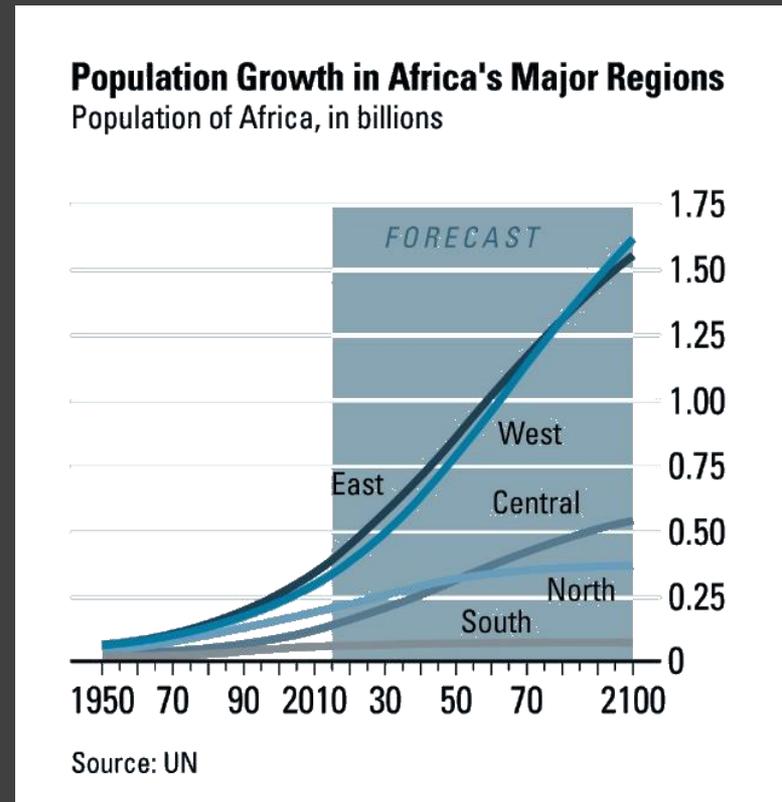
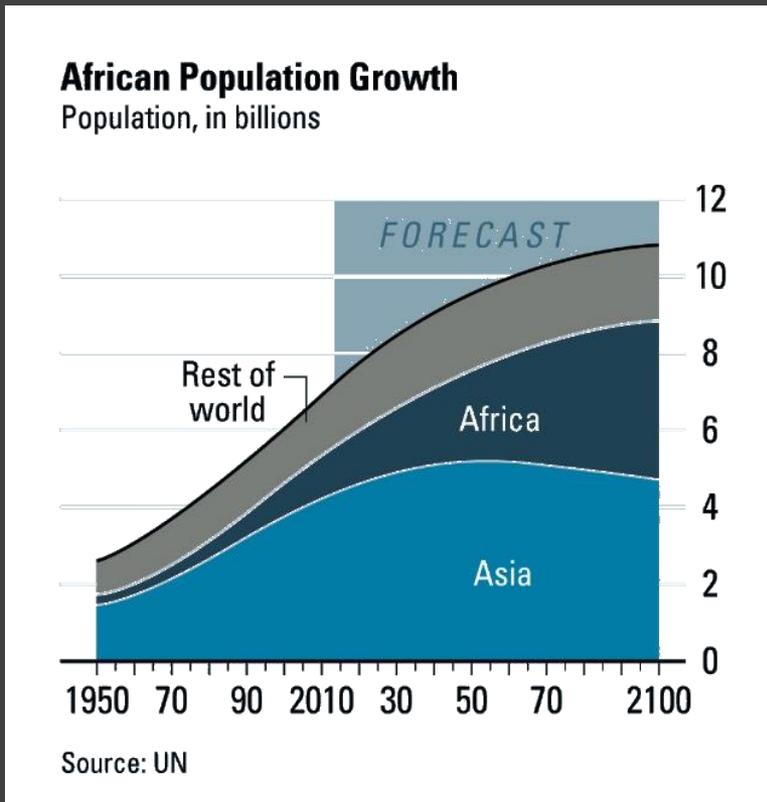
Context

- Decline of natural vegetation across West Africa in the past 40 years
- Successive years of drought and food shortages
 - Soil erosion
 - Low and declining cereal yields
 - Agriculture expansion into marginal lands
 - Loss of ecosystem services



Context

- Fastest growing population in the world



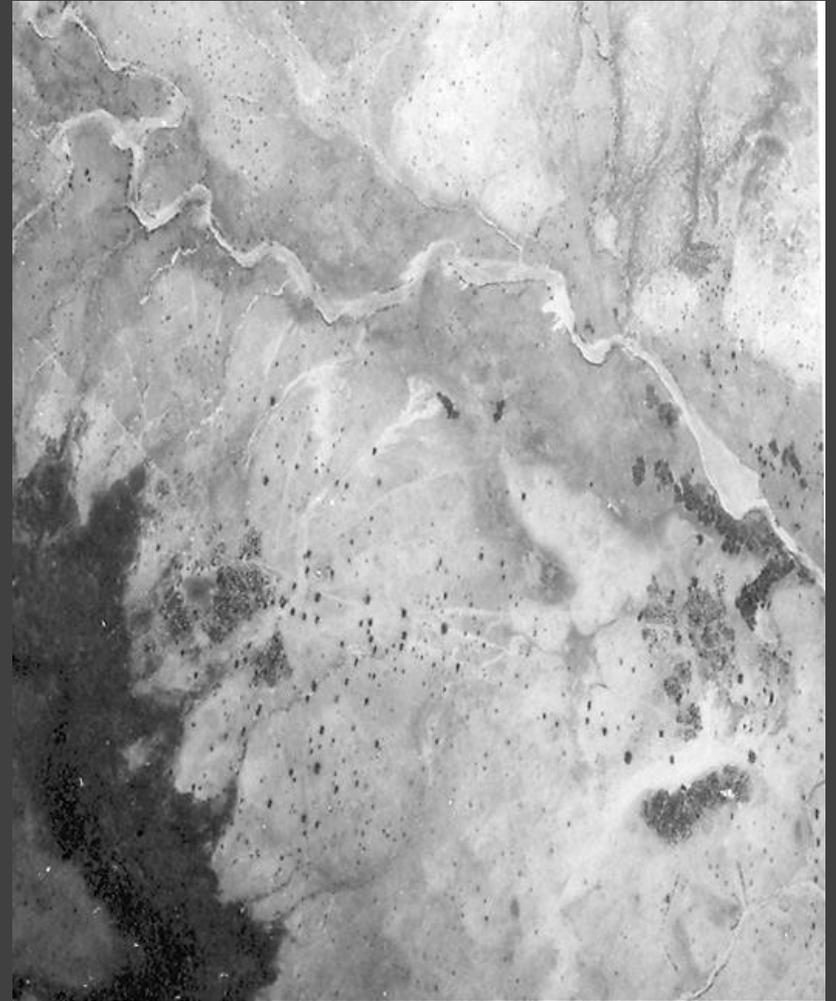
Research problem

How did farmers innovate to face these challenges?

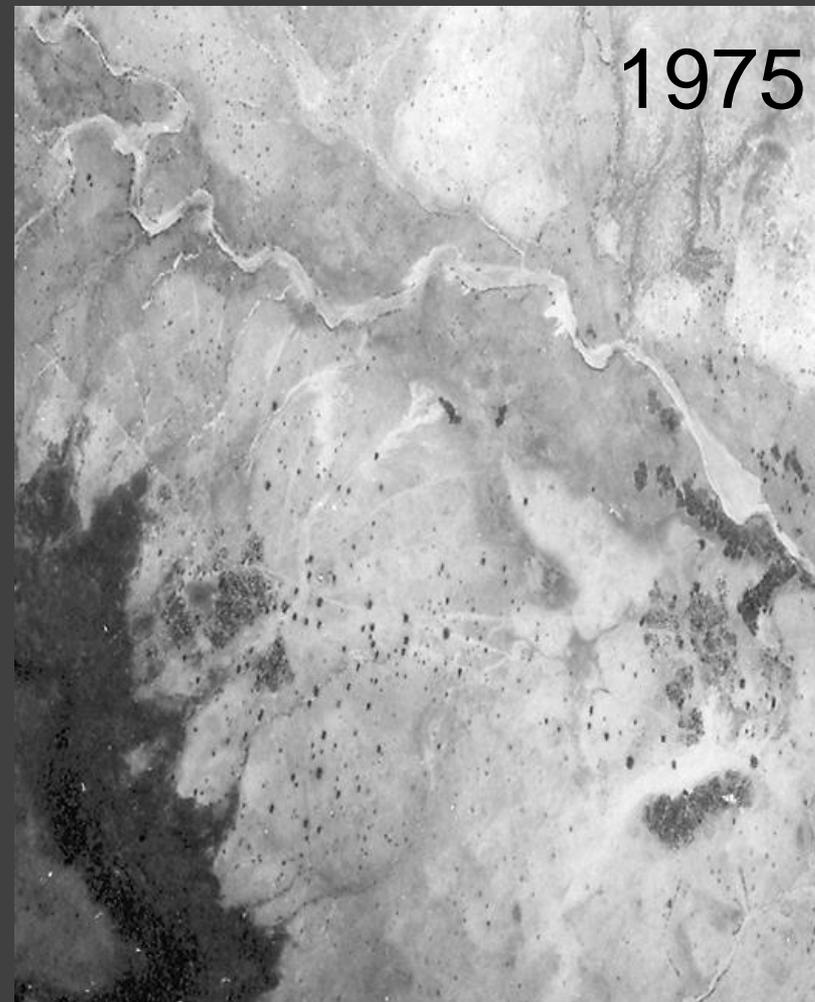
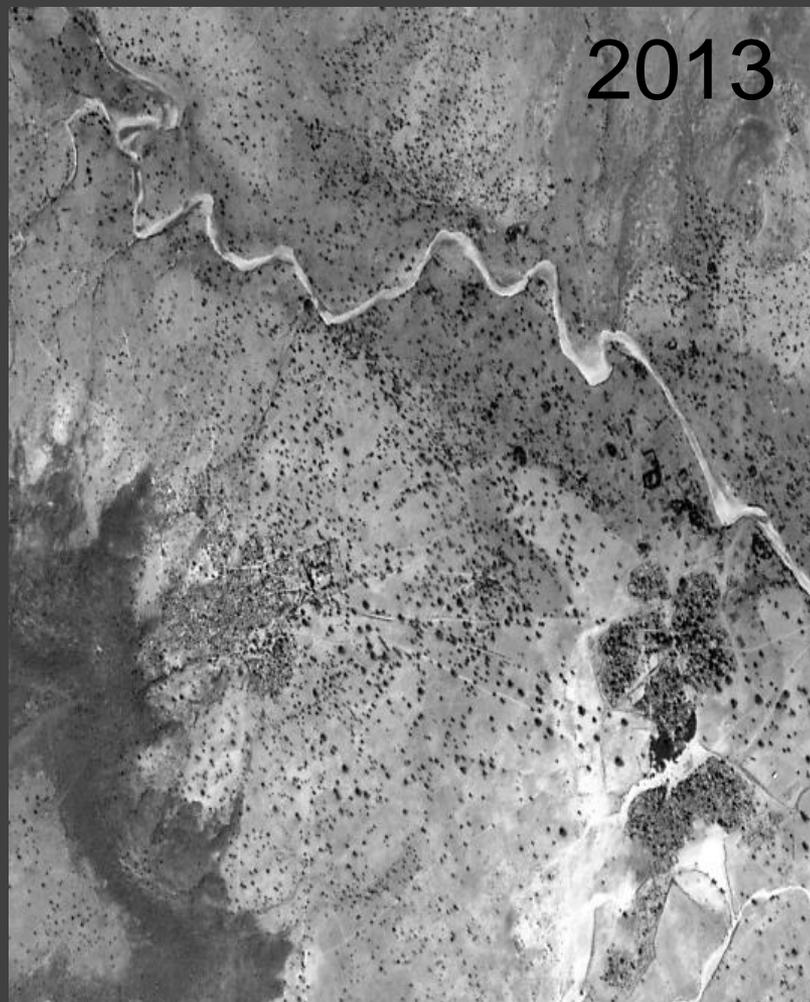
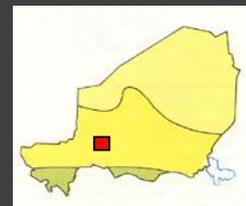
What practices are farmers using to adapt to their changing environment and reduce their vulnerability? To what extent?

USAID funded project to promote resilience in the Sahel – first part of the project in Burkina Faso and Niger

Which image is the most recent?



More people, more trees



Farmer-managed natural regeneration (FMNR)

- Farmers are protecting and managing the trees on their farmland



Farmer-managed natural regeneration (FMNR)

Benefits of On-Farm Trees... a Win-Win Strategy

- Firewood production
- Fodder for animals
- Increase biodiversity
- Habitat for millions of migrating birds
- Fruit production
- Traditional medicine
- Increased soil fertility
- Decreased soil erosion
- Reduced wind speed
- Increased crop yields
- Increased water infiltration
- Decrease in temperature
- Increase in rainfall
- Inexpensive and easy to adopt
- Increase in biomass and carbon
- Contribute to mitigating climate change

Study Area & Context

- U.S. Agency for International Development (USAID) defined 2 study areas in Niger and Burkina Faso to research re-greening
 - What is the extent of re-greening?
 - What is the potential for scaling up FMNR?

Mapping challenge

- Large area (roughly the size of Minnesota)



Mapping challenge

- Large area (roughly the size of Minnesota) → **sampled based approach**



Mapping challenge

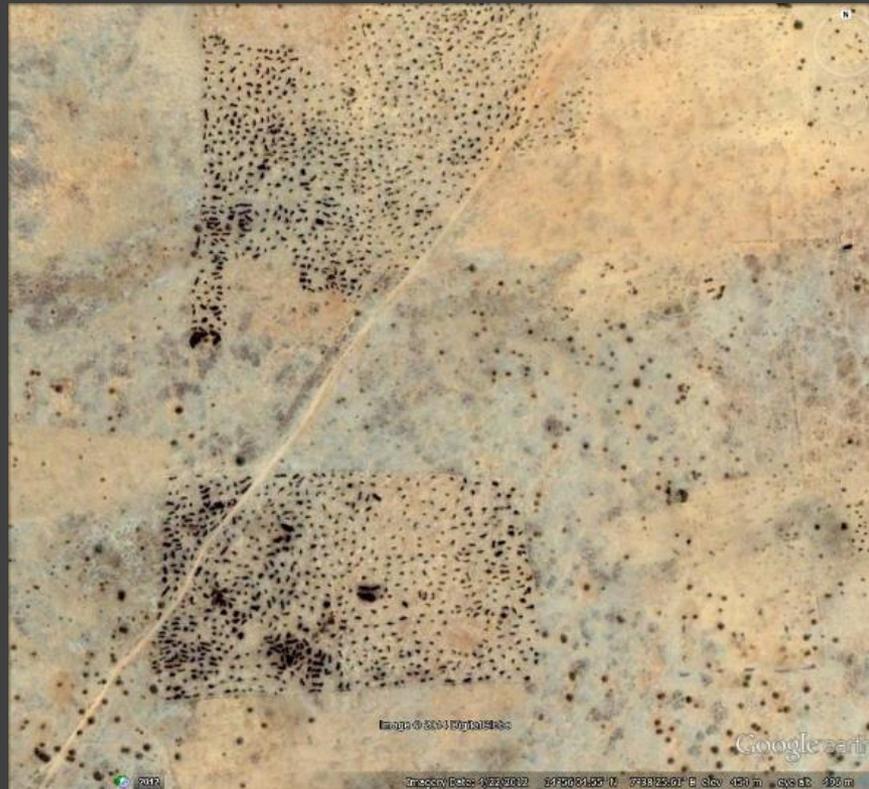
- Large area (roughly the size of Minnesota) → **Sampled based approach**
- Trees are sparse and hard to see → **High resolution imagery and very large scale (1:3,000 to 1:5,000)**



Galma, Niger in 2005

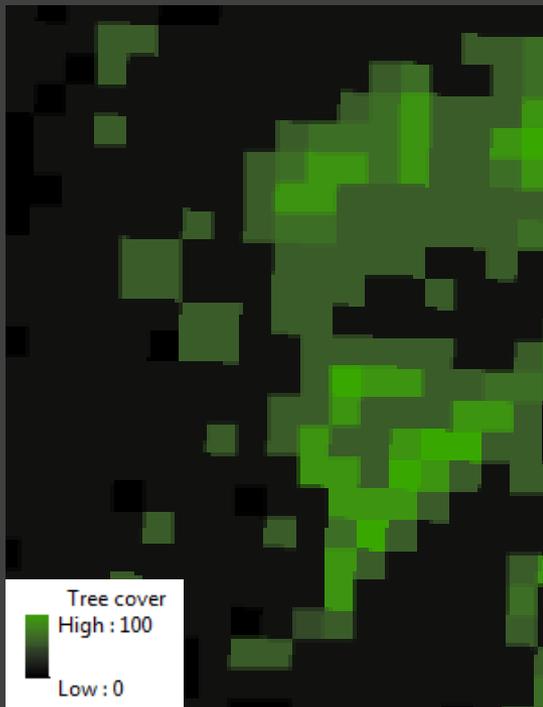
Mapping challenge

- Automatic classification can lead to mistakes: Are there any trees here?



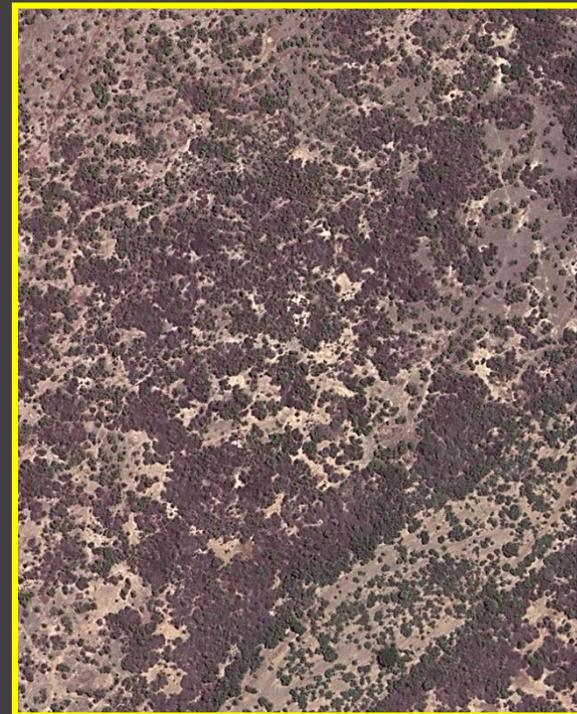
Mapping challenge

- Automatic classification can make mistakes: Are there any trees here?



Global Forest Cover 2013 (1:10,000)

Source: Hansen/UMD/Google/USGS/NASA



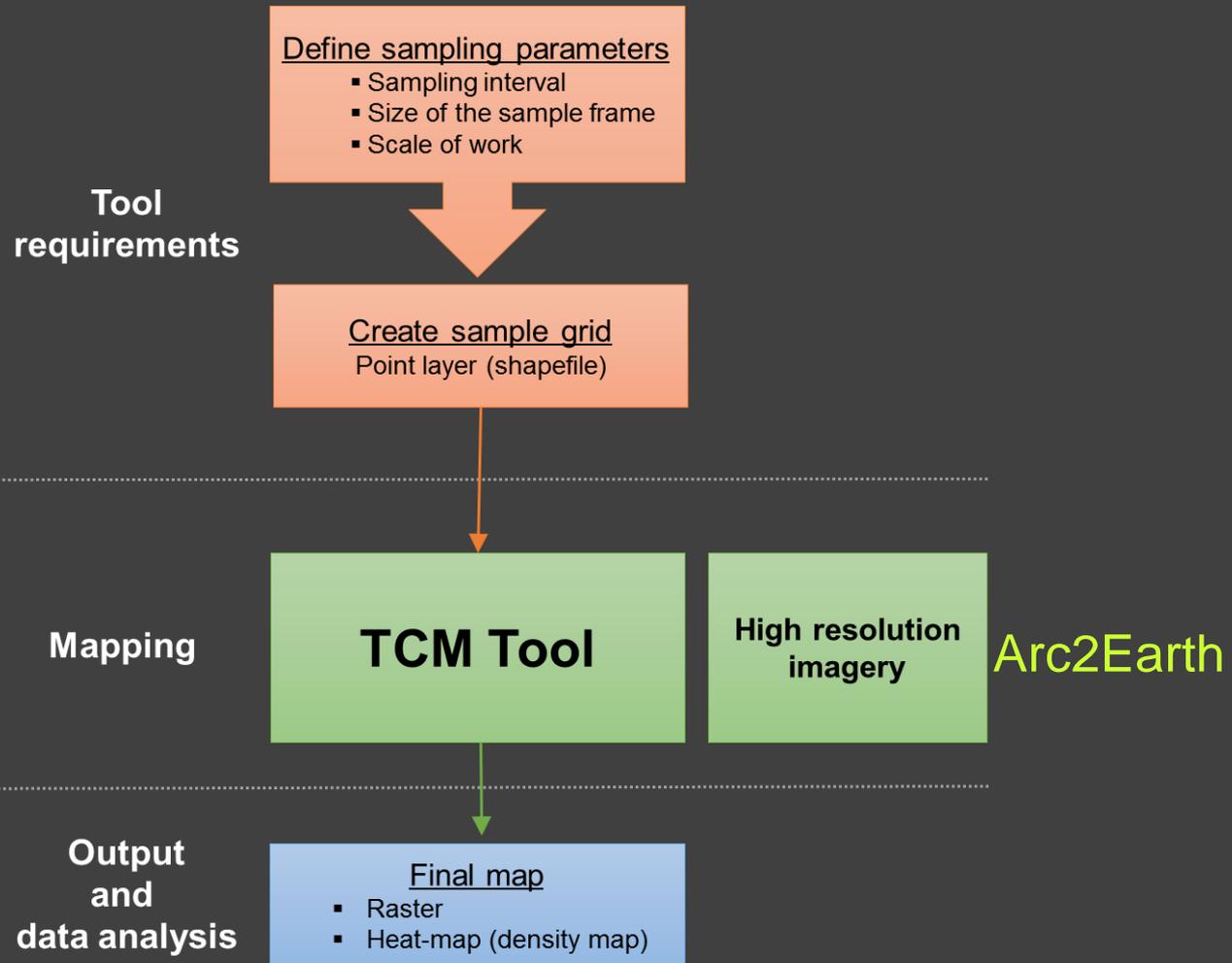
High resolution imagery (1:3,000)

Mix of trees, shrubs, and bushes

Mapping challenge

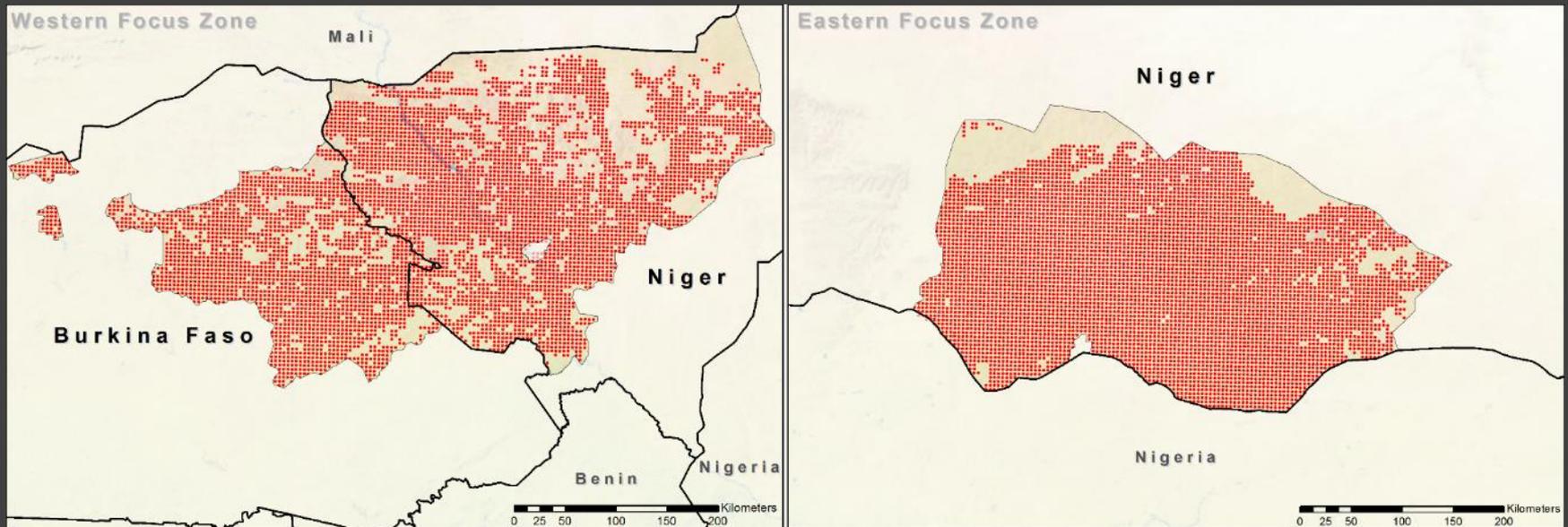
- Large area (roughly the size of Minnesota) → **Sampled based approach**
- Trees are sparse and hard to see → **High resolution imagery and very large scale (1:3,000 to 1:5,000)**
- Manual mapping → **Visual interpretation**
- **Methodology to address these challenges**

Methodology - Overview



Methodology - Create a sample grid

- Grid of 10-hectare samples (1 sample every 2 km)
- 29,757 samples in the study area (samples only on farmland)



Using HR imagery and a calibrating grid of a 100 points, we count the number of trees touching the calibrating grid, in each sample:



Frame width ~ 330 meters here

Mapping Scale 1:3,000

ArcGIS 10.1 or higher
Add-In

Using HR imagery and a calibrating grid of a 100 points, we count the number of trees touching the calibrating grid, in each sample:

Sample ID

Tree Cover field (added by the user after creating the sample grid)

FID	Shape	ID	Percent	Attributed
0	Point	0	10	1
1	Point	1	5	1
2	Point	2	10	1
3	Point	3	5	1
4	Point	4	5	1
5	Point	5	0	0
6	Point	6	0	0
7	Point	7	0	0
8	Point	8	0	0
9	Point	9	0	0

SampleGrid

(0 out of 15973 Selected)

SampleGrid

TCM Tool

Tree Cover Mapping Tool

Inputs

Point layer

Sample grid

Attribute fields

Sample ID Tree cover

Tool inputs

Sample frame (meters) Scale Calibrating grid

Previous records

Existing tree cover value

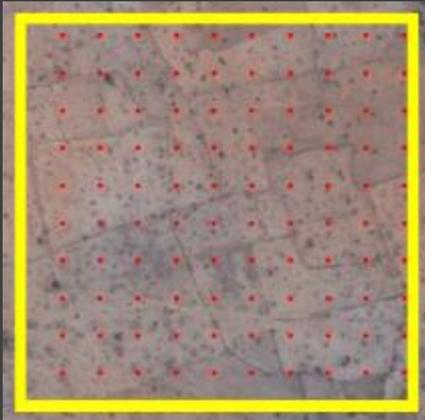
Last attributed sample

Tree Cover Value

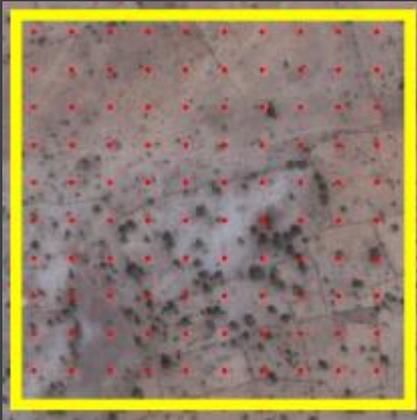
USGS Version 1.0 - March 2016 USAID

Information is stored in the sample grid shapefile

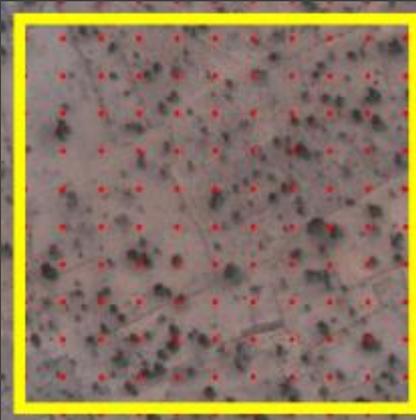
Example of tree cover classes:



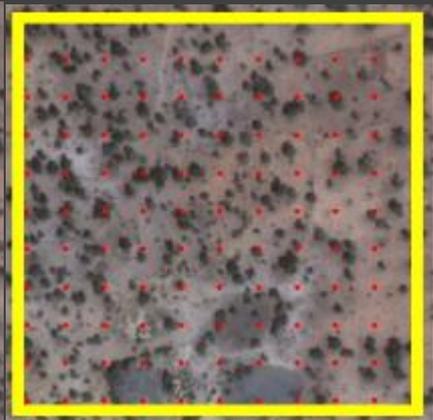
**0 %
No tree cover**



**0 - 2 %
Open with
isolated trees**

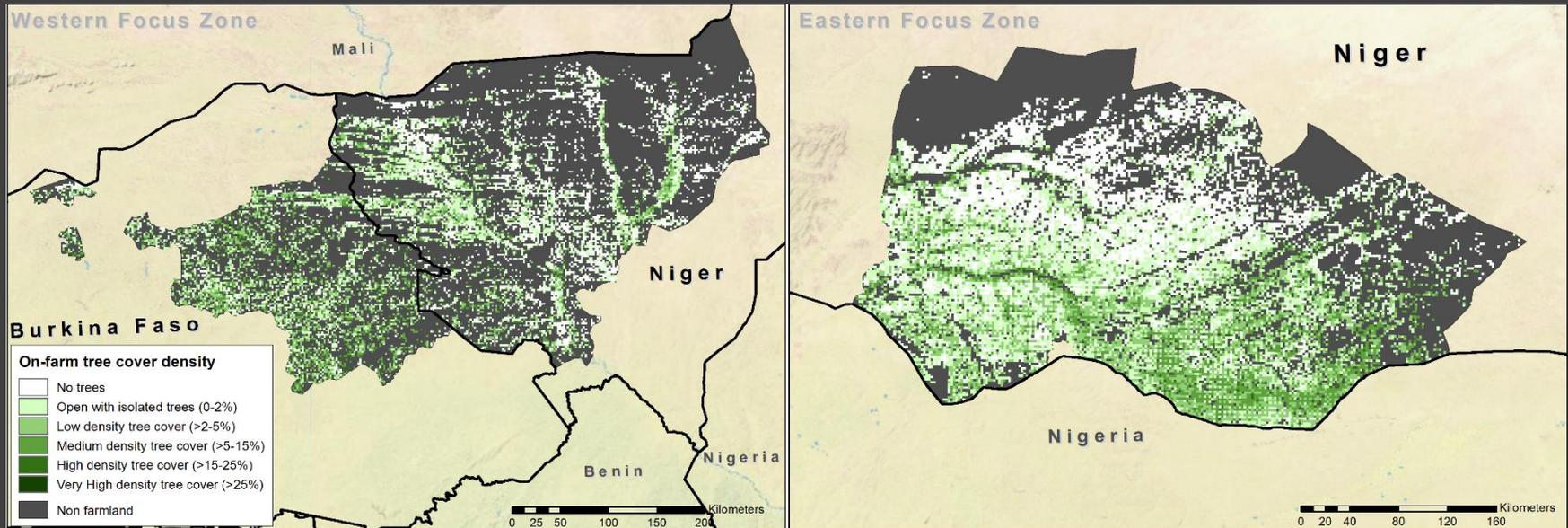


**2 - 5 %
Low density**

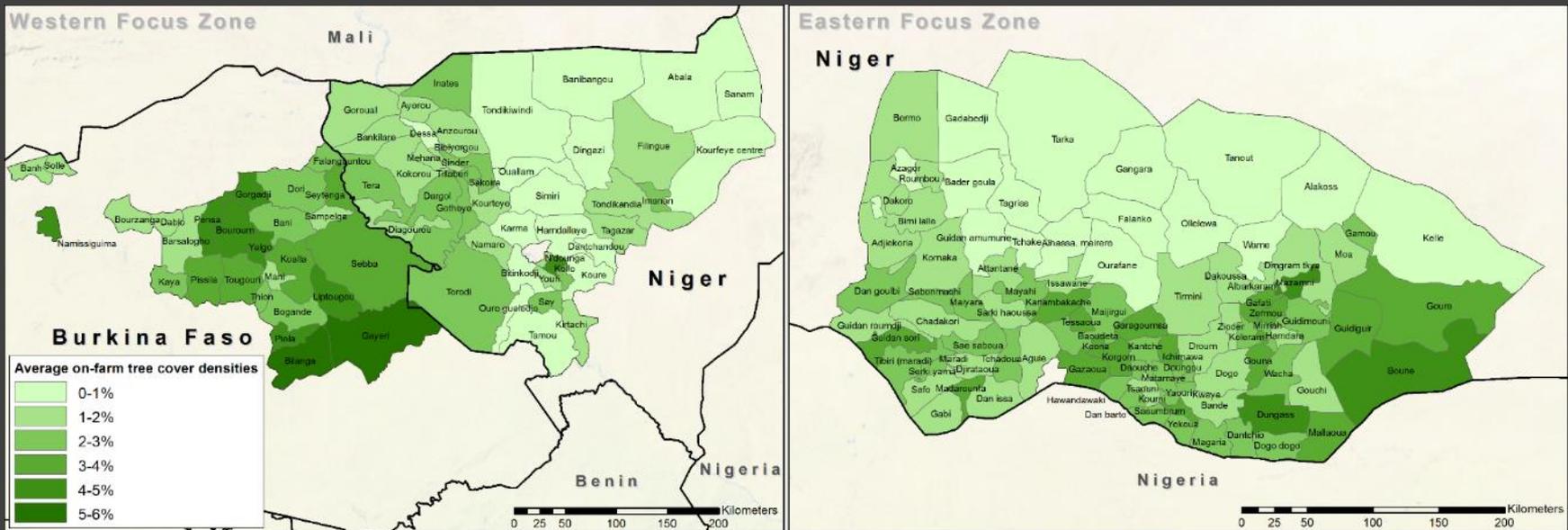


**5 - 15 %
Medium
density**

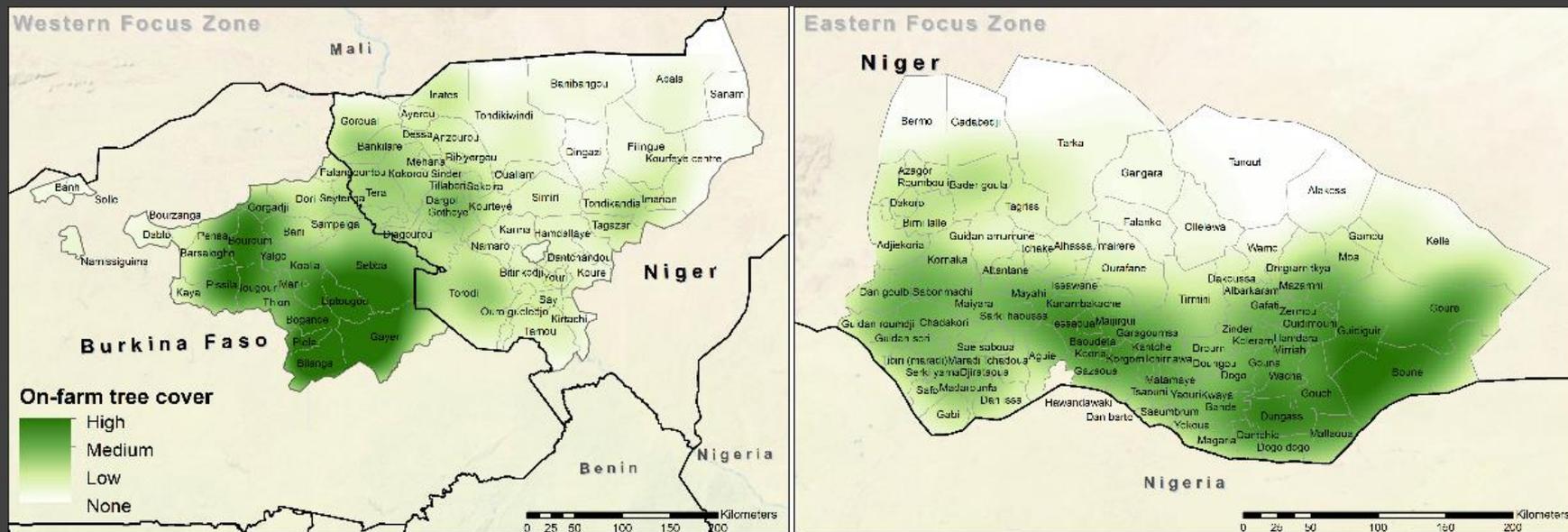
Results in the study area: On-farm tree cover raster map (2 km resolution)



Results in the study area: Average on-farm tree cover densities by commune

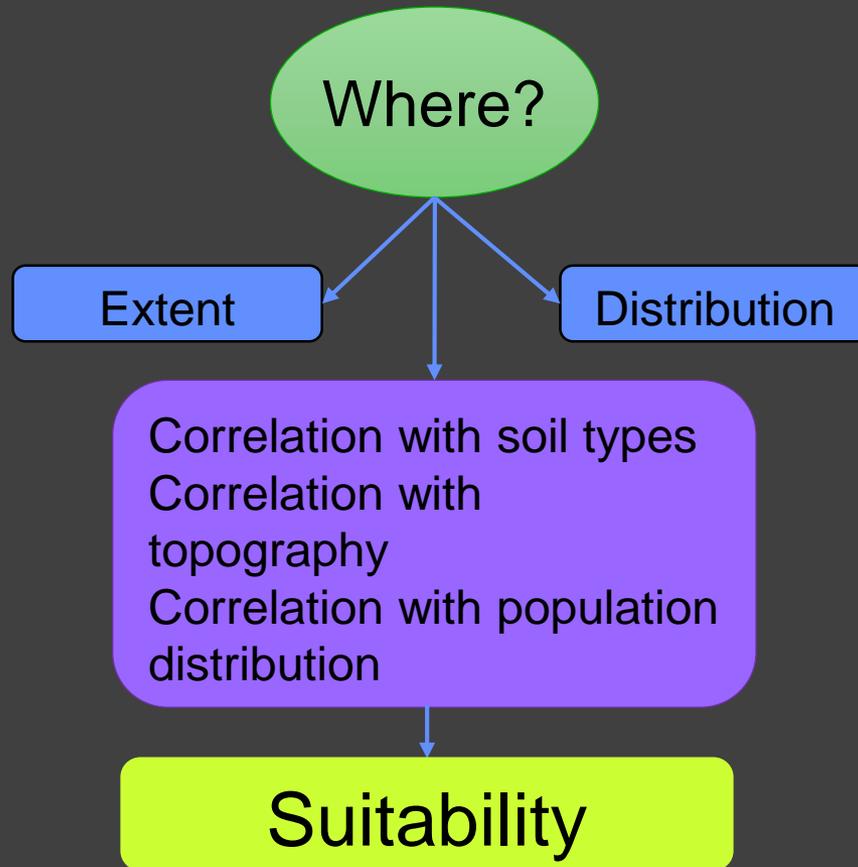


Results in the study area: On-farm tree cover heatmap



Results

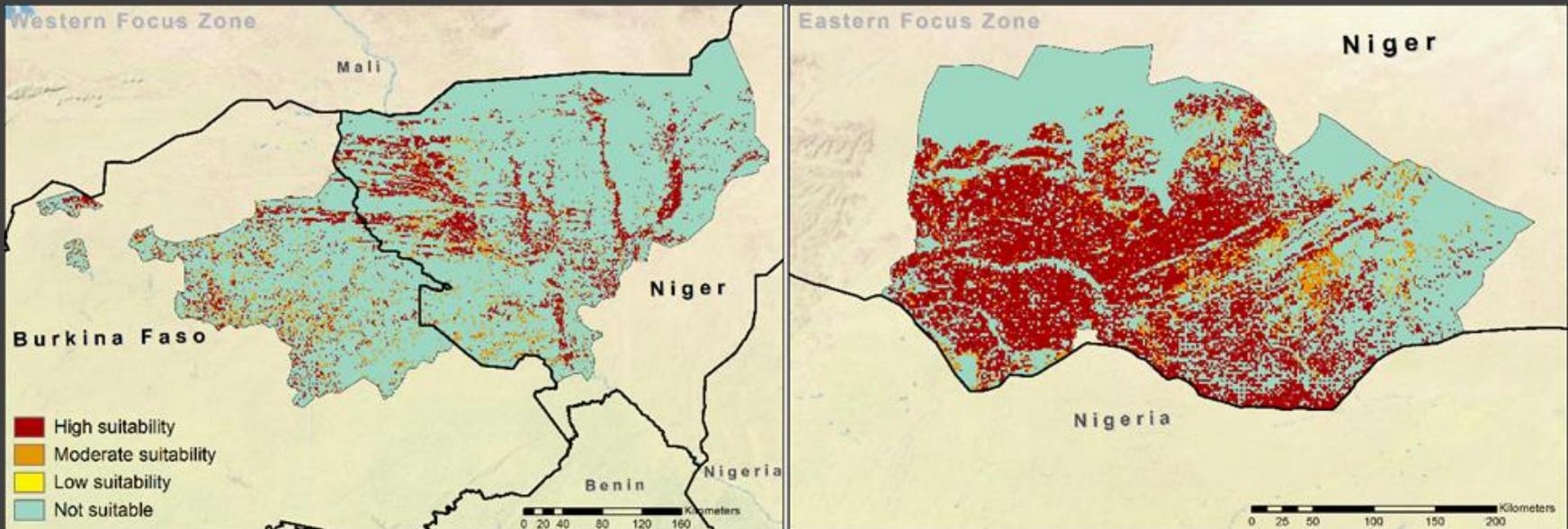
- What did we learn from these maps?



Results

- From the tree cover density map, we were able to create a model to map the suitable areas for scaling-up on-farm tree cover (FMNR)

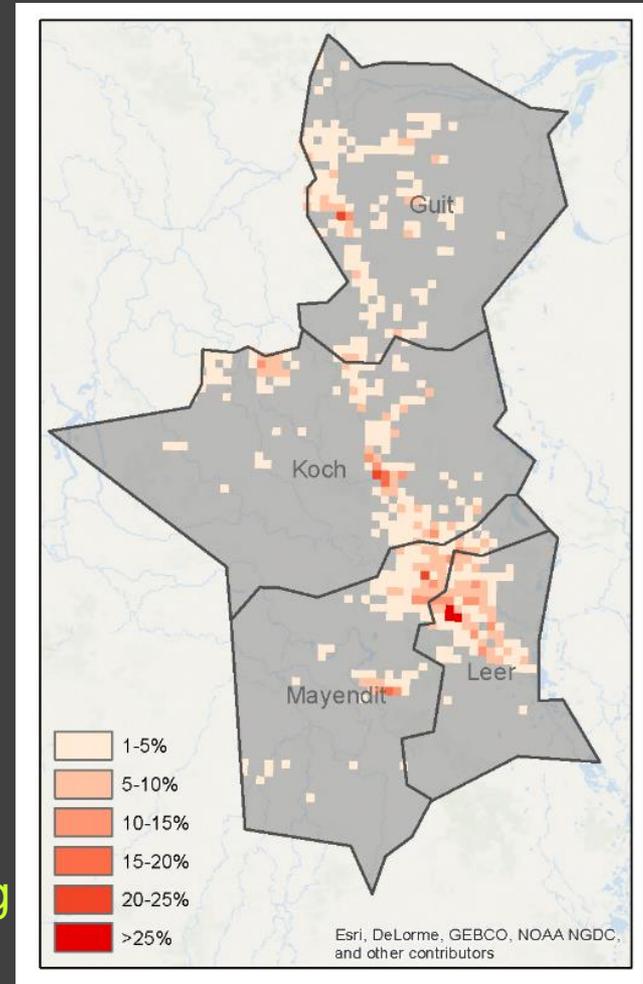
On-farm tree cover suitability in the study area



Advantages of the TCM tool

- Easy to operate
- Easy to share
- Flexible inputs
- Can be used for other applications

Example of settlements mapping
in Unity State in South Sudan



Conclusion on mapping and results

- **New approach, mapping re-greening at this geographic extent has never been done before**
- **Simple methodology and tool is easy to use**
- **Help define suitable land for scaling-up conservation practices and promote resilience in the Sahel**

Thank You



Contact: suzanne.cotillon.ctr@usgs.gov