



# Mapping Conservation Practices And Tree Cover in the Sahel

Gray Tappan  
Suzanne Cotillon

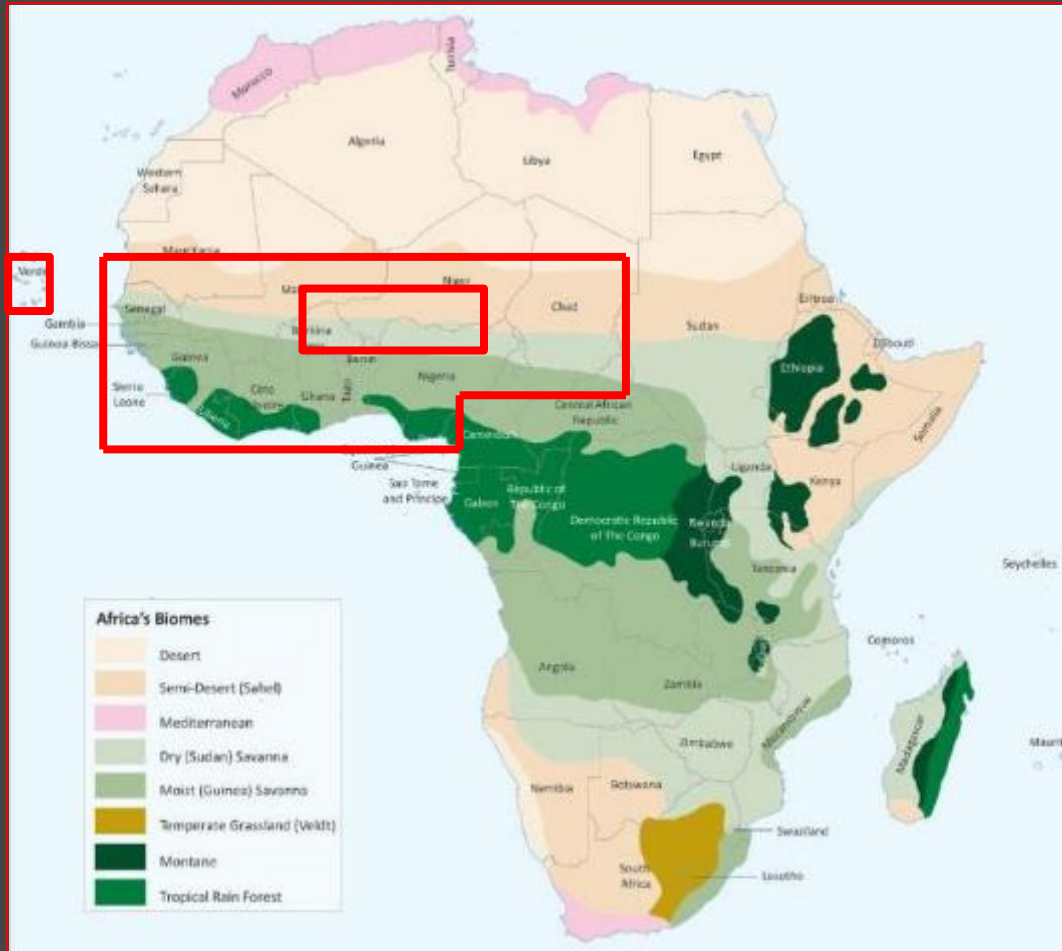
U.S. Department of the Interior  
U.S. Geological Survey



**The U.S. Geological Survey's Earth Resources Observation and Science (EROS) Center's vision is to be the world's leading source of land information for exploring our changing planet.**



# Project Areas



# West Africa Project Partners

---

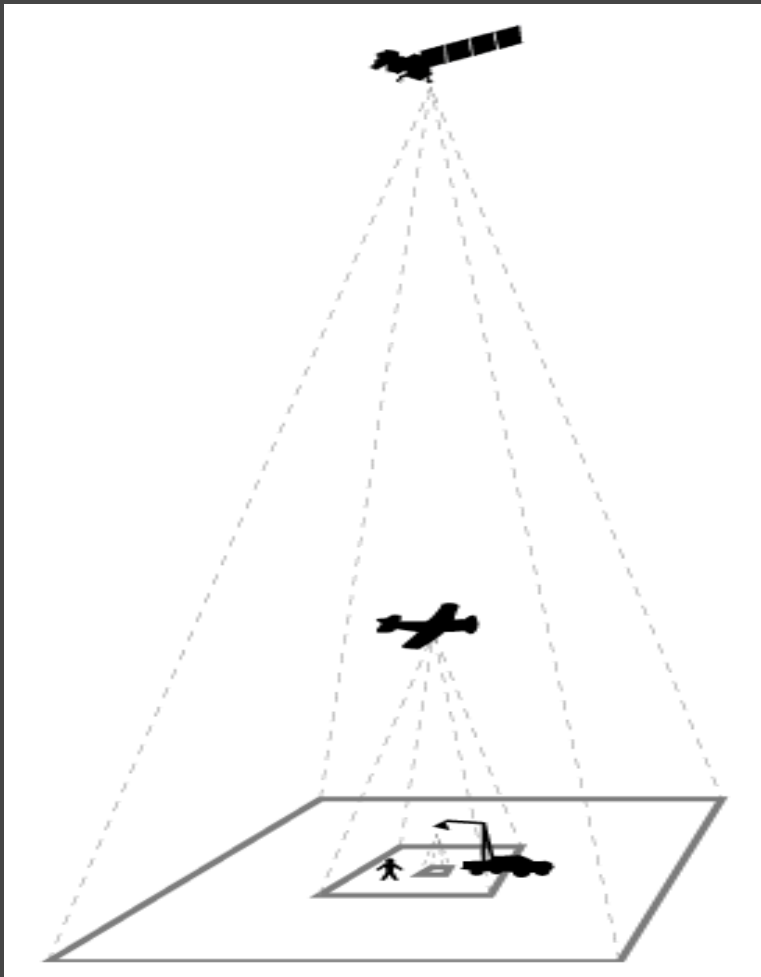
- African Cooperators:
  - CILSS
  - AGRHYMET Regional Center
  - Institut du Sahel
  - National Government Agencies
- US Cooperators:
  - U.S. Agency for International Development
  - U.S. Geological Survey
  - U.S. Forest Service
  - U.S. Dept. of State
- International Cooperators:
  - ICRAF
  - World Resources Institute
  - Vrije Universiteit Amsterdam



AGRHYMET  
Regional Center

# Approach to Mapping and Monitoring

---



## Levels of Data Collection:

- Satellite level
- Aerial level
- Ground level

\*Data at each level collected through time

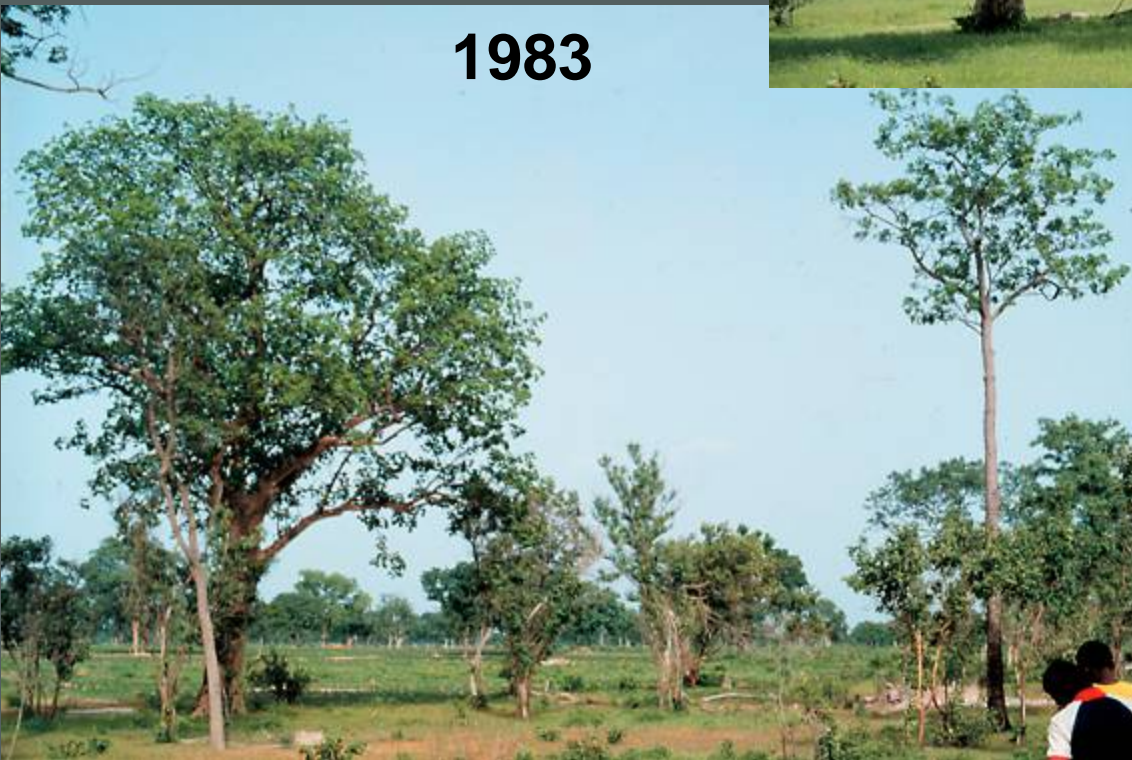


Land Cover Change:  
Open woodland to  
Cropland; (we monitor  
landscapes on the ground  
in several Sahelian countries)

**1998**



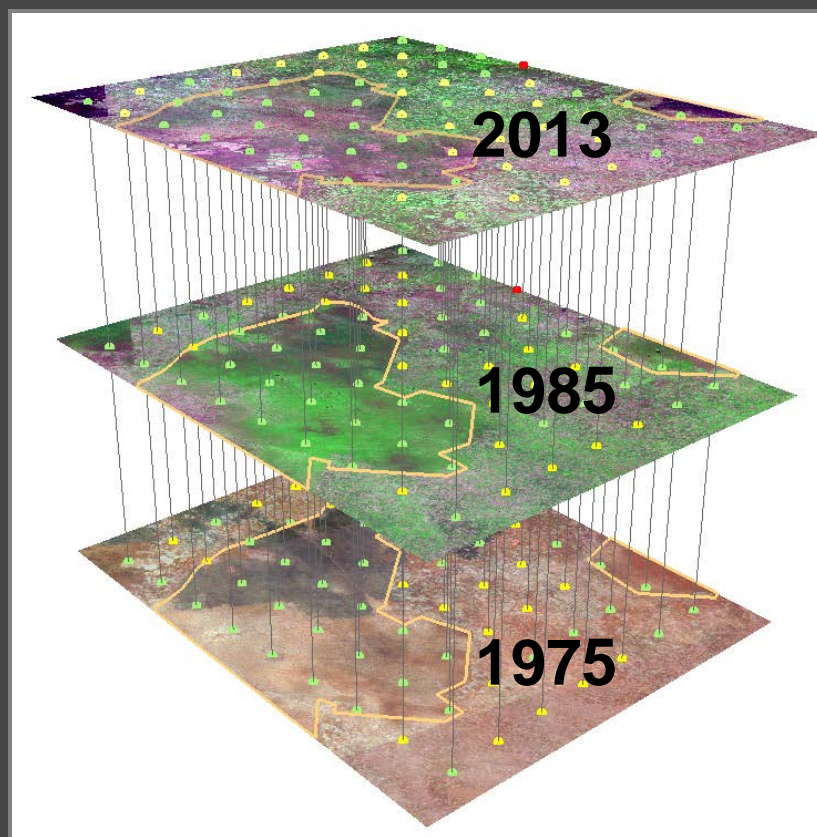
**1983**



## Rapid Land Cover Mapper

---

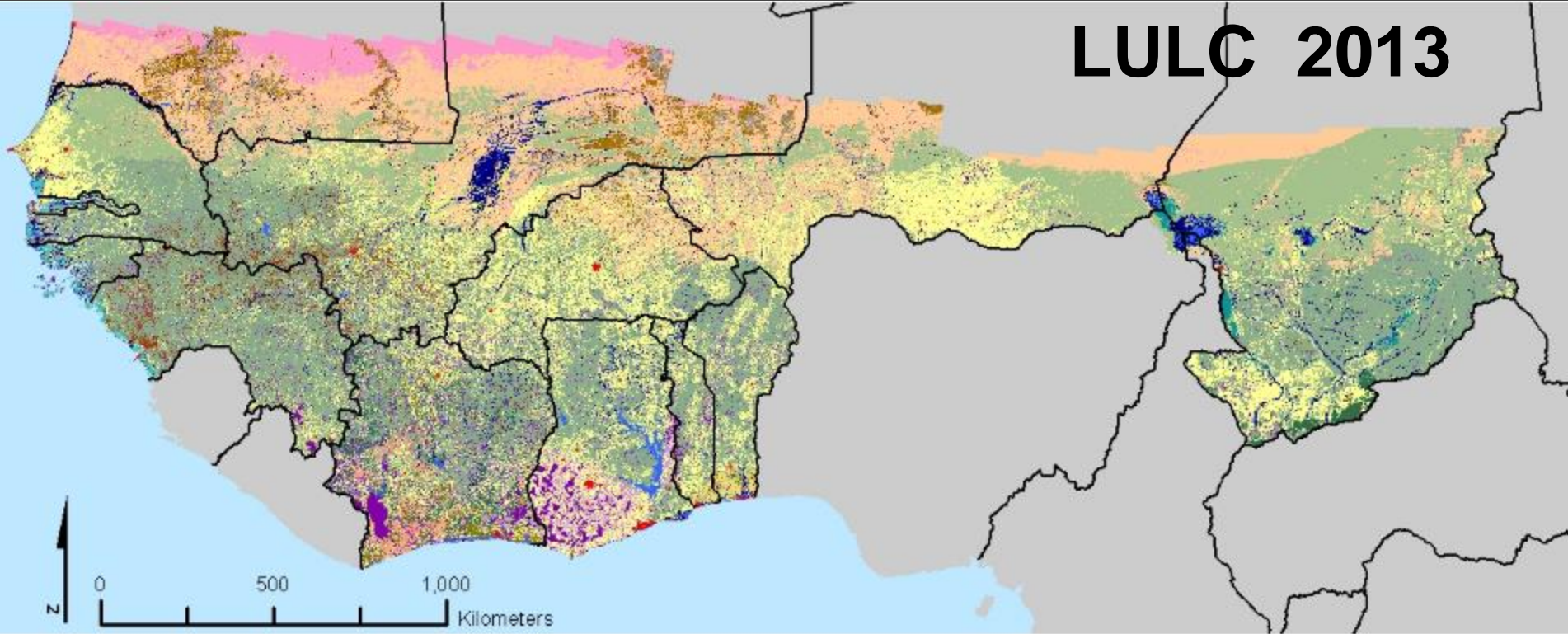
The RLCM tool is designed to facilitate time-series mapping and trends analysis of land use and land cover. We built and implemented it for large area mapping in West Africa



# On-screen mapping using the RLCM tool



# LULC 2013



- |                               |  |
|-------------------------------|--|
| Sandy Area                    | Mangrove   |
| Steppe                        | Water Bodies                                     |
| Sahelian short grass savanna  | Bottomland and wetland                           |
| Savanna                       | Rocky Land                                       |
| Shrub and tree savanna        | Bare Soil  |
| Herbaceous savanna            | Settlements                                      |
| Wooded savannas and woodlands | Agriculture                                      |
| Woodland                      | Irrigated Agriculture                            |
| Bowe                          | Agriculture in bottomlands and flood recessional |
| Degraded Forest               | Cropland and fallow with oil palms               |
| Gallery Forest                | Plantation                                       |
| Forest                        | Open Mine  |

**LULC 2013**

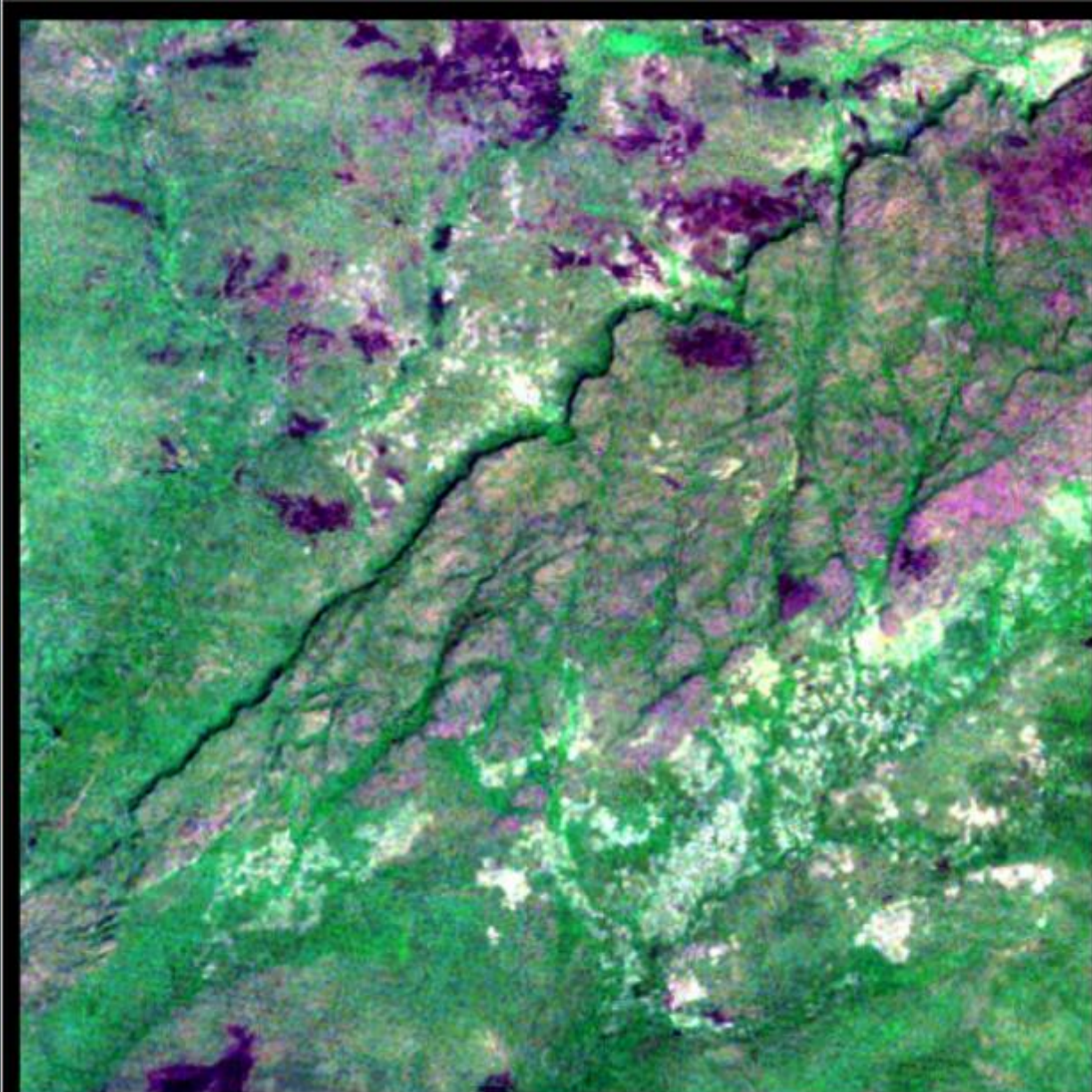
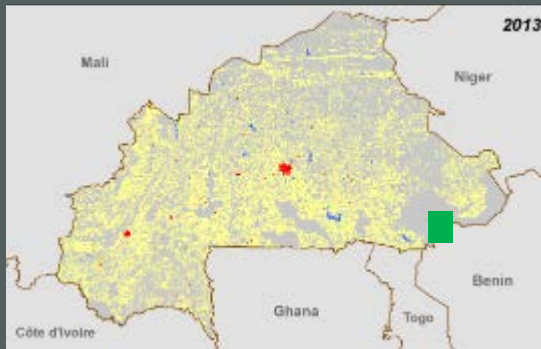
**Burkina Faso**



For example, let's look at Land Use & Land Cover change in Burkina Faso...

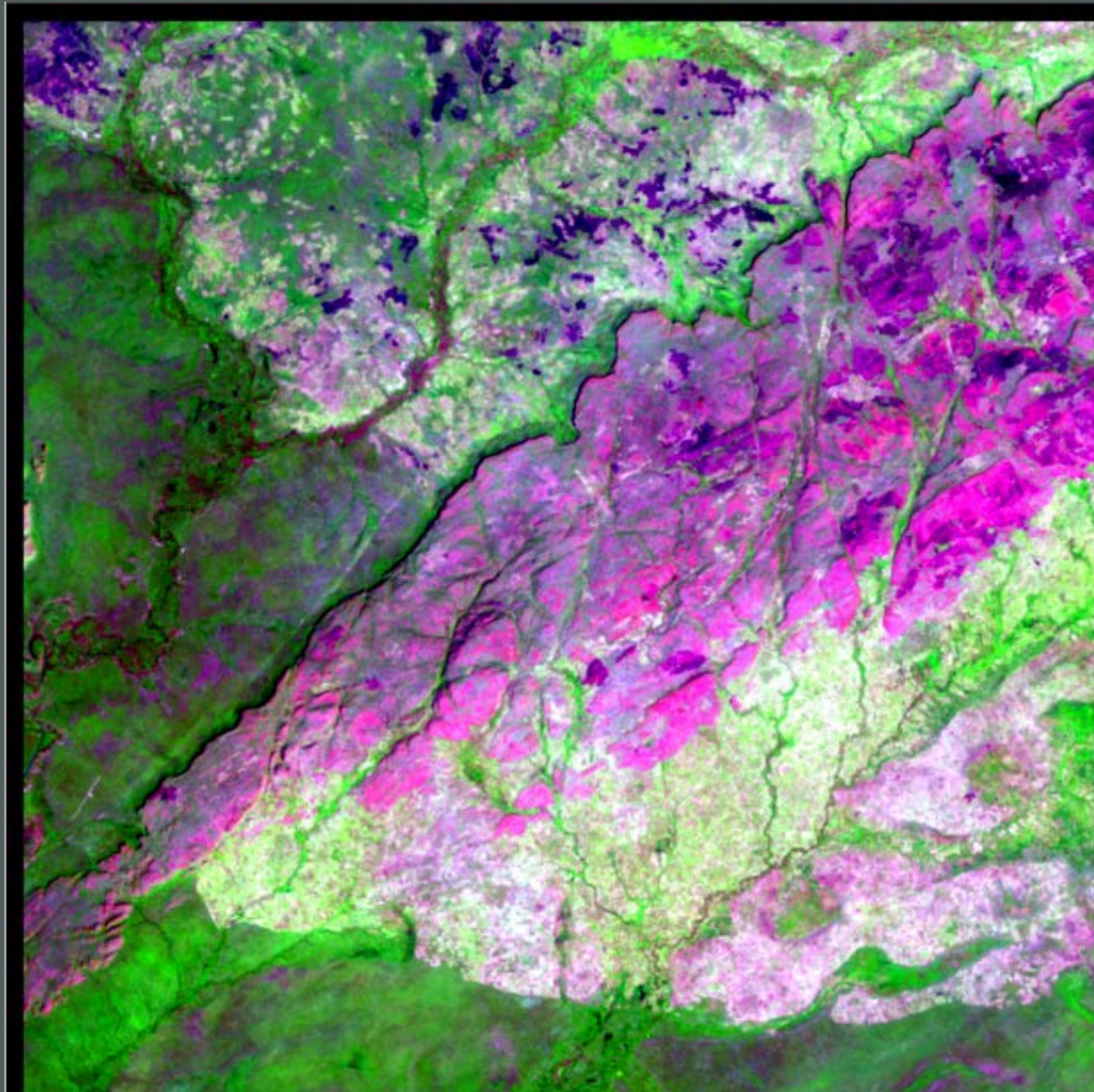
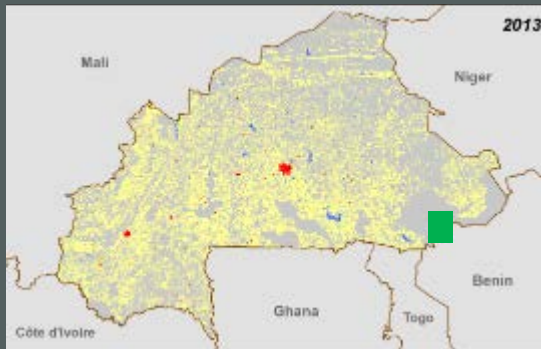
# Burkina Faso: Parc National de l'Arli

Landsat 1972



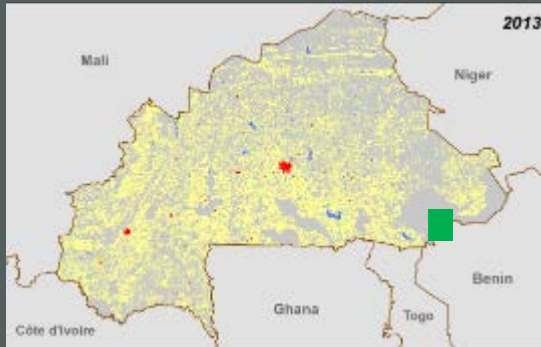
# Burkina Faso: Parc National de l'Arli

Landsat 2000

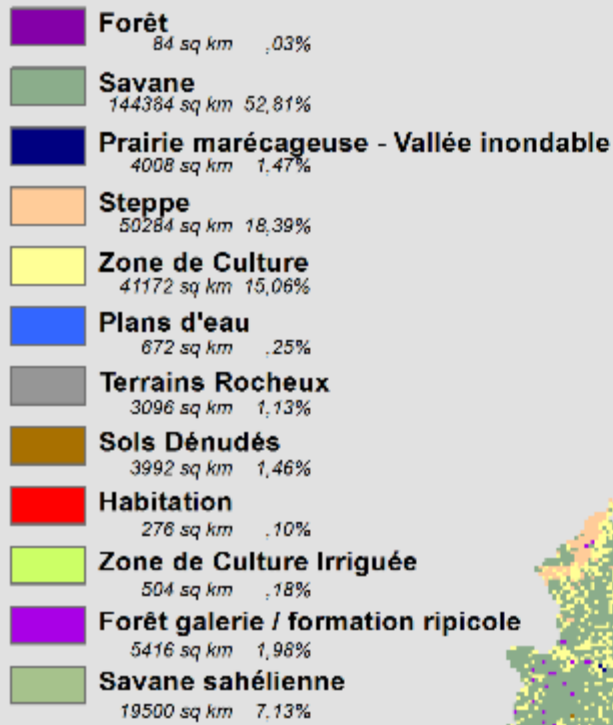


# Burkina Faso: Parc National de l'Arli

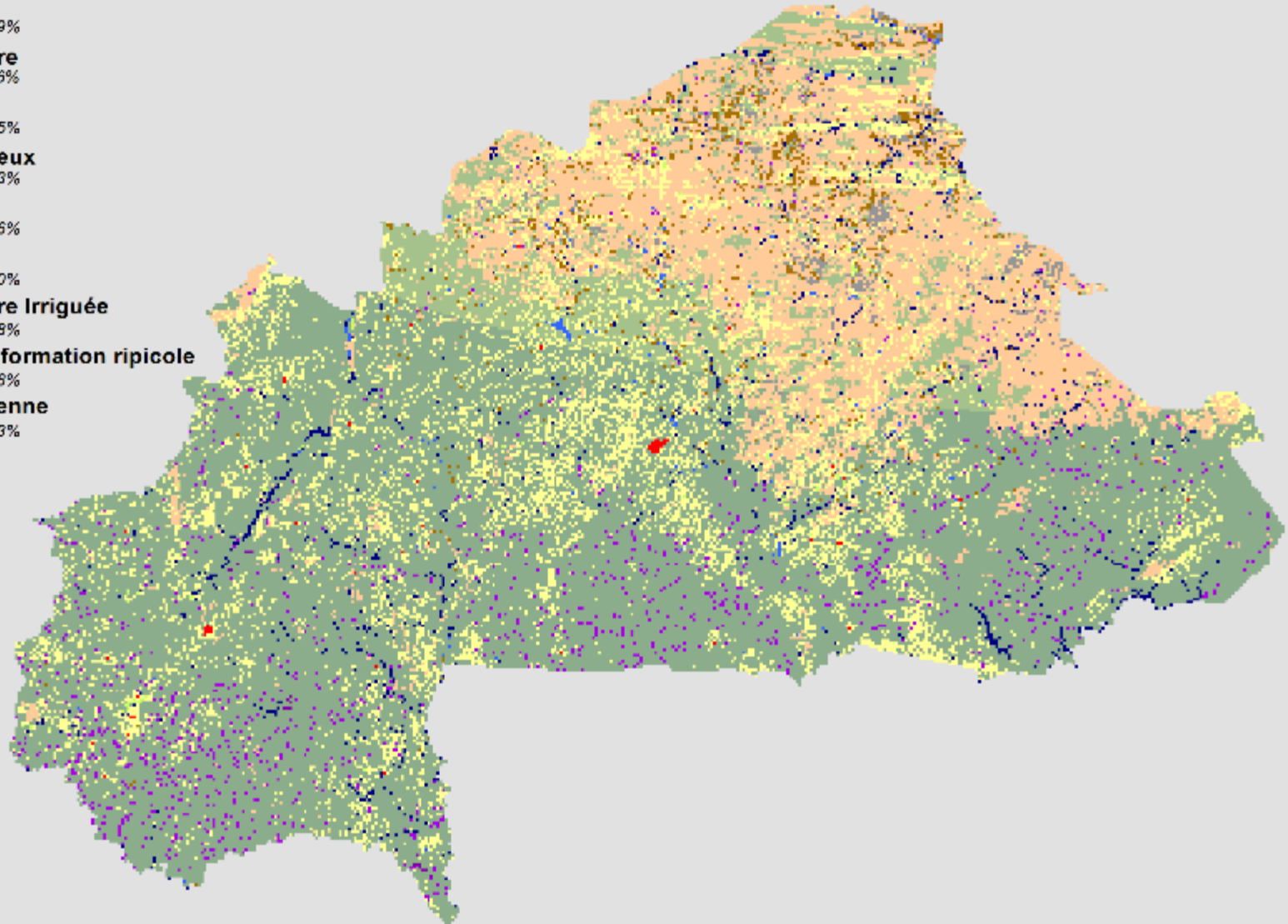
Landsat 2013



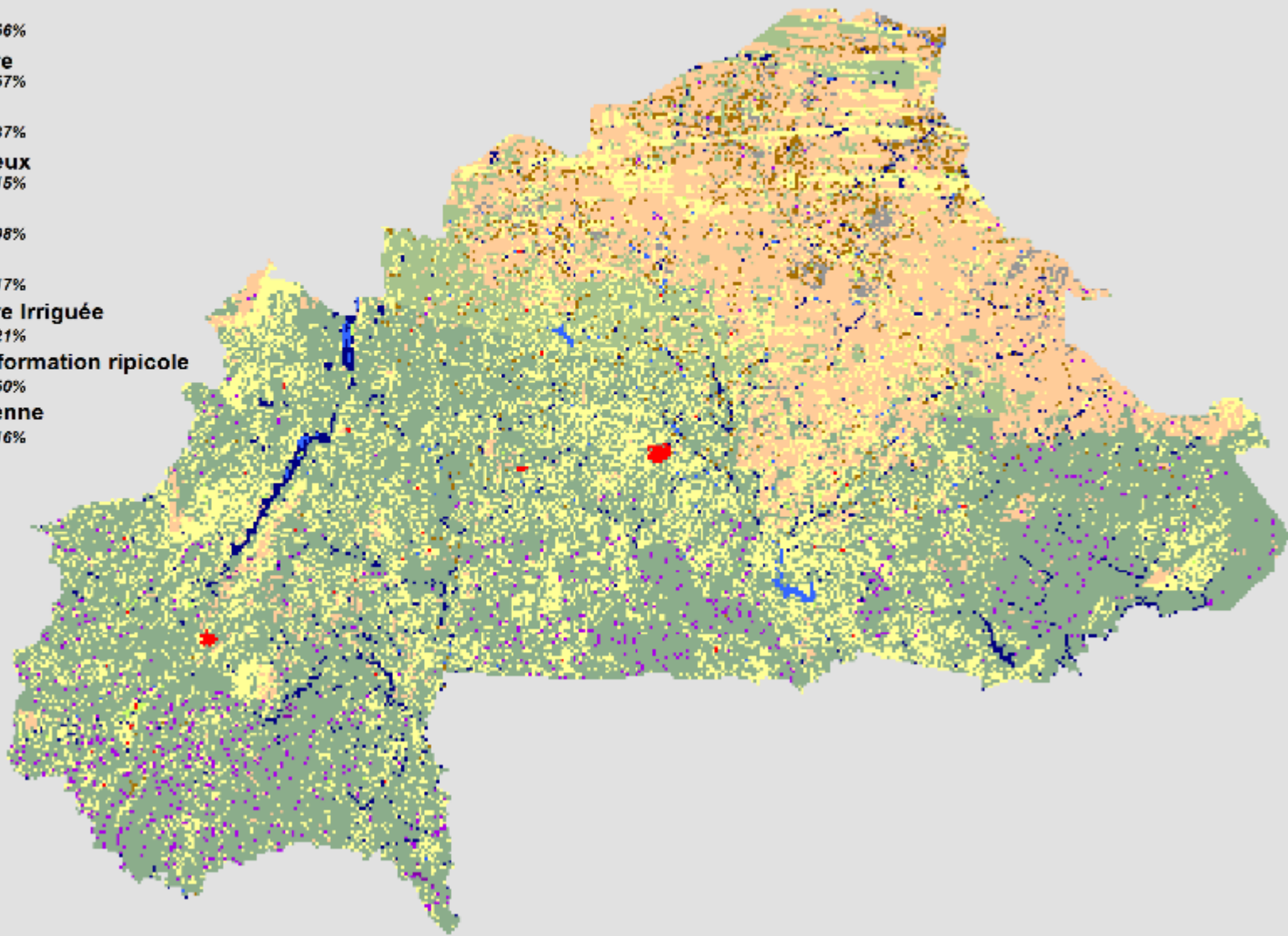
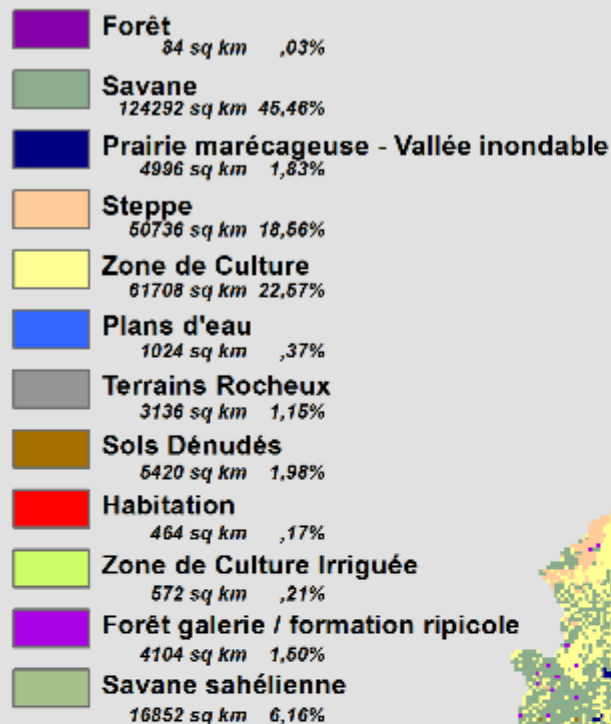
# Occupation des Terres - Burkina Faso 1975



Land Use/Land Cover Maps and trends produced for every country:  
Example of Burkina Faso, 1975

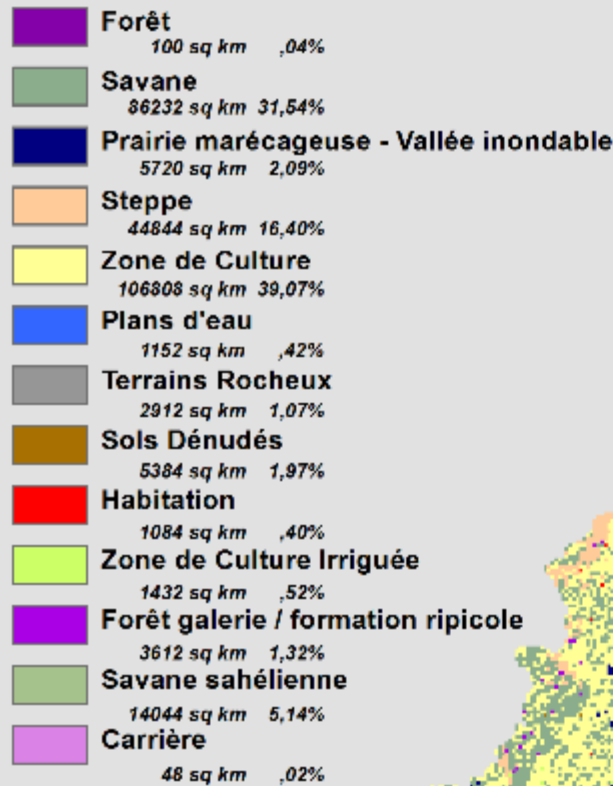


## Occupation des Terres - Burkina Faso 2000

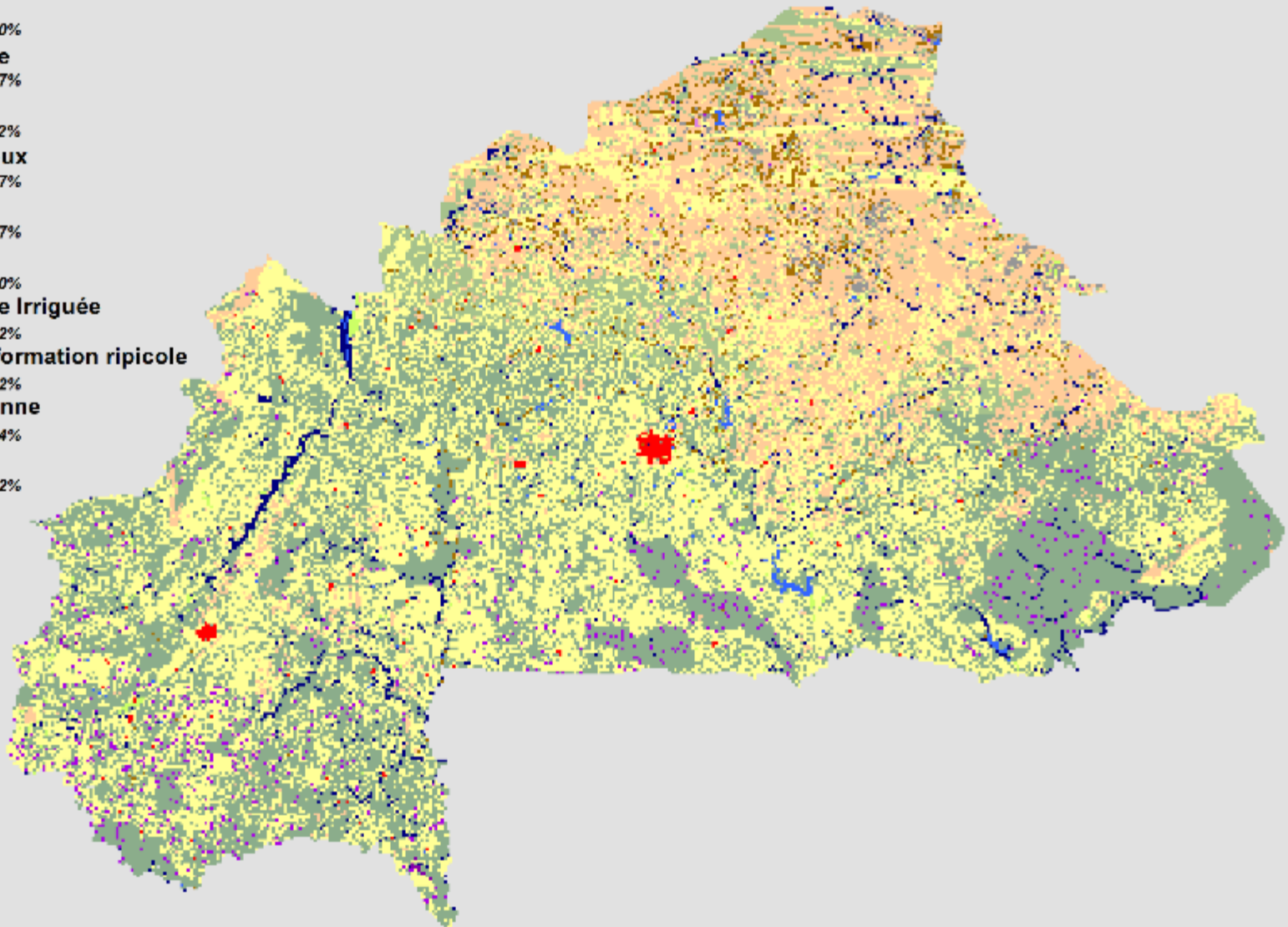


Land Use/Land Cover Maps and trends produced for every country:  
Example of Burkina Faso, 2000

# Occupation des Terres - Burkina Faso 2013

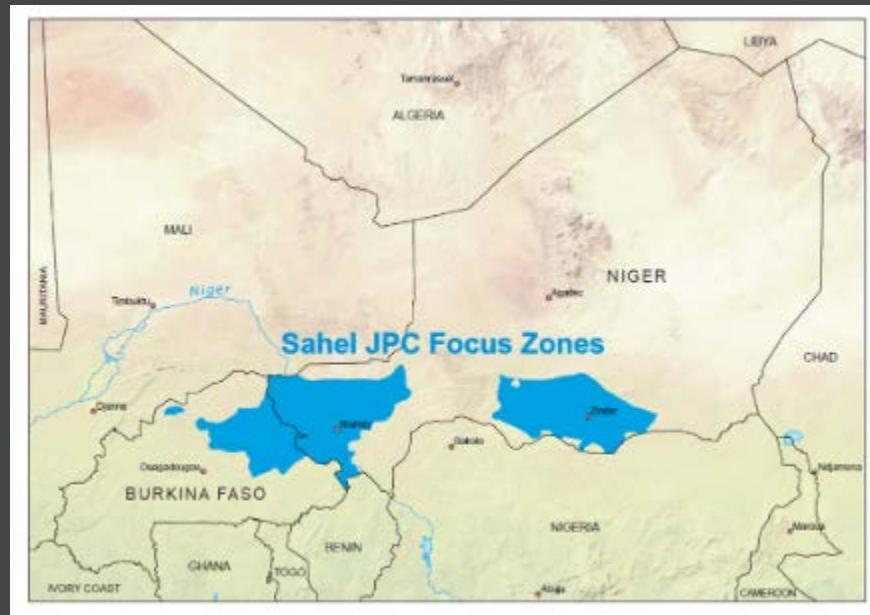


Land Use/Land Cover Maps and trends produced for every country:  
Example of Burkina Faso, 2013



# Mapping and Tracking Land Cover, Land Management Practices, and Tree Cover

- Provide the Resilience in the Sahel Enhanced (RISE) Programs with new maps of unprecedented details
- Help USAID and CILSS geographically target aid investments
- Monitor and evaluate the effectiveness and impacts of these Programs

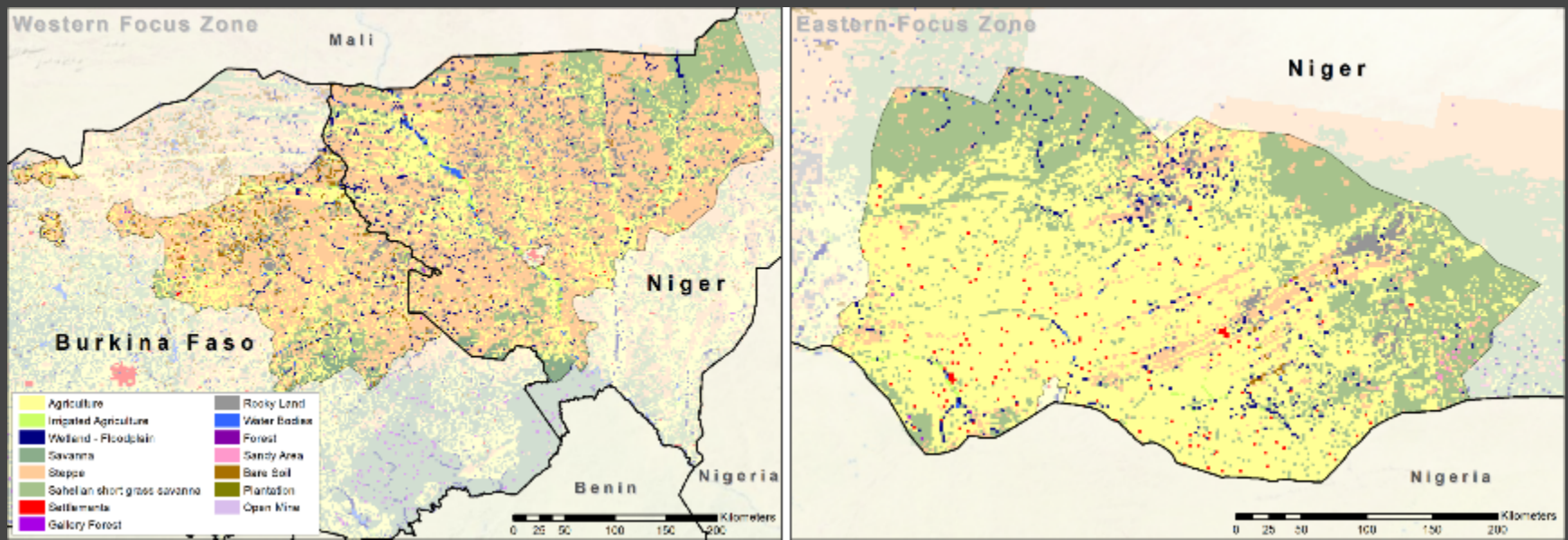


Total area:  
235,200 km<sup>2</sup>

164 communes

# Land Use/ Land Cover

- **Major land cover classes:**
  - Agriculture (yellow): 93,800 km<sup>2</sup> (40%)
  - Steppe (orange): 72,060 km<sup>2</sup> (31%)
  - Sahelian short grass savanna (green): 48,720 km<sup>2</sup> (21%)



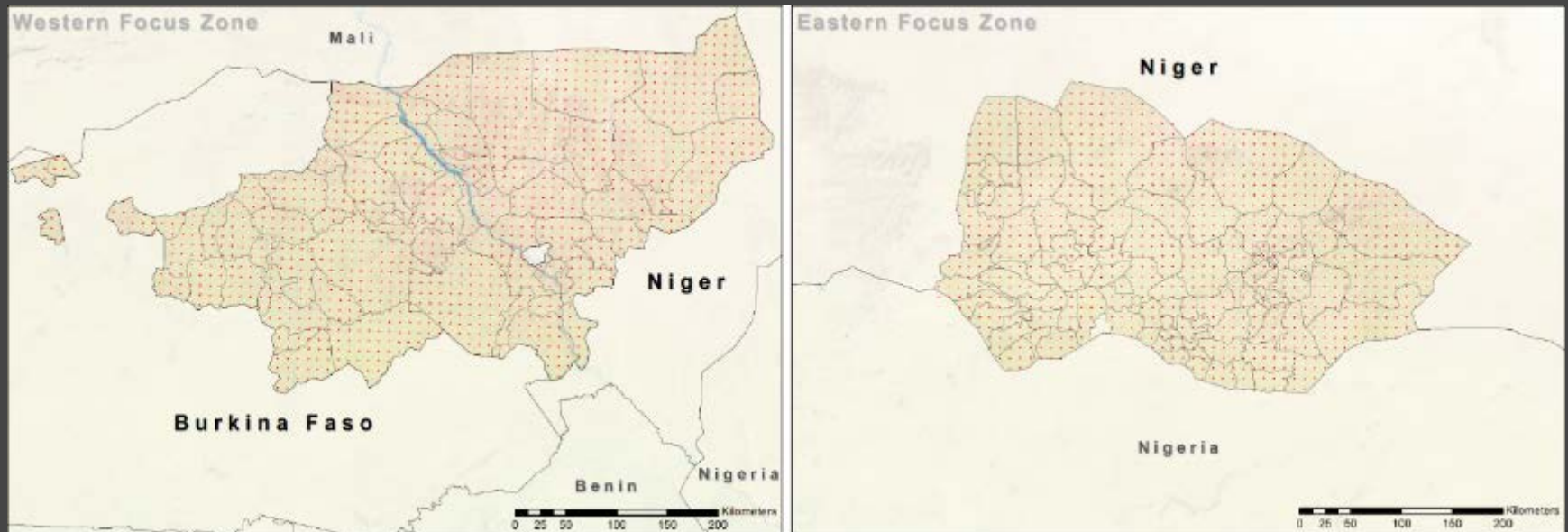
# Mapping of conservation practices and on-farm tree cover density

---

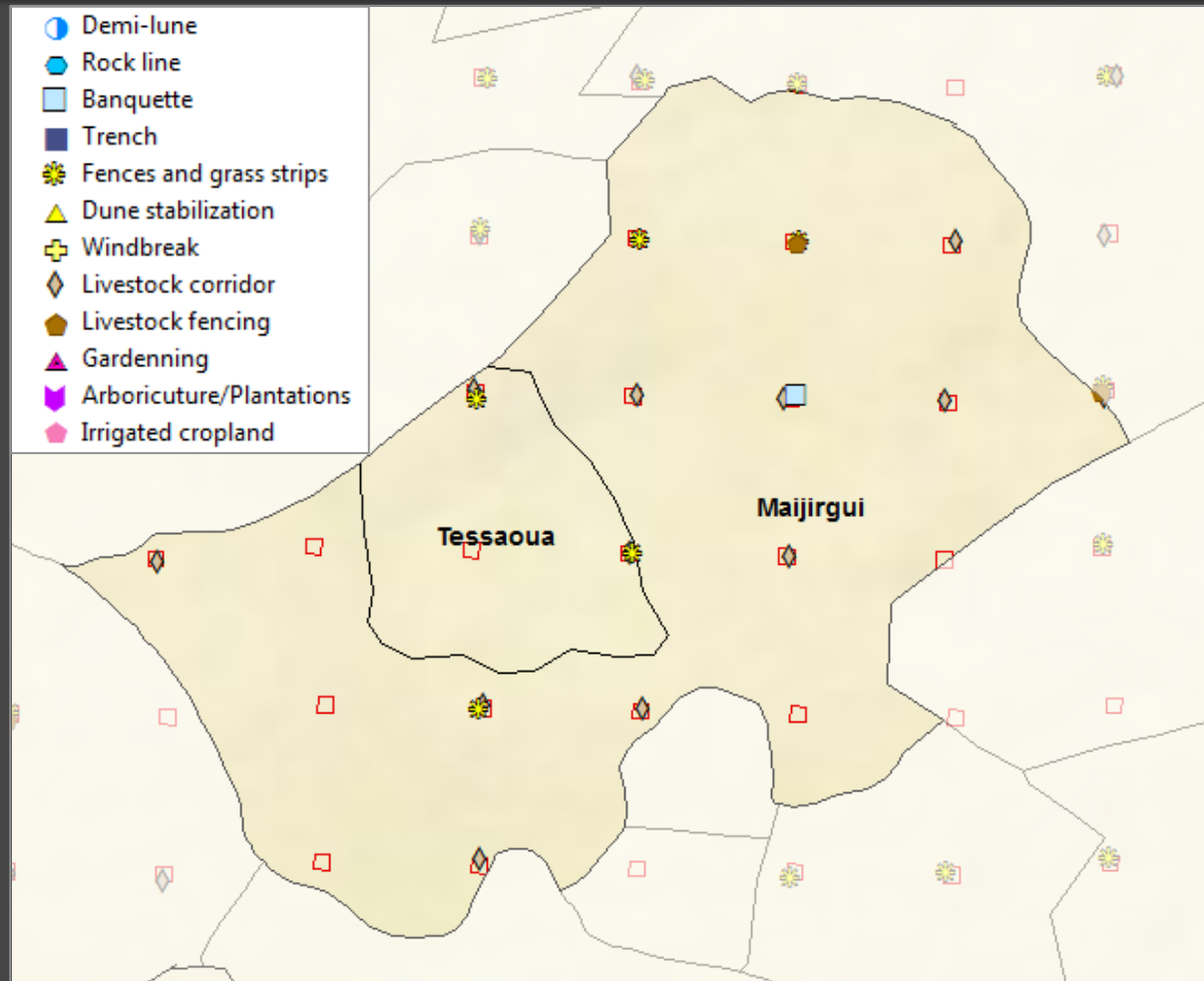
- Use same approach to mapping land cover, tree cover and practices: systematic sampling
  - Allows one to make a map (this cannot be done with random sampling)
  - The analyst defines the resolution of the map (distance between each sample)
  - The analyst defines the size of the sample frame

# Methodology - Mapping conservation practices

- Grid of **1-km<sup>2</sup>** samples over the Burkina and Niger project areas (1 sample every 10 km)
- 2,423 samples in the project areas

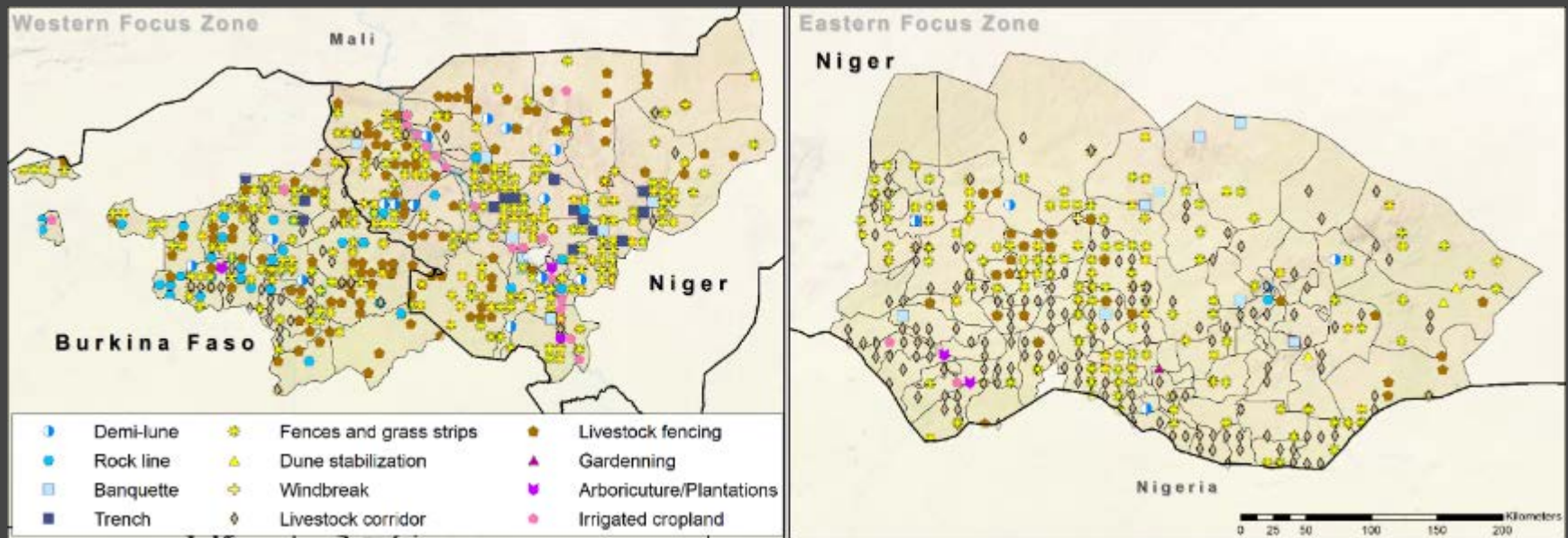


# Using HR imagery, locate the presence/absence of each practice in each sample:



## Results of the practices mapping in the focus zones:

- 2,423 samples in the project areas (10 km apart)
  - 12 different practices
  - 940 practices points mapped



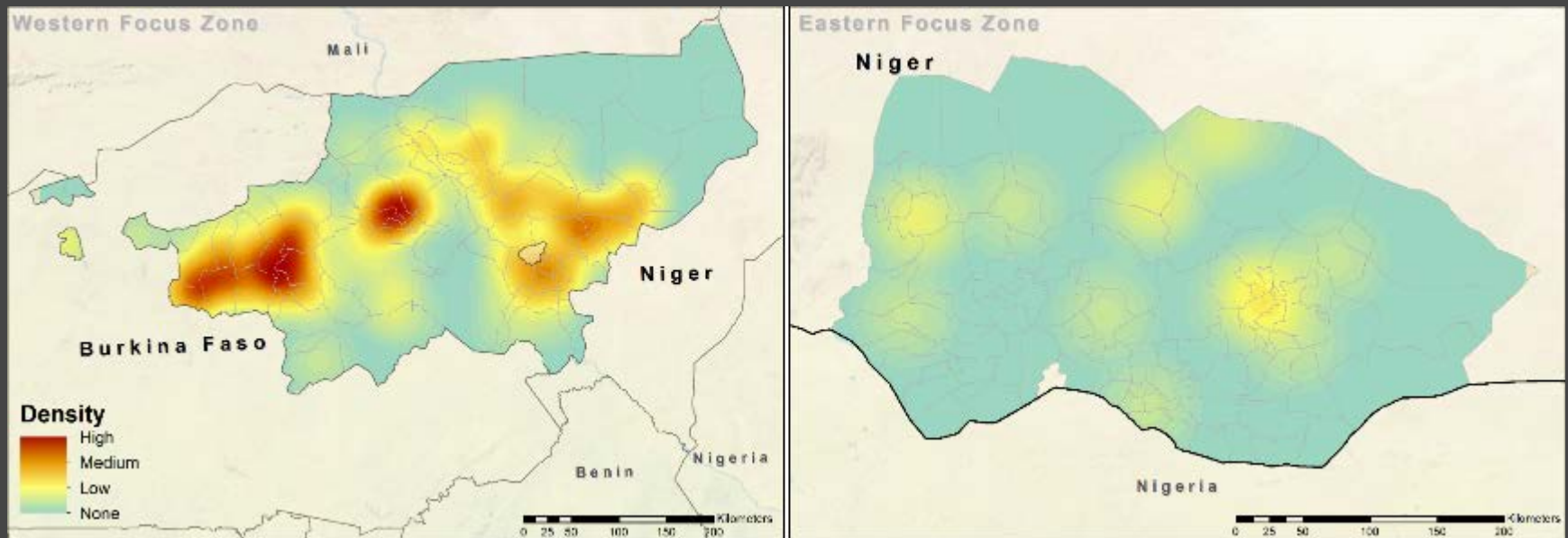
# Using HR imagery, locate the presence/absence of each practice in each sample frame:

- Demi-lune
- Rock line
- Banquette
- Trench
- ☀ Fences and grass strips
- ▲ Dune stabilization
- ⊕ Windbreak
- ◇ Livestock corridor
- ◆ Livestock fencing
- ▲ Gardening
- Arboriculture/Plantations
- ◆ Irrigated cropland



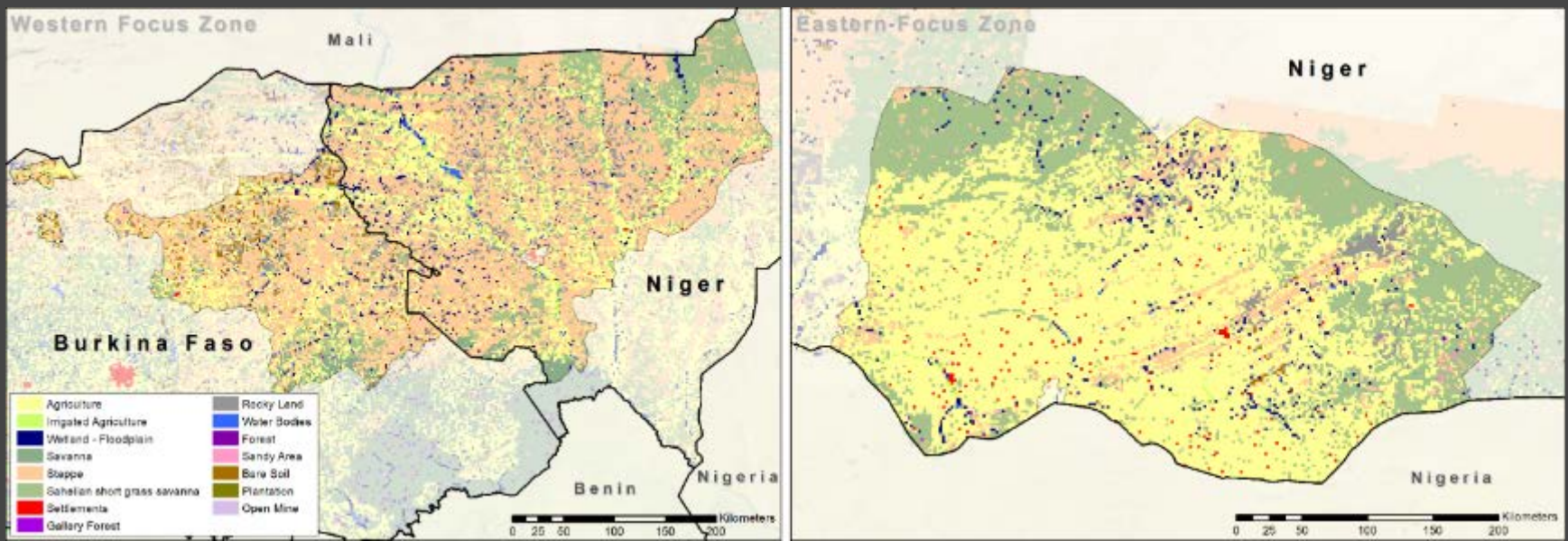
# Results of the practices mapping in the focus zones:

- From the point maps, we can derive a density map of practices
  - Example of density map of Soil and Water Conservation practices (demi-lunes, banquettes, trenches, and rocklines)



# Methodology: Mapping on-farm tree cover

- We looked at tree cover on farmland
  - Agriculture covers 93,800 km<sup>2</sup> (40%) in our study area
  - Farmland was used as a mask to create the sampling grid

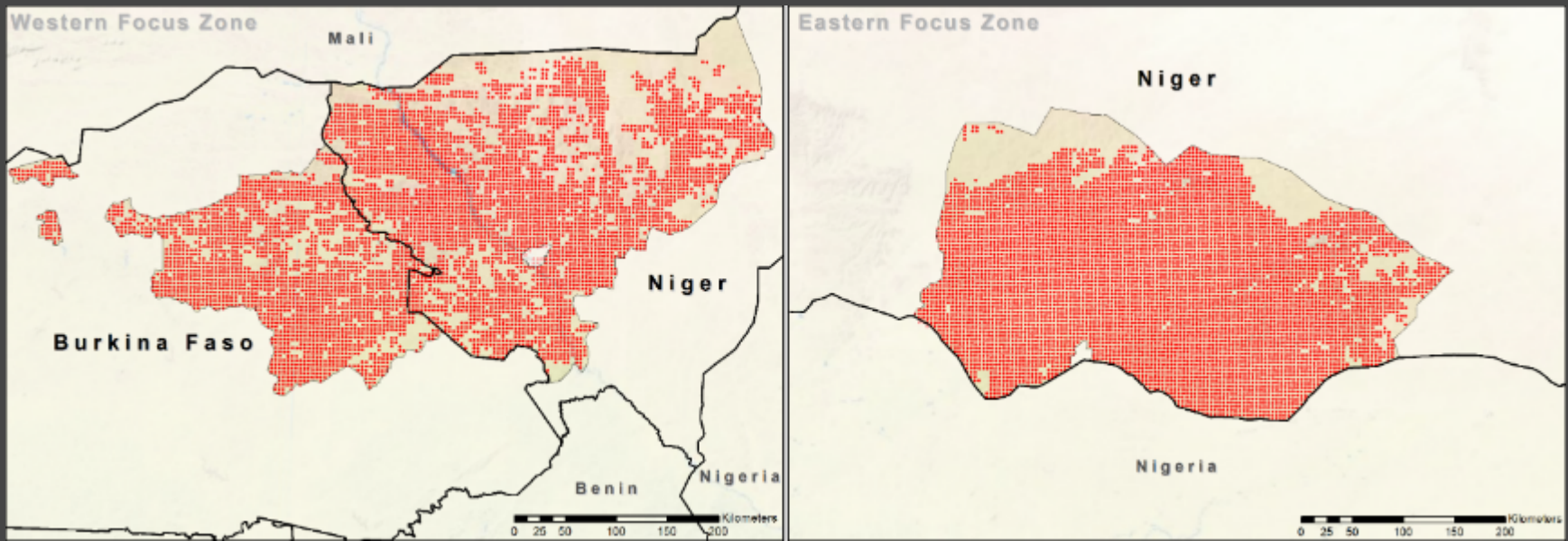


## Regreening: dense tree cover on farmland in southern Niger

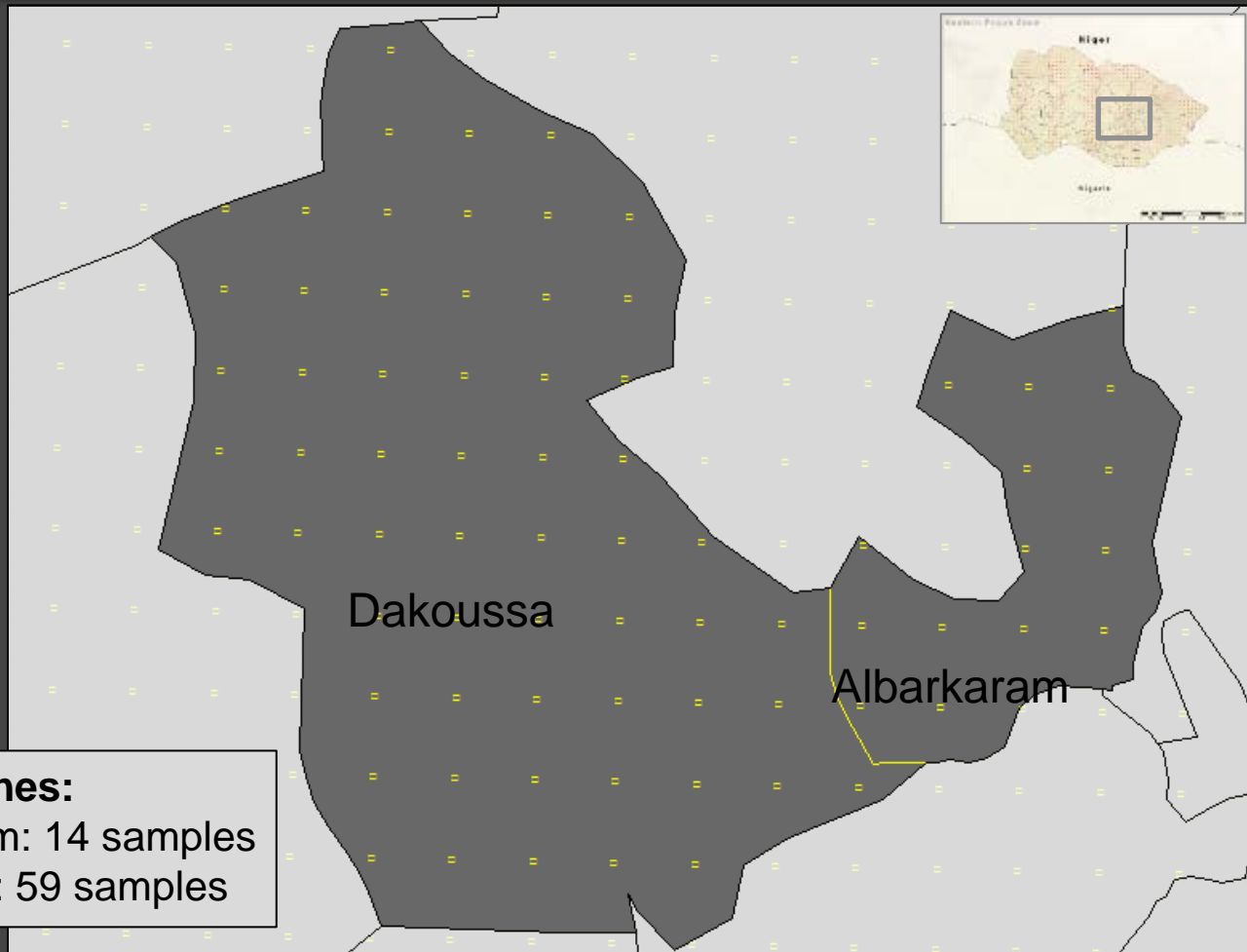


# Methodology: Mapping on-farm tree cover

- Grid of 10-hectare samples in the Burkina & Niger project areas (1 sample every 4 km)
- 11,215 samples in the project areas (samples only on farmland)

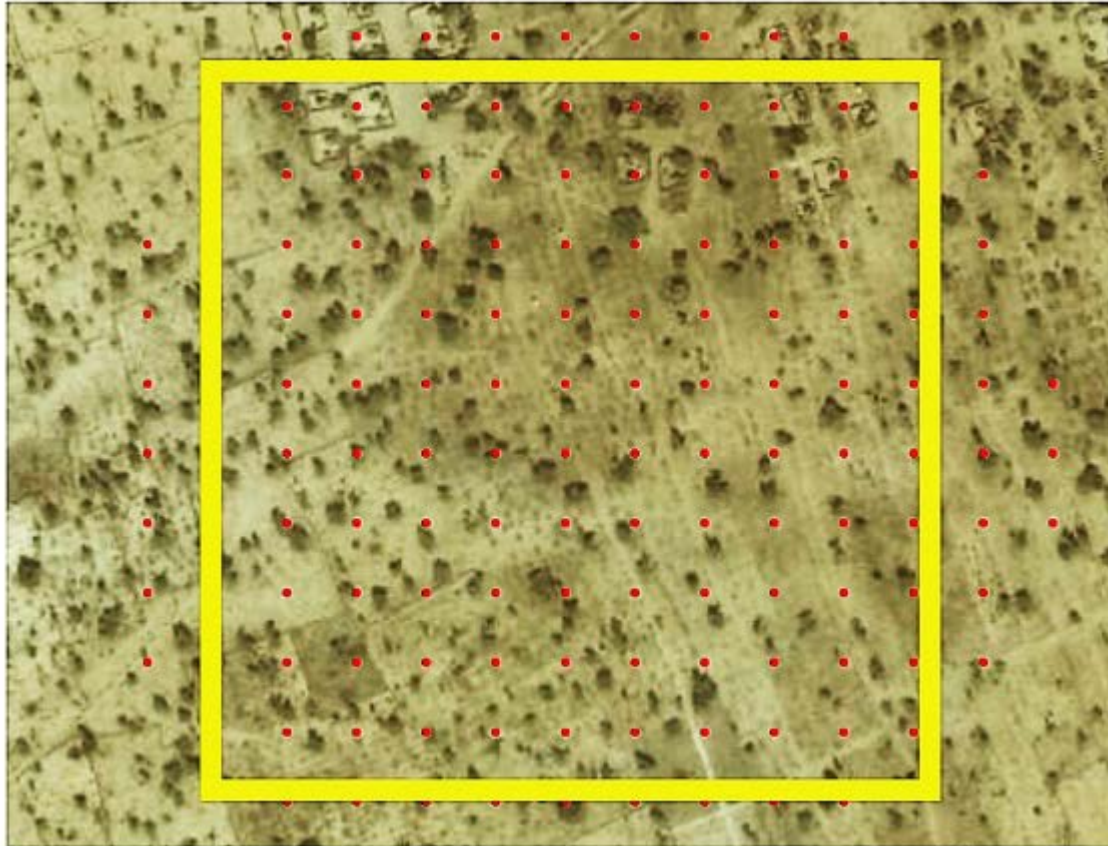


# Grid of 10-ha samples at a local scale (1 sample every 4 km):

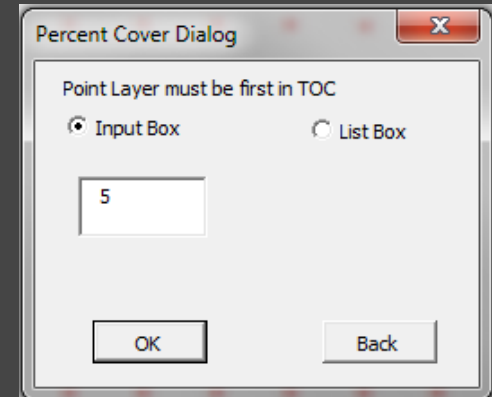


**2 communes:**  
Albarkaram: 14 samples  
Dakoussa: 59 samples

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



0 55 110 220 330 Meters



Table

PointGrid\_RLCM\_2km

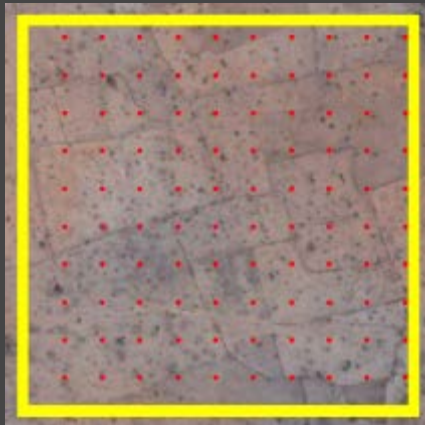
FID	Shape *	ID	X	Y	Percent
87	Point	88	497558.46	1471705.214	2
88	Point	89	499559.349	1471663.405	2
89	Point	90	501560.2544	1471621.615	0
90	Point	91	503561.1765	1471579.845	2
91	Point	92	505562.1155	1471538.095	0
92	Point	93	507563.0716	1471496.366	2
93	Point	94	509564.0451	1471454.656	2
94	Point	95	511565.0363	1471412.966	0
95	Point	96	513566.0453	1471371.296	0
96	Point	97	451495.7259	1470675.413	5
97	Point	98	453496.3133	1470633.16	2
98	Point	99	455496.9113	1470590.928	5
99	Point	100	457497.5203	1470548.715	2
100	Point	101	459498.1404	1470506.523	2
101	Point	102	461498.7721	1470464.351	2
102	Point	103	463499.4154	1470422.198	2

(1 out of 742 Selected)

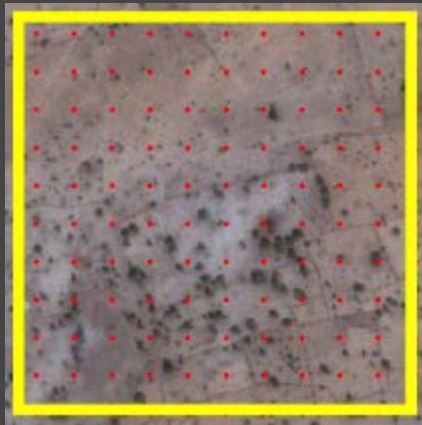
Mapping Scale 1:3,000

# Example of tree cover classes:

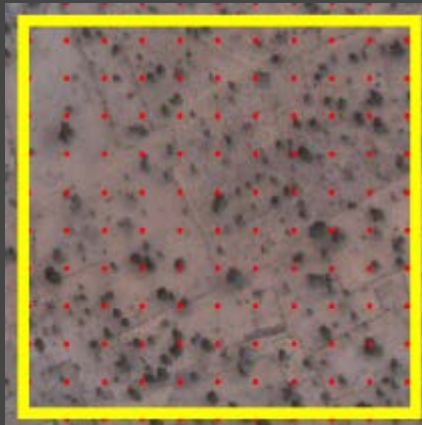
---



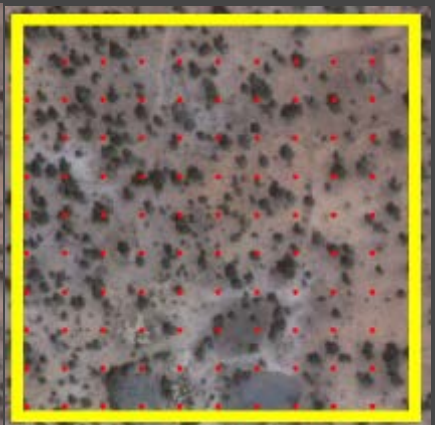
**0 %  
No tree cover**



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

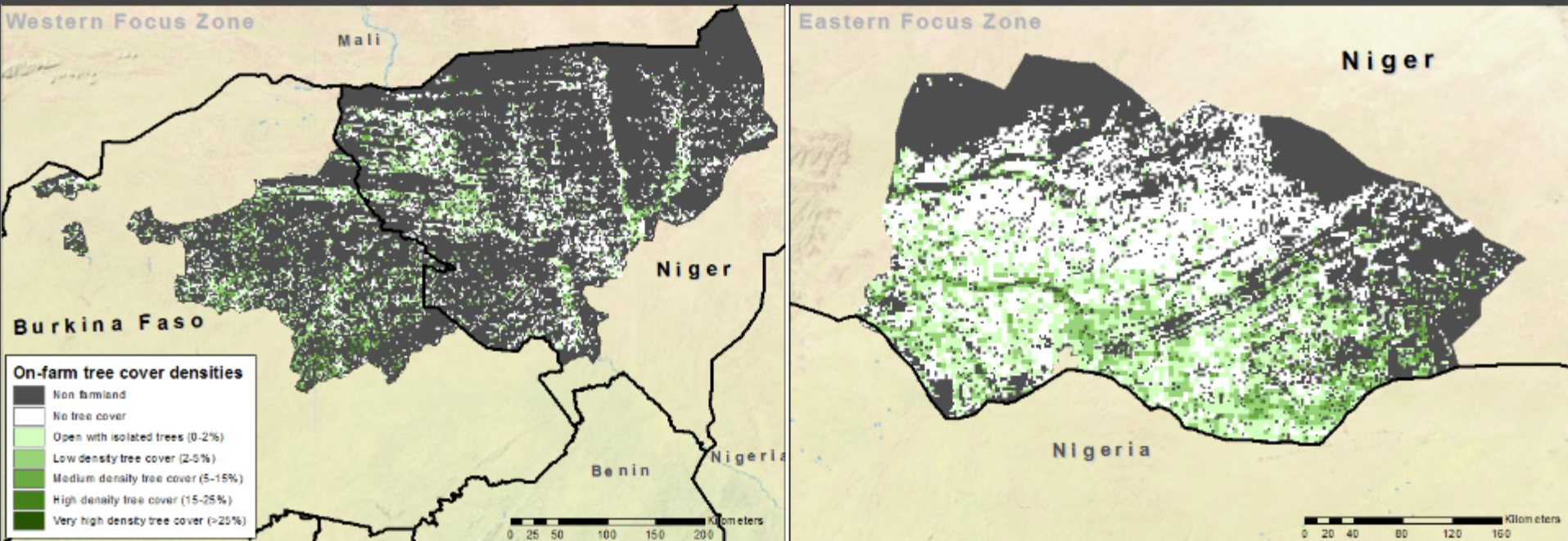


**2 - 5 %  
Low density**

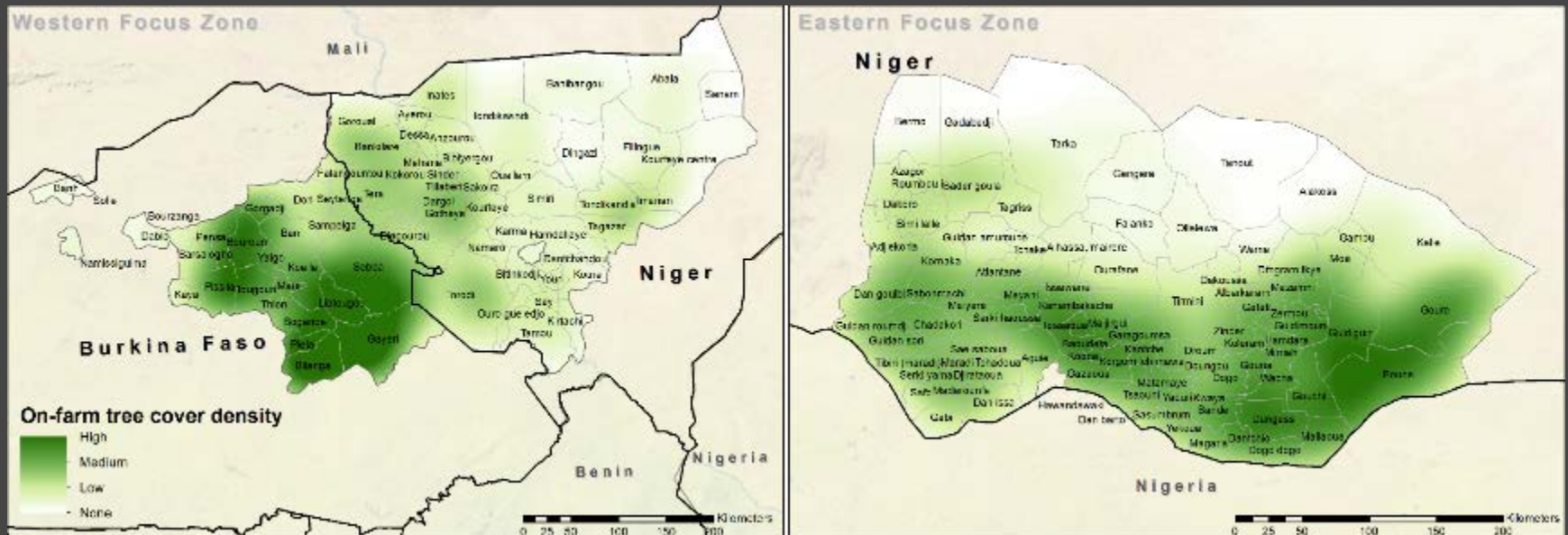


**5 - 15 %  
Medium  
density**

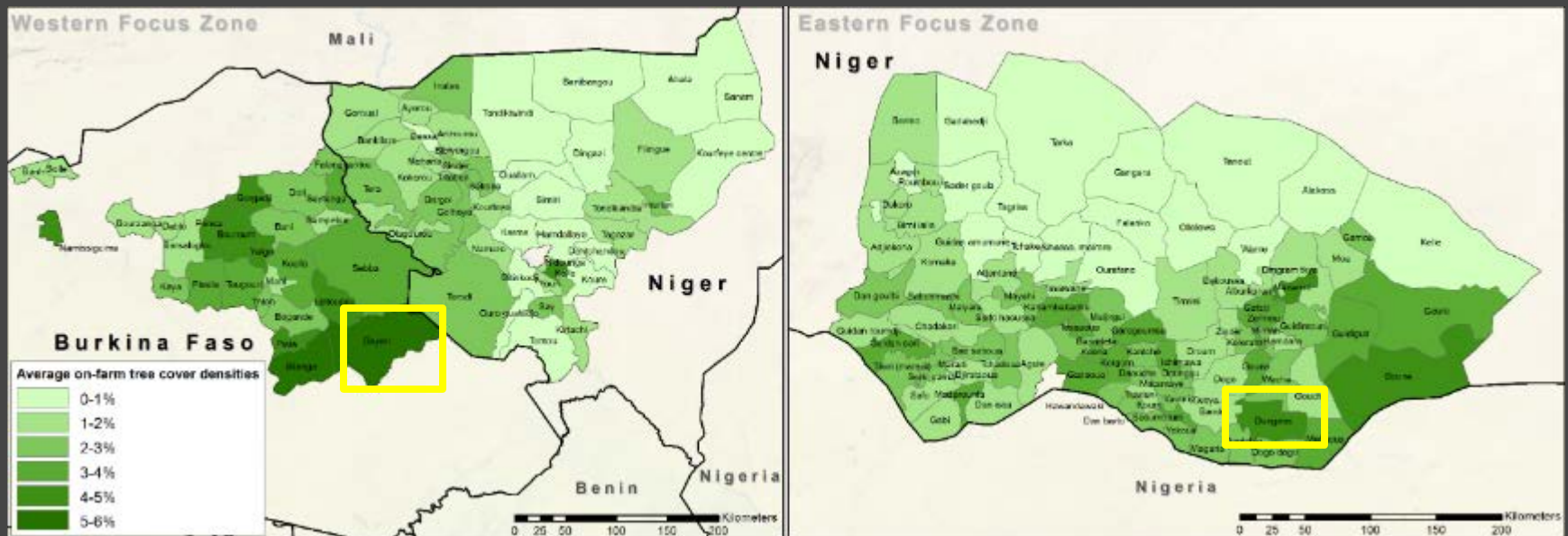
# Results in the Project Areas: On-farm tree cover raster map (4 km resolution)



# Results in the Project Areas: On-farm tree cover density map

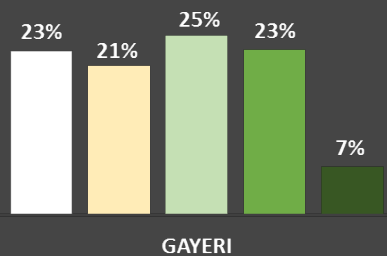
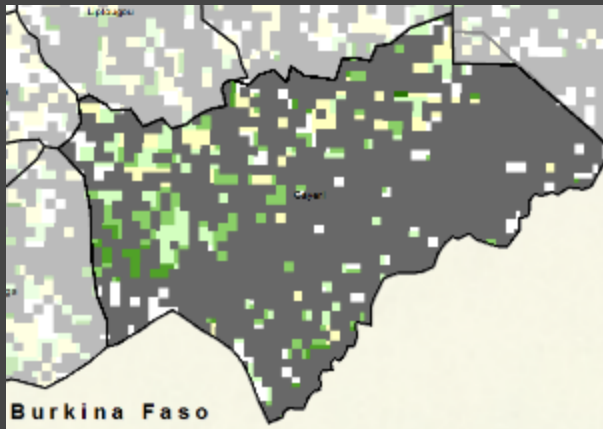


# Results in the Project Areas: Average on-farm tree cover densities by commune

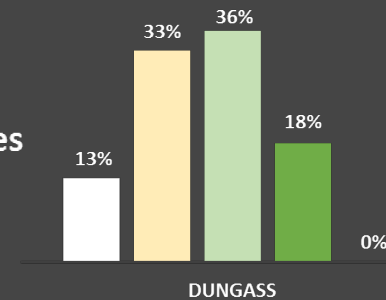
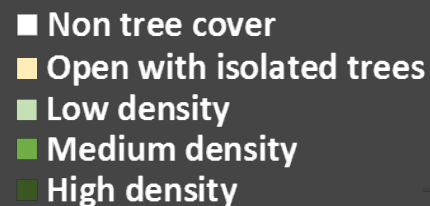
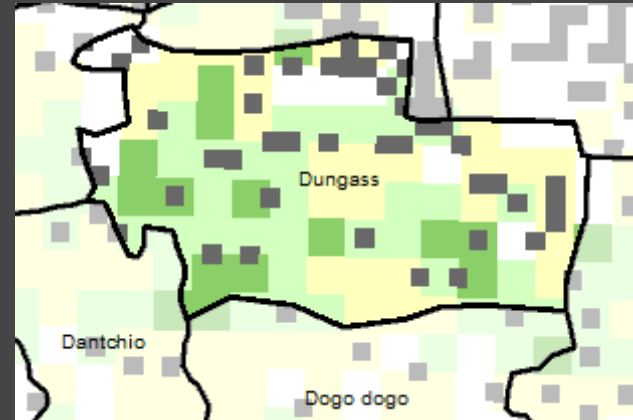


# Comparison of two communes

- **Gayeri:**
  - Farmland covers 20% of the commune, of which 77% is covered by trees
  - Average canopy cover is 5.9%



- **Dungass**
  - Farmland covers 86% of the commune, of which 87% is covered by trees
  - Average canopy cover is 4.4%



# Monitoring on-farm trees in Senegal:

---

Nov 1995



Jan 2011



# Conclusions

---

- New approach: mapping conservation practices and tree cover in drylands has never been done before at this large geographic extent
- A dense systematic sample-based approach allows one to see the patterns of practices and tree cover density at local to regional scales
- The new mapping tools are especially well suited to time-series mapping