Greening Infrastructure in DRC: An Illustration

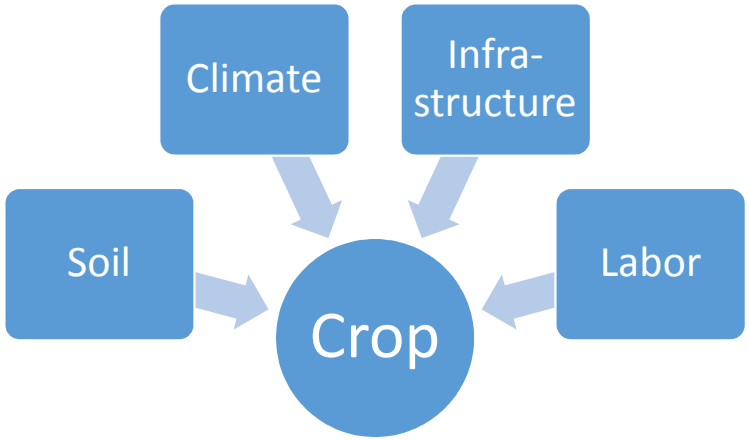
Motivation

- Infrastructure brings many benefits
- Government of DRC aims to create “Growth Poles” to catalyze investment and share benefits of growth regionally
  - *Where* should these Growth Poles be located?
  - Is *deforestation* and damage inevitable?
  - Are there ways of *minimizing* losses and *maximizing* benefits

- Objective – identify areas with **highest economic potential** with **lowest environmental impact – *the optimum.***

Computing Benefits: Production Function Approach

- Main Objective:
  - Understand the relationship between infrastructure endowment, location and agricultural outputs
- Outputs: Amount of each crop produced
  - Crops included: Cassava Bananas/Plantains, Maize, Rice, Palm oil, Beans, and Sugarcane
  - Products chosen based on importance to agricultural sector and data availability
  - Data source: SPAM[1]
- Inputs:
  - Soil and Climate (agro-climatic potential yield, GAEZ)[2]
  - Labor (GRUMP[3])
  - Infrastructure
  - Transport Cost to Nearest Market
  - Other variables affecting economic activity:
    - Conflict
    - Mining activity

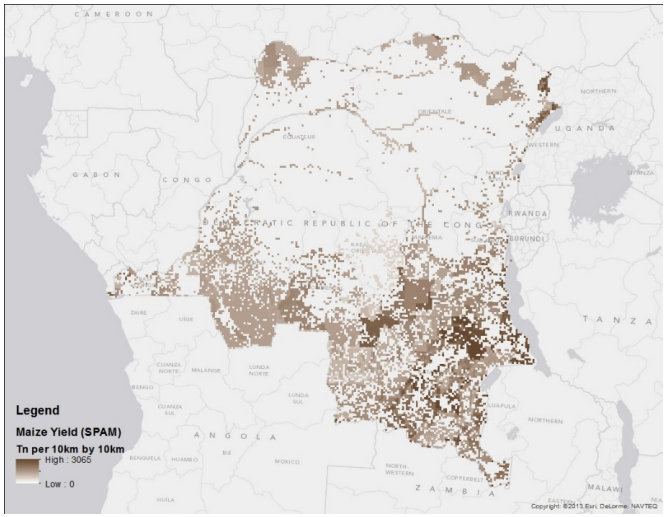


[1] IFPRI Spatial Production Allocation Model
[2] Global Agro-ecological Zones, IIASA/FAO
[3] Global Rural-Urban Mapping Project

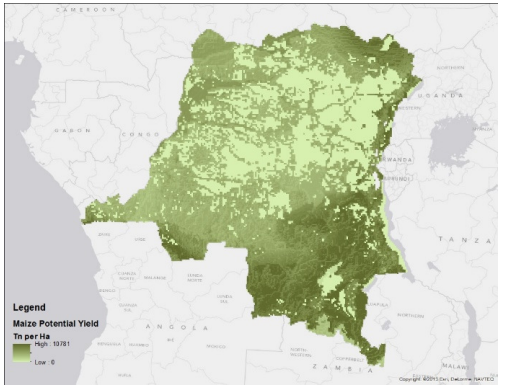
Statistical Methodology

All Outputs and Inputs are Measured at the Pixel Level

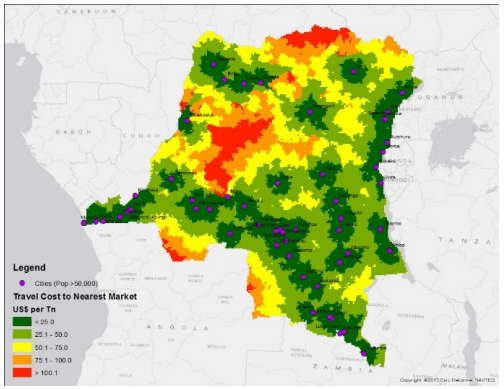
Current Production of Maize (tons)



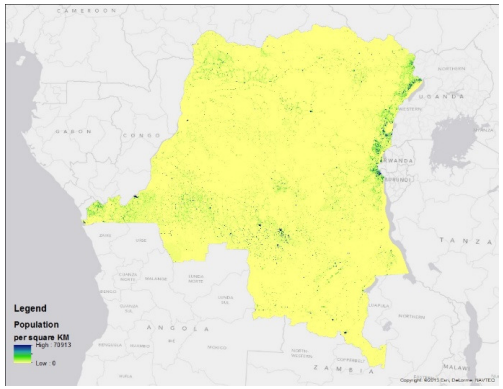
Agro-ecological Potential Yield of Maize



Transport Cost to the Nearest Market ($/Ton)



Total Population



Preliminary Results:

For a **10% reduction in transport costs** to the nearest market, crop production increases…

Crop	Elasticity
Cassava	2.6%***
Banana/Plantain	12.4%***
Maize	0.11%
Ground nuts	6.6%***
Rice	4.6%***
Beans	12.3%***

*** Significant at 1% level
** Significant at 5% level
* Significant at 10% level

Roads and Conflict

For a **10% reduction in transport costs** to the nearest market, crop production increases…

Crop	Elasticity- Low Conflict Areas	Elasticity- High Conflict Areas	Entire Country
Cassava	4.3%***	-2.2%	2.6%***
Banana/Plantain	14.4%***	3.3%***	12.4%***
Maize	1.5%	-2.7%	0.11%
Ground nuts	8.0%***	1.9%	6.6%***
Rice	3.6%***	6.9%***	4.6%***
Beans	13.5%***	9.9%***	12.3%***

*** Significant at 1% level
** Significant at 5% level
* Significant at 10% level

A further measure of road benefits – household welfare and poverty

- **Two indicators of economic welfare:**
  - **wealth index**
  - -measure of living standard calculated based on ownership of consumer durables

  - **multi-dimensional poverty**
  - -indicates whether households are poor in terms of ownership of consumer durables, health standard and education level.

- **Data source:**
- Demographic and Health Survey

Preliminary Results:

For a **10% reduction in distance** to the nearest market, welfare indicators changes by

Indicator	Elasticity
Wealth index	.97%***
Multidimensional poverty indicator	-.92%***

*** Significant at 1% level

But there may be other consequences….

- Roads (and other forms of economic activity) may have adverse impacts on natural habitats and forests

- **How large are these impacts?**

- **What does the evidence tell us?**
  - **Provide a preliminary snapshot of impacts**
  - **Next step to estimate and quantify the determinants of change in forest cover and assess correlates of species endangerment**

Approach

- Use **IUCN Data on 50 Year Extinction Probability** – *to determine where significant biodiversity is located*
  - Other indicators are available and also need to be examined, but few as comprehensive

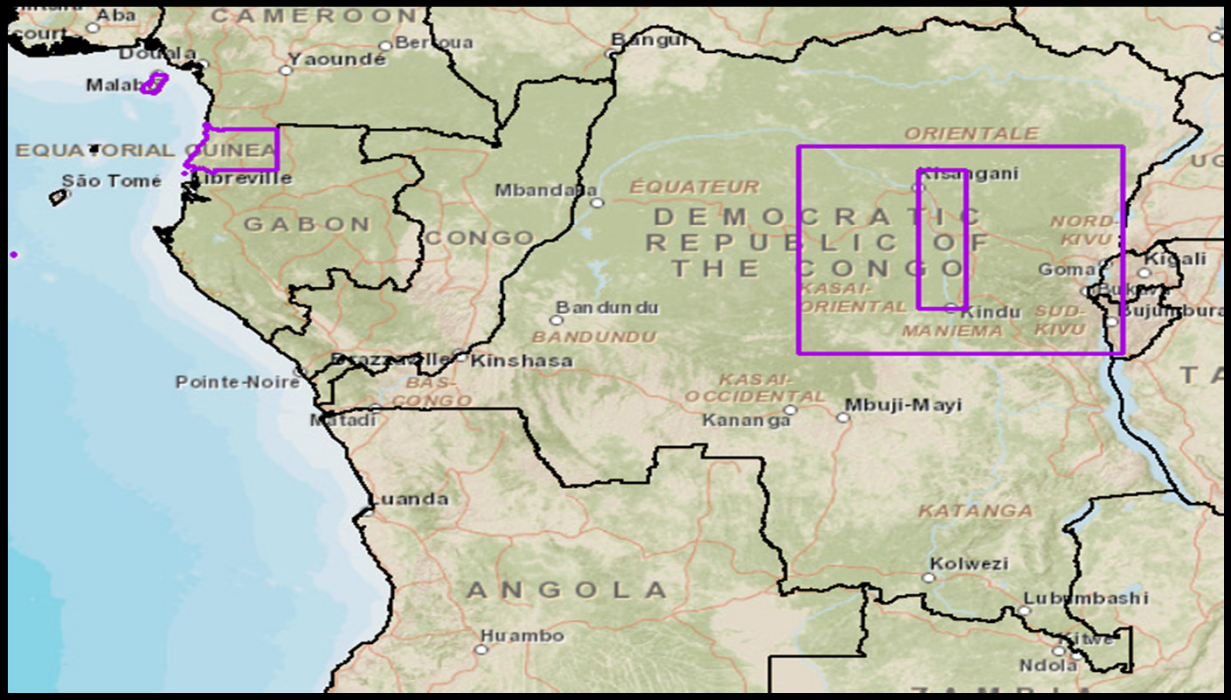
- Hansen's **deforestation data 2000-2012** (at 0.025 degrees resolution) – *to determine what and where impacts have occurred*
  - This is the best and most recent data that has not been used before to our knowledge

- **Overlay** location of roads and other features (PAs) on forest cover
  - Is there any correlation between roads and deforestation over time?
  - Are PA's effective?

- **Assessment is preliminary and illustrative**, but informative……

Example 1 Equatorial Guinea

- Donor funded scheme to improve surface (pave) all major roads
- Examine **change in forest cover around roads and Protected Areas** (marked in green)



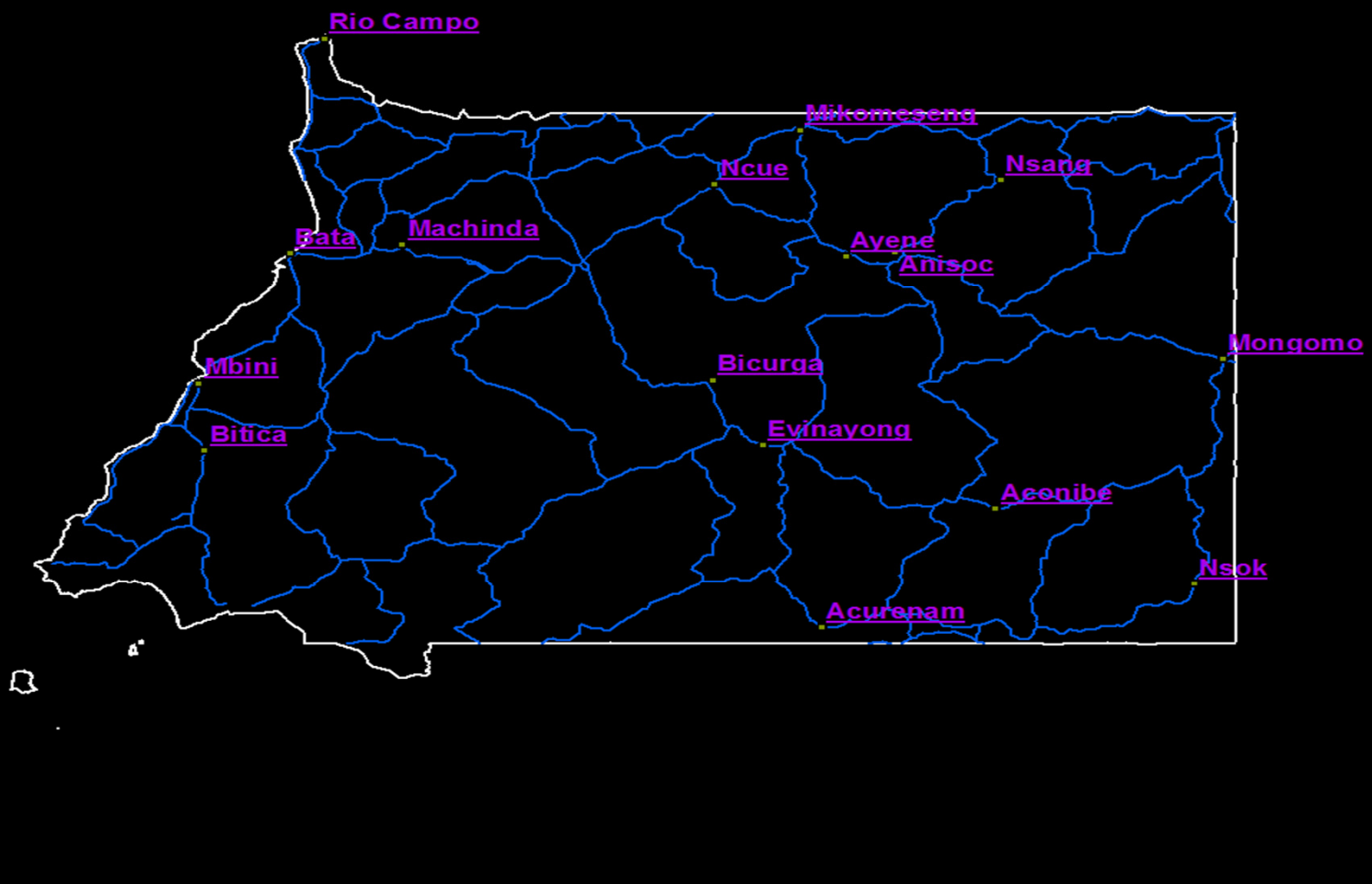
Roads,
Endangered Species
and
Deforestation

Cases
From
Equatorial Guinea,
Eastern DRC
And
The Kindu-Kisangani
Corridor

Equatorial Guinea

Rapid Road Upgrading, Endangered Species, And Deforestation

Equatorial Guinea



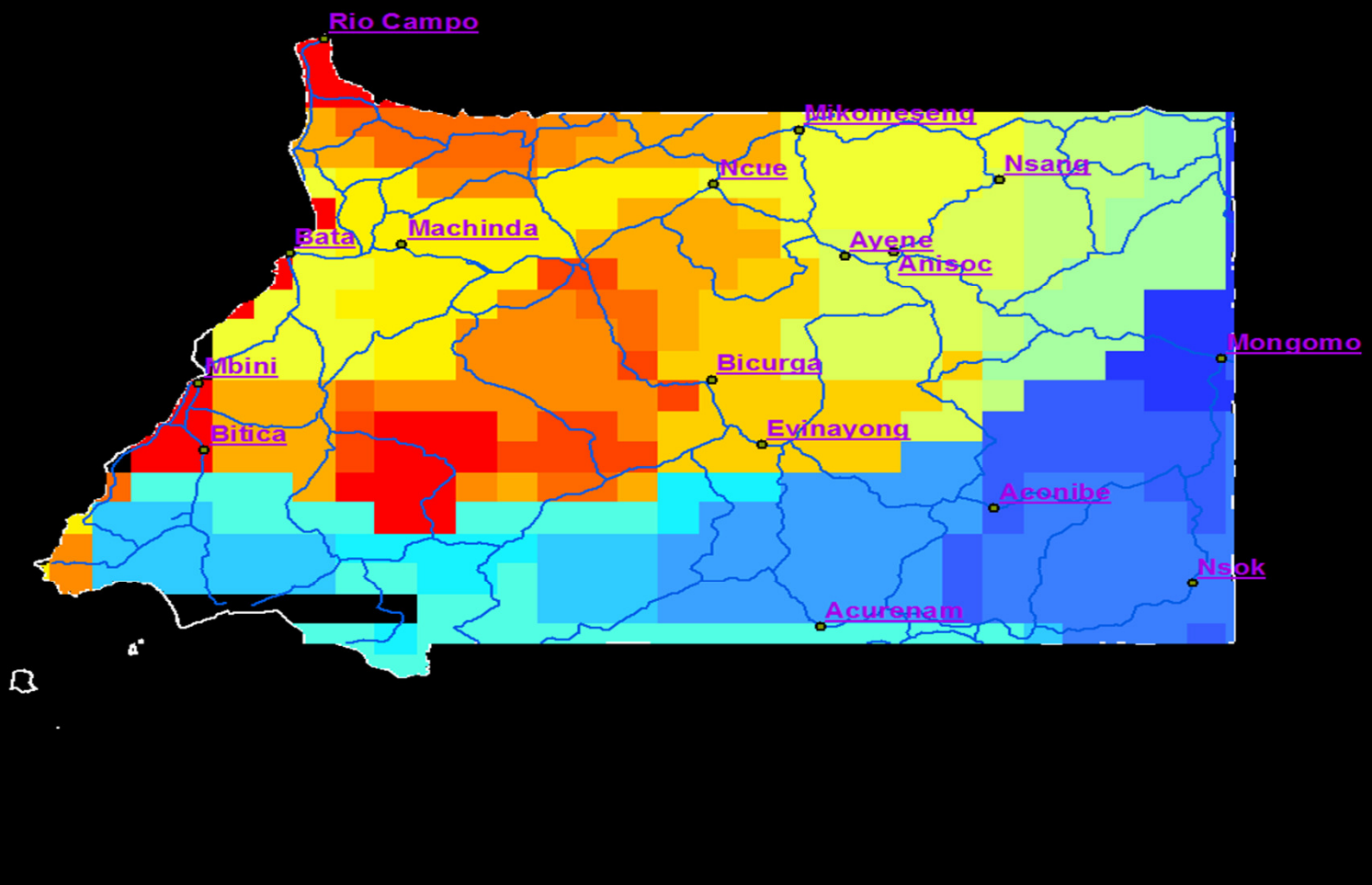
Forest Clearing Areas

Protected Areas

Roads

More Endangered Species

Equatorial Guinea



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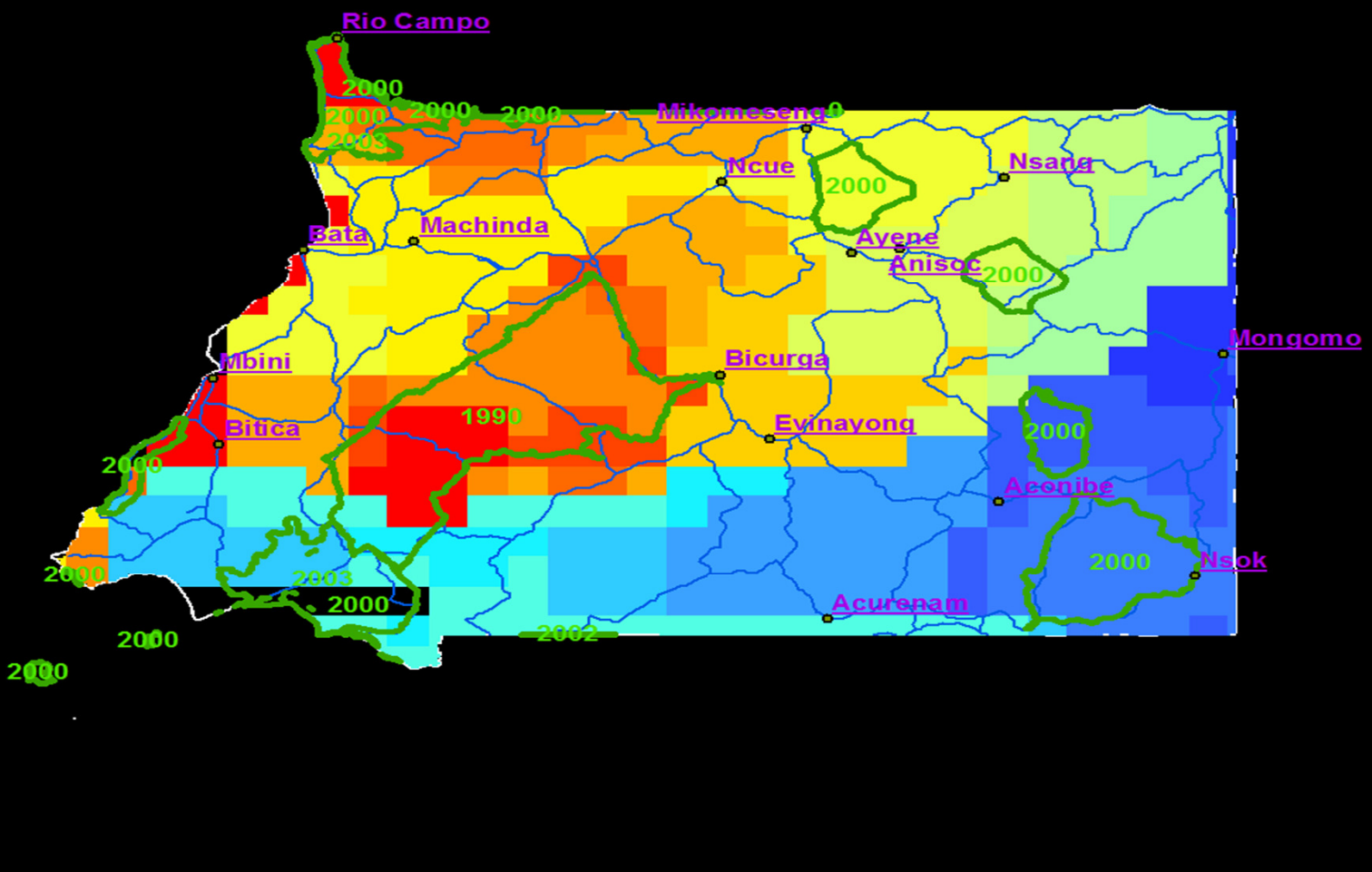

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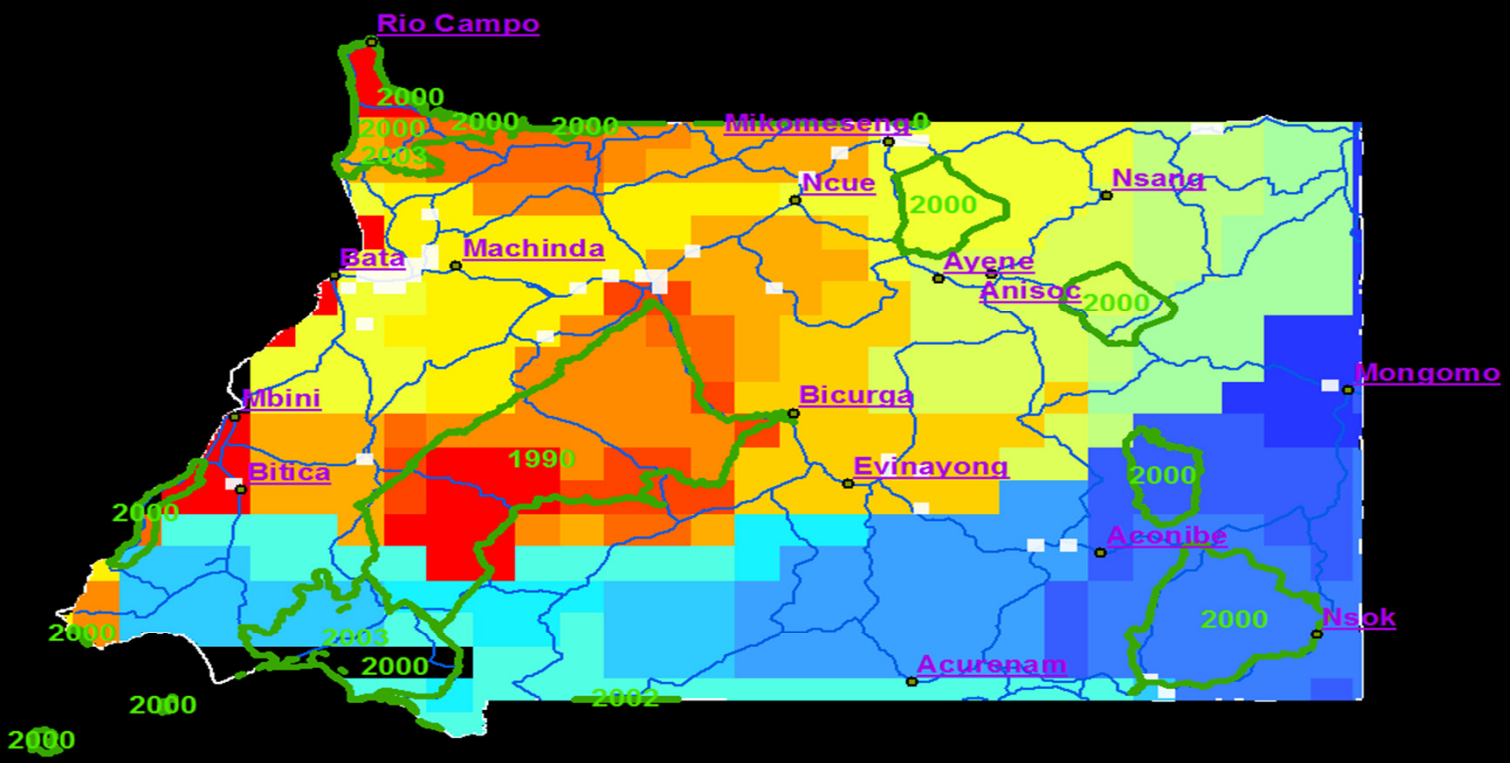
2001



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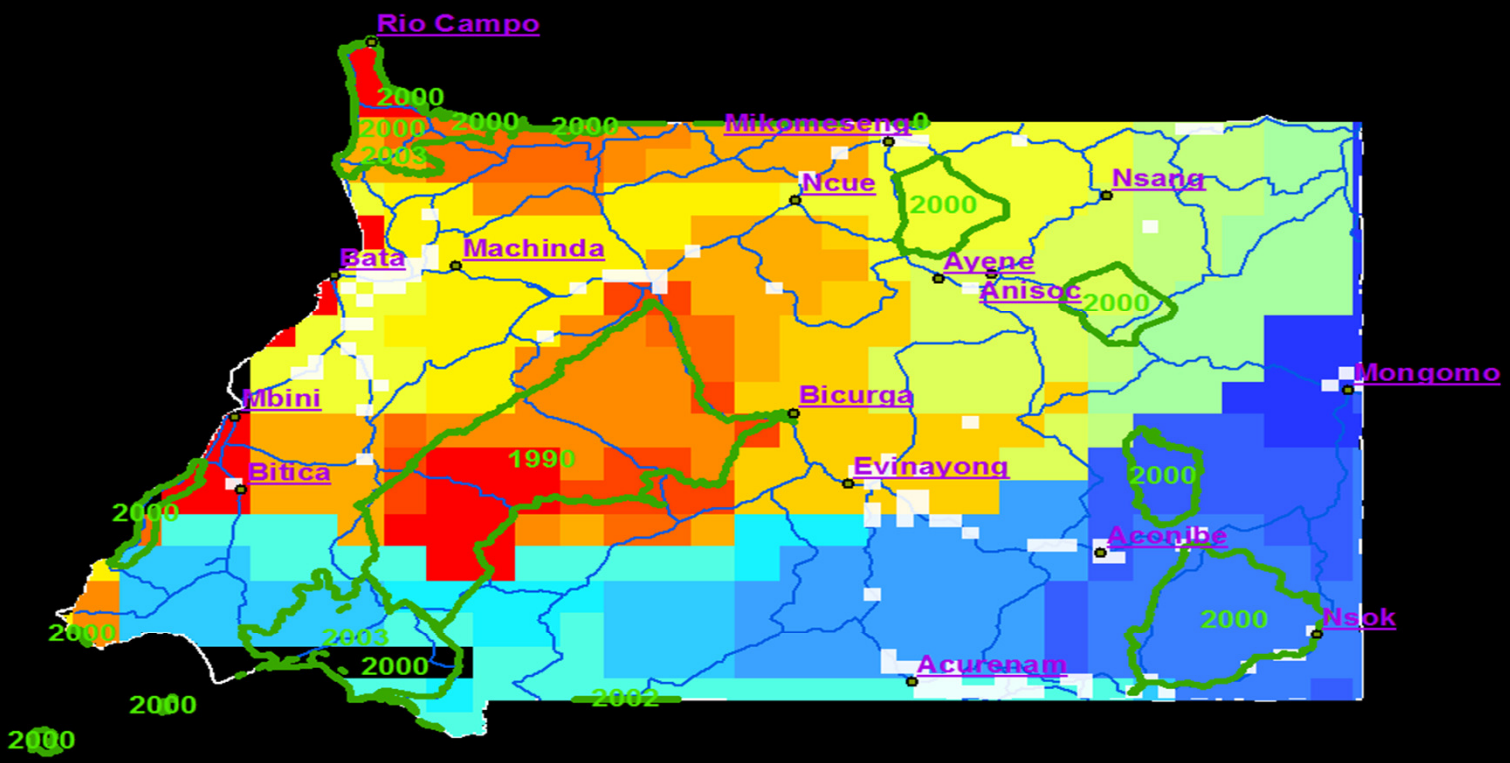

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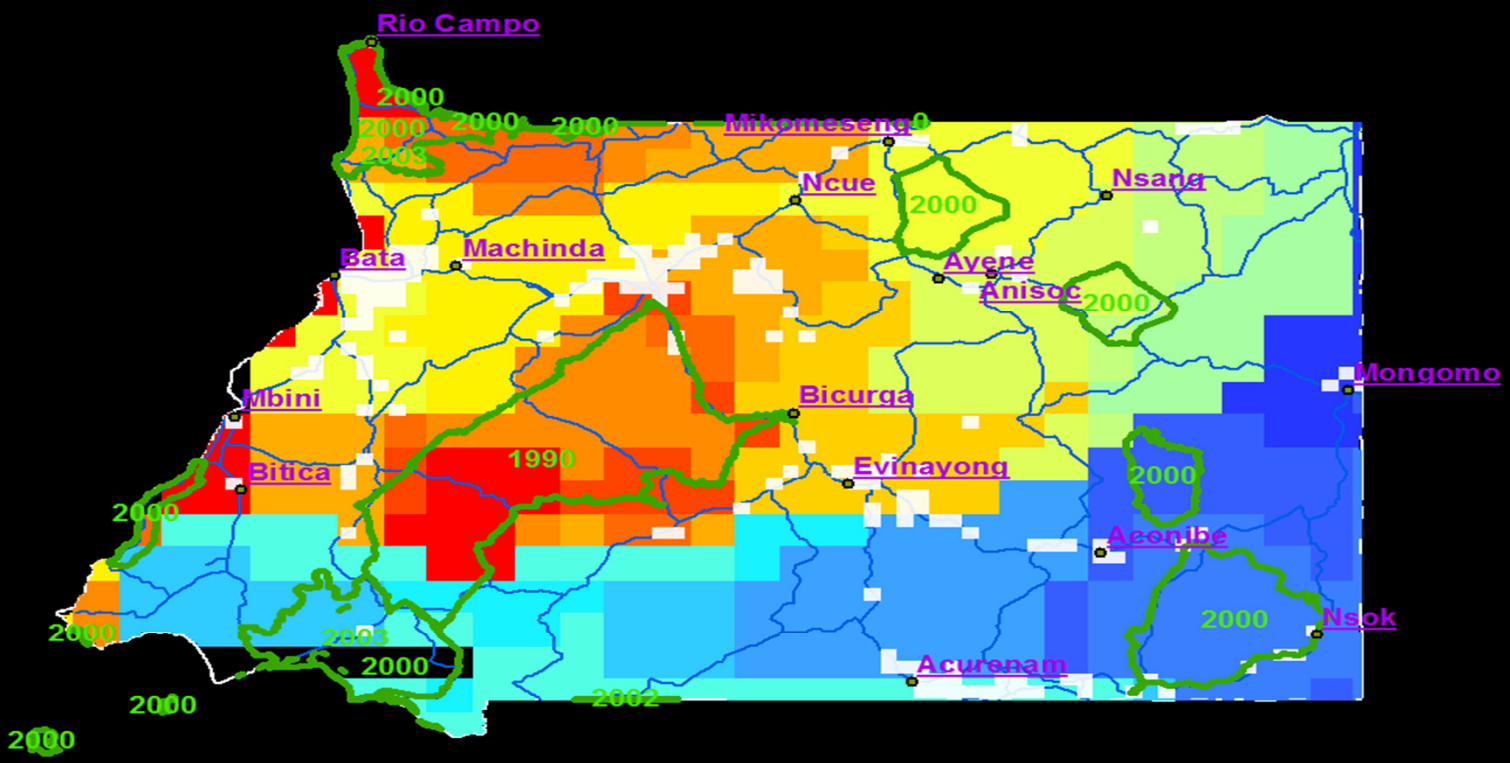
2003



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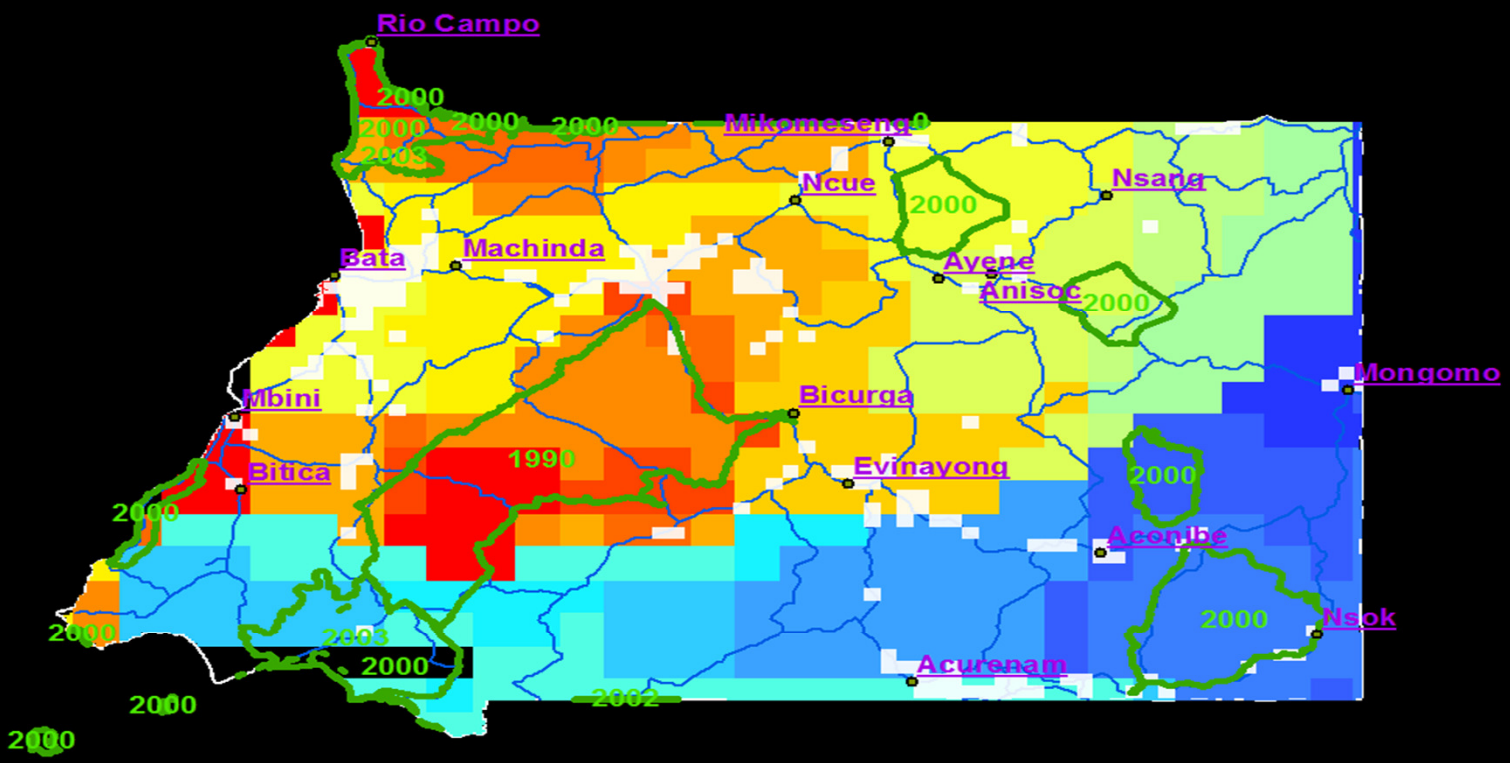
2004



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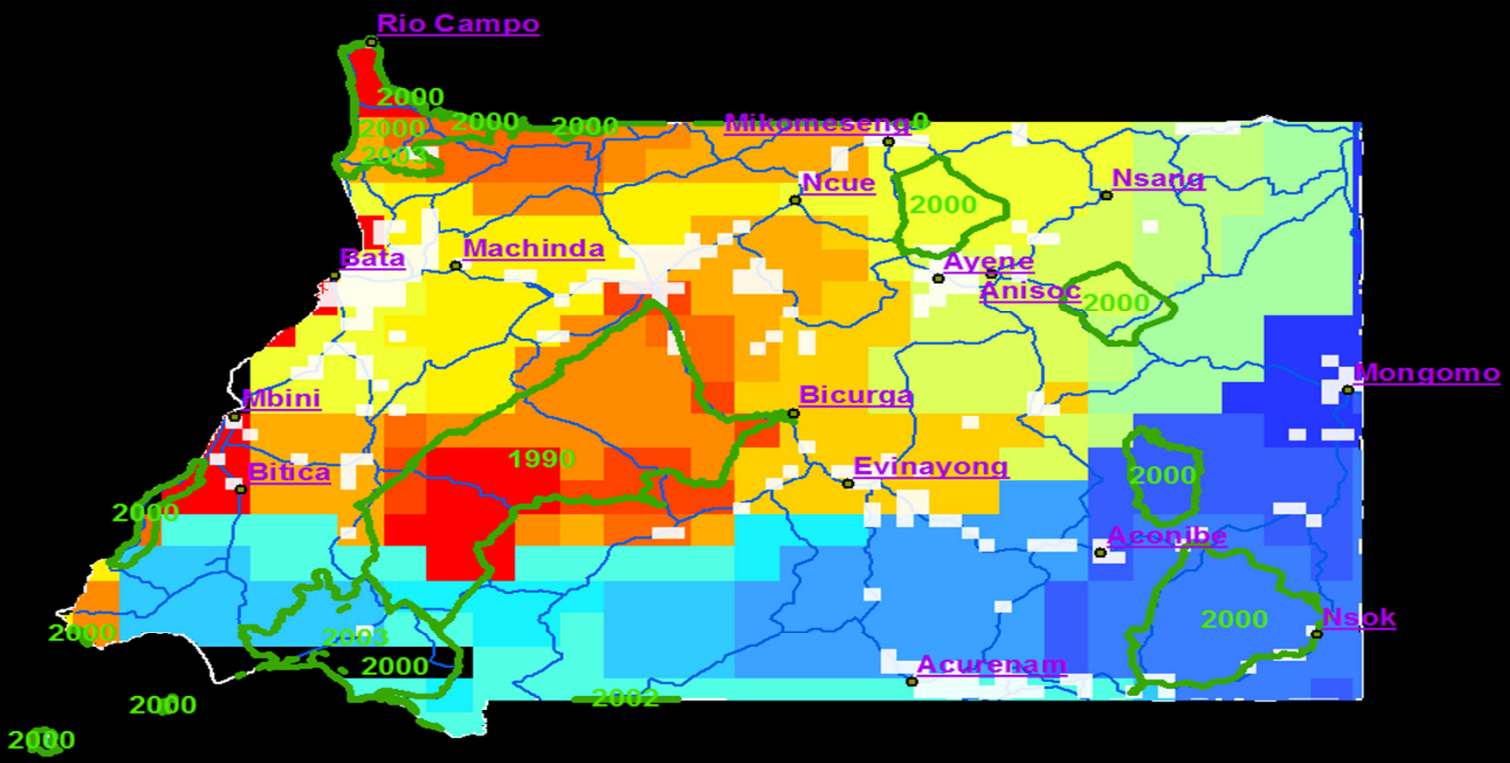

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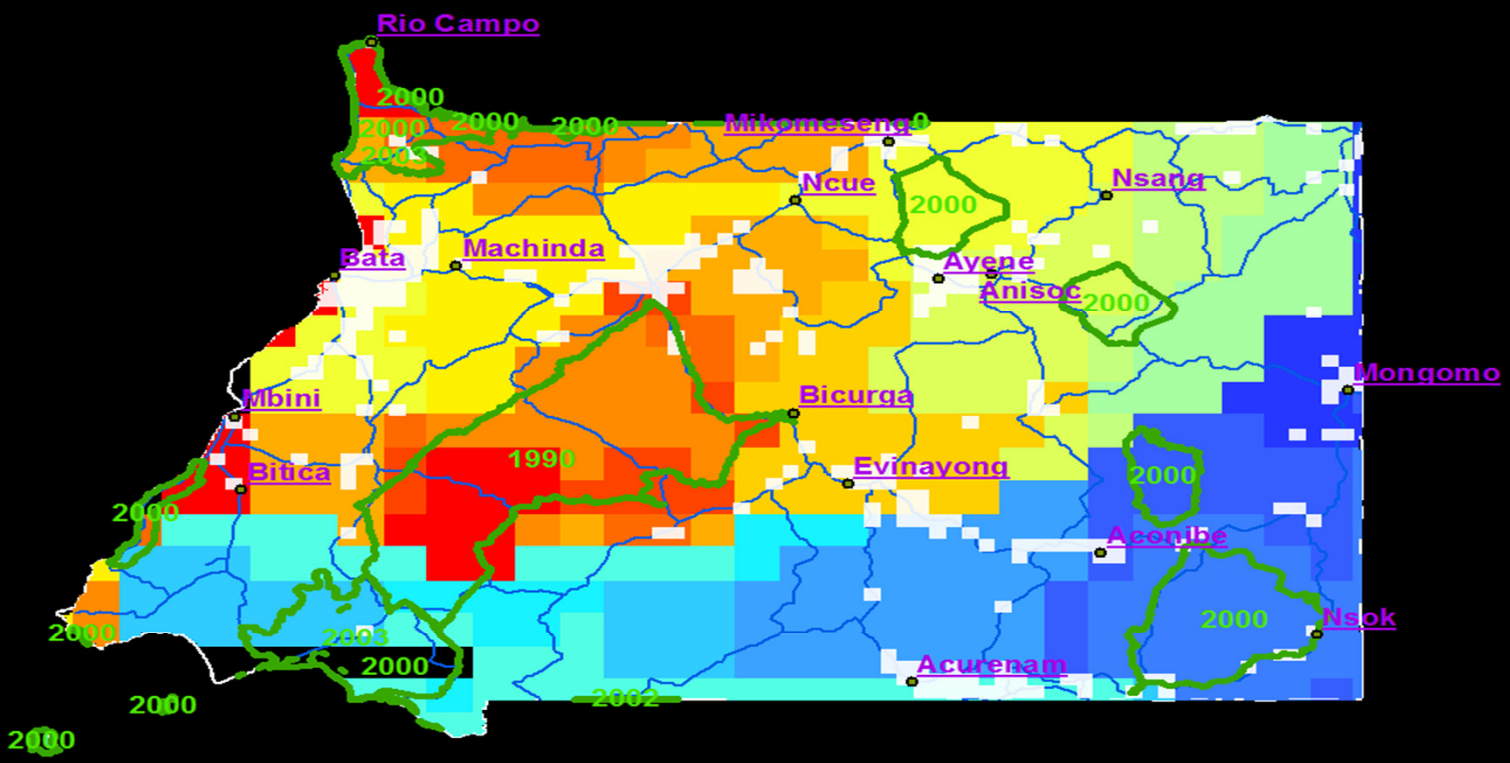
2006



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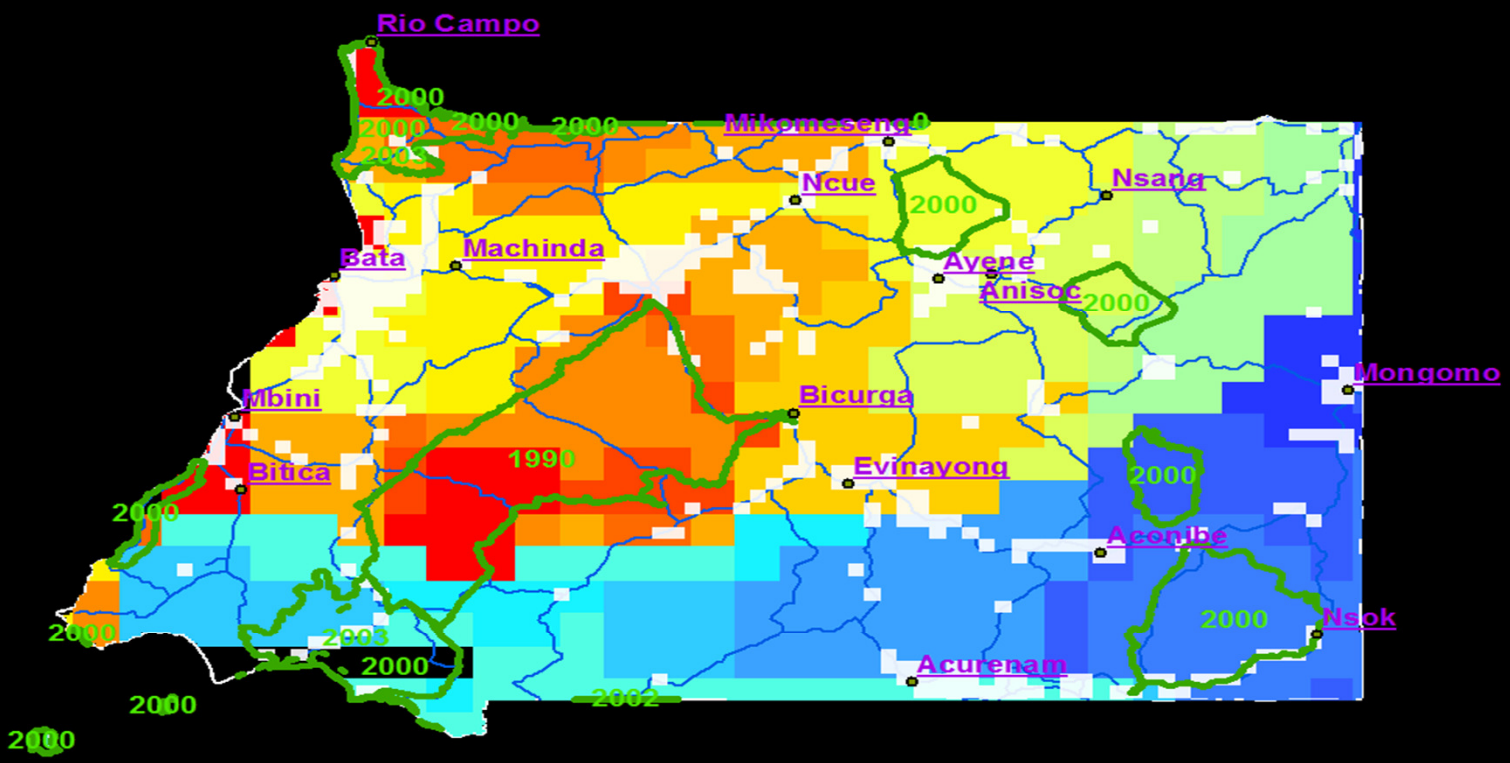

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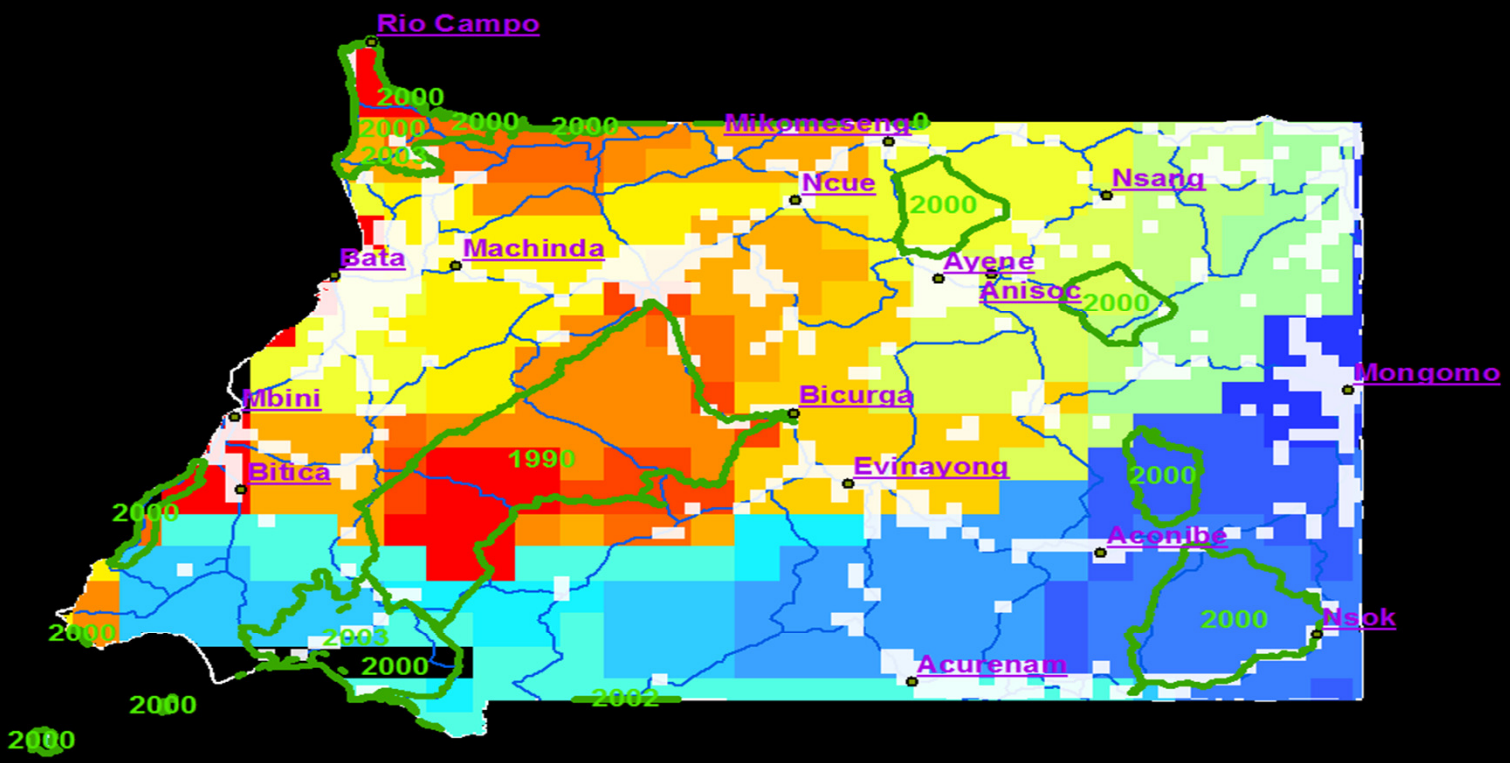
2008



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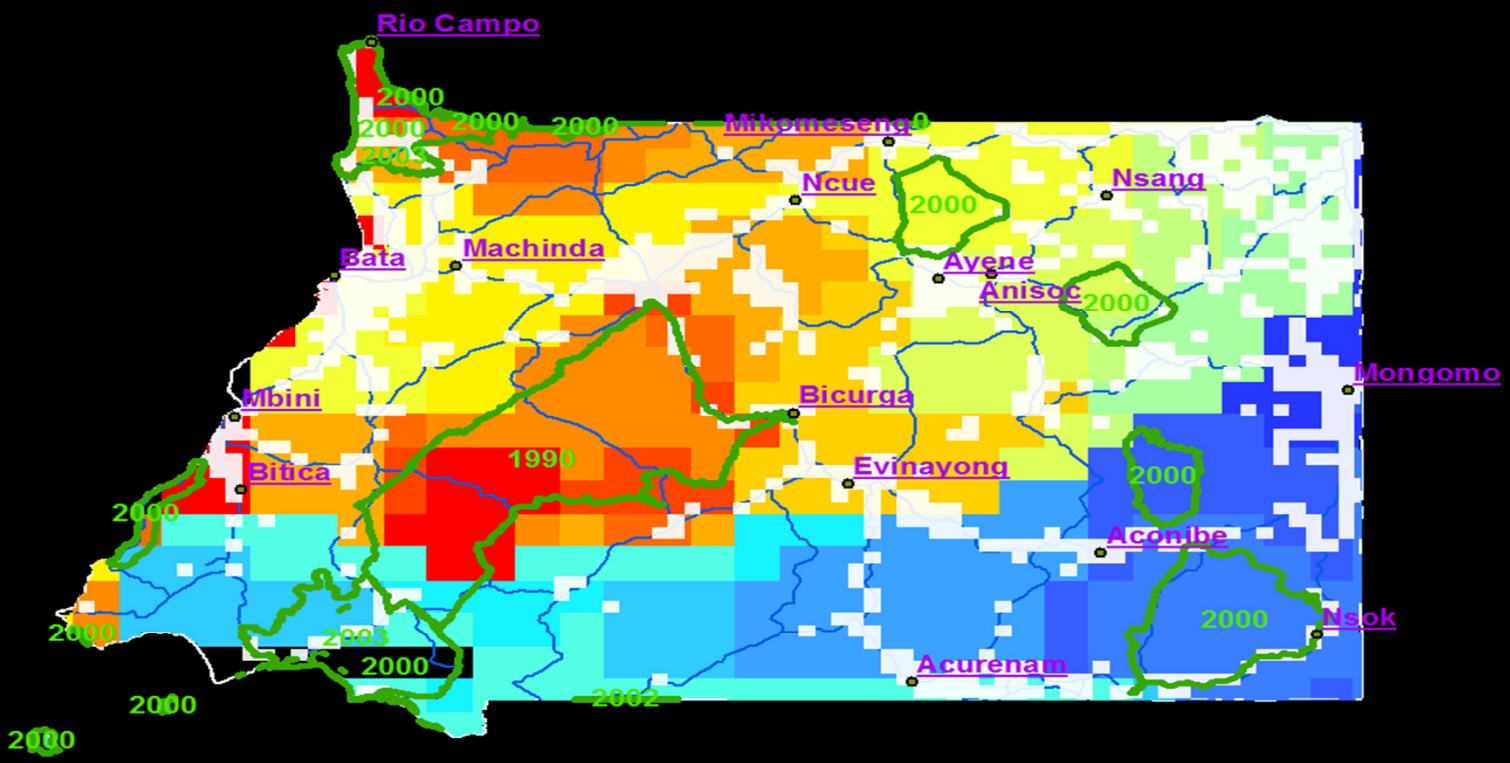

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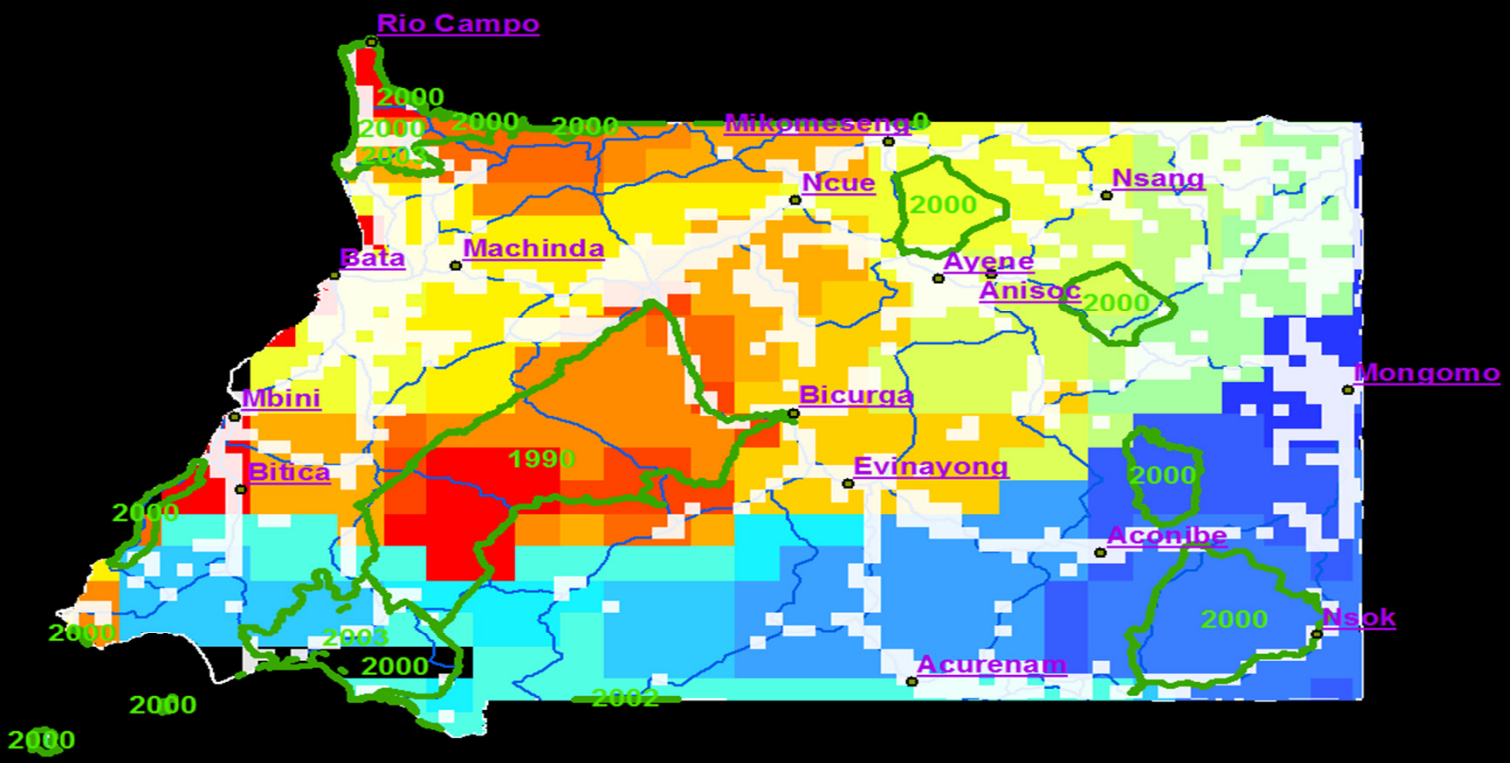

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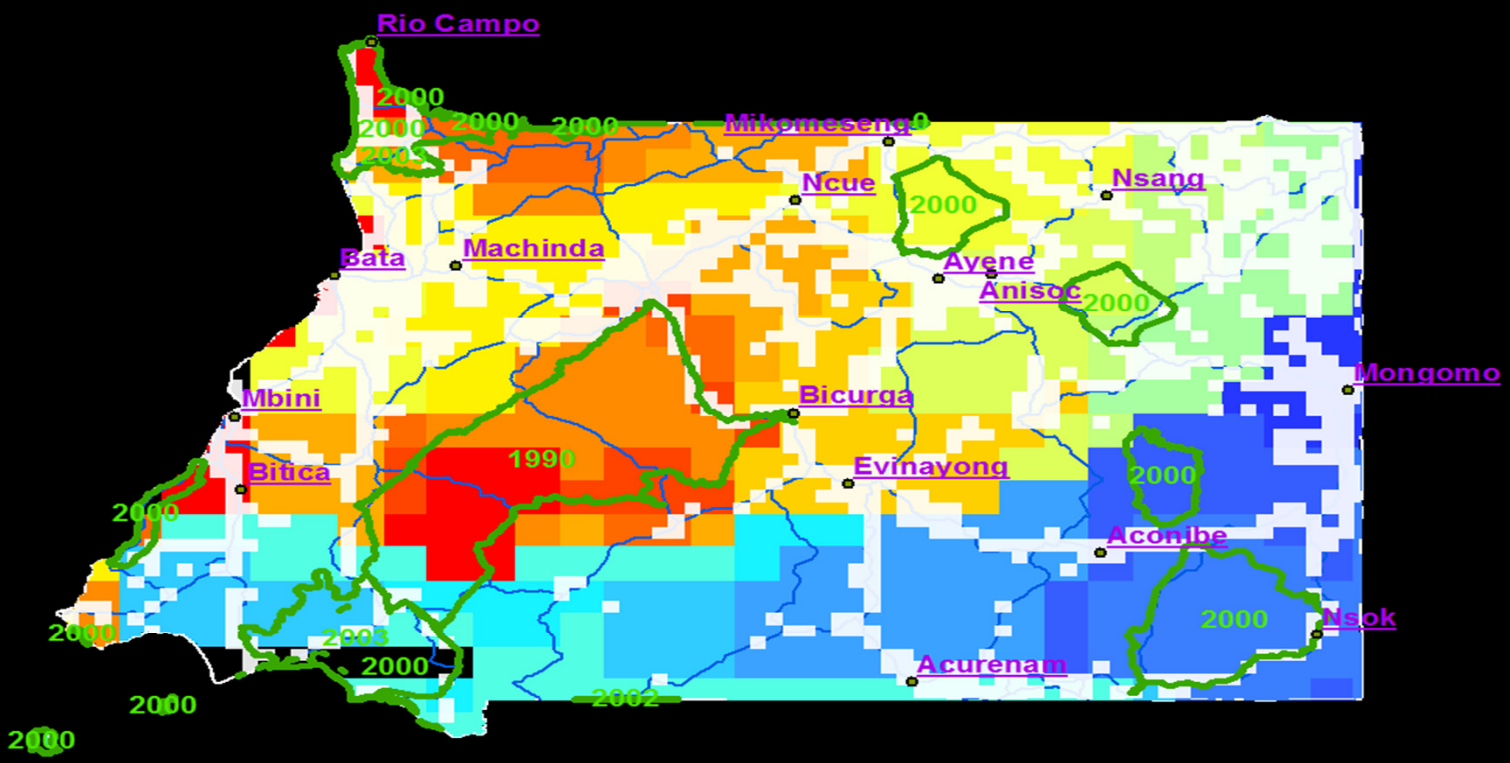

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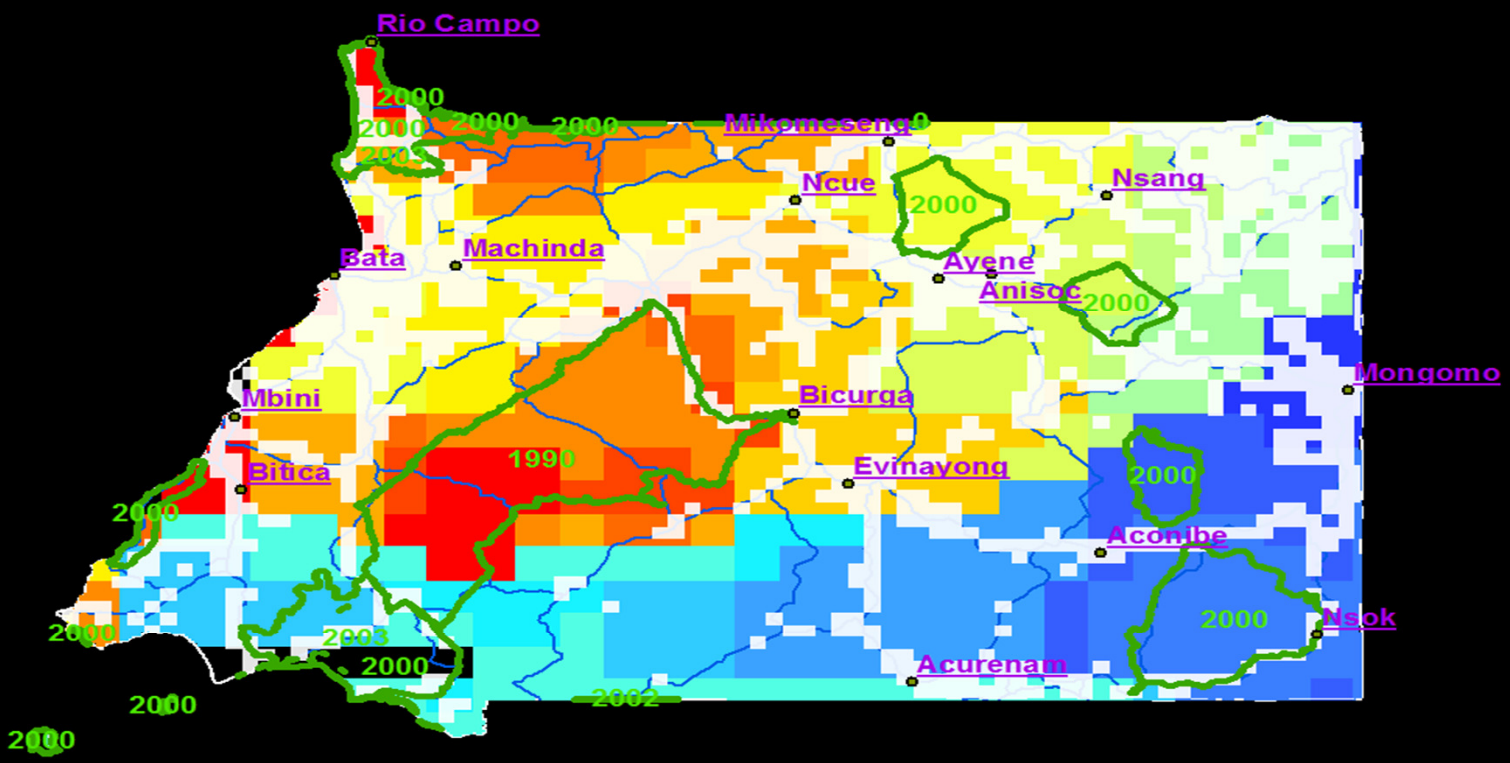

Forest Clearing Areas

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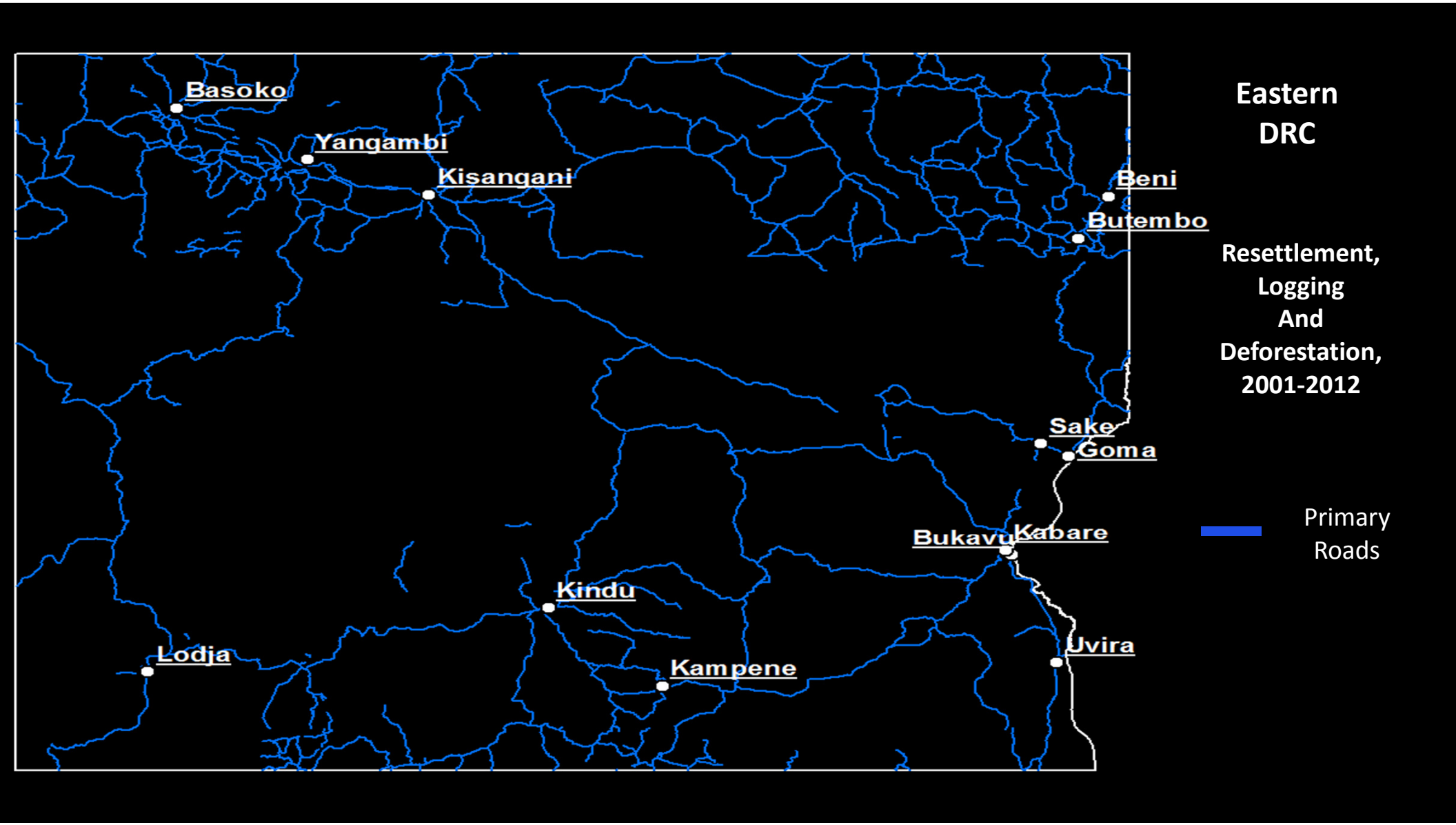
Eastern DRC

Resettlement, Logging And Deforestation, 2001-2012

Eastern DRC

Resettlement, Logging And Deforestation, 2001-2012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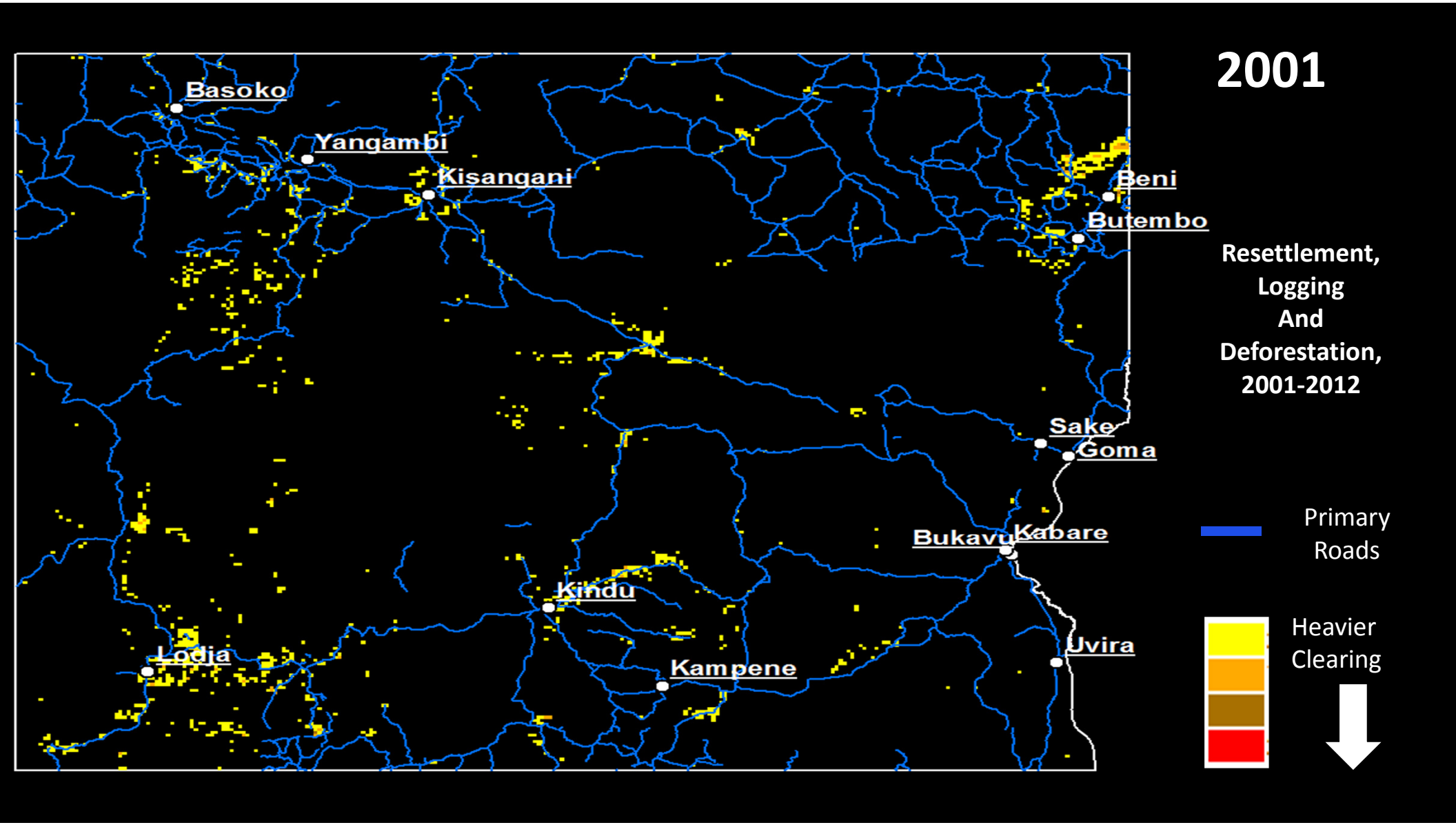
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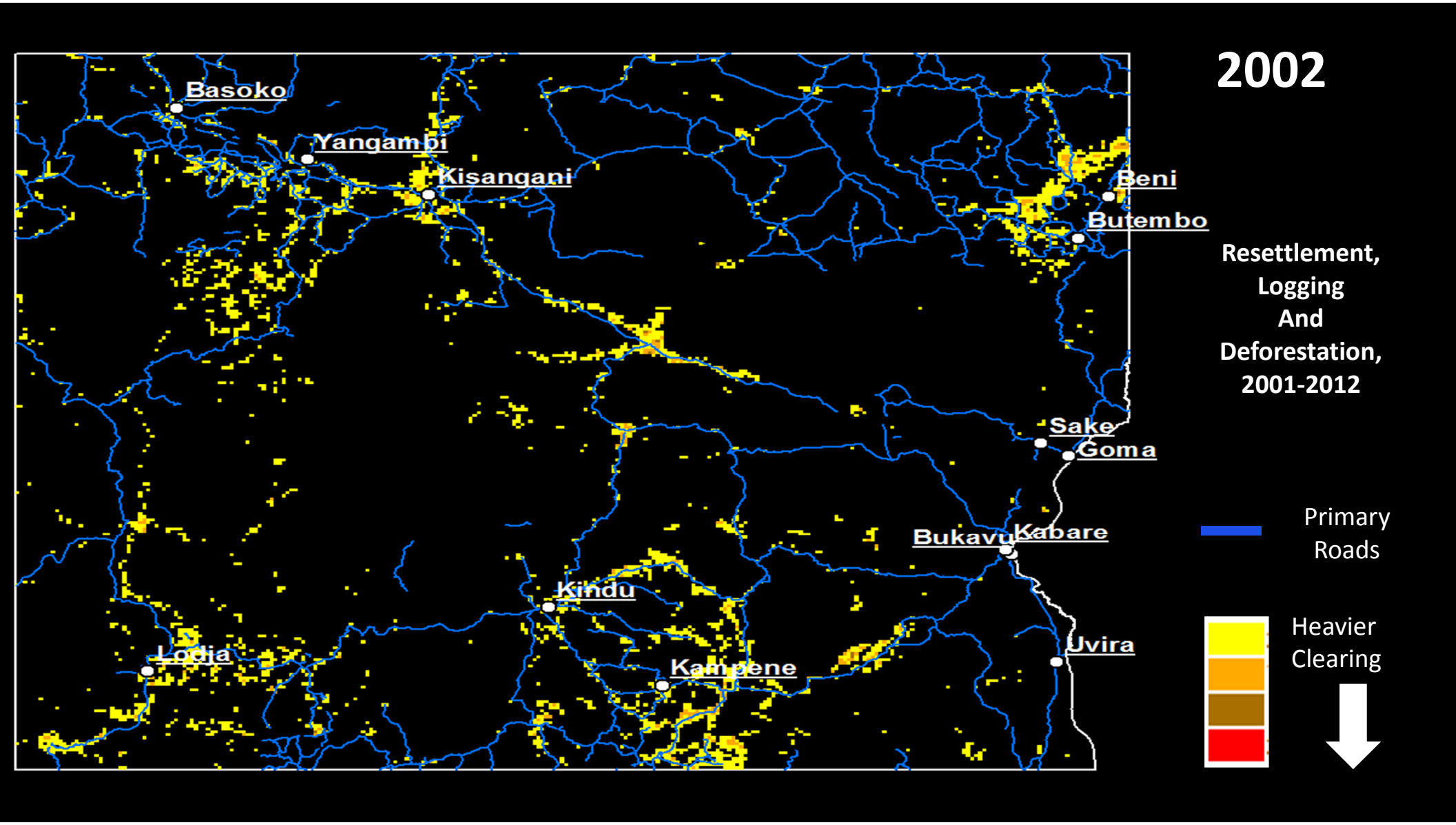
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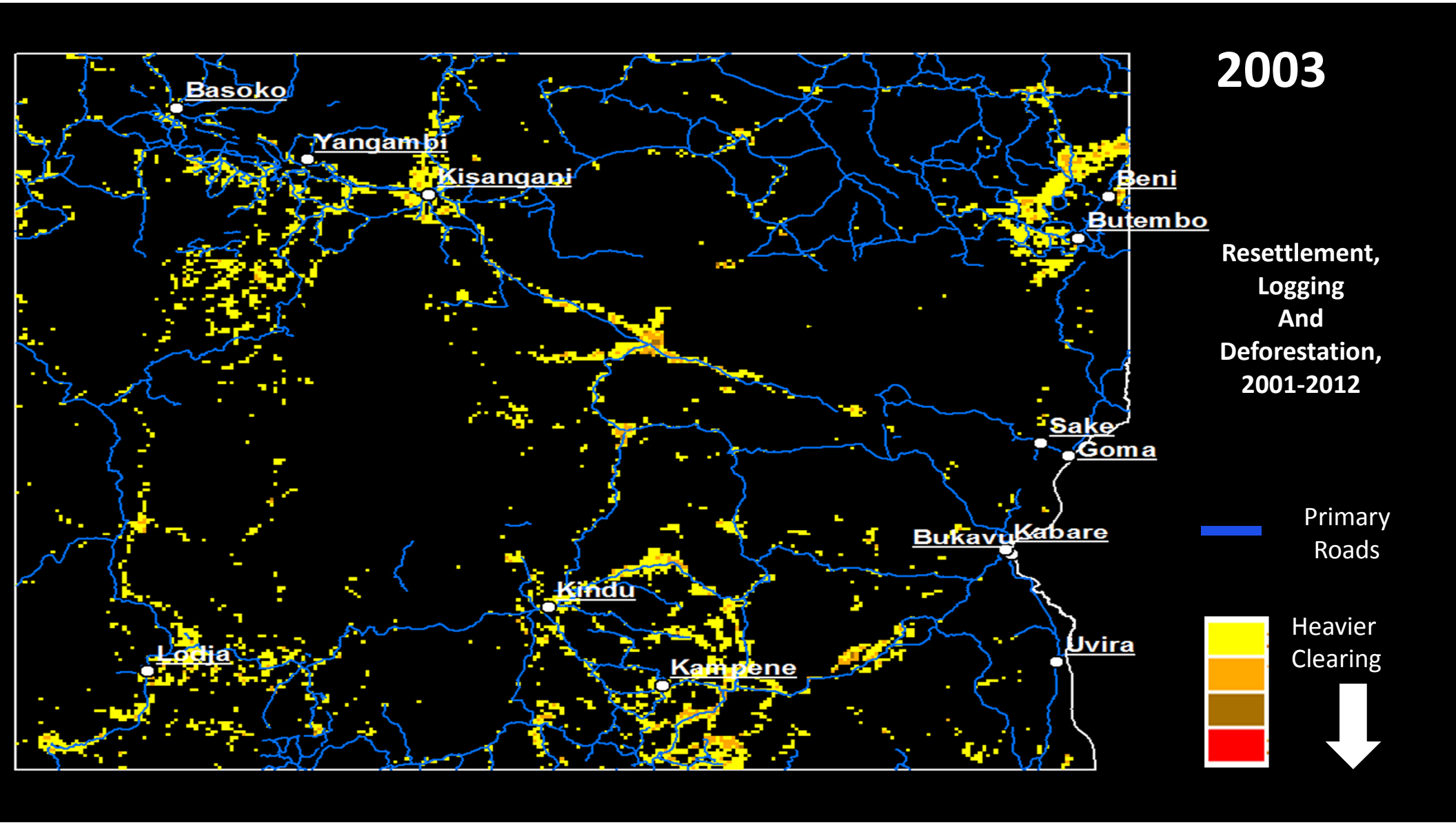
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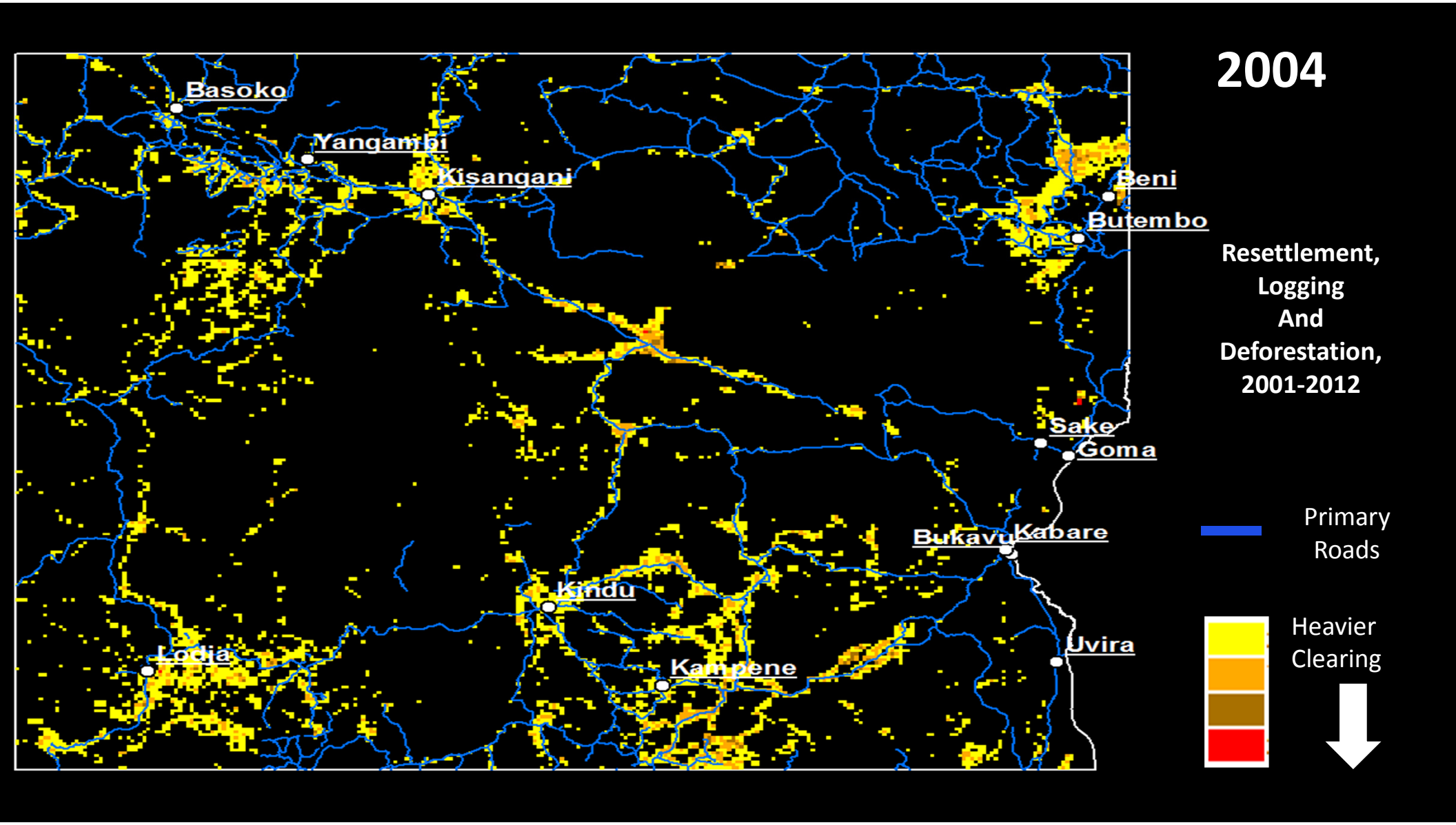
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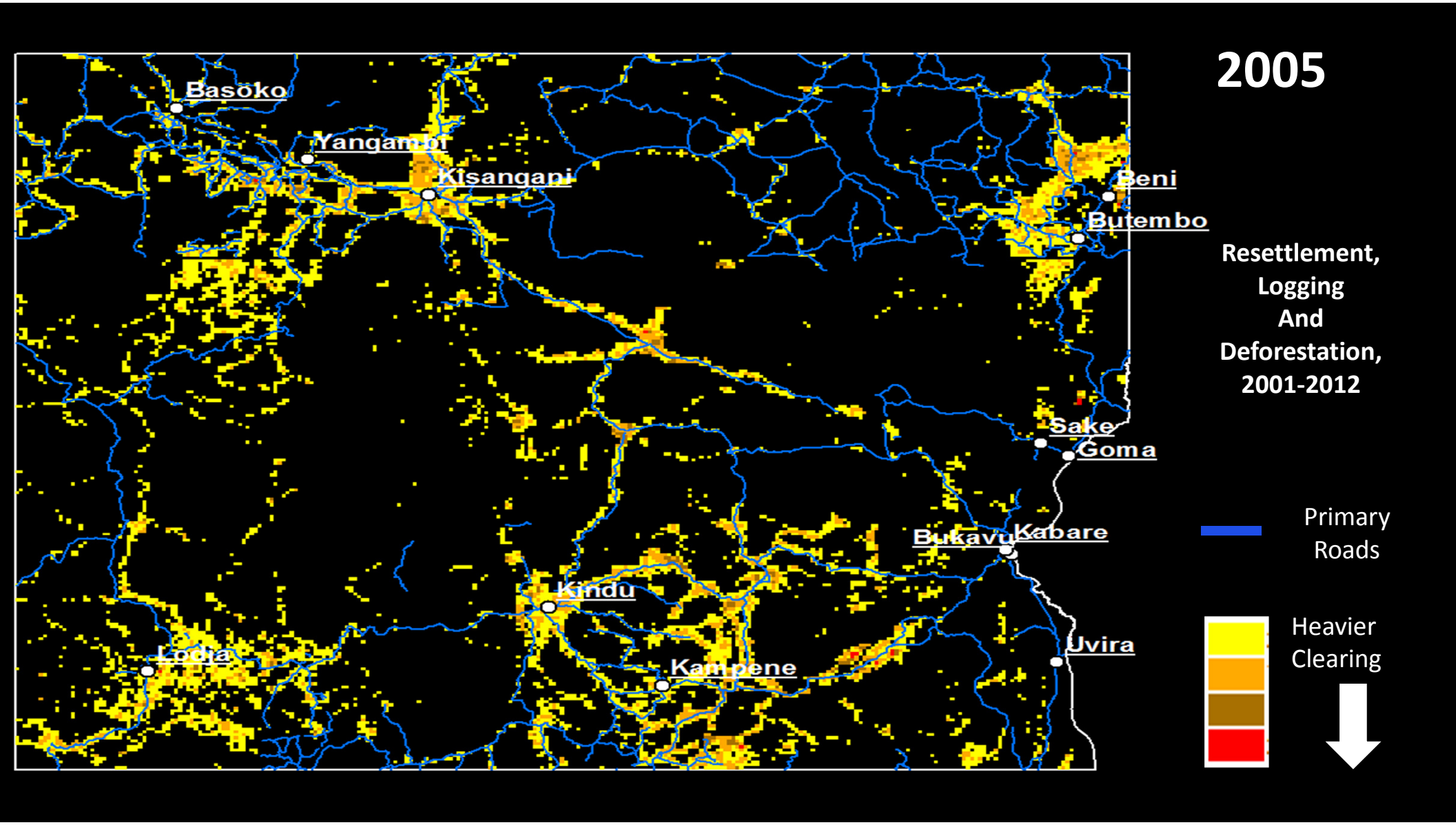
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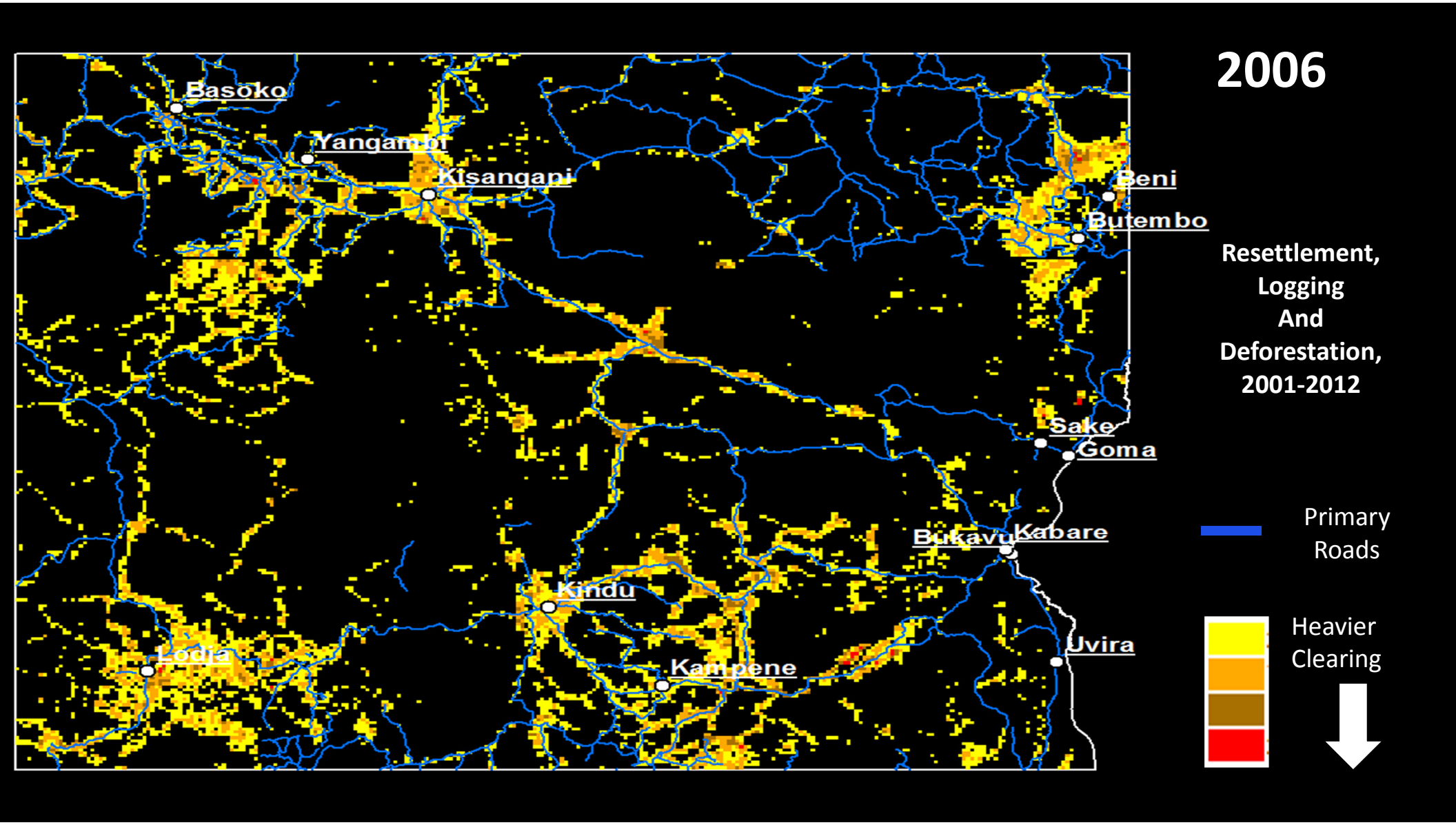
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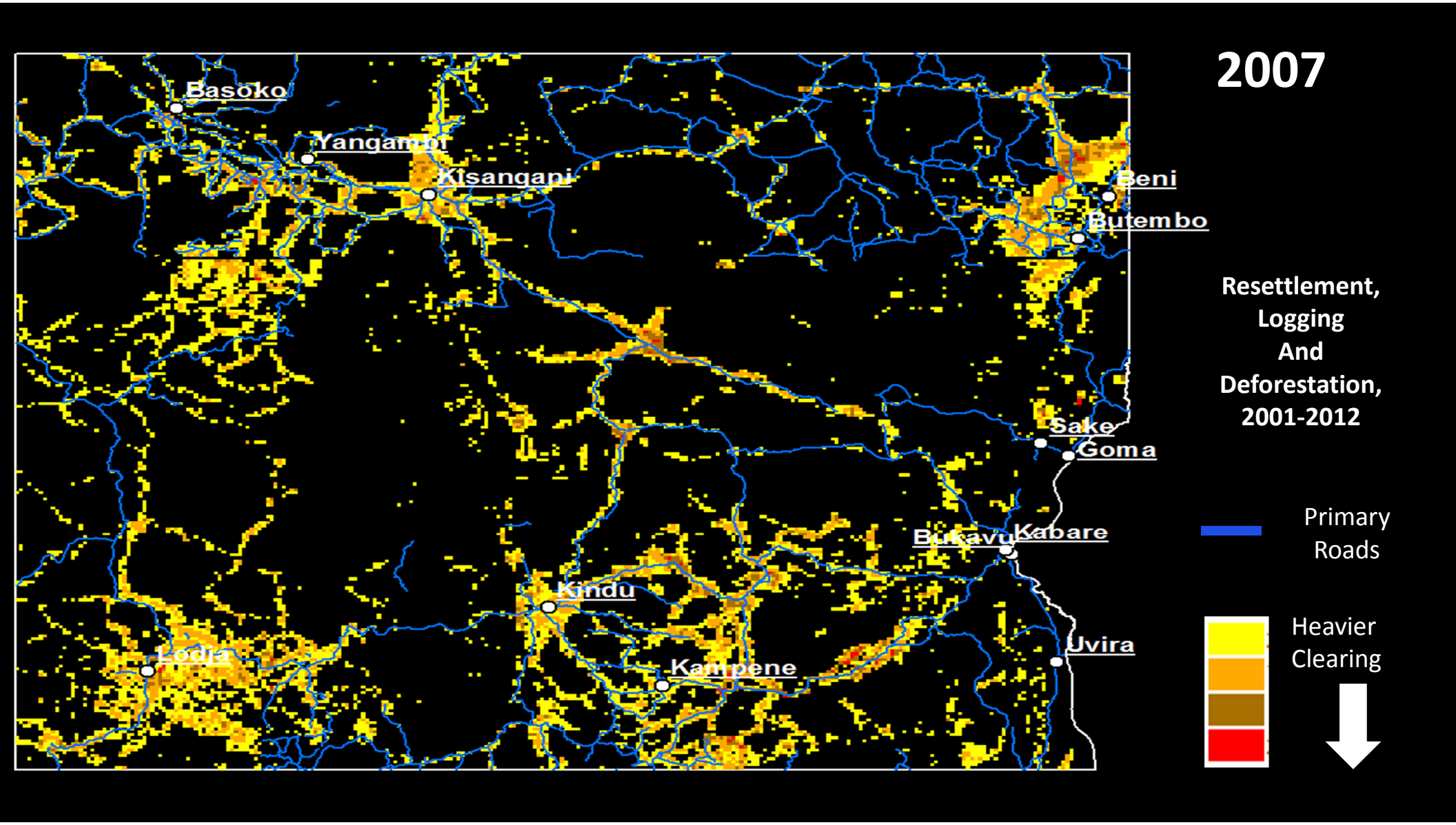
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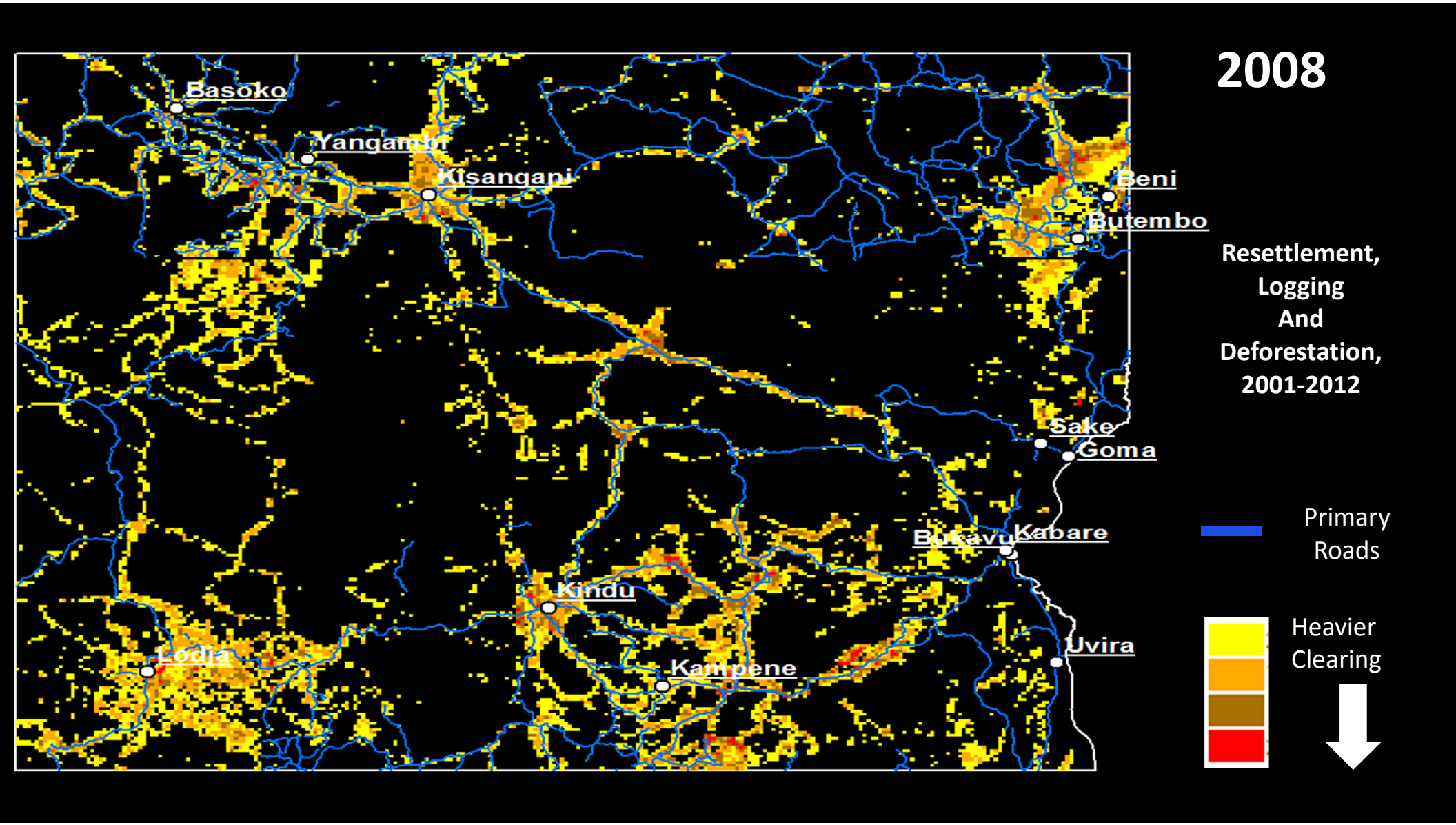
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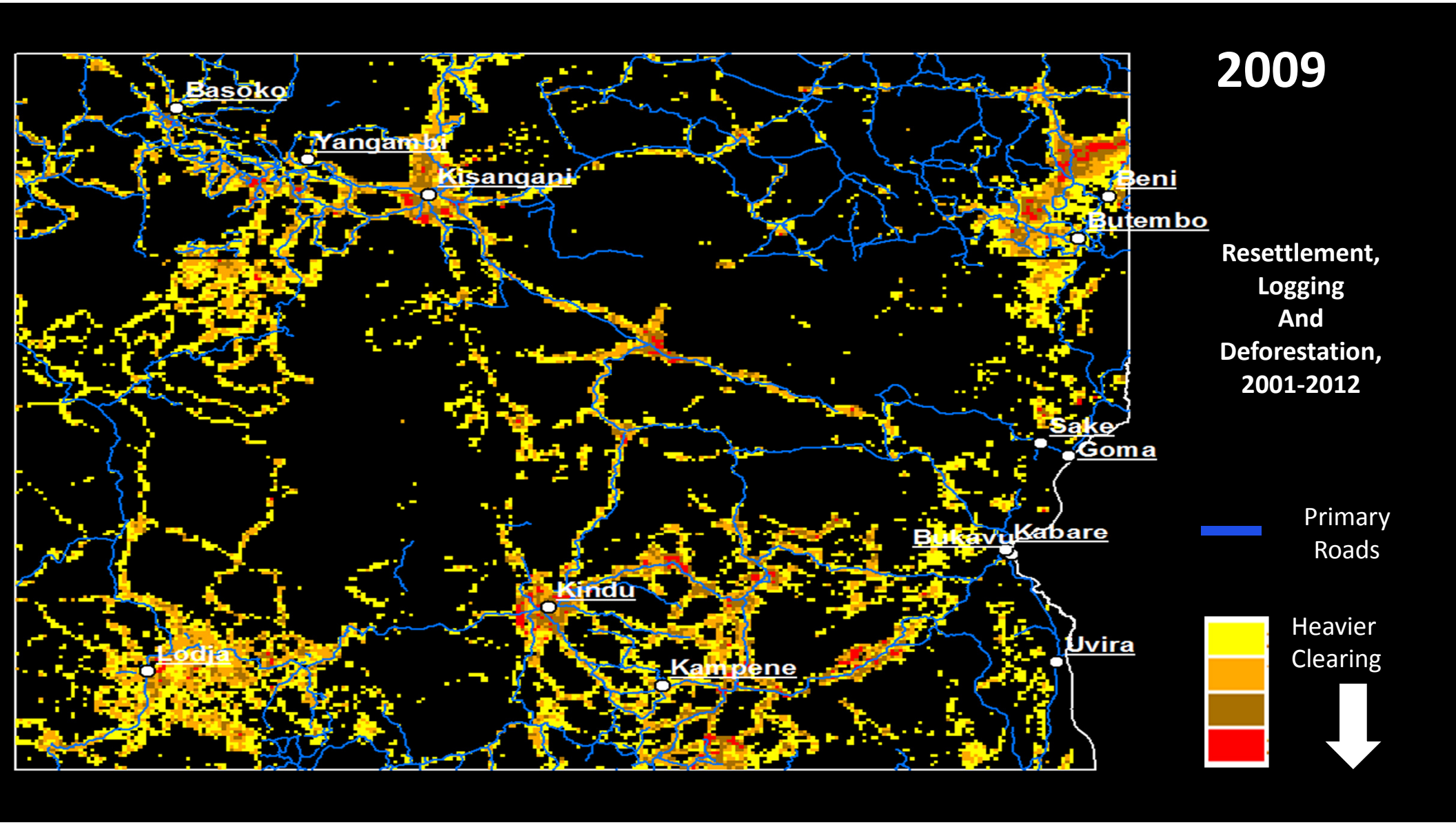
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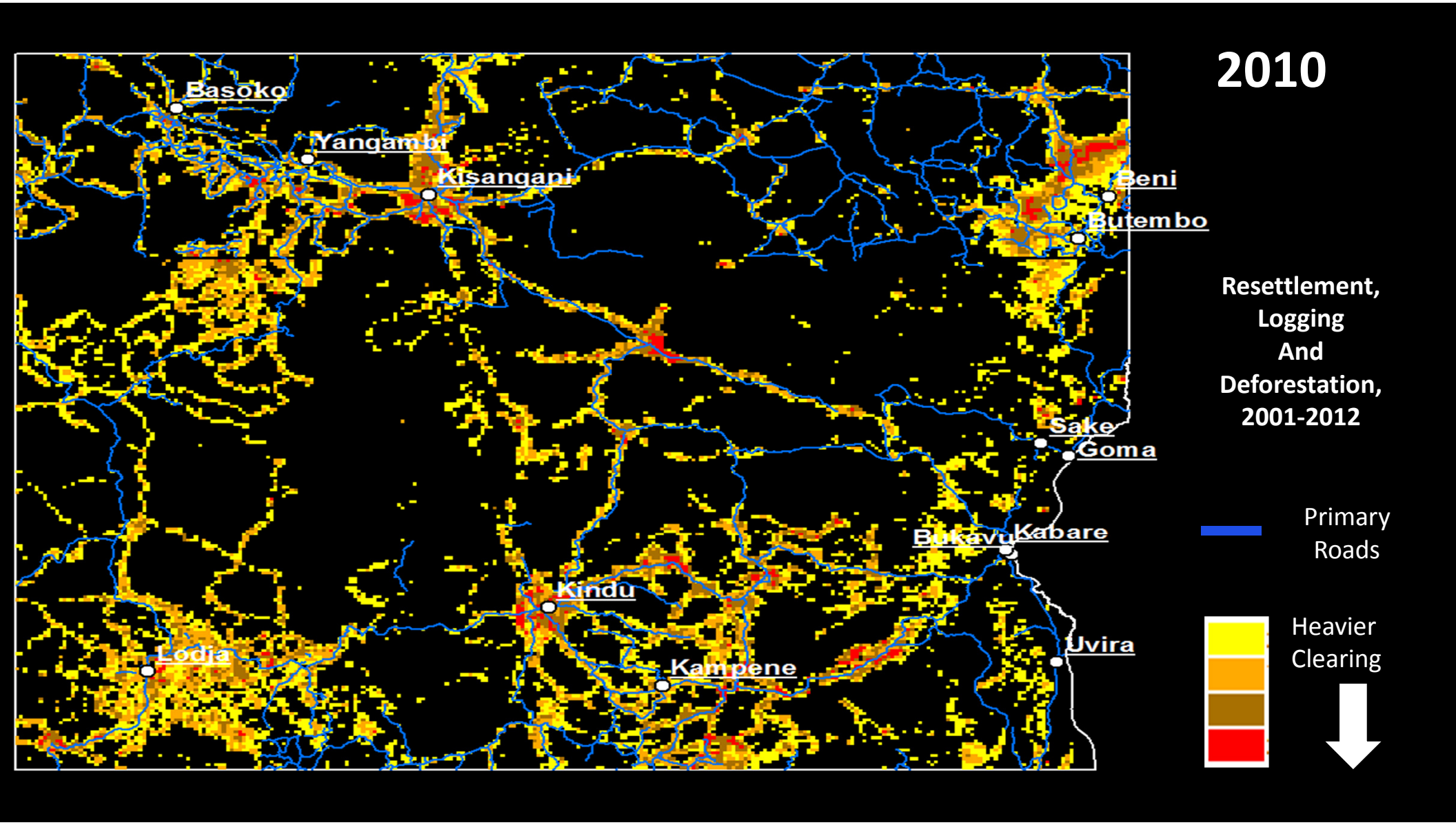
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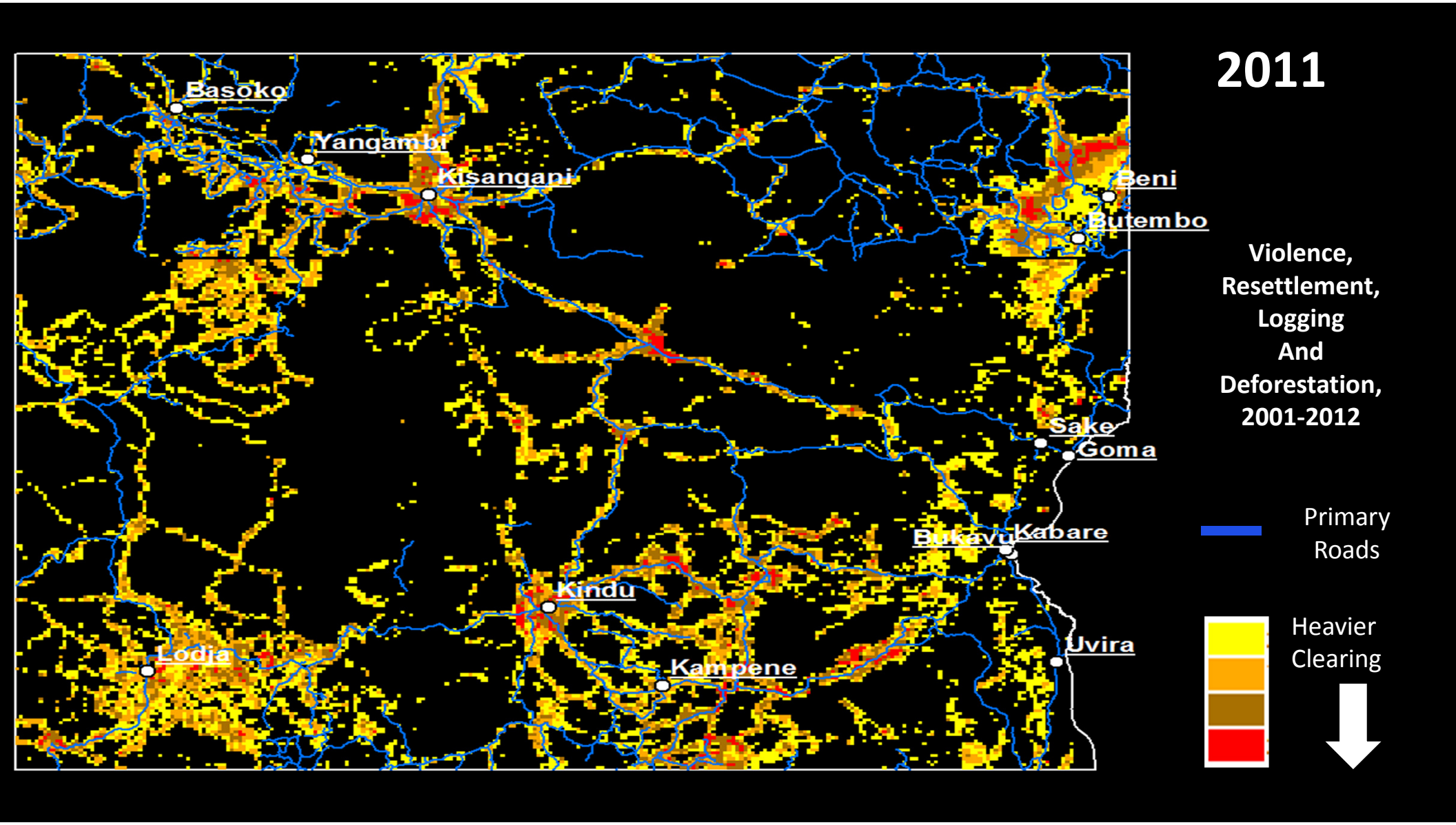
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Violence, Resettlement, Logging And Deforestation, 2001-2012
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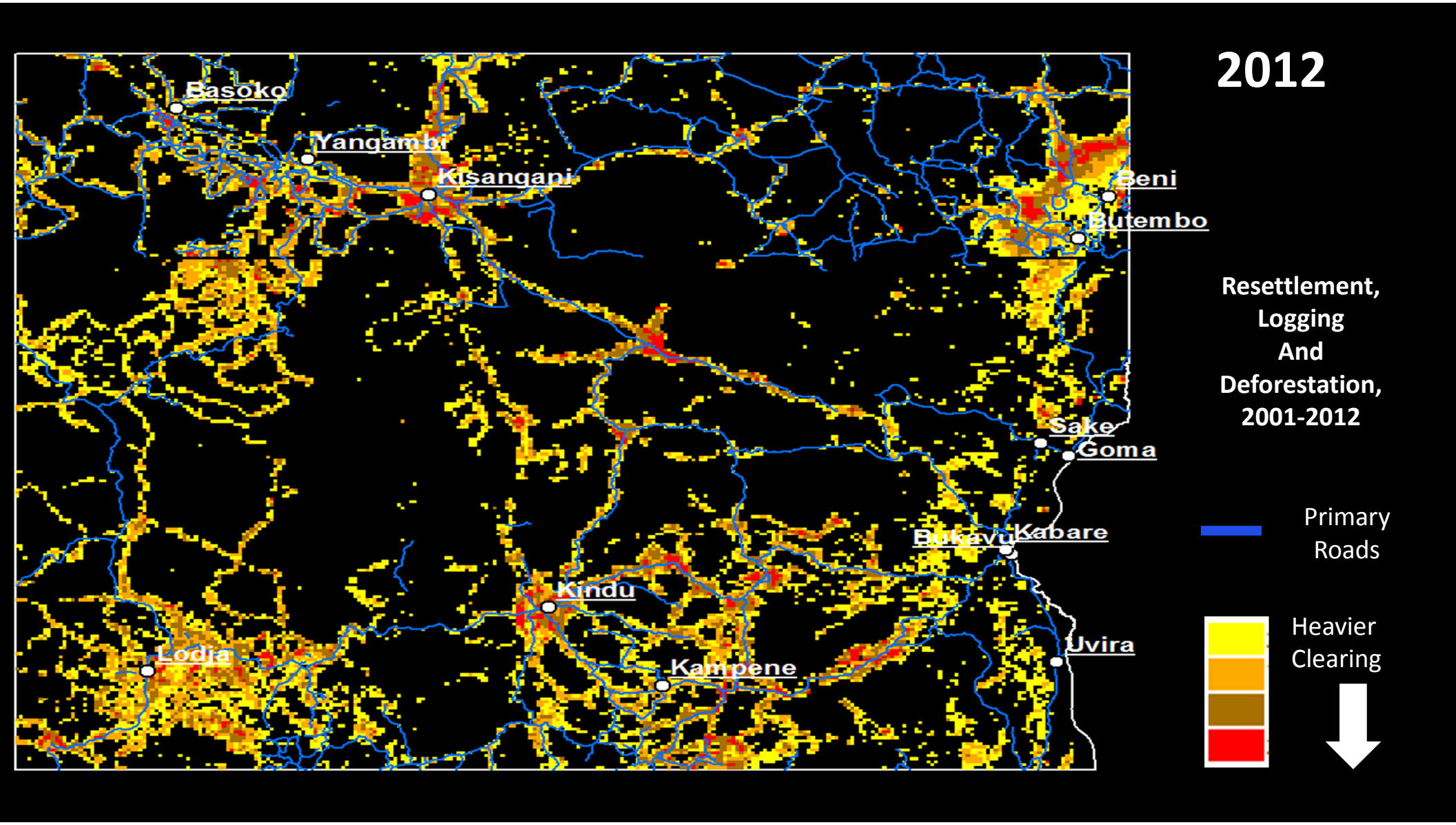
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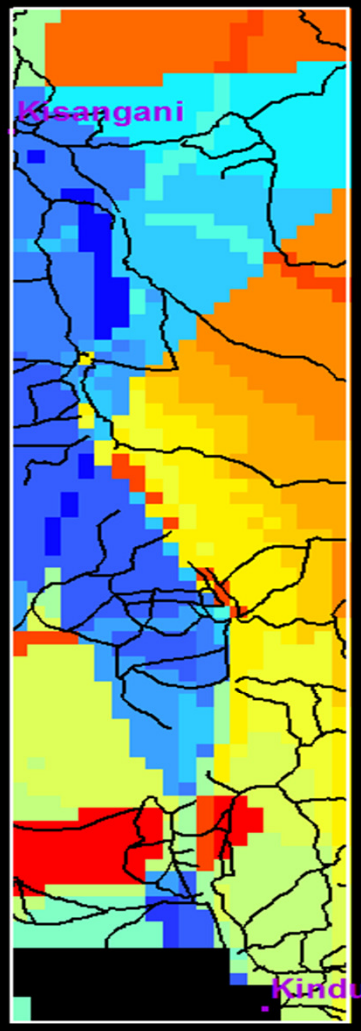
Kindu – Kisangani Corridor

Endangered Species, Deforestation and Potential Road Improvement Siting

Primary Roads

Kindu – Kisangani Corridor

Endangered Species, Deforestation and Potential Road Improvement Siting



Forest Clearing Areas

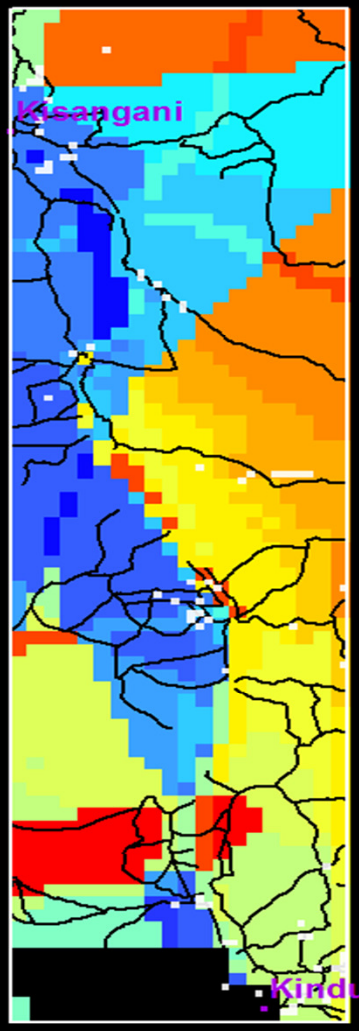
Roads

More Endangered Species

Kindu – Kisangani Corridor

Endangered Species, Deforestation and Potential Road Improvement Siting

2001



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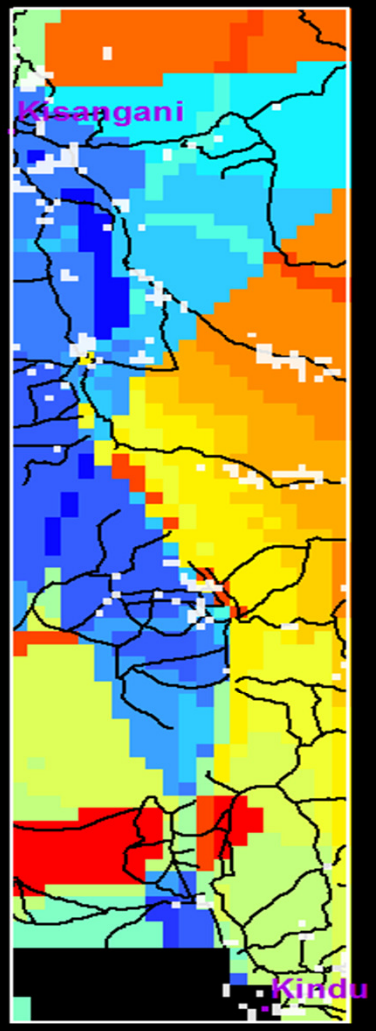

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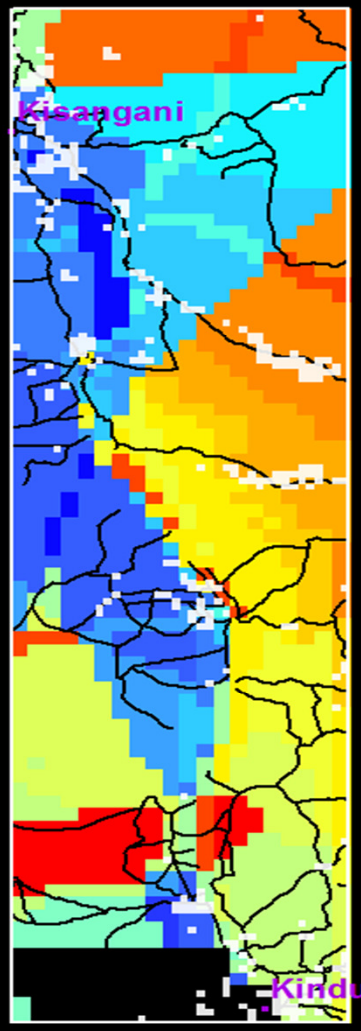


Forest Clearing Areas

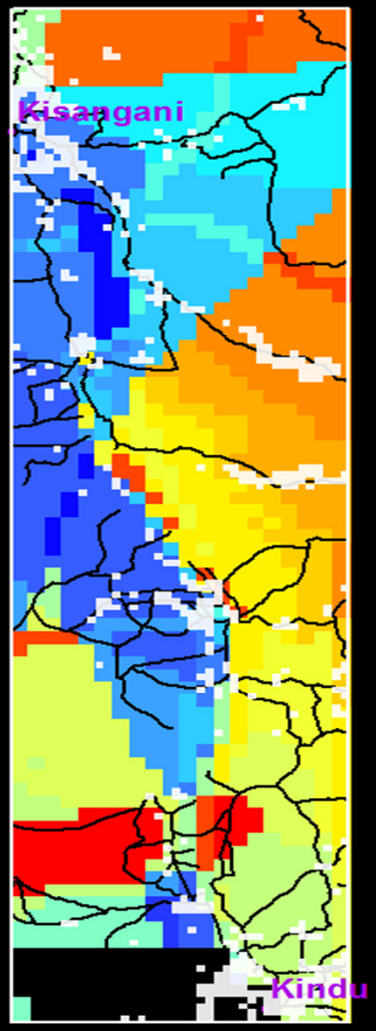
Roads

More Endangered Species

Kindu – Kisangani Corridor

Endangered Species, Deforestation and Potential Road Improvement Siting

2004



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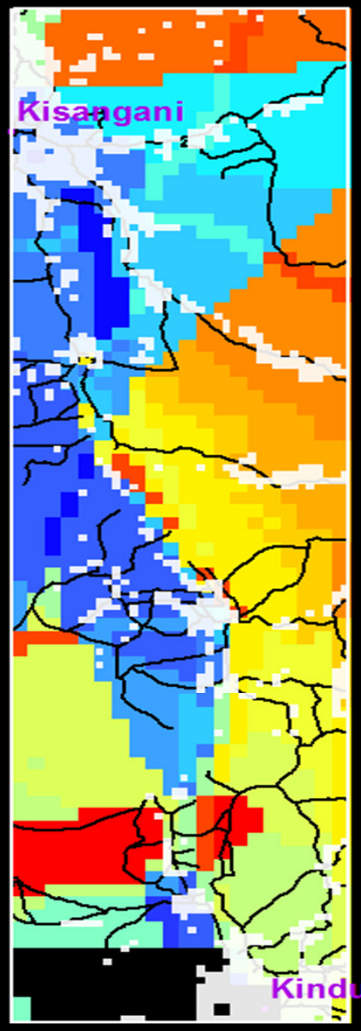
2005



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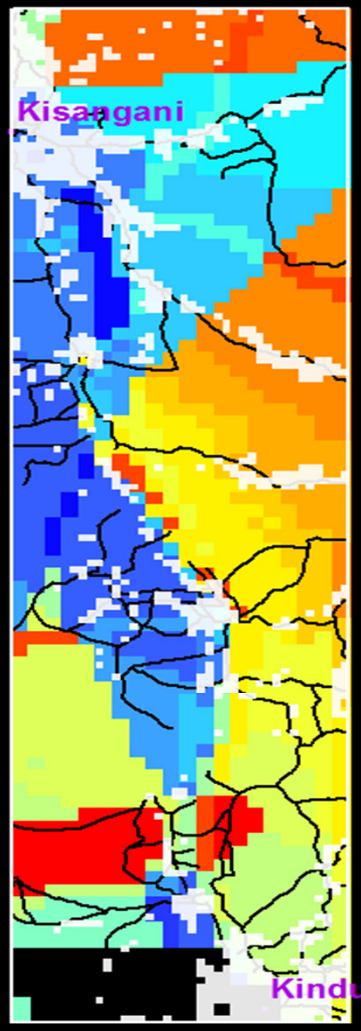
2006



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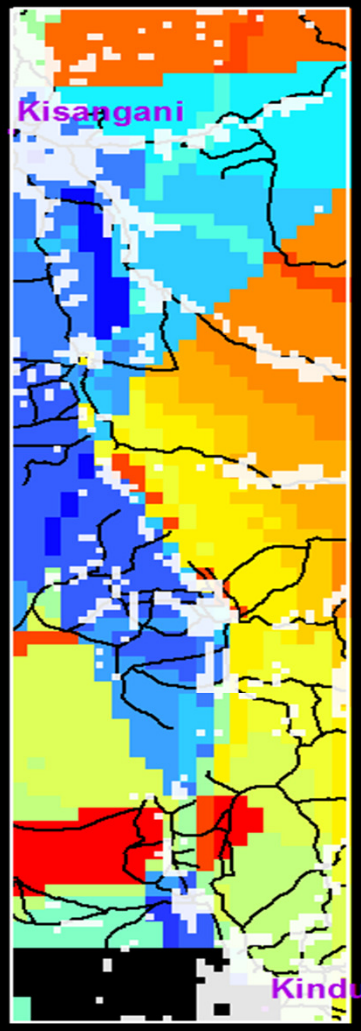
2007



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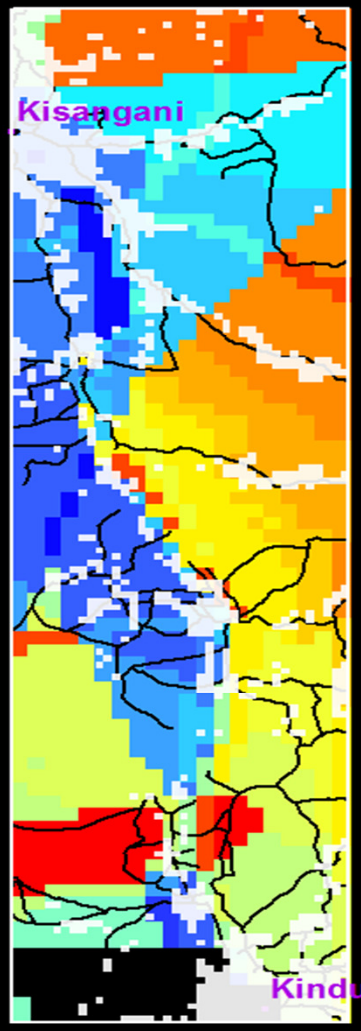
2008



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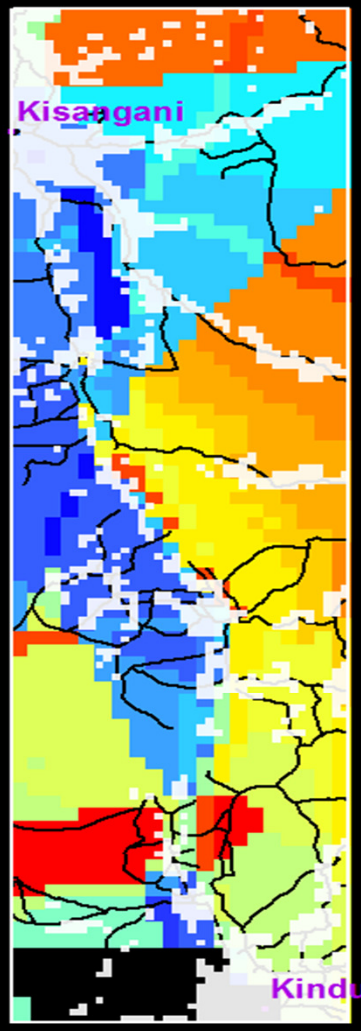
2009



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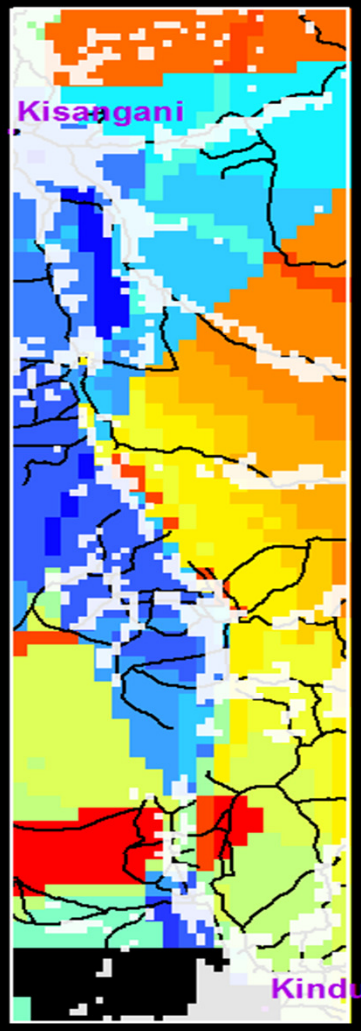
2010



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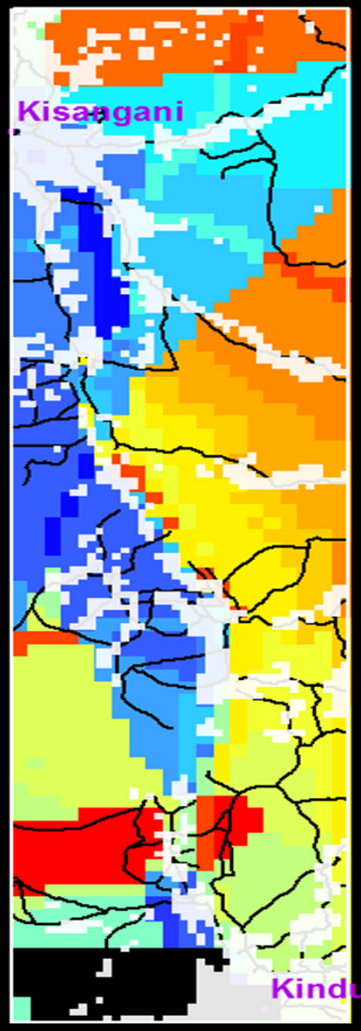

Forest Clearing Areas

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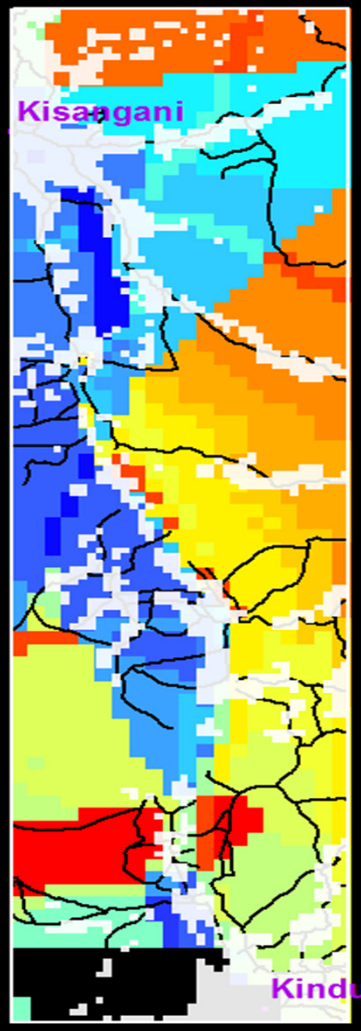
2012



Forest Clearing Areas

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Conclusions

- Roads and infrastructure **generate large benefits** (*but* mainly in areas with limited conflict)
  - Agricultural output higher
  - Poverty lower
  - Wealth higher
- But clear evidence that deforestation correlates with road placement
  - **Sound planning** needed in determining the location of the road
  - Spatial analysis can suggest **win-wins** – environmental damage minimized and benefits maximized
- Next Steps
  - Refine analysis
  - Estimate **deforestation drivers**
  - Estimate **regional benefits** from infrastructure
  - -> **Identify optimal location of growth poles** (with highest potential and lowest impact) and best transit routes
    - Calculate regional growth benefits