



Land-Use and Land-Cover in Benin under Changing Social-Ecological Conditions

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Bundesministerium
für Bildung
und Forschung



Natural Change and Population



West Africa

Increase in Population

2,32 % annual growth rate
between 2000 and 2005

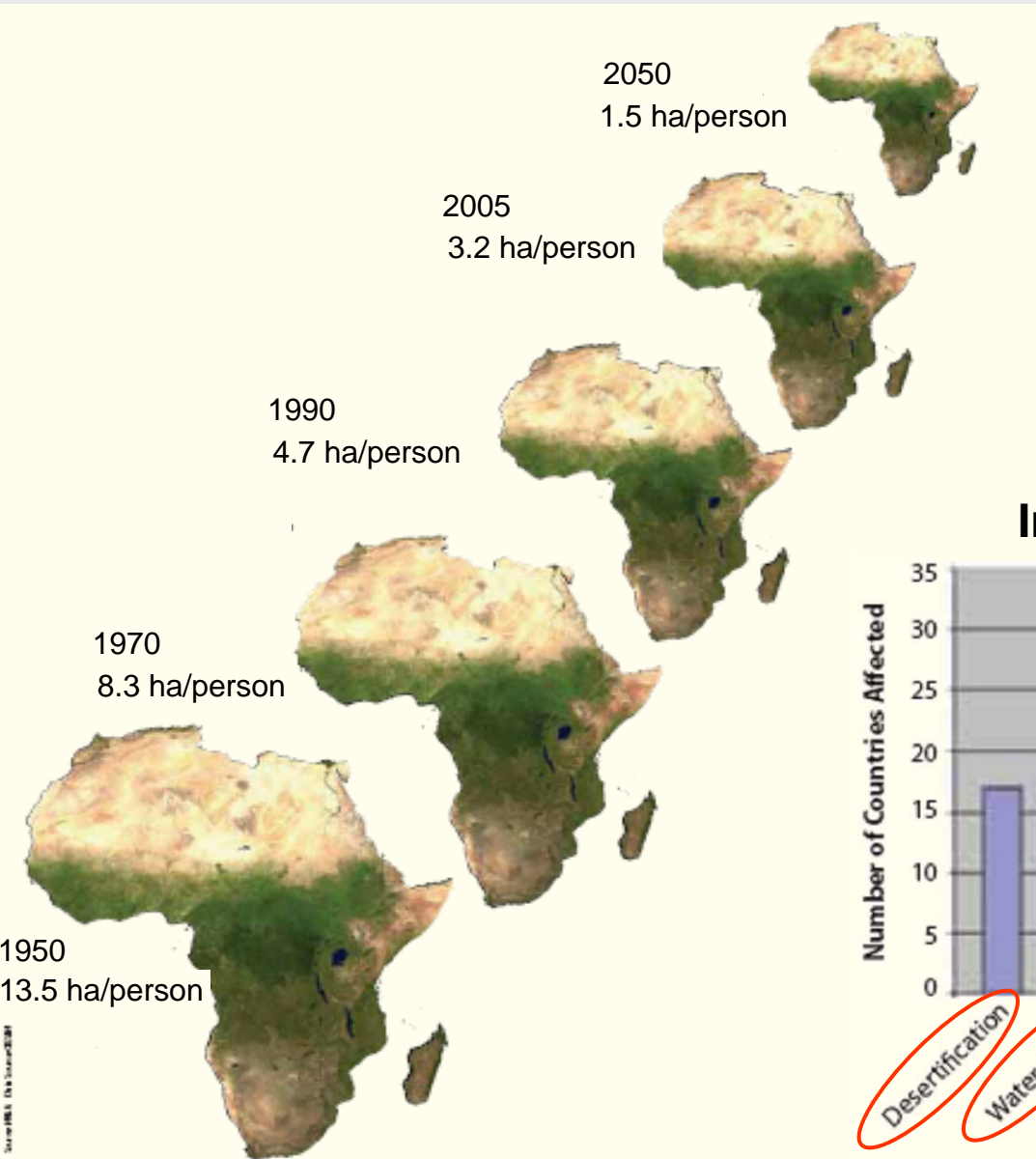
*(nearly double the global
annual rate of 1,24 %; UN 2007)*

Highest rate of urban growth
in the world for the next decades
(UNFPA 2007)

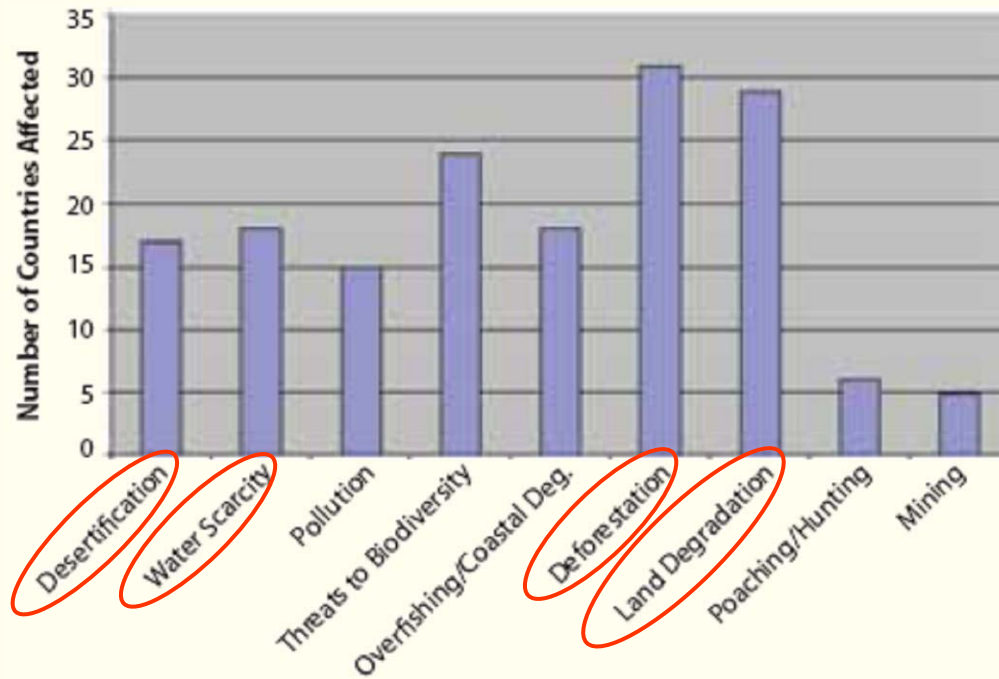
Decline in Rainfall

15% to 30% after 1970s

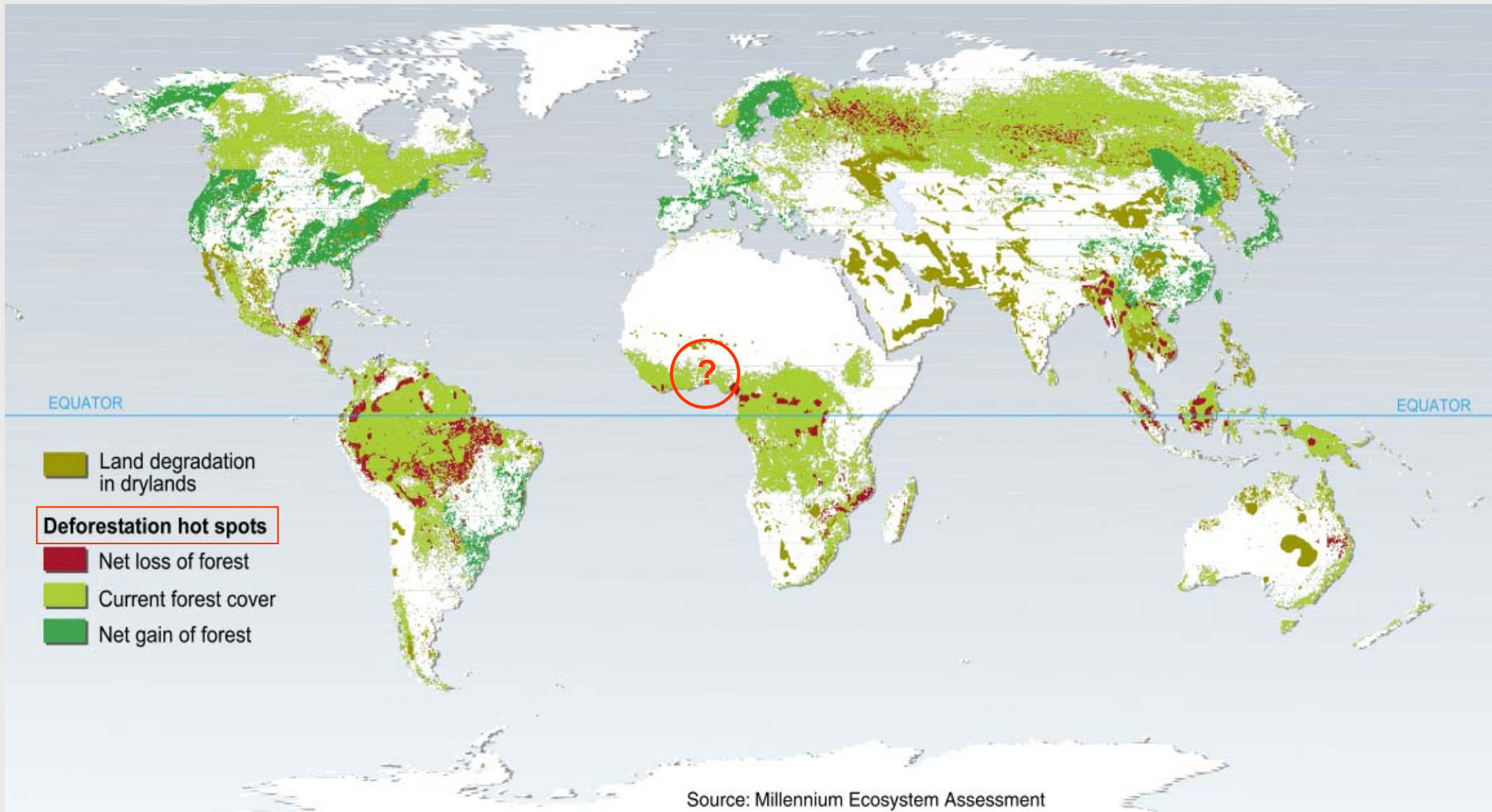
Africa's „Shrinking“ Land Base (UNEP/GRID 2008)



Important environmental issues

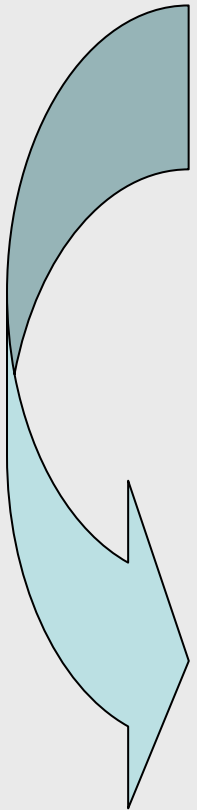


Change in Land-Use and Land-Cover





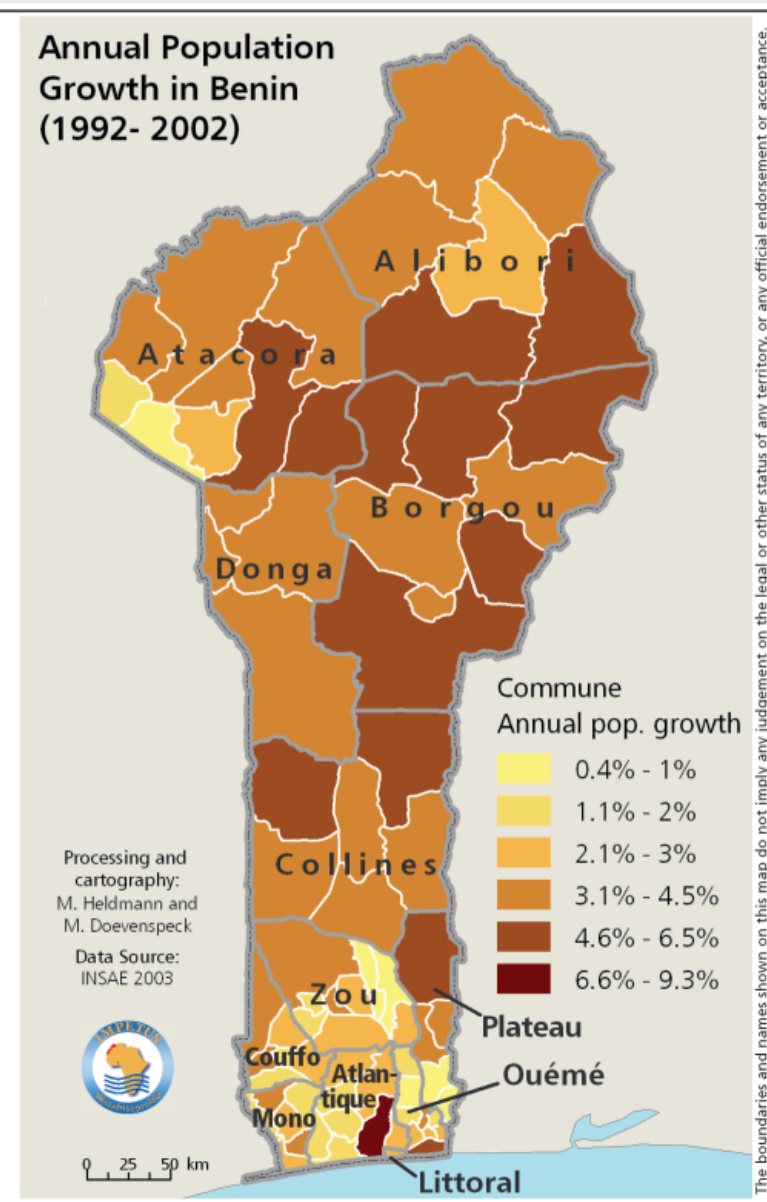
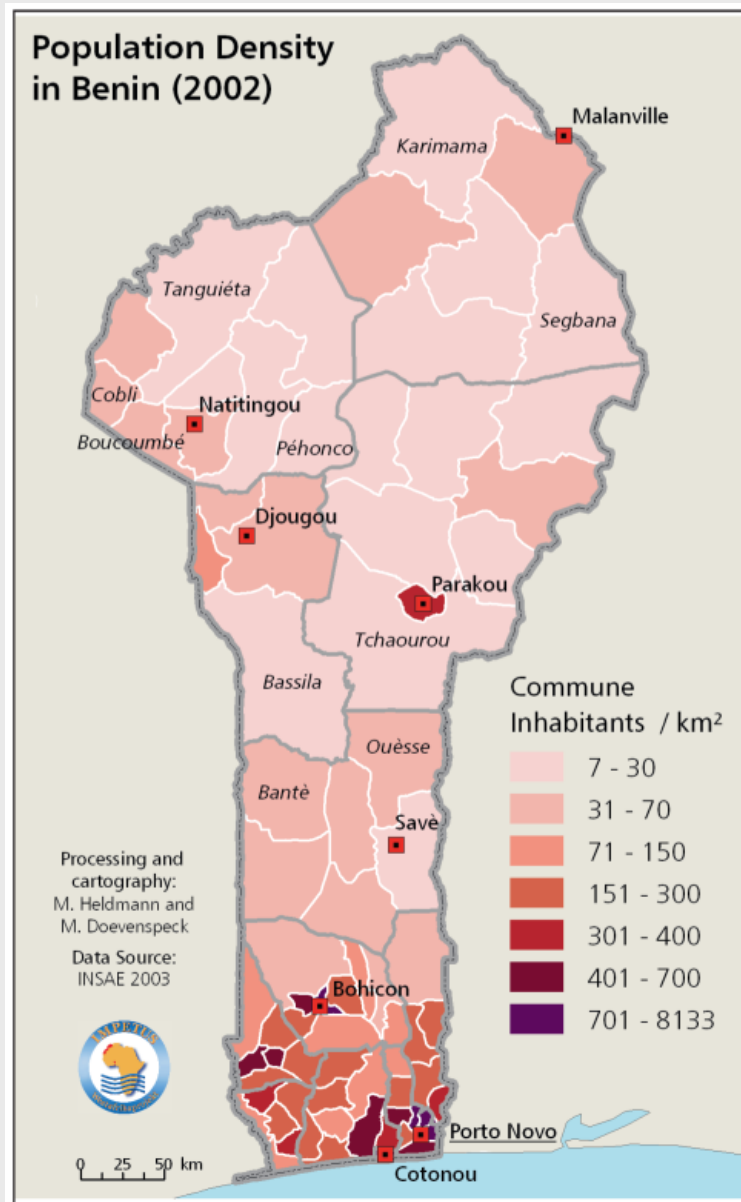
“... the need to provide food, water, fiber, and shelter to more than six billion people drive worldwide changes to forests, farmlands ... ” (Foley, 2005)



Land-Use & Land-Cover Change is a serious challenge



SETUP BENIN

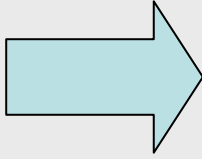


The boundaries and names shown on this map do not imply any judgement on the legal or other status of any territory, or any official endorsement or acceptance.

Cortesy: M. Heldmann & M. Doevenspeck



Natural Vegetation, Land-Use and Land-Cover Change – Actors, Motivations and Consequences



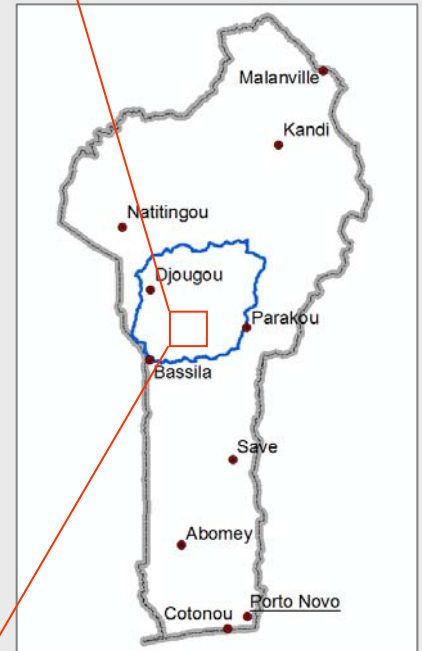
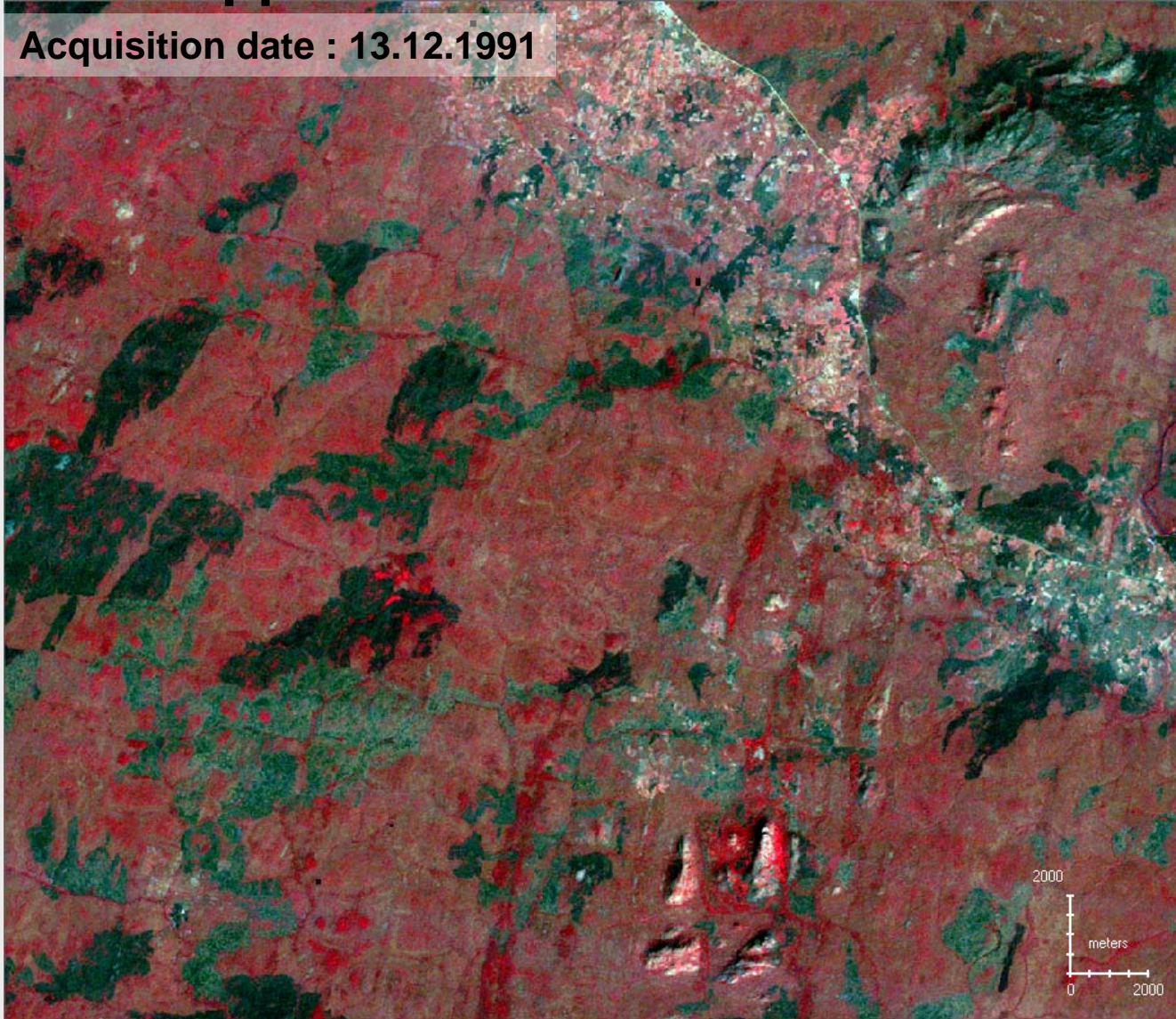
Modification
Conversion



Land-Use and Land-Cover Change in the Upper Ouémé Catchment



Acquisition date : 13.12.1991



Land-Use and Land-Cover Change in the Upper Ouémé Catchment

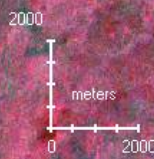


Acquisition date: 26.10.2000

New agricultural areas

Border of protected forest

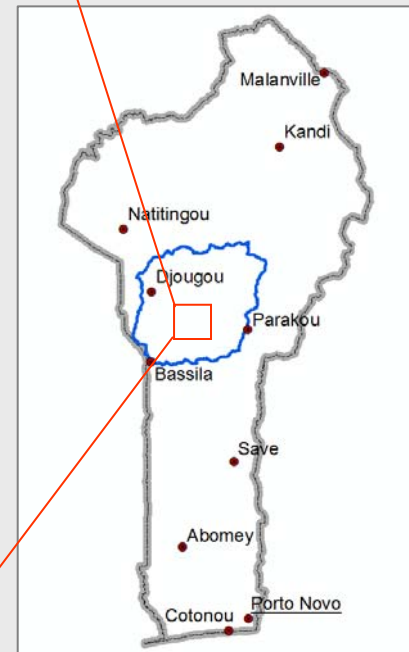
Migrants from North Benin



Forests and Woody Savanna are converted into areas under cultivation



Deforestation

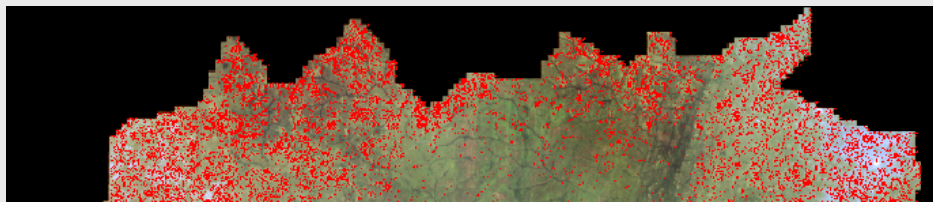


Land-Use and Land-Cover Change as a Regional Problem



Conversion of natural savanna into agricultural used areas (1991 – 2000)

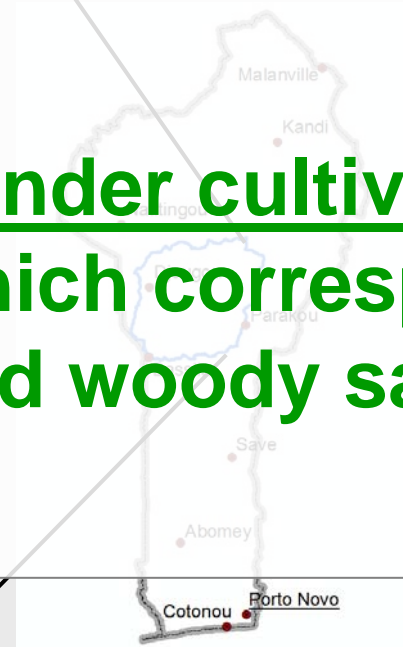
Negative impact on local-regional climate, water, soils etc.



Data source: LANDSAT data

Djougou

Increase of 45% of areas under cultivation between 1991 and 2000 which corresponds to 23,700 ha loss of forest and woody savanna





Challenges in the Context of Land-Use and Land-Cover Change are:

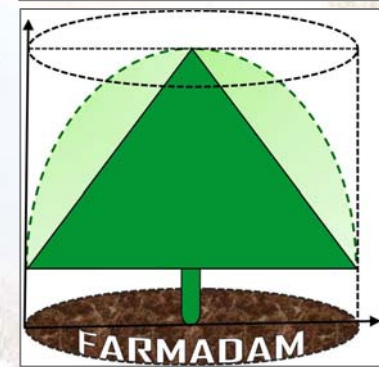
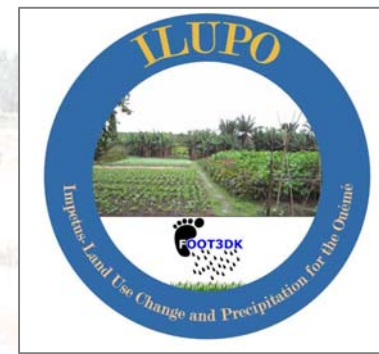
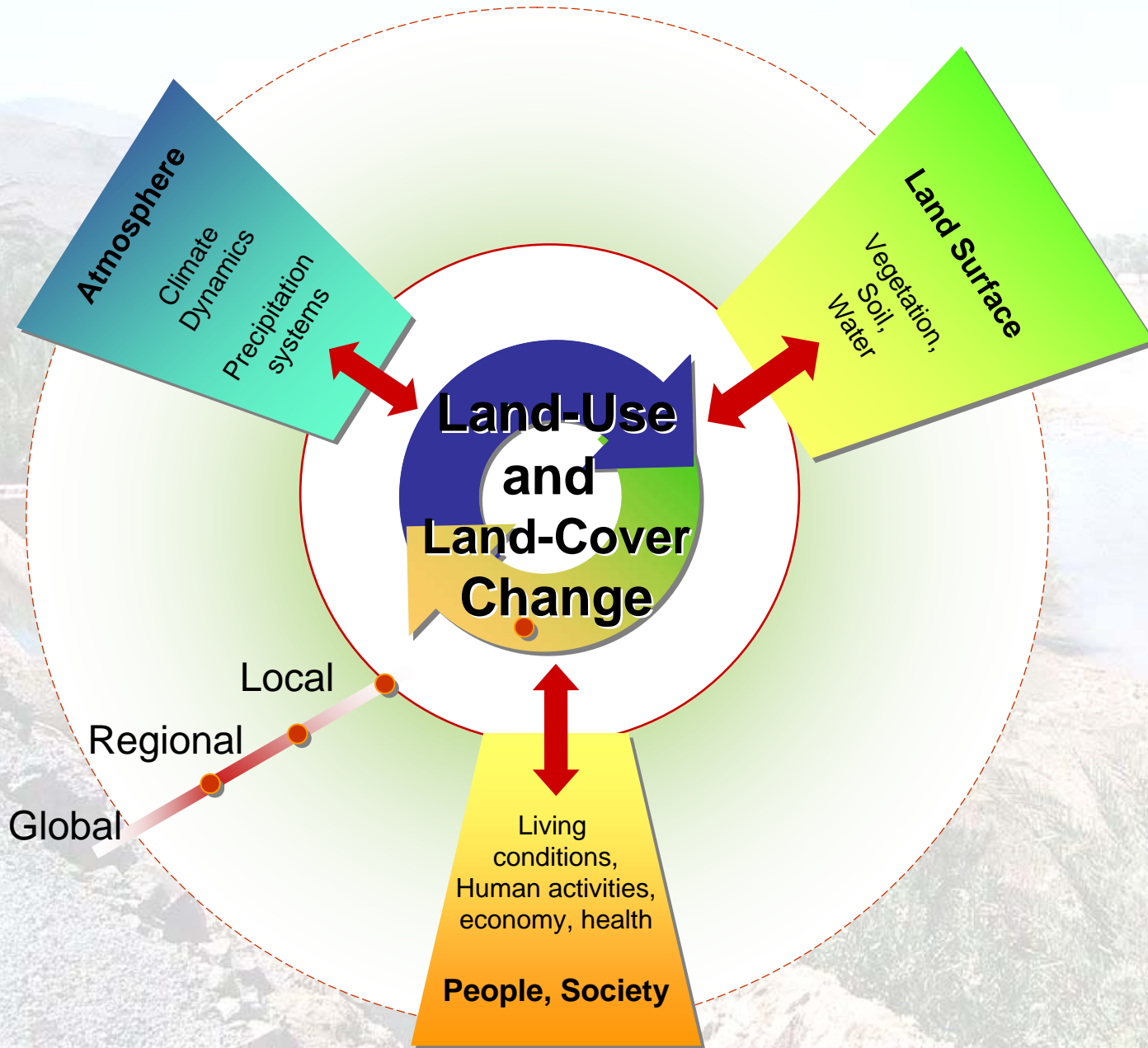


- Assessment of the most relevant **social-ecological processes** triggering LUCC !
- Development of **monitoring- and decision- support-systems** based on coupled (sectoral) models !



- How to **mitigate** the negative effects of land cover and land use changes ?
- How to ensure **sustainable development** ?
- How to **transfer scientific products/results** into information for decision makers ?

Interdisciplinary IMPETUS Framework



Laptop

“Managing Bush Fire”

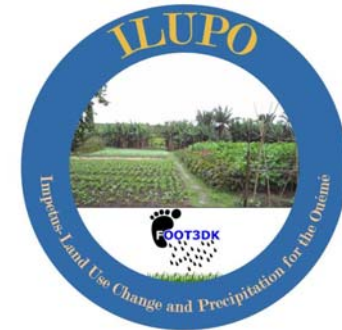
H.-P. Thamm et al.



Poster 16

“IMPETUS – Land-Use Change and Precipitation for the Upper Ouémé”

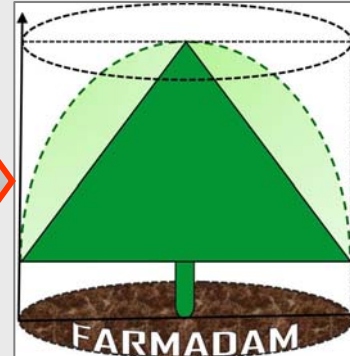
A. Krüger et al.



Flyer

“Farm Management and Adaptation to Water Availability”

M. Janssens et al.



“Land-Use Modeling and Information System”

M. Judex et al.



- **Problem:**

- Severe land-use and land-cover changes in Benin
- Arable land will be scarce
- Necessity for decision makers to estimate the impact of different boundary conditions and planning options
- Detect hot spots of critical development





Land use Modeling and Information System



Choose scenario

B1
 B2
 B3
 B....

Choose time horizon

3 6 9 12 15 18 21 24 27 30 7

cropping conditions

duration of fallow (years)

3 6 9 12 15 18 21 24 27 30 7

duration of field use (years)

3 6 9 12 15 18 21 24 27 30 7

Resource / area protection

	complete	weak	no
Forêt classée 1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Forêt classée 2	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Forêt classée 3	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Forêt classée 4	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Forêt classée 5	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Forêt classée 6	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Modelled results

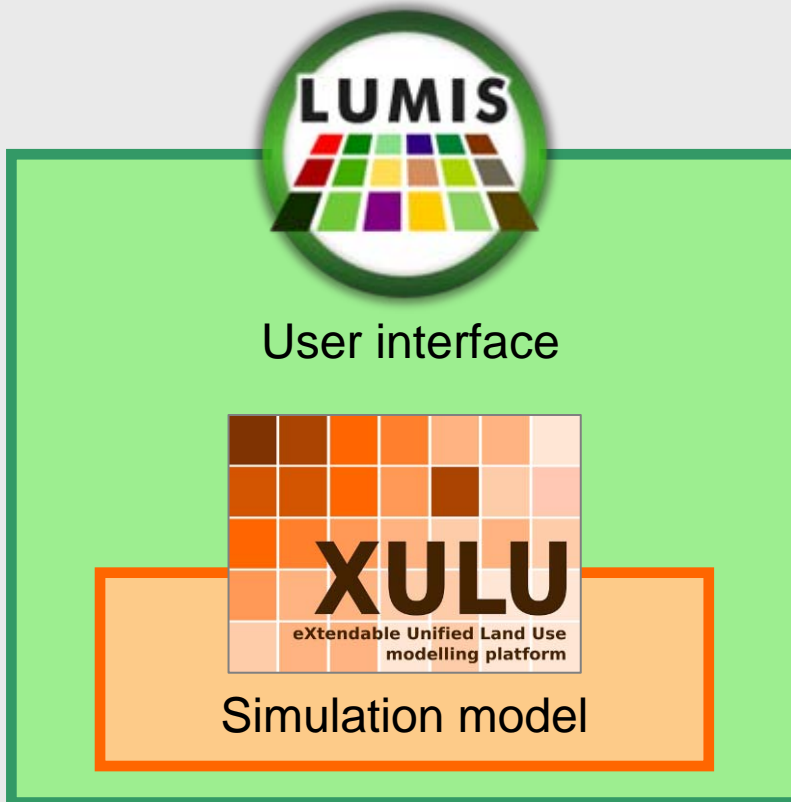
Scenario 1 Scenario 2

2025

2000 2010 2025 2000 2010 2025



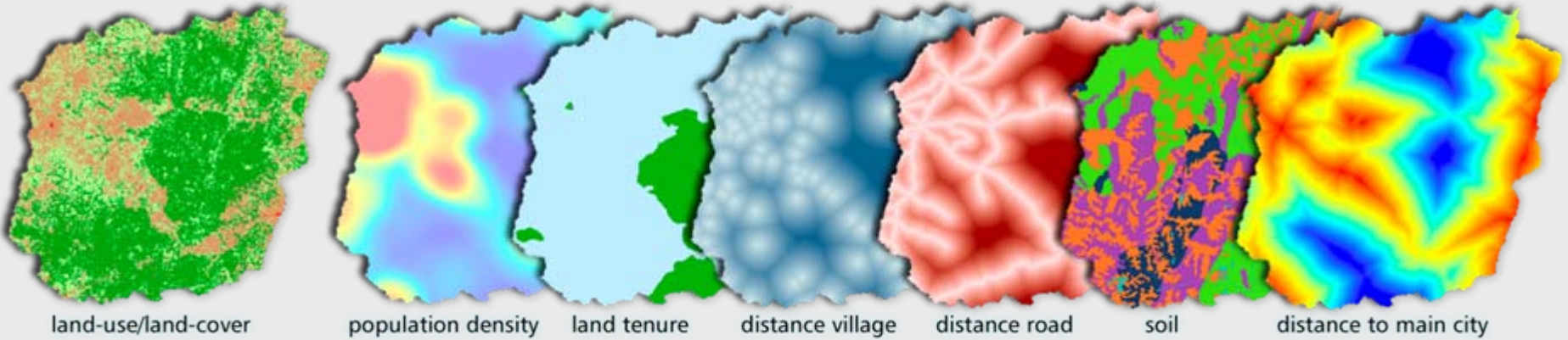
Model behind LUMIS



- Spatial explicit statistic dynamic land use change model XULU (Schmitz 2005, Thamm et al. 2007)
- Adapted from CLUE-S approach (Verburg et al. 2003)
- Spatial resolution: 250 x 250 m²
- Temporal resolution: 1 year

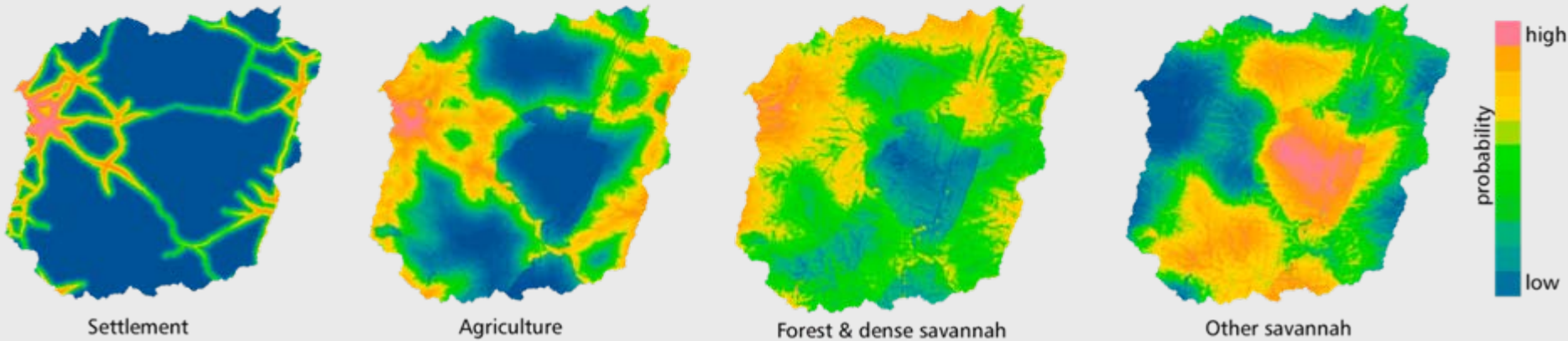


Driving forces and prediction of land use



logistic regression

probability maps for each land-cover type

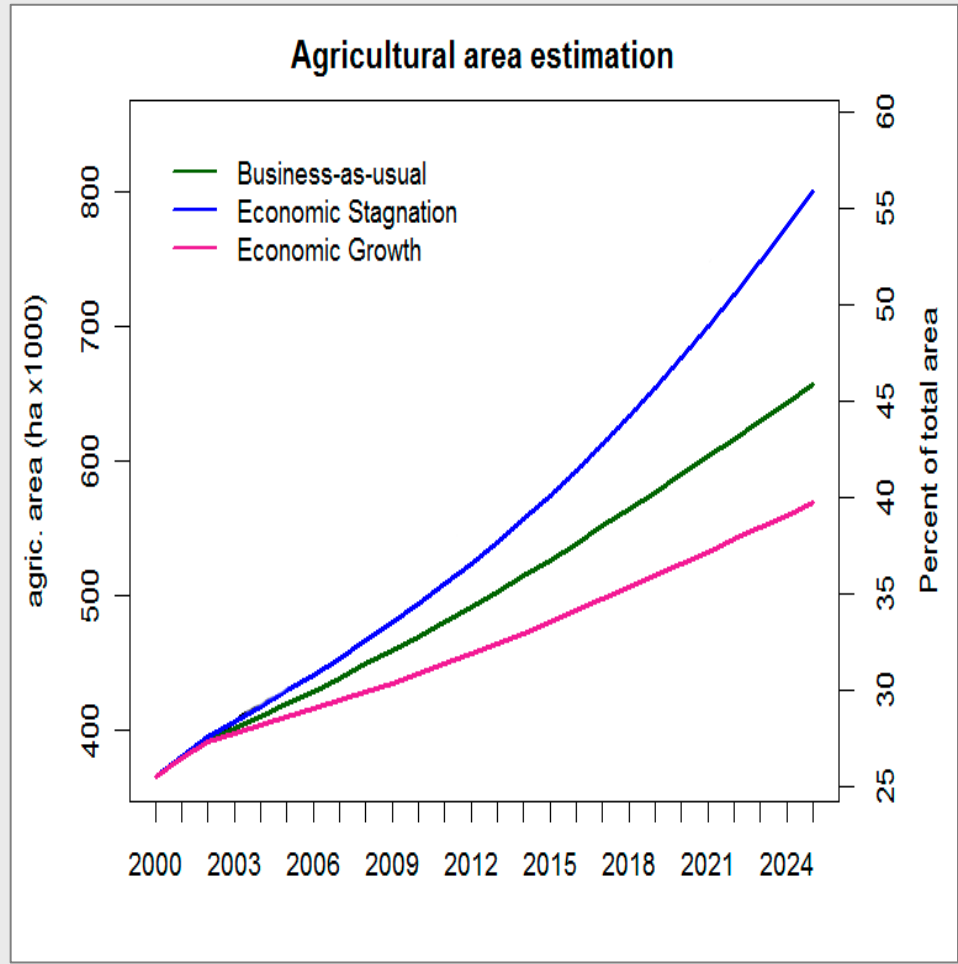




Model validation and scenario calculation

- Validation period 1991-2000
- Model prediction accuracy: 86%
- Scenario calculation until 2025:

“Economic Growth”
“Business-as-usual”
“Economic Stagnation”





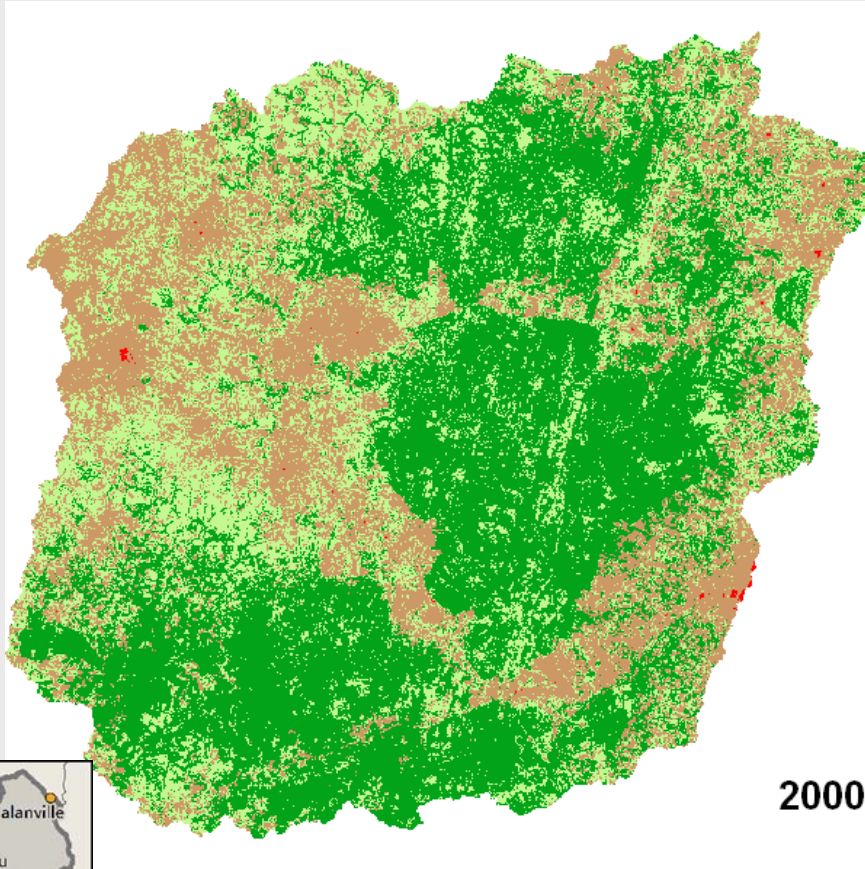
Scenario results



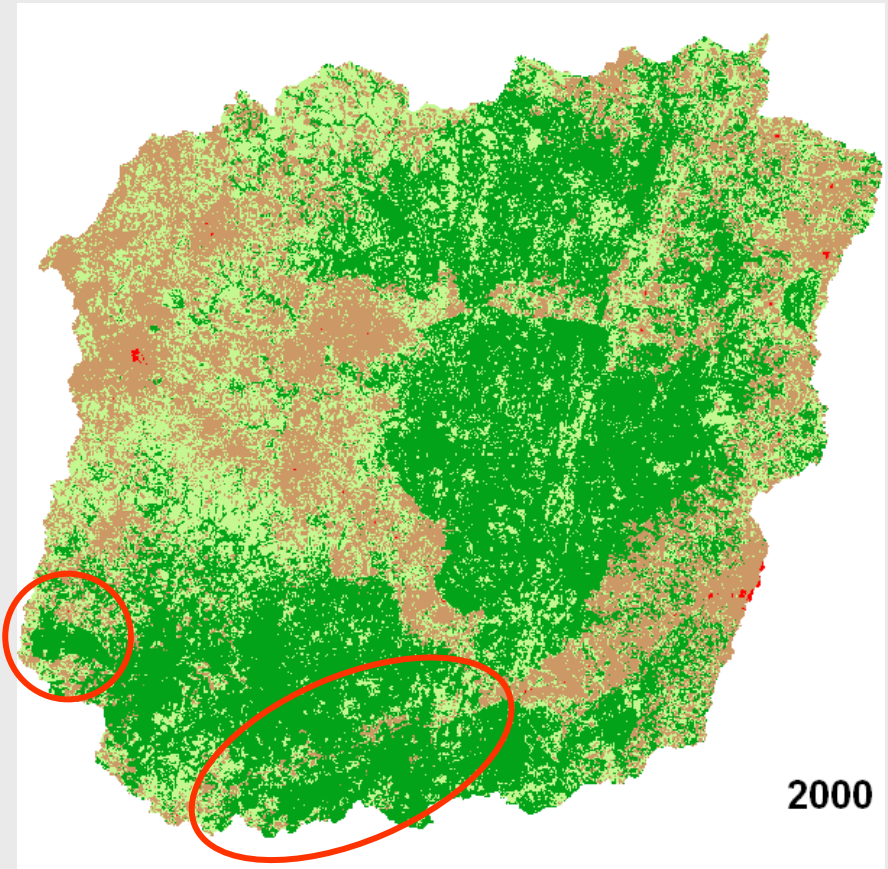
„Economic Growth“

„Economic Stagnation“

(Judex, 2008)



2000



2000



- Settlements
- Agricultural area
- Forest / dense savanna
- other

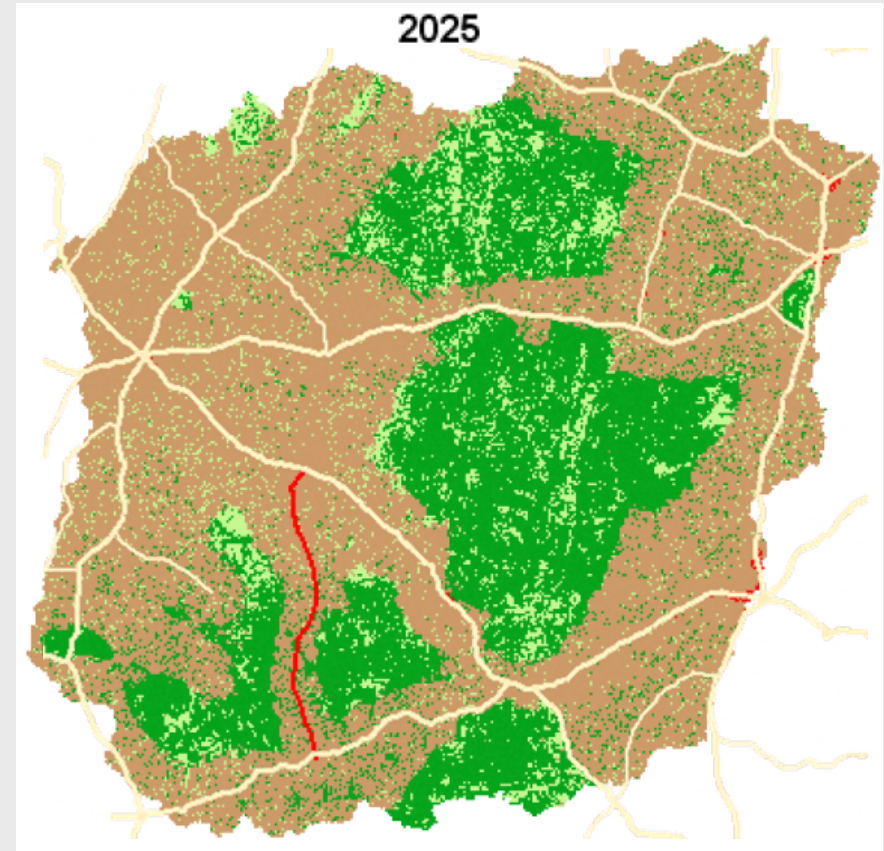
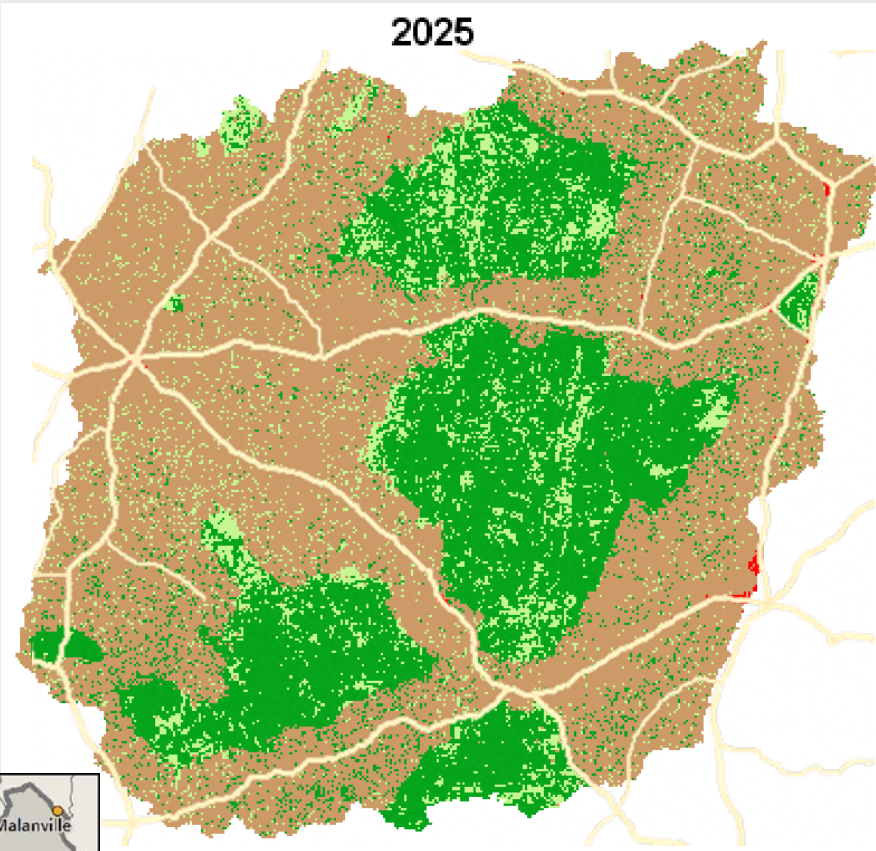


Intervention scenario – new road construction

„Economic Stagnation“

„Economic Stagnation + Intervention“

(Judex, 2008)



- Settlements
- Agricultural area
- Forest / dense savanna
- other



Conclusions:

- **High rates** of land-cover and land-use conversion was observed by remote sensing (45% within the last decade).
- Proximate factors of land cover change are **agricultural expansion** and **urban sprawl** which are driven by interconnected underlying factors (population growth, economic factors and rainfall variability, ...).
- IMPETUS-SDSS LUMIS is a highly **accurate regional LUCC model** and provide a detailed assessment of impacts of future land use and regional planning measures.
- Scenarios show: (a) **high threat** to the ecologically as well as culturally important protected forests and (b) **technological change** is needed to improve agricultural productivity and hence mitigate the „shrinking land base“.

Thank you for your attention!



Village Kpawa. Photo taken with UAV (H.-P. Thamm, 2007)



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