



GLOBIOM :

Vers une modélisation de l'élevage mondial par systèmes de production

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Atelier de formation collective, INRA-CIRAD, Montpellier, Juillet 2011

OUTLINE:

1. Model presentation
2. Illustrative application
- X. Special features

Motivation

LIVESTOCK

- complex sector itself
- strongly connected to other sectors
and to the environment

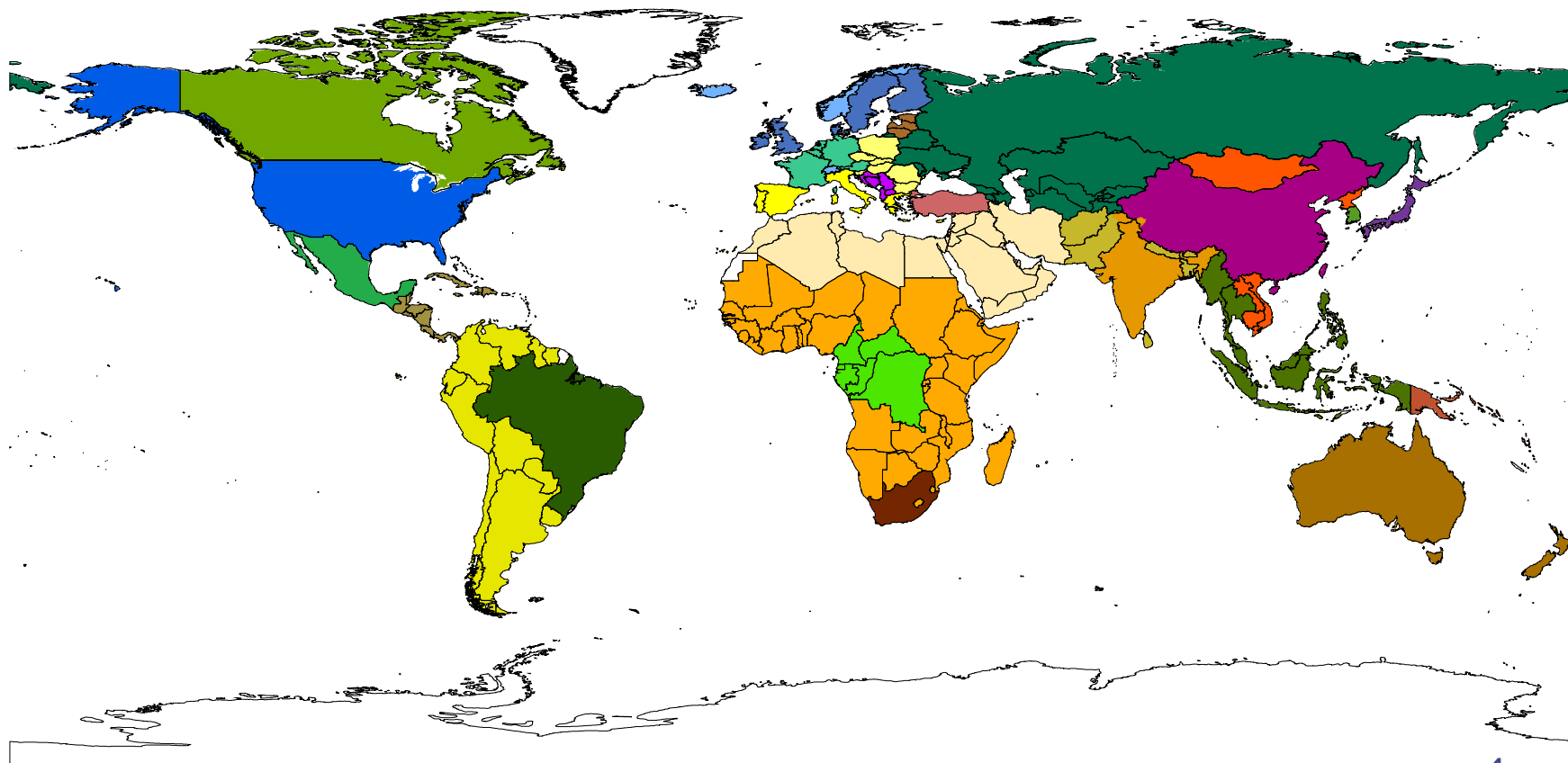
An integrated modeling framework needed

- detailed enough to capture local constraints
and environmental effects
- complete in sector and Earth coverage
to capture “linkage and leakage”

I. GLOBIOM

Global Biosphere Management Model

Basic resolution: 28 regions



I. GLOBIOM

Partial equilibrium model (endogenous prices)

Agriculture: major agricultural crops and livestock products

Forestry: traditional forests for sawnwood, and pulp and paper production

Bioenergy: conventional crops and dedicated forest plantations

Recursively dynamic (10 year periods)

Maximization of the social welfare (PS + CS)

Supply functions

implicit:

production system 1 (grass based)	→	productivity 1 + constant cost 1
production system 2 (mixed)	→	productivity 2 + constant cost 2

Demand functions

explicit:

linearized non-linear functions

$$p = \hat{p} * (q / \hat{q})^{1/e}$$

I. GLOBIOM

International trade:

Spatial equilibrium model

Trade flows between individual regions (BACI database, CEPII)

Homogeneous goods assumption

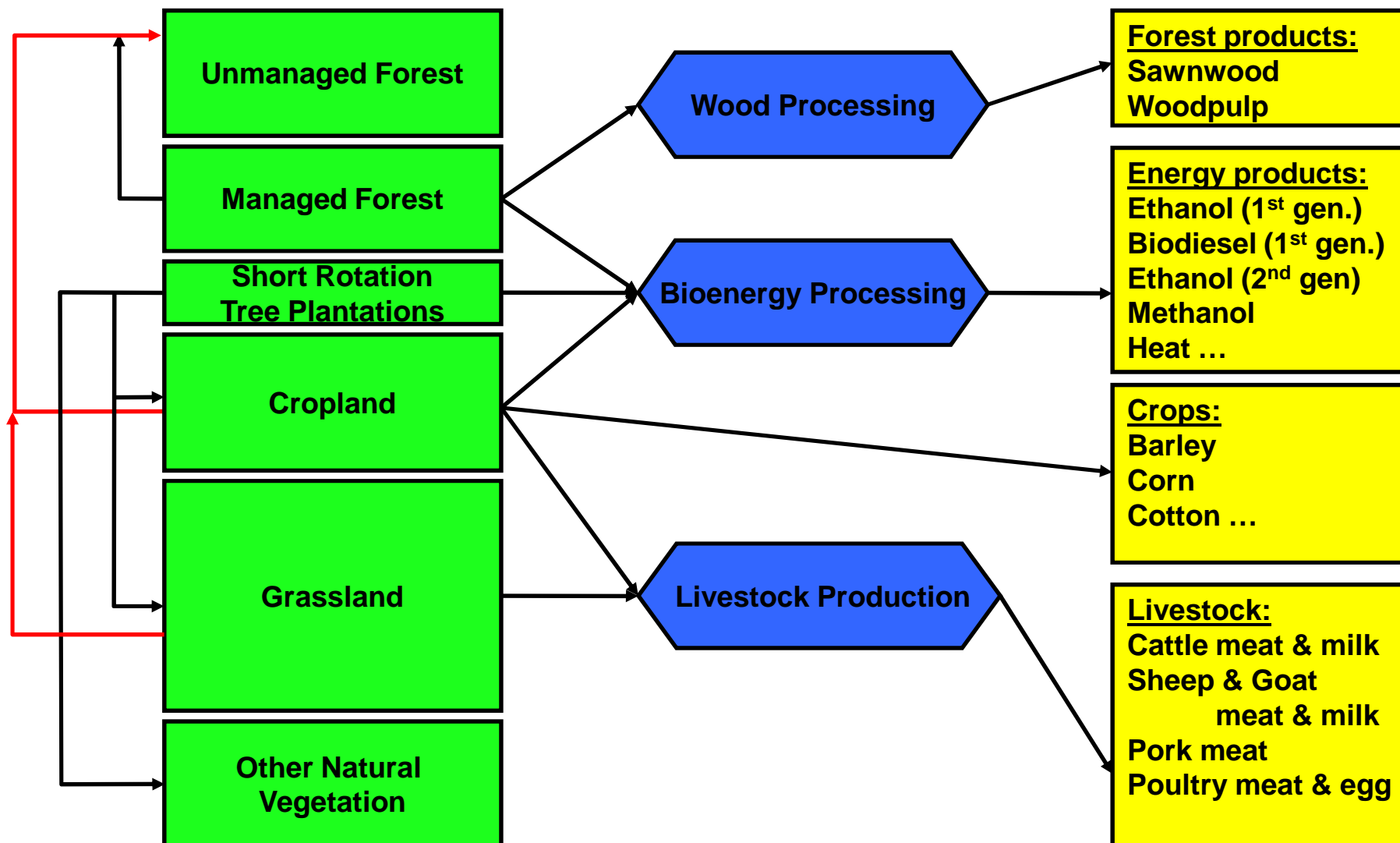
- Within a region imported and domestically produced goods are valued equally
→ no mutual trade
- Differences in prices between regions are due to external trade costs

Trade costs

Trade barriers (MacMap database, ITC/CEPII)

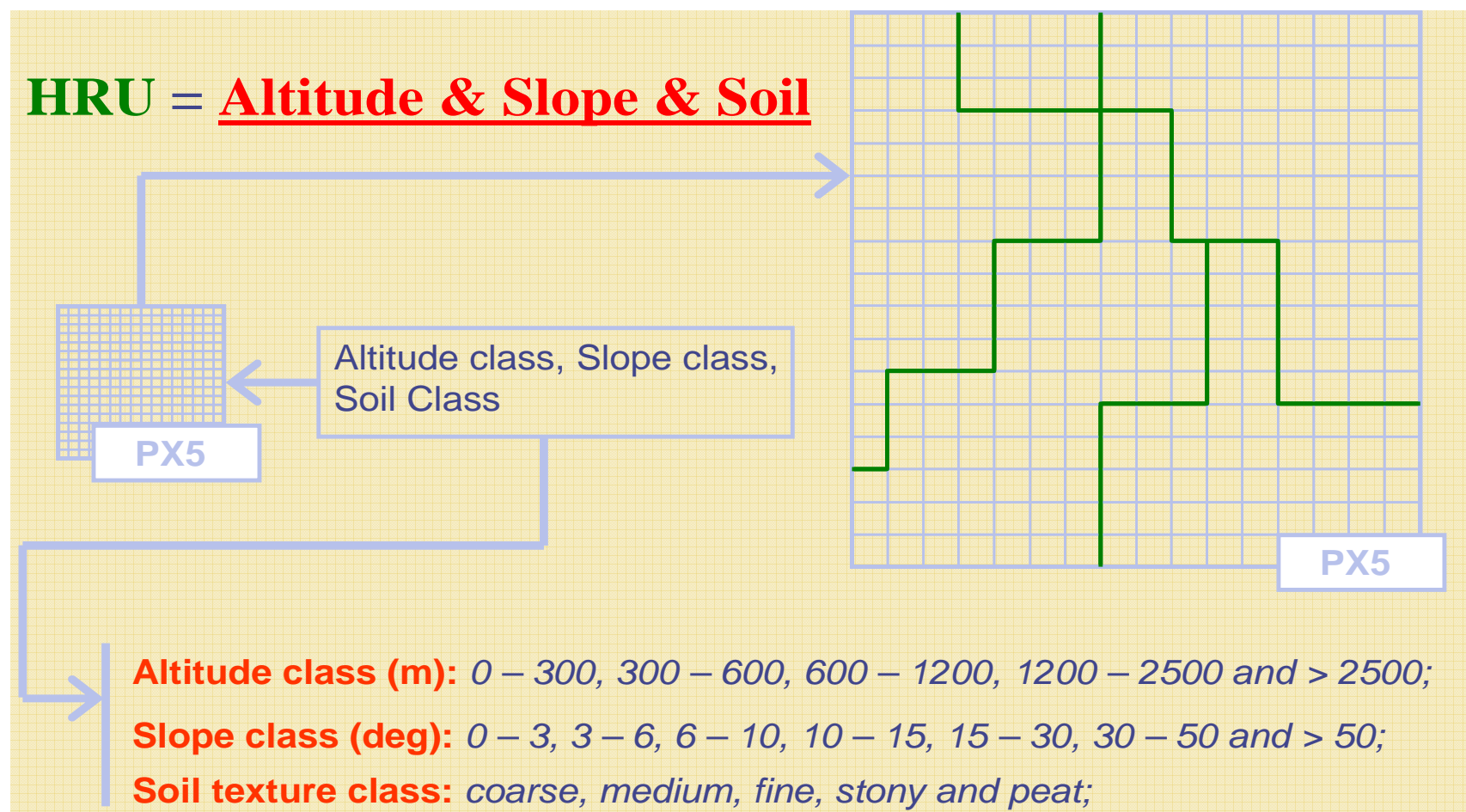
- + Transport cost (Hummels, 2001)
- + Calibration

I. GLOBIOM: Supply chains



I. GLOBIOM: Land

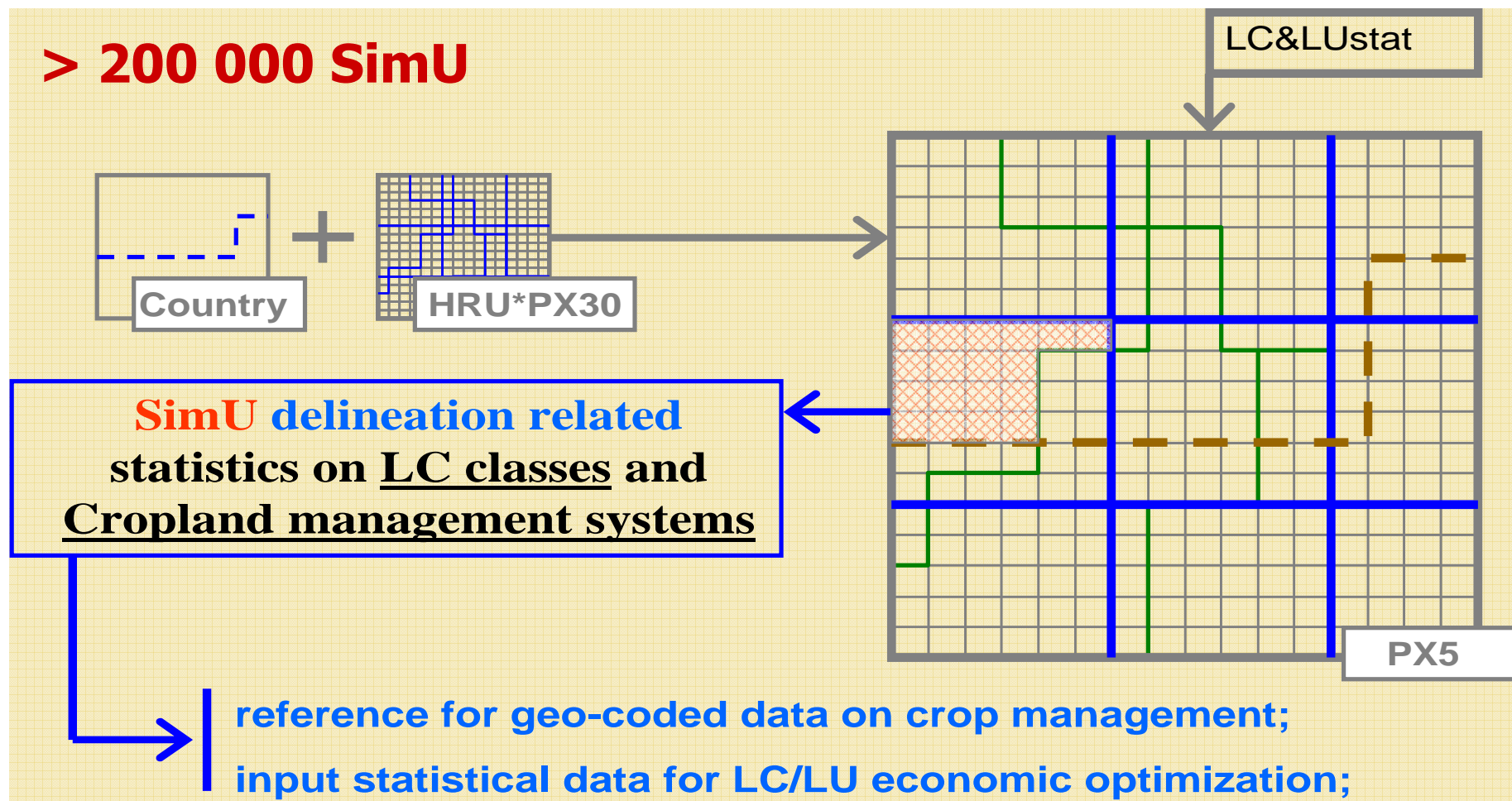
Homogeneous response units (HRU)



I. GLOBIOM: Land

Simulation Units (SimU) = **HRU** & **PX30** & **Country zone**

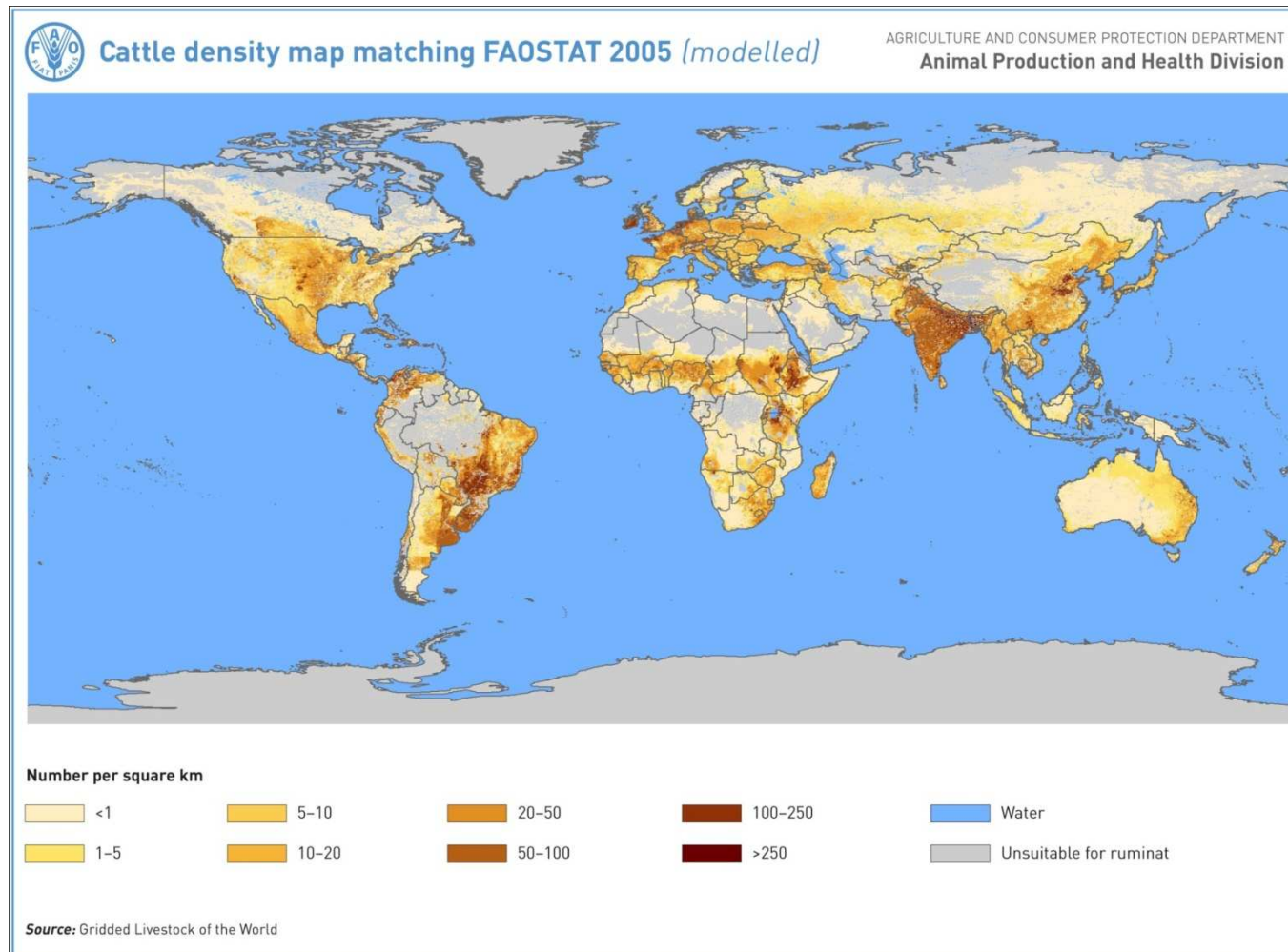
> 200 000 SimU



Source: Skalský et al. (2008)

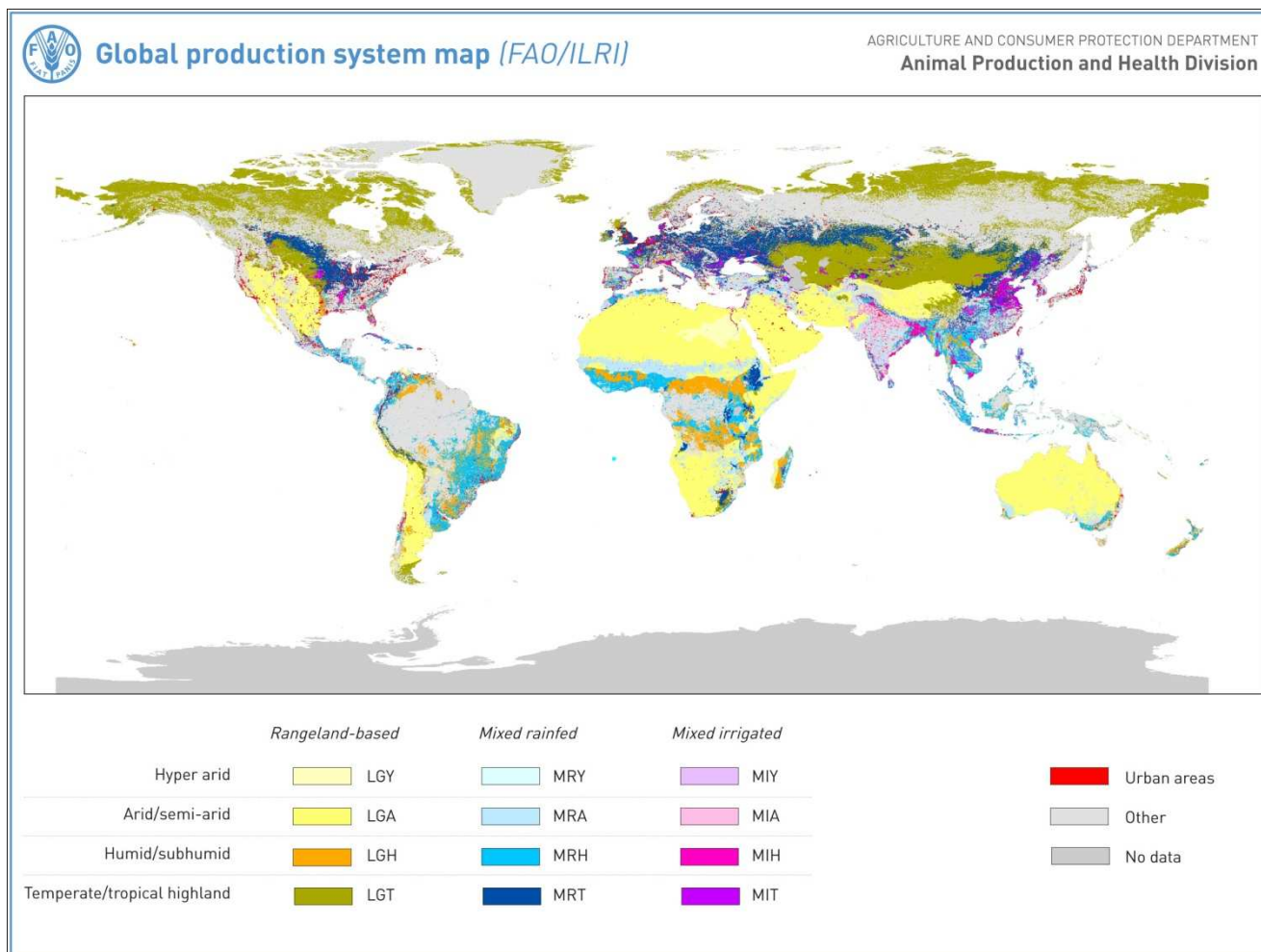
I. GLOBIOM: Livestock

Spatially explicit representation



I. GLOBIOM: Livestock

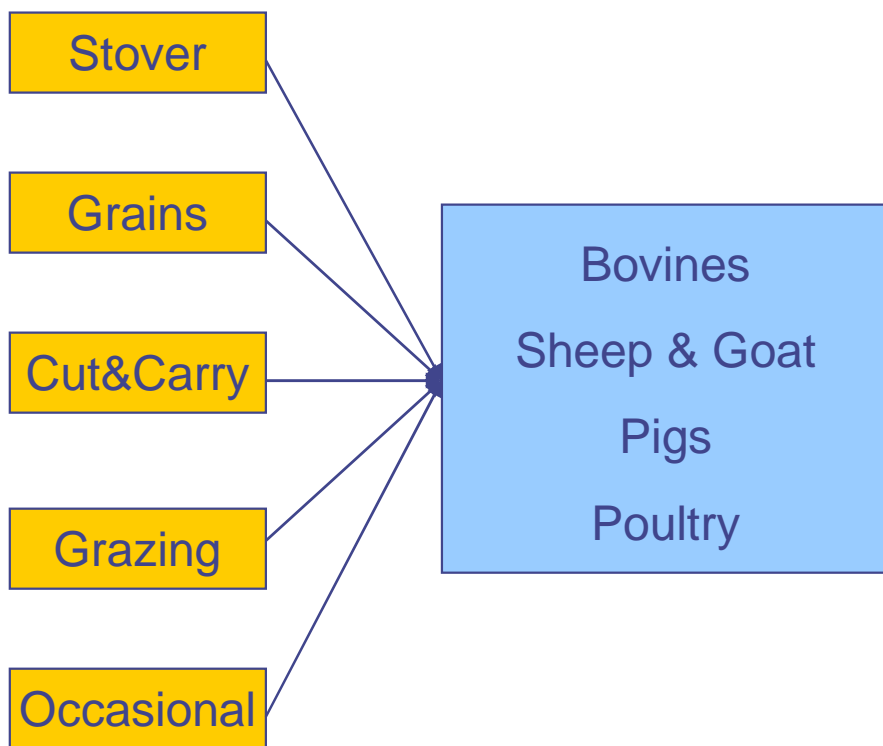
Livestock Production System Approach (8 systems)



I. GLOBIOM : Livestock

Livestock Production System Parameters

Input parameters



Output parameters

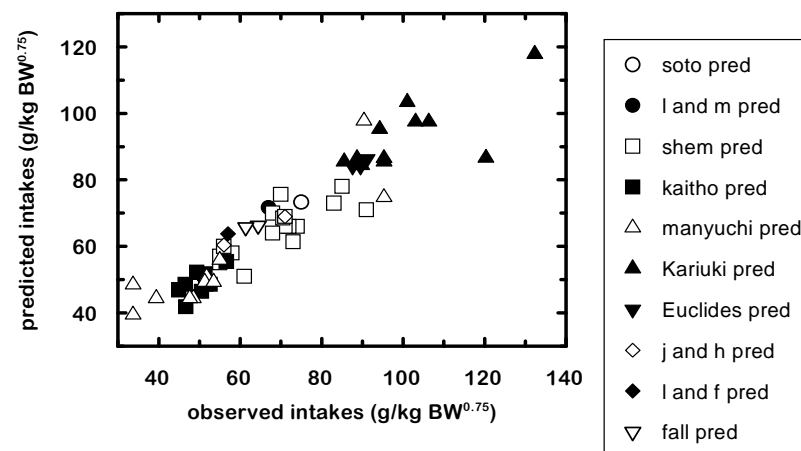


I. GLOBIOM : Livestock

The RUMINANT Simulation model

- ◆ **Dynamic simulation model of digestion in ruminants** (Herrero et al 2004) largely based on IPCC methods
- ◆ **Predicts intake, production (milk, meat), and excretion** (faeces and urine) using a dynamic model of digestion (Illius and Gordon 1991)
- ◆ **Predicts metabolism end products (METHANE, Volatile fatty acids, etc)**

Prediction of intake



- CH₄ coefficients have recently been approved by the IPCC GHG emissions taskforce (Herrero et al 2008, 2009)

I. GLOBIOM: Cropland - EPIC

Processes

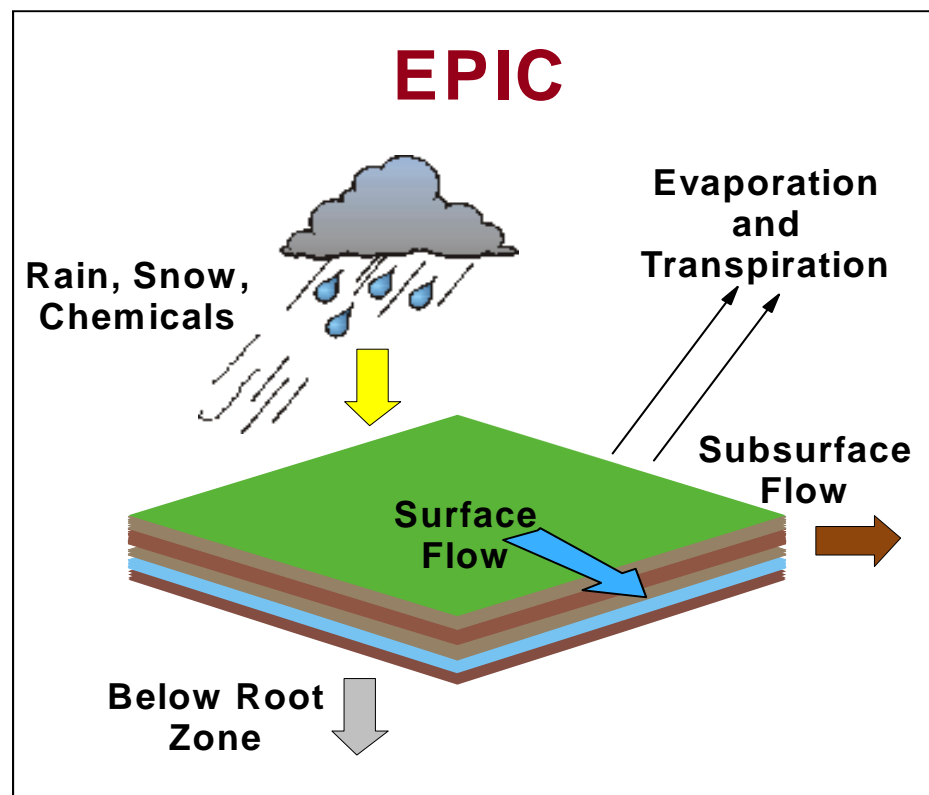
- Weather
- Hydrology
- Erosion
- Carbon sequestration
- Crop growth
- Crop rotations
- Fertilization
- Tillage
- Irrigation
- Drainage
- Pesticide
- Grazing
- Manure

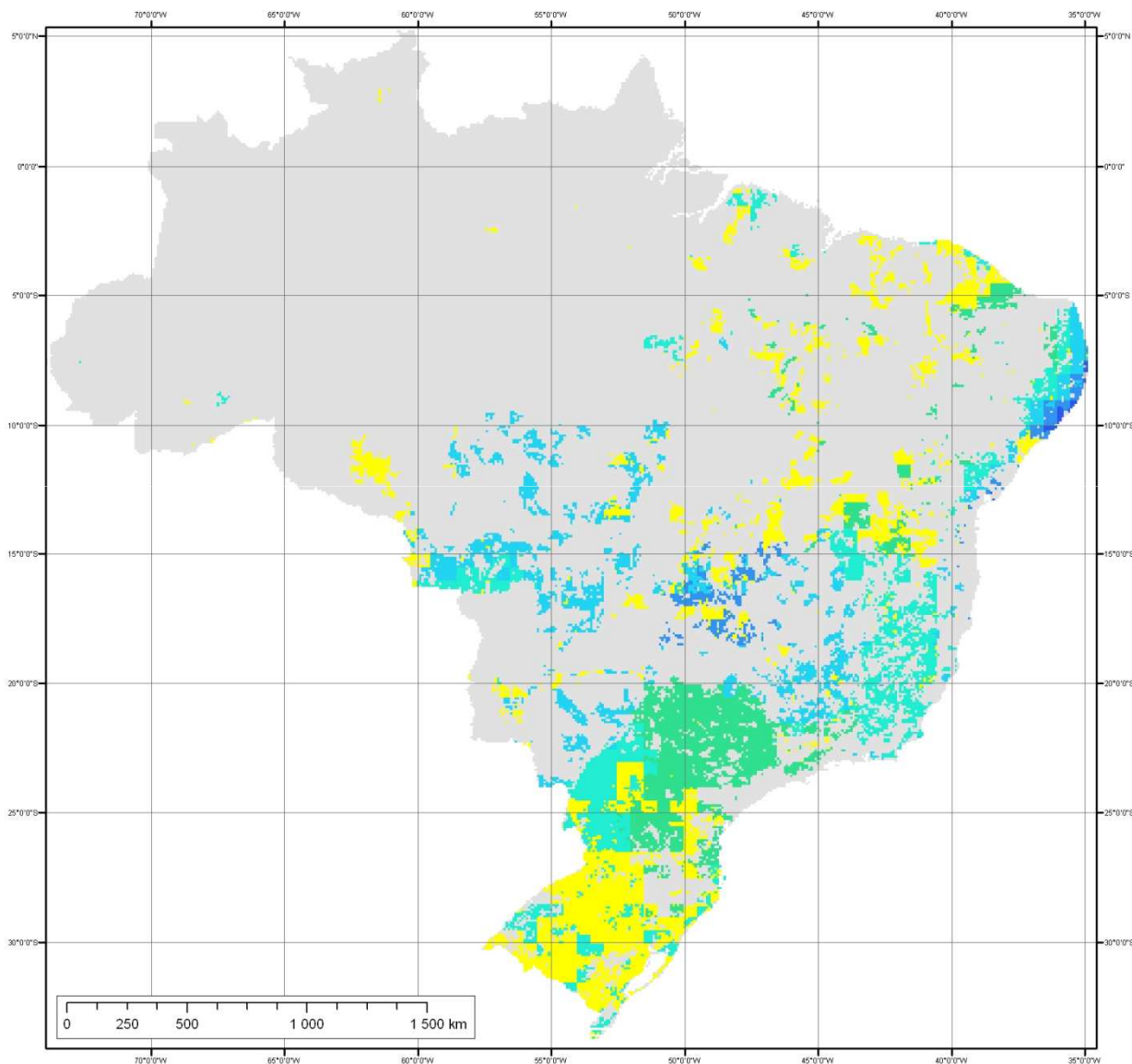
Major outputs:

Crop yields, Environmental effects (e.g. soil carbon,)

20 crops (>75% of harvested area)

4 management systems: High input, Low input, Irrigated, Subsistence



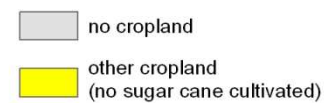
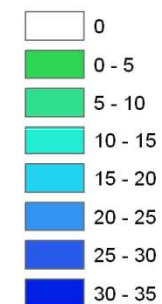


Brazil:

Sugar cane yield,
IFPRI allocated area,
high input system

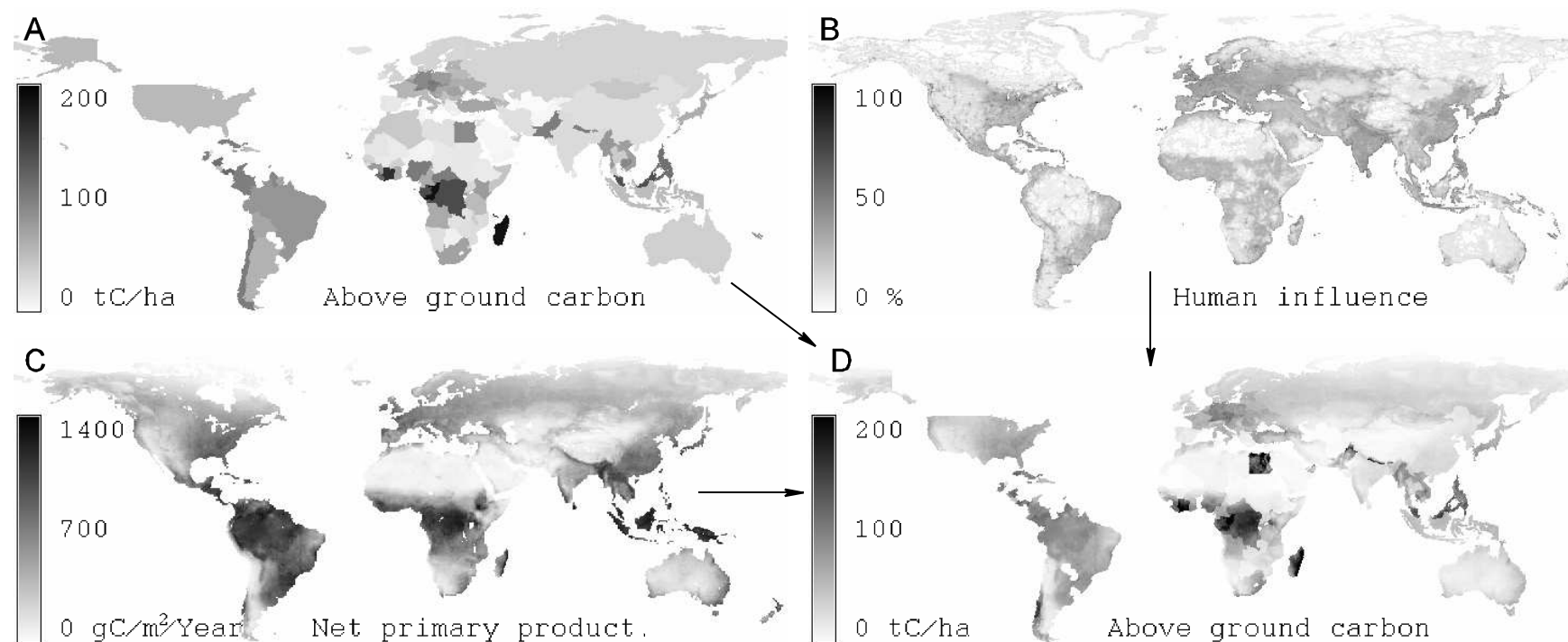
Legend:

Sugar cane Yield (t/ha)



I. GLOBIOM: Forests – G4M

Step 1: Downscaling FAO country level information on above ground carbon in forests (FRA 2005) to 30 min grid



Source: Kindermann et al. (2008)

I. GLOBIOM: Forests – G4M

Step 2: Forest growth functions estimated from yield tables

Major outputs:

Mean annual increment

Tree size

Sawn wood suitability

Harvesting cost

I. GLOBIOM: Scenario analysis

Main exogenous drivers:

Population

GDP

Technological change

Bio-energy demand (POLES team)

Diets (FAO, 2006)

Output:

Production Q

- land use (change)
- water use
- GHG,
- other environment (nutrient cycle, biodiversity,...)

Consumption Q

Prices

Trade flows

II. Preliminary results: Livestock

(Havlík et al, 2009)

Livestock production system development:

STICKY livestock production systems

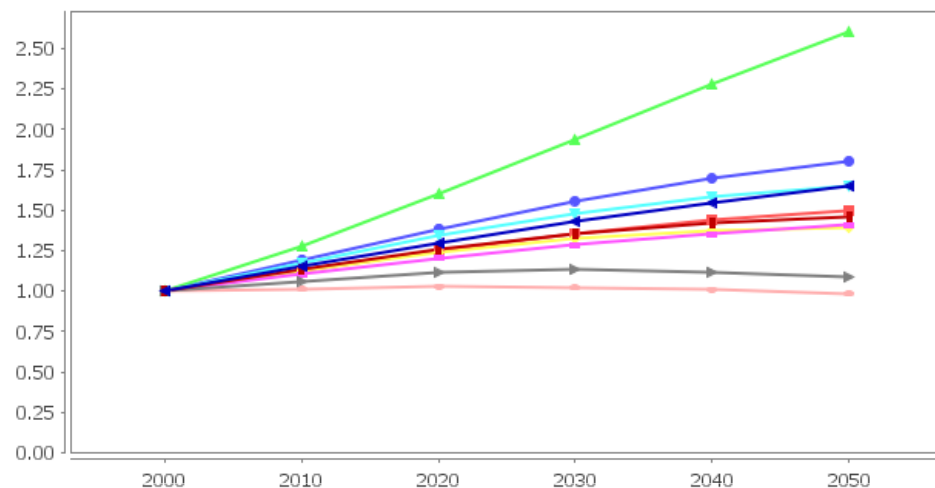
- min 75% of LPS of 2000 still in the same place in 2020

FLEXIBLE livestock production systems

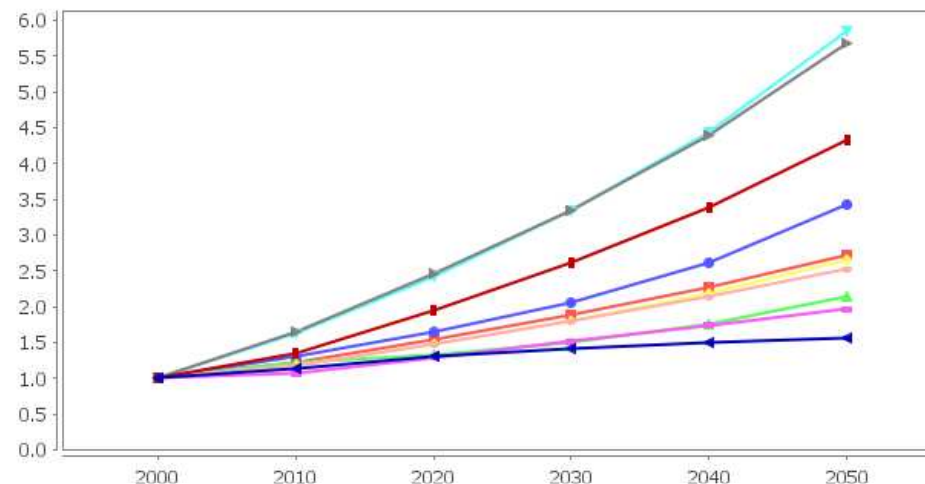
- min 25% of LPS of 2000 still in the same place in 2020



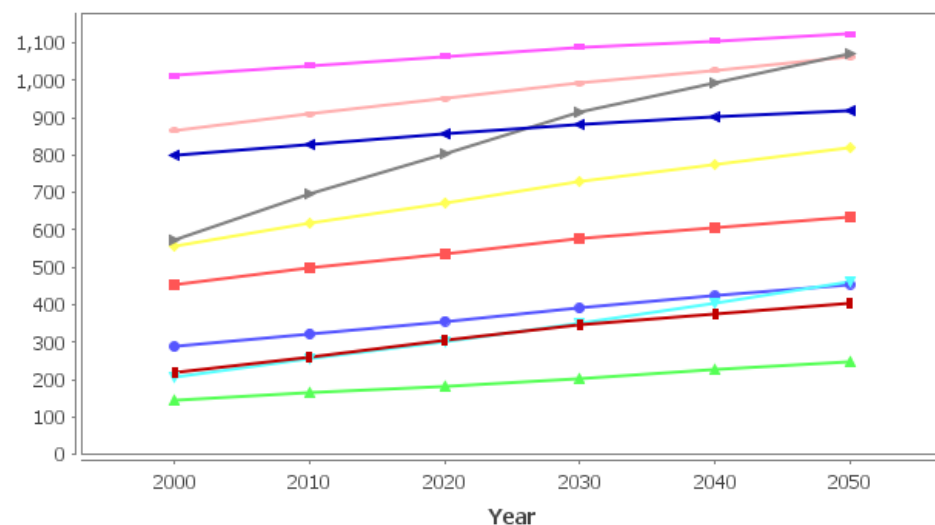
POLES Macro Scenarios
(Population [Relative to 2000], poles_bas_sep10)



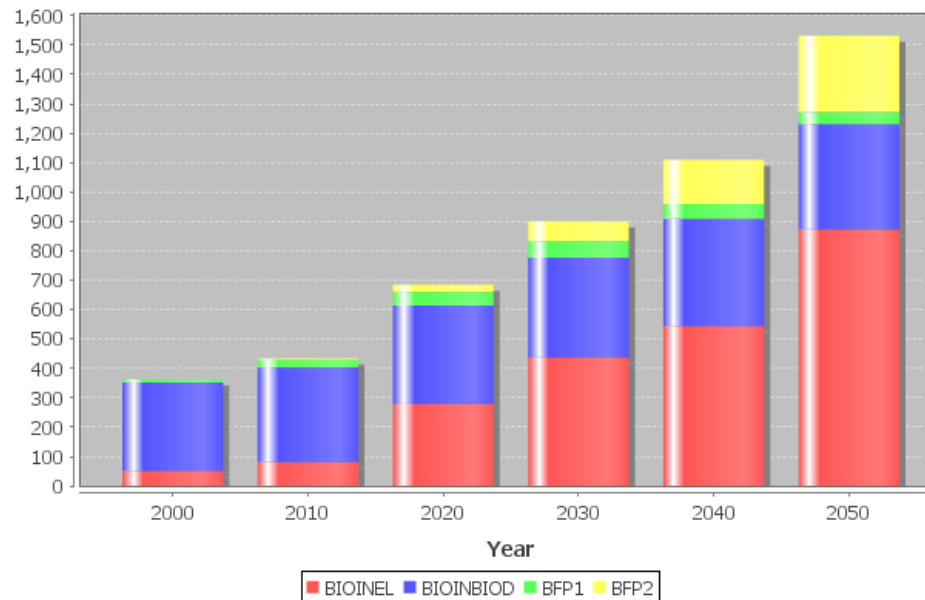
POLES Macro Scenarios
(GDP per Capita [Relative to 2000], poles_bas_sep10)



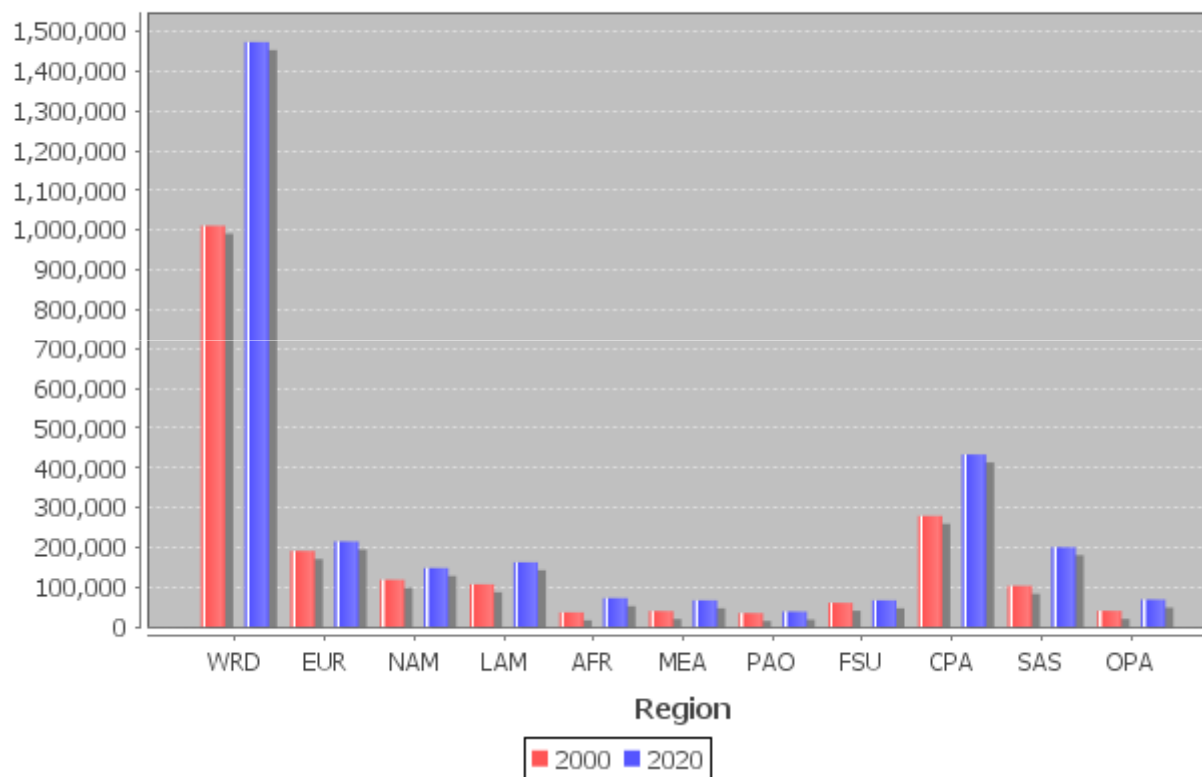
Calorie Consumption [kcal/cap/day]
(animal total, poles_bas_sep10, GHGPrice0, DETAILED)



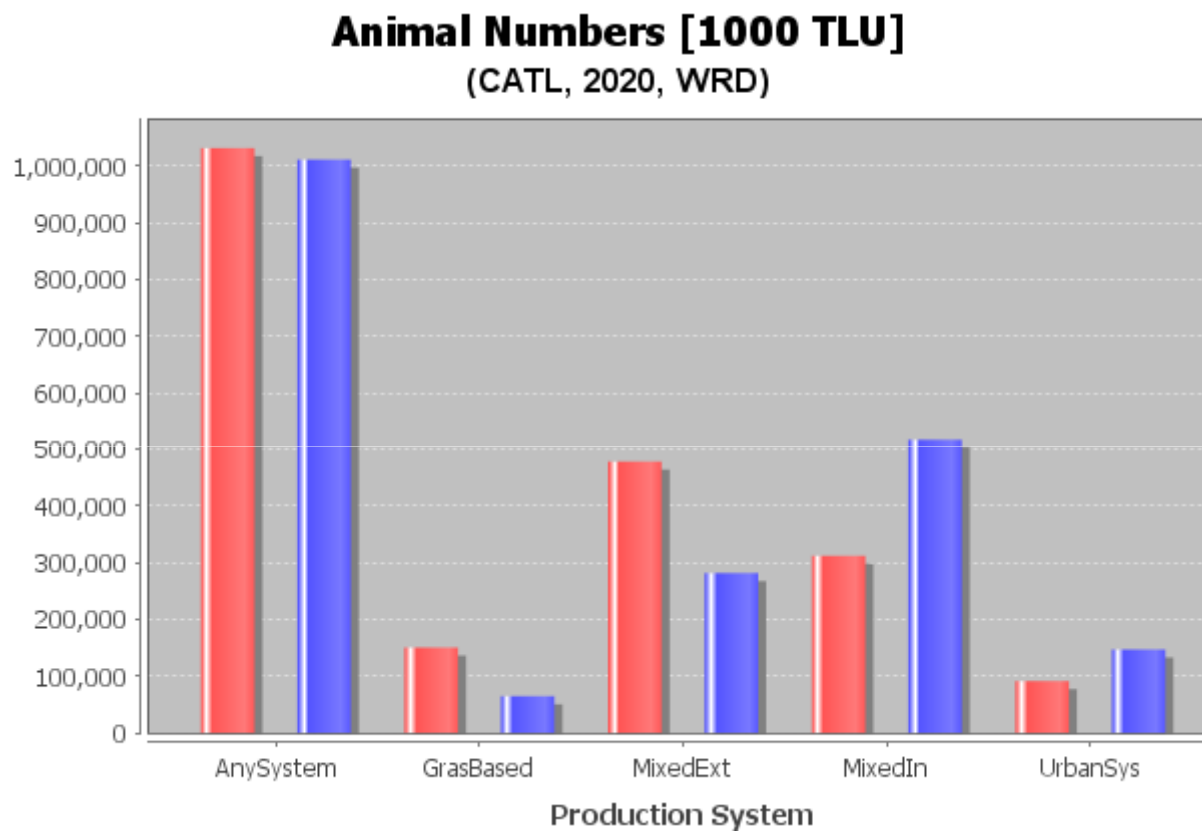
POLES Energy Production/Consumption [Mtoe]
(poles_bas_sep10, GHGPrice0, DETAILED)



Calorie Consumption [billion kcal] (ANIM, WRLD_YTRD_YDFR_NCHG)



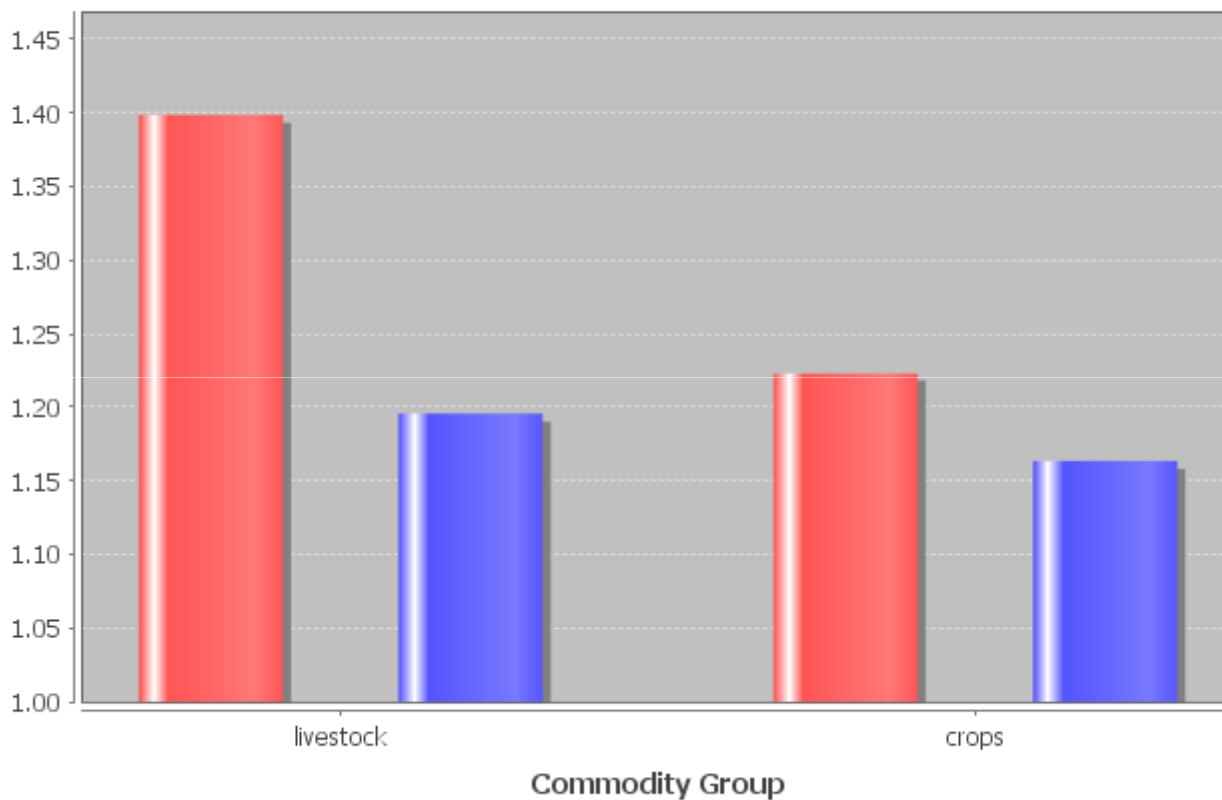
Important increase in absolute animal calorie consumption.



STICKY x FLEXIBLE

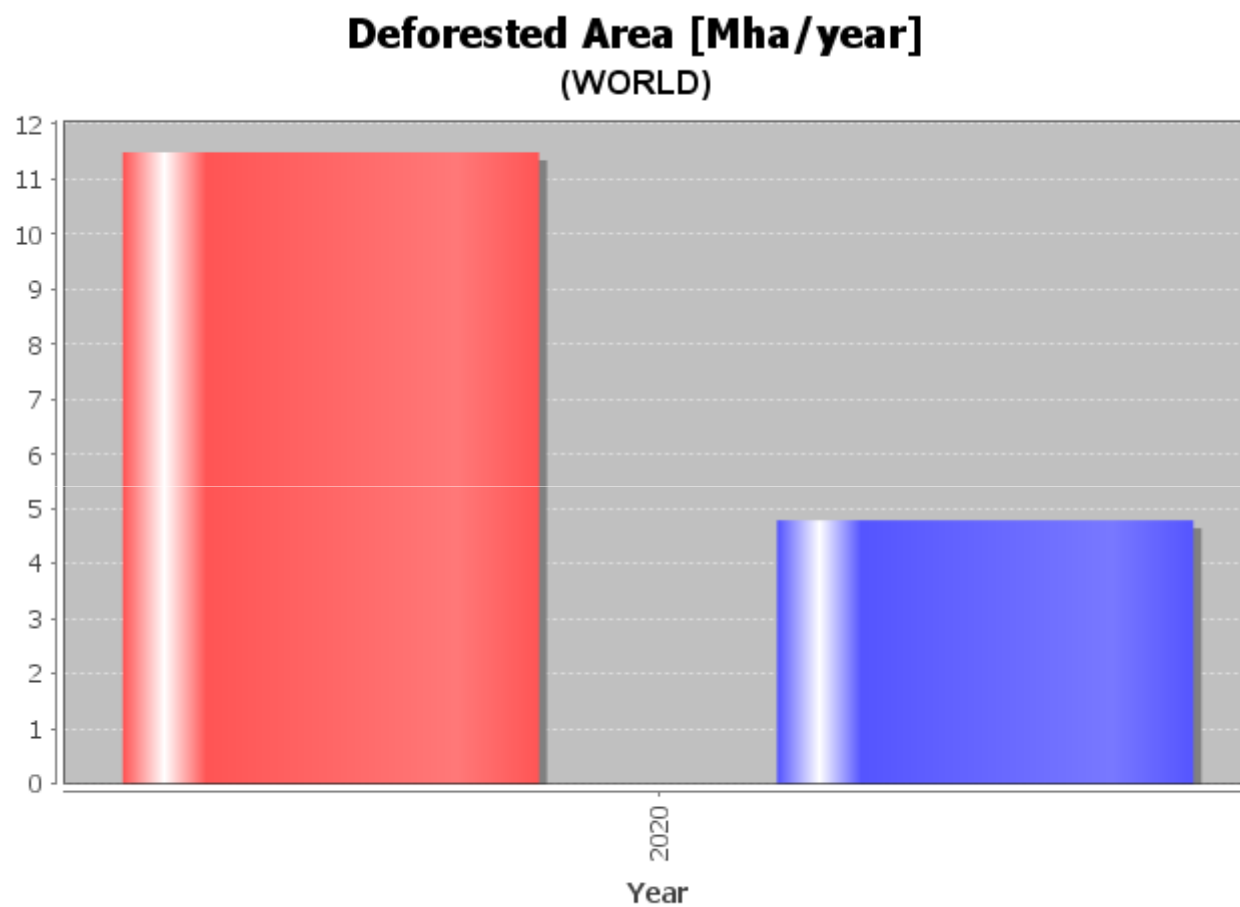
IF system change possible → shift to intensive production systems

Commodity Price Index (2020, WORLD)



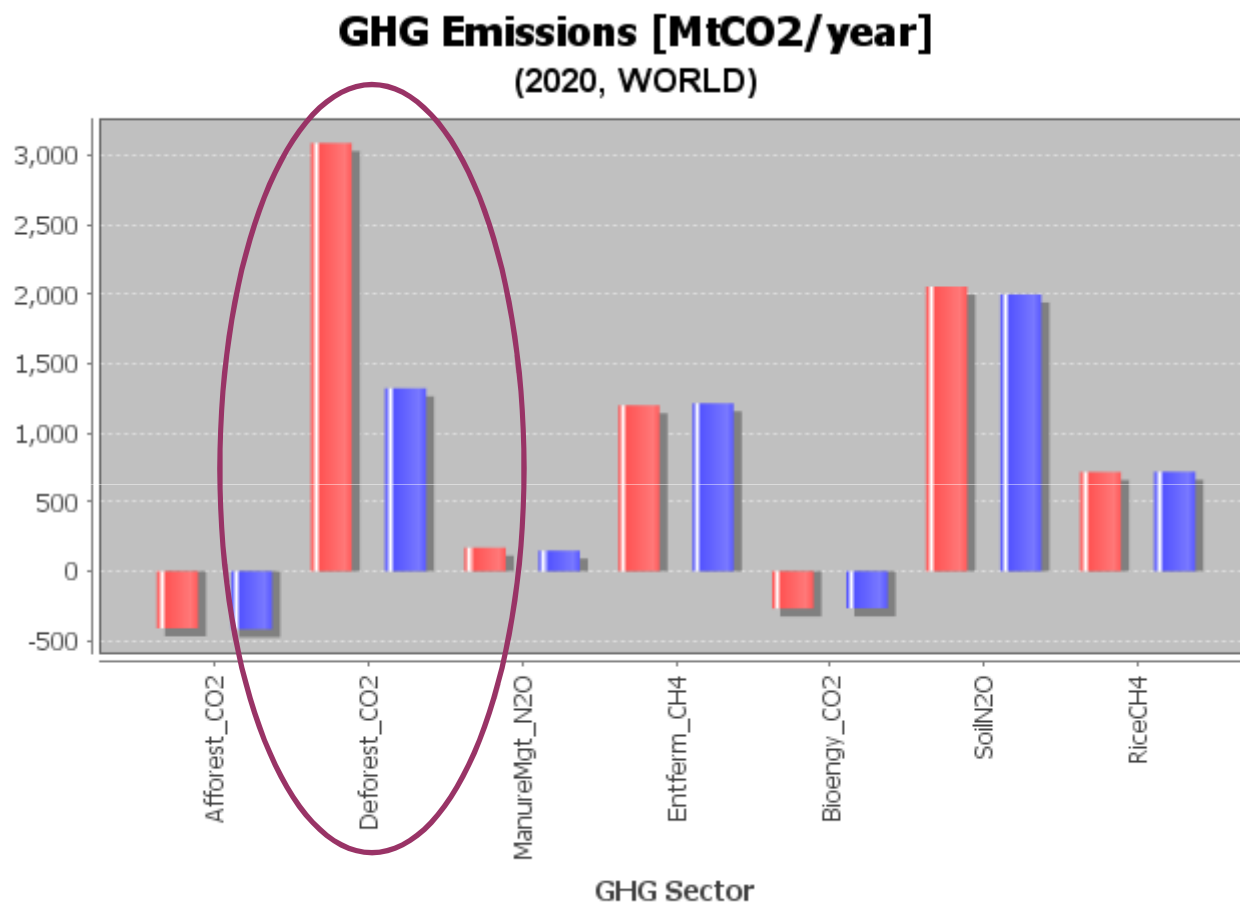
STICKY x FLEXIBLE

Adjustments in production systems help to keep commodity prices low



STICKY x FLEXIBLE

AND to reduce deforestation!

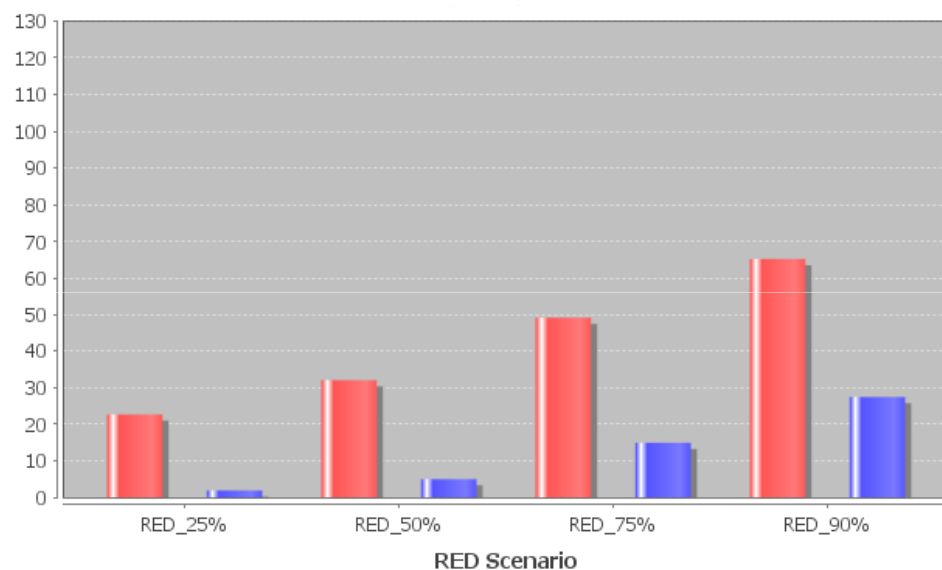


STICKY x FLEXIBLE

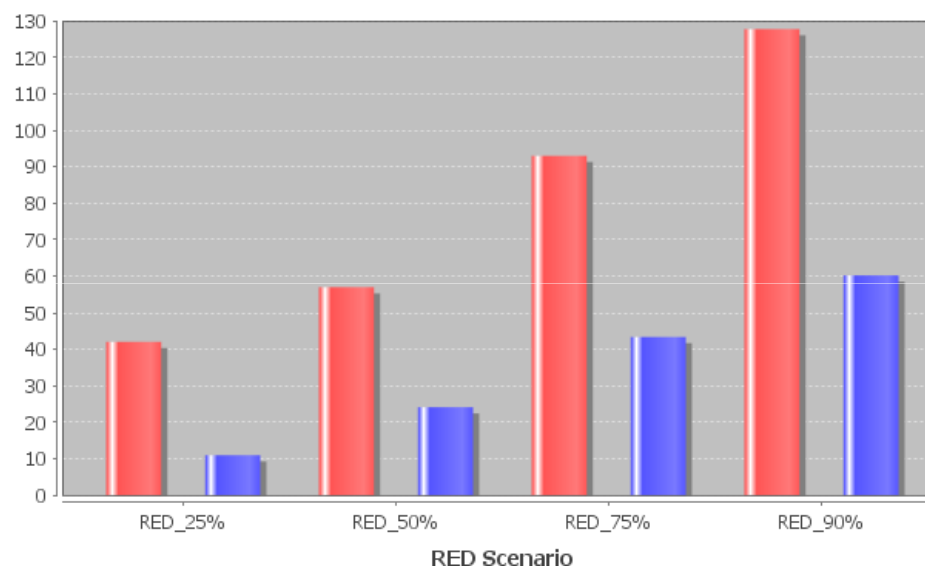
RED through livestock does not have negative effect on non-CO₂ emissions.

Marginal RED cost [USD/tCO₂]

Baseline



2x biofuels

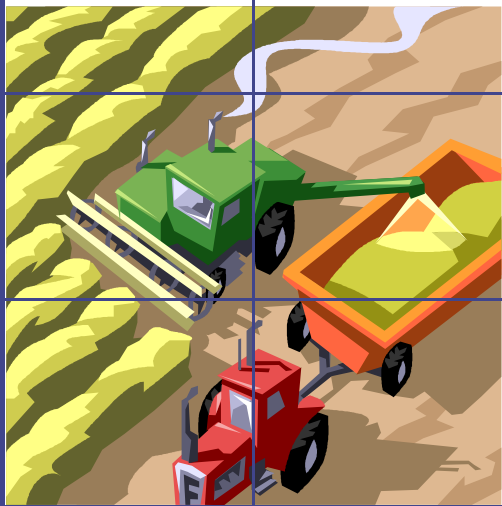
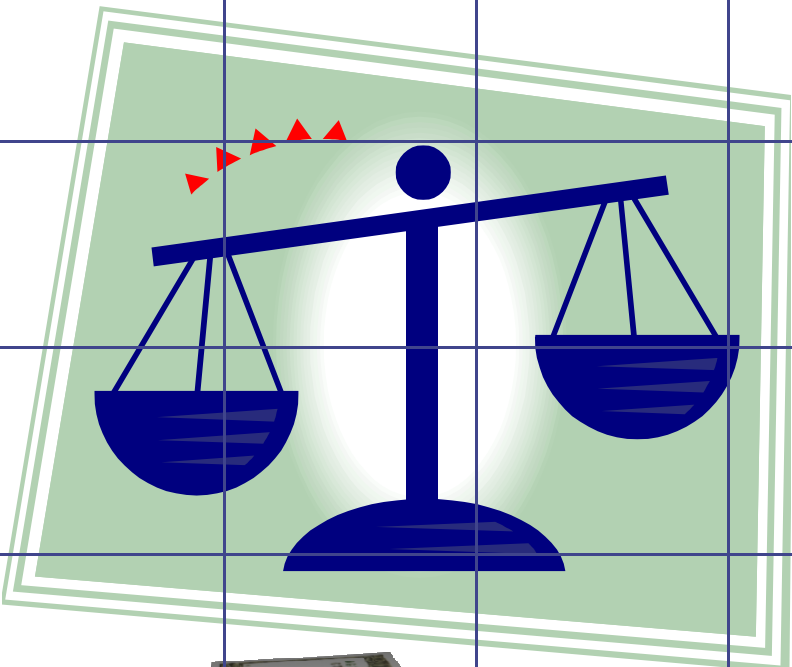
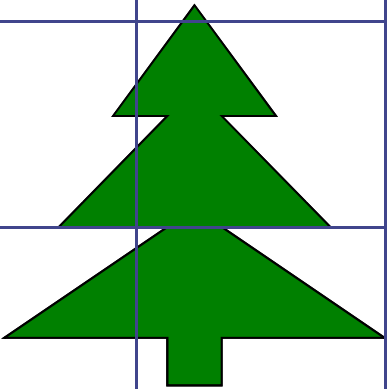



STICKY x FLEXIBLE

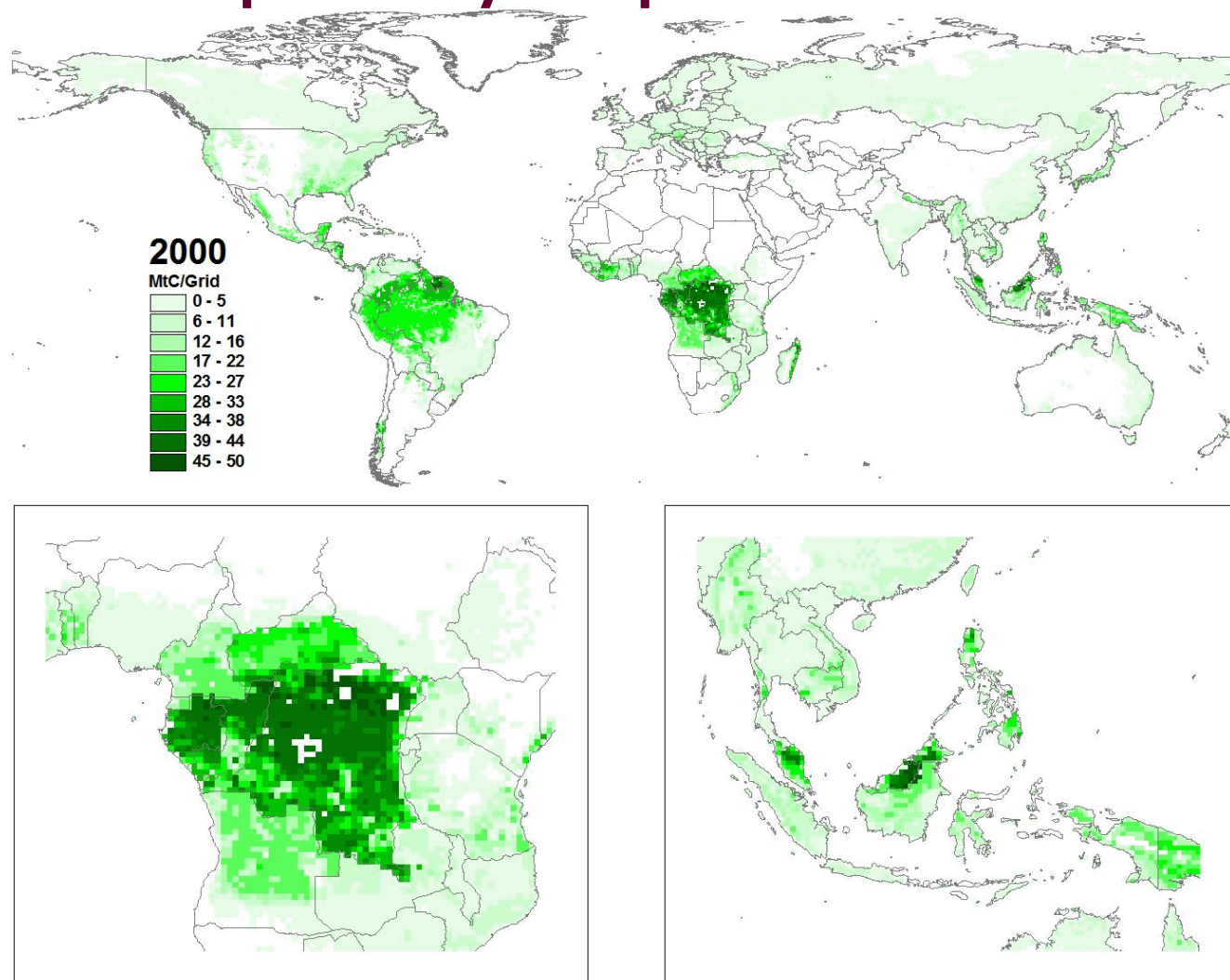
The cost of mitigation policies lower if systems can adapt

X. Special features

Xa. G4M-GLOBIOM link

		
		<p>FM: H=WD</p>
<p>0.5°x 0.5°</p>		

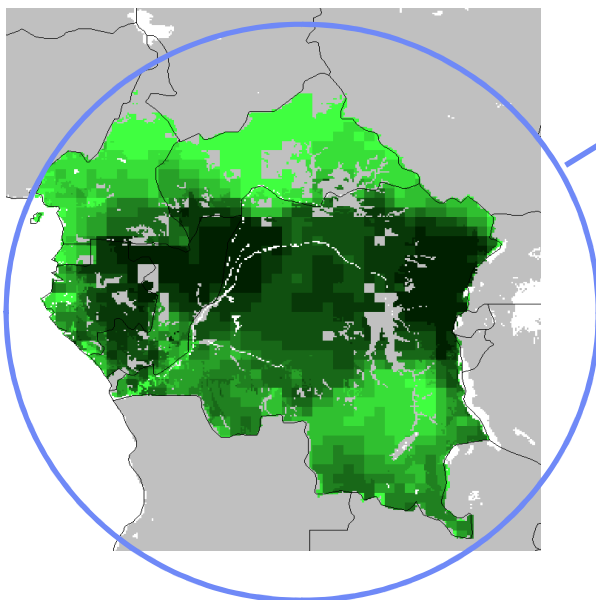
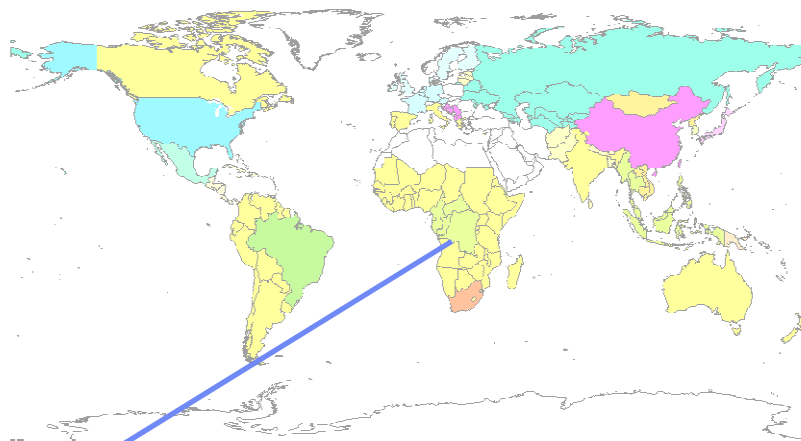
Xa. G4M: Spatially explicit results



Xb: Regional zooming - CongoBIOM

Drivers of deforestation study
for World Bank

1550 Simulation Units
from 10*10km to 50*50 km

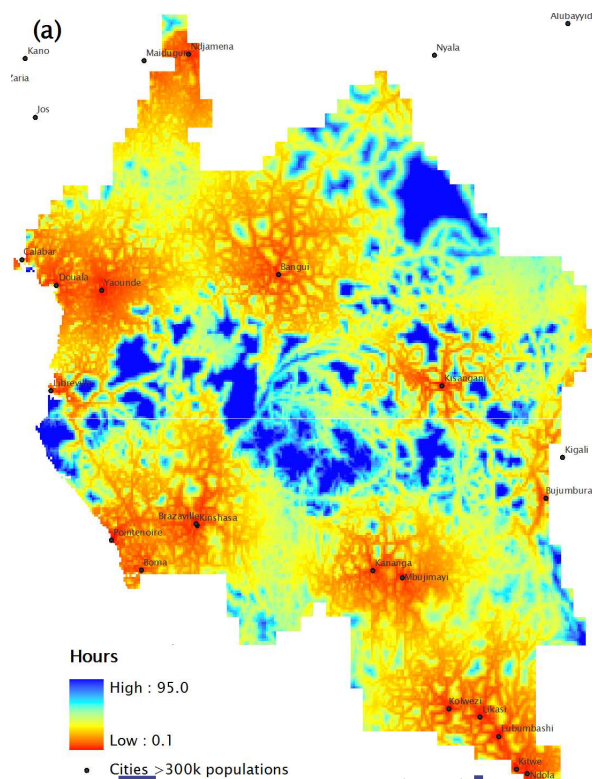


Spatially explicit aspects:

- population
- infrastructure

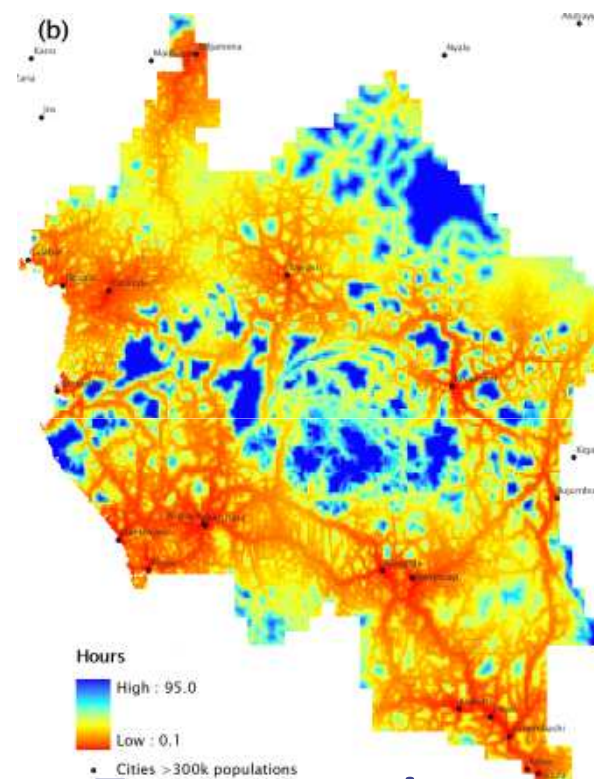
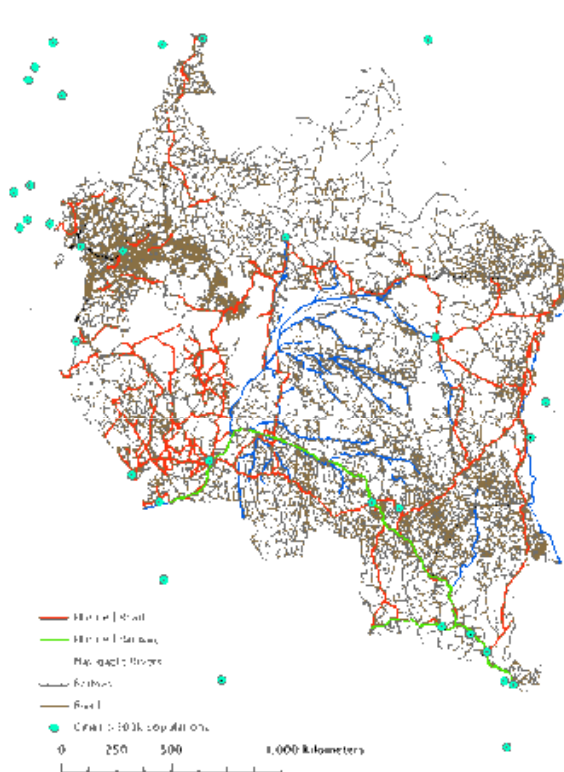
→ market access

Xb: Regional zooming - CongoBIOM



**Transportation
time – Existing
infrastructures**

(Circa 2000)

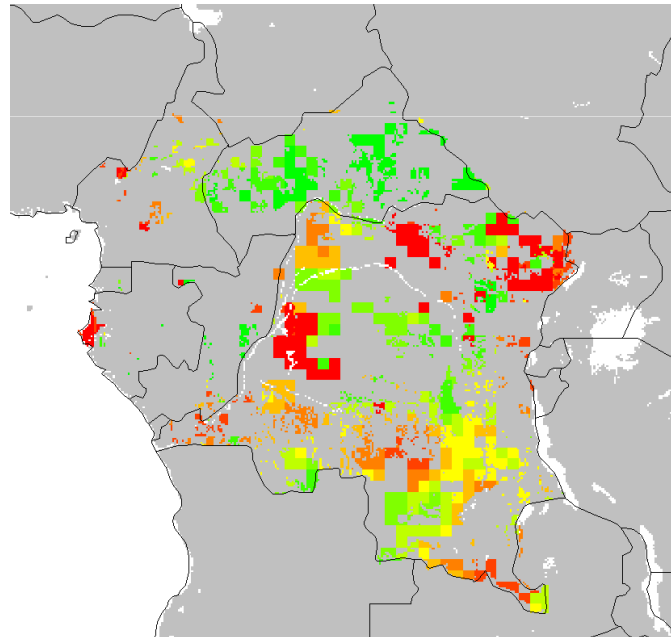


**Transportation
time- New
Infrastructures**

(National Statistics, World Bank)

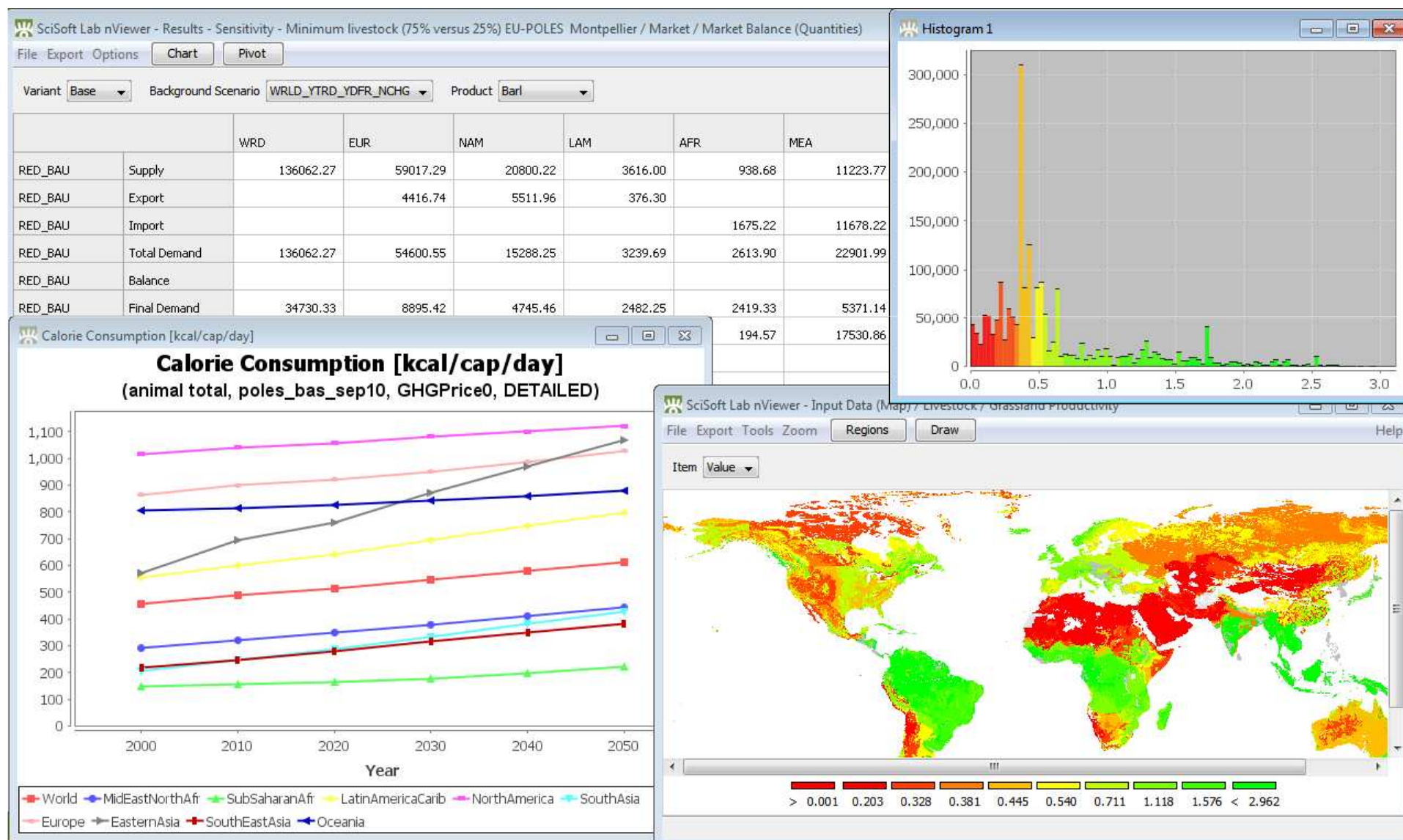
Xb: Regional zooming - CongoBIOM

**Deforestation after infrastructure improvement
[1000 ha/SimU/10 years]**



Green = low Red = high

Xc: Scenario exploration tool - GUI





Thank you !

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