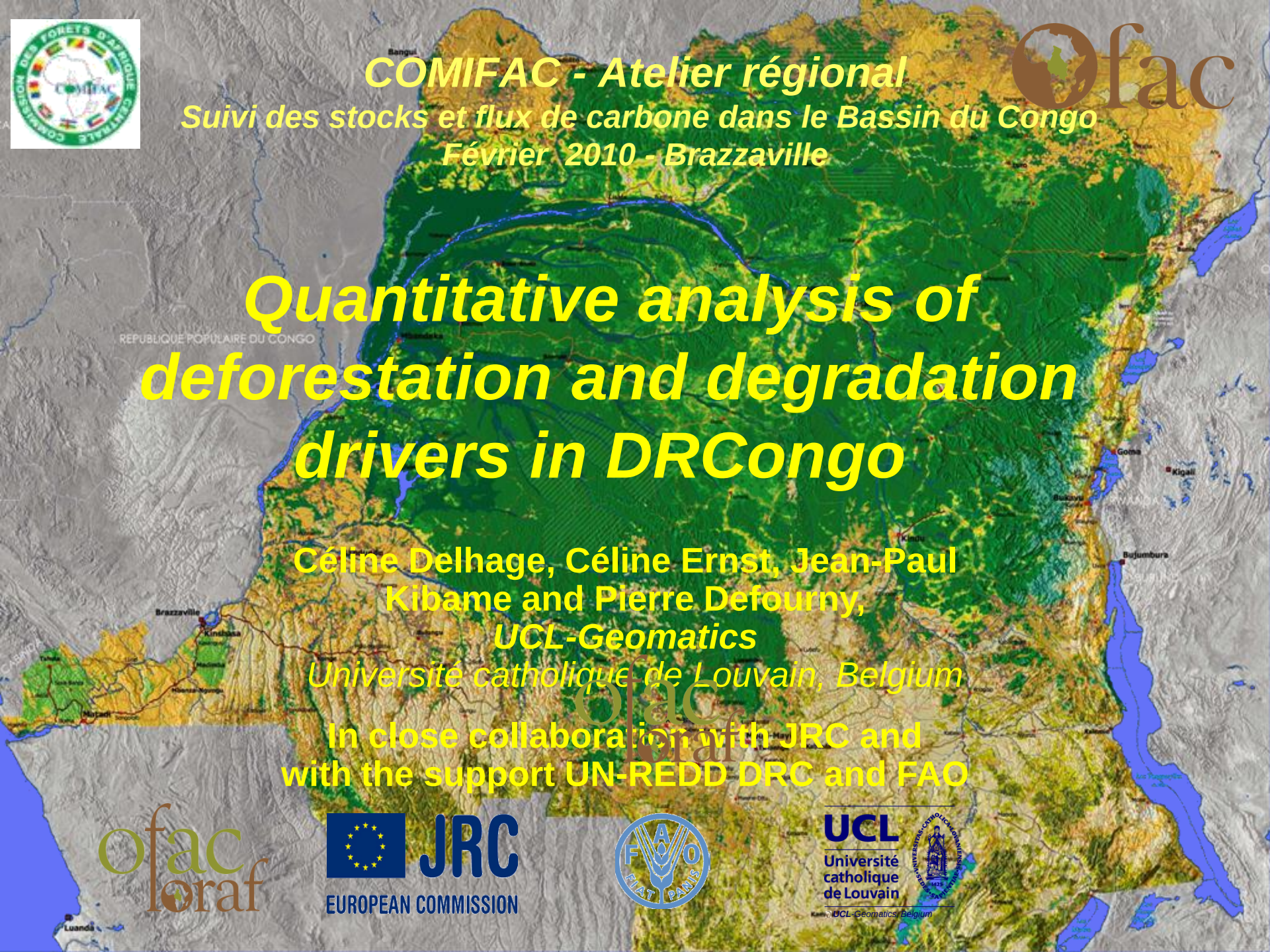


COMIFAC - Atelier régional

Suivi des stocks et flux de carbone dans le Bassin du Congo

Février 2010 - Brazzaville

Quantitative analysis of deforestation and degradation drivers in DRCongo

Céline Delhage, Céline Ernst, Jean-Paul Kibame and Pierre Defourny,

UCL-Geomatics

Université catholique de Louvain, Belgium

In close collaboration with JRC and with the support UN-REDD DRC and FAO

EUROPEAN COMMISSION

UCL Université catholique de Louvain

UCL-Geomatics Belgium

Institutional Context

REDD National Coordination :

UN-REDD program (FAO, PNUD and UNEP partnership) and CBFP program (World Bank)

+ **REDD Working group of administration and numerous NGO stakeholders** (AWF, CI,ONFi, Rainforest Foundation, WCS and WWF)

Study objectives

- Identification and quantification of the **various drivers of deforestation and degradation for 1990-2000-2005 periods at national level for DRC**

  => building national consensus based on objective results

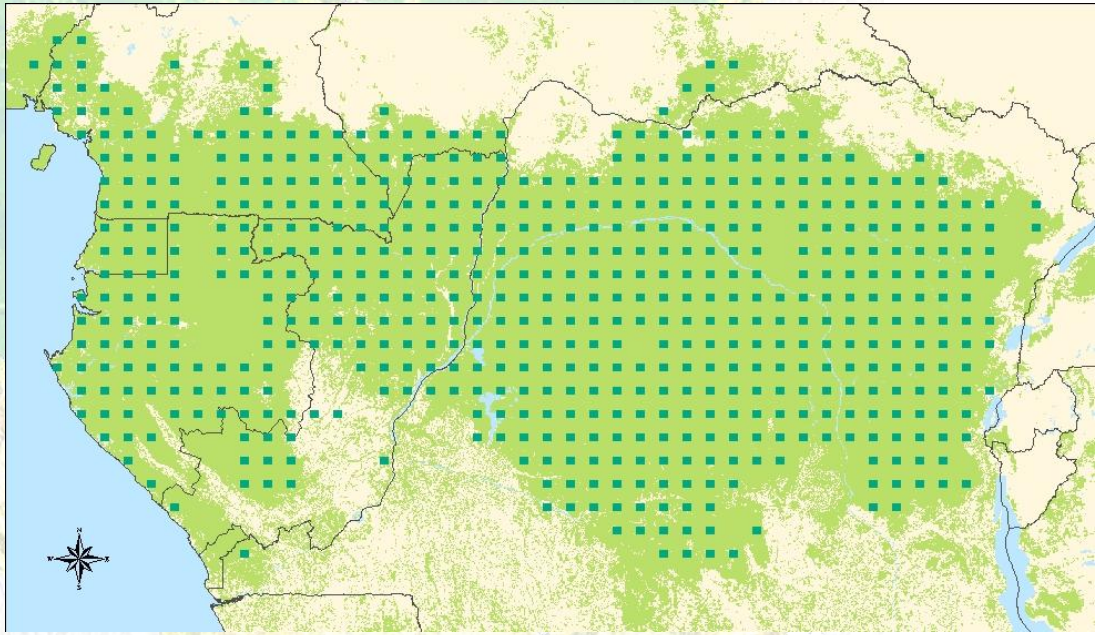
- **Field survey protocol for validation** of the major drivers and processes

in close collaboration with Observatoire des Forêts d'Afrique centrale and the EU-FORAF consortium .

Available Data : Pilot Study Results

Deforestation and degradation estimate in Congo Basin for 1990-2000.

- **Landsat Samples of** 10 x 10 km every 0,5 degree
- 267 Samples for 1990 - 2000



(Duveiller et al., RSE 2008).

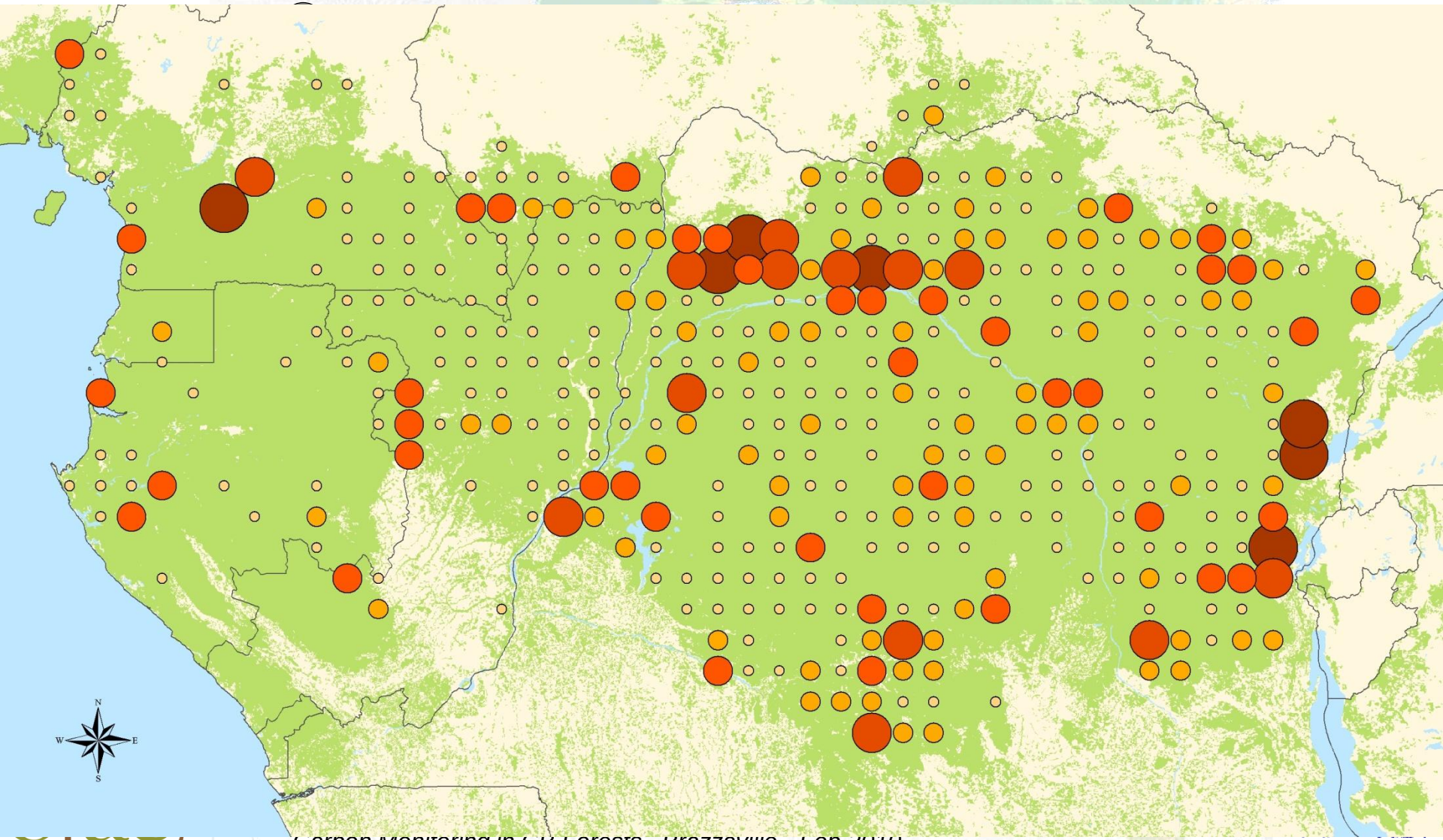
Forest Cover Change

Changed area per sample [ha]

< 50
50 - 500
500 - 1000
1000 - 2500
2500 - 5000

UCL Université catholique de Louvain
JRC EUROPEAN COMMISSION

DEFORESTATION



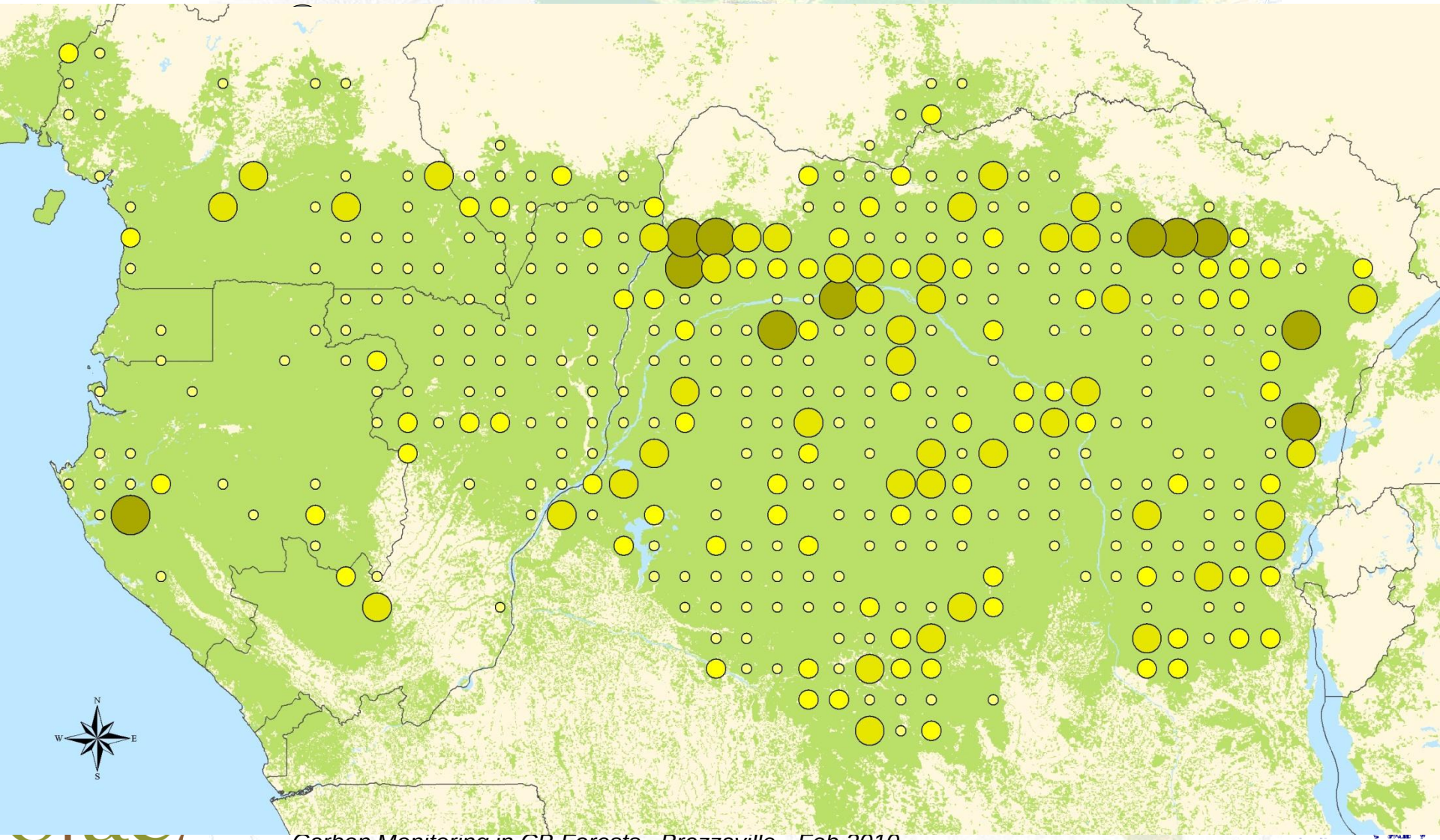
Forest Cover Change

Changed area per sample [ha]

< 50
50 - 500
500 - 1000
1000 - 2500
2500 - 5000

UCL Université catholique de Louvain
JRC EUROPEAN COMMISSION

DEGRADATION



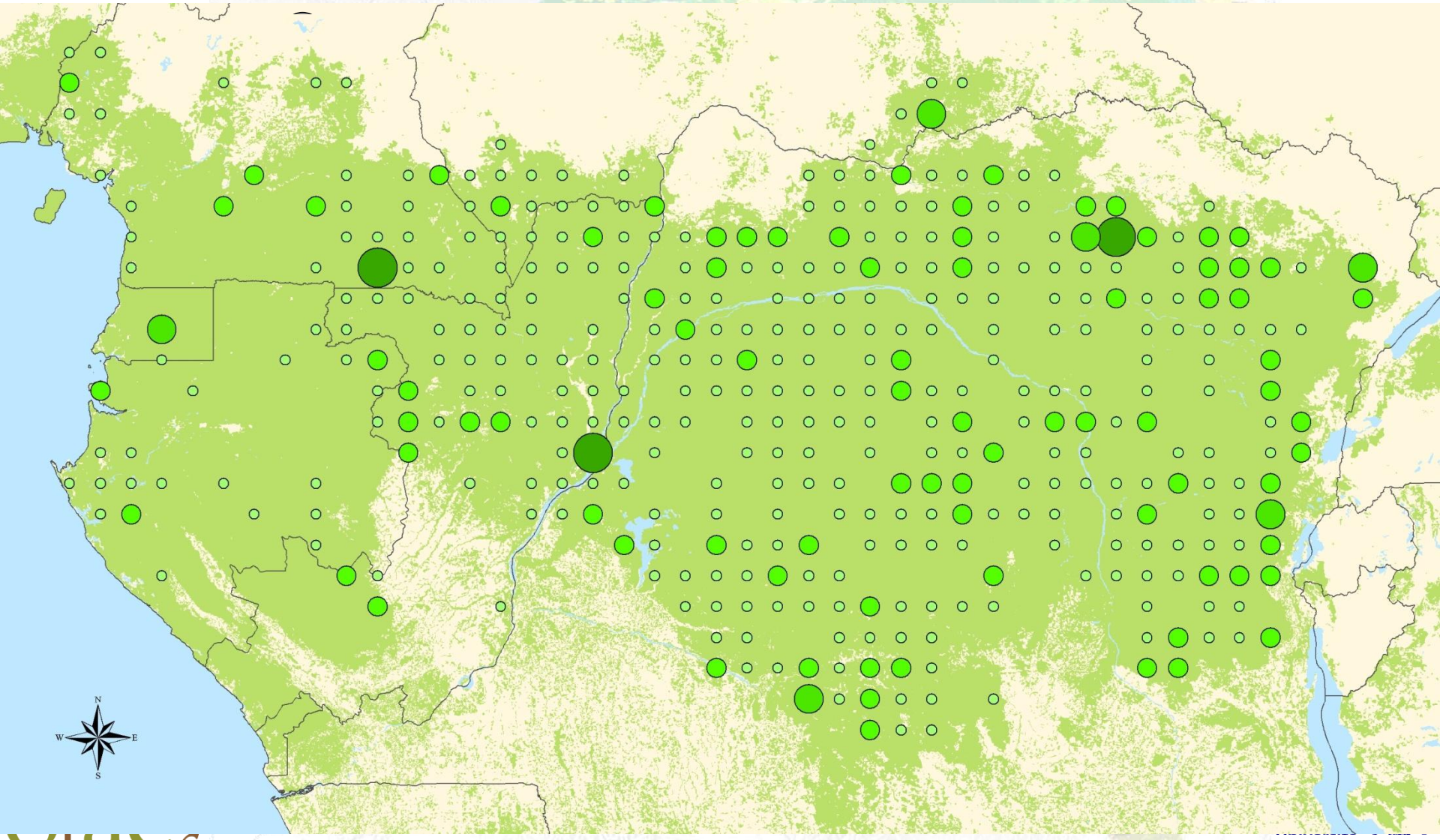
Forest Cover Change

Changed area per sample [ha]

< 50
50 - 500
500 - 1000
1000 - 2500
2500 - 5000

UCL Université catholique de Louvain
JRC EUROPEAN COMMISSION

REFORESTATION



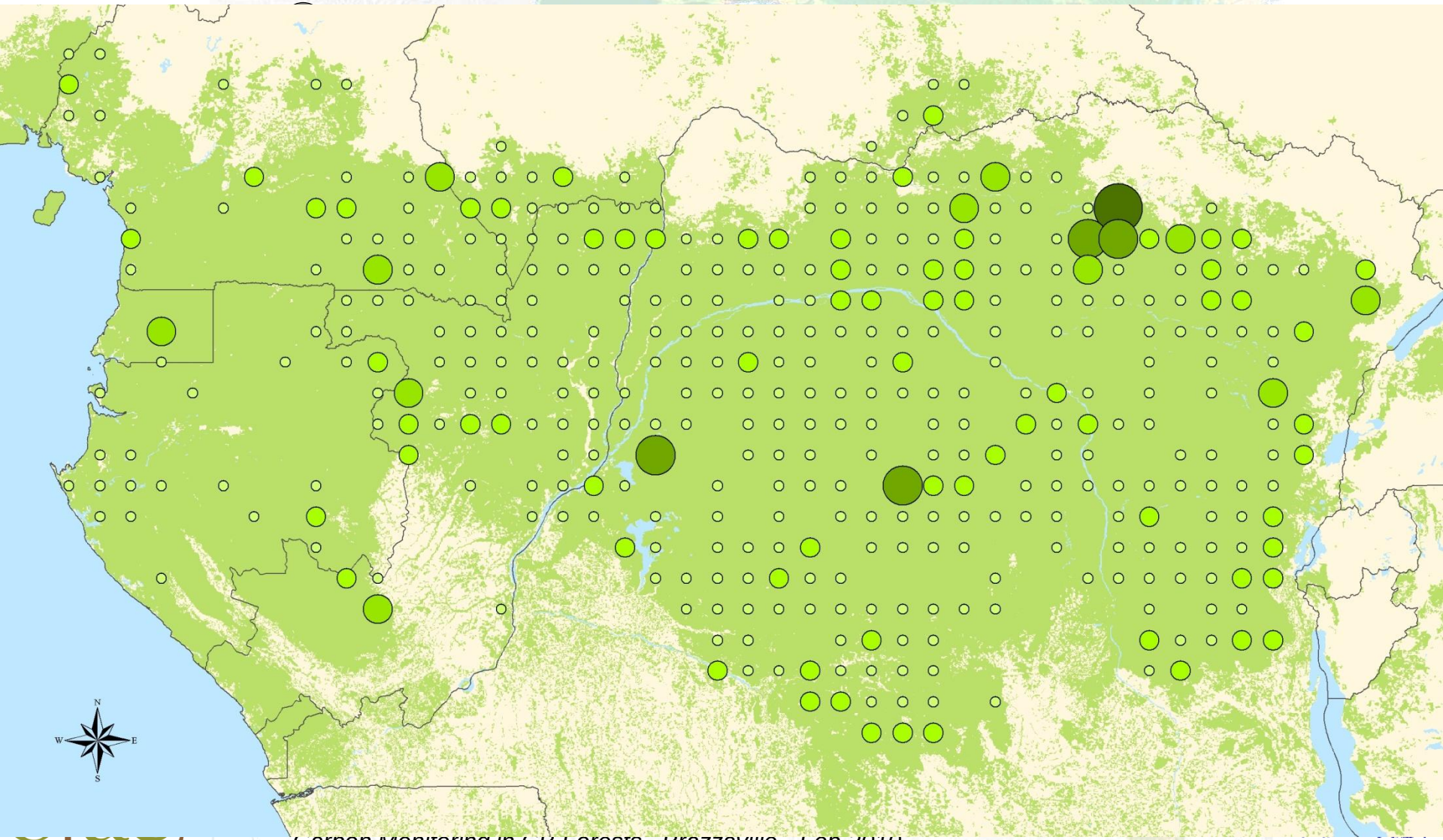
Forest Cover Change

Changed area per sample [ha]

< 50
50 - 500
500 - 1000
1000 - 2500
2500 - 5000

UCL Université catholique de Louvain
JRC EUROPEAN COMMISSION

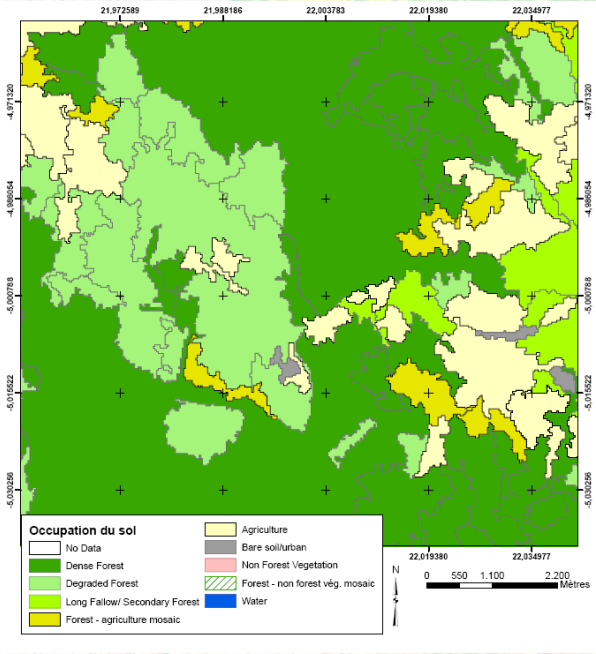
REGENERATION



Available Data : Pilot Study Results

Pilot Study Results:

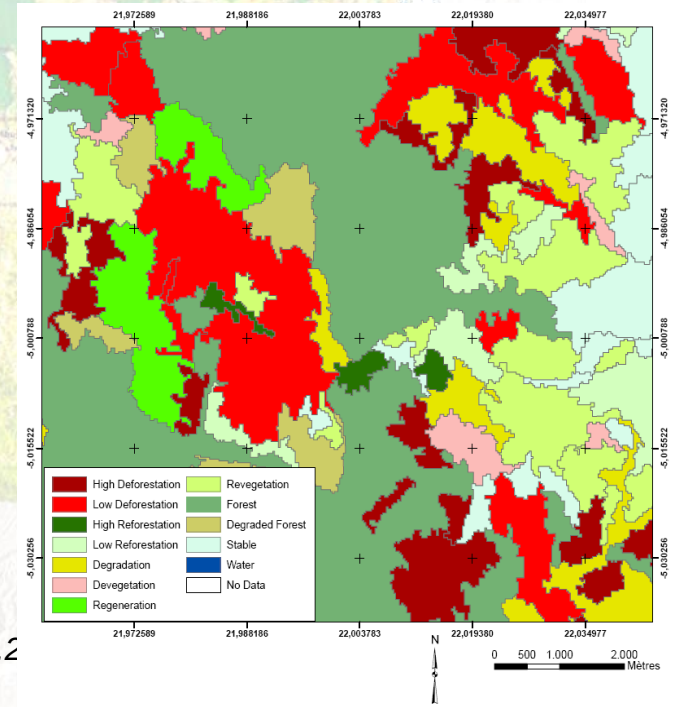
-10 land cover types



4 processes : deforestation, degradation, reforestation, regeneration.

Estimation :

gross deforestation : 0.25% 0.06%,
gross reforestation brute : 0.05% 0.01%
net deforestation : 0.20%.
degradation : 0.19% 0.04% ,
regeneration : 0.07% 0.03%
net degradation : 0.12%.



Forest cover dynamics

4 different processes

FOREST DEGRADATION

Dense Forest → Degraded Forest

FOREST REGENERATION

Degraded Forest → Dense Forest

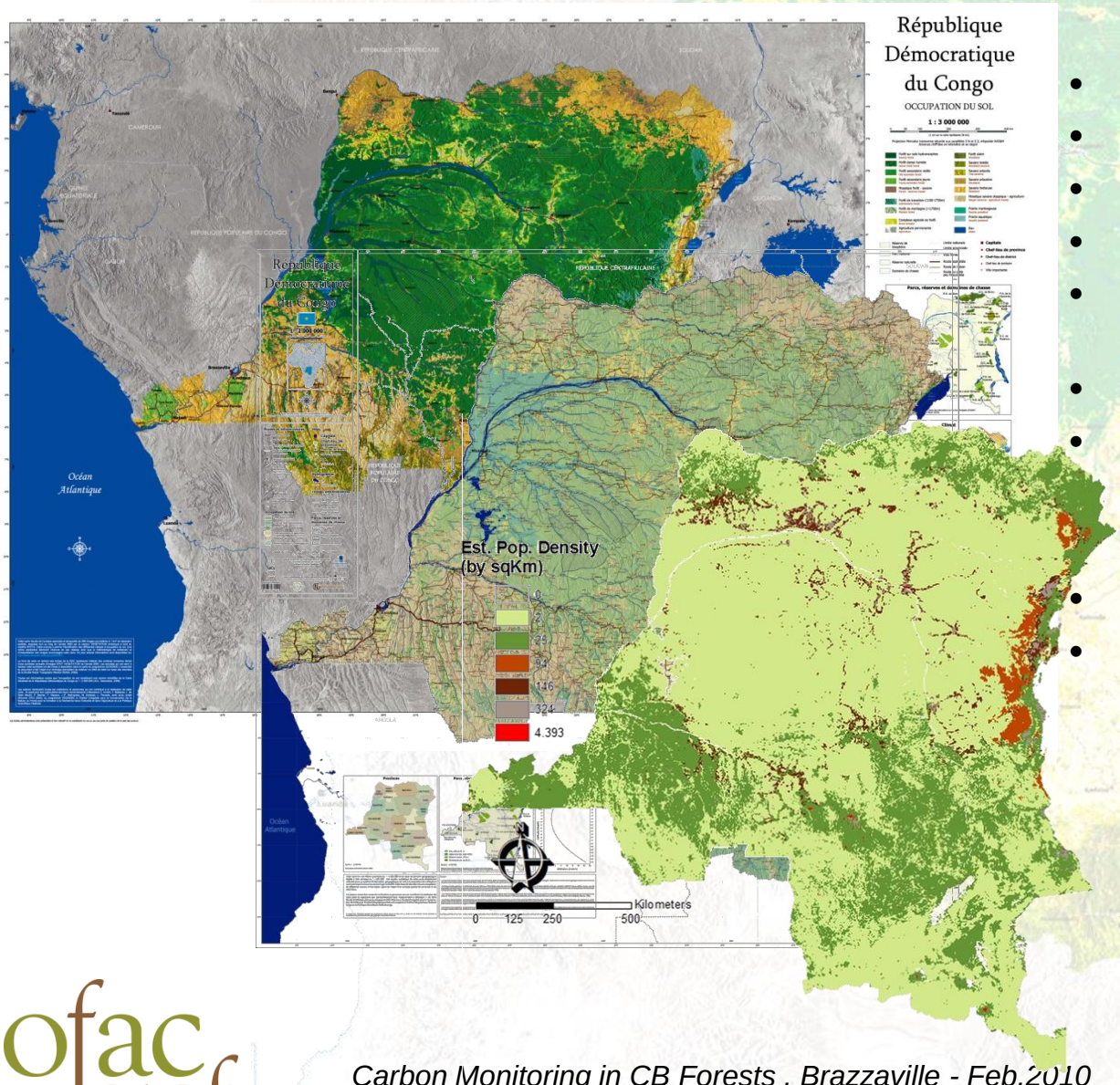
DEFORESTATION

Dense Forest / Degraded Forest → Forest-Savanna Mosaic / Long Fallow / Forest-Agri. Mosaic / Agriculture/Short Fallow / Urban / Bare Soil / Non Forest Veg / Water Bodies

REFORESTATION

Forest-Savanna Mosaic / Long Fallow / Forest-Agri. Mosaic / Agriculture/Short Fallow / Urban / Bare Soil / Non Forest Veg / Water Bodies → Dense Forest / Degraded Forest

Available Data : Existing Maps (FORAF-RGC-UCL)

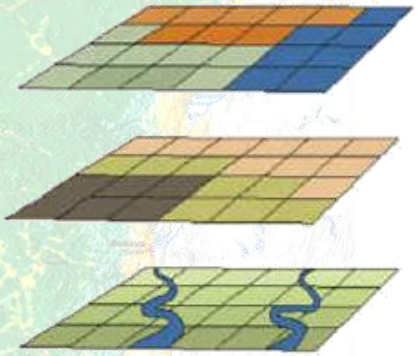


- **Land Cover**
- **Road and River Networks**
- **Topography**
- **Protected areas**
- **Forest and Mining concessions**
- **Urban areas**
- **Security status**

- **Population *(JP Kibambe)***
- **…Accessibility *(JP Kibambe)***

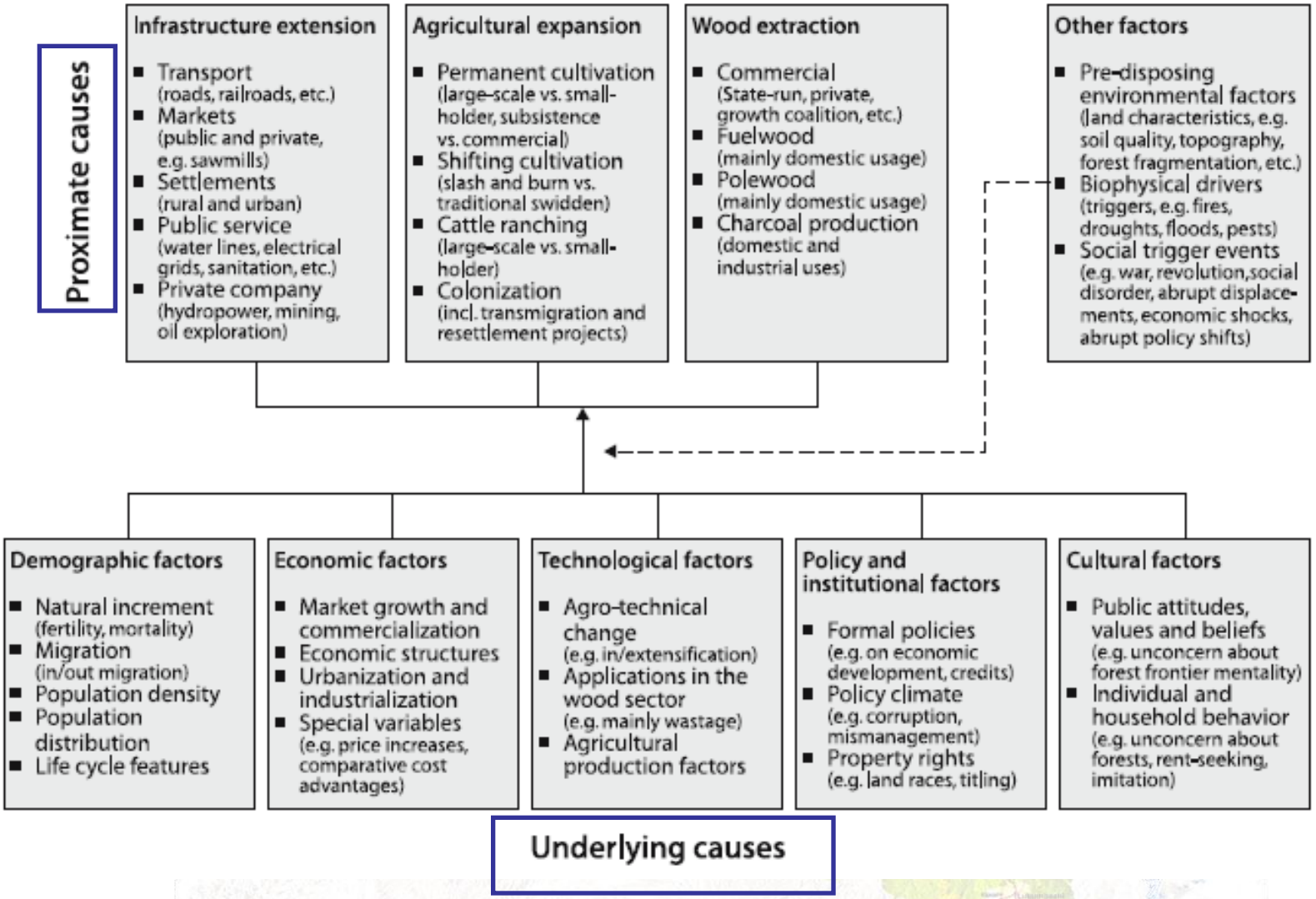
Statistical method for drivers analysis

- **Task 1**: Exploratory Analysis
  - Expert knowledge analysis
  - Statistical Mean Analysis
  - Univariate Analysis

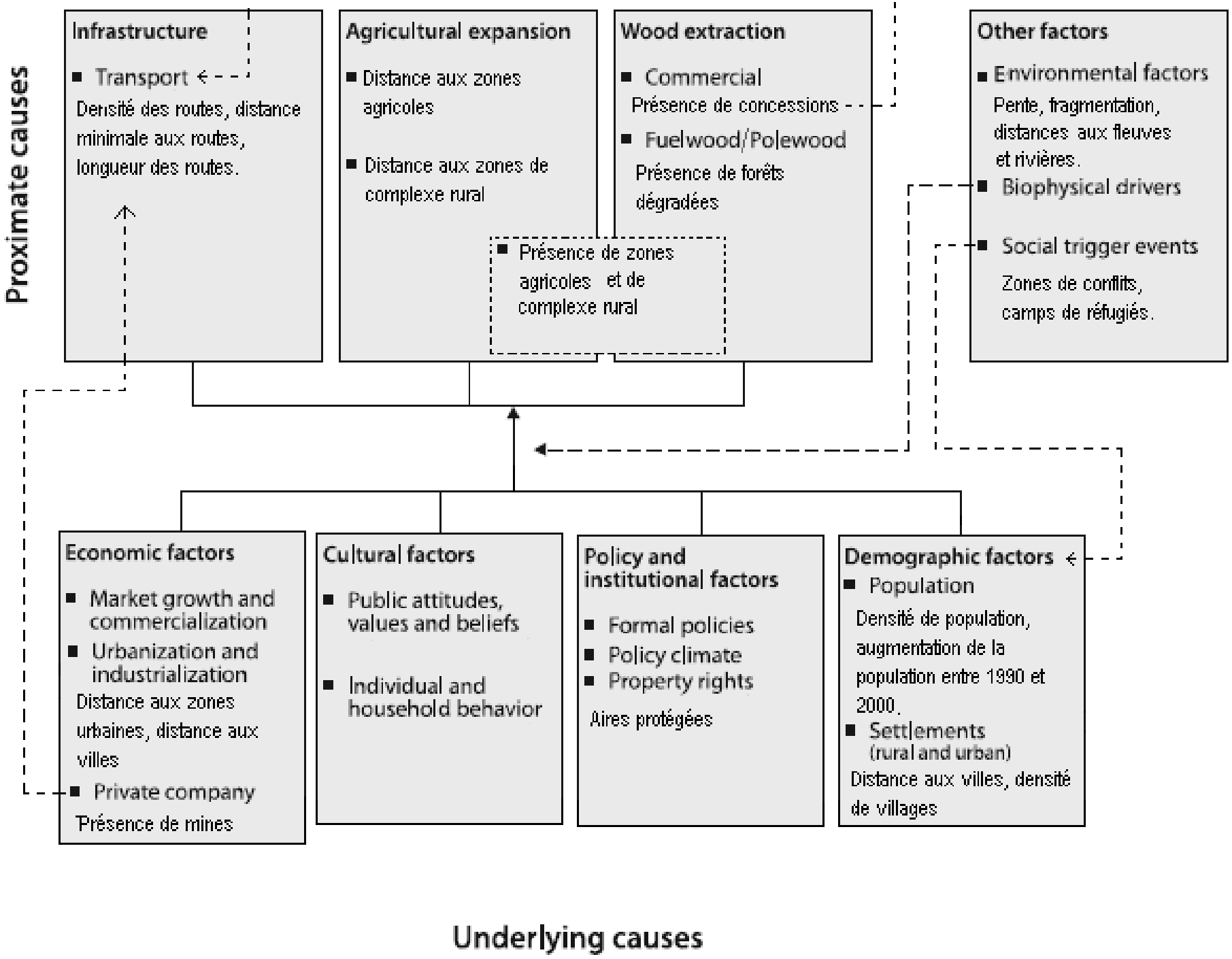


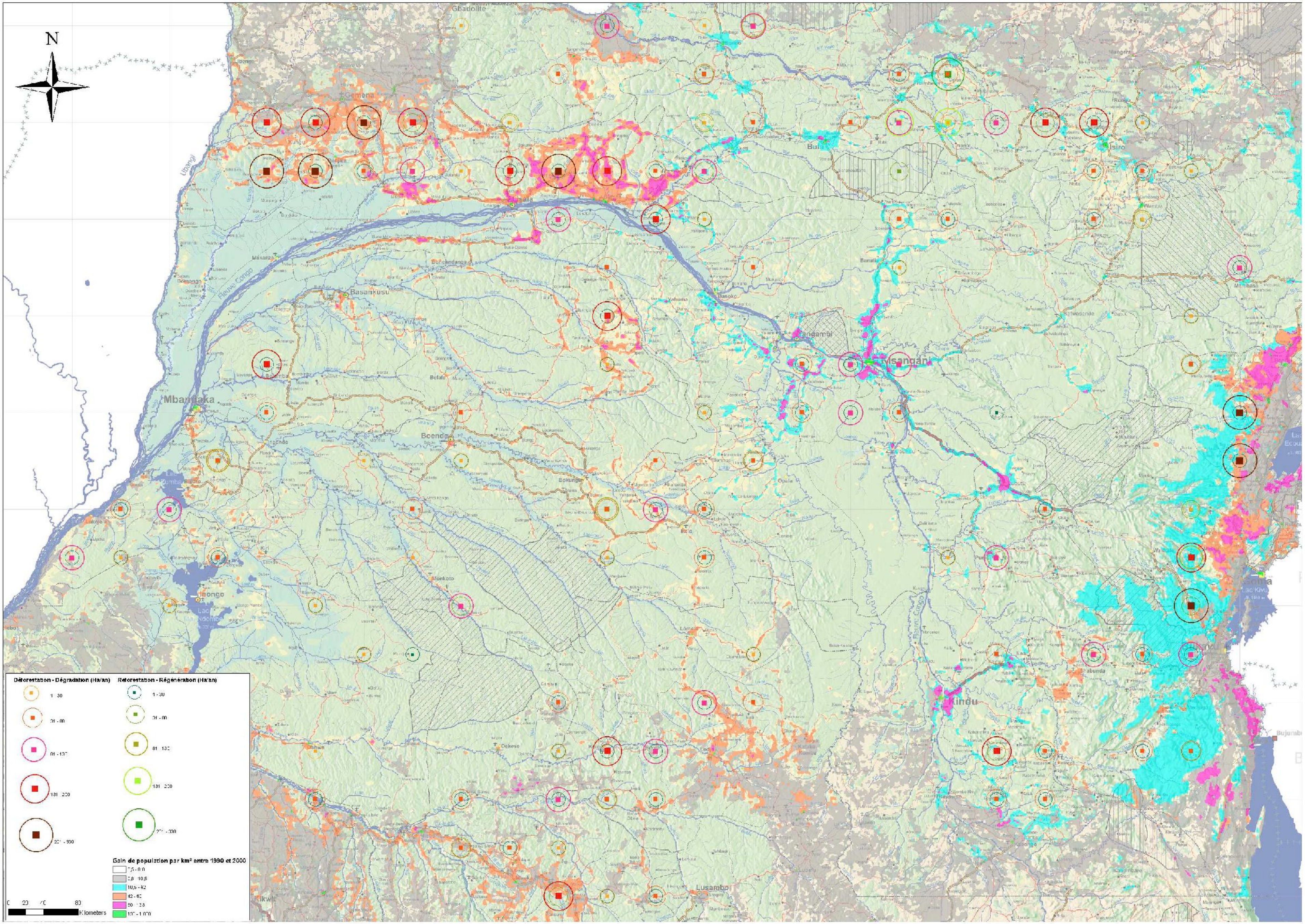
- **Task 2** : Multivariate Analysis
  - Geographically Weighted Regression (GWR)
  - Stepwise Regression
  - Econometric method (Tobit regression)

- Exploratory Analysis



(Geist and Lambin, 2002)


Proximate causes
Infrastructure
Transport
Densité des routes, distance minimale aux routes, longueur des routes.
Agricultural expansion
Distance aux zones agricoles
Distance aux zones de complexe rural
Présence de zones agricoles et de complexe rural
Wood extraction
Commercial
Présence de concessions
Fuelwood/Polewood
Présence de forêts dégradées
Other factors
Environmental factors
Pente, fragmentation, distances aux fleuves et rivières.
Biophysical drivers
Social trigger events
Zones de conflits, camps de réfugiés.
Economic factors
Market growth and commercialization
Urbanization and industrialization
Distance aux zones urbaines, distance aux villes
Private company
Présence de mines
Cultural factors
Public attitudes, values and beliefs
Individual and household behavior
Policy and institutional factors
Formal policies
Policy climate
Property rights
Aires protégées
Demographic factors
Population
Densité de population, augmentation de la population entre 1990 et 2000.
Settlements (rural and urban)
Distance aux villes, densité de villages
Underlying causes



N
Déforestation - Dégradation (Ha/an)
Reforestation - Régénération (Ha/an)
1 - 30
Gain de population par km² entre 1990 et 2000
10,5 - 42
Kilometers
Gbadolite
Basankusu
Mbandaka
Boende
Kisangani
Kindu
Lusambo

Task 1 : Exploratory Analysis

- 10 x 10 km = 1 point for the statistical analysis
  Deforestation and degradation currently combined
  1990-2000 forest cover change only

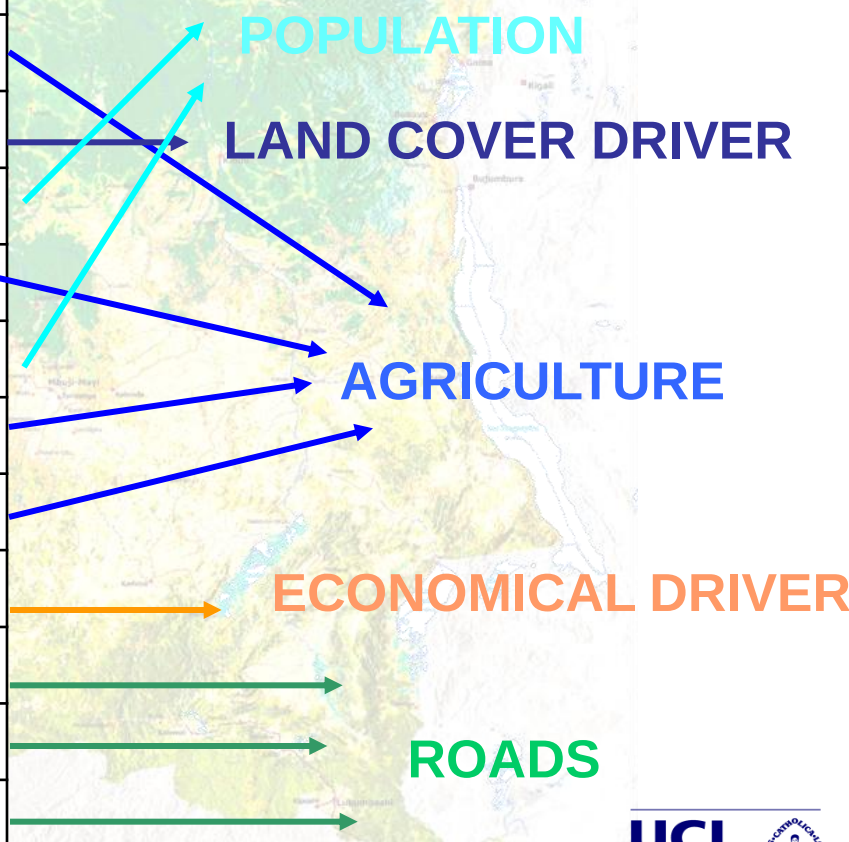
- **GIS Analysis to derive 25 potential explanatory variables :**
  - Population density
  - Proximity of villages / urban areas
  - Land cover type / Land cover fragmentation
  - Elevation / Slopes
  - Proximity of agriculture / rural complex
  - Road density
  - Proximity to different road types / to rivers
  - Distance to protected areas / concessions
  - Distance to national borders
  - …

Task 1 : Exploratory Analysis

- **Statistical Test on Mean Difference select 19 variables**
  - La déforestation correspond à une densité de population, de routes et de villages plus élevées, une plus grande surface occupée par des zones agricoles, des forêts plus fragmentées et dégradées. Elle est plus proche des villes, des routes et des frontières nationales.
  - Les moyennes des deux groupes ne sont pas significativement différentes pour la distance aux fleuves et rivières, l'altitude et la présence de mines et de concessions forestières. On peut s'attendre à ce que ces variables ne jouent pas un rôle important dans l'explication de la déforestation.

Task 1 : Exploratory Analysis
Univariate Regression Results

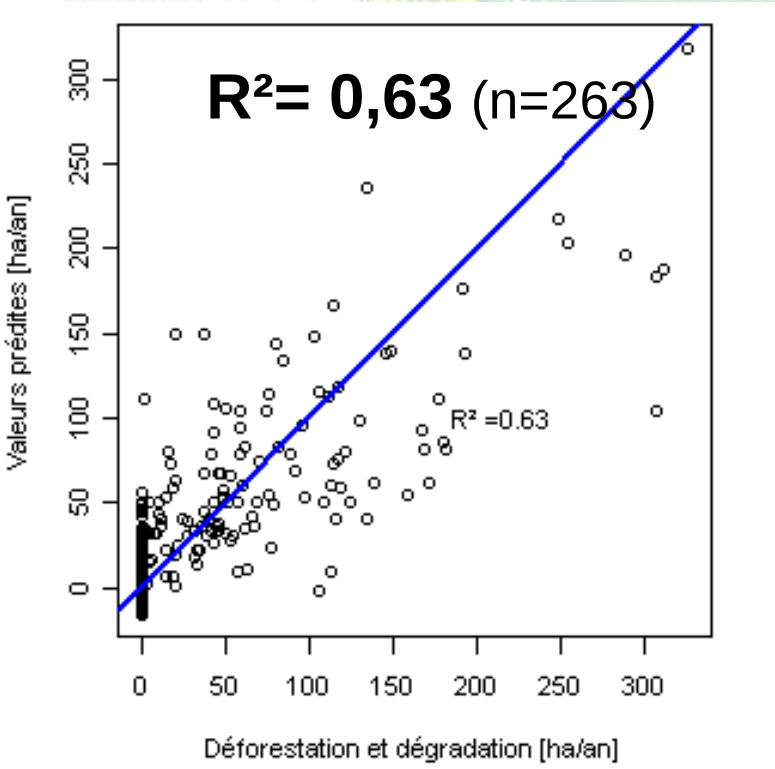
Y	X	r	r^2
DEF_DEG_AN	RURCOM	0,6484	**0,4204**
DEF_DEG_AN	FRAGMENTATION	0,5817	**0,3384**
DEF_DEG_AN	POP_DENS	0,56	**0,3136**
DEF_DEG_AN	DIS_RURCOM	-0,4749	**0,2255**
DEF_DEG_AN	DENSI_LOC	0,4391	**0,1928**
DEF_DEG_AN	FORET_DEG	0,4261	**0,1815**
DEF_DEG_AN	DIS_AGRI	-0,42	**0,1764**
DEF_DEG_AN	DIS_VILLE	-0,3328	**0,1108**
DEF_DEG_AN	RTE_DENSI	0,3263	**0,1065**
DEF_DEG_AN	DIS_MINTOT	-0,3238	**0,1049**
DEF_DEG_AN	RTE2_BUF	0,3206	**0,1028**



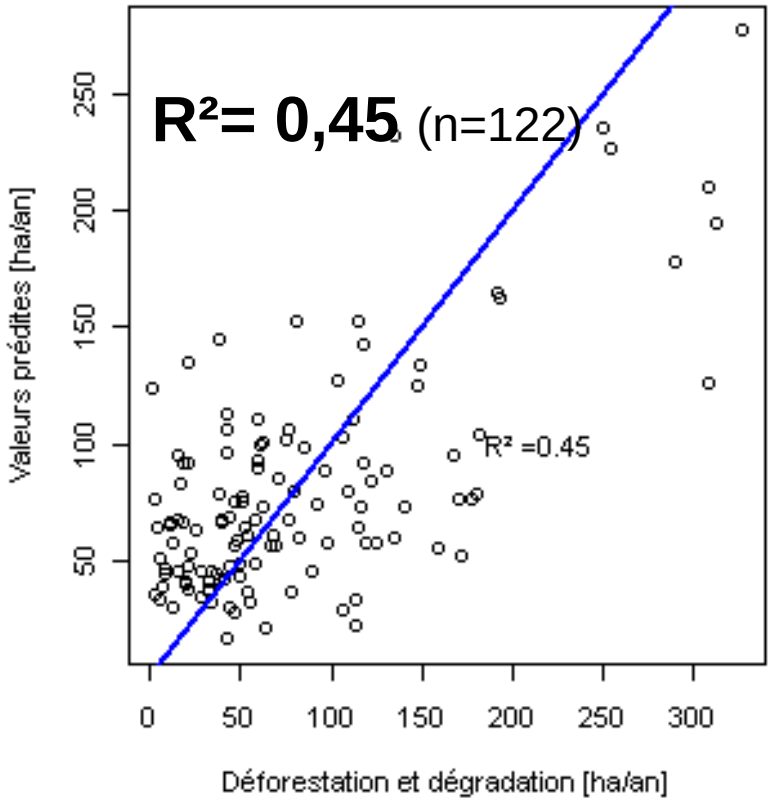
Task 1 : Exploratory Analysis
Multivariate Regression Results

- **Stepwise Regression** (17 variables)

Change and unchanged samples

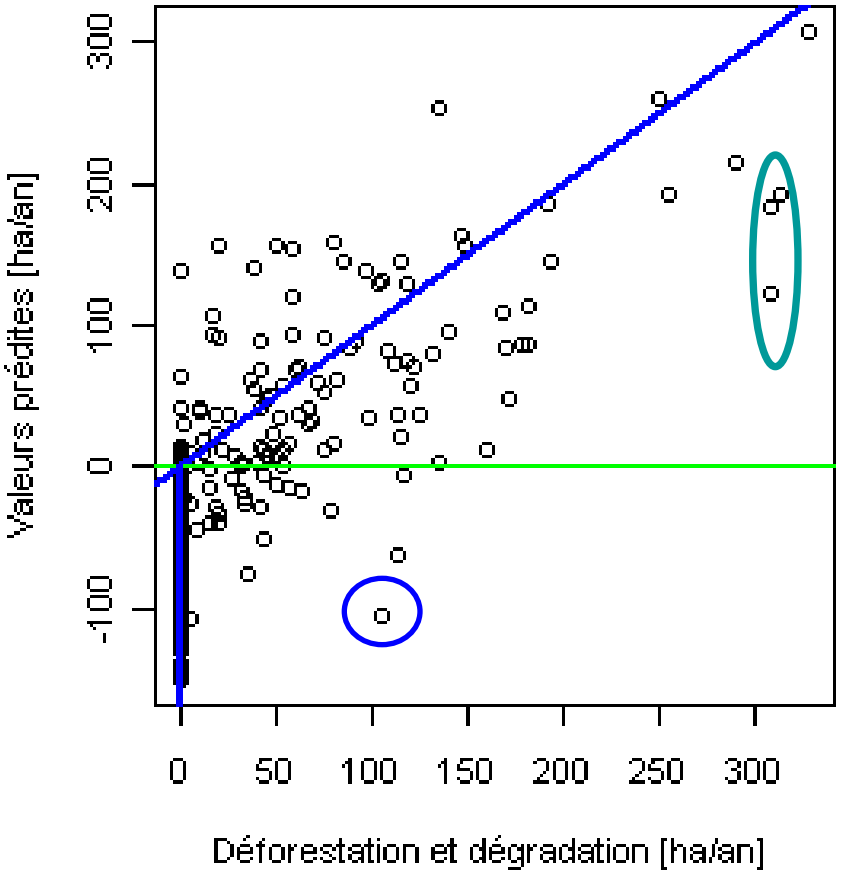


Change samples only



Task 1 : Exploratory Analysis
Multivariate Regression Results

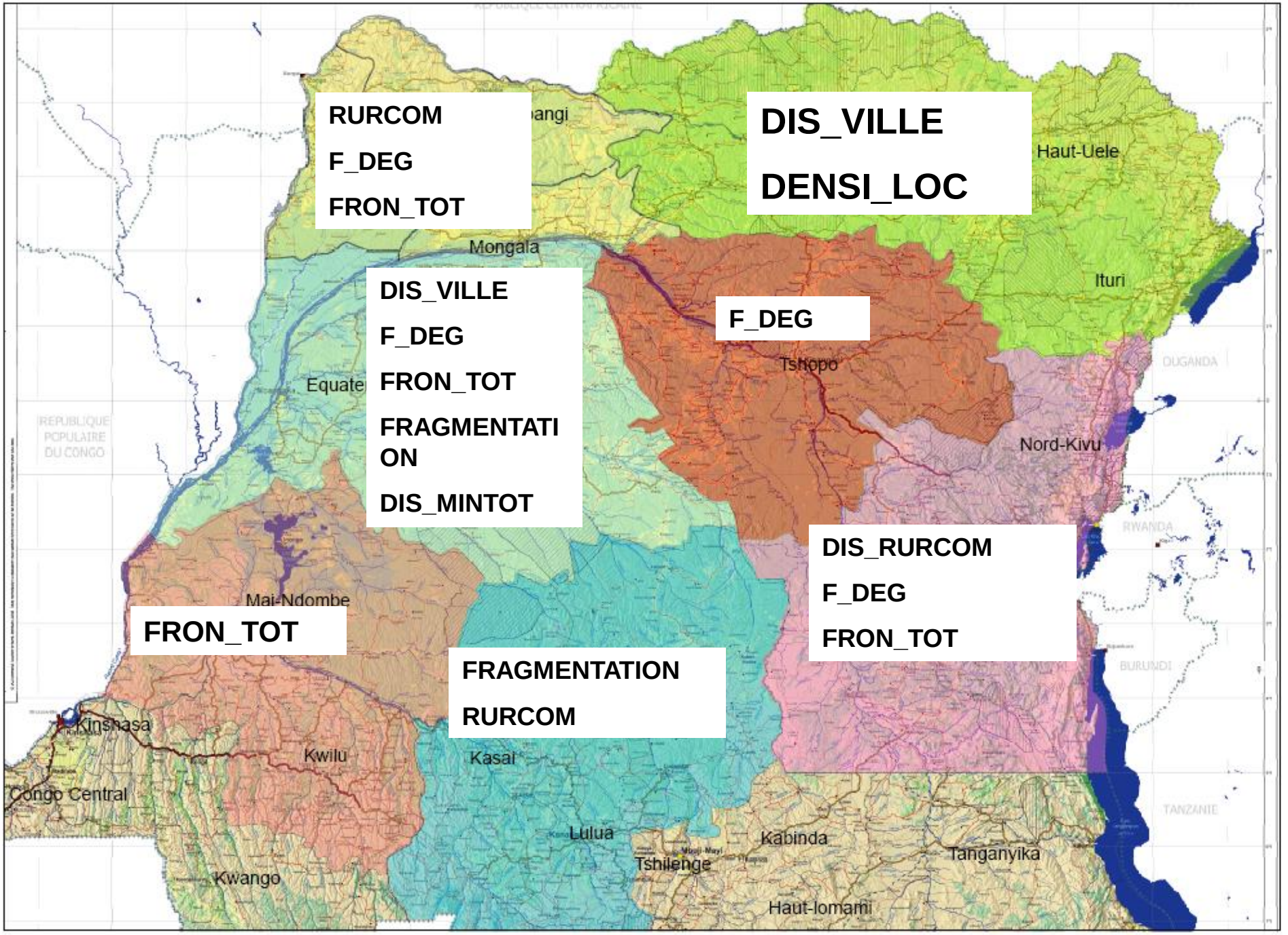
- ***Tobit* Regression Model** (n=263)



10 variables ranked according to decreasing contribution

Presence & distance to rural complex
Distance to roads
Forest fragmentation
Village density
Distance to national borders
Occurrence of degraded forest
Occurrence of frequently used roads
Distance of less used roads
Distance to urban areas

No more population density !


RURCOM
F_DEG
FRON_TOT
DIS_VILLE
DENSI_LOC
DIS_VILLE
F_DEG
FRON_TOT
FRAGMENTATION
DIS_MINTOT
F_DEG
DIS_RURCOM
F_DEG
FRON_TOT
FRON_TOT
FRAGMENTATION
RURCOM
Haut-Uele
Ituri
Mongala
Tshopo
Nord-Kivu
Equate
Mai-Ndombe
Kinshasa
Kwilu
Kasai
Congo Central
Lulua
Kabinda
Tshilenge
Tanganyika
Kwango
Haut-lomami
DUGANDA
RWANDA
BURUNDI
TANZANIE
REPUBLIQUE POPULAIRE DU CONGO

Forthcoming activities

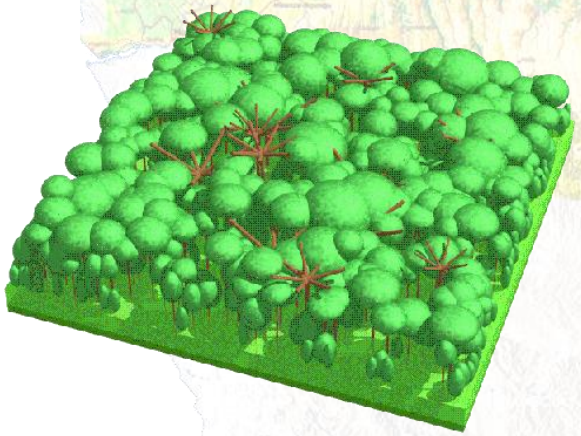
- Discussion of preliminary results with national stakeholders
- Development of sub-national levels
  to progress from drivers to land use processes
- Accessibility model to be integrated
- Application to deforestation and degradation separatley

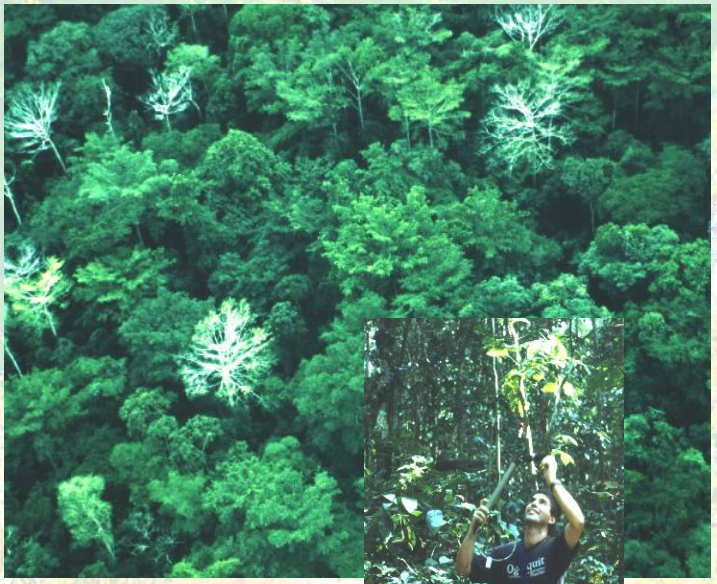
to 1990 – 2000- 2005 operational results

(n>400 samples of 20 x 20 km)

=> 4-y VEGECLIM Project for forest cover and Carbon stock simulation based on land use and climate change scenarios

Merci de votre attention





UCL Université catholique de Louvain
UCL-Geomatics, Belgium