Overview of the use of EO in the French LULUCF inventory

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27/02/2025

Citepa

1 General concept

French land use model for the LULUCF inventory

Geographically explicit monitoring

Before NGHGI edition 2023 :
Land use change detection based on field survey

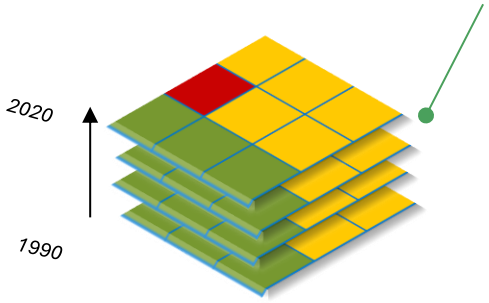
- **LULUCF Regulation UE 2018/841** : “geographically explicit” monitoring of land use change excepted from UE member states

Model overview

- Systematic gridded model for land use change monitoring & resulting carbon stock changes
- Basic mapping unit : 0,25 ha grid (220 M° cells)

0,25 ha cell : 50m * 50m, and their centroids

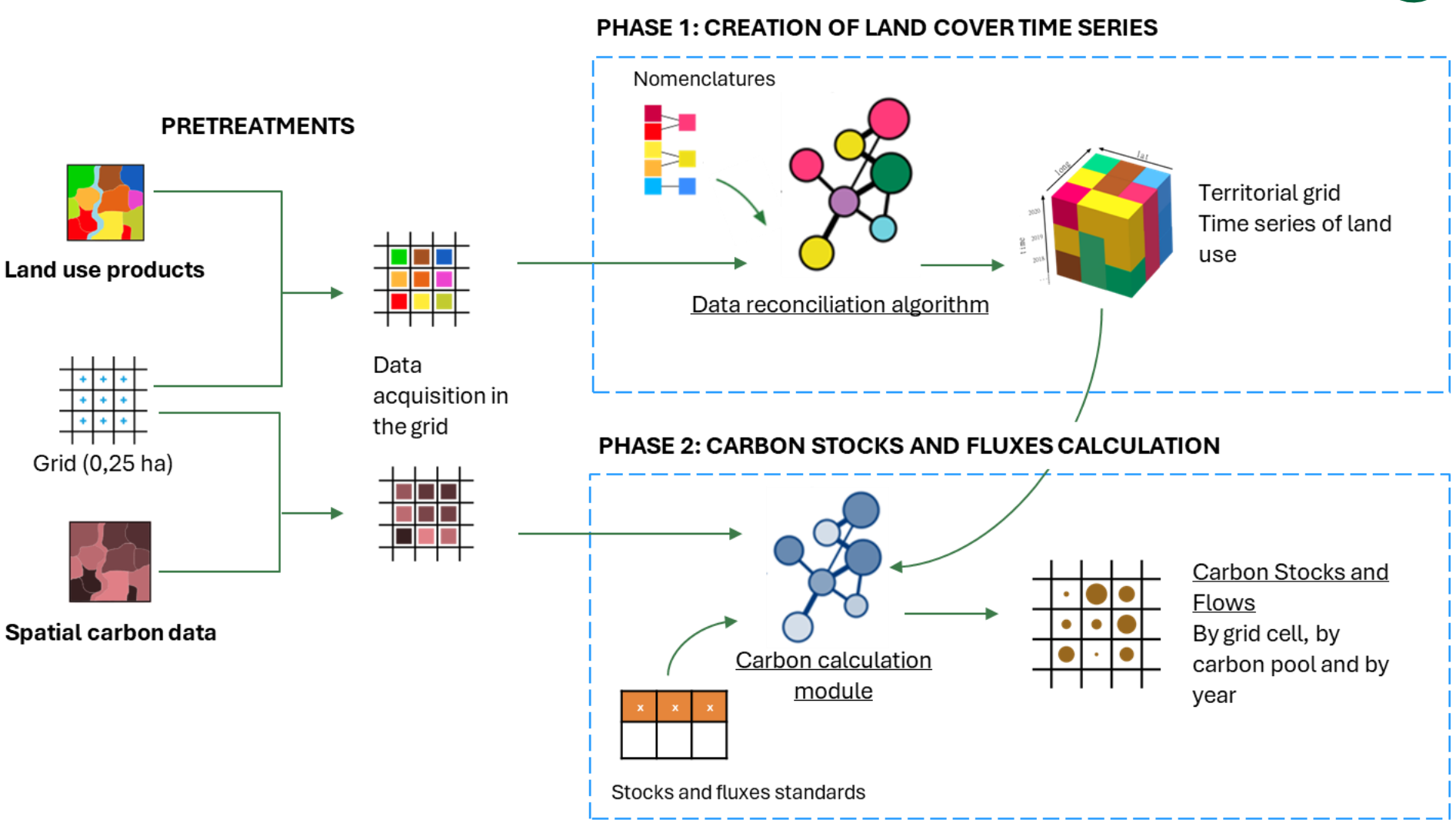
Time axis



= combination between EO data and spatialized (geographic) statistical data

→ Allows to easily collect any kind of spatialized data for each centroid : land use ; specific carbon stocks ; regional management practices …

Model overview



Main avantages and issues

General principle = Hierarchy between the products + various algorithms to apply change dynamics

Mains issues :

- Detect “true” changes (lots of false changes when doing simple wall-to-wall methodologies
- Ensure time consistency even if the data is not available in the 1990-2010 period
- Differences in spatial resolution and land use categories

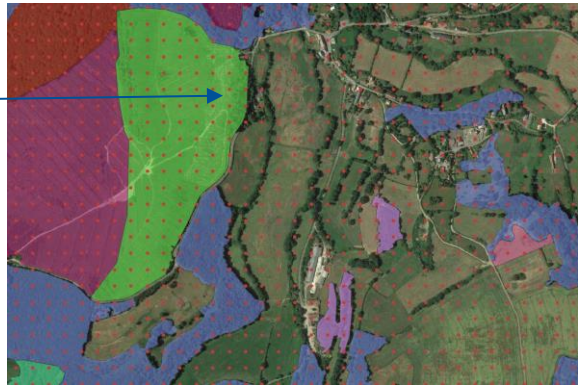
Allows interoperability and easy integration of new dataset

Allows spatialized forecasting

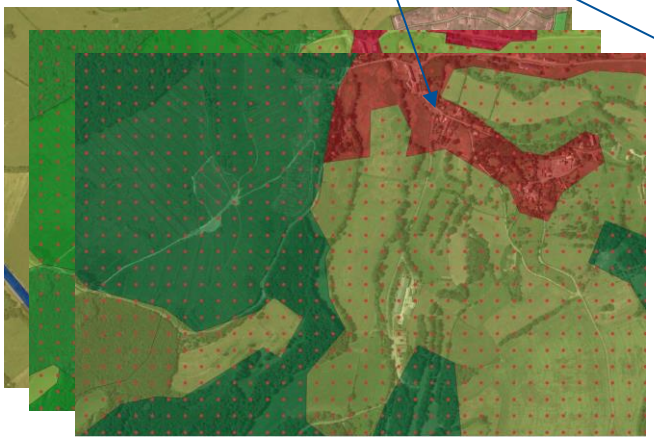
2 Creation of the land use time series

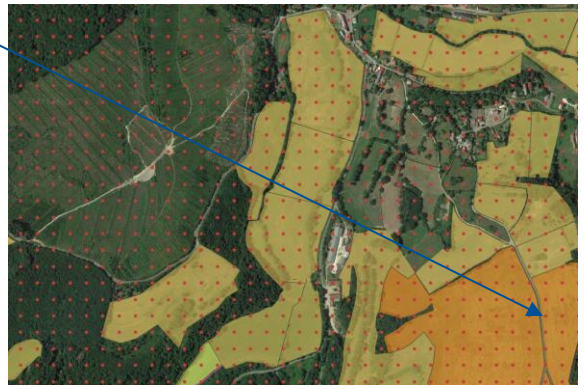
Multisource land use model

General principle = Hierarchy between the products + various algorithms to apply change dynamics



Discontinus and highly relevant **<u>for forest land use</u>** :
'BD Forest' *(French national forest inventory)*





Discontinus and highly relevant **<u>for agricultural land use</u>** :
LPIS data *(used for CAP declarations)*

= bottom-up
Allows to have a reliable crop type every year

Continus products (Copernicus : Urban Atlas, Natura 2000 -when available on the area-, Corine Land Cover) ; Bdcarto (French generalist product)
<u>for settlements and the remaining unfilled areas</u>

General approach

Step 1 : Intersection of centroids with products to collect land use information

Step 2 : Assignation of a reference use for each centroid, based on available information, and a hierarchy established between products

Step 3 : Land use change application by period for the relevant centroïds thanks to :

a. Change products (Urban Atlas, Natura2000, CLC)

b. Additional afforestation/deforestation dynamics (NFI maps)

c. Additional module for artificialization dynamics (buildings mapping)

d. Agricultural rotation (LPIS data)

Nomenclature

72 sub-classes

3 levels of nomenclature

Cross reference tables created for each land use data set

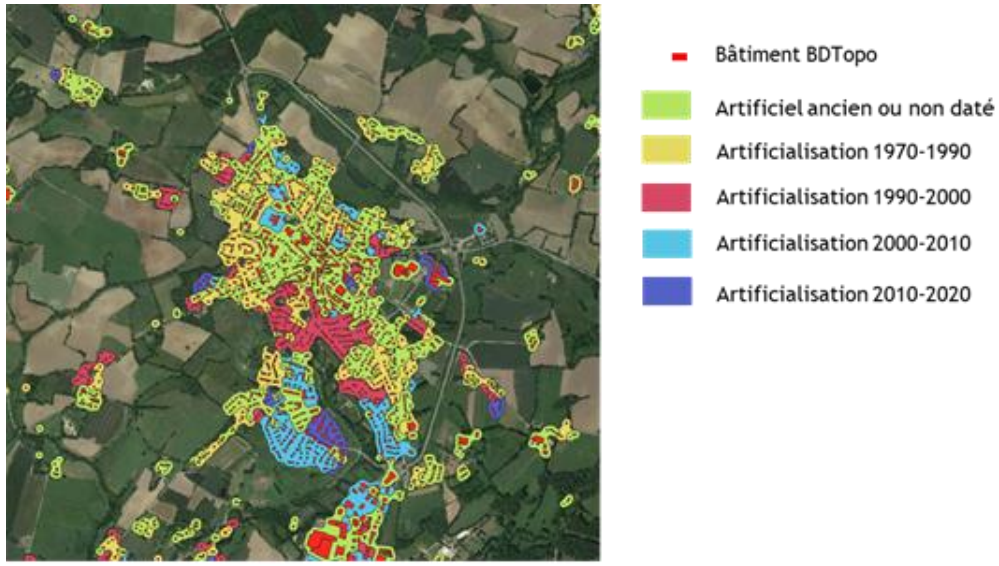
Niveau 1 (usage général)			Niveau 2 (usage précis)			Niveau 3 (occupation) - utile pour le calcul	
1		Agricole	10		Agricole à définir	100	Agricole indéfini
			11		Cultures annuelles, légumes et fleurs	110	Cultures annuelles, légumes et fleurs indéfinies
						11bh	Blé tendre d'hiver
						11bp	Blé tendre de printemps
						11dh	Blé dur d'hiver
						11dp	Blé dur de printemps
						11cz	Colza
						11ah	Avoine d'hiver
						11ap	Avoine de printemps
						11lf	Légumes ou fleurs
						11be	Betterave industrielle
						11cf	Choux, racines et tubercules fourragers
						11ci	Autres cultures industrielles
						11ls	Légumes secs
						11mf	Maïs fourrage
						11mg	Maïs grain
						11oh	Orge d'hiver
						11op	Orge de printemps
						11xc	Autres céréales
						11pf	Plantes à fibres
						11pg	Pois protéagineux
						11pm	Pomme de terre
						11sh	Seigle d'hiver
						11so	Sorgho

Improvement of specific dynamics

For forest dynamics, settlements, agricultural rotations :
- Very low dynamics with the general model, particularly in 1990-2006 → Creation of an additional modules.

Modelling of new settlements :

Buffers applied to each building to create precise urban areas and collect the year of construction of the building



Addition of afforestation and deforestation dynamics

Compare (wall to wall) two editions of the NFI maps, adding treatments to limit false changes.

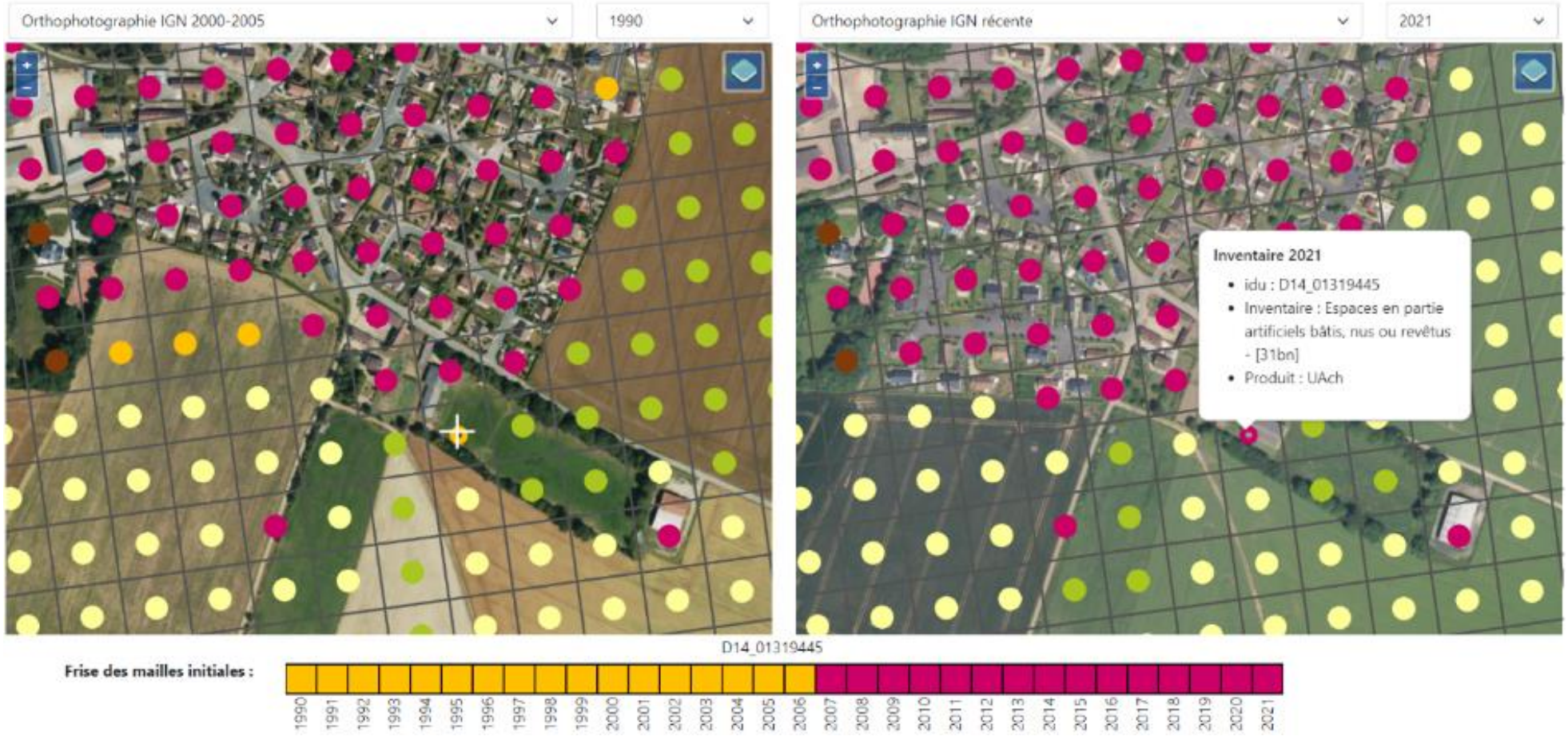
Agricultural rotations :

When LPIS data is not available, crop rotation model (trained on recent conversions, fitting with crop statistics – Markov chains)

Products integrated

Data	Data producer	Product year	Perimeter	Pertinent use	Continuous or discontinuous
BD Forêt	IGN	*variable*	*National*	*Forests*	*only covers forest lands*
RPG (LPIS)	IGN	2010 to 2022	*National*	*Agricultural lands*	*only covers agricultural lands*
Urban Atlas **& change map**	EEA/ Copernicus	2006-2012, 2012-2018 (& annual : 2018)	European	*Settlements*	*Continuous, but only available for urban areas*
Corine Land Cover change map	EEA/ Copernicus	1990-2000, 2000-2006, 2006-2012, 2012-2018	European	*all*	*Continuous*
Natura 2000 **& change map**	EEA/ Copernicus	2006-2012, 2012-2018 (& annual : 2018)	European	*Natural areas*	*Continuous, but only available for specific areas*
Bdcarto	IGN	2018	*National*	*all*	*Continuous*
BDtopage	IGN OFB	2024	*National*	*Wetlands*	*Discontinuous*
BDtopo	IGN	2024	*National*	*Settlements*	*Discontinuous*

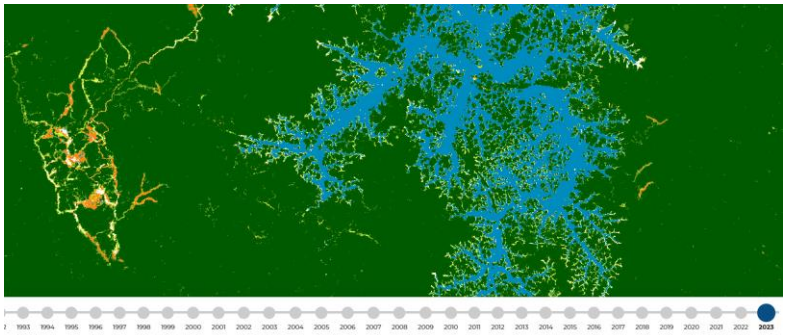
Visualization tool



LULUCF sector - Oversea territories

Sampling points and photo interpretation

- French Guiana :
  - Classification of sampling points by visual interpretation of satellite images dated 1989 (**Landsat**), 2008 and 2012 (**SPOT**)
  - For post 2012 : Tropical moist forest maps updated up to year 2023 (**Landsat 2**)



Zoom on the Petit Saut area (French Guiana)

C. Vancutsem et al. , (2021). https://forobs.jrc.ec.europa.eu/TMF

- Guadeloupe, La Réunion :
  - 1990 : **SPOT**
  - Then : TerUti-LUCAS field survey
- Saint-Martin : **ESA-CCI-LC** Climate Change Initiative land cover version 2.0.7 1955-2015

Lessons learned (areas)

Improvement of **transparency** (visualization tool) + **precision**
Easy to add a new dataset, run cross validation thanks to the gridd.

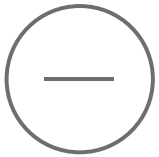
Direct link between land use and carbon calculation model – mapping of stocks and fluxes

High impact of :

1. Choice of the products + hierarchy between the products
2. Nomenclatures
3. Size of the grid
4. Treatment (e.g. buffers) for wall-to-wall modules parameters
5. Difficulty to anticipate the final impacts (recalculation of areas, CO2)

Lack of data for the period 1990-2000 and post 2018.

1. Necessity to add some non cartographic adjustments – final result is not totally spatially explicit
2. Temporal and spatial consistency can be discussed



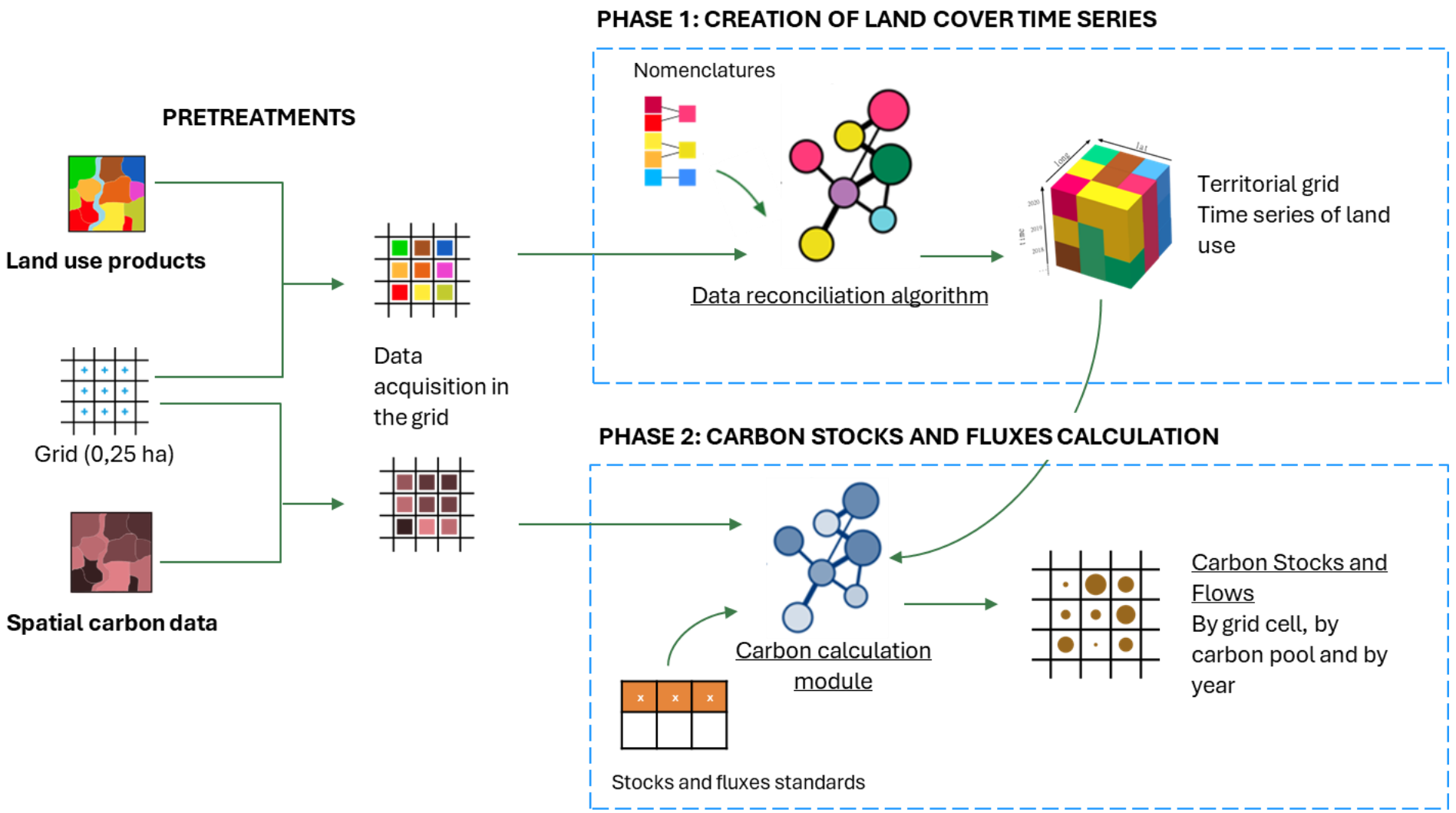
Increase of complexity compared to the old method :

1. a lot of pre-processing, long analysis and calculation times, a lot of data storage
2. need to master programming languages and maintain a remote server

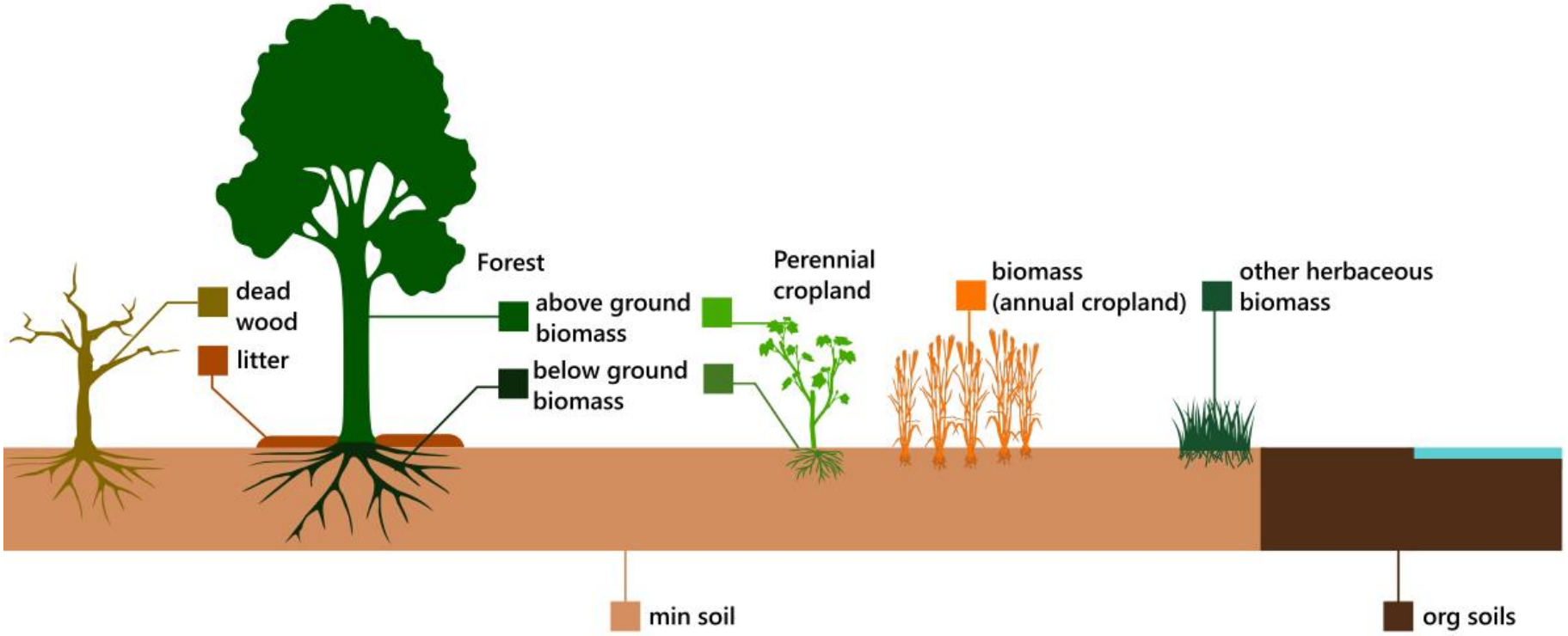
- Comparison with validation dataset ?

3 Gridded carbon stock change model

Carbon stocks and fluxes calculation



Carbon pools



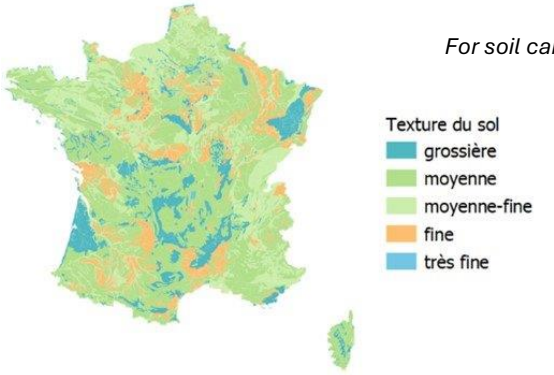
Carbon stock initialization

1) Initialization of stocks in 1990: Allocation of carbon stocks, by carbon pool according to: land use, different zoning, agricultural practices

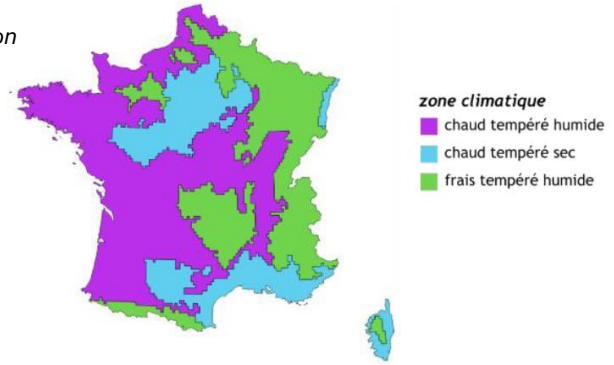
Different zoning used for the spatialization of carbon stocks

Mapping of sylvo-ecoregions (IGN)
For forest biomass and deadwood

For soil carbon

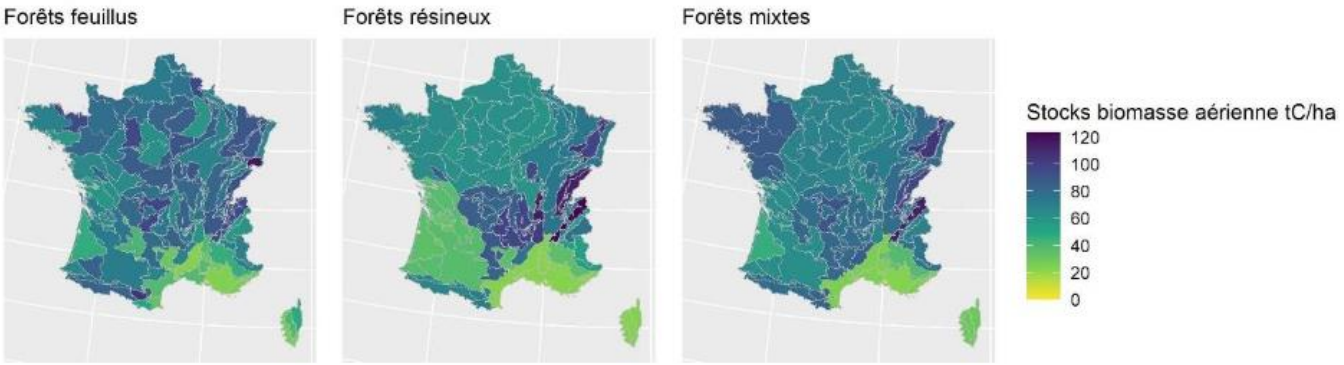


Soil texture mapping [BDGSF - Citepa]



Mapping of climate zones [JRC according to IPCC 2006]

Spatialization of the carbon stock in forest biomass by forest type



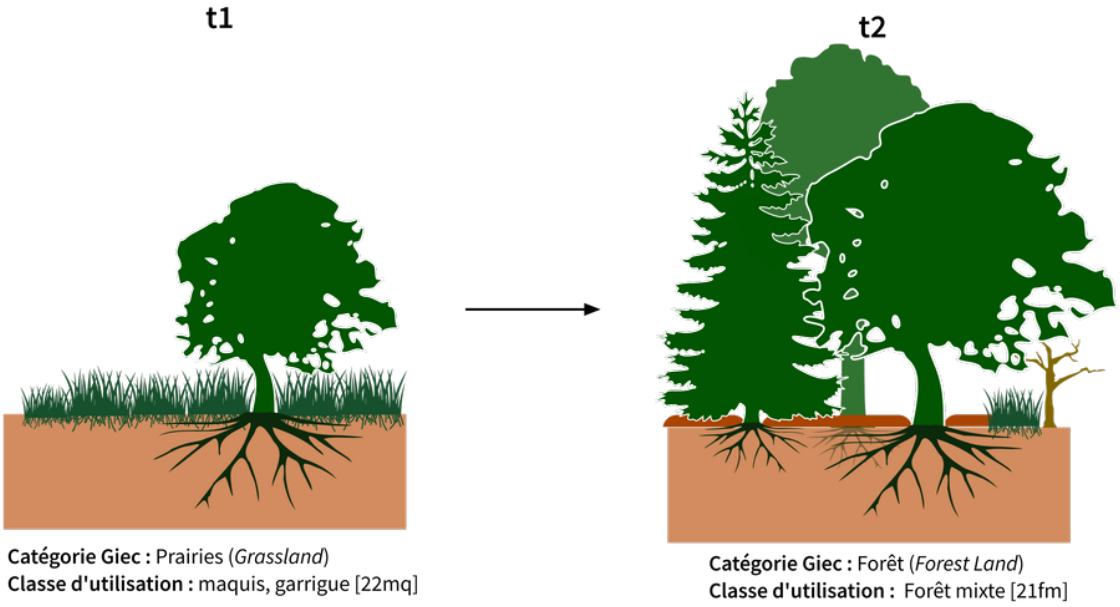
Gridded carbon stock change model

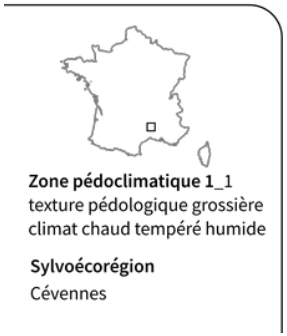
2) For each year, comparison of the inherited stock with the new stock (related to the new land use, or different management practices in the area)

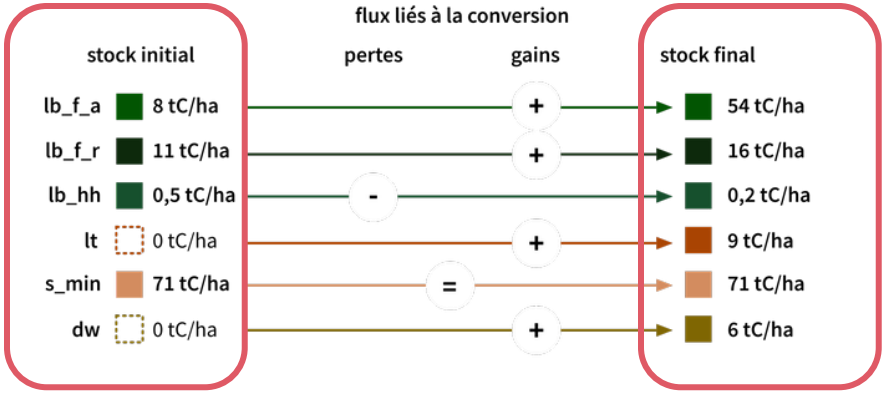
The **difference in stock** between years creates carbon emissions or removals.

Carbon flows are delimited by maximum flow rates by type of use, in order to adapt to the speed of stock change.

- The change in the stock may be interrupted by another change in land use.







Lessons learned (carbon calculations)

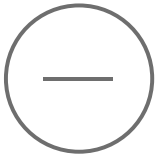
Improvement of **transparency**, flexibility of the method to be combined with spatialized stocks, management practices…

Distinction of biomass types (correct gains and losses methods)

Harmonization of the calculation for all land use changes, all pools, and changes in management for agricultural soils.

Increase of complexity compared to the old method :

1. a lot of pre-processing, long analysis and calculation times, demanding data storage
2. need to master programming languages and maintain a remote server



High impact of :

1. The choice of the speed of conversion to the new carbon reference stock
2. The decision whether to differentiate stocks between categories where a lot of land use changes occur (e.g. herbaceous stocks among cropland types)

Comparison with inversion model for CO2 emissions ?

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