Committee on
Earth Observation Satellites

CGMS

WGClimate-22 & GHG-TT-5

Earth observation data in the French inventory
- LULUCF sector -

WGClimate
The Joint CEOS-CGMS
Working Group on Climate

WGClimate-22 & GHG-TT-5
11 - 13 February, 2025
ESA ECSAT, Harwell, UK

Mélanie Juillard, Citepa
Session 6 : National emission estimates

French National GHG inventory team

About Citepa

❖ **National agency compiling GHG emissions for France - UNFCCC reporting**

≈ 50 employees – experts of all sectors + mitigation & adaptation … also compiling pollutants emissions

❖ **Methods :** mostly sectoral bottom-up approach, IPCC guidelines and country-specific activity data + emission factors

❖ Use of EO data ? : LULUCF sector ; shipping emissions

❖ Currently no use of atmospheric EO combined with inverse modeling for QA/QC

❖ Implication in projects aiming at comparing top-down and bottom-up estimates : Verify, RECCAP2, EyeClima, World Emissions

Ventilation of the results of the inventory

Species inventoried :

Direct GHGs : CO_2, CH_4, N_2O, HFC, PFC, SF_6 et NF_3
Indirect GHGs : SO_2, NO_x, COVNM et CO

Perimeters :

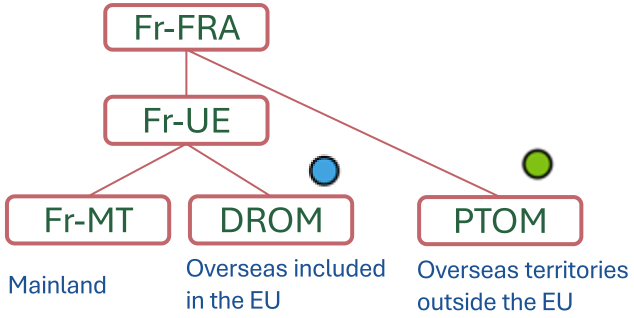
- Mainland + Overseas territories
- NUTS 2 for LULUCF data

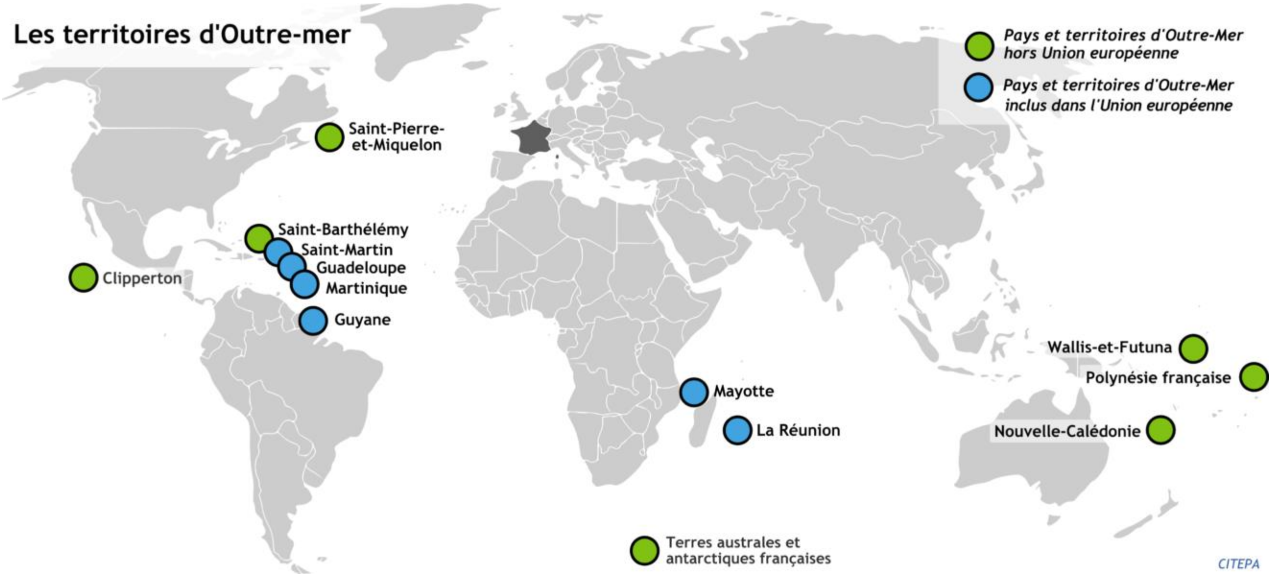
Period :

1990 to the last year inventoried (n-2)
Proxy for n-1
Proxy for monthly estimates (m-3)

Reporting format :

5 major sectors, approximately 220 sub-sectors





WGClimate
The Joint CEOS-CGMS Working Group on Climate

Ventilation of the results of the inventory

CRT Sectors
(UNFCCC common reporting format)

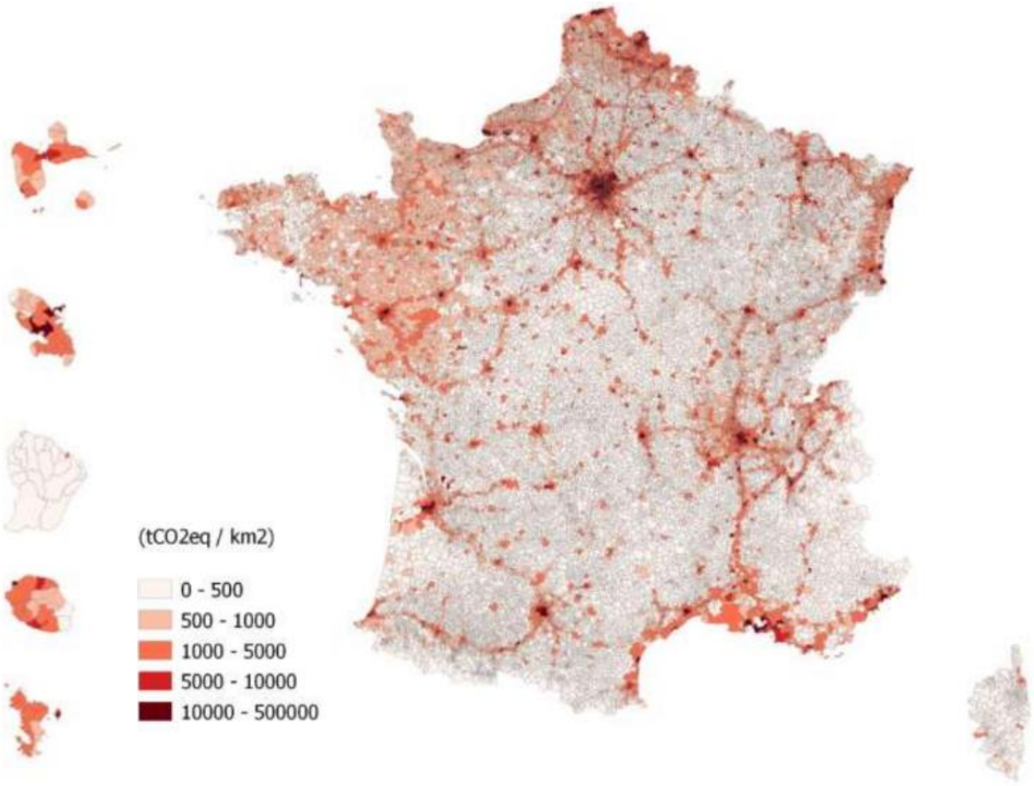
- Energy (consumption)
- Industrial processes and product use
- Agriculture
- Land Use, Land-Use Change and Forestry (LULUCF)
- Waste
- International transport (excluded from the total)

Publication by economical sector : "Secten"

- Energy Industry
- Manufacturing and construction
- Centralized waste treatment
- Use of buildings
- Agriculture
- Transport
- Emissions Excluded from total
- LULUCF
- Natural emissions

Methodologies

Ventilation of the results of the inventory



Spatialization of CO_2e (tCO_2e/km^2) – Citepa ed. 2023
All sectors, year 2021 (without LULUCF)

→ *Use of statistics, proxies, national maps*

Economical sector

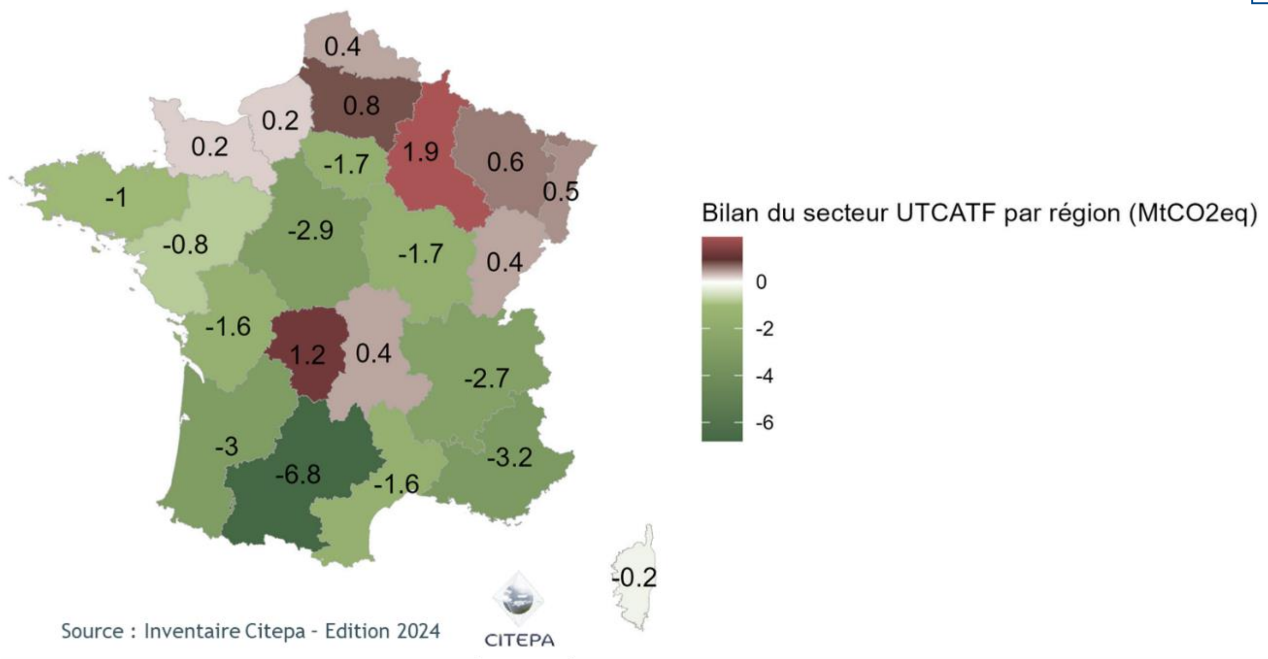
- "Secten" Report & Data
  - Fr-MT | Fr-UE
- Projections (NDC)
  - Fr-UE

Spatialization

- Overseas data
  - DROM | PTOM
  - **all GHGs 1990 to (n-2)**
- Territorial inventory : by municipalities
  - Fr-UE
  - **all direct GHGs year 2021**

WGClimate
The Joint CEOS-CGMS Working Group on Climate

Ventilation of the results of the inventory



LULUCF results by NUTS 2 (MtCO2eq) – Citepa ed. 2024

Economical sector

- "Secten" Report & Data
  - Fr-MT
  - Fr-UE
- Projections (NDC)
  - Fr-UE

Spatialization

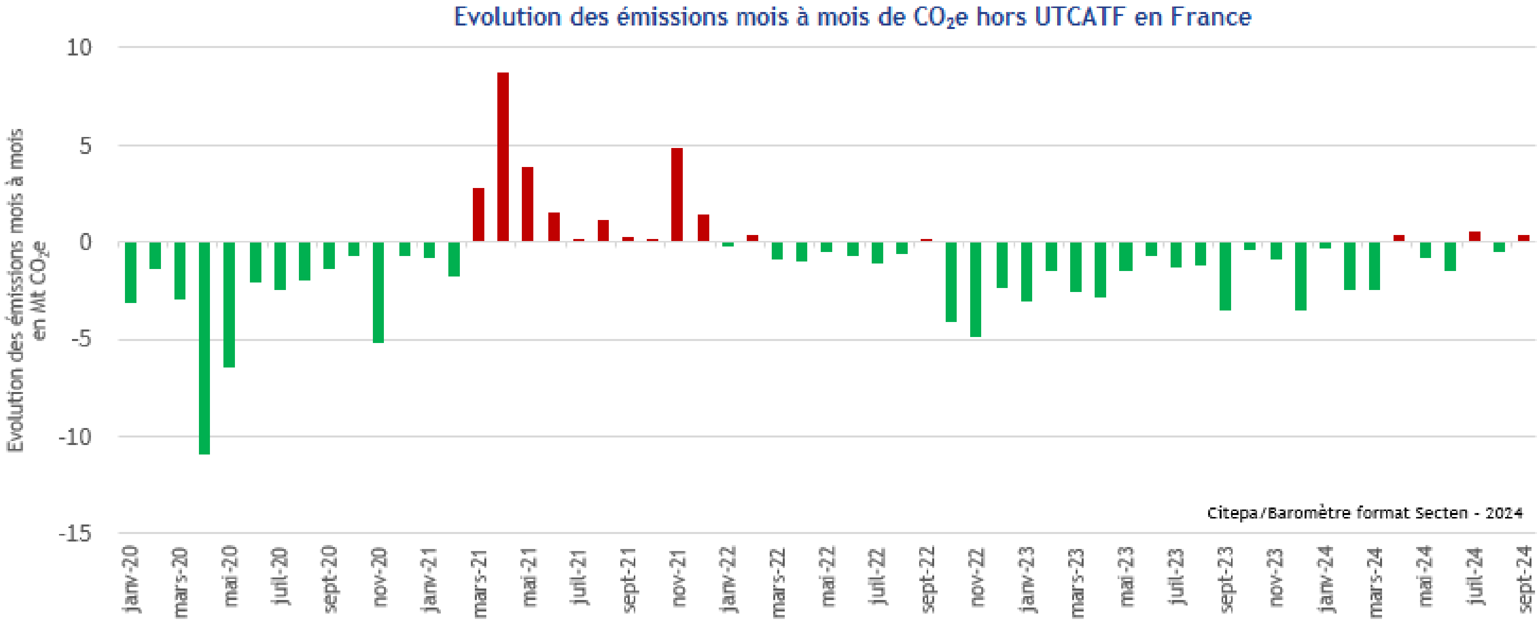
- Overseas data
  - DROM
  - PTOM
- Territorial inventory : by municipalities
  - Fr-UE

CO2e
1990 to (n-2)

- LULUCF data by NUTS2
  - Fr-UE

WGClimate
The Joint CEOS-CGMS Working Group on Climate

Ventilation of the results of the inventory



Monthly data for CO2e (MtCO2e) – Citepa dec. 2024
All sectors (01-2020 to 09-2024, without LULUCF)
- Detail by sectors available

Economical sector

- "Secten" Report & Data
  - Fr-MT
  - Fr-UE
- Projections (NDC)
  - Fr-UE

Spatialization

Monthly data

- Barometer
  - Fr-UE

WGClimate
The Joint CEOS-CGMS Working Group on Climate

Use of Earth Observation products in the inventory : **LULUCF sector**

CEOS CGMS

- Usual approach for UNFCCC inventories :

Emissions = Activity data * Emission factor

WGClimate
The Joint CEOS-CGMS Working Group on Climate

Use of Earth Observation products in the inventory : LULUCF sector

- Usual approach for UNFCCC inventories :

Emissions =	**Activity data**	*	**Emission factor**

- LULUCF emissions :

	Activity data		Emission factor		
Land use change	Areas (ie forest land converted to cropland)	X	Carbon stock change	X	Period of conversion (usual = 20 years)
			or Emission factor		
Management change	Areas (ie more use of tillage in cropland)	X	Carbon stock change	X	Period of conversion (usual = 20 years)

WGClimate
The Joint CEOS-CGMS Working Group on Climate

Use of Earth Observation products in the inventory : **LULUCF sector**

- <u>Usual approach for UNFCCC inventories :</u>

Emissions = Activity data * Emission factor

- LULUCF emissions :

Land use change	Areas (ie forest land converted to cropland)	X	Carbon stock change	X	Period of conversion (usual = 20 years)
			or Emission factor		
Management change	Areas (ie more use of tillage in cropland)	X	Carbon stock change	X	Period of conversion (usual = 20 years)

→ EO data ?

→ Field survey / statistics

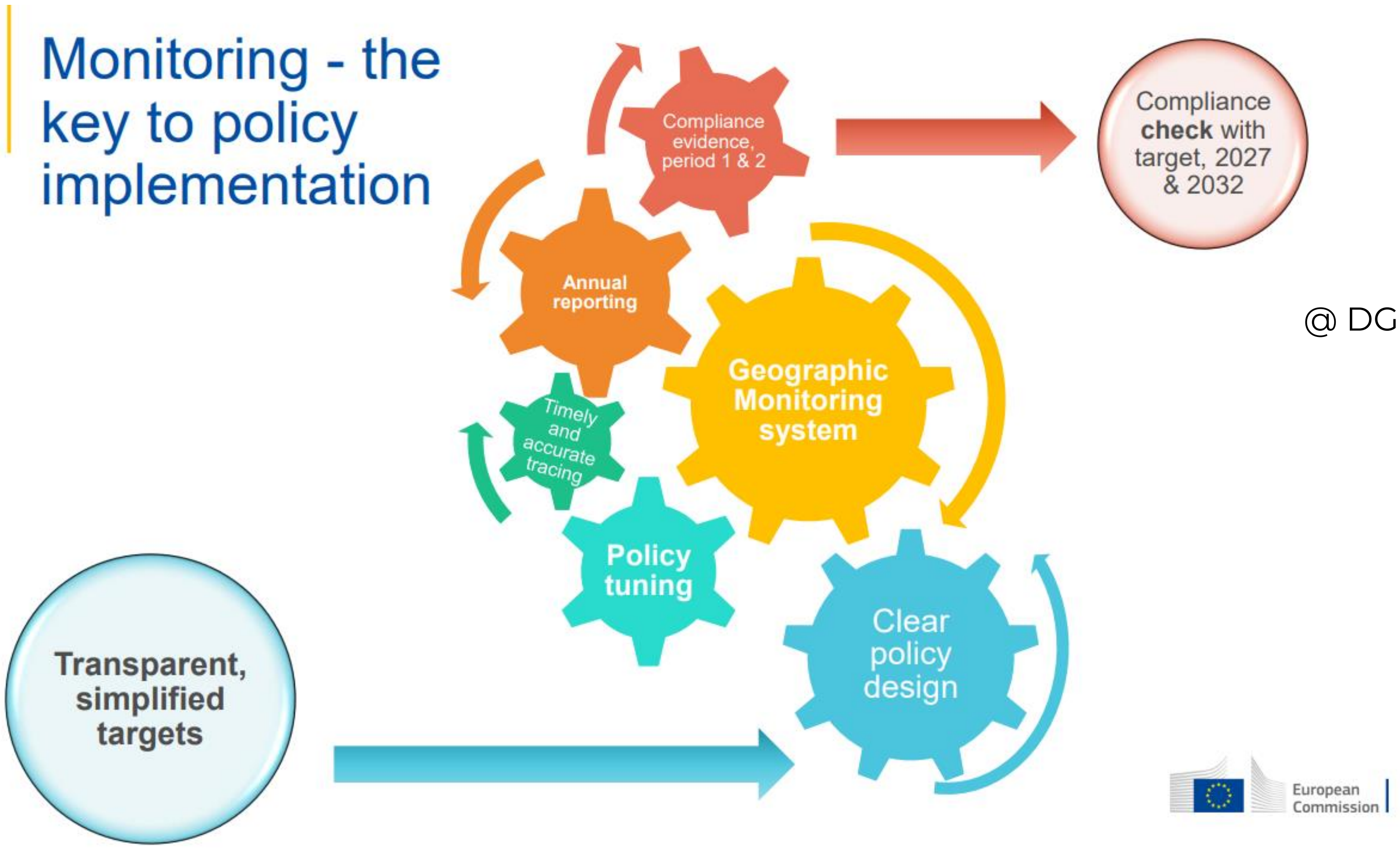
- To estimate carbon stocks
- To get spatialized input or emission (co)-factors

Geographically explicit monitoring

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

Use of Earth Observation products in the inventory : **LULUCF sector**

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



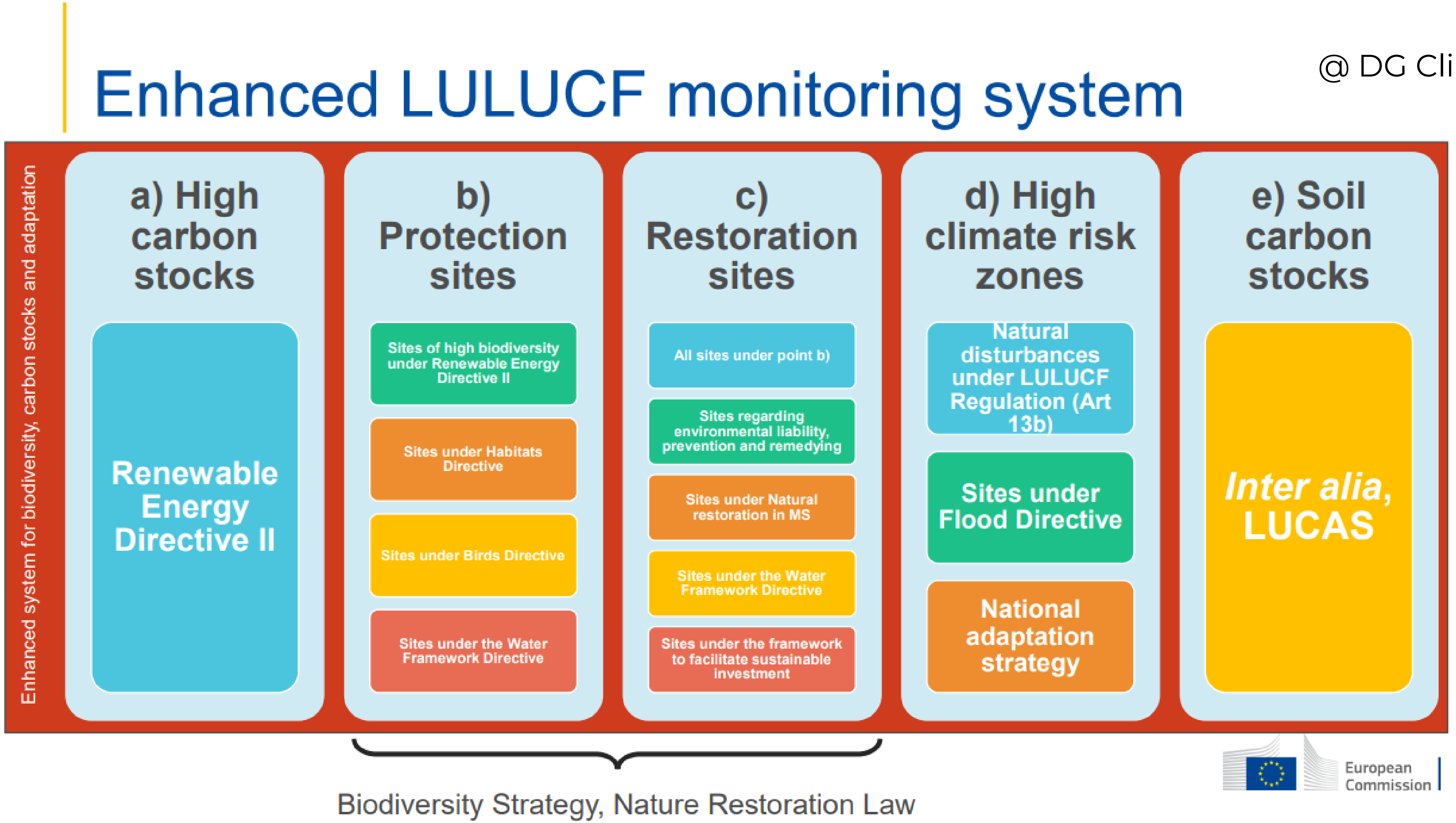
@ DG Clima

WGClimate
The Joint CEOS-CGMS Working Group on Climate

Use of Earth Observation products in the inventory : **LULUCF sector**

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

@ DG Clima



WGClimate
The Joint CEOS-CGMS Working Group on Climate

Use of Earth Observation products in the inventory : **LULUCF sector**

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

Key take-aways of the LULUCF revision: Regulation (EU) 2023/839*

@ DG Clima

Higher ambition	• Explicit MS targets - for first time • Full territorial scope from 2026
Better monitoring	• Move to Tier-2 and Tier-3 level, geographically explicit basis (use of earth observation)
Improved governance	• Corrective action process • Recommendations by Commission
EEA in the lead for implementation	• Reinforced EEA team, Copernicus tools

* http://data.europa.eu/eli/reg/2023/839/oj or consolidated version here: https://europa.eu/!98HPxX

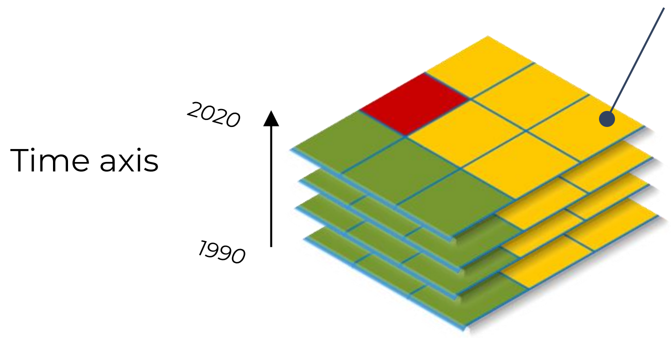
European Commission

WGClimate
The Joint CEOS-CGMS Working Group on Climate

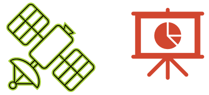
Use of Earth Observation products in the inventory : **LULUCF sector**

- 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

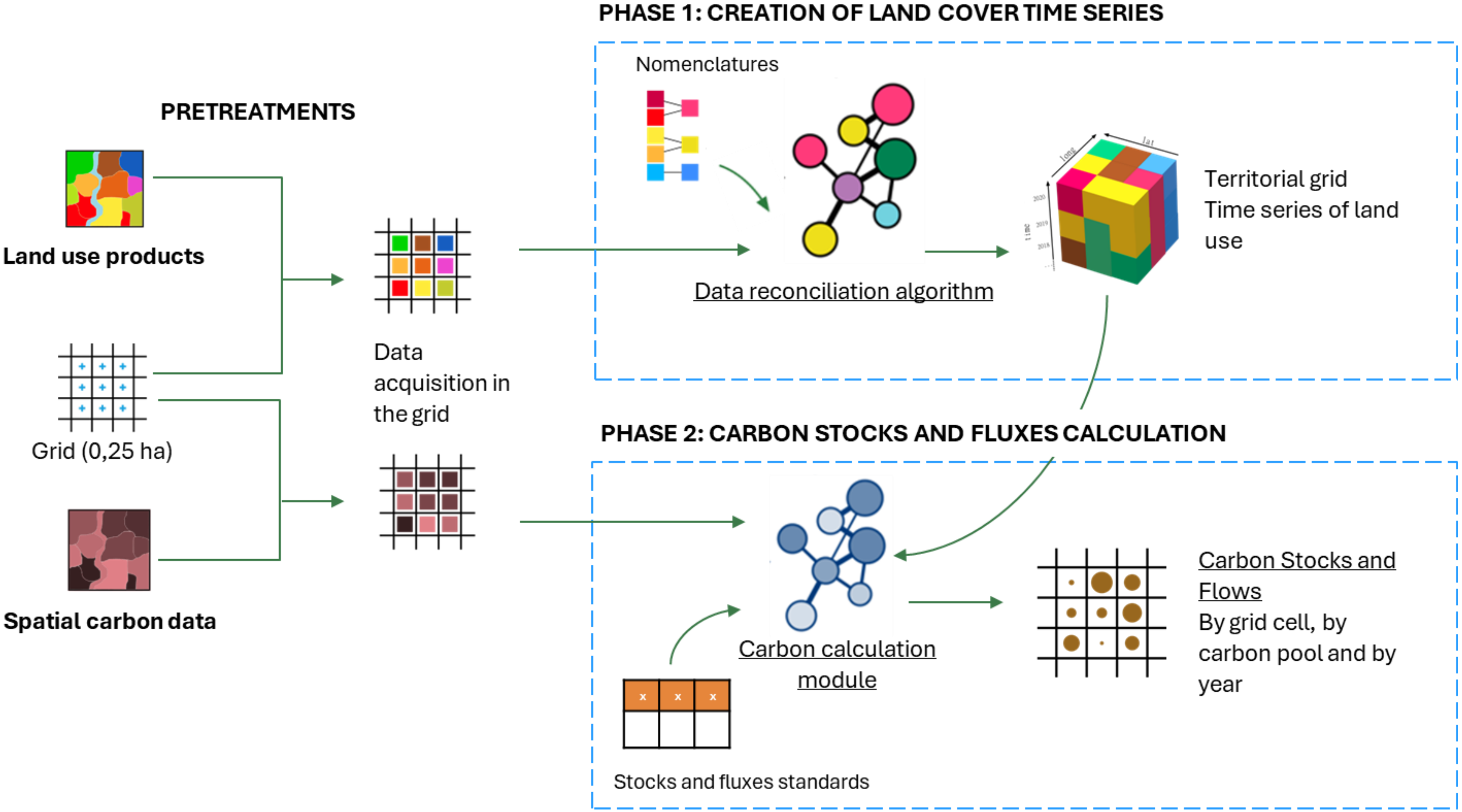


= combination between EO data and spatialized statistical data



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

Use of Earth Observation products in the inventory : **LULUCF sector**



WGClimate
The Joint CEOS-CGMS Working Group on Climate

Use of Earth Observation products in the inventory : **LULUCF sector**

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

Mains issues :

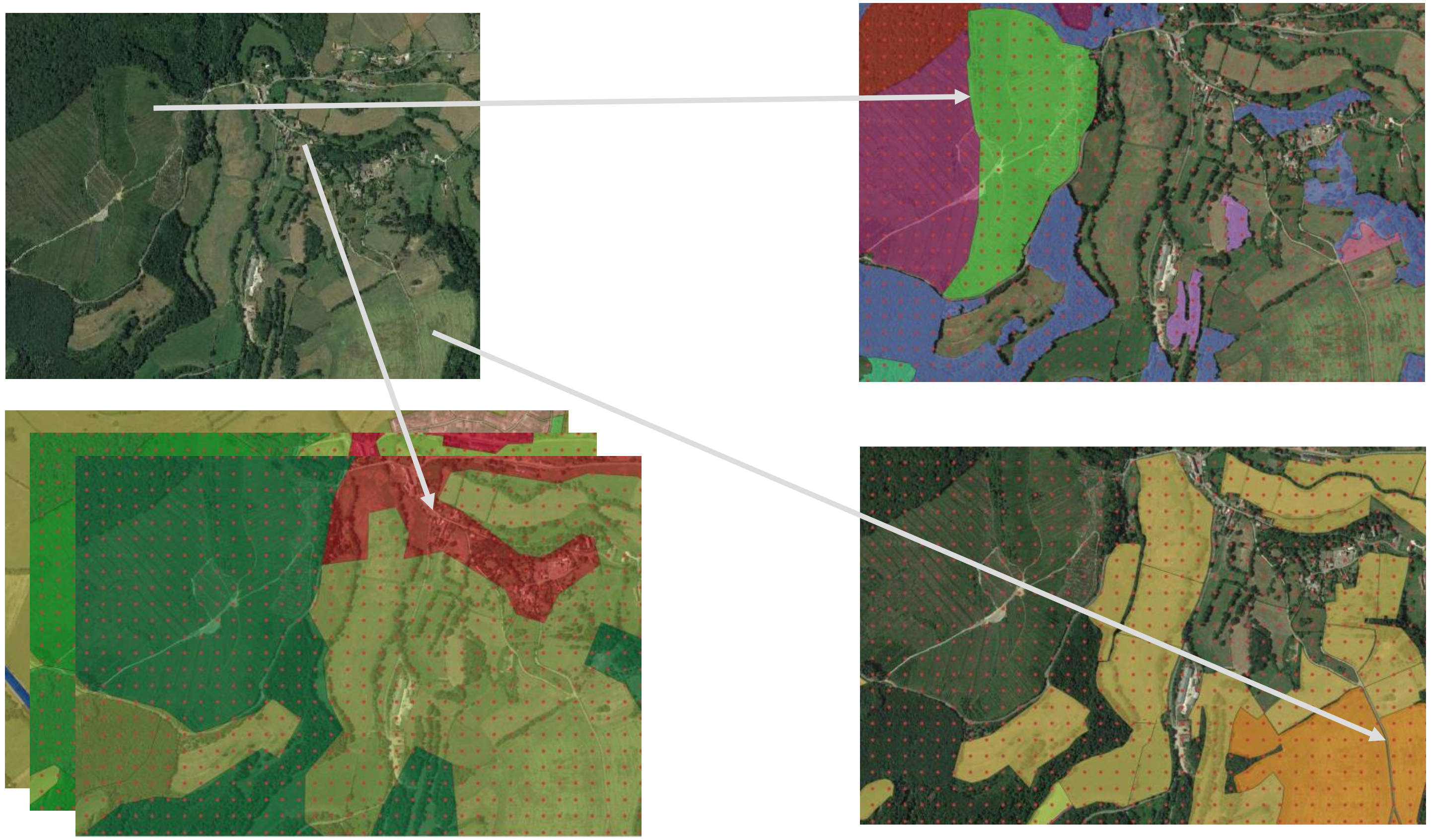
- Detect “true” changes (lots of false changes when doing simple wall-to-wall methodologies
- Ensure time consistency even if the data is not available in the 1990-2010 period
- Differences in spatial resolution and land use categories

Allow interoperability and easy integration of new dataset

WGClimate
The Joint CEOS-CGMS
Working Group on Climate

Use of Earth Observation products in the inventory : **LULUCF sector**

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>

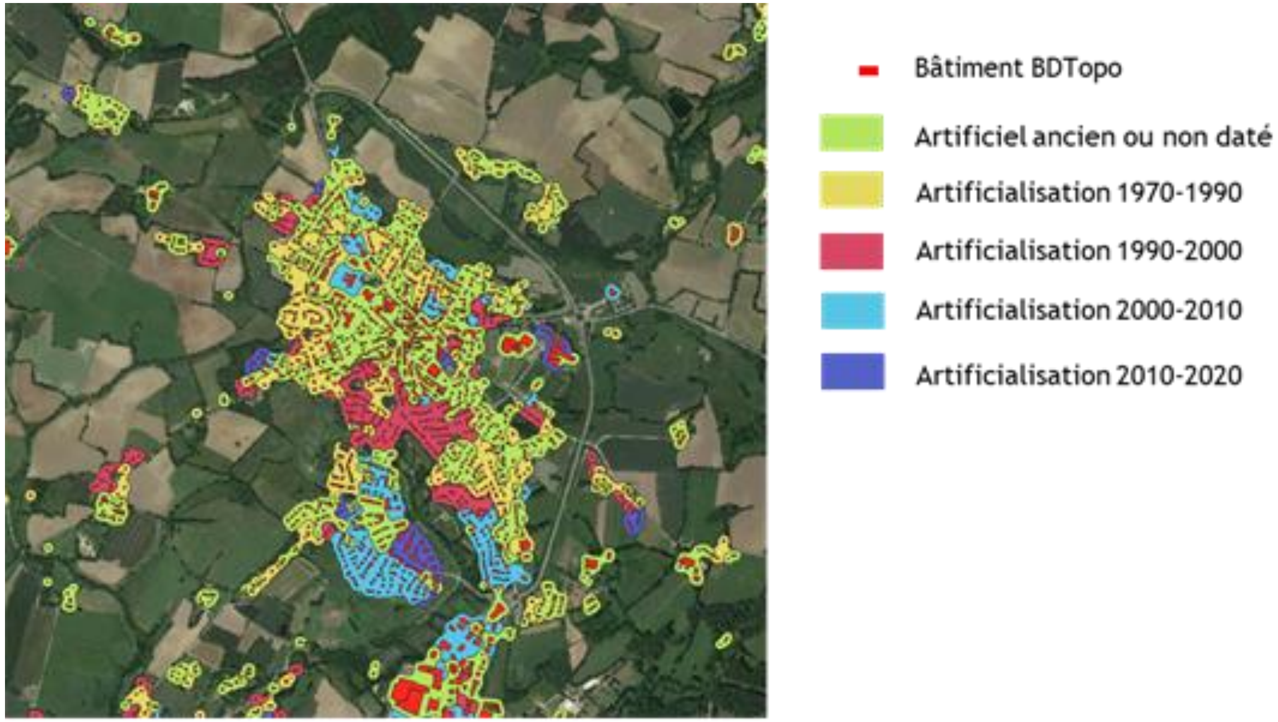
WGClimate
The Joint CEOS-CGMS
Working Group on Climate

Use of Earth Observation products in the inventory : **LULUCF sector**

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

Modelling of new settlements :

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



Agricultural rotations :

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

WGClimate
The Joint CEOS-CGMS Working Group on Climate

Use of Earth Observation products in the inventory : **LULUCF sector**

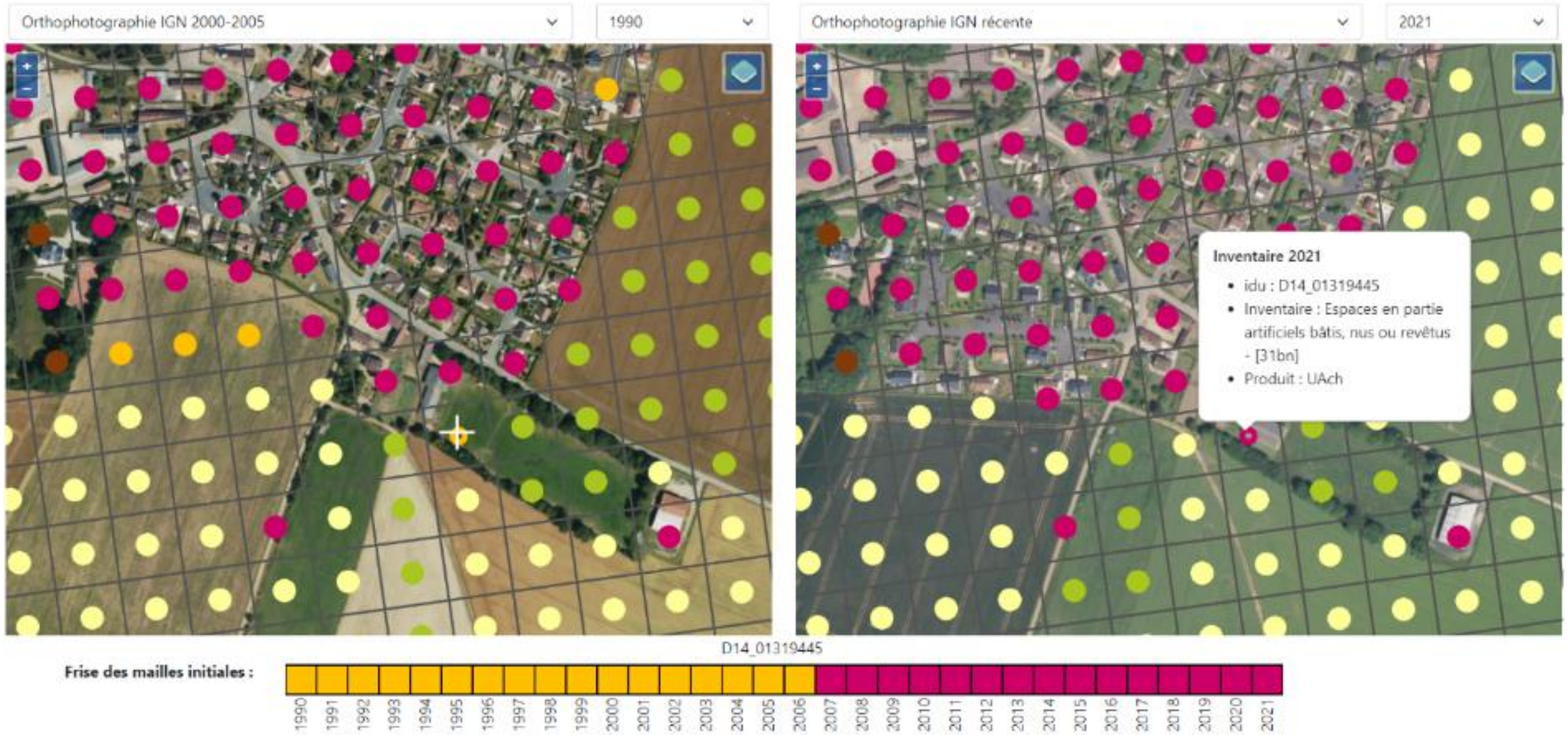
Products integrated

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*

WGClimate
The Joint CEOS-CGMS Working Group on Climate

Use of Earth Observation products in the inventory : LULUCF sector

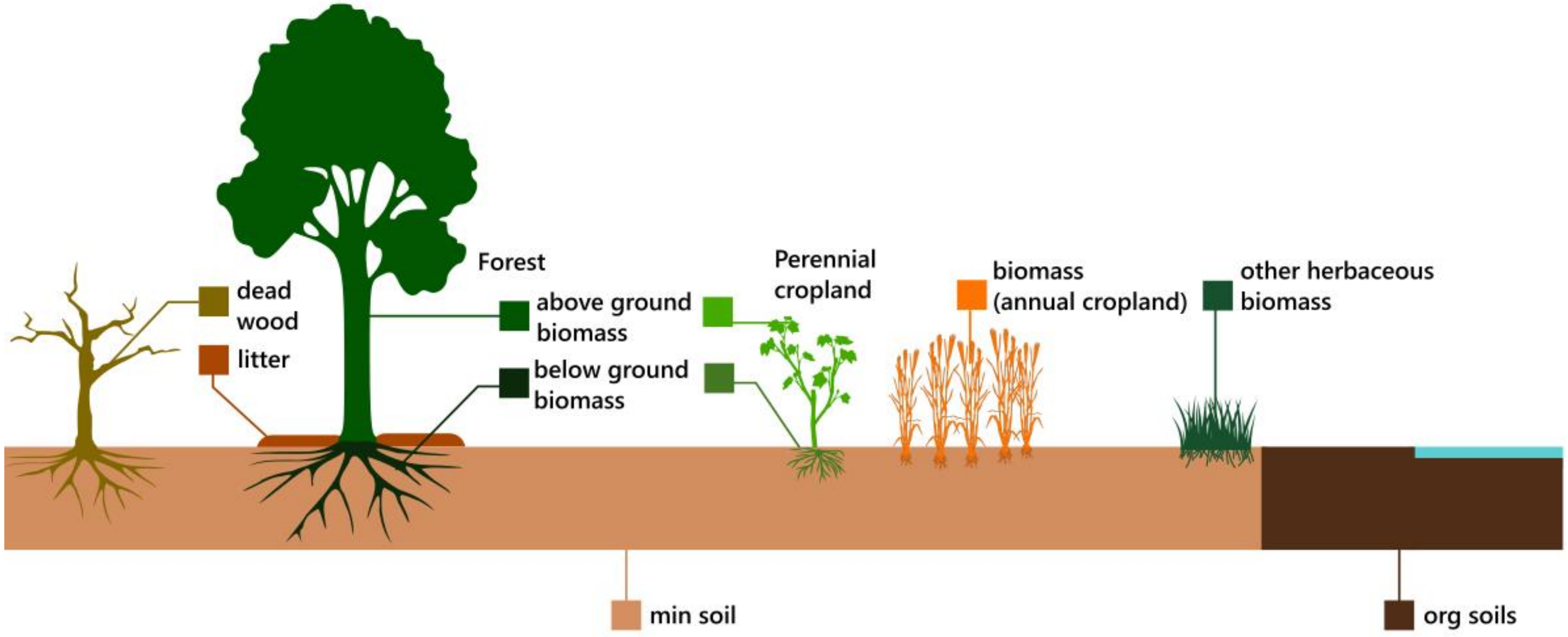
- Visualization tool : output of the model overlaid on orthophoto → **transparency**



WGClimate
The Joint CEOS-CGMS Working Group on Climate

Use of Earth Observation products in the inventory : **LULUCF sector**

- Carbon stock change estimates

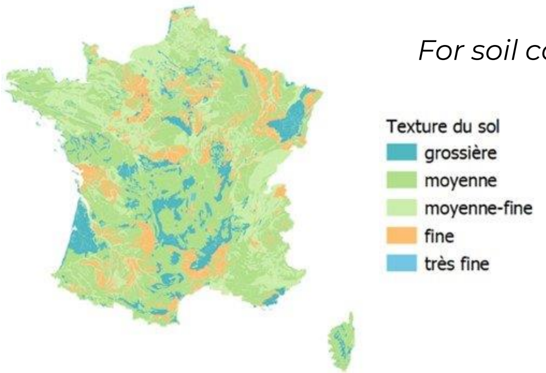


Initialization of stocks in 1990: Allocation of carbon stocks, by carbon pool according to: land use, different zoning, agricultural practices

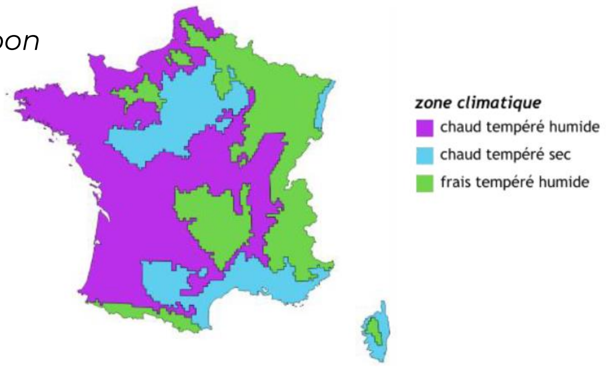
Different zoning used for the spatialization of carbon stocks

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

For soil carbon

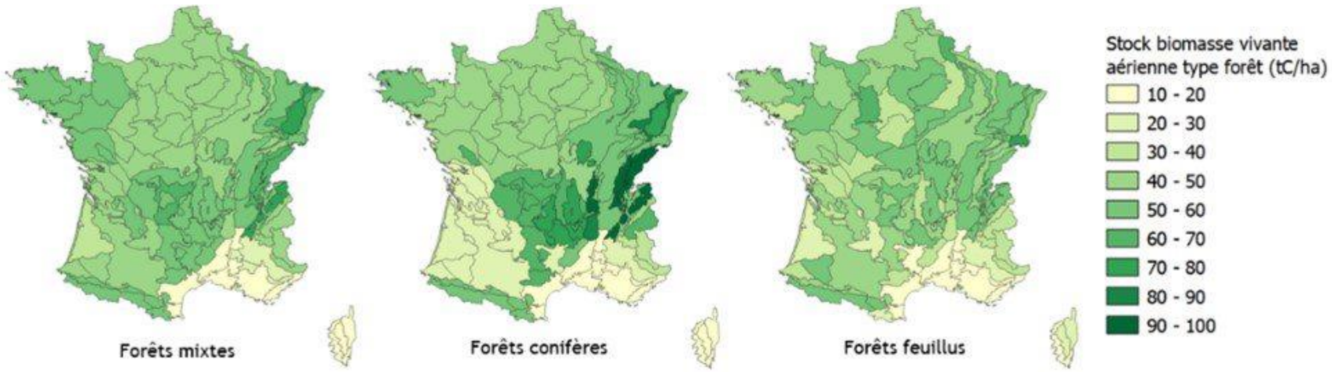


Soil texture mapping [BDGSF - Citepa]



Mapping of climate zones [JRC according to IPCC 2006]

Spatialization of the carbon stock in forest biomass by forest type



WGClimate
The Joint CEOS-CGMS Working Group on Climate

Use of Earth Observation products in the inventory :
LULUCF sector

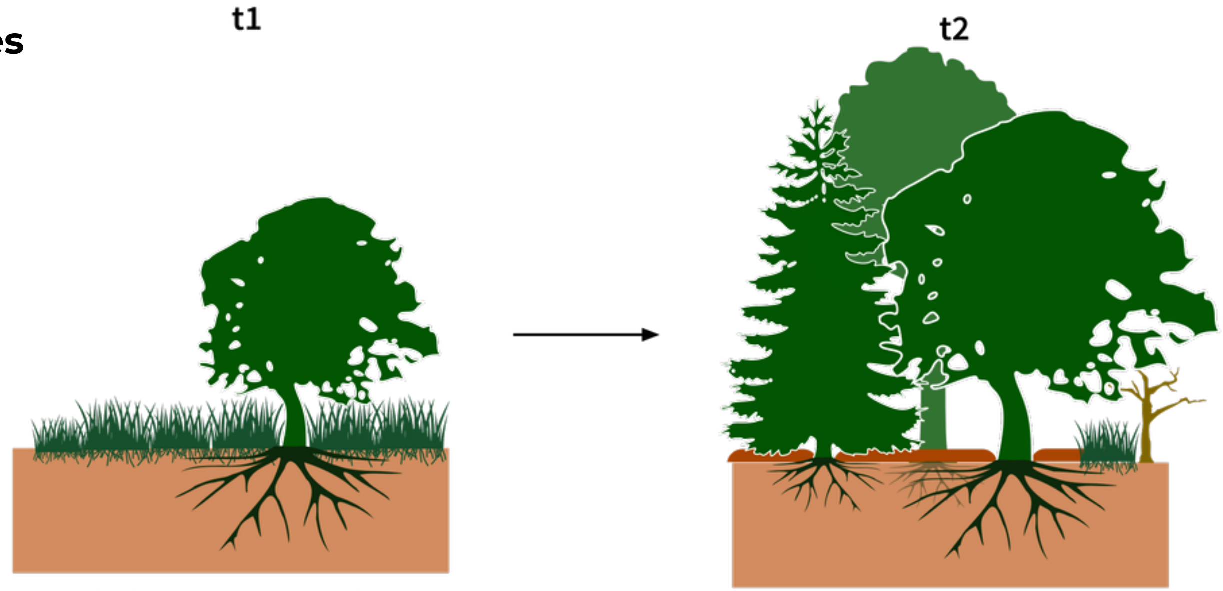
Carbon stock change estimates

Computation for each cell, each carbon pool from 1990 to 2023

For each year :
Stocks depends on :
- The land use subcategory
- Various zoning
- Management practices

Land use t1

Carbon stock t1 by carbon pool



Catégorie Giec : Prairies (*Grassland*)
Classe d'utilisation : maquis, garrigue [22mq]

Catégorie Giec : Forêt (*Forest Land*)
Classe d'utilisation : Forêt mixte [21fm]

Land use t2

Carbon stock t2 by carbon pool

Zone pédoclimatique 1_1
texture pédologique grossière
climat chaud tempéré humide

Sylvoécorégion
Cévennes

flux liés à la conversion

	stock initial	pertes	gains	stock final
lb_f_a	8 tC/ha		+	54 tC/ha
lb_f_r	11 tC/ha		+	16 tC/ha
lb_hh	0,5 tC/ha	-		0,2 tC/ha
lt	0 tC/ha		+	9 tC/ha
s_min	71 tC/ha	=		71 tC/ha
dw	0 tC/ha		+	6 tC/ha

t3 (...)

WGClimate
The Joint CEOS-CGMS Working Group on Climate

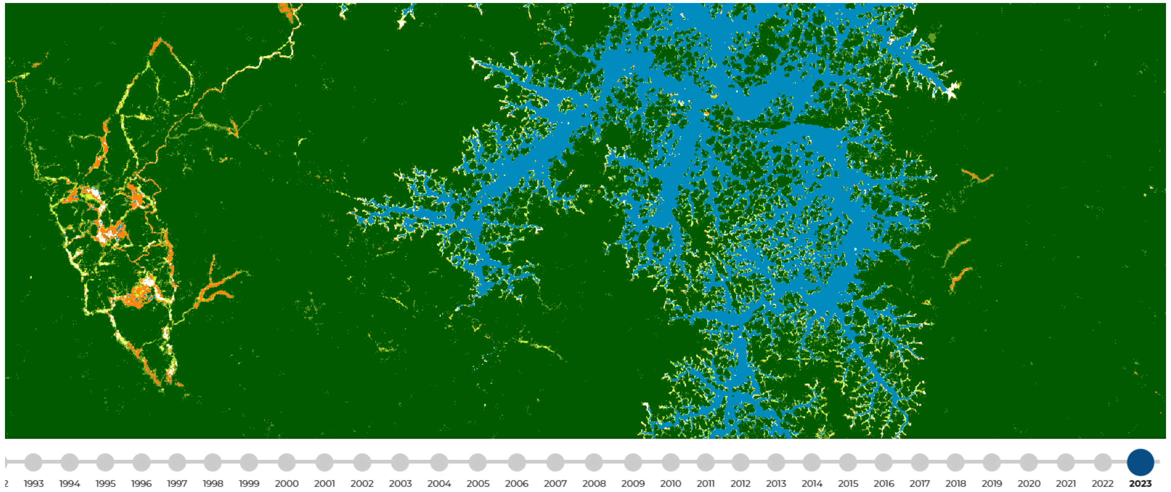
Use of Earth Observation products in the inventory :
LULUCF sector - Oversea territories

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**)

    C. Vancutsem et al. , (2021).

    https://forobs.jrc.ec.europa.eu/TMF



Zoom on the Petit Saut area (French Guiana)

- 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

Use of Earth Observation products in the inventory : LULUCF sector

General comments on this approach & use of EO

- Geographic monitoring can help to better **fit the efforts / policies and measures results** at different scales (data published at municipality scale)
- **Interoperability & transparency**
- Any new quality data can be integrated in the grid
- The forest balance is **still relying on the precious NFI estimates** allow to have detail between harvest, mortality, growth, by species, deadwood values.... → detection of the collapse of the carbon sink
- Sampling **photo interpretation methods** can allow to track changes where land use data are scarce
- EO can be powerful a tool to **downscale** the estimates and interpolate between ground variables
- EO can improve timeliness and validate some proxy or extrapolation choices

→ Will be compared to the Net Carbon Exchange method within **RECCAP2**

Other LULUCF & EO subjects :

- Detection of biomass outside forest (hedges)
- Water table levels : emissions in wetlands
- Wildfires
- Crop residues

- Difficulty : understand the maturity of the datasets and choose where to begin

WGClimate
The Joint CEOS-CGMS Working Group on Climate

Thank you

WGClimate-22 & GHG-TT-5

11 - 13 February, 2025
ESA ECSAT, Harwell, UK