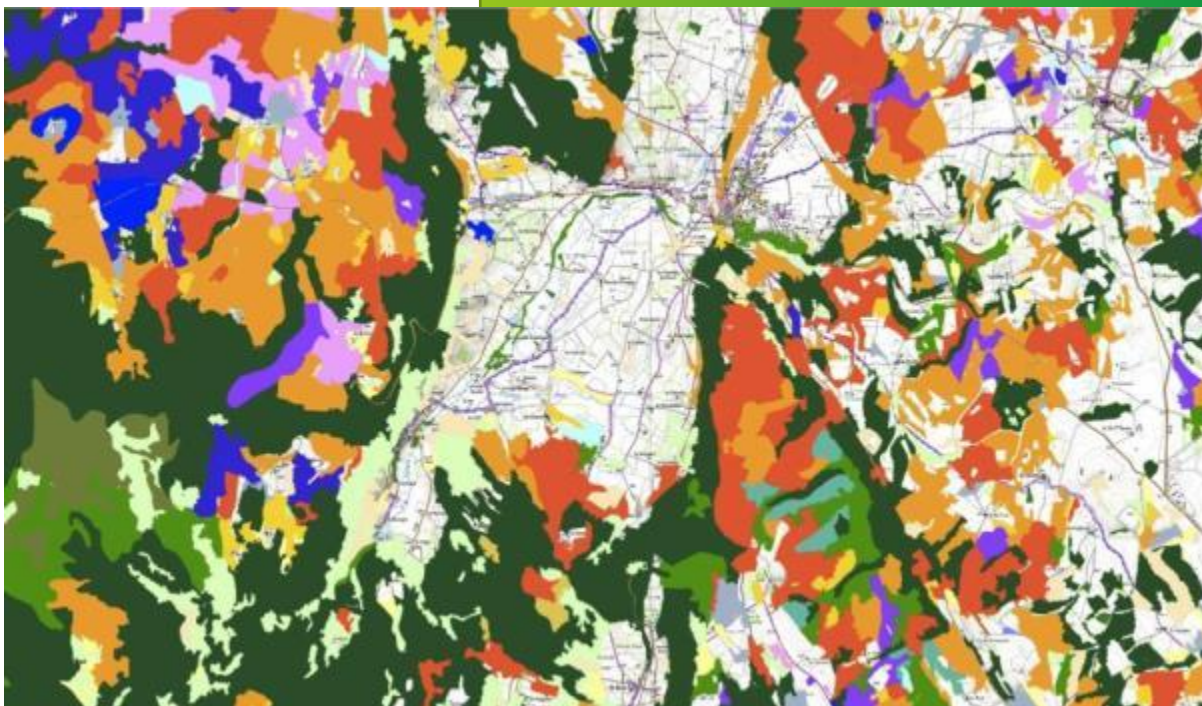




INSTITUT NATIONAL  
DE L'INFORMATION  
GÉOGRAPHIQUE  
ET FORESTIÈRE

## INNOVATING PROCESS TO PRODUCE AND REGULARLY UPDATE GEOGRAPHIC INFORMATION IN FOREST AREAS AT IGN FRANCE



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IGN FRANCE

# IDENTITY

## French National Mapping Agency

### Missions

- 📍 Describe the physical geometry of the surface area and land cover of the French national territory
- 📍 Establish and update a permanent inventory of national forest resources

### Key figures

- 📍 1 716 employees
- 📍 162.8 M€ budget



# IGN'S PUBLIC SERVICE OBJECTIVES (1/2)

1. Design and implement a geodetic infrastructure consistent with international systems,
2. Make and periodically update the aerial or satellite imagery coverage of the entire French territory,
3. Produce and update the very detailed reference database describing physical geography above the surface of earth,
4. Manage historical documentation (archives),
5. Set up and administer the French Inspire portal, distribute geographic and forest databases in addition to cartographic archive collections ([www.geoportail.fr](http://www.geoportail.fr))
- 6. Produce and update forest resource and environment databases,**

# IGN'S PUBLIC SERVICE OBJECTIVES (2/2) :

**Research area:** IGN carries out research and development in all fields relevant to IGN's competence.

Geodesy, Sensors, Photogrammetry Remote sensing and computer vision, GIS, Forest inventory

## **Education:**

IGN manages the activities of a school of geomatics, the national school of geomatics (ENSG) [www.ensg.eu](http://www.ensg.eu)

## **Business:**

IGN may design, produce, market and sell any product or service developed from data collected or skills acquired from its public service operations

In 2014, IGN created its projects' incubator IGNfab in order to give a hand to SMEs with regard to technical expertise, data and network.



# FROM GEOPORTAL TO GEOPLATFORM

With the Geoportal experience, IGN-F and its partners took the initiative to build the *Geoplatform*, which aims to provide to officials and citizens an open, collaborative and shared infrastructure, bringing together communities and uses around geo-located data and services

## Open Gouvernance

- An ecosystem of uses and communities, bringing together users and producers of data and services that can be federated around themes or technical communities.

## Platform

- An open and mutualized platform, consisting of a catalogue of data, processing tools, generic applications, learning databases and algorithms. All these will be available online through APIs.

## Collaborative

- Collaborative solutions (crowd and community sourcing) for maintaining and enriching authoritative geographic data.



2



## FOREST MONITORING



# FOREST MONITORING AT IGN-F

Statistical  
forest  
inventory

1. The IGN is in charge of the permanent **inventory of the national forest resources**, in both public and private forests

The **national forest inventory** is used to monitor :

- the state of the French forest and its ecosystem
- Its evolution over time, *for planning, management, industry....*
- Its potentialities.

BD Forêt

2. The IGN is also in charge of producing and updating the forest map : a geographical reference frame of description of forest species (**Forest database**)

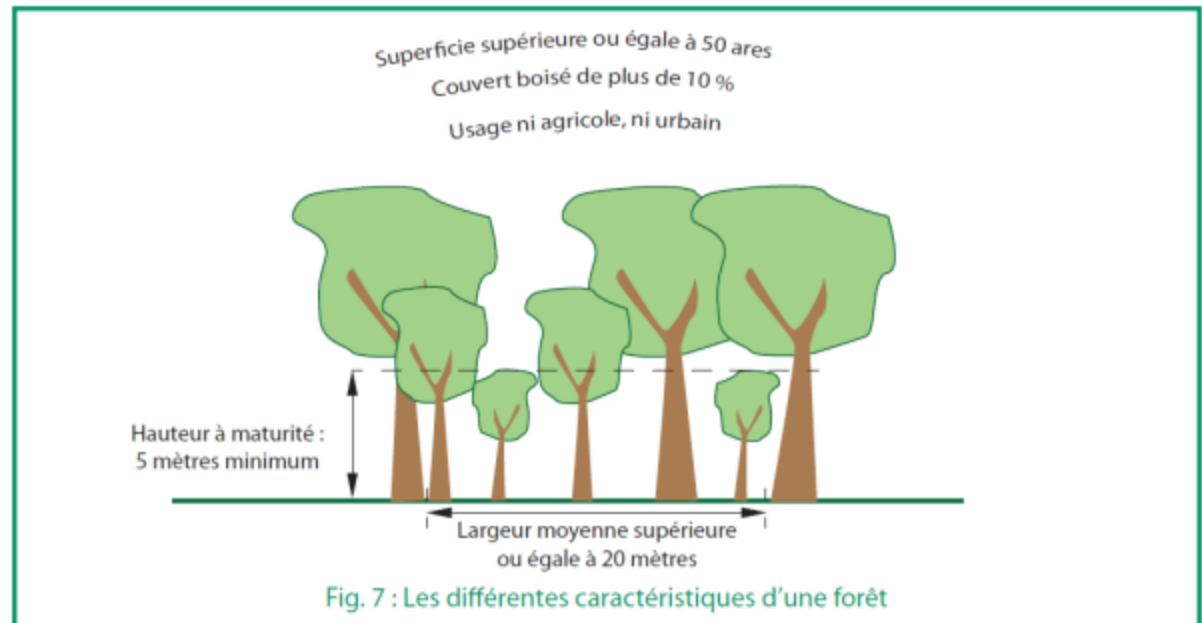


# FOREST :FAO\* DEFINITION

Land spanning more than 0.5 hectares :

- with trees higher than 5 meters
- and a canopy cover of more than 10%,
- or trees able to reach these thresholds *in situ*.

It does not include land that is predominantly under agricultural or urban land use.



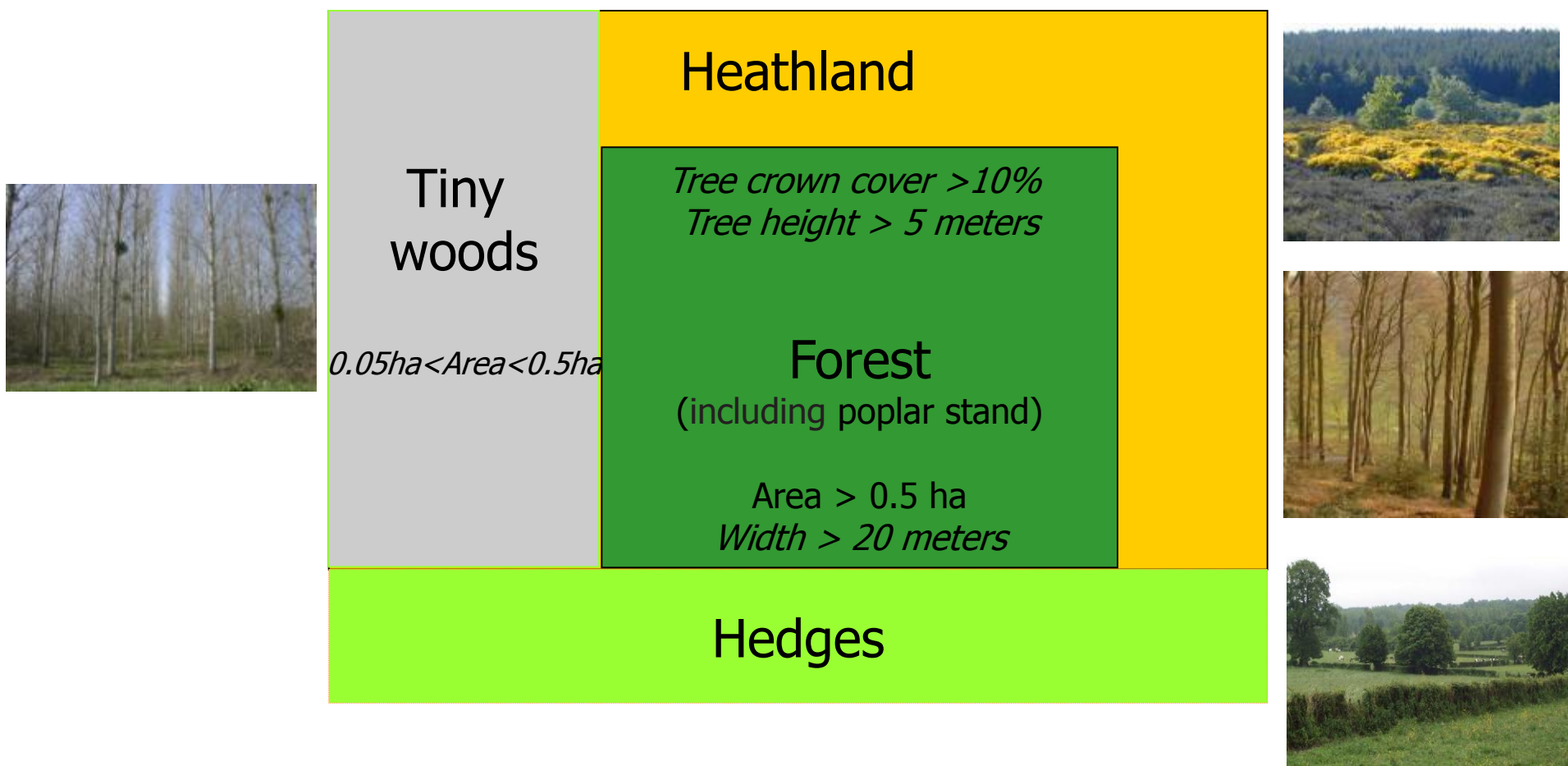
\*Food and Agriculture  
Organization of the United  
Nations



## FOREST INVENTORY AT IGN-F

# AREAS CONCERNED BY THE FRENCH NFI

Statistical  
forest  
inventory



# A CONTINUOUS INVENTORY IN SPACE AND TIME

Statistical  
forest  
inventory

Since 2005, a systematic statistical survey method has been applied annually.

*Same method as Sweden, Norway, the United States and Finland*

→ Flexible, easily adaptable to multiple spatial divisions and many themes.

→ It **annually** provides accurate national and regional results by aggregating data from five annual campaigns.



# A CONTINUOUS INVENTORY IN SPACE AND TIME

Statistical  
forest  
inventory

Since 2005,



Every year for the  
whole country :

**1. Photo-interpretation :**

\* 80 000 plots

**2. Field survey :**

\* 8500 + 6400 plots

# Phase 1 : photo-interpretation



## Systematic sampling BD ORTHO®

Systematic grid :

1 km x 1 km

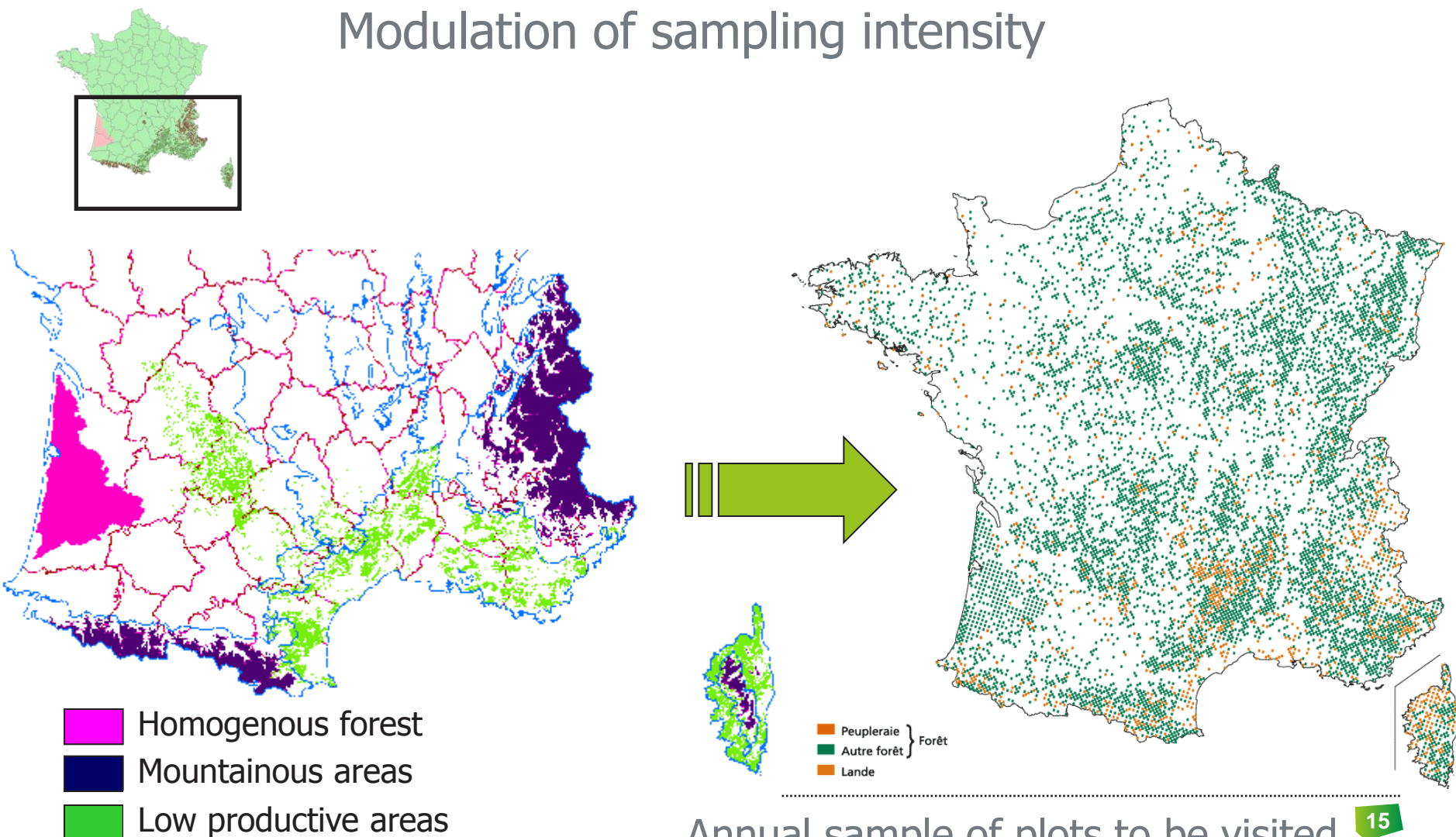
1/10 each year

For each plot :

- land cover
- land use
- hedge

# Selection of field plots to be visited

## Modulation of sampling intensity





# Phase 2. Field survey

Statistical  
forest  
inventory

**After the photo-interpretation phase, the field teams visit about 8500 new plots every year**

- 6 800 plots in productive forests (land cover x land use)
  - 500 plots in poplar stands
  - 500 plots in heathlands
  - 500 plots in hedgerows and hedges
- + 6 400 "return" plots  
(five years after the first field work)

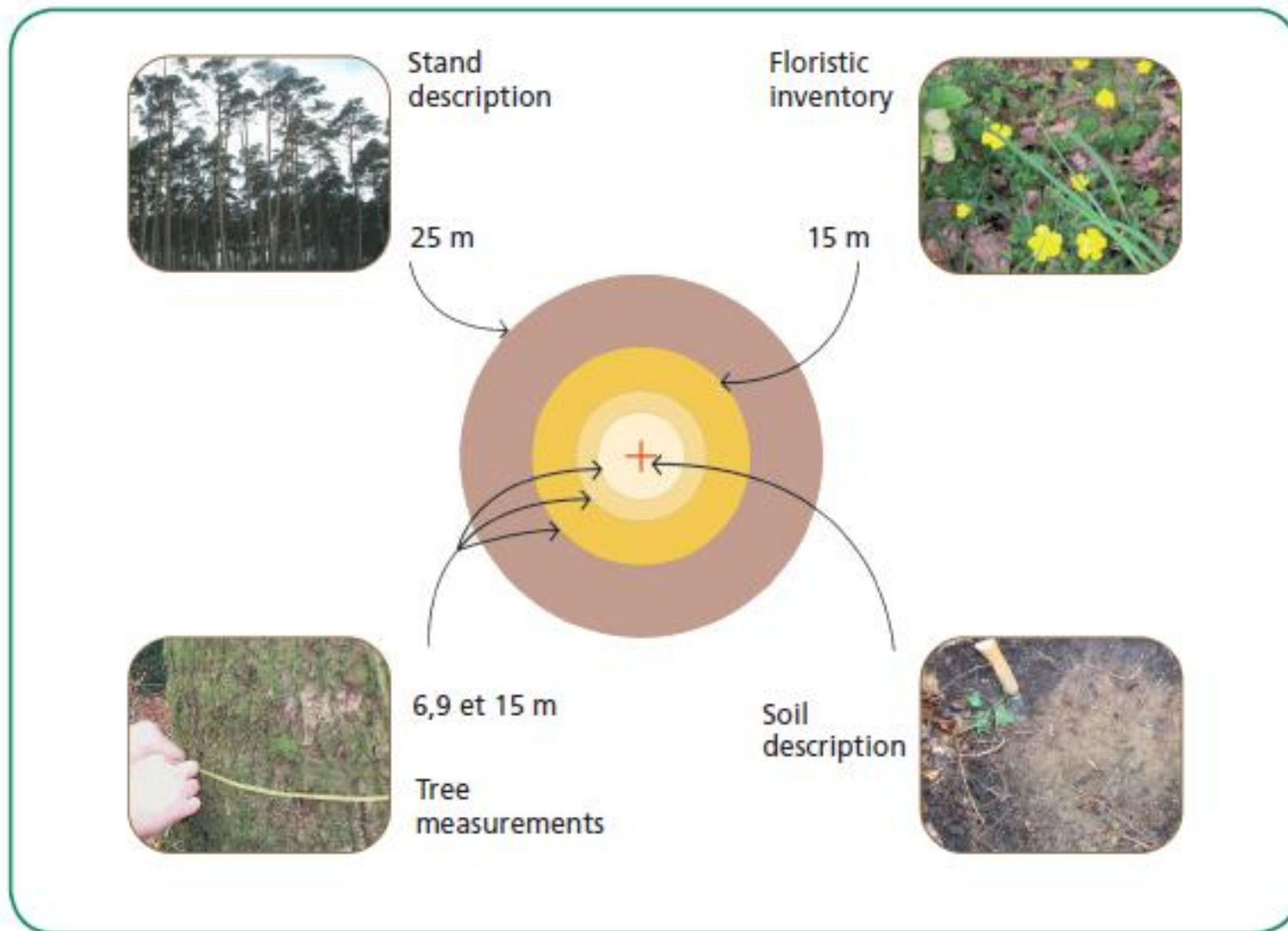
➔ Temporary plots





# Observations and measurements

Statistical  
forest  
inventory



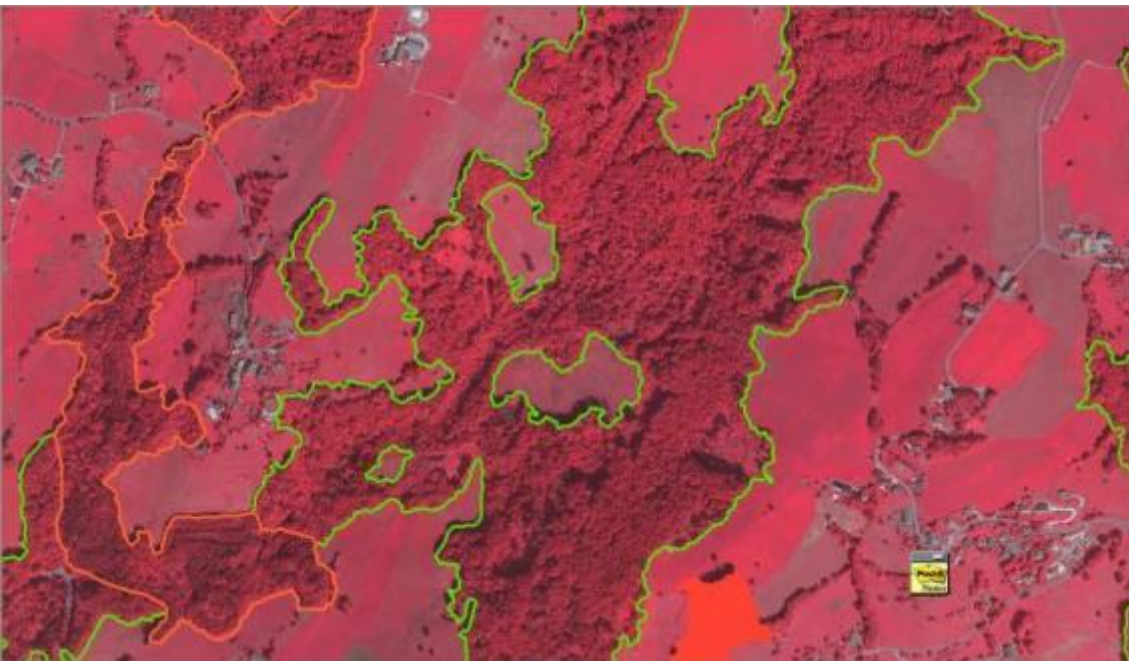


## FOREST DATABASE BD FORÊT

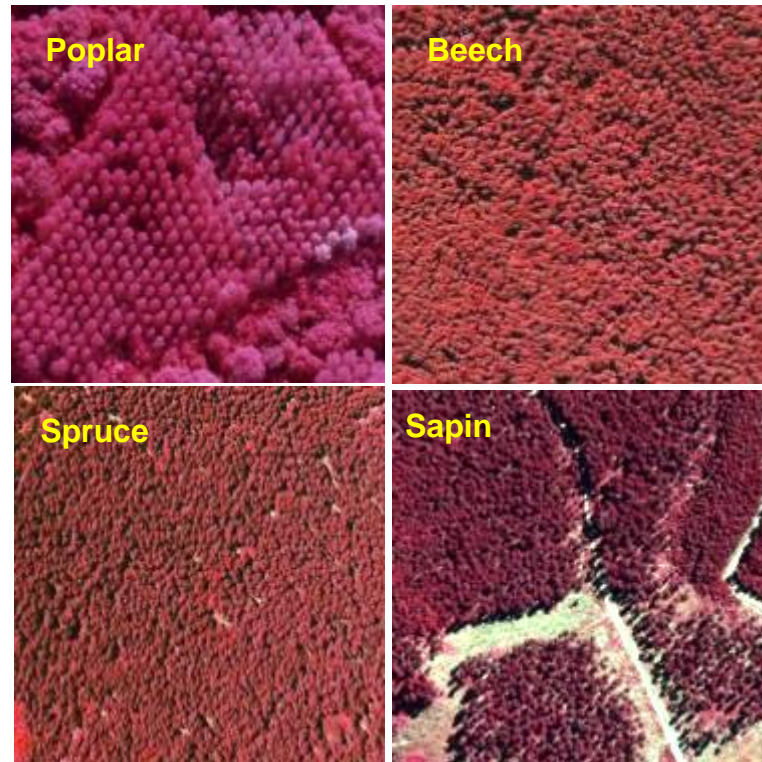
# FOREST MAP (BD FORÊT®)

Production method : **photo-interpretation of color infrared orthoimages (GSD 25/50 cm)**

- Minimal Mapping Unit : 5000 m<sup>2</sup>
- Hierarchical data model : 32 posts
- a layer geometrically compatible with other IGN databases



1. Automatic IR orthoimage segmentation



2. Manual determination of forest species



## MAIN RESULTS OF THE FOREST MONITORING



# A reliable NFI in response to new challenges

Statistical  
forest  
inventory

## Biodiversity

## Monitoring forest ecosystems

## Climatic changes

- Attenuation: carbon sink function
- Adaptation: evolution undergone or wanted
- Climate events

## Renewable materials

- Direct effect (avoidance of fossil emissions)
- Substitution effect

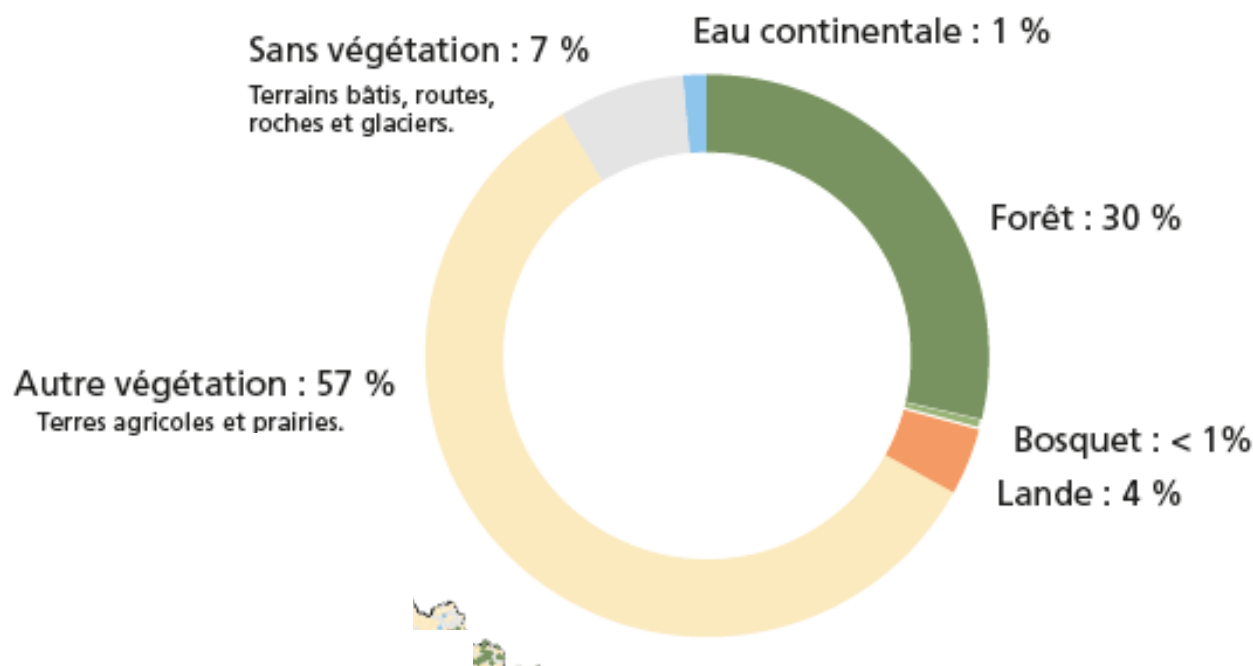
## Other societal expectations

- Leisure
- Environmental amenities (landscape, water, etc.)

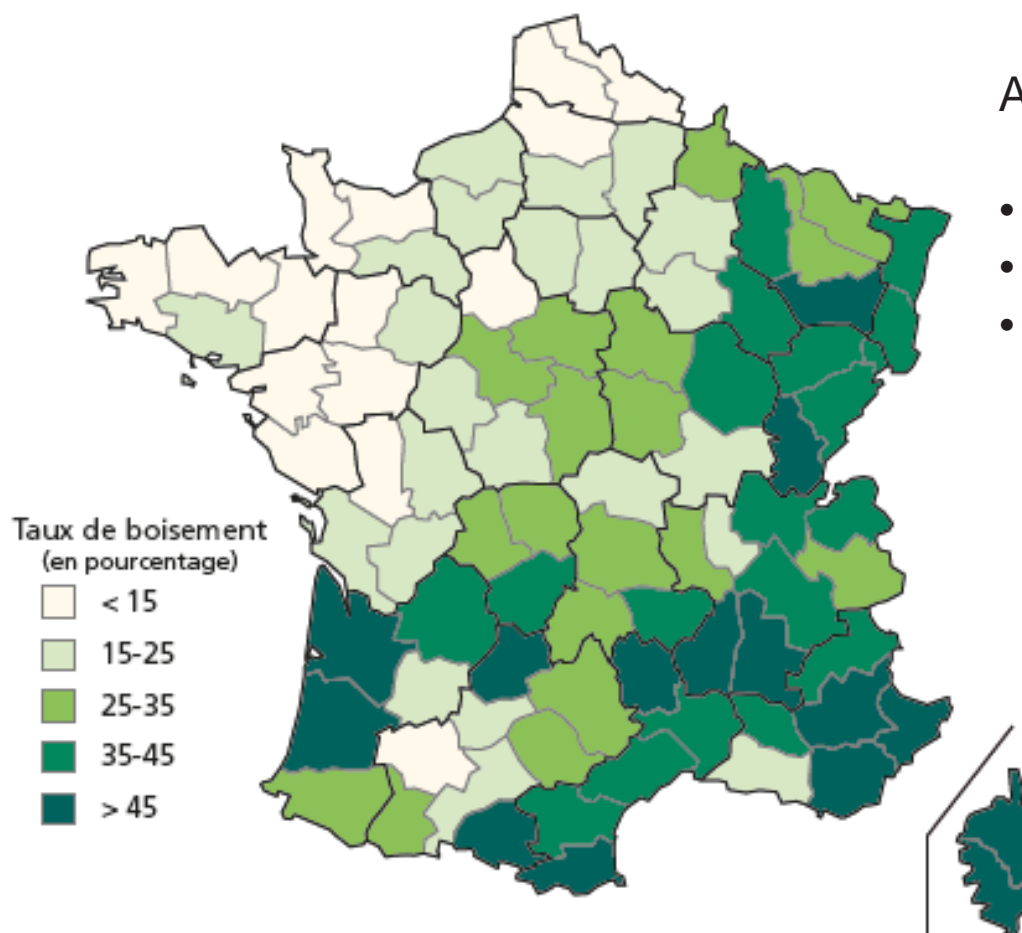
# Forest area

Forest :  **$16.3 \pm 0.1$  million ha** (rate = 31%)

Production forest :  **$15.5 \pm 0.1$  million ha**



# Afforestation rate



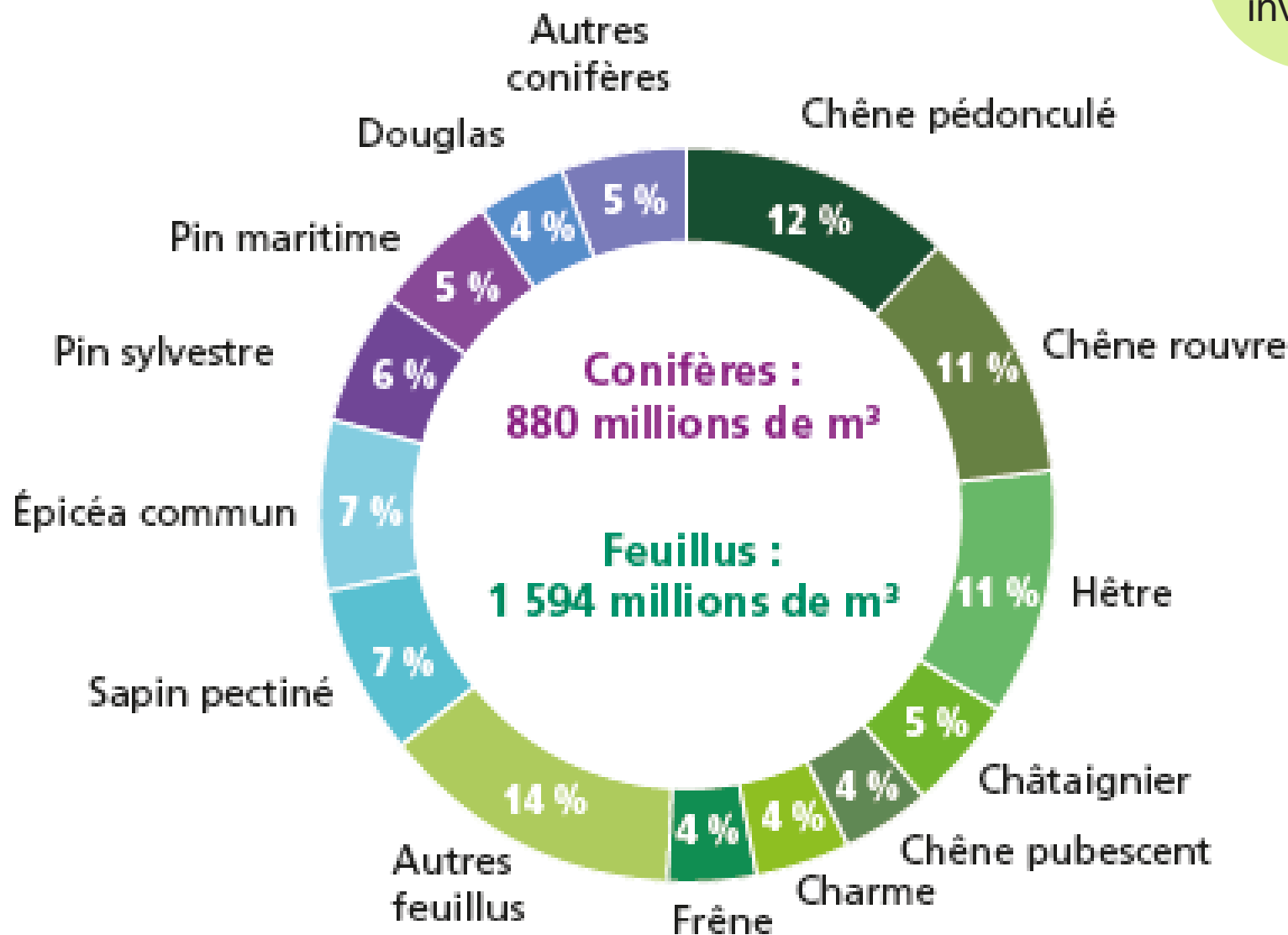
Taux de boisement des départements

Available maps :

- Forest diversity
- Growing stock (m<sup>3</sup>/ha)
- ...

# Growing stock

Statistical  
forest  
inventory



Répartition du volume de bois vivant sur pied par essence



# TOWARDS A MULTISOURCE FOREST INVENTORY

Statistical  
forest  
inventory

Objective : improve the accuracy of small area statistical estimates without increasing the prohibitive cost of field measurements

Rich and spatially sparse information (eg French forest inventory)

+ “Poor” and spatially dense information (auxiliary information like satellite or aerial photography)

+ *correlation between the two sources*

= rich and dense information

Implementing the multisource forest inventory requires the following up-to-date and always available data: Digital Surface Model\* and BD Forêt

\*and Lidar data whenever available



**INNOVATION**

**BD Forêt**

- 1. Federate the forest description data in France**
- 2. Use Remote sensing to automate the production and update of forest data**

# COLLABORATIVE APPROACH TO IMPROVE THE FOREST MAP

BD Forêt



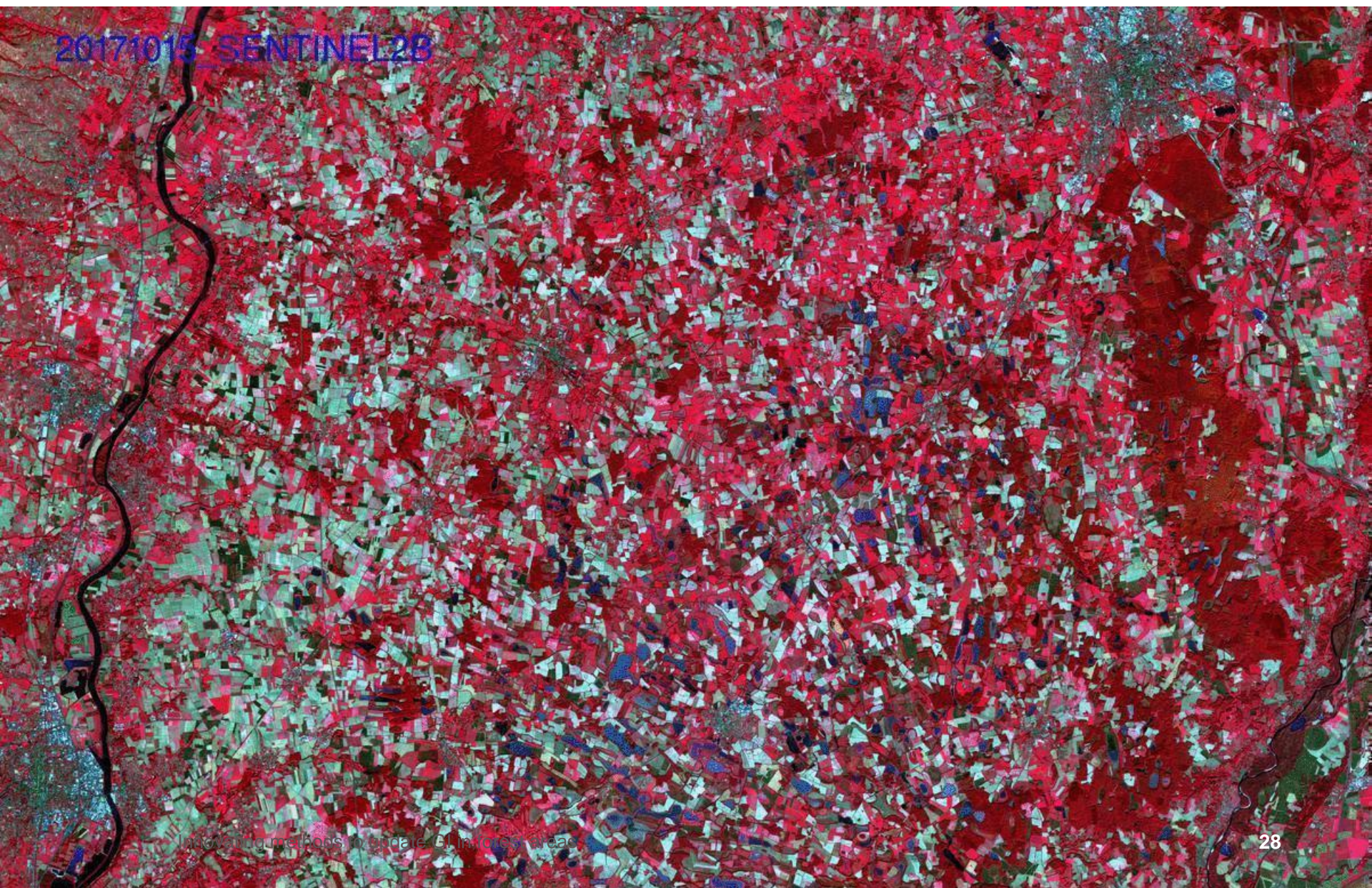
The national forest office (Office National des Forêts) is responsible for managing the French public forests (1/4 of the French forest surface).

- On the one hand, the ONF does not have any national forest database.  
→ Need for data describing forest stands (useful to implement forest layout and to manage the public forest)
- On the other hand, the IGN wants to improve its method to update the BD Forêt

**→ The ONF and the IGN are conducting experiments to assess the technical feasibility of a common database**

## 1. Federate the forest description data in France







20171024\_s1a\_asc

A Synthetic Aperture Radar (SAR) image from Sentinel-1, showing a wide river delta or estuary. The river channels are visible as dark, winding lines against a lighter, textured background of land. The image is characterized by a high level of detail and a color palette dominated by blues, greens, and yellows, typical of SAR imagery. The text '20171024\_s1a\_asc' is overlaid in the top left corner.

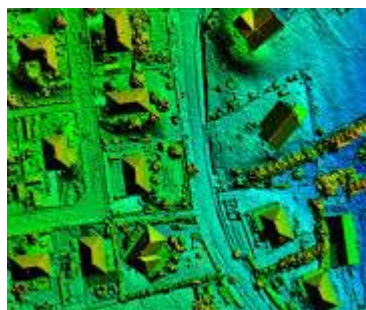


# TECHNOLOGICAL CONTEXT SUITABLE FOR AUTOMATING FOREST DATA PRODUCTION

## Plethora of images



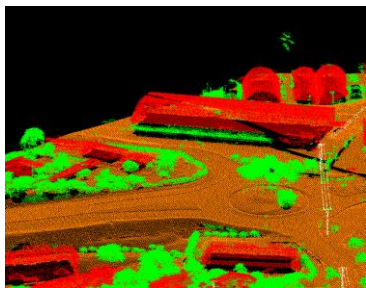
Aerial images



DSM



Spatial images



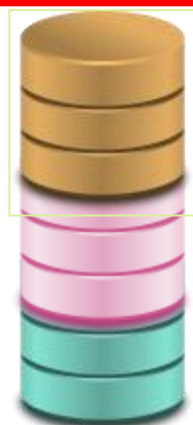
Lidar



Sentinel 2 images

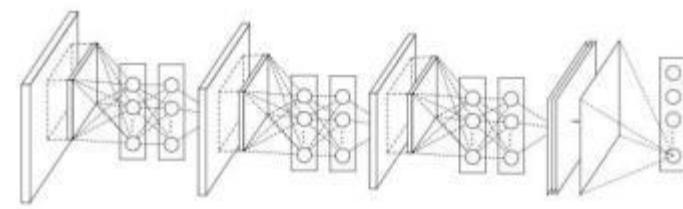


Sentinel 1 images



Existing geographic databases

## progress of image processing algorithms



Algorithms



Forest map (BD Forêt)



Collaborative methods



Manuel interaction

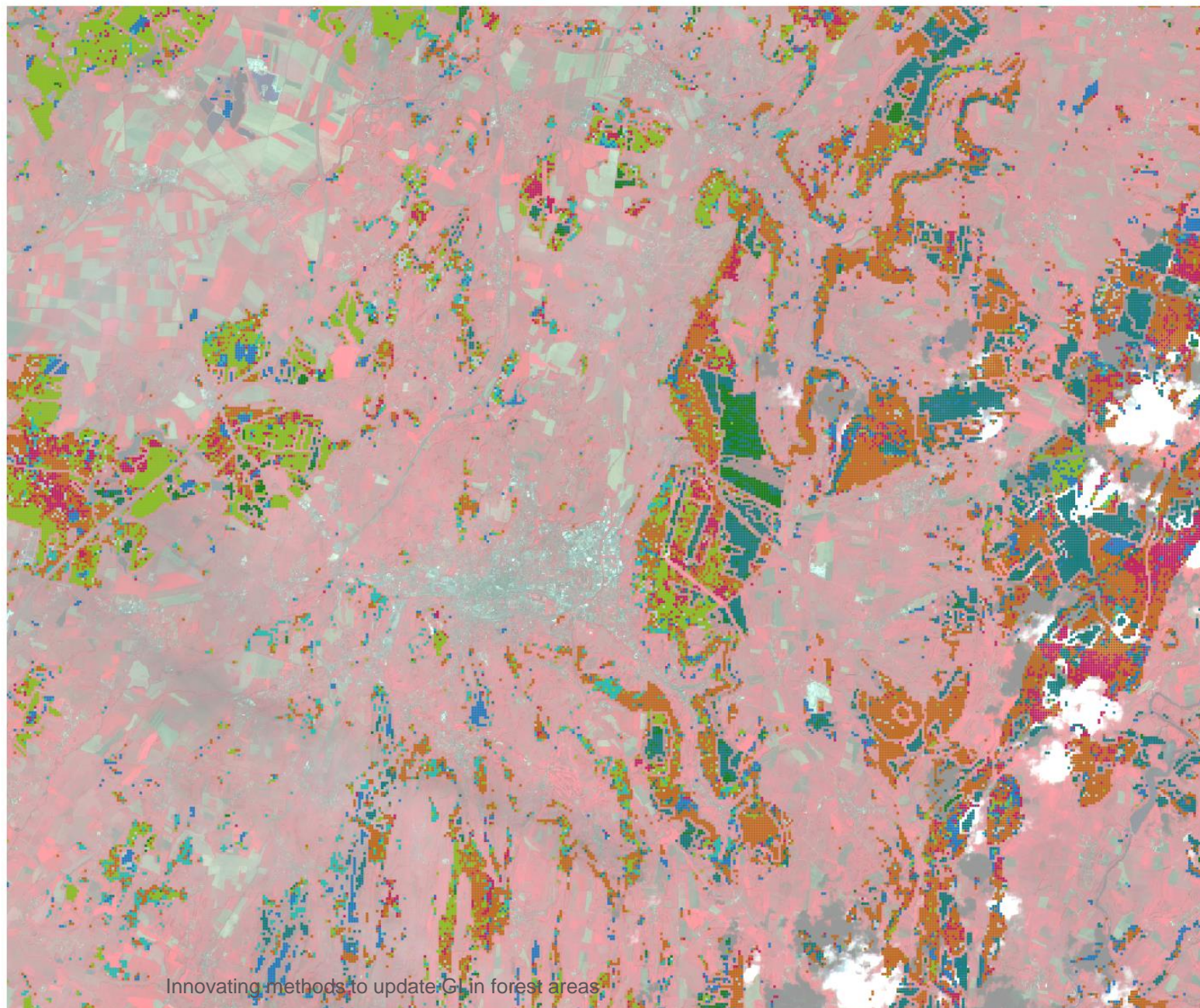
## community sourcing development

Innovating methods to update GI in forest areas



# SENTINEL 1 / SENTINEL 2 PROCESSING WITH DEEP LEARNING MODELS

GRU 24 2017  
avec dates  
& pondération



- oak
- beech
- chestnut
- birch
- poplar
- Robinia
- other deciduous
- douglas
- other conifers
- mixed

0 1 2 3 km

Example: discrimination of tree species (S1 / S2 - RNN)

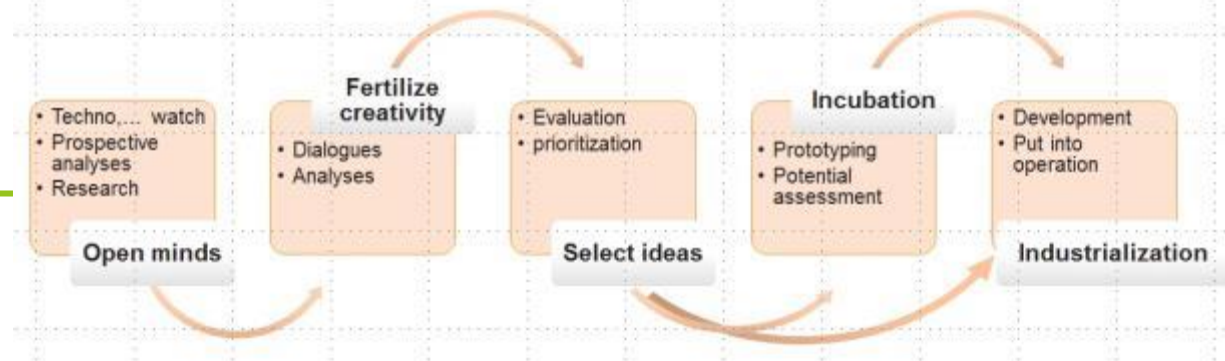
# OVERALL METHODOLOGY TO DESIGN THE METHOD TO UPDATE THE FOREST DATABASE

BD Forêt

1. Define metrics and methods to evaluate the results
2. Prepare the experimental zones; prepare all data for experiments on at least two vintages (eg :2013 and 2016)
3. Prepare training data for supervised learning methods
  - Extract of existing Forest database (BD Forêt)
  - Data from a partner like the National forest office
  - Basic image processing
  - Ad-hoc capture by a photointerpreter
  - Other...
4. Run, qualify and compare the mapping methods of a forest / non-forest mask + define a method for updating the outline of these masks between two vintages
5. Discrimination of tree species
6. Define the relevant manual interaction for a proper “quality/cost” ratio



# CONCLUSION



**The IGN must innovate in order to be able to respond to new challenges.**

BD Forêt

Statistical  
forest  
inventory

A new approach for the Forest Map :

- animation of a community of forest stakeholders that can contribute to the updating of the database
- automation of the database update by remote sensing (and Deep learning)

Already a powerful and accurate statistical inventory

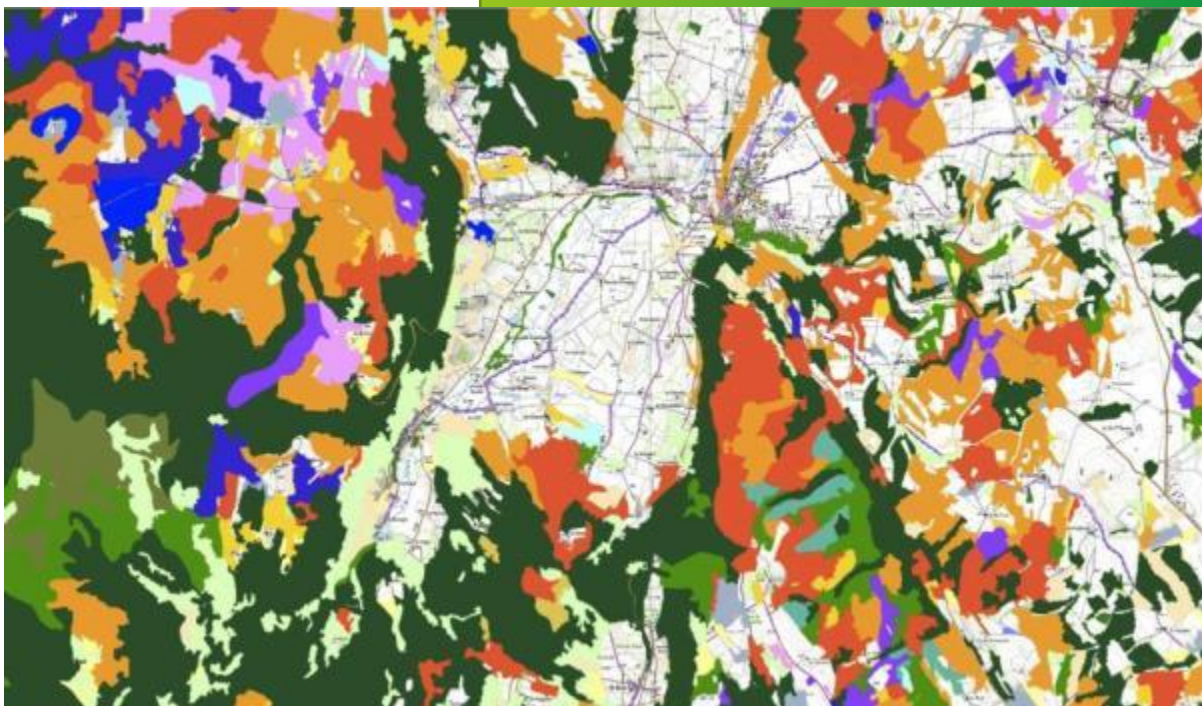
Towards a multi-source inventory (using more and more auxiliary information, often derived from remote sensing) to gain in efficiency, accuracy and flexibility.



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THANK YOU

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