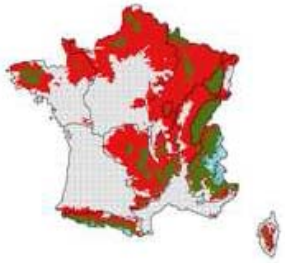
Testing new genetic resources for forest adaptation:

from pioneer realisations to the building of a national cooperative project

Coordination : nom prénom, organisme

Stakes

Beech



Pedonculate oak

2055, A1B
Arpège
Cheaib et al, 2012

- Bioclimatic situation of France : most major forest species are vulnerable
- Due to the relative poverty of the European flora, former introductions of alien species

⇒ **The active introduction of new forest resources appears as a key adaptation measure:**

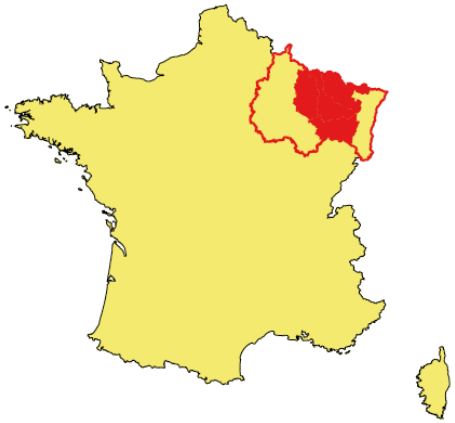
  - Assisted migration of provenances of species of autochthonous tree species or short distance species transport
  - New alien species introduction

→ Presentation of two pioneer projects and of the ongoing building of a national collaborative project

Seeking alternative species for future Lorraine forest

CNPF CENTRE RÉGIONAL DE LA PROPRIÉTÉ FORESTIÈRE GRAND EST
Office National des Forêts
Liberté • Égalité • Fraternité
RÉPUBLIQUE FRANÇAISE
MINISTÈRE DE L'AGRICULTURE DE L'AGRO-ALIMENTAIRE ET DE LA FORÊT
arbre
AFORCE
RMT Adaptation des forêts au changement climatique

An action undertaken by local forest managers



The Lorraine Region: a productive forest region

870 000 ha = 36 % of forested area (source IFN/IGN)
Public forests: 64 % , Private forests: 36 %
Semi continental climate: MAT : 9 to 10 °C and annual precipitation: 700 to 1000 mm at low elevations
Most important species (volumes): beech and oak at low altitudes; fir and spruce in montains
3.8 million m^3 harvested/yr and 24 000 jobs in timber industries.

Partnership between public and private forests

ONF and CNPF with financial support from DRAAF
Inclusion of results from previous national and regional projects
Frequent communications with national levels (consistency)

A three-level project

- Inventory of introduced species potentially interesting in the context of climate change.
- Experimental designs to monitor these stands
- **Species/provenance tests, plantations with non-native or unconventional species, potentially resilient to climate change.**

Vulnerability analysis

Climate change in the Lorraine region

+ 1.25 to + 1.85°C in 2050, + 2 to 4°C by the end of the century, depending on models (Aladin, LMDZ) and scenarios (B1, A1B, A2)

Uncertainty around future amount of precipitation => uncertainty around species suitability

Species-level approach

Predictions from Species Distribution Models (niche or process-based models)

-> Very high risk / high uncertainty for beech

-> High risk/high uncertainty for oaks

-> Very high risk / moderate uncertainty for Scots pine

-> Very high risk for spruce and high risk for fir in mountainous areas

Most sensitive environments where alternative species are sought

In case of drying scenario:

-> Beech forests on limestone plateau

-> Hydromorph mixed oak forests in plains and clayey plateau

(Species importance taken into account)

Choice of study-species

Using « nomades » tools (New methods for forest species acclimation)

IKS : climate envelope model defined by 3 limiting factors : total heat sum, winter cold, annual water balance

Nomades grid for species choice:

-Climate filter: analysis of species suitability under future climates
-Soil filter: resistance to clogging and active limestone
-Pests filter: discard vulnerable species
-Quality filter: integrating wood quality criteria

Additional literature review, analysis of previous plantation tests and expert knowledge

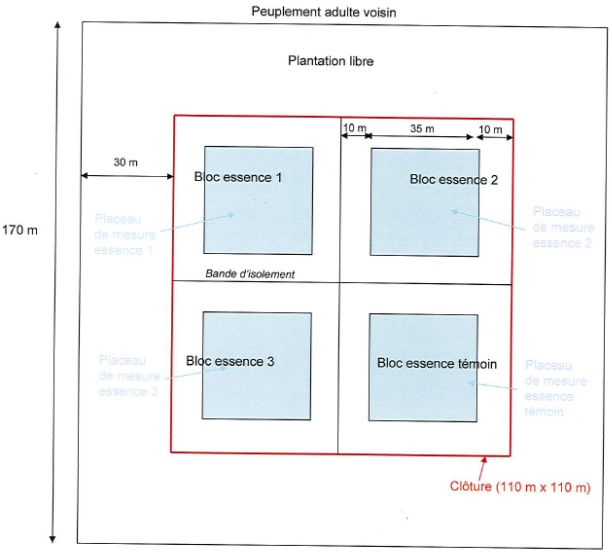
Species chosen for calcareous environments

-Fagus sylvatica 1-0G(FSY 201 NE): control
-Quercus pubescens 1-0G (Normandie)
-Abies bornmuelleriana 3-0g (VG Bostan)
-Calocedrus decurrens 1-0G (Northern California)

Species considered for clayey environments

-Quercus robur: control
-Pinus pinaster (! climate)
-Alnus rubra or cordata (uncertainty on wood quality and growth)
-Tillia cordata or platyphyllos (already present)

Experimental design (calcareous environment)



Plantation in FD de Haye

-Calcareous environment (high future risk, defined study-species,..)
-Typical calcareous station, relative spatial homogeneity
-Altitude : 350 m. Precipitation : 850 mm/yr.

Design

Plantation test without repetition (to be integrated in the national test network)
-4 monitoring plots 35 x 35 m (12,25 ares) with 10 m-isolation strips and 3m x 3m plantation spacing
-Choice of long-term monitoring
-Measurements : dendrometry, wood quality, diseases and pests

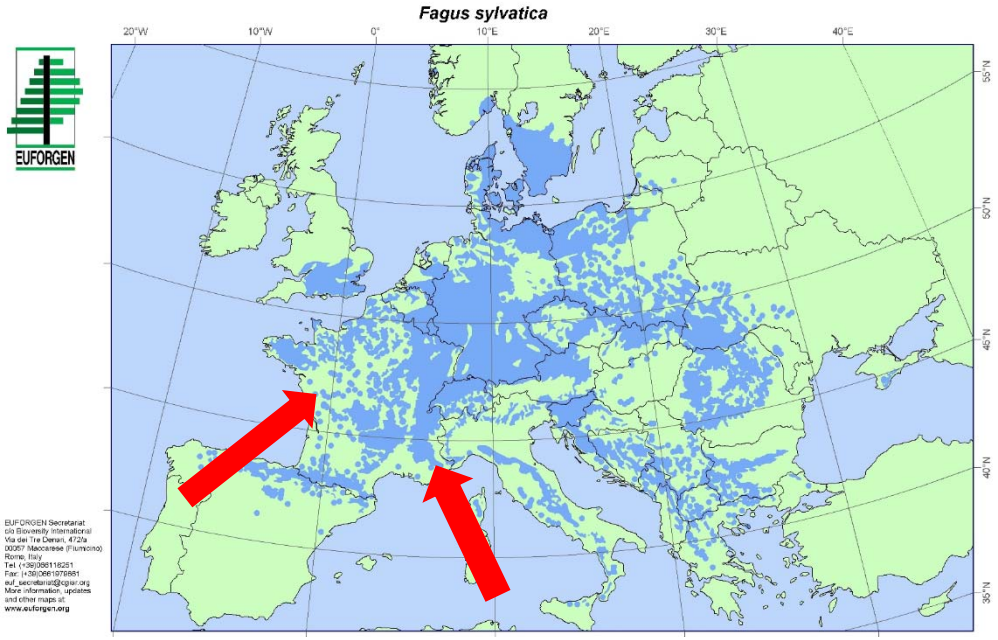
Implementation

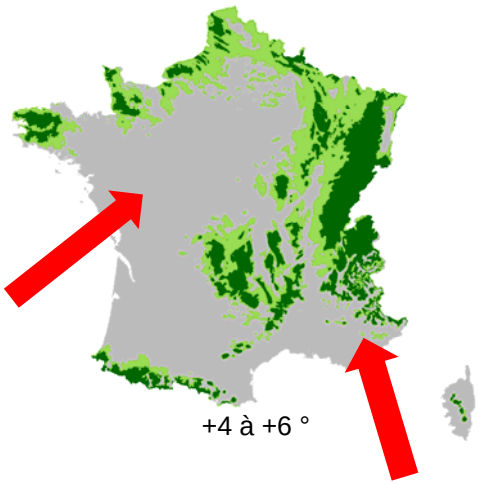
- Plants grown in the Guéméné Penfao experimental nursery
- Plants in buckets
- In-situ grinding of vegetation from previous stand and fencing (deer browsing)
- - Soil preparation with mini-excavator and plantation in winter 2016/2017
- Cost : 4 500 € (fence) + 3 600 € (plants/plantation) + 2 000 € (3 ha-grinding) = 10 000 €

NB : plantation of Quercus pubescens delayed to fall (plants not available)

GIONO Projet
…men who transplanted trees,
ONF (Brigitte Musch)

A the range boundary, original and threatened resources



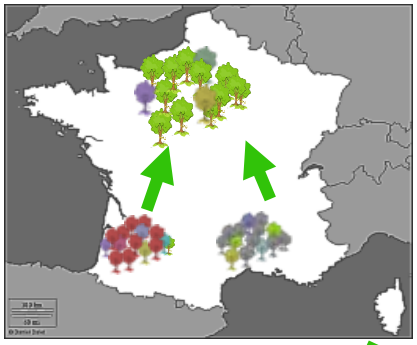


- Simulated drift the Beech climatic beech envelop: ~10km/an (Le Bouler 2015)
- Estimated Beech migration capacity: ~30 m/an

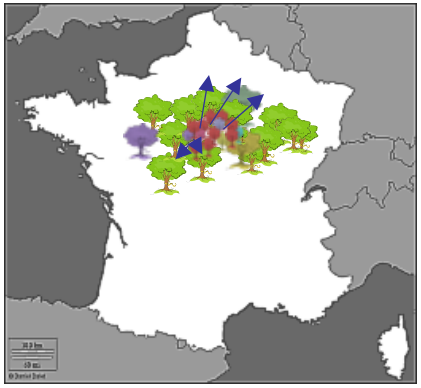
Giono: an action-oriented project

- Selection of threatened stands (4 fir stands, 4 oak stands, 6 beech stands)
- Seeds collection during 2 or 3 years
- Planting stocks production
- Plantation in the core area (in progress, 2 plantation campaigns achieved)
  - Provenances comparison test (marginal and local provenances)
  - For each provenance: 20 maternal progenies X 24 ind.
  - 4 repetitions
  - 1 site/essence, a 2nd one projected

Enrich the genetic diversity in order to increase the adaptive capacity



Assisted migration of resources adapted to a warmer-dryer climate = diversity enrichment



Spontaneous reproduction an hybridization

More resilient stand

Towards a national partnership network

Towards a national partnership network

- Emerging from experiences and thinking processes of Aforce members
- EXPRESS process (nov 2016-feb 2017) : 2 workshops, 5 working groups:
  - General framework
  - Forest material to be tested
  - Experimental design and monitoring protocols
  - Seeds and planting stocks supply, logistics
  - Data bases
- An ongoing call for innovative projects launched by Ministry of Agriculture (deadline : March 13th !)

=> **Ongoing building of a national global project, structured in 3 parts**

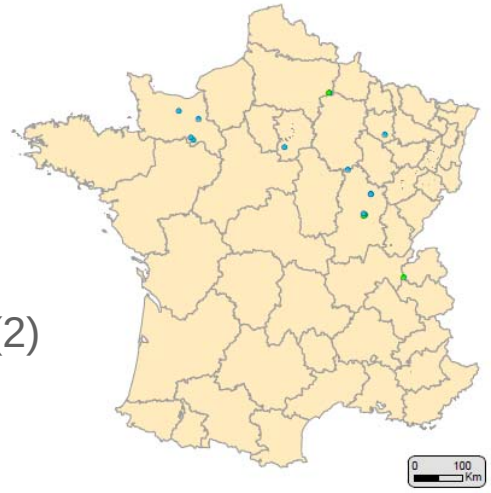
Part 1: Building of a long term partnership

- Core-group and monitoring committee (stakeholders),
- Consortium agreement definition → shared data base
- Development of a collaborative platform
- Strategy for knowledge sharing and practices improvement:
  - Targeting professionals and civil society
  - In a collaborative way of thinking

Part2: existing trials referencing and evaluation

(1)

(2)



- Pre-existing **experimental networks** of partners: meta-data collection and sharing
  - Ref. VALORESO project
- Referencing of **unconventional introductions** of species by foresters:
  - Lorraine survey -> ONF survey in public-owned forest -> extension to private forest
- Assessment of the performances of species introduced in **arboretums**

***Cedrus atlantica*:**
(1)Species trials of FCBA, INRA, CNPF, ONF and distribution according a thermic gradient (Pierangelo et al., 2015)
(2)Unconventional introductions referenced in public forest (intermediate results)

Initiate a consistent network of linked trials

Experimental nursery, Peyrat-le Château

- Identify (methodology) the productive system to be targeted: adaptation stakes = production stakes X vulnerability level
- Trials design, monitoring protocoles and sites selection:
  - Different types of trials:
    - Ex situ trials (young stages, controled conditions)
    - Simple performance forest trials
    - Species and provenances comparison trials
    - Reference stands in normally managed compartments (« Futur islands »)
- Identification of genetic resources to be tested
  - A common list per targeted productive system
- Seed collection or purchase, planting stocks growing
- Sites preparation and plantation

As a conclusion

- Thanks to these pioneer projects and many others we:
  - Learned about difficulties:
    - Lack of quantitative knowledge about species ecological requirements & limits of existing experimental network
    - Seed and planting stock logistics and search for homogeneous sites !
    - High costs of establishment and long term monitoring
  - tested and combined tools:
    - scenarios, models simulations, monitoring protocols…
  - Built a partnership, and a vision, collected ideas, eg:
    - Targeting vulnerable productive systems
    - Combining of different types of experimental design…etc
- Many remaining questions:
  - Social perceptions for example