Adaptation, mitigation & ecosystem services Challenges to sustainable management and research needs

Jean-François Dhôte
Office National des Forêts, Head of R&D Dept

Office National des Forêts

Impacts of global change are already observed

Quercus robur, Vierzon
(M. Legay)

Trends

- vegetation period : +10 d. between 1962 & 1995
- altitudinal shift of vegetation : + 66 m en 25 ans
- increasing productivity : + 20-50% since 1900

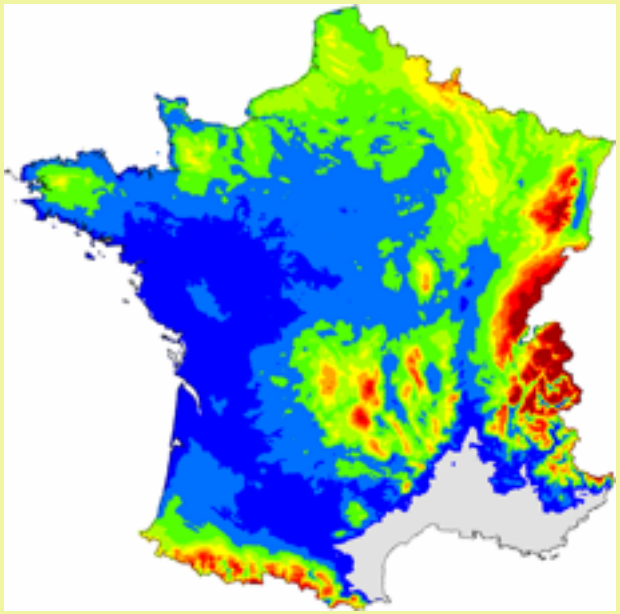
Crises of decadal importance

- **drought** : *Waldsterben* ; Tronçais, Vosges, Vierzon
- **storms** = main disturbance since 1950
- increasing gravity & geographical spread of **fires** : habitat security, human health & forest impacts (Portugal, Greece, Russia…)
- damage **sequences** and vulnerability of regional forest-wood chains : eg Aquitaine (Martin + Klaus + moth + bark beetle)

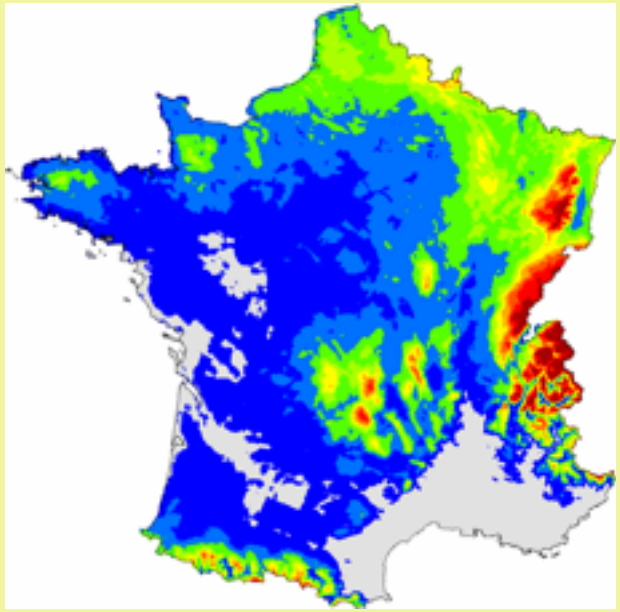
Climate change & sustainable forest management

- **Mitigation** : how can forest management **contribute** to reduce GHG emissions, by using timber ?
- **Adaptation** : how to adapt management options **now**, in ordre to provide the required services **tomorrow** (prevention, diversification, crises management, logistics, planning, R&D) ?
- **Ecosystem services** : how to achieve the quality, **continuity**, coherence and compatibility of the different services ?
- Is there a **convergence** of the options for mitigation *vs* adaptation ? If not, how to increase it, what trade-offs are feasible ?
- How to make decisions in a situation of increased **uncertainty** (no regret options, reversible pathways, spatially distributed panels of options, dead-ends, increasing **adaptive capacity**) ?
- **Education and continuous training** : sharing experiences, updating knowledge, **hierarchy of messages** and perception of challenges

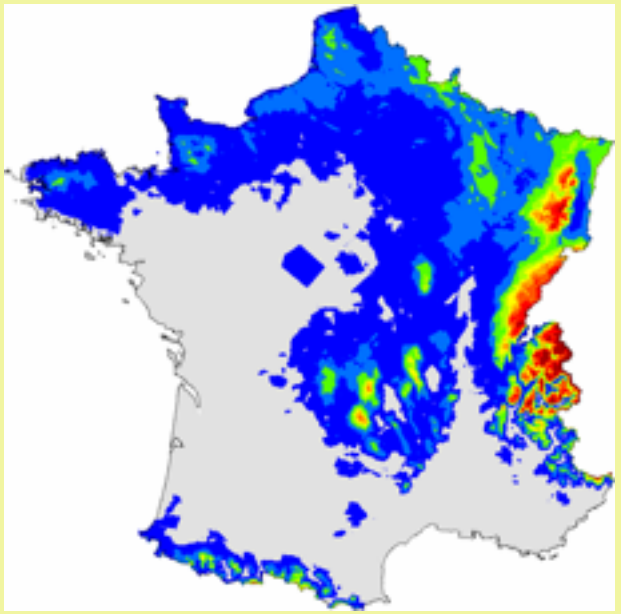
Converting lowland Beech forests



Present



estim. 2050



estim. 2100

Source : Badeau et al. (2010) : niche climatique actuelle et estimée sous scénario B2

Short-term dynamics ≠ long-term prognosis

Management option in lowland forests : shift to other species, keep Beech as secondary species, control deer browsing, favour even-aged management

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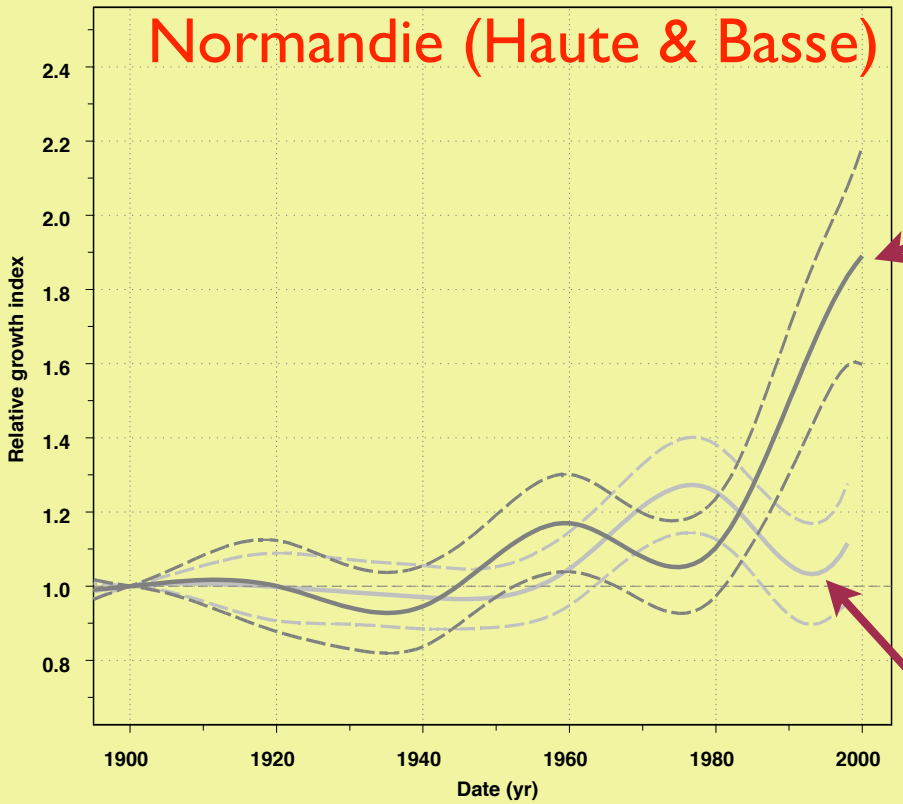
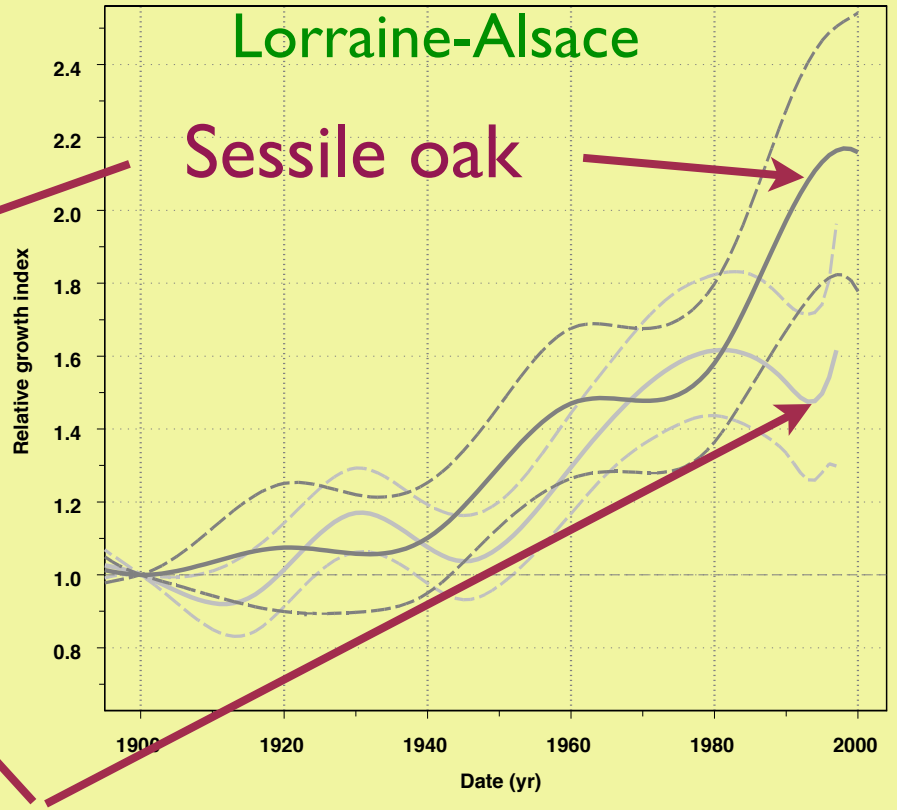
Relative competitivity of species and mixture management





Beech

Source : Bontemps et al., Oikos, 2011

Contrasted requirements (t° and water) of species

Oak : strong ++ response to recent warming

Vegetation response to climate forcing : lag in lowland forests

LETTER

doi:10.1038/nature10548

Changes in plant community composition lag behind climate warming in lowland forests

Romain Bertrand[1,2], Jonathan Lenoir[3], Christian Piedallu[1,2], Gabriela Riofrío-Dillon[1,2], Patrice de Ruffray[4], Claude Vidal[5], Jean-Claude Pierrat[1,2] & Jean-Claude Gégout[1,2]

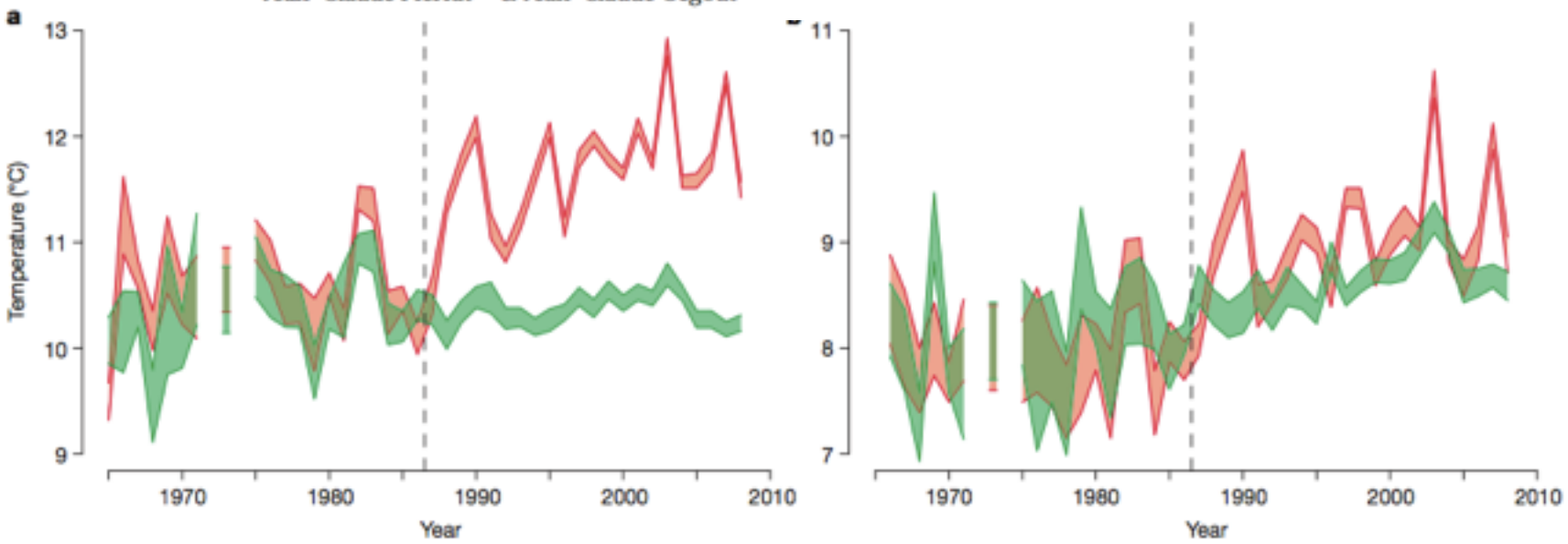


Figure 2 | Comparison of floristically (green) and climatically (red) reconstructed temperature trends between 1965 and 2008. **a**, Trends in lowland forest plant communities (<500 m a.s.l.). **b**, Trends in highland forest plant communities (500–2,600 m a.s.l.). The thickness of lines shows the range of reconstructed temperature trends (n = 1,000 trends). Dashed lines indicate the start of the contemporary climate warming period (1987–2008). Breaks in trends are due to no sample convergence for the years 1965 (in highland areas), 1972 and 1974 (in both lowland and highland areas).


Sequence of hazards : windthrow-drought-fire-bark beetles
heavy loss of volume & carbone,
degraded protection service
(Chablais, 1999-2003-2011)


Rationale :
enhance regeneration, in order to :
- prevent massive forest damages
- increase adaptive capacities
- secure quality & continuity of ecosystem services

Present guidelines for adaptation (ONF, 2009)

- **Shorter rotations, active management**
  - harvest younger & smaller (in height) : less vulnerability to storms
  - heavier thinnings : reduce water uptake and drought stress
  - favour continuous genetic adaptation (selection of resistance)
- **Adapt species, diversify mixtures**
  - oaks, black locust, chestnut ; pines, douglas, cedar, mediterranean firs
  - save remarkable populations on rear end (genetic resource mngt)
  - assisted migration : introduce southern provenances
- **Stabilize ecosystems, conserve senescent stages**
  - restore the forest-wildlife balance (prevent selective browsing)
  - liming : restore the fertility of poorest/impoverished soils
  - protect µ-habitats with high diversity (CWD, senescence, reserves)

R&D needs for adaptation to CC

- **Social & human sciences, economics**
  - perceptions of land-use, species change, harvest intensification
  - perceptions of degraded forests/services, large dieback crises (incl. human health impacts)
  - landscape and regional resource models as negociation tools
  - how to fund specific investments for adaptation ?
  - scenario analyses on payment of environ. services, wildlife control
  - viability domains of silviculture under combined risks
- **Conservation issues**
  - optimisation of deadwood retention : biodiversity, protection, fires, security
  - favour ecological connectivity or set barriers to fight against pests?
  - robustness of Natura2000 network in the light of CC ?

R&D needs for adaptation to CC

- **Management planning and species choice**
  - localized estimates of climate change ; t°, rainfall, windiness
  - new protocoles for (adaptive) site description
  - remote sensing and continuous forest inventory
  - species portfolio : how many species ? at what scales to diversify ?
  - species choice : timber uses, productivity, drought-storm-biotic risks, water and nutrient use efficiency ; which new species ?
  - planning methods : when to change species ? to what extent ? spatial optimization ; association of short and long rotations
- **Genetic improvement and silviculture**
  - breeding : varieties to optimize performance/resistance
  - mechanical solutions for : plantation, soil preparation, low-impact logging
  - mixtures : which combinations of species ?
  - nutrient budgets, guidelines for liming or ash return

Diversity of drivers to take into account in decision-making

- **Climate and pollution**
  - trends, cycles, fluctuations ; future N-deposition ?
- **Land-use change**
  - here and abroad (eg emissions embedded in imported goods…)
- **Timber markets**
  - solid wood, fibres, wood chemistry, energy
  - competition with other resources and between wood uses
- **Silvicultural and harvesting systems**
  - species introductions ; plantations ; soil management
- **Ecology**
  - gradual shifts and disturbances, genetic diversity
  - conservation policies