Climate change and forest genetic resources (FGR): state of knowledge, risks and opportunities

Bruno Fady, Judy Loo, Ian Dawson, Barbara Vinceti, Julia Baldinelli

Climate change and forest genetic resources (FGR): state of knowledge, risks and opportunities

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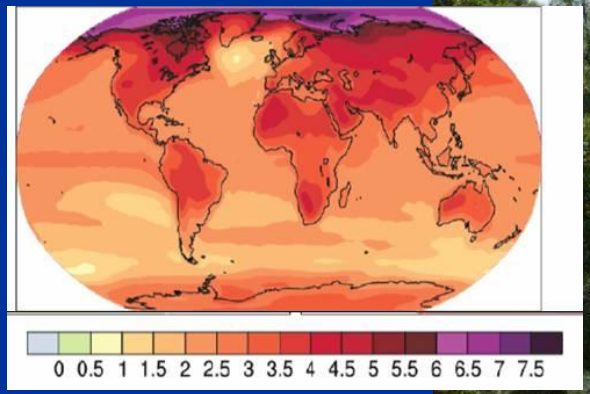
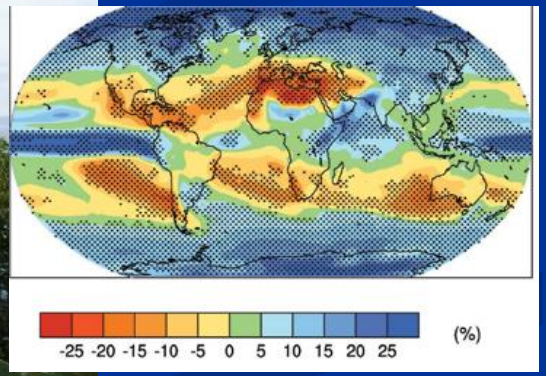
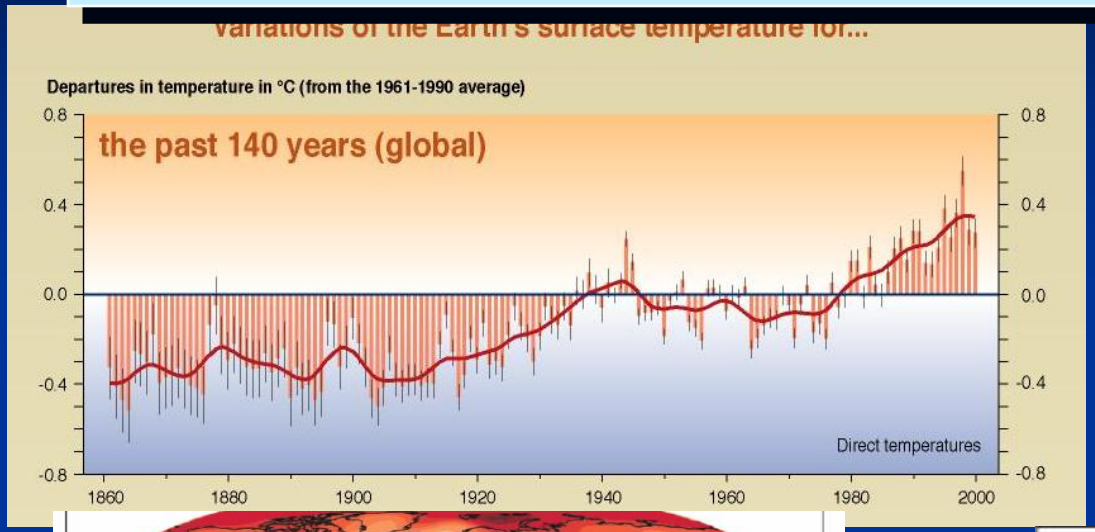
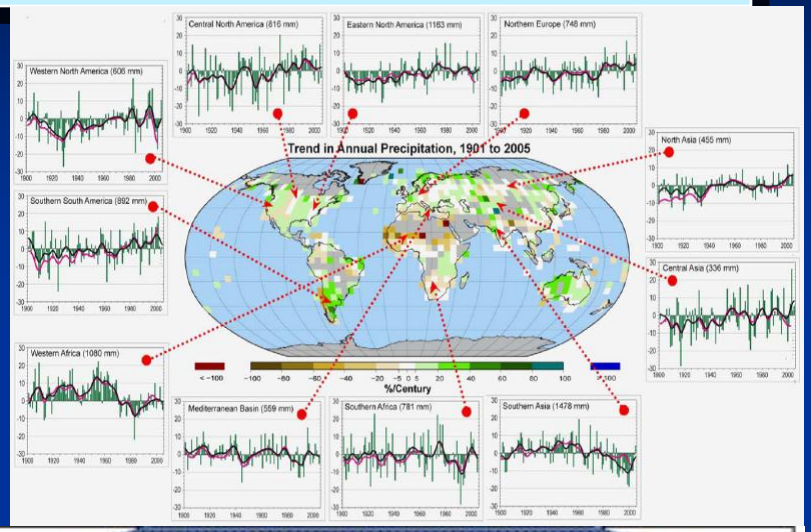


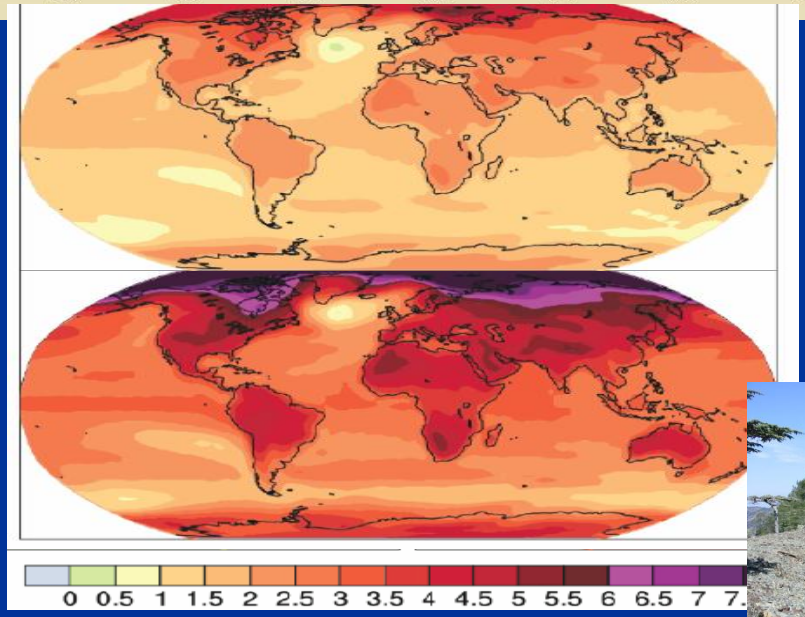


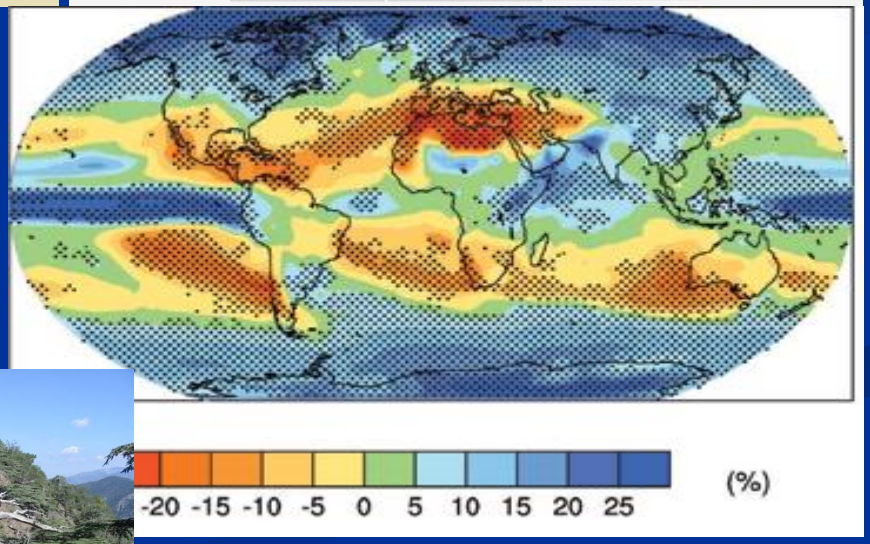
CGRFA Seminar, FAO, Rome, Italy, 16 July 2011

Climate change is here and now! It has happened and is predicted to continue to do so.









http://www.ipcc.ch/graphics

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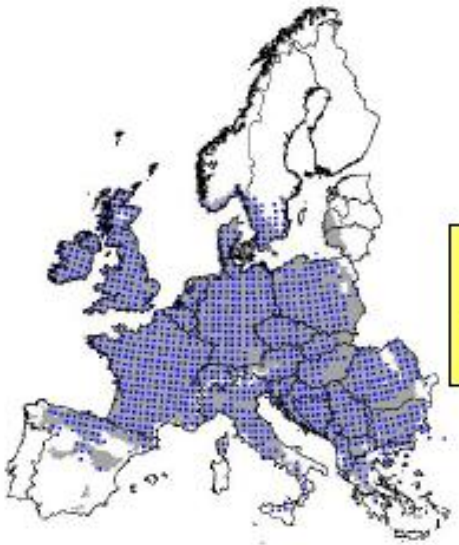
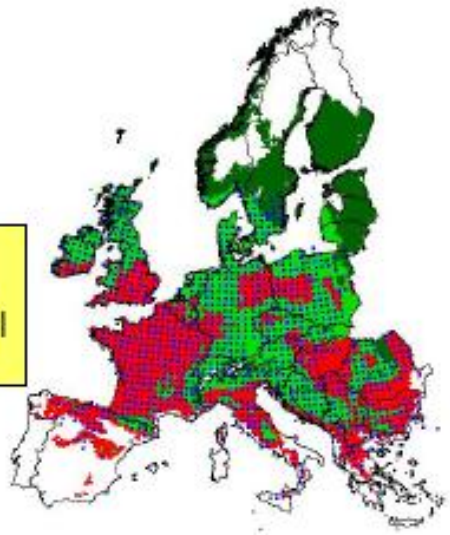
Climate change will modify the location of suitable bioclimates for tree species



Current Distribution
simulated using BIOMOD

- **Observation**
- Simulation

Project future climate
Climate model - HadCM3
Greenhouse gas emissions model - A1FI



Future Distribution: 2080
simulated using BIOMOD

- **Loss of habitat**
- **Stable habitat**
- **Gain of habitat**

Quercus petraea, Thuiller GCB 2003, Thuiller et al. PNAS 2005

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Opportunities offered by FGR for trees to cope with climate change

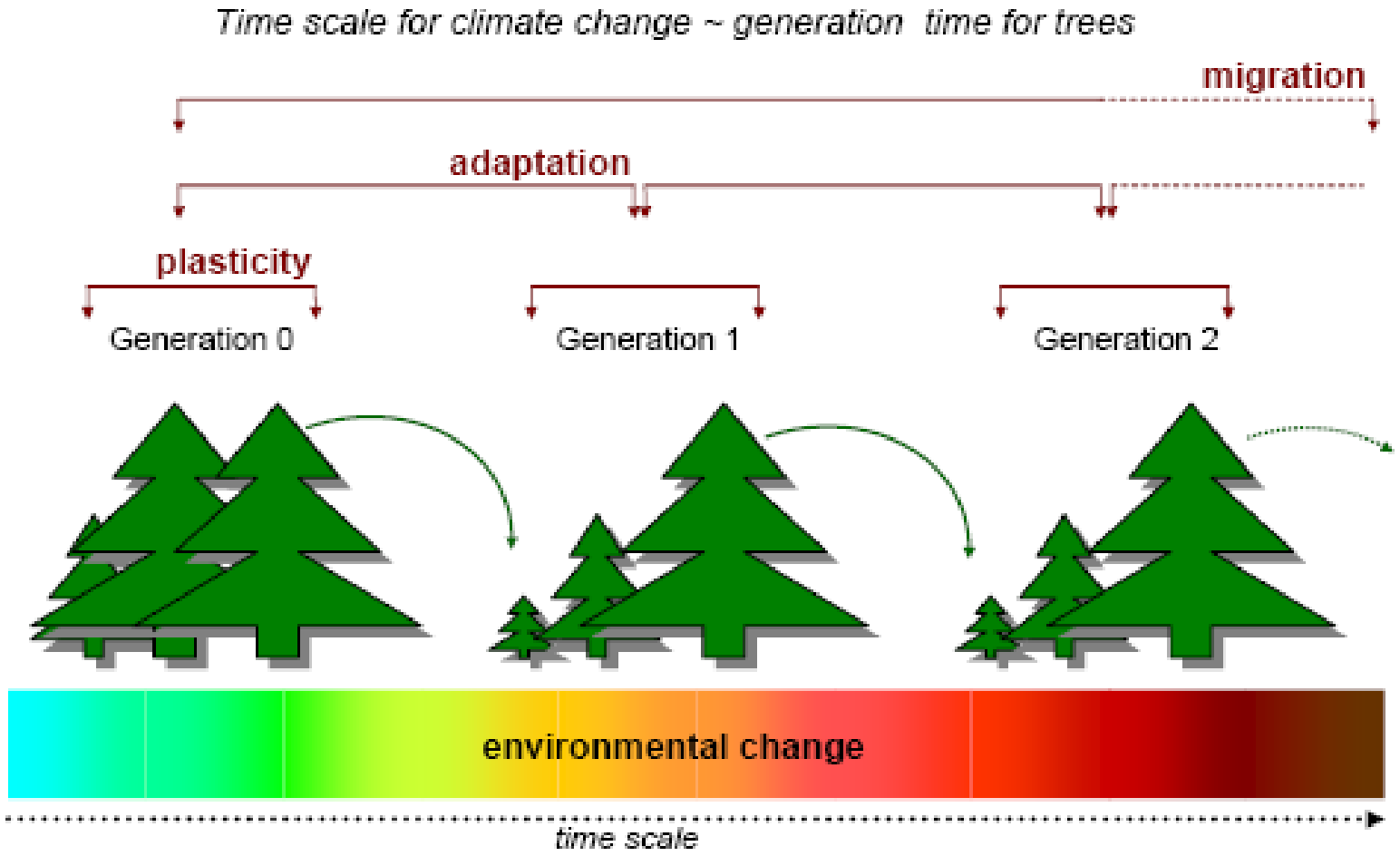
Trees (mostly undomesticated, with high genetic diversity) have 3 mechanism for responding to climate change:

- **Phenotypic plasticity / acclimatization** (trees will continue to survive, grow and reproduce locally because their biological requirements are flexible)

- **Adaptation** (selection of the best fitted progeny)

- **Migration** through seed and pollen dispersal (regeneration under friendlier environments after long distance dispersal or hybridization)

Opportunities and risks offered by FGR for trees to cope with climate change: A question of time and space



(*Lefèvre et al., unpublished*)

Phenotypic plasticity: gaps in knowledge and priorities for action

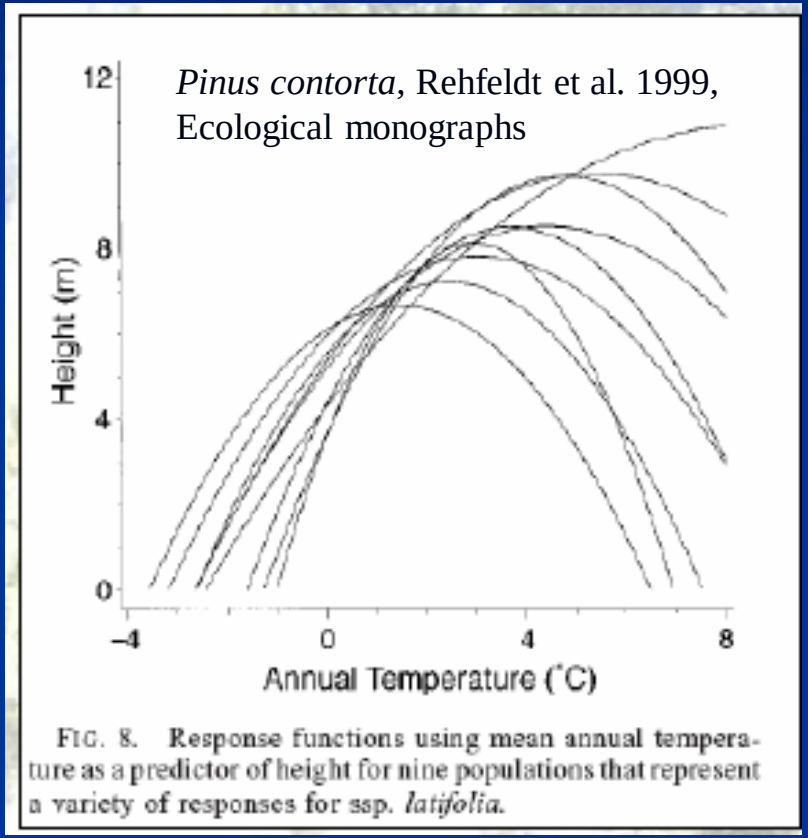


FIG. 8. Response functions using mean annual temperature as a predictor of height for nine populations that represent a variety of responses for ssp. *latifolia*.

Phenotypic plasticity under increasing temperature: yes… but **up to a certain point !!**

The unknowns:

- Geographic distribution of species;
- Underlying genetic basis of phenotypic plasticity (epigenetics).

Priorities for action:

- Inventories (including remote sensing);
- Provenance trials / reciprocal transplants including marginal populations;
- Using larger genotypic portfolios in plantation forests.

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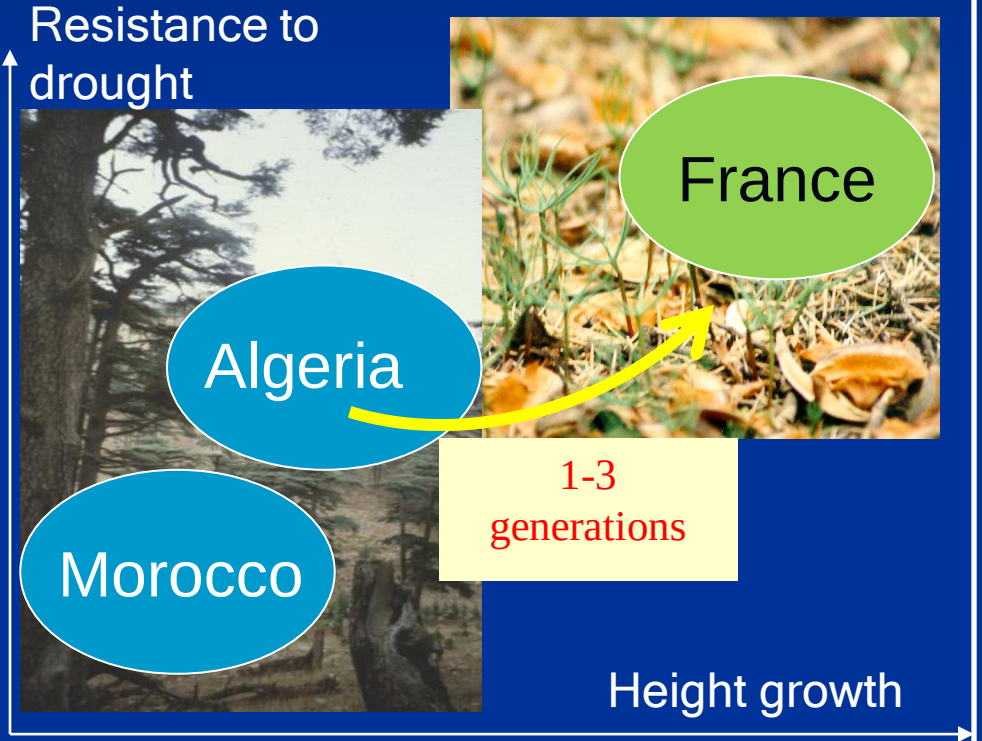
Adaptation (genetic): gaps in knowledge and priorities for action

(*Lefèvre et al., in prep*)



Adaptation and gene flow under strong selection pressure… **a (relatively) fast mechanism**

The unknowns:

- Correlation between traits;
- Fragmented landscape effects;
- Genomics of adaptation and reproduction.

Priorities for action:

- Development and analysis of common garden trials / conservation units;
- Science-based conservation strategies in high priority areas;
- Breeding programs with larger genetic basis and traits.

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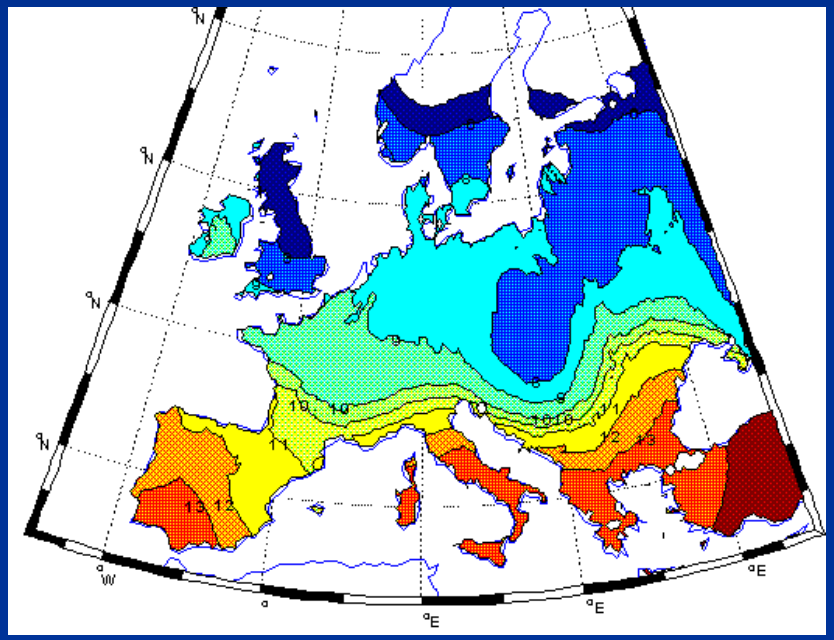
Migration: gaps in knowledge and priorities for action

European oak isochronal pollen map
(www.pierroton.inra.fr/Fairoak/)



Migration can be fast (500 m / year during the last 12000 years in Europe… **fast enough?**

The unknowns:

- Cryptic refugia;
- Fragmented landscape effects;
- Reproduction and LDD.
- Community effects of migration.

Priorities for action:

- Valuating “conservation” actions;
- Assisted migration and gene flow;
- Maintain and manage marginal populations;
- Germplasm characterization, conservation, multiplication and delivery.

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FGR and climate change: risks, opportunities and already some tools for action

Trees can naturally:

- acclimatize through phenotypic plasticity,
- adapt under natural selection,
- migrate to more suitable locations…

… but with some limitations!

FGR under "adaptive" forest management are an asset to alleviate ("option value") these limitations.