# Climate change and forest genetic resources (FGR): state of knowledge, risks and opportunities
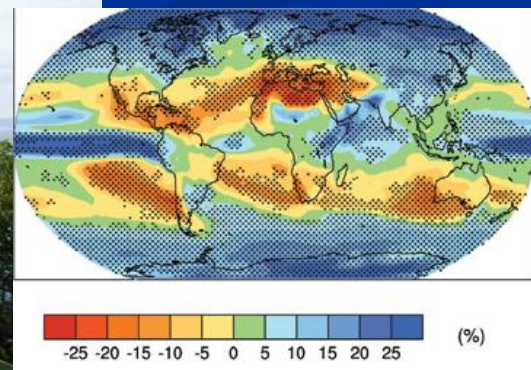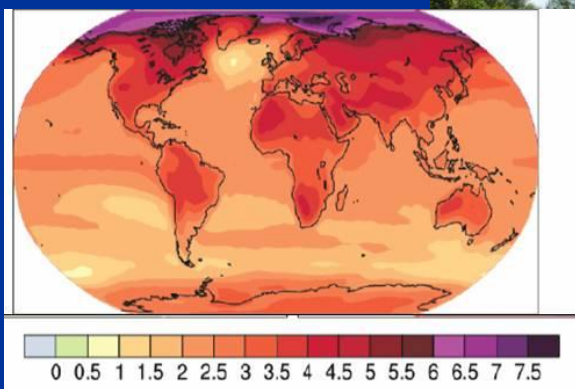
**Bruno Fady**
INRA – URFM, Ecologie des Forêts Méditerranéennes, Avignon

**Judy Loo, Ian Dawson, Barbara Vinceti and Giulia Baldinelli**
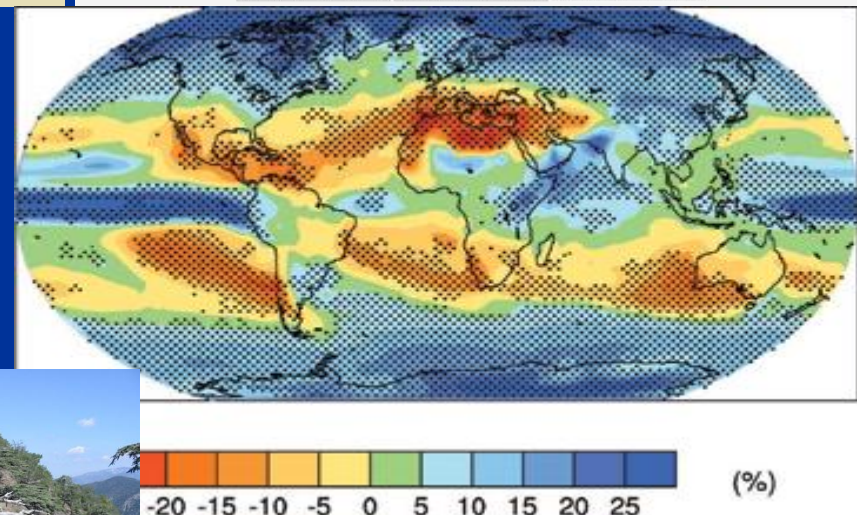Bioversity International, Rome, Italy
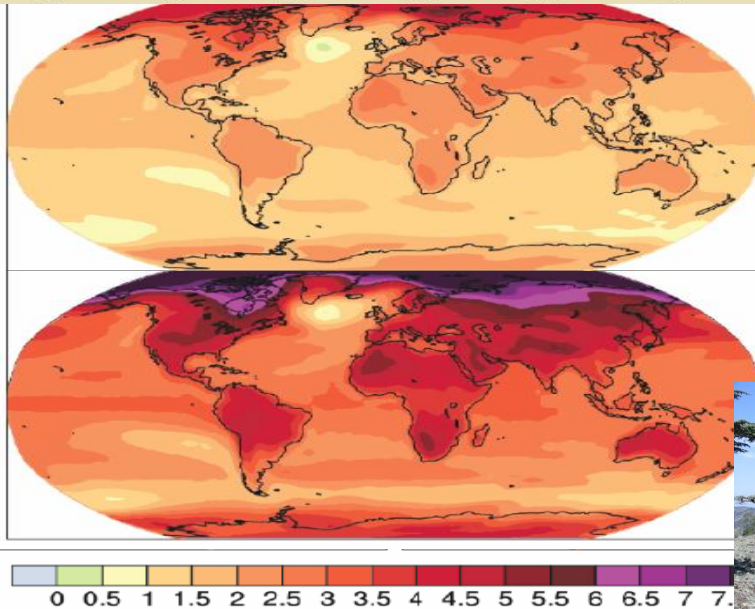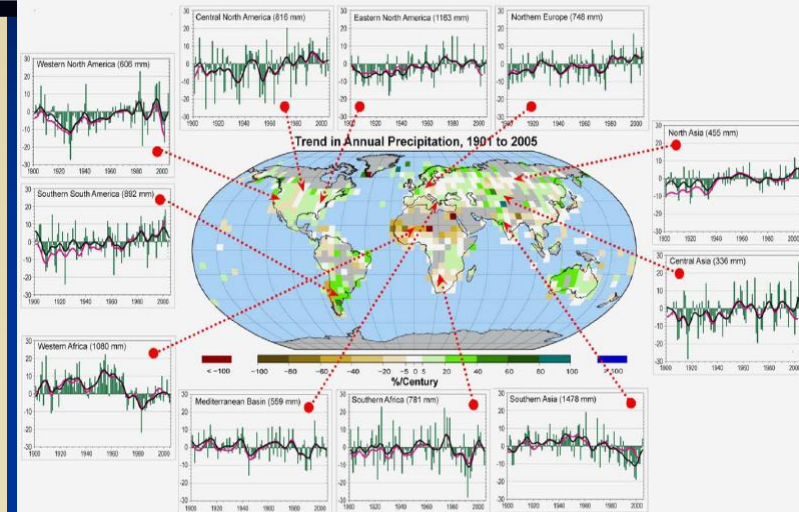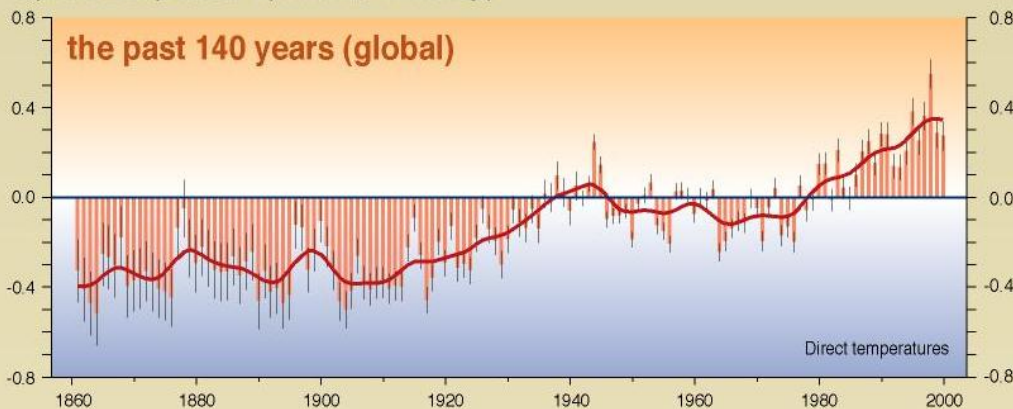World Agroforestry Centre (ICRAF), Nairobi, Kenya

*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.*

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



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

**Current Distribution**
simulated using BIOMOD

- Observation
- Simulation

**Future Distribution: 2080**
simulated using BIOMOD

- Loss of habitat
- Stable habitat
- Gain of habitat

*Quercus petraea*, Thuiller GCB 2003, Thuiller et al. PNAS 2005
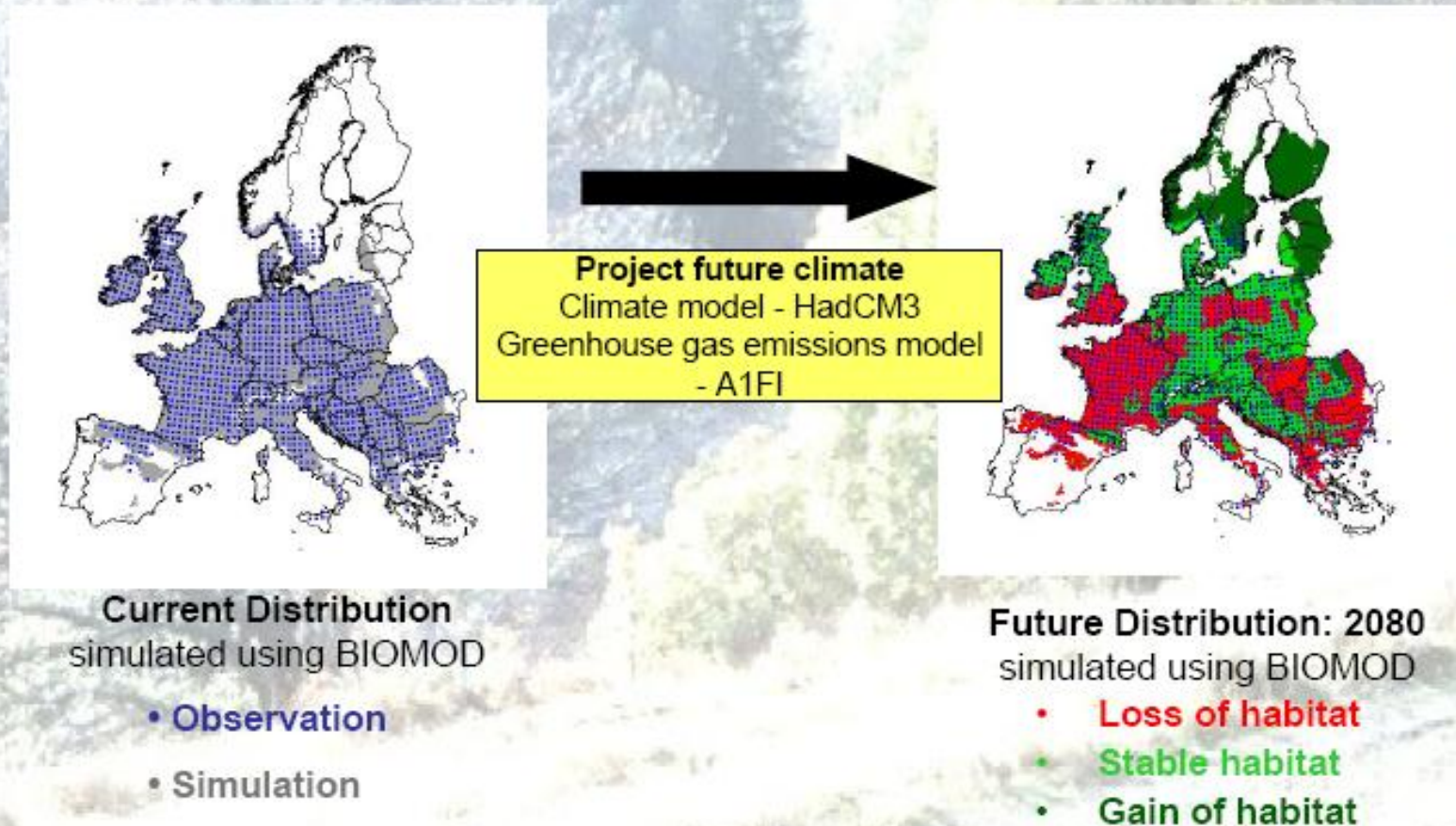
## Opportunities offered by FGR for trees to cope with climate change

Trees (mostly undomesticated, with high genetic diversity) have 3 mechanism for responding to climate change:
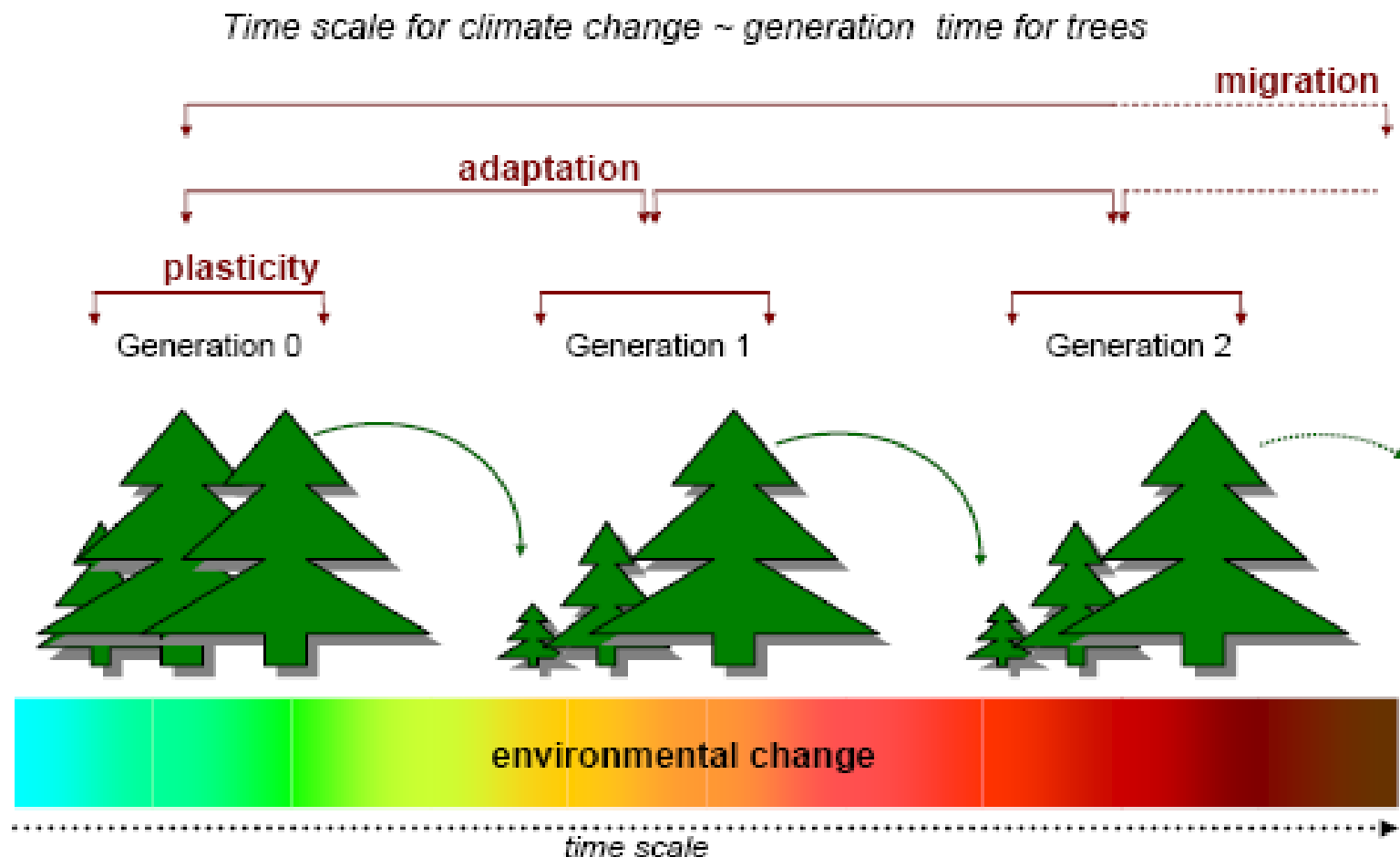
- **Phenotypic plasticity / acclimatization** (trees will continue to survive, grow and reproduce locally because their biological requirements are flexible)

- **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



Time scale for climate change ~ generation time for trees

migration

adaptation

plasticity

Generation 0    Generation 1    Generation 2

environmental change

time scale

# *Phenotypic plasticity: gaps in knowledge and priorities for action*

*Pinus contorta*, Rehfeldt et al. 1999, Ecological monographs

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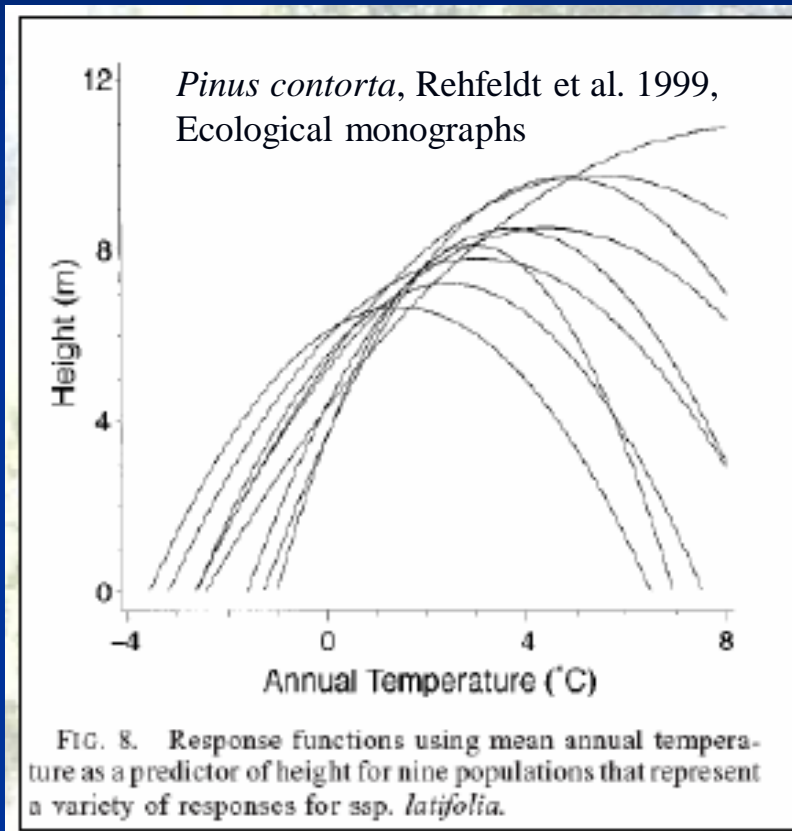
Phenotypic plasticity under increasing temperature: yes… but **up to a certain point !!**

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*)

Resistance to drought
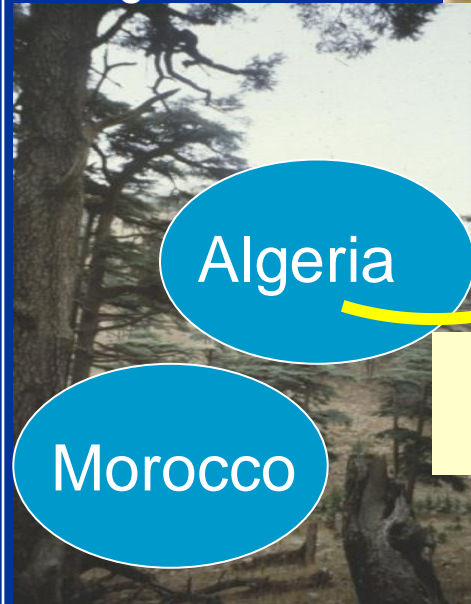
France

Algeria

Morocco

1-3 generations

Height growth

Adaptation and gene flow under strong selection pressure… **a (relatively) fast mechanism**
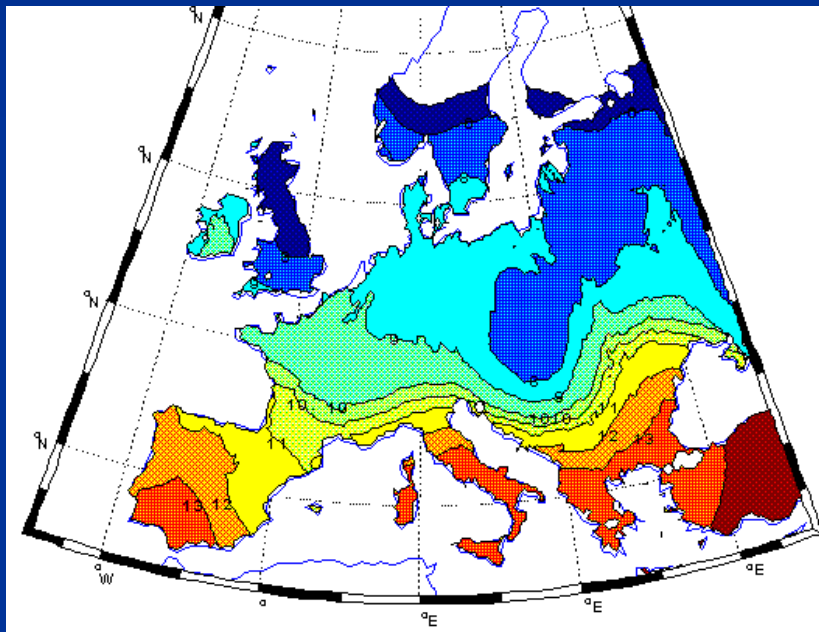
The unknowns:
- Correlation between traits;
- Fragmented landscape effects;
- Genomics of adaptation and reproduction.

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.