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

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

http://www.ipcc.ch/graphics
Climate change will modify the location of suitable bioclimates for tree species.

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 mechanisms 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(Lefèvre et al., unpublished)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

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.

Phenotypic plasticity under increasing temperature: yes... but up to a certain point!!
Adaptation (genetic): gaps in knowledge and priorities for action

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.

Adaptation and gene flow under strong selection pressure... a (relatively) fast mechanism
Migration can be fast (500 m / year during the last 12000 years in Europe... fast enough?

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

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.
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.