# Influence of climate change on the natural distribution of tree species

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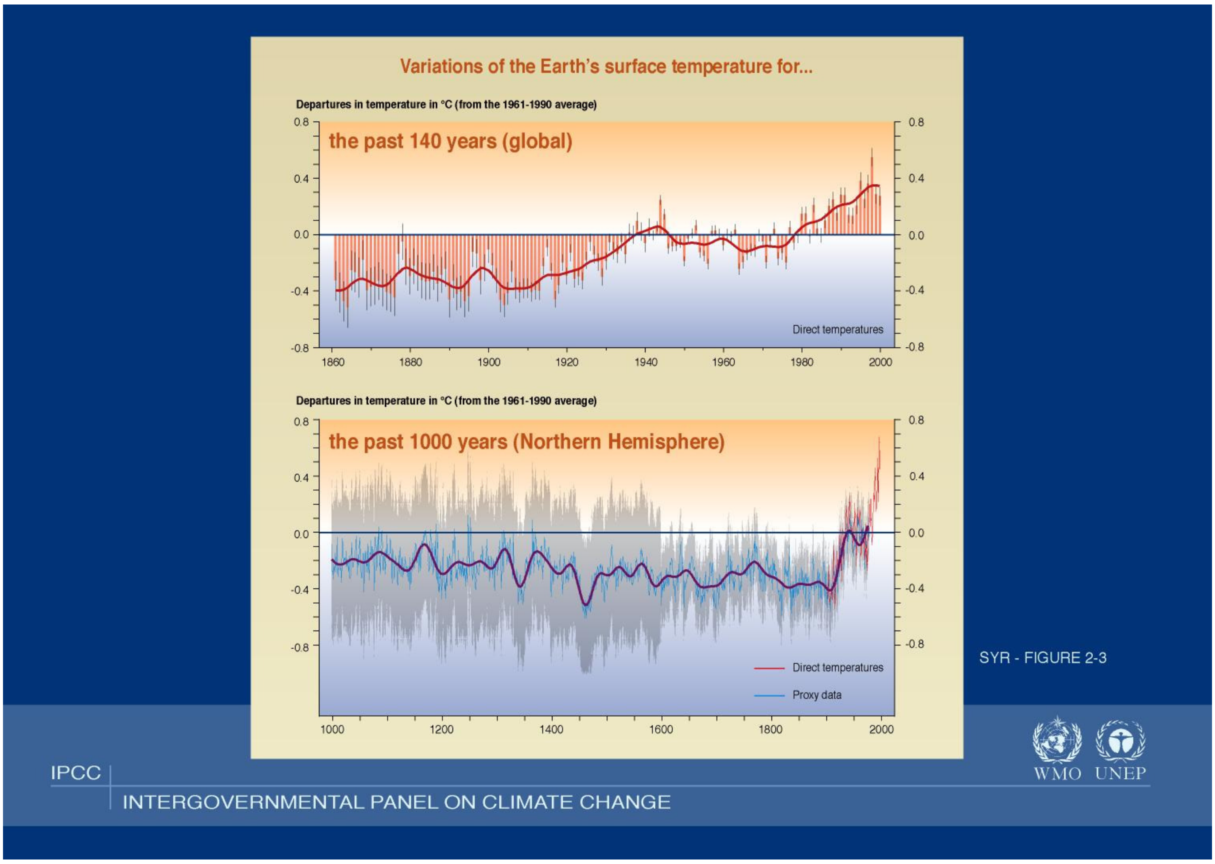
## Summary

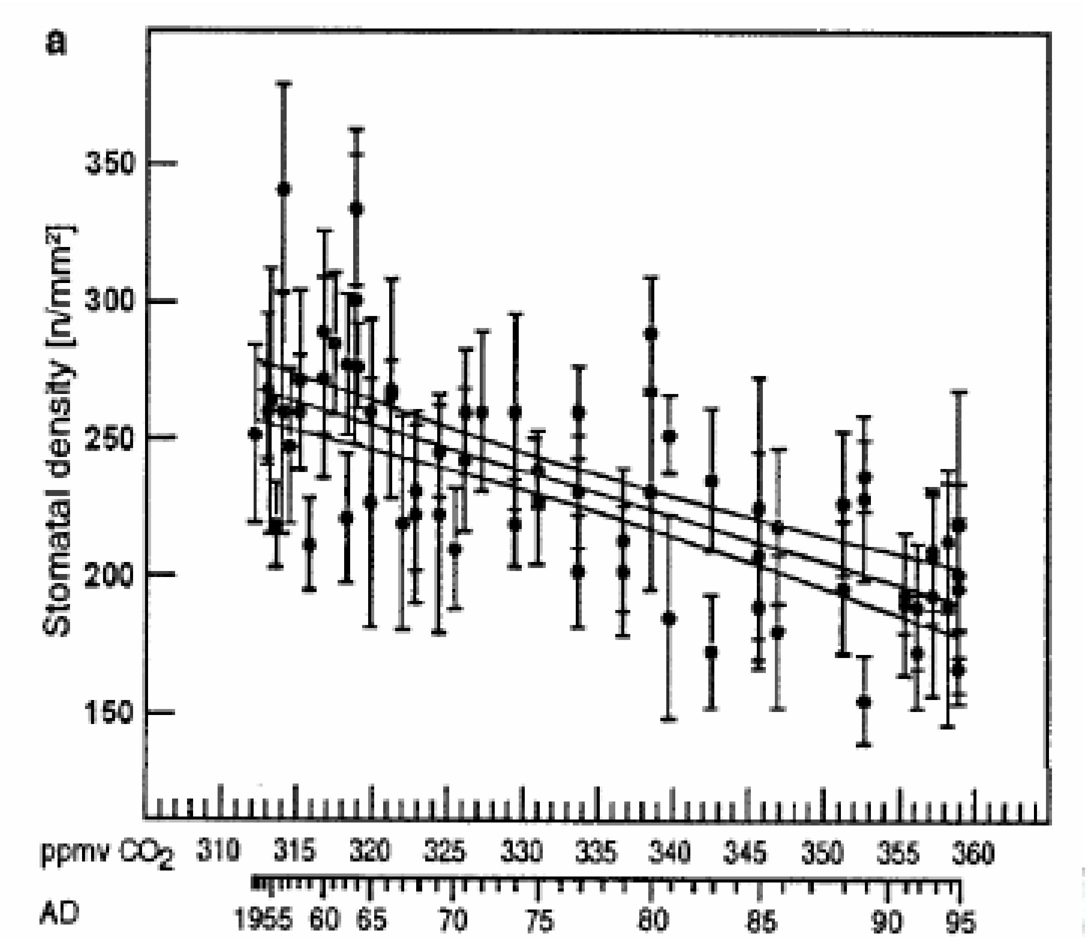
Climate change is now a reality we have to face. Temperatures have been rising worldwide for the last 150 years (figure 1) and all models predict that this increase in temperature will continue (up to several degrees) for several centuries. Strong modifications in rainfall patterns are also expected, as well as an increase in extreme events such as heat waves and late spring frosts. These strong climatic modifications will have an effect on trees, but to what extent is really not entirely predictable as climate change scenarios are still coarse at the local scale and much is still to be learnt on tree and forest ecosystems response to such changes.

Figure 1. Variation of Earth's surface temperatures in the past 140 years worldwide (top panel) and the past 1000 years in the Northern Hemisphere (bottom panel).



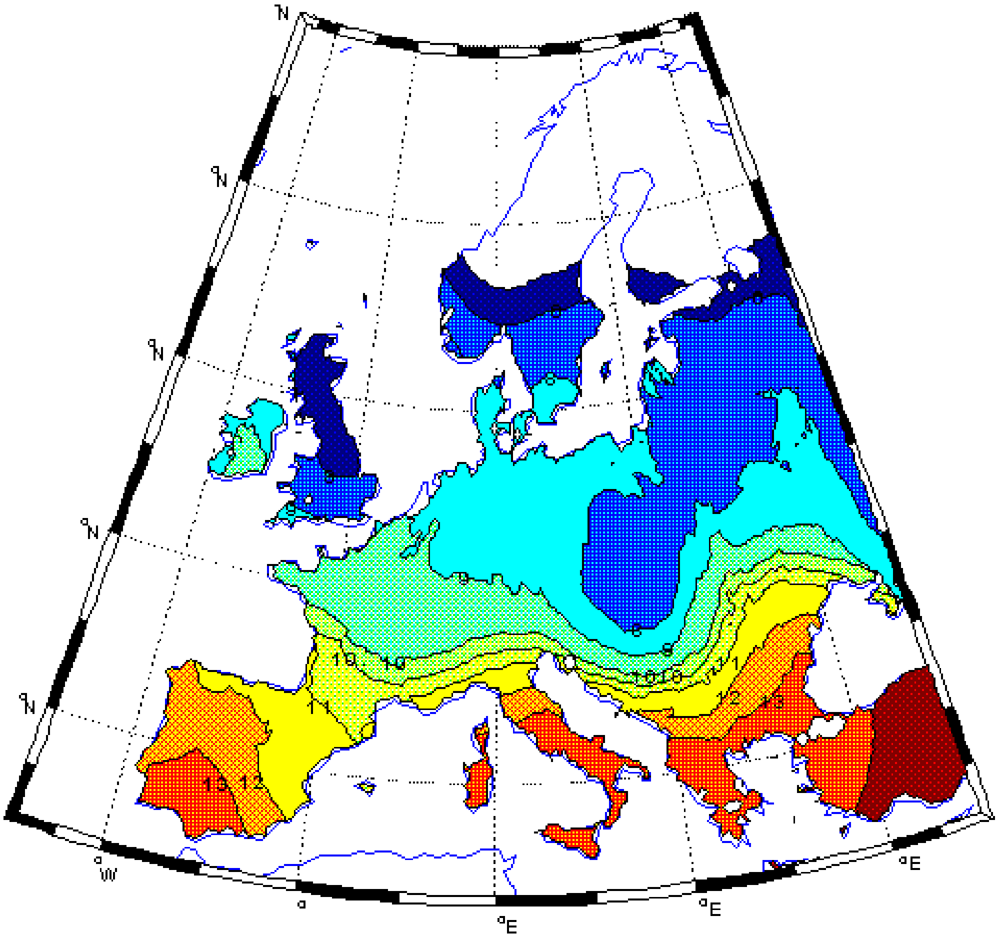
Plants can use three mechanisms to face any ecological change:
- Acclimatization (because of phenotypic plasticity, survival, growth and reproduction is possible locally even though the environment is changing);
- Adaptation (because of selection, there is a modification in the genetic make up of progeny that renders local survival, growth and reproduction possible);
- Long distance dispersal (seeds can germinate in friendlier environments).

Figure 2. An example of acclimatization: evolution of leaf stomatal density in a single *Betula pendula* tree with increasing CO2 concentration (from Wagner et al. 1996, PNAS 93, 11705-11708)




We know from current experiments and paleoecological data that trees can use all three mechanisms, with more or less success depending on the species and the ecological / geographical context (figure 2 and 3). We also know that species and population extinctions have happened in the past because of climate change, and most recently during the Quaternary Ice Ages.

Figure 3. European oak isochronal pollen map (www.pierroton.inra.fr/Fairoak/ ). Fossil pollen data show a rapid habitat recolonization of tree species across Europe after the last Ice Age (up to 500 m per year on average during the last 12 000 years).




It is our role to include climate change considerations not only within gene and species conservation networks, but also in everyday forestry management and practice, at the national and range-wide European level. Local populations may not be adapted to more frequent climatic extremes (figure 4).

Figure 4. Mortality of *Abies alba* juveniles after the 2003 summer heat wave, southern France (Mont Ventoux, elevation 1200 m).

Public awareness in the forestry area needs to be risen on the reality and effects of climate change. Further integrated research (both biology and social sciences) is needed to understand and model the effects of climate change on forests ecosystems. Minimum requirements regarding climate change should be included when planting and managing forests. Issues such as the choice of forest reproductive material, the role of marginal and disjunct areas, the importance of habitat (and not just genotype) conservation, the diversification of management systems, the need for long term monitoring, the need to evacuate populations further north than their current distribution (i.e. artificial long distance dispersal), the need to enhance gene flow for adaptation (hybridization), etc. should be addressed.