Adapting forest management to increased drought risk in Europe

Catalonia and Brandenburg

Natural Risks
Understanding drought-related impact
Water-stressed forests are likely to spread according to most climate change forecasts. Even under scenarios showing a slight reduction or a constant average annual rainfall, physiological drought is expected to increase due to:

- Higher evaporative demand by a warmer atmosphere
- Changes in rainfall regimes in relation to growing periods
- Lower soil water content: increased runoff (storm frequency and severity)
- Longer vegetative periods

The measures proposed here to address the consequences of climate change are feasible if the foreseen increase in temperature is +2°C (X. Castro, Barcelona September 2009). With a higher impact - +6°C - the possibility of success is reduced, as forest plasticity is limited (Brandenburg).

Specific problems
Deterioration of woodland health leading to individual trees becoming stressed and death occurs either from direct consequences of drought or pests attacking weaker trees.

Ultimately this can lead to a loss of woodland biodiversity and changes to ecosystems.

To address these problems silviculture must use:

- Fast intervention, do not postpone decisions.
- Drought resistant genetic stock to replace species at the limit of their site suitability.
- More intensive management, bringing in to management under exploited forest.
- Extended - or reduced – crop rotation periods.
- Prioritised silviculture inputs to protect valuable biodiversity stands.
- Be adaptive in use of silviculture systems.

Soil water content in European forest soils simulated with the forest growth process based model Gotiwa+. Simulations use a pixel of 10'x10' combined with climate predictions of HadCM3 model under a socioeconomic scenario A2. Source: Gracia et al 2002
Adaptive management actions

Changes of species / genetic management / selection of certain traits / provenances.
A number of foreign species could be listed in each region which would provide a good alternative in case natural evolution of the present species is too slow in relation to the adoption of these new species. Another alternative for adaptation to the new conditions is the adoption of nursery techniques to obtain a hardening in the plant characteristics - irrigation regime, root development, inoculation by mychorrhizae. Knowledge of the traits of the different provenances is a demand needs to be improved.

Promotion of mixed stands / uneven-aged stands / forest conversion.
Mixed stands are expected to be more resilient. Composed of species with different rotation periods they offer advantages as they allows greater diversity of structure, valuable especially when there is excessive competition for water. They also react differently to rain interception and soil quality. The most important advantage forests gain with a mixed structure is the wider range of natural risks they can successfully adapt to.
On the other hand mixed stands need higher management intensity and therefore probably more investment is needed. Specialised silvicultural protocols can help.
Using alternative species can achieve in advance the changes that natural evolution would produce.

Re-evaluated silvicultural techniques:
- reforestation techniques
- management models
- thinning regimes
- management of understory

Reafforestation techniques, plantation design, election of stand structure and silvicultural treatments should also be adapted to the expected new drought conditions, applying experiences from semi arid lands. Traditional forest management models usually design optimal stand densities to maximise timber production. Thinning regimes will have to be re-evaluated from a water-saving point of view. Therefore integrating eco-physiological knowledge into forest modelling is required.

Forest management operations should avoid soil erosion and compaction to preserve water storage properties.
Silvicultural treatments will be directed to obtain shorter trunks but with a bigger diameter, delaying pruning and shortening the rotations. These practices will cause changes in the root system, avoiding decay of species facing a drought episode.
The understory composition and its coverage play an important role in the amount of water available for tree seedlings and reduce drying of the soil. Selection, thinnning and treatment of the understory should take into account dominant winds and horizontal precipitation to achieve the most appropriate microclimates. Some appropriate techniques would include burning, grazing, mechanical treatments, mulching.
Other measures
To promote agro-forestry systems or multifunctional forest combining wood and secondary forest products. To apply one made to order silviculture focussed in the specifics goals.

Increase of monitoring in forest health.
An increase of monitoring is needed in this field to determine the pest and pathogen damage thresholds for the water stressed stands. National and regional inventories must include those aspects. It’s also important to increase the research and improve the training of the technical staff in this field and about internal physiology mechanism too.

Management planning documents
The adoption of these silvicultural measures adapted to drought, including a vulnerability assessment in the planning documents will be essential at national and regional level and these management instruments establish compulsory guidelines which should be included in the planning documents of the estates.

Examples of good practice:

Catalonia
When forest owners produce their forest management plans forestry advisors suggest the promotion of mixed and uneven-aged stands, planning intensive thinning to reduce density and favour vitality of the remaining trees. Also forests owners are advised to choose carefully species for new plantations that will be harvesting 60 to 100 years later. The forest management plan must best options for the future incorporating the available knowledge at the time the plan is produced.

Brandenburg
Within the fenced regeneration area, a single-tree to group-mixture of planted oaks, pine, birch, and aspen regeneration has established itself, creating optimal conditions for a new, stable, and climate-adapted forest generation.

This new mixed stand can withstand a wider range of natural risks because different species have different responses to drought periods.

Further reading:
• Legay, M., Ginisty, C., Bréda, N. 2006. Que peut faire le gestionnaire forestier face au risque de sécheresse?. ONF. Rendez-vous techniques, 11: 35-40
• www.crea.uab.cat
• www.efimed.efi.int

Pinus pinea cones production in Aleppo Pine (grafting)