Silvicultural factors influencing windthrow in maritime pine stands

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SILVICULTURAL FACTORS INFLUENCING WINDTHROW IN MARITIME PINE STANDS

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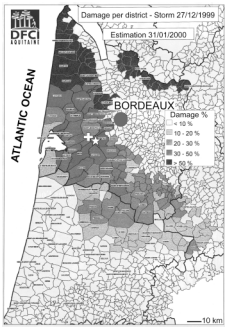
Silvicultural strategies and site characteristics are critical factors to consider when assessing the vulnerability of forest stands to strong winds. Windthrow hazard depends upon the interaction of numerous factors whose relative importance has yet to be assessed in the specific context of maritime pine plantations in South Western Europe. Following the December 1999 storm which caused the windthrow of 30 million m3 in Aquitaine Region (> 3 annual harvest), different studies were undertaken at stand level to analyse the effects of silvicultural factors on stability. The main factors analysed were stand density, tree genetic improvment and fertilisation. Data were collected in the same area (Pierroton) on large experimental sites of various ages (8, 20, 51yrs) which were damaged by the storm. Those sites were initially set up to study different silvicultural regimes (old stand) and nutritional levels (young stand). Preliminary results are presented and provide some information to be considered in the management of forests to reduce the risk of wind damage.

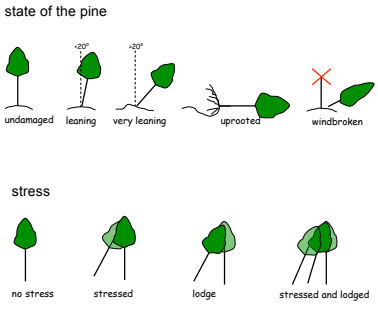
MATERIAL AND METHODS

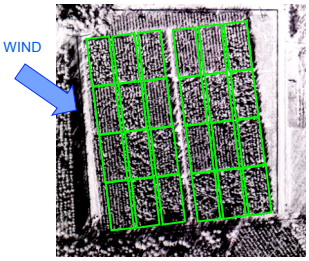
Study area. Map of the Landes with districts limits (communes), mean damage level per district, and the experimental sites: the cross for «Pierroton L» (8 yr.-old) and «Pierroton U» (20 yr.-old), the star for «Saint-Alban» (51 yr.-old). The 3 sites are less than 5 km apart on humid bent with a sandy podzol.The winds have been recorded to a maximum speed of 173 km/h in Cap Ferret (ocean border).

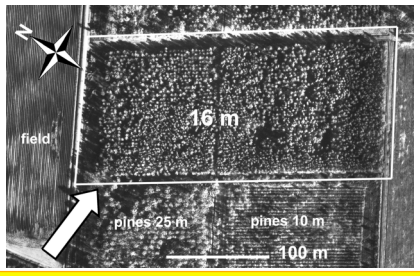


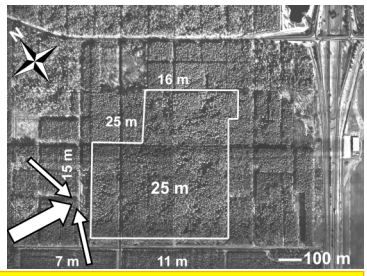
Methods of damage inventory. The complete survey of each stand has been done:
- one code for the state of the pine
- one code for the stress
- girth at breast height

On sampled pines: height, living crown height and horizontal area, root system size, biomass...



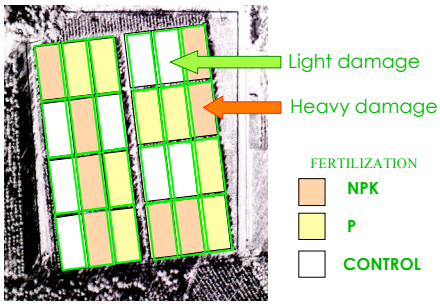




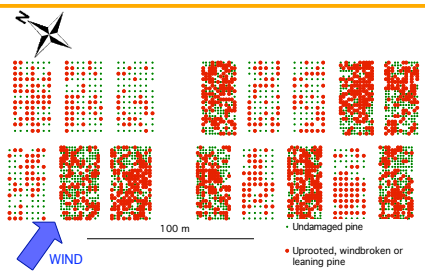


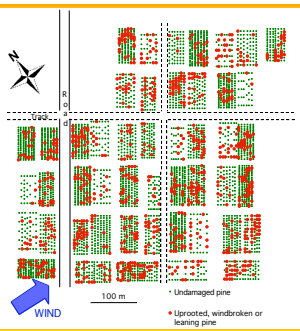
Aerial pictures of the 8 yr-old fertilization trial (left), 20yr-old and 51 yr-old (right) trials taken 2 weeks after the storm. The outlines show the study plots. The arrows show the extreme and mean wind directions during the storm. The heights of the stands upwind are indicated.

RESULTS

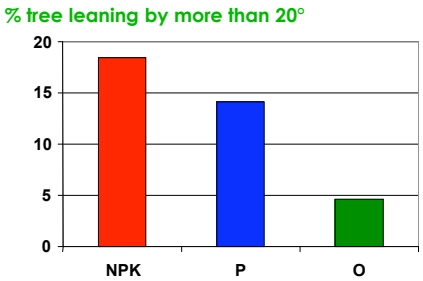


High level of damage (upper aerial view) are observed on the fertilized plots.

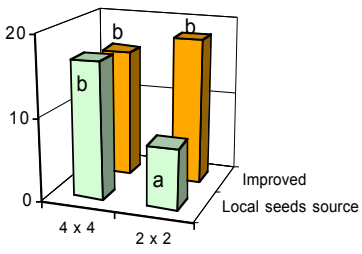




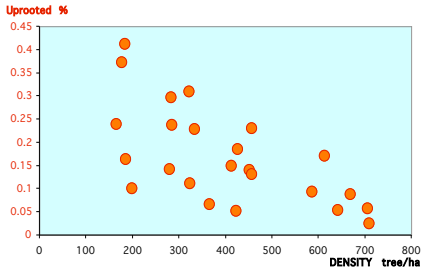
Maps of the wind damage. The damage are not localised on specific areas. The 20 yr-old trial shows 50-60% damaged pines, mainly leaning trees, and the 51 yr-old one shows 20-30 % damaged pines, mainly uprooted trees.



The trees that received NPK and P fertilization were bent over more by the wind than those not fertilized (control).
One hypothesis to explain the observed influence of fertilization on wind damage is that it modifies the biomass allocation between roots, trunk, and crown, and therefore induces an increased sensitivity of the fertilized stand to the wind. Currently, an estimation of tree biomass partitioning is in progress.



Damage according to genetic improvment and density at 20 yr-old. The density had no effect within the improved pines. For the local seeds source, the percentage of uprooted pines is significantly lower at high density, which are not practised in managed stands. The genetic improvement seems not modify the vulnerability to strong winds.



Damage according to density at 51 yr-old. The density reduces significantly the intensity of damage. The managed stands have mainly a density about 350 trees/ha ; it would be more safe to increase the density than to reduced it. However, the relationship is softened in phosphorus fertilised stands, which is the usual practice in the Landes of Gascogne.

Under strong winds, initial results show that high fertilisation levels or low stand densities increase windthrow risk in maritime pine stands of various ages, whereas genetic improvement has no significant effect. Those results also demonstrate the necessity to consider various scales for analysis from tree to landscape levels, and to have a multi-factorial approach in windthrow risk evaluation.