General remarks to susceptibility of forest to storm

par Heinrich Spiecker

Université de Fribourg – Institüt für Waldwachstrum, Bertoldstr. 17, 79085 Freiburg (Allemagne)

General remarks to susceptibility of forest to storm

Key factors for storm damages are:

• Meteorologic conditions

• Topographic situation: high susceptible:
- valleys in wind direction, mountain ranges against the wind direction (Aldinger et al., 1996)

• Site conditions: high susceptible:
- sites influenced by standing water,
- shallow soil (Aldinger et al., 1996),
- precipitation during the period before the storm,
- sites with high nutrient content and high water availability (hypothesis: unfavourable root-shoot-ratio), high skeleton content increases stability (stronger root system, lower tree height) (see Winterhoff, 1997).

• Forest structure (species, height, structure, vitality): high susceptible:

- In southern Germany N. spruce was the most affected species. Standing volume, age and tree height never was registered before to be higher than in recent years. Especially N. spruce stands consisting of large trees were blown dawn. Height has been mentioned by several authors as a decisive factor. Especially high risk has been observed after a height of 20-28 m has been reached (Wangler, 1974; König et al., 1995). Right after thinning storm risk is especially high (Winterhoff, 1997).

- Norway spruce in pure and mixed stands is highly susceptible to storm. This was the result of a simple statistical analysis of storm damages by several authors in various regions of Europe. Norway spruce often was planted on less stabile sites. Besides species composition other factors like site conditions, height of trees, etc. have to be considered. When taken these factors into account properly still Norway spruce is by far more susceptible to storm than beech and oak (Winterhoff, 1997; von Lüpke and Spellmann, 1997).

The susceptibility to storm can be reduced by:

• Reduction standing volume: In many regions in Europe standing volume has increased considerably in recent decades (Kuusela, 1994), therefore the risk of increased salvage cuttings due to storm has increased.

• Decrease of average age: Average age of trees in many regions of Europe has increased as well. In addition with the phenomenon of accelerated growth (Spiecker et al., 1996) the average height of stands has increased and therefore the risk of storm has increased as well.

• Adequate species composition: Besides other species Norway spruce has been planted beyond its natural range. Norway spruce is on many sites less stabile against storm than pine sp., beech or oak (Aldinger et al., 1996; Weidenbach, 1991; Winterhoff, 1997; von Lüpke and Spellmann, 1997).

Natural regeneration versus plantation

Starting conditions are decisive for the success of natural regeneration:
- existing seeds, seedlings and young plants,
- deer population,
- seed trees,
- weed competition etc.

Pioneer species:

• Pioneer species (softwood species like aspen, birch, Salix sp., on moist sides black alder but also hardwoods like Norway spruce and pine) may regenerate naturally. They protect shade tolerant species like European beech or Silver fir against frost. In addition they may shade the ground and may help to improve quality of valuable trees (trees of the same species may even better serve for this purpose!).

• Advantage of starting with a pioneer forest are primarily that work can be postponed to a later date when other urgent work after the storm has been accomplished (Huss, 1993). Total work input may be however be even higher. Because tending may be more intensive later on (Zimmermann, 1985).

• Pioneer species may also stimulate decay of branches, reduce frost. It may increase competition to improve stem quality and to reduce competition of ground vegetation. Work input right after the storm may be reduced and time for providing seed material may be prolonged. In addition less plants are needed (Huss, 1991).

• Pioneer species (softwood species like aspen, birch, Salix sp., on moist sides black alder but also hardwoods like Norway spruce and pine) may regenerate naturally. They protect shade tolerant species like European beech our Silver fir against frost. In addition they may shade the ground and may help to improve quality of valuable trees (trees of the same species may even better serve for this purpose!). Besides the pioneers often climax species like oak, beech, hornbeam, lime tree, sycamore, ash and Silver fir regenerate naturally as well (Schölch et al., 1994).

Natural regeneration may not be adequate when regeneration unwonted species like Norway spruce on shallow soils where this species is regenerating well but will become unstable at a later stage.

Advantages and disadvantages of natural regeneration and planting has been discussed in many text books. Recently natural regeneration became more popular because of economical and economic assumptions which not always have been scientifically well established.

No general conclusion can be made in respect to actions after storm, because starting conditions and aims may vary!

Treatment models: even sized high forest versus uneven sized forests

Most forests in Europe are more or less even aged. Uneven sized 'Selection Forest' cover only a small percentage of the forest area in Europe. Even in regions where Selection Forests are most common their percentage is below 20% (Black Forest 8.0%, state of Baden-Württemberg 3.5%, Allgäu - Bavaria- and Bregenzer Wald - Austria - 12.0%, Switzerland 8.4% and Slovenia 18.0%).

No general statistics could be found which compare storm damages of uneven sized forests and even sized forests. Individual case studies (e.g. Landesforstverwaltung Baden-Württemberg, 1994, page 52/53) can not be generalized.

As discussed above ('general susceptibility to storm') the susceptibility to storm is controlled by meteorologic conditions, topographic situation by site conditions and only to some extent also by forest structure. Since uneven sized forest will remain in the long run only on specific sites where storm risk is low - (on storm exposed sites they may have been blown down by now and even sized stands may have followed!) - conclusion from actual observations have to be drawn with care.

These observations may however - combined with other information about storm risk - give some hints which are summarized below:

Stand stability versus tree stability

For this comparison a distinction between stand stability and tree stability is important. While stand stability may be decreased due to increased roughness of the canopy in uneven sized stands the stability of the individual tree may increase. Especially in cases where cutting take place continuously in short time intervals stability may be increased.

Storm risk and tree height

The tallest trees are most exposed to wind and are blown down with highest probability (see above 'general susceptibility to storm'). While falling they damage neighboring trees of smaller size. Since the number of large sized trees is limited in uneven sized stands a substantial number of small and medium sized trees will survive.

Regeneration after storm

Since generally a substantial number of small and medium sized trees will survive no generally no seeding, planting and other regeneration measures are needed after storm.

General conclusions

On susceptible sites uneven sized stands will not be appropriated because individual tree stability will not develop. On 'stabile' sites frequently repeated cuts will increase individual tree stability. Low standing volume with a low proportion of large sized trees will reduce the risk of storm in uneven sized stands.

Enrichment

• by seed

• by planting

Natural regeneration may produce to some extent acceptable trees but may sometimes not generate the species composition wonted. Besides missing species some species may need to be established before or after another species depending on its growth relations. Under such circumstances enrichment may be the answer.

Planting under opened canopy of pioneer species offer various alternatives for changes toward mixed stands. In between these natural pioneer tree species valuable species may be planted in wide spacing especially when relatively large trees are planted (Spiecker, 1986).

When designing the planting pattern the height growth differences between species have to be taken into account. Groups of at least the size of the crown projection area of an adult tree generally is recommended (Petri, 1966). Other authors recommend groups of about 0.1 ha when regenerating mixed stands. Planting in rows in a wider spacing is recommended when larger areas should finally be covered by a species (Spiecker, 1986). In Alsace for reforestation of oak forests after the storm in 1984: 3 x 1,3 m = 2 500 plants per ha (Balanger, 1988).

Larger plants (higher than 1 m) are less affected by browsing; more competitive to ground vegetation and less plants are needed. Perhaps at a later stage artificial pruning and tending is needed.

Enrichment planting has an effects on forest protection, cleaning and herbicide application When planting only on parts of the side there is no need for cleaning the side, even though it may be difficult to be accessed for some time. Work load can be reduced after the storm and less plant material is needed. Plant quality and vitality have an impact on the outcome of enrichment planting.

Pioneer species (softwood species like aspen, birch, Salix sp., on moist sides black alder but also hardwoods like Norway spruce and pine) may regenerate naturally. They protect shade tolerant species like European beech our Silver fir against frost. In addition they may shade the ground and may help to improve quality of valuable trees (trees of the same species may even better serve for this purpose!) .

Planting under an opened canopy of pioneer species offer various alternatives for changes toward mixed stands v

Références bibliographiques

ALDINGER E., SEEMANN D., KONNERT V., 1996. Wurzeluntersuchungen auf Sturmwurfflächen 1990 in Baden-Württemberg. *Mitteilungen des Vereins für Standortkunde und Forstpflanzenzüchtung Nr. 38*, 11-25.

BALANGER L., 1988. Wiederaufforstung nach der Sturmkatastrophe von 1984 in den Vogesen. *Holz-Zentralblatt*. S. 782-784.

BURSCHEL P., BINDER F., 1993. *Bodenvegetation-Verjüngung-Waldschäden.* Allgemeine Forstzeitschrift. H.5, 216-223.

LANDESFORSTVERWALTUNG BADEN-WÜRTTEMBERG, 1994. *Dokumentation der Sturmschäden 1990, verschiedene Autoren und ein Beitrag von Ingrid Kühnel*. Schriftenreihe der Landesforstverwaltung Baden-Württemberg, Bd. 75, 190 p.

HUSS J., 1993. *Konzeptionen zur Wiederbewaldung von Sturmschadensflächen*. Allgemeine Forstzeitschrift, H.1, 25-30.

KENK G., MENGES U., BÜRGER R. 1991. *Natürliche Widerbewaldung von Sturmflächen*. Allgemeine Forstzeitschrift, H.2, 96-100.

KUUSELA K., 1994. *Forest resources in Europe*. European Forest Institute, Research Report, 1, 154 p.

KÖNIG E., BAUMANN B., 1990. Der Einfluss des Verbisses durch Rehwild auf die Naturverjüngung von Nadelmischbeständen. *Allgemeine Forst- und Jagdzeitung*, 161(9), 170-176.

KÖNIG A., 1995. *Sturmgefährdung von Beständen im Altersklassenwald*. J.D. Sauerländer's Verlag, Frankfurt, 194 p.

KÖNIG A., MÖßMER R., BÄUMLER A., 1995. *Waldbauliche Dokumentation der flächigen Sturmschäden des Frühjahrs 1990 in Bayern meteorologische Situation zur Schadenszeit*. Bericht Bayr. Landesanst. Für Wald und Forstwirtschaft, 2, 335 p.

Petri H., 1966. *Versuch einer standortsgerechten, waldbaulichen und wirtschaftlichen Standraumregulierung von Buchen/Fichten-Mischbeständen*. Mitteilungen der Landesforstverwaltung Rheinland-Pfalz, 1, 131 p.

SCHMIDTKE H., SCHERRER H.-U., 1997. *Sturmschäden im Wald*. Vdf Hochschulverlag AG an der ETH Zürich, Schlussbericht NFP 31, 40 p.

SCHÖLCH M., EH M., KENK G., 1994. *Natürliche Wiederbewaldung von Sturmflächen*. Allgemeine Forstzeitschrift, H. 2, 92-95.

SPIECKER H., 1986. 100jähriger Eichenbestand aus 5x2 m-Pflanzverband. *Allgemeine Forstzeitschrift*, 37, 910.

SPIECKER H., 1986. Das Wachstum der Tannen und Fichten auf Plenterwaldversuchsflächen des

Schwarzwaldes in der Zeit von 1950 bis 1984. *AFJZ*, 157(8), 152-163.

SPIECKER H., 1991. Zur Dynamik des Wachstums von Tannen und Fichten auf Plenterwald-Versuchsflächen im Schwarzwald. *AFZ*, 46, 1076-1080

SPIECKER H., MIELIKÄINEN K., KÖHL M., SKOVSGAARD J.P. (eds.), 1996. *Growth trends in European Forests*. European Forest Institute Research Report n°5, Springer-Verlag, 372 p.

WANGLER F., 1974. *Die Sturmgefährdung der Wälder in Südwestdeutschland - eine waldbauliche Auswertung der Sturmkatastrophe 1967*. Dissertation, Forstwissenschaftliche Fakultät, Universität Freiburg, 226 p.

WEIDENBACH P., 1991. Die Wiederbewaldung der sturmgeschädigten Waldflächen - Die Orkanschäden 1990, Ursachen und Folgerungen. In: Wilhelm-Münker-Stiftung; *Beiträge zur Lebensqualität, Walderhaltung und Umweltschutz, Gesundheit, Wandern und Heimatpflege*, H.33, 44 p.

WINTERHOFF B., SCHÖNFELDER E., HEILIGMANN-BRAUER E., 1995. *Sturmschäden des Frühjahr 1990 in Hessen - Analyse nach Standorts-, Bestandes- und Behandlungsmerkmalen*. Forschungsberichte der Hessischen Landesanstalt für Forsteinrichtung, Waldforschung und Waldökologie, 20, 176 p.

WINTERHOFF B., 1997. *Die Sturmschäden des Frühjahrs 1990 in Hessen*. Allgemeine Forstzeitschrift H.11, 616-620.

VON LÜPKE B., 1991. Einfluß der Konkurrenz von Weichlaubhölzern auf das Wachstum junger Traubeneichen. Forst und Holz, H.7: 166 p.

VON LÜPKE B., SPELLMANN H., 1997. Aspekte der Stabilität und des Wachstums von Mischbeständen aus Fichte und Buche als Grundlage für waldbauliche Entscheidungen. *Forstarchiv*, 68, 167-179.

ZIMMERMANN H., 1985. *Zur Begründung von Mischbeständen mit Fichte und Buche auf Sturmflächen im öffentlichen Wald Hessens*. Allgemeine Forstzeitschrift, 1326-1330.