EUROPEAN FOREST INSTITUTE
ATLANTIC EUROPEAN REGIONAL OFFICE – EFIATLANTIC

Appendix 3: Background Information on 11 Storms Selected for Detailed Analysis

Storm of 31 January 1953

Meteorological conditions

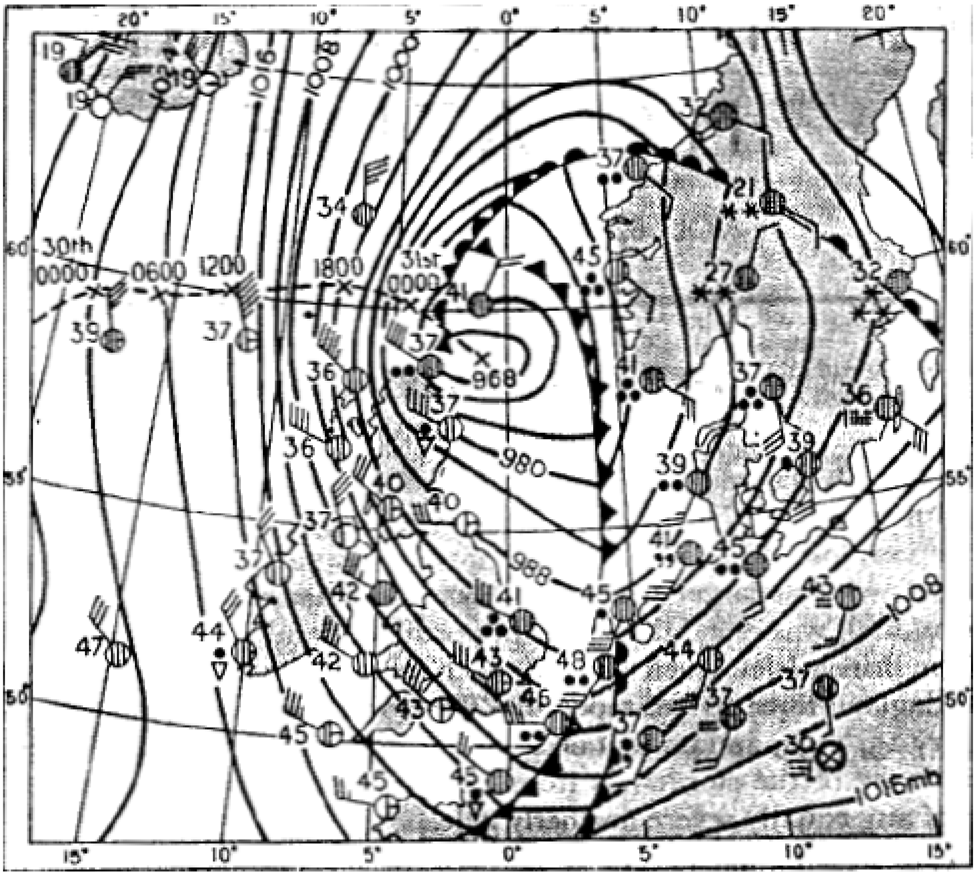


Figure 1 *: Synoptic chart with storm track (--x--x--)*

The gale started in the early hours of 31st January and was strong throughout the area at daybreak. It continued to rise in intensity to 11.00 in Morayshire (where gusts up to 113mph / 50 ms^{-1} had been blowing since 9 am) and in Aberdeenshire up to 12 noon, with gusts of up to 101 mph / 44 ms^{-1}. Gusts of over 90 mph / 40 ms^{-1} continued to 14.00 in Morayshire and 16.00 in Aberdeenshire, after which the intensity gradually died away. In Aberdeenshire the average wind speed exceeded 45 mph / 20 ms^{-1} from 09.00 to 18.00 in areas south of the River Dee. The storm peaked in the afternoon. At Dyce, gusts of more than 40 ms^{-1} were recorded between 10.00 and 16.00 with a maximum of 44 ms^{-1} at noon.

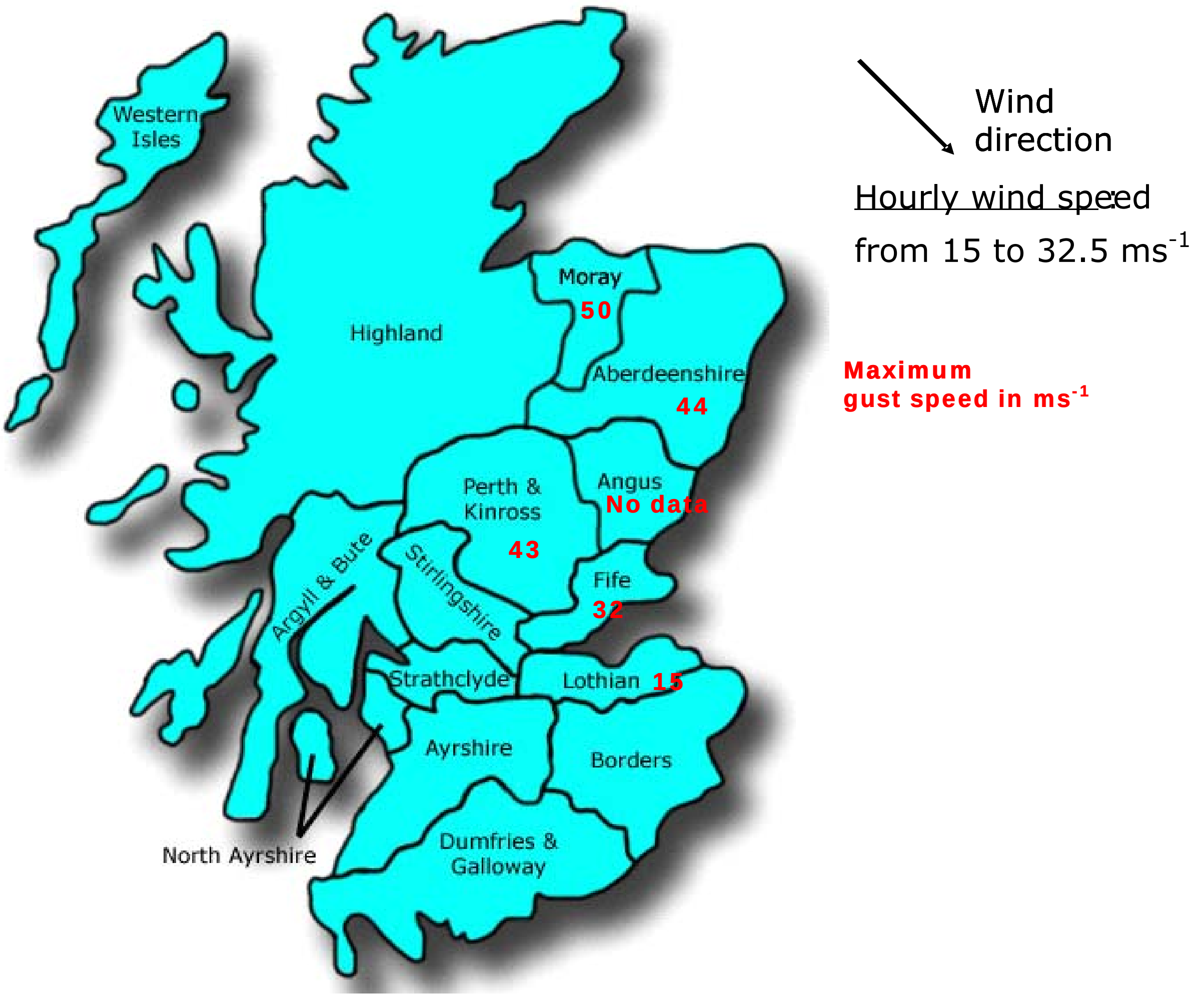


Figure 2 *: Wind direction and maximum gust speed*

Mean wind direction (degrees from true north) and speed (mph, averaged over 10 minutes)

Location	Time (GMT) 0001	0300	0600	0900	1200	1500	1800	2100	Highest hourly mean speed (mph)	Highest gust speed (mph)
Lerwick	210/17	190/13	020/14	360/43	360/77	360/81	350/52	350/40	74	98
Kirkwall	-	210/24	-	360/66	-	340/67	-	350/48	-	107
Wick	190/19	260/22	310/43	340/51	340/51	350/55	360/39	340/37	-	83
Stornoway	-	320/58	-	350/58	-	360/39	-	350/37	-	89
Kinloss	-	280/47	-	320/81	-	350/58	-	330/46	-	113
Aberdeen (Dyce)	-	270/22	-	300/45	-	350/50	-	350/35	340/63	101
Benbecula	-	320/60	-	340/38	-	360/37	-	350/43	-	84
Tiree	360/36	310/45	310/46	310/52	330/44	350/50	330/41	340/41	360/74	98
Leuchars	-	290/19	-	310/29	-	360/34	-	340/24	330/36	71
Prestwick	-	310/28	-	310/38	-	310/28	-	310/25	310/39	66
Renfrew	-	310/23	-	310/39	-	330/23	-	310/07	310/31	65
Edinburgh (Turnhouse)	250/20	250/25	270/29	270/30	290/29	330/34	330/25	310/26	-	
Stranraer (West Freugh)	-	310/32	-	300/46	-	330/52	-	330/41	-	75

N.B. Directions (degs.) 360 = North, 090 = East, 180 = South, 270 = West e.g. 270/22 = a mean speed of 22 mph from the West.

***Figure 3** : Wind direction and speed at several locations*

The wind direction was north-west to north. A striking and unusual feature of the wind was its maintained intensity for many hours at a force normally associated with windthrow and the frequent very intense gusts of hurricane force above this high average speed. The ratio of the maximum gust to maximal mean hourly wind speed shows the gusty nature of the storm, varying between 1.9 and 2.2 in the most damaged areas. Most of the damage in woodlands took place between 10.00 and 14.00 when the winds were of hurricane force.

The North-east of Scotland was considered to be less subject to exceptional storms than the western regions, despite being a windy region. The last previous storm believed to have caused damage to woodland in this area was January 1927, when a gust of 31 ms^{-1} was recorded at Aberdeen.

Short description on damage

Besides the wind, a storm surge caused severe floods in England and in the Netherlands on the night of 31st January. More than 300 people died in the UK. No data is available for Scotland.

Primary damage

Immediately after the storm, the Forestry Commission made a first estimation of damage: 0.993 million m^3 of trees were blow down (0.84 million m^3 was coniferous forest and 0.15 million m^3 was hardwood). Around 15% of broadleaves (beech and oak) were damaged, and the balance was mostly Scots pine (also larch, spruces and Douglas fir). Privately owned estates suffered 90% of the damage, probably because the age of trees were much higher. Timber blown would have had a standing value of more than £4,000,000

The regions in North-east Scotland with the highest damage were: Nairn, Moray and Banff and the Spey Valley below Grantown-on-Spey. There was also severe damage in lowlands of Aberdennshire, lower Dee, Don Valleys and Kincardineshire and Angus. The first assessment under-estimated the damages as the final estimation was that volume damaged reached 1.80 million m^3, of which 1.53 million m^3 was coniferous.

County	Volume Blown (cu m)	% of growing stock	Felled to 23.12.53 (cu m)	Converted to 23.12.53 (cu m)	Disposed of to 23.12.53 (cu m)
Morayshire	23,285	10	17,990	16,957	7,815
Banffshire	12,936	25	3,349	2,926	1,968
Aberdeenshi	29,107	25	28,045	25,502	17,937
Kincardinesh	10,388	15	9,811	6,350	2,738
Angus	3,248	8	3,536	3,136	2,887
Perth	64,402	5	4,119	3,903	5,233
Fife	854	10	1,014	935	930
TOTAL	**144,219**	**14**	**67,864**	**59,710**	**39,508**
The gale damage summary by counties in public forest.					

Table 1: This table was published at the end of 1953. The public forest represented 8% of all the damaged forest.

Secondary damage

At the time the effect of the storm was expected to last for several years. There were concerns that the population of *Hylobius abietis* (which attacks the roots of young Scot pine) would need to be controlled although the roots would dry quickly so this was only a potential threat. Insect attack, particularly by Pine Shoot Beetle (*Myelophilus piniperda*) was expected to be heavy in 1954, especially as they would be aided by the exceptionally early spring. Pine Weevils (*Hylobius abietis*) were also expected to be a large risk to any new planting. Aditional issues included indirect effects such as rabbit fences broken down in the storm, letting rabbits into young plantations, and roads blocked for extraction. Considerable browning occurred on Scots pine, Douglas fir and Norway spruce during the spring of 1954, but there was no extensive dying due to blast in older woods.

Tertiary damage

Of the softwoods, it is estimated that about 336 000 m^3 would go into pitwood and the balance into sawn goods. The hardwood would produce sawn timber. The 'National Coal Board' was expected to absorb the pitwood. The quantity of sawn softwood although large, was less than 10% of the annual consumption of this category in the UK. The timber would have to be transported longer distances than normal, both for conversion, and later to consumers. The objective was completion of salvage within two years, and it was estimated that there was sufficient sawmill capacity to enable this to be done, but availability of labour would likely be the limiting factor.

Policy response

There is little data on policy responses to this storm. In order to meet the objective of complete salvage within two years the Forestry Commission suspended the licensing of standing softwood timber for clear felling in Scotland, so that the resources of the timber trade could be concentrated on the blown timber.

Effects on timber market

There is no available data on the actual effects of this storm on the timber market.

Literature

- Peniston 1953. The gale of the 31st January 1953
- Steven, 1953. Storm damages on Scotland in January 31, 1953. Nature
- Met office, 1977. The gale of 31 January 1953.
- Quine, C.P. Damage to trees and woodland in the storm of 15-16 October 1987.

Storm series of 1967

Series of five storms in Central Europe:
21.02.1967
23.02.1967
28.02.1967
13.03.1967
25.05.1967

Meteorological conditions

Preceding the devastating storm series of 1967 precipitation was measured high above average. High precipitation was evident especially during December 1966, January, March and May 1967, accompanied by extraordinary high air temperatures as compared to the long-term average. As a result ground frost could not develop as in regular winters and thawing started in February. Thus, when the storm series occurred, the soils were fully saturated (Wangler, 1974).

Storm activity during 18th to 20th of February 1967

The storm activities began on 18th February. A cyclone over the northern Atlantic Ocean combined with two smaller low-pressure areas over France and the North Sea and a significant low-pressure system emerged. The German lowlands faced storm winds while gale force winds were registered at higher altitudes. The winds in the lowlands intensified during the night of 19th to 20th of February with 7 to 10 Beaufort (up to 100 km/h) in southwestern Germany. At higher altitudes wind speeds were much higher with ind speeds of 11 to 14 Beaufort (100 – 165 km/h) reported from the Feldberg (Black Forest, Southwest Germany). The wind direction was recorded as southwest to west (Wangler, 1974).

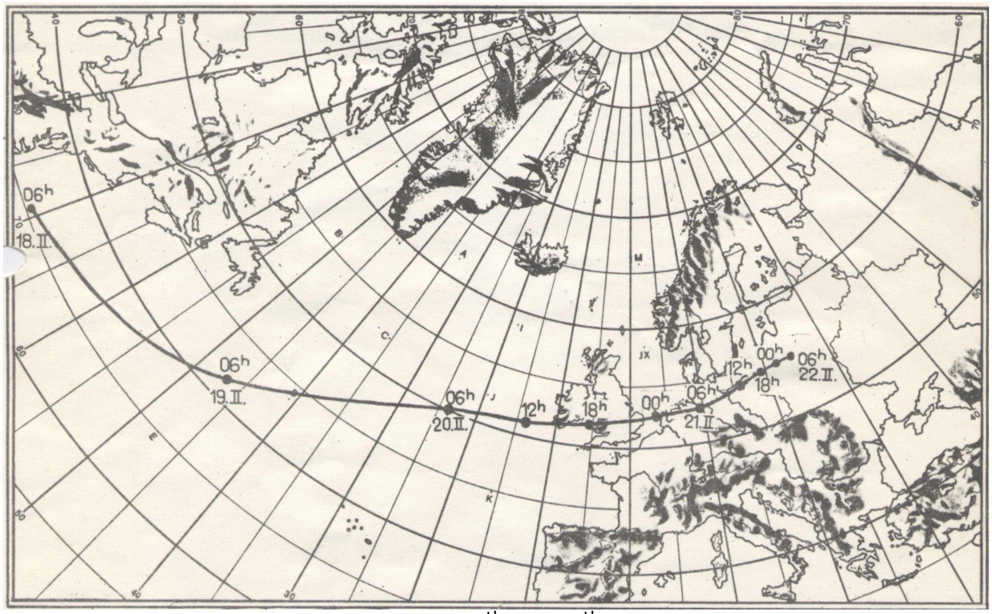


Fig. 1: Track of the cyclone from 18th to 22th of February 1967 (Berliner Wetterkarte, 22.02.1967).

Storm event of 21.02.1967

Influenced by yet another low-pressure area, a second massive cyclone expanded from the northeastern Atlantic Ocean to Norway. This cyclone also affected Central Europe developing into a strong storm with gale-force winds on February 21st. At the Feldberg weather station (Black Forest, Germany) several peak gusts reached speeds of up to 16 Beaufort (>180 km/h). Wind direction was southwest to west. The storm lasted about 24 hours and damages were amplified through intensive rainfall on non-frozen soils. To illustrate the unusually warm temperatures during this time the Feldberg weather station (1486 m asl) measured 4C which is considerably above average temperatures for February (Wangler 1974).

Storm event of 23.02.1967

On February 23rd, the next heavy winter storm, originating from a cyclone in the Azores, reached the German North Sea region with subtropical hot air. On its back side cold air followed building an unusual acute cold front. This cold front entailed heavy showers and thunderstorms and included a noticeable temperature drop of 10C to 13C in southwestern Germany (Wangler 1974). As a result wind speeds of a magnitude, so far not recorded, occurred in the North Sea (up to 150 km/h or 14 Beaufort) and 13 Beaufort (approximately 140 km/h) on average in inland Germany. During the cold front track, the wind direction shifted from west/northwest to northwest which then delivered the strongest gusts. The heights of the waves in the North Sea were estimated at 10 meters (http://www.villahoffnung.de/dgzrs/dgzrs4.htm). This storm was later named after the maritime rescue ship 'Adolf Bermpohl' from the German offshore island Helgoland whose crew drowned in a rescue operation in the North Sea during the storm. Coming from north/northwest direction, the storm also reached Switzerland with extremely powerful wind gusts. Most of the devastating damage occurred in less than one hour (Bosshard, 1967).

Storm event of 28.02.1967

During the night of the 27th to the 28th of February, another cyclone tracked from the northeastern Atlantic Ocean to the Norwegian Sea coupled with a huge windstorm area, carrying several fronts on its southern side. Very low air pressures (approx. 945 hPa) were measured between Iceland and Norway. On the 28th of February the windstorm area dominated the western- and central European regions including the Alps. Rough winds with peak gusts of 9 to 11 Beaufort (75 to 120 km/h) were registered in the lowlands of Germany. In upper altitudes, for instance at the Feldberg (Black Forest), several gust wind speeds of 16 Beaufort (200 km/h) were measured (Wangler 1974). The cold front moved across the State of Baden-Württemberg with high squalls towards the evening. They were accompanied by light rainfall and relatively high air temperatures. The wind direction was southwest to west with eventual gusts from south/southwest and west/northwest.

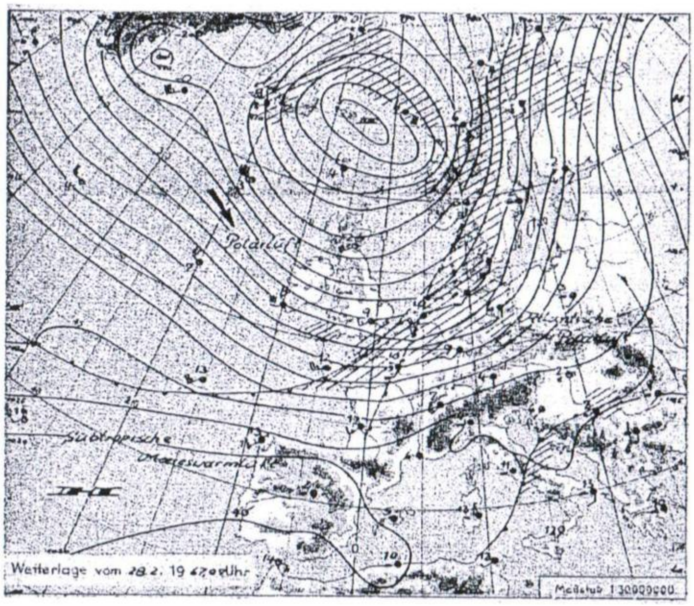


Fig. 2: Weather map of the German Weather Service (DWD) from 28.02.1967 (Steller, 2003).

Storm event of 13.03.1967

Another winter storm in the series of 1967 occurred on the 13th of March. It developed from a low-pressure area in northwestern Spain and cold polar air. A closely delineated, but very intensive low-pressure system developed as a result tracking to Germany from Brittany (Wangler 1974). Hence, a strong air pressure gradient emerged. The core region of this extreme weather event was located over central Germany on the morning of the 13th of March with an air pressure of only about 1000 hPa. The storm reached wind speeds above 200 km/h (17 Beaufort) in the higher elevations of the Black Forest (Southwest Germany) whereas wind speeds of up to 100 km/h were measured in the lowlands of Germany. The storm lasted only for a few hours. The wind direction shifted from south/southwest to west/northwest during the course of the storm (Wangler, 1974). Prior to the storm heavy precipitation occurred and air temperatures were above the seasonal average. The cities of Stuttgart and Freiburg (both located in southwestern Germany) for example measured 12C. In the wake of the storm, however, a significant temperature decline along with the arrival of the cold front lead to noticeable snowfall in high and mid-elevations (Wangler, 1974).

The average wind speeds in Switzerland were measured at 70 to 120 km/h, with peaks at an even higher level. The storm moved in from southwestern direction. Wind peaks were only reached after several hours but then gradually declined (Bosshard, 1967).

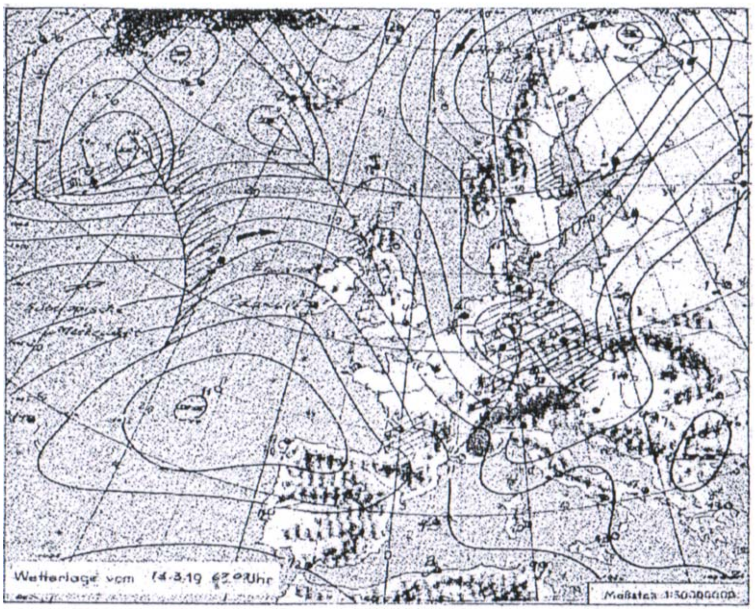


Fig. 3: Weather map of the German Weather Service (DWD) from 13.03.1967 (Steller, 2003).

Storm event of 25.05.1967

The last of the 1967 storm series was a strong and long-lasting storm which occurred on the 25th of May. That day, a low-pressure area shifted from a big cyclone from western Scotland over the English Channel and northwestern France rapidly into Germany. The storm reached peak gusts of 8 to 11 Beaufort (60-120 km/h) in the lower and mid-elevations. However, at the Feldberg in the Black Forest (southwestern Germany) several gust wind speeds of 16 Beaufort (up to 200 km/h) were measured (Wangler, 1974).

Short description of damage

In the German North Sea region no low tides were observed as a consequence of the storm of February 23rd. Several ships sunk, dikes broke and flooding occurred. Inland Germany experienced considerable damage throughout the winter storms including devastating effects to forests (Bissolli et al., 2001).At least 80 sailors died in the series of 1967 storms with 40 fatalities registered in Germany alone (Münchner Rück, 2001). The total economic damage from 21st until 23rd of February was estimated for Germany at about 1.2 billion Euros (Münchner Rück, 1999). Newer estimations by the German insurance company Münchner Rück (2001) gave a lower total economic damage of 600 million Euros.

Primary damage to forests

The winter storm series in 1967 significantly damaged European forests. West Germany, Switzerland, Austria, France, and Czechoslovakia were most heavily affected (Kohler, 1973). About 110% of the average annual harvest in the affected countries was damaged and/or windthrown by the storms. In West Germany two thirds of the total damage to forests were reported by the State of Baden-Württemberg and state of Bavaria. In Baden-Württemberg, 7.7 million m^3 of timber were damaged by the storm. Tree species most affected were Norway spruce and Silver fir. The damage can be divided according to ownership: 2.2 million m^3 in state forests, 3.0 million m^3 in municipal forests, 0.9 million m^3 in small private forests, and 1.7 million m^3 in large private forests (Wangler 1974). The total amount of storm damaged timber in Germany was about 11.3 million m^3 (Majunke, 2008). In Baden-Württemberg 12,500 ha of forested area were damaged. More than 50% of these damages were large-scale (Wangler 1974). Damage to tree species in Baden-Württemberg included: 7.2 million m^3 Norway spruce/Silver fir/Douglas fir, 0.3 million m^3 Scots pine and larch, 0.2 million m^3 beech, 0.08 million m^3 oak and other tree species (Wangler 1974).

Table 1. Storm damages to timber divided by ownership and tree species groups in Baden-Wuerttemberg in the 1967 storm series (Wangler, 1974).

Ownership classes	**Damage in million m3**
State forests	2.2
Municipal forests	3.0
Private forests (small)	0.9
Private forests (large)	1.7
Total	7.8
Tree species groups	**Damage in million m3**

Norway spruce/Silver fir/Douglas fir	7.2
Scots pine and Larch	0.3
Beech	0.2
Oak and other species	0.08
Total	7.78

In Baden-Württemberg, regions were affected to different degrees. Hence, it can be assumed that high wind speeds were not the only factor responsible for windthrow. In fact site conditions contributed to the intensity and amount of damaged timber (Wangler 1974). In Southwest Germany, coniferous stands located on compacted, water-saturated soils in the lowlands were mainly affected (Wangler 1974). In Switzerland, high wind peaks were responsible for damages to forest stands. The effects of the storm on 23rd of February to Swiss forests were devastating especially at the foot of the Jura Mountains. The area of major loss due to the storm on 13th of March occurred at lower and midland elevations. The total wind breakage amount for Switzerland was 450 000 m^3. In comparison the total wind thrown timber was estimated at 1.93 million m^3. The main damage type was root breakage followed by stump and stem breakage and wind throw (Bazzigher and Schmid, 1969). It was found that most of the wind broken trees had a weakness in their roots, which contributed to their instability. Furthermore, a noticeable putridity occurrence for Norway spruce was observed, which had made it highly vulnerable to storms as compared to other tree species (Bazzigher and Schmid, 1969). The total economic damage for Switzerland was reported at about 220 million Swiss francs (Bazzigher and Schmid, 1969).

Secondary damage

In Canton Zurich, Switzerland, bark beetle outbreaks were anticipated but did not appear as the weather conditions were rather cool and moist during the spring and early summer of 1968 (Wegmann, 2009).

Policy response

The Federal Government of Germany enacted an ‘interest price reduction’ for credit during the economic forest year of 1967. This accounted towards the processing of storm damaged timber in community and large private forests. A total of about 2.8 million D-mark (approximately 1.4 million Euros) were made available for this. In addition the Federal Government of Germany supported owners of small private forests (≤ 5 ha) with 5 D-mark (2.5 Euros)/m^3 for the processing of storm damaged timber if subcontracted to third parties. To support the export of timber, restrictions on exporting to third countries was lifted. Further, the possibility to issue certificates was given, allowing freight trains used for short-distance hauling to also transport long distance (Kohler, 2003). For these trains transport taxes were reduced to 6.5%. The Federal Government supplied financial support for the reforestation of storm damaged areas in the range of 3.62 million D-Mark (1.81 million Euros). The scale of the damages led to the initiation of the 'Forstschadenausgleichsgesetz' ("forest damage compensation act") which was approved on the 29th of August 1969. It defines the type of emergency and activities to stabilize markets, including the development of an economic equalization fund and tax relief for forest owners and forest enterprises in case of calamities (Kohler, 1973).

Financial aid for the export of coniferous wood has been provided by the State of Baden-Württemberg. An interest price reduction for credits for the processing of storm damaged timber in small private forests was also released. In addition, a so-called 'timber supply bonus' to support forest owners' storage of spruce and fir roundwood was made available. In 1968 a 'timber damage bonus' to compensate financial losses of private and municipal forest owners, and a support package for combating forest pest was released. Further 1.25 million D-mark (0.6 million Euros) were provided by the Baden-Württemberg for reforestation. Hence, 95% of storm damaged areas in private and community forests were subsidized (Kohler, 1973).

Table 2: Economic effects of the storm catastrophes 1967 to the state of Baden-Württemberg in million D-mark (Landtag von Baden-Württemberg).

	State forests	Community forests	Private forests	Total
Timber price losses	67.3	76.3	80.4	224
Additional expenditures for reprocessing storm damaged timber	10.4	12.3	13.6	36.3
Additional expenditures due to forest protection activities	0.7	0.84	0.92	2.46
Additional expenditures due to increased road maintenance	1.5	1.78	1.96	5.24

Additional expenditures due to reforestation	0.25	0.31	0.37	0.93
Other additional expenditures	0.15	0.17	0.18	0.5
Total losses	80.3	91.7	97.43	˜270

The Austrian Government focused primarily on sustaining export markets. Further mechanisation, processing, and reforestation were supported (Holzkurier, 1967a; Holzkurier 1967b). A new procedure for processing coniferous roundwood was developed for the state forest enterprises, and the mechanisation in harvesting methods advanced (Flachberger, 1968). The Government in Switzerland strongly supported the export of timber. About 30% of the storm damaged timber - 200 000 m^3 roundwood and 100 000 m^3 sawnwood - was exported mainly to France and Italy (Kohler, 1973). Planned cuts for the years following the 1967 storm events were reduced. Switzerland covered 50% of the reforestation costs in private forests in order to allow for rapid reforestation of storm damaged areas. In some of the Swiss Cantons guidelines for the selection of tree species were provided (Wegmann, 2009).

Effects on timber market

Due to the high degree of storm damaged timber in Germany, a drop in timber prices occurred especially for Norway spruce and Silver fir roundwood. This drop was most visible for the States of Baden-Württemberg and Bavaria. Prices at about 50% below average were estimated. Moreover, the prices for sawnwood declined due to a decrease in sawnwood production of nearly 10% (Kohler, 1973). However, the export of coniferous roundwood increased quite considerably. In 1968 the timber market conditions were nearly back to normal levels. The timber imports increased about 11% in 1968 as compared to 1967, with a record high of 500 000 m^3 (Kohler, 1973). In Switzerland timber prices decreased about 10% temporarily (Wegmann, 2009).

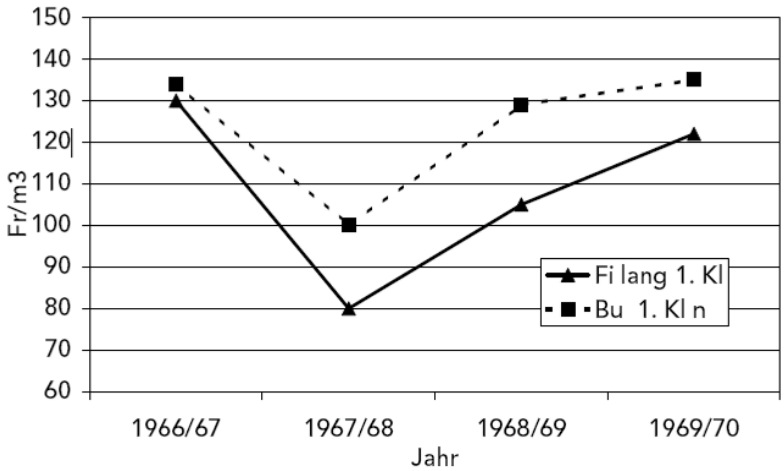


Fig. 4: Development of timber prices from 1966 to 1969 in Switzerland (Swiss francs/m^3) for Norway spruce and beech (Wegmann, 2009).

Literature

Bazzigher, G.; Schmid P. (1969): Sturmschaden und Fäule. Schweizerische Zeitschrift für Forstwesen, 120 (10), pp. 521-535.

Berliner Wetterkarte (1967): Windstärke 12 in Berlin. Beilage 44/67; SO 12/67; 22.02.1967.

Bissolli, P., L. Göring, Ch. Levebvre (2001): Extreme Wetter- und Witterungsereignisse im 20. Jahrhundert. Climate Status Report of the German Weather Service (DWD), pp. 20-31.

Bosshard, B. (1967): Erhebungen über die Schäden der Winterstürme 1967. Schweizerische Zeitschrift für Forstwesen, 118 (12), pp. 806-820.

Flachberger, K. (1968): Die mechanisierte Holzerzeugung im obersteirischen Windwurfgebiet. AFZtg (Wien), 79 (7), p.153.

Holzkurier (1967a): Schadenshöhe liegt bei 110 Mill. Schilling. Bericht über die Wirtschaftsführerkonferenz des Forstvereins für Oberösterreich und Salzburg vom 24. Mai 1967. Holzkurier 22 (24), p. 3.

Holzkurier (1967b): Die Forstwirtschaft wendet sich an den Bundeskanzler. Beschluss der Präsidentenkonferenz der Landwirtschaftskammern Österreichs. Holzkurier 22 (20), p. 1.

Klawa, M. (2001): Extreme Sturmereignisse in Deutschland: Entwicklung, Zusammenhang mit der Nordatlantischen Oszillation und Auswirkungen auf die Versicherungswirtschaft. Dissertation at the University of Cologne, Germany, 134 pp.

Kohler, V. (1973): Die Auswirkungen der Sturmkatastrophen 1966 und 1967 auf dem Nadelstammholzmarkt in Baden-Württemberg und grundsätzliche Folgerungen für die Zukunft. Mitteilungen des Instituts für Forst- und Holzwirtschaftspolitik der Universität Freiburg im Breisgau, 251 pp.

Kuner, M. (1967): Die Winterstürme der letzten Jahre. Schweizerische Zeitschrift für Forstwesen, 118 (7), pp. 435-446.

Landtag von Baden-Württemberg: Stellungnahme zu den Beschlüssen des Landtags. 3. Sturmschäden in den Wäldern. 5. Wahlperiode. Drucksache 4499.

Majunke, C. (2008): Sturmschäden in Deutschlands Wäldern von 1920 bis 2007. AFZ – Der Wald. 07/2008, pp. 380–381.

Münchner Rück (Eds.) (1999): Naturkatastrophen in Deutschland. Schadenerfahrungen und Schadenpotenziale. Eine Veröffentlichung der Münchener Rückversicherungs-Gesellschaft.

Münchner Rück (Eds.)(2001): Winterstürme in Europa (II): Schadenanalyse 1999 – Schadenpotenziale. München, 2001.

Oeschger, H. J. (1968): Sturmgefährdung und Anbau der grünen Douglasie. AFZ 23 (10), pp. 171-172.

Steller, H. (2003): Schadverursachende Winterstürme in Baden-Württemberg von 1800 bis 2000. Seminararbeit Institut für Meteorologie und Klimaforschung, University of Karlsruhe, Germany.

Wangler, F. (1974): Die Sturmgefährdung der Wälder in Südwestdeutschland. Eine waldbauliche Auswertung der Sturmkatastrophe 1967. Dissertation at the University of Freiburg, Germany, 226 pp.

Wegmann, S. (2009): Grosse Sturmereignisse und ihre Folgen im Kanton Zürich. Züricher Wald, 6, pp. 4-8.

Webpages

http://www.villahoffnung.de/dgzrs/dgzrs4.htm (26.03.2010)

http://de.wikipedia.org/wiki/Adolph-Bermpohl-Orkan (18.03.2010) http://www.spiegel.de/spiegel/print/d-46409527.html (18.03.2010)

http://www.eilunh.de/Nachrichten/html/180207aktuelles.html (18.03.2010)

http://wapedia.mobi/de/Liste_von_Wetterereignissen_in_Europa (19.03.2010)

Storm of 22nd September 1969

Meteorological Conditions

During the autumn of 1969 several extra-tropical cyclones gave rise to extensive wind damage in Scandinavia (Alexandersson & Ivarsson, 2005). Most of the 1969 damage in Scandinavia occured in Sweden during the extra-tropical cyclone on 22 September. The path of the storm was from southern Norway to southern Finland (Figure 1). The maximum recorded wind speed in Sweden during the storm was 35 ms^{-1} at the coastal meteorological station Ölands södra grund.

A second storm on November 1 1969 had a more northerly path. During this storm, the highest recorded wind speed in Sweden was 36 ms-1 of northerly direction at the coastal meteorological station Örskär.

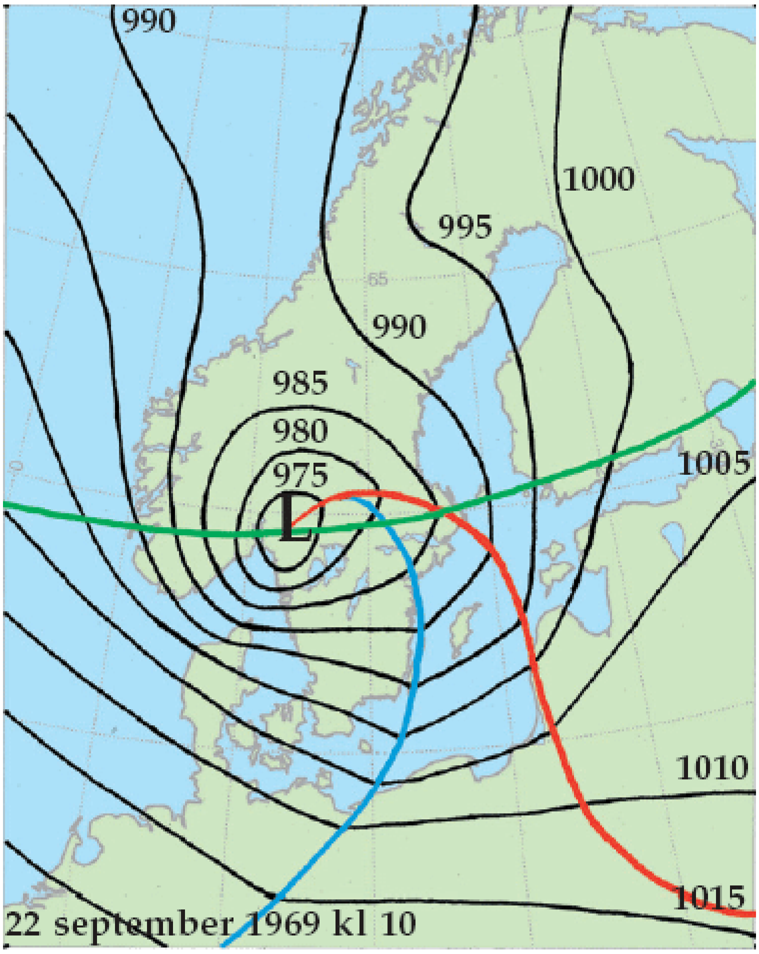


Figure 1: Isobars (hPa) of the extra-tropical cyclone of 22 September 1969. The path of the cyclone in green (Alexandersson & Ivarsson, 2005).

Short description on damage

All together the storms during the autumn of 1969 caused 42.2 Mm^3, 2.4 Mm^3 , and 0,065 Mm^3 of damage to forests in Sweden (Jantz, 1971), Norway (Skogbrand, 2010), and Denmark (Holmsgaard, 1986), respectively. Most of the damage in Sweden occurred on 22 September (Alexandersson & Ivarsson, 2005), in Denmark during 22-29 September (Holmsgaard, 1986) and in Norway on 1 November (Skogbrand, 2010). In addition to extensive damage to forests, buildings and telecommunications were severely damaged as well as accidents at sea and disruption to communications. The damage in Sweden was mainly concentrated in southern Sweden where most of the productive forest land is owned by private individuals.

Primary damage

Damage by all storms during the autumn of 1969 in Sweden was estimated by NFI at 42,2 Mm^3 (estimate 37,2 + 5 because of systematic error in method of inventory) (Jantz, 1971). The distribution of damage between counties in terms of % of growing stock is described in Figure 2 and is based on the NFI inventory (data in Persson, 1975). The main part of the damage in the western and central counties Jönköpings, Iän, kronobergs Iän, Hallands Iän, Älvsborgs Iän, and Skarabors Iän occurred after the storm on 22 September, while the main part of the damage in the Svealand occurred during the 1 November storm (Persson, 1975). The damage was mostly confined to spruce, especially older forest and the thicker trees Jantz, 1971). In the most heavily damaged district, almost 70% of the damaged volume was made up of spruce that held 50% of the total growing stock. Damage in Scots pine on average corresponds to its share of the total growing stock. Deciduous forest suffered little damage. The observed damage was positively correlated with tree height, and recently thinned stands were also more susceptible to damage, especially older recently thinned stands and in stands where a large proportion of the basal area had been removed (Persson, 1975).

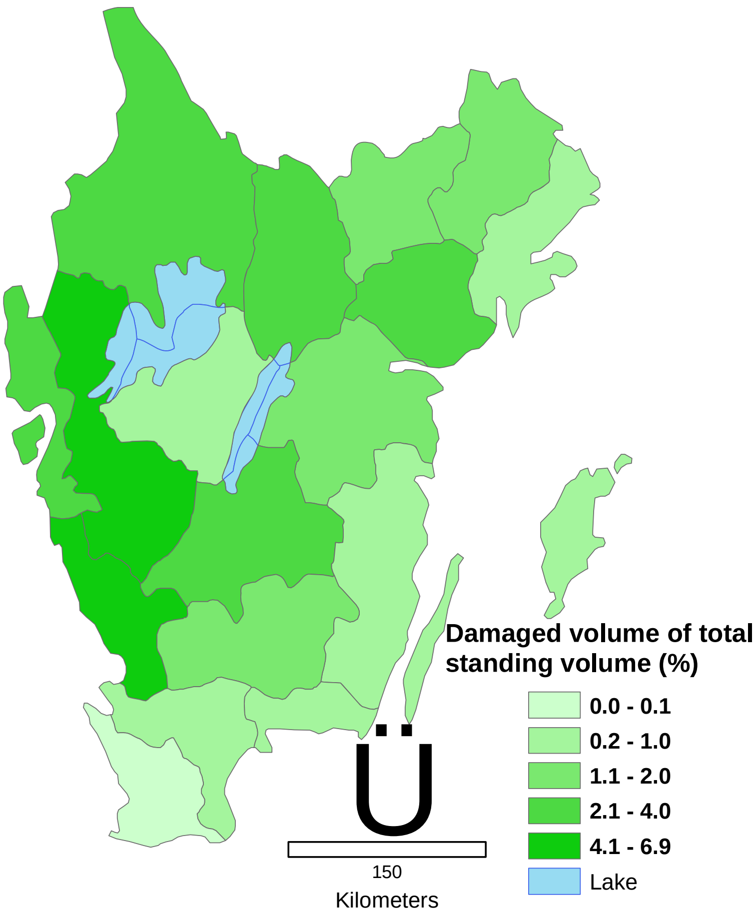


Figure 2. Wind damaged volume by total standing volume per county after the 1969 storms in southern Sweden. Based on data from NFI presented in Persson (1975).

Secondary damage

During 1971 – 1982 Sweden and large parts of the Nordic countries were affected by the most extensive outbreak of spruce bark beetle (*Ips typographicus* and *Pityogenes chalcographus*) ever recorded. In Sweden approximately 3 Mm^3 of trees were killed during the 1970s (Figure 1) (Eidmann, 1983) with the damage concentrated in 10 counties (Eidmann, 1983). Several factors contributed to the extensive damage: large bark beetle populations at the time of the storms, ample breeding material resulting from the wind damaged trees in 1969, and reduced vigor of the trees (Eidmann, 1983). Typically, the beetle population increases in fallen trees during the first season, and then attacks on standing trees occur over the next few years before the outbreaks fades out. The outbreak during the 1970s was prolonged, which was attributed to exceptionally dry summer weather in 1969, 1973, 1975, and 1976, and low amounts of precipitation during spring and early summer over several consecutive years. Together this gave rise to an abundance of drought-stressed trees (Eidmann, 1983).

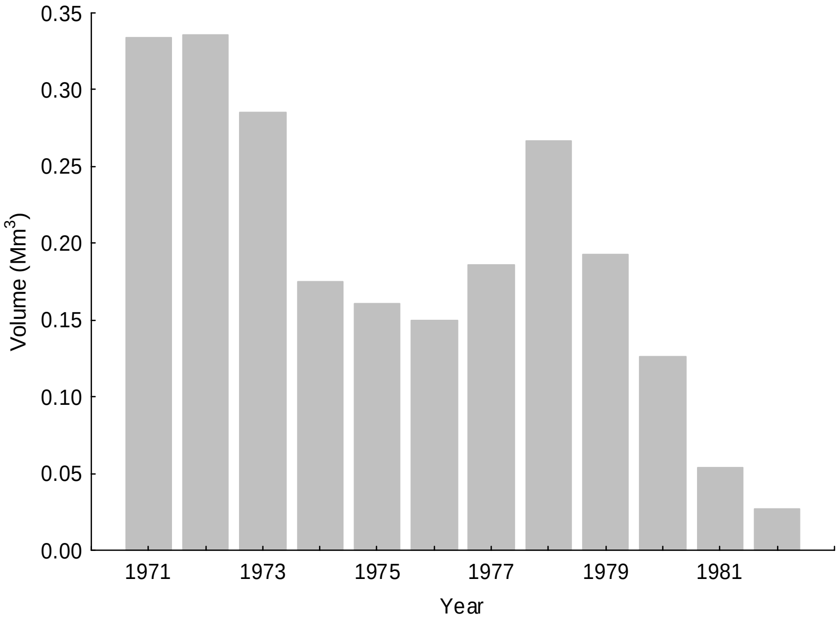


Figure 3. Volume of killed spruce by spruce bark beetle in Sweden during 1971-1982 (in thousands of m^3). (Based on Eidmann, 1983.)

Tertiary damage

In total, 50 MEUR of damage was caused in Sweden (monetary value of 1969) (SMHI, 2010). There were sixteen casualties (10 on 22 Spetember and 6 on 1 November), killed either directly during the storms or indirectly during the salvage work (SMHI, 2010).

Policy Response

In response to the 1969 storms it was decided on 22 November 1972 to establish a central committee for forest protection in Sweden as an advisory and reference forum to the Swedish Forest Agency. The committee was to act to prevent or reduce forest damage and to initiate action when damage occurs. Members of the committee are invited from the Swedish Forest Agency, the forest industry, the state forest company Sveaskog, forest owner association, universities, Swedish Environmental Protection Agency, and the Swedish hunters organization. The committee is still active in 2010.

In January 1978, more strict regulations were enacted in the Swedish Forestry Act that made it possible for proactive action to be taken to prevent bark beetle outbreaks and not after a damage event already had occurred (Ekelund & Hamilton, 2001). This was motivated by increasing spruce bark beetle populations due to new forest operations since the 1960s that involved harvesting all year around and the storage of logs with bark in the forest and alongside roads. The wind damage in 1969 and snow damage to young forest had aggravated the situation. The total annual reduction in growth due to spruce bark beetle damage was estimated to be 5% (Ekelund & Hamilton, 2001). The Swedish Government invested money to control the spruce bark beetle populations. In 1980 approximately 2,700,000 EUR (money of 1980) had been approved (Ekelund & Hamilton, 2001). The new regulations limited the period during which un-barked logs could be stored in the forest, regulated how un-barked logs were to be transported out of the forest and the maximum volume of un-barked logs that could be left at felling and pre-commercial felling sites(Ekelund & Hamilton, 2001). Together with the forestry industry, the Swedish Forest Agency and the Regional Boards of Forestry were to implement these the new regulations and ensure they were complied with.

References

Alexandersson, H. & Ivarsson, K.I. (2005) Januaristormen 2005. Faktablad No. 25, Swedish Meteorological Institute, Norrköping, Sweden.

Eidmann HH (1983) Hur gick det med granbarkborren? Härjningen 1971-82, bekämpningen och feromonerna. Skogsfakta, No. 11.

Ekelund H & Hamilton G (2001) Skogspolitisk historia. SUS 2001. Swedish Forest Agency, Jönköping. ISSN 1100-0295

Jantz K (1971) Stormfällningarna belysta av Riksskogstaxeringen. Skogen, 9:303-305.

Persson P (1975) Stormskador på skog – uppkomstbetingelser och inverkan av skogliga åtgärder. Research Notes No. 36, Dept. Forest Yield Res., Royal College of Forestry, Stockholm.

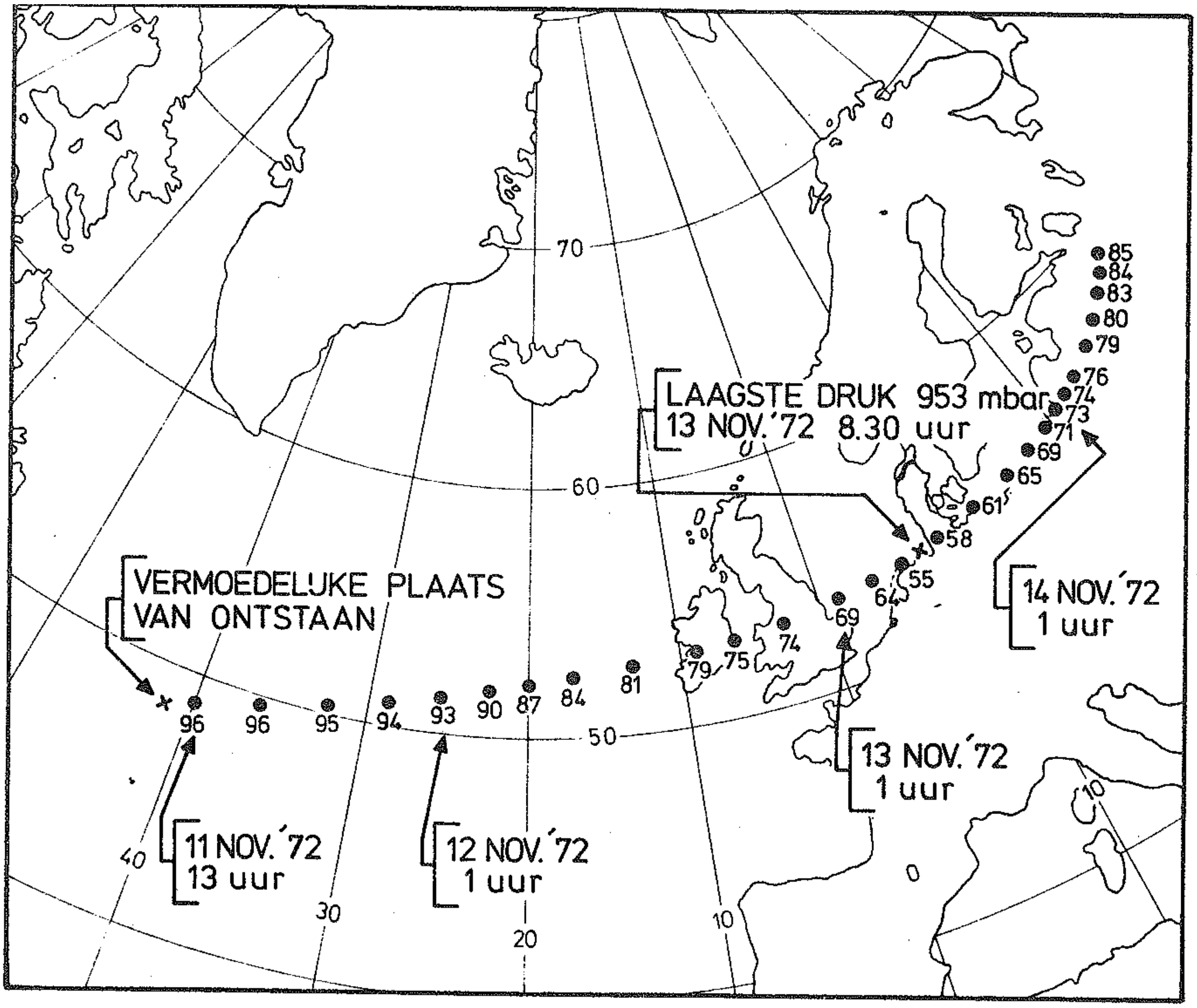
Skogbrand (2010) Data compiled at Skogbrand, Norway.

SMHI (2010) Orkanernas höst. Swedish Meteorlogical and Hydrological Institute.
http://www.smhi.se/kunskapsbanken/meteorologi/orkanernas-host-1969-1.5748:

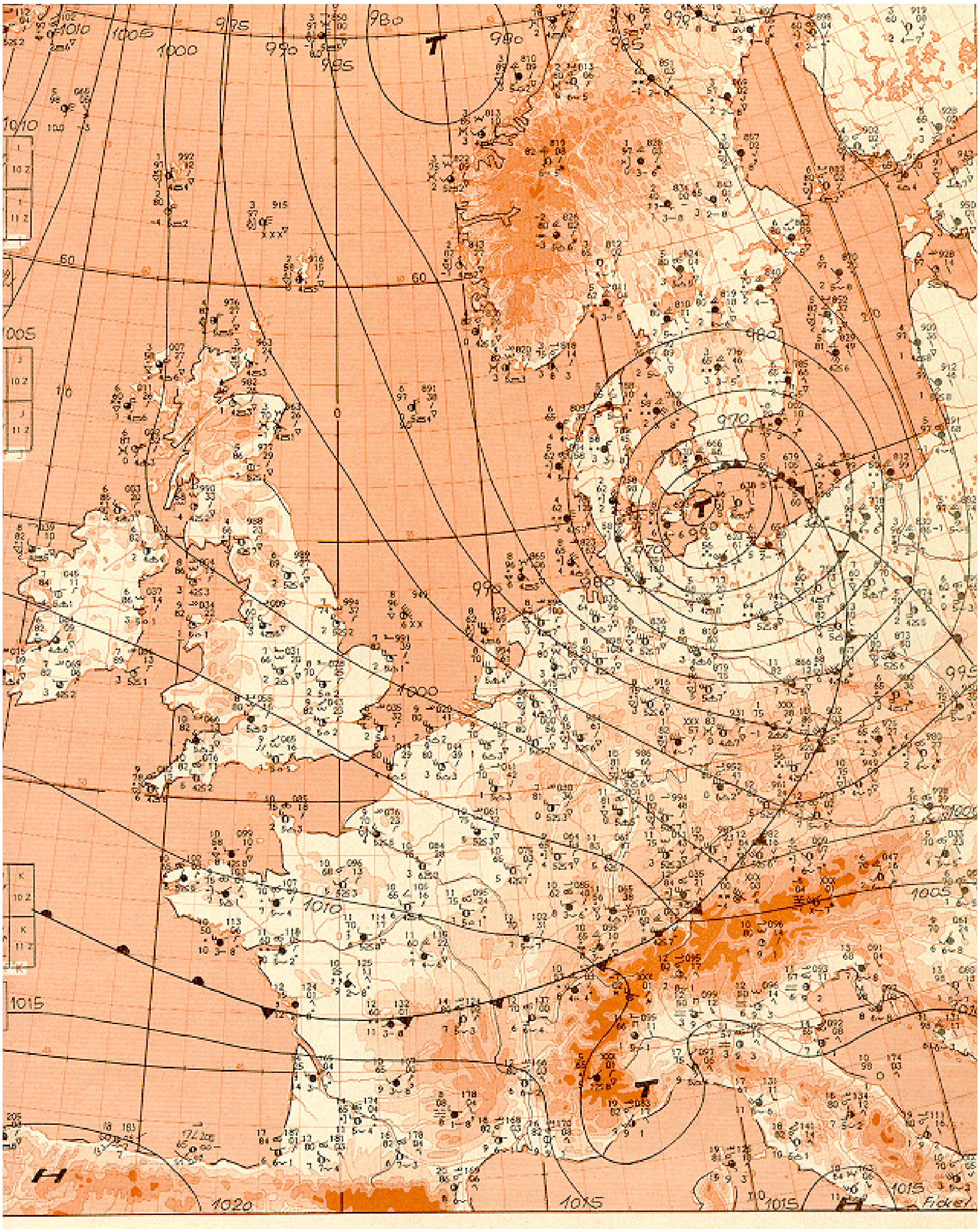
Storm of 13 November 1972

Meteorological conditions

In the Netherlands, the storm of 13 November 1972 reached Force 11, with gusts up to 151 km/h. This was an exceptionally heavy storm, which passed very quickly. The air pressure in the centre of the depression lowered to about 953 mbar just north of the mouth of the Elbe (Fig). Over land, on the Dutch coast, average windspeeds of up to 28ms-1 were measured with gusts exceeding 40ms-1 (Kate and Zwart 1973)

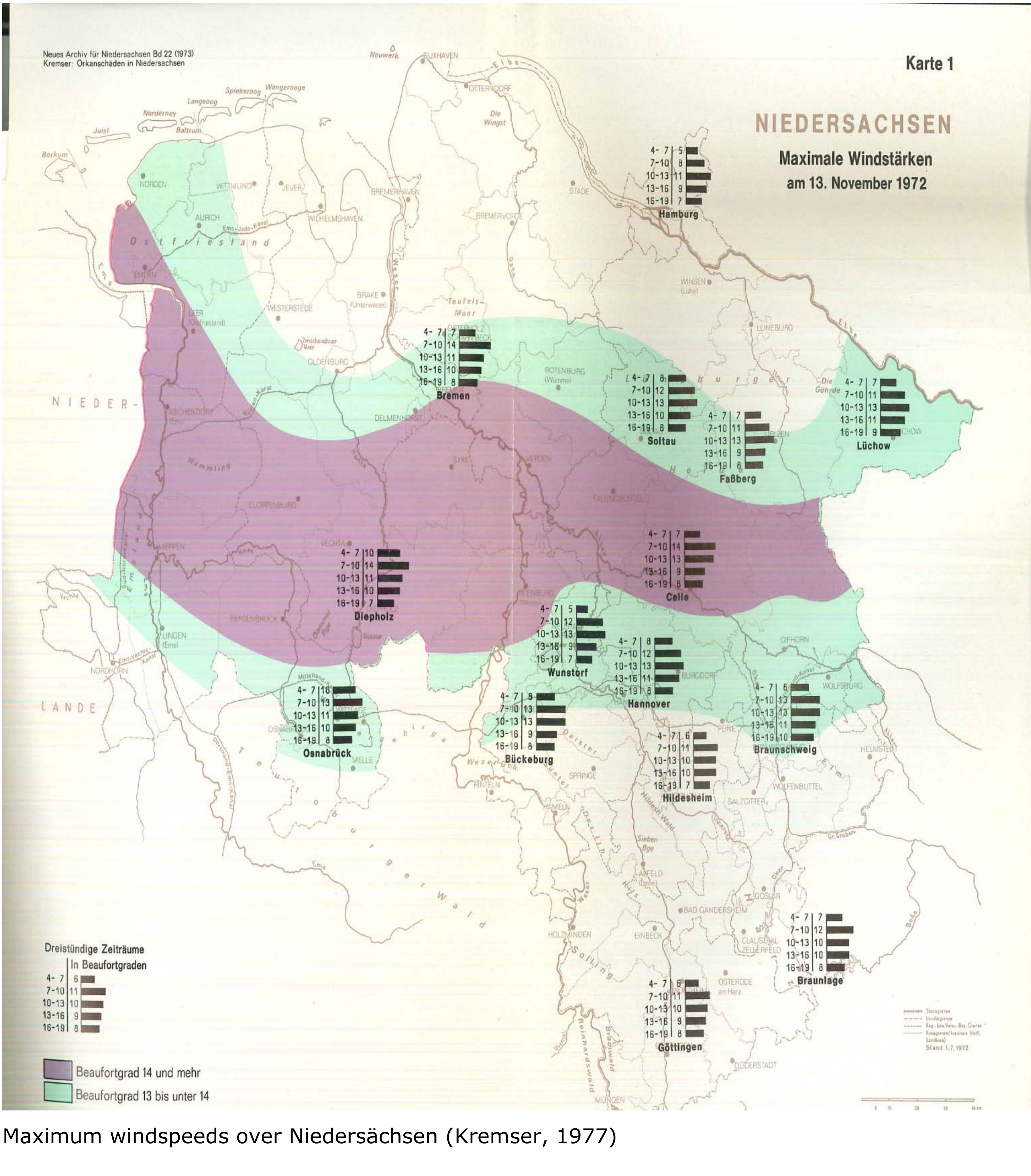


The track of the depression of the storm of November 1972, after Kate and Zwart (1973)



weather map of the Deutschen Wetterdienstes from 13-11-1972: 12:00 GMT

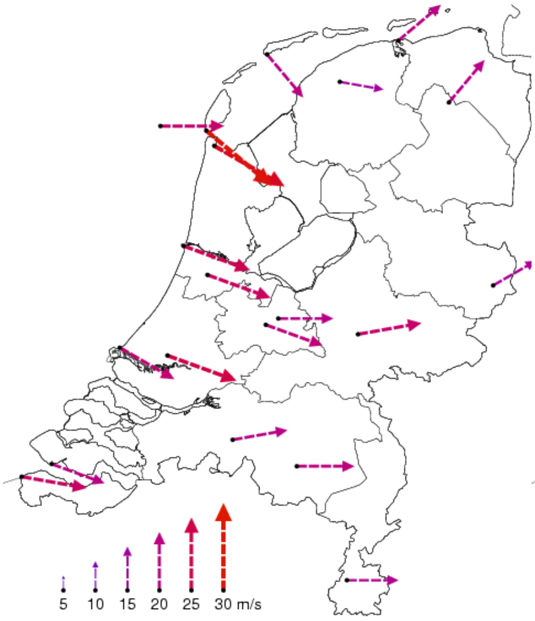
The depression that caused the storm of April 1973 followed the same track and behaved in a similar way as the depression leading to the severe storm of 1972. This time the air pressure lowered to about 968 mbar, 150 km northwest of Den Helder. In the Netherlands, again average windspeeds up to 28ms-1 were measured at the coast, and again gusts exceeding 40 ms-1 were reported. However, the area that was affected by this storm was much smaller than the area affected by the 1972 storm and was restricted mostly to The Netherlands (Kate and Zwart 1974).



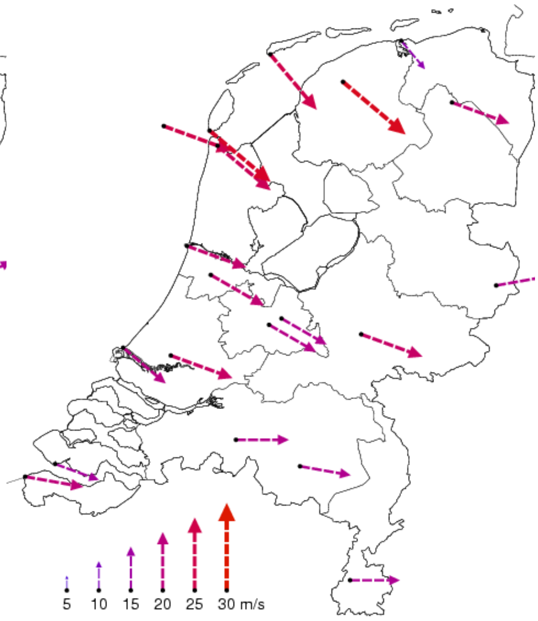
Maximum windspeeds over Niedersächsen (Kremser, 1977)

"*An extremely active storm-depression crossed our country during the night from Sunday to Monday. In the centre of the depression, that passed by just north of the Waddensea, a pressure of 955 mbars was measured. The wind speeds, attending the passage of the fronts accompanying this depression, were around 25 ms-1 on average. On many location gusts of 41 ms-1 were measured. The westerly circulation, maintained by a high-pressure region over Spain en a low-pressure region over Scandinavia, will continue on Tuesday as well. A new depression, lying on the ocean now, will course easterly quickly and can reach Western-Europe by tomorrow. These developments will maintain the weather's changeability*".

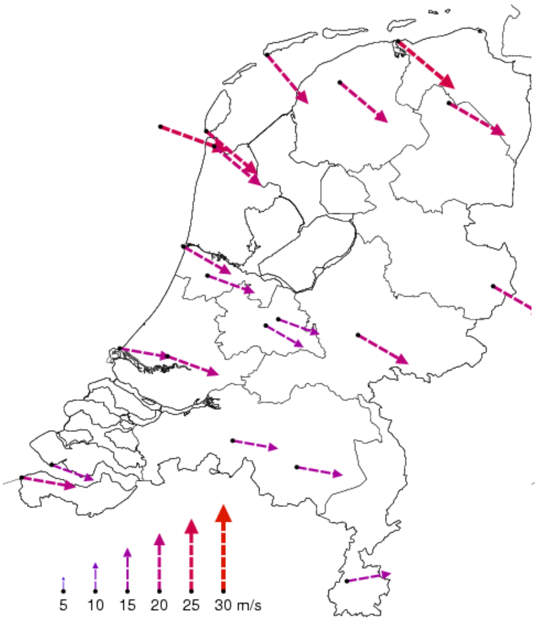
Extract from a weather report of the storm on November 13, 1972 in The Netherland



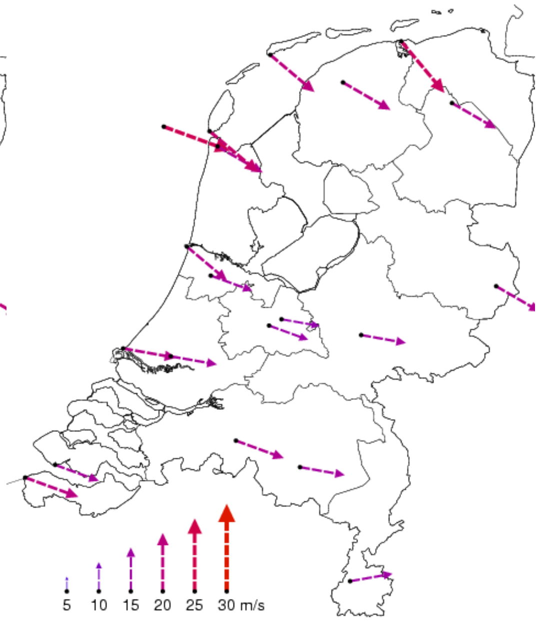
0600GMT



0700GMT

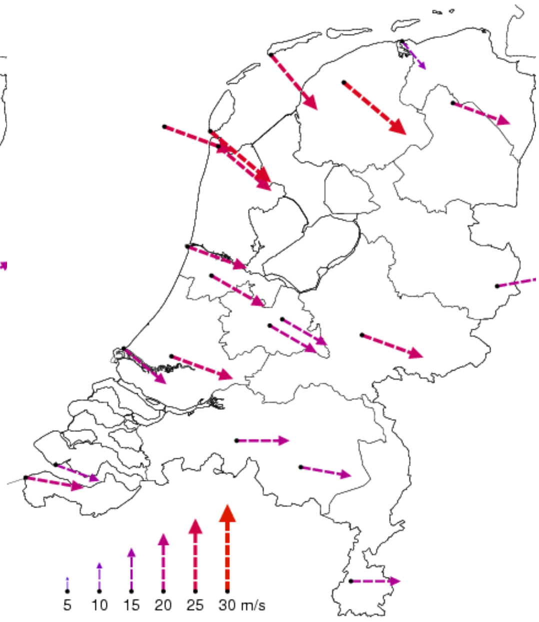


0800GMT

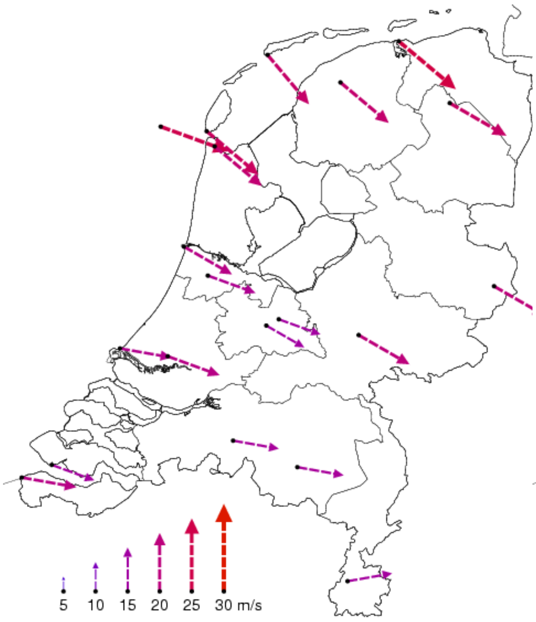


0900GMT

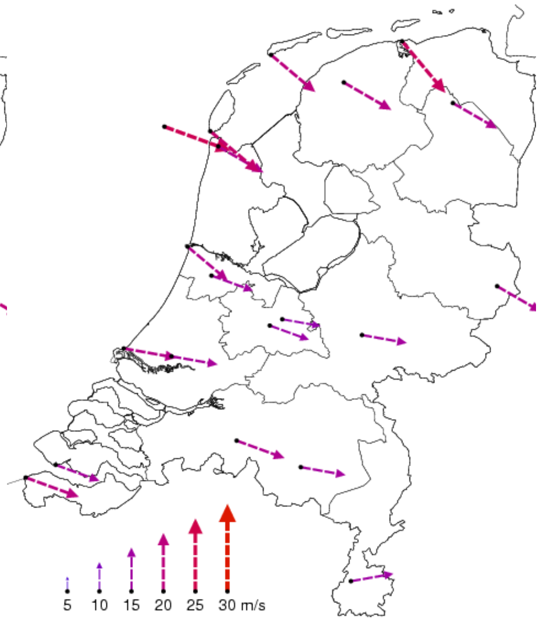
0600GMT



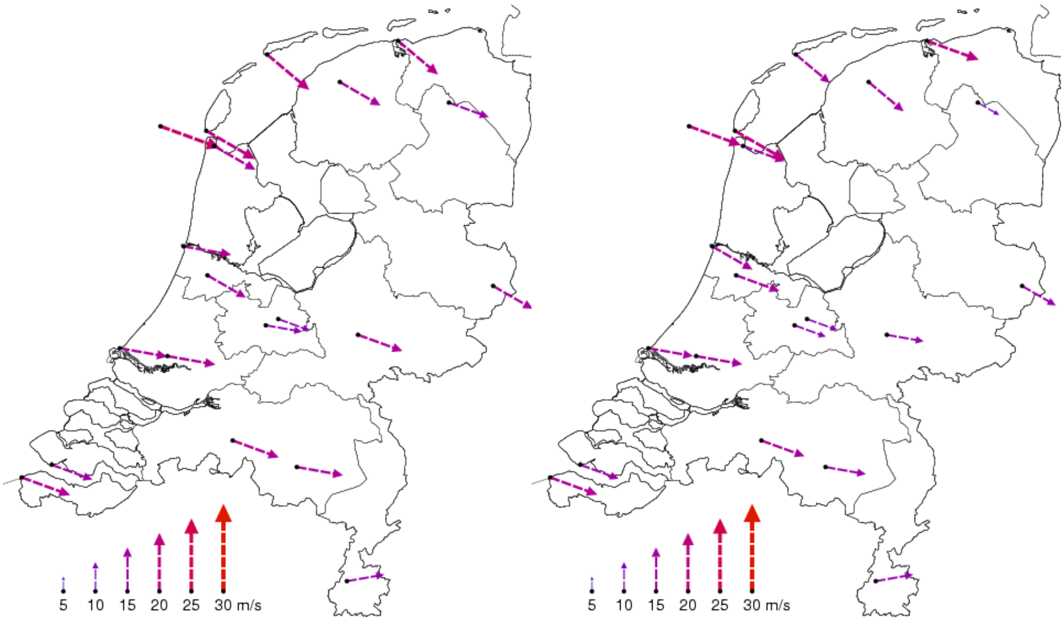
0700GMT



0800GMT



0900GMT



1000GMT 1100GMT

Hourly windfields during passage of storm (02:00 - 11:00 GMT)

The paths of both storms (13 November 1972 and 2 April 1973) were hardly different. The place of origin was almost the same. The speed at which both depressions deepened and the location where they deepened were almost the same. The storm of 13 Novermber 1972 mostly hit the northern part, the 2 April 1973 storm hit mostly the central part of the country. No damage was reported outside the Netherlands in 1973.

Short description on damage

In The Netherlands, the impact of the 1972 storm was enormous and many trees were damaged. The second storm in 1973 caused additional damage in the Netherlands.

The 1972 storm affected south-England,northern-France, Belgium, The Netherlands, northern-Germany, Denmark and Poland. Wind gusts in Germany reached up to 50 ms-1 (170 km/h), but by that speed the anemometers broke down. Wind gusts might have reached up to 200 km/h (Otto 1994). In the U.K. the Daily Mirror reported a 'Floody Sunday' as due to the heavy rains hundreds of houses were flooded in southern-Wales. The Dutch 'Redding Maatschappij' (Lifeboat Association) rescued 40 people from sea. In the Netherlands especially, forests in the northern part of the country were damaged and much damage to buildings was reported (Kate and Zwart 1973).

The storm of April 1973 caused considerable damage too, but this time the damage was restricted mostly to the Netherlands. Forests in the central part of the country were affected, but the total damage was on average less than the damage caused by the 1972 storm (Kate and Zwart 1974).

Primary damage

The total damage in Europe is reported to be 25 Mm^3 by Guillery (1987), whereas Doll (1991) reported 28 Mm^3 in the plaines of northern Europe.

The Netherlands

In the Netherlands, especially the Northern provinces were affected. 4-5 million trees were blown down. 'Vereniging Natuurmonumenten' estimates a loss of a million guilders (Kate and Zwart 1973). The storm of Arpil 1973 caused particular damage in the forests of the Veluwe and Utrecht, situated in the centre of The Netherlands. The number of fallen trees was about half the number of trees blown down by the 1972 storm (Kate and Zwart 1974).

The total damage estimate for the Netherlands is 0.75 Mm^3 by Heij (1972), 0.8 Mm^3 by Rottmann (1986), 0.93 Mm^3 by Nas (1990) and 1 Mm^3 by Doll (1991). According to Heij (1972), the storm hit mostly conifers, especially older pine stands on the Veluwe and Douglas fir, spruce and larch in Drente.

Geographic spread within NL (November 1972 storm only):

Drente	470
Overijssel	165
Gelderland	225
Friesland	53
Groningen	15
Utrecht	21
N-Holland	11
N-Brabant	14
other provinces	1
Total	975

(van Nispen tot Sevenaer 1975)

The damage was almost exclusively to conifers. About 60% of the damage was to Pines while larch suffered least damage (Luitjes 1977). The normal annual coniferous harvest is 590 thousand m3 (van Nispen tot Sevenaer 1975) but around 6000 ha needed to be reforested (van Nispen tot Sevenaer 1975).

In the Netherlands, the salvage fellings of the 1972 storm were just about finished when the country was struck by the storm of April 1973. Although the amount of damage was about half the damage of the 1972 storm (see Table), the prize for wood was much lower due to the previous storm (State Forest Service 1973).

Table. Damage in The Netherlands, in thousands m^3 by the 1972 and 1973 storms. After State Forest Service 1973. (See report for breakdown to province and owner)

	Pinus	other	Total

		species	
1972	456	472	928
1973	434	138	572

Germany

In West-Germany, damage was estimated at 16.5Mm^3, of which 4.2Mm^3 spruce, 10 Mm^3 pine and the other 2.3Mm^3 broadleaved species, mainly beech. The planned harvest for 1973 was 26 Mm^2 (State Forest Service 1973). Wiebecke (1973) reported about 18 Mm^3 damage, of which 60% pine, 34% spruce, 6% oak and beech. The normal harvest in West-Germany was 26Mm^3, so the storm “delivered” 68% of this in two hours. Around 90% of the damage was in Niedersachsen. Bøllehuus (1999) reported 17 Mm^3 of damage in West-Germany. Doll (1991) reported 17.6 Mm^3 in the northern part of West Germany and 7.5 Mm^3 in East Germany. Also Guillery (1987) reports 17.6 Mm^3 in West Germany, mainly in Luneburger Heide and its surroundings. Mayer (1985) reports 15.92 Mm^3 in Niedersachsen and 0.9 Mm^3 in Nordrhein Westfalen. Also Schmidt (1973) reports 15.9 Mm^3 in Niedersachsen (See Schmidt (1973) for a more detailed breakdown of damage by owners, tree species and forest districts). Schmidt (1973) reports for Niedersachsen that the damaged volume was five times the normal annual harvest.

Mayer (1985), underbark, commercial volume (=probably Erntefestmeter):

	'Niedersachsen'	'Nordrhein-Westfalen'
Oak	260000	0
Beech	640000	90000
Spruce	4610000	700000
Pine	10410000	110000
Total	15920000	900000

Schmidt (1973)

Owner	Damage
State	7700000
Church	600000
Co-operative forest	400000
Private	7200000
Total	15900000

Kremser 1977:

	Oak	Beech	Spruce	Scots pine	
Schleswig Holstein		2	34	7	43
Niedersachsen	255	643	4610	10414	15922
Nordrhein-	4	90	701	105	900

Westfalen					
Hessen		30	150	20	200
Rheinland-Pfalz		15	55		70
Baden-Württemberg					0
Bayern			150	60	210
	259	780	5700	10606	17345

http://www.spiegel.de/spiegel/print/d-42762309.html

The Damage in Niedersachsen was more than 10% of the standing stock or about 15.9 Mm^3, about 5 times the annual harvest. The damage in Nordrhein-Westfalen, especially close to Detmold, was about 1 Mm^3, in Reinhardswald (Hessen) about 300 thousand, and in Schleswig-Holstein about 50 thousand m^3. Southwest Germany and Bayern had virtually no damage.

Otto (1994) reports that in Niedersachsen 17 Mm^3 was damaged and(?) 100 thousand ha deforested. 84% of the damage occurred in the plains with 16% in hilly and mountainous areas. The damage to oak was 126% of the normal harvest, in beech 61%, in spruce 462% and in Scots pine 1228%. In the centre of the storm (Wildeshäuser Geest) 4 forest districts lost 40-60% of their standing volume. Another 16 districts lost 20-40% of their standing volume, the remaining 15 districts lost 10-20%. In the central zone of the storm was an area where the loss of standing stock was over 20%, a tenfold annual harvest. In this central area, damage was in all types of species and stands where even 200-300 year old healthy oaks were damaged. Outside of the central zone, some patterns could be distinguished. Coniferous even-aged stands suffered most damage. Mixed coniferous/broadleaved stands seemed to be more stable. High thinning seemed to give more stability than low thinning.

Damage map of Niedersachsen (Kremser 1977)

Eastern Germany:

In a map by Kremser (1977), 2.5 million m^3 of damage is mentioned in the area of Magdeburg and Potsdam (western part of Brandenburg and northern part of Sachsen-Anhalt), 3-6 times the planned harvest of 1973. A small zone south from this is indicated as having twice the planned harvest for 1973. A source is identified as "Die sozialistische Forstwirtschaft 12/72".

The path of the storm (damage) was over mid/north Netherlands (0.9 Mm^3), then middle of West-Germany (18 Mm^3), ending in the mid of Eastern Germany (east of Potsdam) (7.5 Mm3). It is not very likely that other countries sustained damage.

In Niedersachsen , Schmidt (1973) highlights who were affected by the storms

Owner	Damage (m3)
State	7700000
Chruch	600000
Co-operative forest	400000
Private	7200000
Total	15900000

Wiebecke (1973) writes that out of a total of 110 thousand ha of damage, 100 thousand ha occurred in Niedersachsen, of which 55 thousand ha was in privately-owned forests.

In the Netherlands, Van Nispen tot Sevenaer (1975) documents that storm damage affected 465 thousand m^3 in State forests and 500 thousand m^3 in privately-owned forests.

Secondary damage

Niemeyer (1982) reports that in Niedersachsen in 1973-74, 459881 m^3 of Norway spruce and 378293 m^3 of Scots pine were treated against bark beetles.

Extract from Luitjes 1977 (translation) The Netherlands:
"1973: In *Pinus* a strong development of *Tomicus piniperda* and *Hylurgops palliatus* took place. Less numerous were *Xyloterus lineatus* and *Gnathotrichus materiarius*. *Ips sexdentatus* was observed rarely. In spruce a high density of *Hylurgops palliatus* and *Dryocoetes autographus* was observed. *Pityogenes chalcographus* and *Xyloterus lineatus* were less numerous, whereas Ips typographus was found only on two locations, in a very low density. Density of insects on larch and Douglas fir were generally low. In general the insects *Tomicus piniperda*, *Xyloterus lineatus* and *Gnathotrichus materiarius* would be classified as damaging. *Hylurgops palliatus* and *Dryocoetes autographus* were numerous and compete for space with damaging insects and are thus useful. Furthermore they are a food source for common predators (like *Thanaainus formicarius*

and *Rhizophagus depressus*) and host for parasites. However, they might also contribute to spread blue stain fungi.
1974: More types of species in pinus and spruce than on larch and Douglas. No insects in Douglas fir bark and wood. New was the occurrence of Ips cembrae, until then not found as damaging species. *Ips typographus* had spread over the full province of Drente, and caused much mortality. Very incidentially it was found in Scots pine. *Tomicus piniperda* was again very numerous. *X. lineatus* was less frequent than in 1973. Ips sexdentatus was not very frequent in both years. H. palliatus and D. autographus were in both years numerous. *H. abietis* was found in stumps, young beetles in the ones infested the previous year, now also larvae in Douglas fir stumps.
In 1975 and 1976 the development of *Ips cembrae* and *I. typographus* was studied in more detail (for the first time in NL). In 1976 hardly any breeds were found, perhaps due to the exceptionally dry summer of 1976.
In April 1975 a regulation came into force that it was not allowed to have logs with bark of Picea or Larix in the forest (harvested, uprooted or broken) between June 1 and October 1. Moreover, the Industry Board for Forestry can oblige owners to fell standing trees attacked by *Ips* and to lay out catch trees".

No account of total damage is given.

Germany (Niedersachsen):
Altenkirch et al. (1979) reports that the "Most impotant damaging agents were Ips typgraphus and Pityogenes chalcographus in spruce. Also *Trypodendron lineatum/Xyloterus lineatus* was important due to its damaging activites in lying wood. 172 thousand m^3 of spruce was infected in 1974, 222 thousand m^3 in 1975. In Scots pine Tomicus piniperda was most important. In 1974 570 thousand m^3, in 1975 249 thousand m^3 was infected".

Tertiary damage

Wiebecke (1973) mentions an early estimate of costs for clearing, protection, regeneration, road repairs of over 1 billion DM. Follow-up damage in neighbouring stands is not included and neither are losses due to lower-priced assortments and loss of investments.

In the Netherlands, especially the Northern provinces were affected with 4-5 million trees blown down. 'Vereniging Natuurmonumenten' estimates a loss of a million guilders (Kate and Zwart 1973).

In the Netherlands in the years before the storms, a number of pine stands had been selected as seed tree stands, to provide first class seeds for the forestry sector.

However, a large number of these selected stands were heavily damaged by the storms. Harvesting of the fallen cones from these damaged stands provided enough seeds for the first years after the storms (State Forest Service 1973).

Direct casualties

In total 54 people died due to the 1972 storm, of which 9 were in the Netherlands and 39 in Germany (Kate and Zwart 1973).

In the Netherlands 3 people died due to the 1973 storm, in England 3 people also died and in Germany several casualties were reported (Kate and Zwart 1974).

Casualties in clearing up damage

Netherlands:
In the state forests, 90 accidents were reported in 1973 and 71 in 1972, 40 of these accidents were related to the working situation in the storm damaged forests.
Types of injuries:

Head	2
Eyes	-
Body	2
Arms	4
Wrists and hands	14
Legs	8 (of which 3 broken legs)
Feet and ankles	10
Total	40

Causes:

Chainsaw	16
Axe	9
Rolling or falling trees or branches	10
Stumbling and falling	5
Total	40

Additionally, in private enterprises 106 accidents were reported (39 wrists and hands, 35 legs and 32 feet and ankles) although figures provided probably do not present a complete overview (State Forest Service 1973).

Germany (Niedersachsen):
Arnold et al. (1977) states that 700 accidents were reported in the state forests in connection with clearing up the storm damage. Especially during the first months there were a considerable number of accidents, which decreased once forest workers were adapted to the situation. About 30% of accidents were due to stresses in the wood and

rolling stems, 25% was due to the use of chainsaws. This could have been lower when chain brakes would have been used and the use of safety clothing would have helped (as in Sweden). Falls accounted for 14% of accidents. A considerable number of accidents were due to falling root plates. There were 6 deadly accidents. A detailed table with causes and injured parts of the body can be found in Arnold et al. 1977.

To mitigate the expected increase in injuries in private forests, 3000 leaflets about safety were issued. Also safety demonstrations were given on several occasions. In private forests 602 accidents were reported the first 7 months, of which 12 were deadly. The use of a helmet could have prevented most of deadly accidents. No knowledge of safety precautions or the unwillingness to apply them was a major cause of accidents.

Policy response

In Germany, the estimated cost for clearance and replanting was around 1 billion DM (1972). The government took a lot of measures (e.g. subsidies, tax assistance). The 1973 harvesting plan was cut down by 20% and Germany asked the European Union to temporarily limit German wood imports. On March 5 of 1973, Germany was allowed to stop its importats of firewood, softwood logs, pulpwood, mine wood and also to limit to 2,000,000 m^3 its importation of sawn softwood.

In The Netherlands, the state decreased its wood sales as long as private owners didn't sell their wood. The Low-Lands State also hired extra labour in the state forests to allow the harvester to work with private owners. To speed up the clearance, owners with more than 50 m^3 were able to apply for a subsidy of 21 guilders/m^3 if the pine wood was harvested before May the 15th , 1973 (and the others species before January the 1st , 1974). A subsidy of 50% is given for owners to replant within 3 years while Stefels (1975) mentions a 90% subsidy for replanting.

Van Nispen tot Sevenaer (1975) recorded that despite agreements between forest owners and wood traders to avoid a market collapse, prices decreased strongly. The time limits set within the subsidy schemes contributed to this decrease. Not all the wood could be sold immediately and had to be stored, with extra costs. Subsidies for clearing and transport helped a great deal. However, these were subsidies only for the extra costs due to the storms.

Wiebecke (1973) highlights a range of measures that were introduced in Germany from the late 1960s (translation):
The severe storm damages of 1967 and 1968 initiated the forest damage compensation law in 1969. This enabled the government to initiate a series of help measures if needed.

To avoid a flooding of the market with roundwood and to avoid or slow down drops in wood prices, the harvest of Scots pine was determined at 30% and spruce at 70%, with the harvest ratio in individual cases not dropping by more than 80%. For specific important assortments an import licence procedure was prescribed. Corresponding to the 1969 law, transport costs could be lowered due to freight subsidies. Tax measures supported companies in various ways, especially by using the favourable tax tariff of the income tax. After the forest damage compensation law of 1969, further measures were introduced including claims to the compensation fund (Betriebsausgaben-Pauschalsätzen)

Particularly important was the financial support for the stricken forest owners. From the federal government 35.5 million DM was allocated for Niedersachsen and 2.5 million DM for Nordrhein-Westfalen and Hessen. From the government of Niedersachsen 40 million DM was made available. This money was used as subsidies to process the wood, for transport costs, conservation and storage.

There was a lot of criticism of the measures. The lowering of the harvest in areas far away from the actual damage lead to a boom in the wood market and caused difficulties in the delivery of wood to the industry.This experience shows how difficult it is to use very general regulations in individual cases. We have to keep in mind that the instruments were large. There is a large risk of oversteering.

While there was a demand for more broadleaves in the forest, it was thought that private owners would plant those species that will yield cash in the shortest timeframe. However, in contrast to earlier catastrophies this time the public discussion started focussing on the future goals of forestry and the consequential implications for forest policy decisions. Thus, a primarily technical clear-up of the storm damage without interference should be supplemented by a modification of the silvicultural and economic goals of forestry.

In the Netherlands, clear felling of forest areas by the storms removed exotic tree species in nature reserves and provided growing space for native tree species (State Forest Service 1973). Moreover, new plans drawn up for the State Forestry areas that were damaged by the storms, focussed attention on the structure and stability of the forest. They further aimed at increasing the proportion of broadleaved tree species (State Forest Service 1973). The storms clearly demonstrated the lack of capacity for mechanical clearance. In the whole country only one small forwarder and a second-hand skidder were operational. The Dutch State Forestry Service invested in mechanisation, by buying 136 chainsaws and a skidder. In consultation with the State Forestry Service a contractor bought a further processor (State Forest Service 1973) and several entrepreneurs invested in mechanisation. In some of the major forest areas, co-operation of forest owners contributed to clearing up of damage resulting in timely clearance (for the subsidies), limited extra costs for clearance, and reasonable prices for stored logs.

The few places where the blown down trees were not harvested acted as eye-openers to foresters and provided much information on natural regeneration (Neefjes 2007).

http://www.spiegel.de/spiegel/print/d-42762309.html reports in January 1973 that: "Wood felling is reduced by 20% in West Germany. Because two thirds of the damaged trees in Niedersachsen are Scots pine trees, only 30% of the foreseen fellings in pine can be carried out and only 70% of spruce. The aim is to have 5 Mm3 of windthrown wood redirected to South and Southwest Germany. Railroad transport is given 14-22% reduction in transport fares. Not sure if road transport will receive support as well. Also import reductions are being asked for in Brussels. The Hannover administration is recruiting a forest-worker army from Yugoslavia, Austria and Switzerland to support the usual 2600 forest workers".

Otto (1994) notes that in Germany "The largest mistake made after the storm was impatience. Standing remnants of stands and unstable new edges were often harvested too soon, because people thought they would not recover. Smaller follow-up damage always takes place and should not be taken as a reason to harvest everything. In the state forest there was 7 Mm3 direct damage, with additionally at least 1 Mm3 harvested in the next years in de-stabilised stands and edges".

In relation to the labour force the State forestry service in Germany (?) hired local workmen to help with the clearance (State Forest Service 1973).In the Netherlands, a number of Swedish harvest machines/ harvesters were put to work and in some places Swedish and Norwegian forest workers were employed to help with the clearance (State Forest Service 1973).

Regarding pests and diseases, I*ps typographus* had not been reported in the Netherlands yet, but *Tomicus piniperda* was already much feared. The policy was to clear all the fallen pine wood from forests following the 1972 storm before May 15th 1973. However, the new storm of Aril 1973 made this impossible, as during this storm many pine trees were blown down. The new date for pine wood to be cleared or for its bark to be removed, was set at 23rd July. This date also proved to be ambitious and special storage places were therefore set up. Pine wood was stored and kept wet or stored more than 2 km away from the closest pine stand (State Forest Service 1973).

In Germany, Luitjes (1977) reports that in April 1975 a regulation came into force where it was forbidden to have logs with bark of Picea or Larix in the forest (harvested, uprooted or broken) between June 1 and October 1.

During 1973 four extra editions of the forestry magazine 'Bosbouwvoorlichting' were published in The Netherlands to inform on the clearance work (State Forest Service 1973).

Effects on timber markets

After both storms the wood prices decreased temporarily from 35-40 Dutch guilders per m3 to 1 Dutch guilder per m3. In the Netherlands, the salvage fellings of the 1972 storm were just about finished when the country was struck by the storm of April 1973. Although the amount of damage was about half the damage of the 1972 storm (see Table), the price for wood was much lower due to the previous storm (State Forest Service 1973).

In the Netherlands, wood export to northern Germany came to a standstill since in Germany large quantities of wood had also became available due to the storm (see above). Part of the Dutch wood was exported to Belgium, some was used in Dutch paper mills and pine wood was used in the Dutch mining industry. Nevertheless, wood prices still dropped, even though the world market wood prices were on the increase. In the summer of 1973 wood prices in the Netherlands were on the increase again (State Forest Service 1973).

http://www.spiegel.de/spiegel/print/d-42762309.html: (January 1973)
The timing of the storm (in the beginning of felling season) was much better than the catastrophe in 1967. Spruce market was doing quite well, expectations are that the spruce can be marketed within the area. For Scots pine wood there is probably a need to export it.

Literature

Altenkirch, W., G. Hartmann, H. Kolbe, H. Niemeyer, D. Stahl, W. Thalenhorst 1979. Dokumentation der Sturmkatastrophe vom 13. November 1972. Teil V: Forstschutz gegen biotische Schäden. Mitteilungen aus der Niedersächsischen Landesforstverwaltung Heft 31.

Arnold, H-U., W. Behrndt et al., 1977. Dokumentation der Sturmkatastrophe vom 13. November 1972. Teil II: Die Aufarbeitung des Sturmholzes. Mitteilungen aus der Niedersächsischen Landesforstverwaltung Heft 27.

E. Bøllehuus, 1999. FSL's stormfaldsberedskab - januar 1999 http://www.fsl.dk/Storms-1tormber.htm

Guillery, C. 1987. Introduction *Revue Forestière Francaise* (39) 4 245-247

Heij, W. 1972. Het opwerken en bewaren van stormhout *Nederlands Bosbouw Tijdschrift* (44) 12 277-284

Kate, H. ten, en B. Zwart, 1973: De storm van 13 november 1972. Verslagen V-248, 21 p. Koninklijk Nederlands Meteorologisch Instituut.

Kate, H. ten, en B. Zwart, 1974: De storm van 2 april 1973. Verslag V-256, 20 p, Koninklijk Nederlands Meteorologisch Instituut.

Kremser, W., 1977. Dokumentation der Sturmkatastrophe vom 13. November 1972. Teil I: Darstellung des Schadensereignisses. Mitteilungen aus der Niedersächsischen Landesforstverwaltung Heft 27.

Kuiper 2008, Weermagazine mei 2008

Neefjes, M. 2007. Product van storm en moeder natuur. Vakblad Natuur, Bos, Landschap 4 (3) : 24-25.

Otto, H.-J., 1994. Nach dem Sturm. Erfahrungen und Folgerungen aus der Sturmkatastrophe 1972 in Niedersachsen. Der Wald Berlin 44, p. 52-55.

Schmidt, G.D., 1973. Schäden in Niedersachsens Wäldern durch den Orkan vom 13. November 1972. AFZ Nr 3, p. 26.

State Forest Service, 1973. Jaarverslag Staatsbosbeheer [Annual report 1973]

van Nispen tot Sevenaer W. J. C. M., 1975. De gevolgen van de stormrampen voor de bosbouw in Nederland *Nederlands Bosbouw Tijdschrift* (47) 2 41-52

Wiebecke C., 1973. Volkswirtschaftliche Bedeutung der Sturmkatastrophe 1972 und forst- und holzwirtschaftspolitische Folgerungen *Forstarchiv* (44) 140-143

Storm of 16th October 1987

http://www.bbc.co.uk/essex/content/image_galleries/1987_storm_gallery.shtml

Meteorological conditions

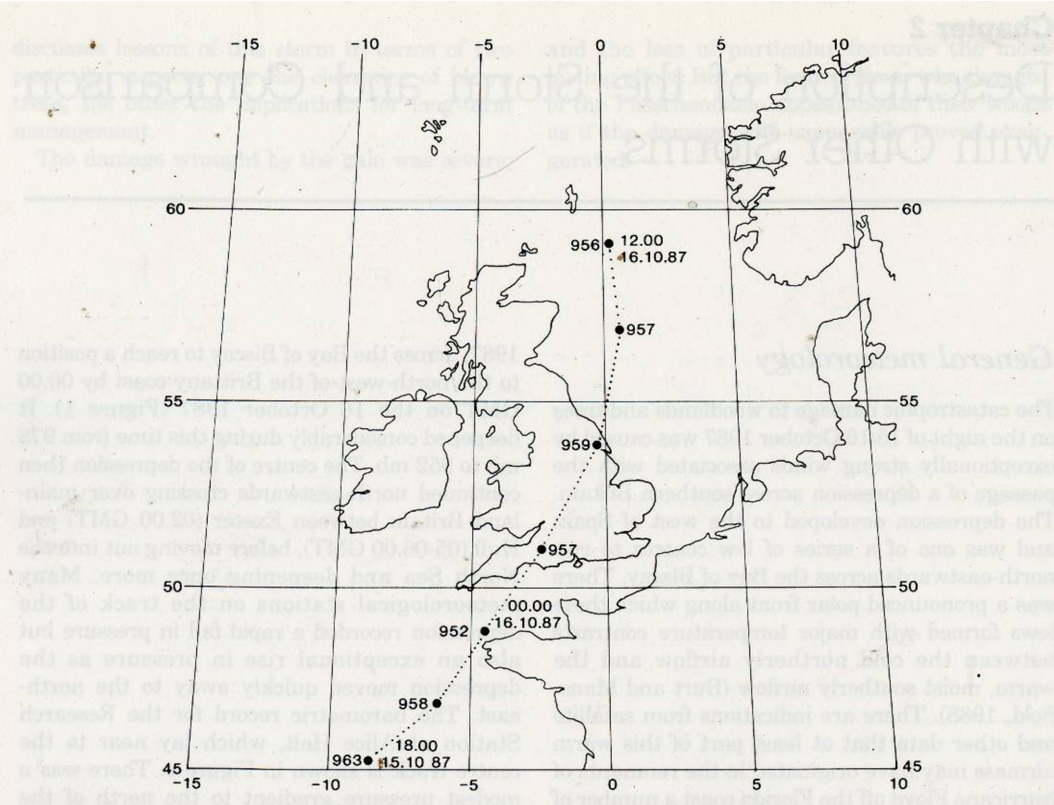
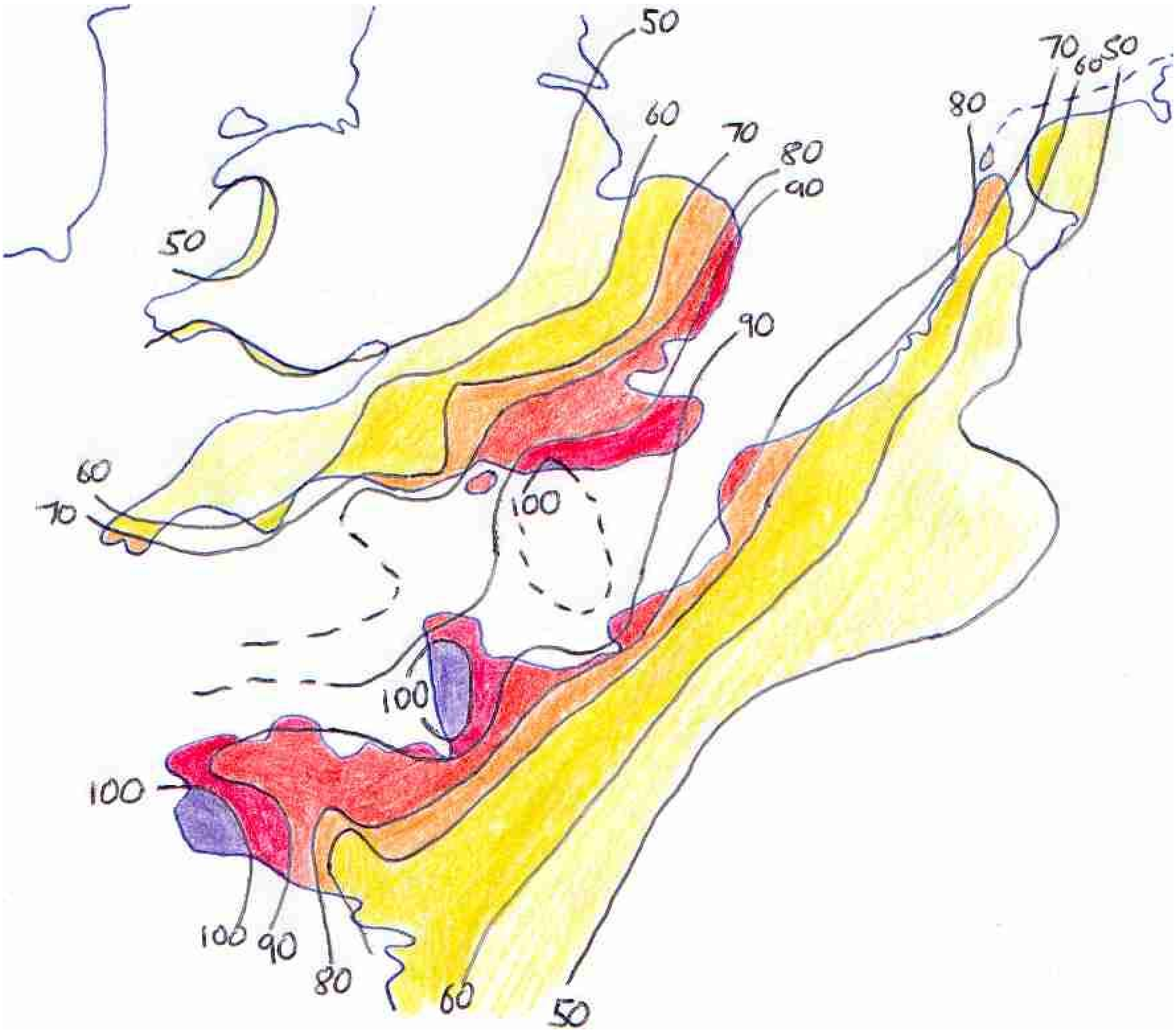


Figure 1. *Passage of centre of depression at 3 hourly intervals. (Pressure in millibars.)*



http://www.dandantheweatherman.com/Bereklauw/Octstorm.html

In France, the first depression reached Brittany about 6 pm on 15 October with winds of 13.3 to 16.8 ms^{-1}, followed by the second with winds of 29.9 ms^{-1} about midnight. North-west of a line from the mouth of the vilaine trough Rennes to Deauville gusts over 38.3 ms^{-1} were generally experienced overland with over 46 ms^{-1} on coasts. The wind hit the west coast of the Cotentin at 59 ms^{-1} at Granville and was still 44 ms^{-1} at St Vaast le hougue on the east.

In England, an intense, and almost certainly exceptional, depression crossed the coast of South Devon soon after midnight, moving quickly, and deepening rapidly, with a track across the Midlands and out towards the Humber Estuary. Some very severe conditions due to storm force winds were generated around the southern and eastern flank of the low, with gusts well in excess of 35 ms^{-1}, reaching a peak in the period 0300 GMT to 0700GMT, with gusts to 45 ms^{-1} reported along the south coast.

The very stormy conditions were accompanied by some heavy rain, this rain pushing into Scotland and parts of Northern Ireland after dawn. Clearer weather, on westerly winds, swept across southern Britain, pushing the worst of the stormy winds away into the North sea. The ratio maximum gust to maximum mean is between 1.6 and 1.8. and there are lower figures on the coast and higher on urban areas. There is no evidence of the peculiarly gusty nature to the storm. In South-East England, gusts in excess of 40 ms^{-1} have a return period of 200 years.

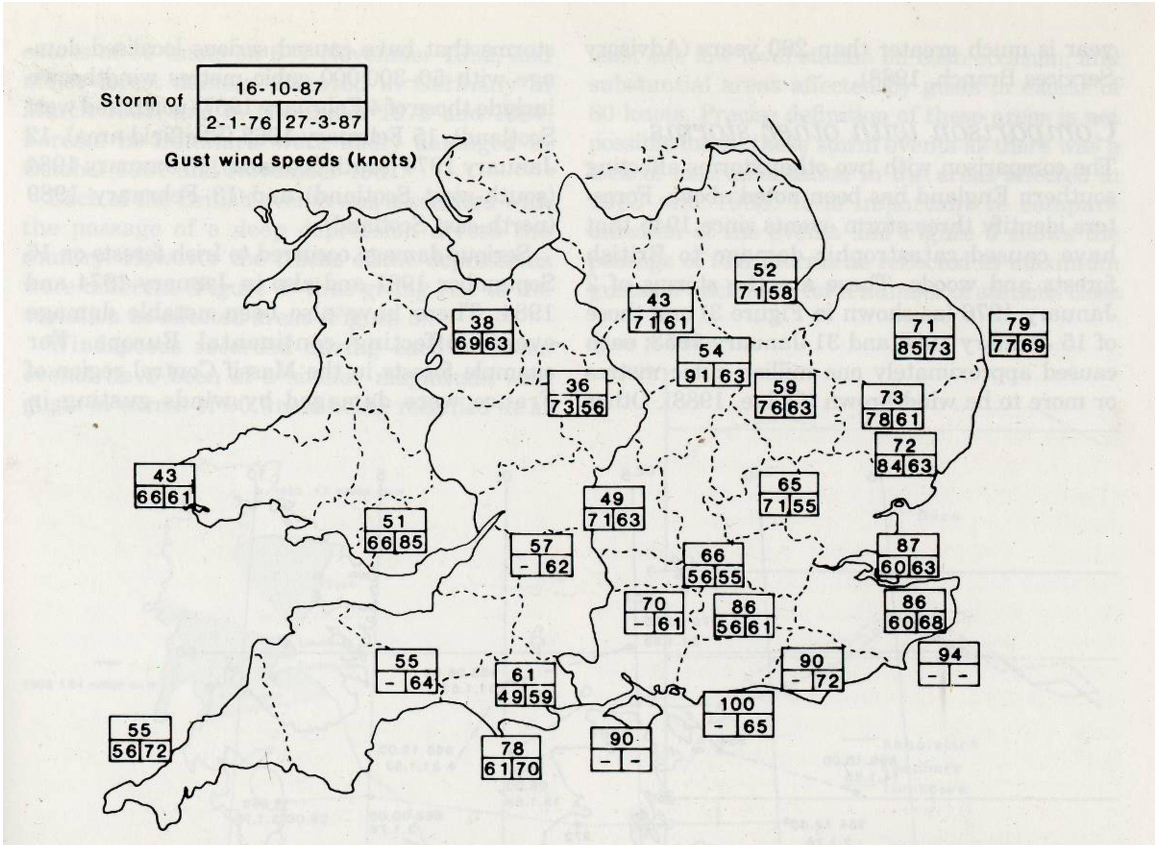


Figure 3. *Comparison of the storm of 15/16 October 1987 with two previous storms in southern England and Wales. (Maximum gust recorded at selected Meteorological Office recording stations.)*

Footnotes: 1knot=0.51ms^{-1} ; 1km/h=0.28ms^{-1}

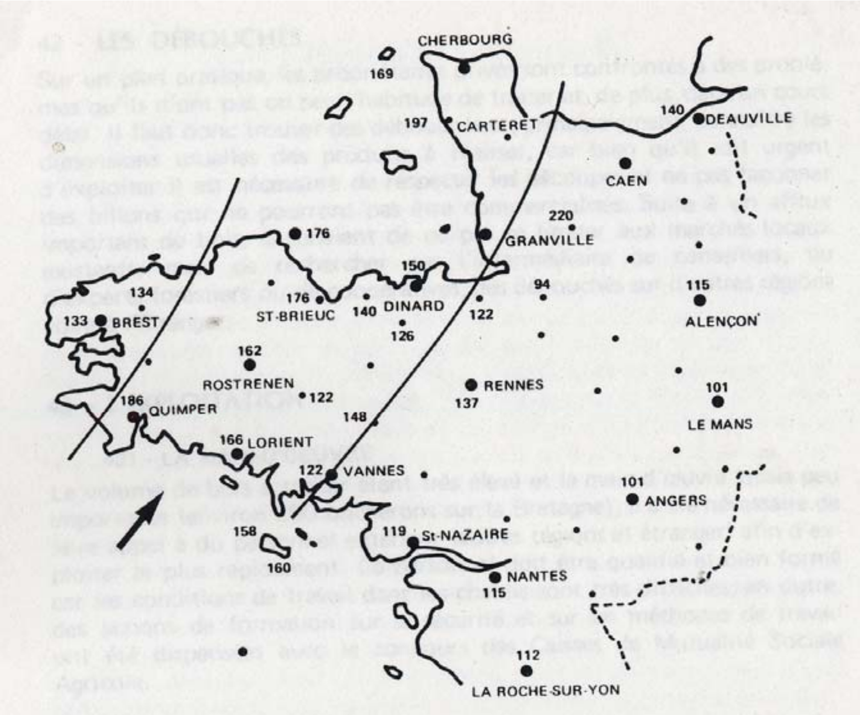


FIGURE 1

Vitesses maximales du vent en km/h dans la nuit du 15 au 16 octobre 1987.
Maximum speeds of the wind (km/h) during the night of october 1987, the 15th to the 16th.

Short description on damage

Three millions householders and businesses were without electricity at the peak of the power cuts in England and the estimated damage to buildings was assessed at £1 million. There was also a big psychological impact from non-woodland trees that were blown down with loss of familiar trees having a dramatic effect on people travelling to work. The South-east of England is highly populated and a lot of trees fell down near properties. Overall there were a total of 18 storm-related in England. In France 4 people died and 15 people as a result of the storm.

Overview of primary damage to forest (see Annex 4,5,6,7,8)

England:

The volume assessments for conifers involve the volume overbark of the main stem of the trees up to 7 cm diameter. For broadleaves, it's until the main stem is no longer obvious. There are difficulties in assessing the damage in the private forest. A global estimation is thought to be reliable with the sampling of a wide panel of private properties.

Table 1. Estimated volume of damage[a]

Thousands of cubic metres overbark

	Suffolk	Essex	Kent	E. Sussex	W. Sussex	Surrey	Hants	Other[b]	Total
Forestry Commission conifers	430	0	160	140	50	20	50	80	930
Forestry Commission broadleaves	0	0	10	20	50	0	30	0	110
Total	430	0	170	160	100	20	80	80	1040[c]
Private Woodland conifers	80	10	70	240	300	90	40	150	980
Private Woodland broadleaves	200	90	300	340	400	160	80	150	1720
Total	280	100	370	580	700	250	120	300	2700
Non-woodland conifers and broadleaves	30	10	20	10	30	20	10	40	170
Total conifers	510	10	230	380	350	120	100	230	1930
Total broadleaves	230	100	330	370	480	170	110	190	1980
Total volume blown	740	110	560	750	830	290	210	420	3910

a As published on 16 November 1987.
b 'Other' includes London, Norfolk, Cambridgeshire, Hertfordshire, Buckinghamshire, Berkshire, Dorset and the Isle of Wight.
c Subsequently revised following later survey work to 1100 thousand cubic metres.

In the Forestry Commission woodland, post storm aerial photography was used for calculating the windthrown volume. The more information already known about the woodland the easier is it to assess damage according to the report of FWAC (1989).

Other results show that 72 % of the damage occurred to privately owned woodlands and trees.

Table 2. Proportion of original standing volume blown down

	Suffolk	Essex	Kent	E. Sussex	W. Sussex	Surrey	Hants
Forestry Commission conifers	27%	5%	44%	51%	20%	8%	3%
Forestry Commission broadleaves	3%	neg.	10%	23%	22%	neg.	3%
Private Woodland conifers	20%	7%	25%	35%	30%	10%	4%
Private Woodland broadleaves	8%	4%	18%	18%	18%	5%	2%
Non-woodland	3%	2%	4%	6%	5%	3%	2%
Total	13%	4%	18%	24%	19%	6%	2%

In total, 12 % of the original growing stock was brought down by the storm, representing 4 years of the normal increment in these areas and a little over 5 times the average annual cut (775 000 cubic meter) of recent years For conifers, it represents 5 months total UK production and for the broadleaves 2 years UK production.

In France (see annex 2)

The total damage in France measured 7.3 million cubic meters.The most significant impact of the 1987 storm was in Brittany with 6.5 millions m3 of trees blown down, representing 20 % of the growing stock and 8 to 10 times the annual harvesting for the Brittany. In Normandy, the volume blown down represented only 0.75 million cubic meters.

Table 4. Estimated volume blown by species group, size class and ownership

		Volumes in thousands of cubic metres		
		Forestry Commission	*Private Woodlands*	*Total (rounded)*
Pine	Small roundwood	200	200	400
	Sawlogs	500	350	850
	Total	700	550	1250
Other conifers	Small roundwood	100	200	300
	Sawlogs	100	250	350
	Total	200	450	650
All conifers	Small roundwood	300	400	700
	Sawlogs	600	600	1200
	Total	900	1000	1900
Oak	Under 16″ diameter	10	320	300
	Over 16″ diameter	10	480	500
	Total	20	800	800
Beech	Under 16″ diameter	60	240	300
	Over 16″ diameter	20	360	400
	Total	80	600	700
Other broadleaves	Under 16″ diameter	5	200	200
	Over 16″ diameter	5	300	300
	Total	10	500	500
All broadleaves	Under 16″ diameter	75	760	800
	Over 16″ diameter	35	1140	1200
	Total	110	1900	2000

Secondary damage

In England:

The 1988 summer was cool and damp but the 1989 summer was dry. Before the 1989 dry summer, 73 % of the damaged volume from the Forestry Commission forest had been harvested and 48 % of the damaged volume from the private woodlands. The Forestry Commission harvested the majority of the trees before the summer and has minimized the secondary damages.

However, the storm-damaged trees were subject to a loss in timber value due to stain (discoloration of the wood that does not involve a reduction in strength) and decay (loss of wood quality).

Psot-storm harvesting concentrated firstly on broken and shattered trees. With the exception of beech and pines trees with roots could wait for 3-5 years. In relation to tree species:

Beeches (0.8 million cubic metre of beech were blown down): were not so damaged because most trees were blown at the roots. In the first year (1988), there were no more problems than usual due to the weather and very low insect population prior to the storm. Most of the trees was partly rooted and remained green.

Pines (1.2 million cubic metres of pines were blown down): In 1988, there were some problems with blue Stain caused by the insect *Tomicus. Piniperda*, which is often associated with the fungus *Leptographium*. Scots pine are more affected than the Corsican pine. Thus, Scots pine needed to be cleared first. Another insect, *Ips sexdentatus (*associated with *Ophiostoma brunneociliata* and *O. ips*), attacked the fallen pines.

Beeches and pines: In the second year (July 1989) brown stain started to appear caused by the fungi *Stereum Sanguinolentum* and *Peniophora Gigantea* but mostly on snapped trees. This meant that the wood could not be used for paper pulpwood and many sawnwood uses. *Stereum Sanguinolentum* and *Peniophora Gigantea* caused very low problems of decay.

There was little damage to standing trees surrounding windthrown areas but the population of *T piniperda* must have been detected afterwards.

Table 8. Progress of clearance of timber in woodlands [a,b]

Quarter ending	Private Woodlands cu.m.	%	Forestry Commission cu.m.	%	Total cu.m.	%
December 1987	127 000	5	60 000	6	187 000	5
March 1988	432 000	16	169 000	16	601 000	16
June 1988	670 000	25	302 000	29	972 000	26
September 1988	870 000	32	430 000	41	1 300 000	35
December 1988	1 150 000	43	570 000	55	1 720 000	46
March 1989	1 306 000	48	755 000	73	2 061 000	55
June 1989	1 550 000	57	875 000	84	2 425 000	65

a Excluding non-woodland trees, clearance of which by June 1989 was assessed at 100 000 cubic metres out of an estimated total of 170 000 cubic metres.

b Percentage calculated relative to 3.7 million cubic metres. This volume represents the original estimated total: in the event some blown trees may not be harvested while others such as leaning and edge trees may be removed.

Tertiary damages

In England:

There were problem for the market to absorb windthrown material especially for broadleaves. For conifers there was a high demand for small roundwood in the first year and the pulpwood market was quite good (200 000 cubic meter exported in the early clearance 1988). It was expected that conifers would be sold by early 1990 except for the Forestry Commission's log store. 74 % of estimated blown conifer volume was cleared on 1989. The market for broadleaves had been falling since 1980 (-25% of sold volume in 7 years), especially beech and white hardwood. These trees were sold at a lower value market. There were no problems with selling high quality hardwood overseas.

Table 9. Estimated price levels in south-east England

Description	Prices in £ per cubic metre under bark	
	Before October 1987	*September 1988*
standing and windblown		
mature pine	20-25	10-15
mature oak	25-40	10-40
mature beech	15-25	0-10
logs at roadside		
pine	35-40	20-30
oak	40-60	30-60
beech	30-35	10-20

Source: Dewar, 1988.

However, prices within the affected areas fell substantially. Storage was a solution so that timber could be sold at higher prices in following years and to limited. Storage at Lynford, Thetford Forest prevented prices deteriorating further following the 38% fall in prices of sawlogs at the Cambridge auction in 1988.

Table 10. Prices obtained in the Forestry Commission's Cambridge auctions for sawlogs free on lorry

Grade	Prices in £ per cubic metre under bark				
	July 1987[a]	*February 1988*	*July 1988*	*February 1989*	*July 1989*
Standard Category I	50.14	30.84	32.57	34.83	42.61
Merchantable	46.05	24.59	30.76	33.48	37.27

a From non-windblown material.

Two important pieces of advice was provided by the FWAC to the private sector:

- do not panic and try to clearing up anything which is not a danger to life or limb
- do not reduce the value of timber by cutting into small lengths.

In France:

Most of the wood blown down in Brittany was of an average to poor quality. Thus problems selling it were likely to arise. Much of the wood wass normally used to make wood pulp so it could not be absorbed locally. In Normandy, most of the trees blown down were hardwood, but the timber was dispersed.

The estimation of French forestry services in 1987 of the volume of timber to be put on the market included:
1.8 million cubic meter of hardwood pulpwood
0.9 million cubic meter of coniferous pulpwood
0.7 million cubic meter of coniferous timber
1.3 million cubic meter of hardwood timber.

Policy response

In the United Kingdom:

A few days after the storm, the Forest Commission created the Forest Windblow Action Committee (FWAC) to manage the crises, which was composed of representatives from Timber Growers UK, Forestry Commission, British Timber merchants' association of England and Wales and UK wood processors' association. The main actions of the FWAC were to:

- Assess the quantity of timber blown down, figures published on 16 November 1987
- Hold 4 public meetings with woodland owners.
- Publish a booklet *Guidelines for dealing with windblow in woodlands* in January 1988
- Prepare lists of contractors and timber merchants, which were made available to over 1500 enquirers
- Provide a first report to the Forestry Commission in 1988 which proposed actions and made recommendations for government assistance.
- Provide a second report to the Forestry Commission in 1989 giving a brief account of the FWAC work and suggested lessons to be drawn form the storm

The FWAC also created a Windblow Task Force at the Forestry Commission's Research Station of Alice Holt Lodge to provide advice and information to woodland owners, timber merchants, contractors and other enquirers.

Other measures were also taken to deal with the storm.
Financial

- A few weeks after storm, the *Countryside Commission Task Force Trees* gave grant aid of almost €5.75 millions (£2.5 million in 1987) to 70 authorities and voluntary organisations.
- The Governement provided financial aid divided between non-woodlands and woodlands.
  - Non woodlands: the Secretary of State for the environment financed 75% of local authorities expenditure and provided £250 000 for Royal Parks and £2.75 million for Countryside Commission for replanting, mostly in publicly owned land.
  - Woodlands: In November 1988 £6 million was provided for restoration operations over 1988/1989 and 1989/1990. In June 1988 extra grant aid of £3.5 million was provided as an incentive to replant storm damaged areas over the

next five years (£150 per ha of coniferous x 5000 + £ 400 per ha of broadleaves x 7000ha).

- In March 1988, the Chancellor of the Exchequer announced the complete removal of forestry from income and corporation taxes

Storage:

- Mostly clean logs of fresh sawn pines were stored so that less than 5% of logs was blue stained. The costs were:
  - to clear the site: £49,000
  - Water and irrigation system: £16,000 or 34,800 actual euros
- One 4 ha of storage maximum site in Lynford, Thetford Forest. 50 000 cubic metre overbark in December 1988 and 75000 c.m in april 1989 (height of 3.5 metres of pines logs, 45 mm water per day sapwood moisture 120% to 130%)
- In February 1989, the first sample of wood was removed from the store and the quality of the wood was good.

Transport :
A subsidy for transport was quite slow (8 month after the storm) which limited its impact (road and rail). In 1989, it was estimated that 30-40000 tonnes of wood (wood density of pine : 740 kg/m^3 ; wood density of beech : 800 kg/m^3) had been hauled by rail, but this could have been increased if more rapid turn round of wagons. There are no figures for road haulage.

In 1988, there was a shortage of haulage capacity and it was estimated that with assistance with transport costs, up to 250.000 cu m per annum could have been absorbed by markets in other parts of Britain.

Labour:
The Forest Commission divided up forests on the basis of forest damage. They deferred harvesting in North Lincolnshire and Sherwood because the damages were low, but they harvested within the clearance period (2.5 years) in Thetford, NewForest, WestDowns and SouthDowns and Suffolk. The biggest problem was for the Weald as there were not enough men to harvest, even with a private local harvester. In this area they transfered 2 harvesters and 3 forwarders and gave courses on harvesting (chainsaw operators) for 100 men.

In France:

- 50 % subvention for the creation of tracks and log stores.
- 30 % subvention for buying forest exploitation materials.
- Training on security and logging method was provided by the government.

Effects on biodiversity

In England:

It was recognised that leaving dead tree on ground can be good for biodiversity (FC Hardings et al. 1988; Winter, FWAC 1988a, b; Nature Conservancy Council 1988) and in 1989, the Forestry Commission to planned to leave 200 000 cubic metres uncleared or partially cleared. The storm also provided an opportunity for species diversification by using natural regeneration or planting.

In 2002 a survey was carried out on 20 sites that had been damaged in the 1987 storm assessing the amount, size and species of naturally regenerating trees. A total of 22 tree and shrub species were found and saplings of the most abundant species were generally well established, being up to 11m stall and 7cm in diameter. The predominant species changed between observations. At many sites, seedling oak and beech were replaced by sapling birch. The type and amount of vegetation also varied between sites; it appeared to be related to soil type and to influence sapling density. The number of species present on sample plots varied between 0 and 8 with total sapling densities of up to 40 000 per hectares. Successful regeneration of broadleaved trees (>1100 per hectares) occurred on 75 % of sites, but the dominant species was usually different to the original crop.

Annex 1

Table 3. Proportions of areas[a] of pines blown in different age groups

	Percentage of area in 1986[b]					
Planting year class	*1966-75*	*1956-65*	*1946-55*	*1936-45*	*1926-35*	*1916-25*
Scots pine	9.9	22.6	28.8	34.6	71.0	94.3
Corsican pine	4.3	19.3	35.8	56.3	85.5	96.4

a Districts covered: South Downs, Weald, Suffolk.
b The analysis is crude since the representation of each species differs between 5-year planting year classes and among Districts.

Annex 2

	Forest	Growing stock of production forest (m^3)		Annual Increment of production forest(m^3)		Annual harvesting of 1985 (m^3)			Blowdown (m^3)		
	Cover %	Public forest	Private forest	Public forest	Private forest	Bois oeuvre	Bois d'industrie	total harvesting	Bois oeuvre	Bois d'industrie	Total blowdown
Morbihan	12.1	324,600	8,620,500	9,700	421,400	164,067	27,730	191,797	387,000	1,240,000	1,627,000
Cotes-du-Nord	9.1	293,100	7,082,600	11,250	307,500	54,565	18,678	73,243	618,000	2,000,000	2,618,000
Ille-et-Vilaine	7.9	1,728,100	5,334,200	39,400	195,350	151,371	12,286	163,657	156,000	470,000	626,000
Finistere	7.5	671,100	5,152,100	18,950	267,050	30,039	24,078	54,117	387,000	1,240,000	1,627,000
Total Britanny		3,016,900	26,189,400	79,300	1,191,300	400,042	82,772	482,814	1,548,000	4,950,000	6,498,000
Manche	3.5	100,800	2,149,300	6,650	86,350	28,471	2,632	31,103	56,500	43,500	100,000
Orne	13.8	5,491,900	7,439,200	120,300	241,950	226,358	165,305	391,663	70,000	30,000	100,000
Calvados	6.8	513,300	4,204,400	15,000	156,650	43,628	24,916	68,544	36,000	20,000	56,000
Seine-Maritime	14.4	9,974,500	6,002,200	228,550	191,650	256,712	114,496	371,208	210,000	105,000	315,000
Eure	19.4	3,557,400	11,613,900	72,700	371,200	239,442	255,189	494,631	121,300	60,650	181,950
Total Normandy		19,637,900	31,409,000	443,200	1,047,800	794,611	562,538	1,357,149	493,800	259,150	752,950
Total		**22,654,800**	**57,598,400**	**522,500**	**2,239,100**	**1,194,653**	**645,310**	**1,839,963**	**2,041,800**	**5,209,150**	**7,250,950**

Annex 3: Conversion to updated euros

Calender year			
GDP deflator at market prices			Money GDP
Calender year	2008 = 100	per cent change on previous year	Cash £ million
1986	46.876	3.42	389,149
1987	49.384	5.35	428,665
1988	52.485	6.28	478,510
1989	56.329	7.32	525,274
1990	60.683	7.73	570,283
1991	64.602	6.46	598,664
1992	67.031	3.76	622,080
1993	68.959	2.88	654,196
1994	70.050	1.58	692,987
1995	71.926	2.68	733,266
1996	74.529	3.62	781,726
1997	76.606	2.79	830,094
1998	78.305	2.22	879,102
1999	79.949	2.10	928,730
2000	80.897	1.19	976,533
2001	82.616	2.13	1,021,828
2002	85.174	3.10	1,075,564
2003	87.791	3.07	1,139,746
2004	90.004	2.52	1,202,956
2005	91.832	2.03	1,254,058
2006	94.392	2.79	1,325,795
2007	97.111	2.88	1,398,882
2008	100.000	2.98	1,448,392
2009[1]	101.500	1½	1,400,000
2010[1]	-	2¾	1,454,000

£1 in year	In 2009 prices is worth	In 2009 Euro
1986	2.165	2.430
1987	2.055	2.307
1988	1.934	2.171
1989	1.802	2.022
1990	1.673	1.877
1991	1.571	1.763
1992	1.514	1.700
1993	1.472	1.652
1994	1.449	1.626
1995	1.411	1.584
1996	1.362	1.529
1997	1.325	1.487
1998	1.296	1.455
1999	1.270	1.425
2000	1.255	1.408
2001	1.229	1.379
2002	1.192	1.338
2003	1.156	1.298
2004	1.128	1.266
2005	1.105	1.241
2006	1.075	1.207
2007	1.045	1.173
2008	1.015	1.139
2009[1]	1.000	1.122
2010[1]		

Sources and footnotes:

GDP Deflat For years 1964-65 to 2008-09 (1964 to 2008): calculated from ONS data for seasonally adjusted
For years 2009-10 to 2013-14 (2009 to 2013): derived from HM Treasury forecasts for GDP deflator

Cash GDP: For years 1964-65 to 2008-09 (1964 to 2008): ONS data for money GDP (not seasonally adjusted,
For years 2009-10 to 2013-14 (2009 to 2013): HM Treasury forecasts for money GDP at the Pre-

For years 2009-10 to 2013-14 (2009 to 2013), money GDP forecasts as shown in the Pre-Budget Report 2009

For further information and the 'User's Guide' to these series, please visit the following page on HM Treasury's
http://www.hm-treasury.gov.uk/Economic_Data_and_Tools/GDP_Deflators/data_gdp_index.cfm

Footnotes: (1) For years 2009-10 to 2013-14, this presentation now only shows percentage changes in line with

ECB reference exchange rate, UK pound sterling/Euro, 2:15 pm (C.E.T.)

2009	0.89094
2008	0.79628

Exported from:
http://sdw.ecb.europa.eu/browse.do?node=2018794

Storms of January 25th to March 1st 1990

25./26.01.1990	'Daria'
03./04.02.1990	'Herta'
07./08.02.1990	'Judith'
	'Nana'
13.-15.02.1990	'Ottilie' and 'Polly'
25.-27.02.1990	'Vivian'
28.02./01.03.1990 '	Wiebke'

Meteorological conditions

The meteorological situation during the winter of 1989/1990 showed some peculiarities. Above the western North Atlantic Ocean and Canada air temperatures in February were considerably lower than average. In contrast, above Northern and Eastern Europe a distinctive higher air temperature was measured. These preconditions resulted in the situation where storm cyclones could develop but not following their usual winter course (Kühnel, 1994).

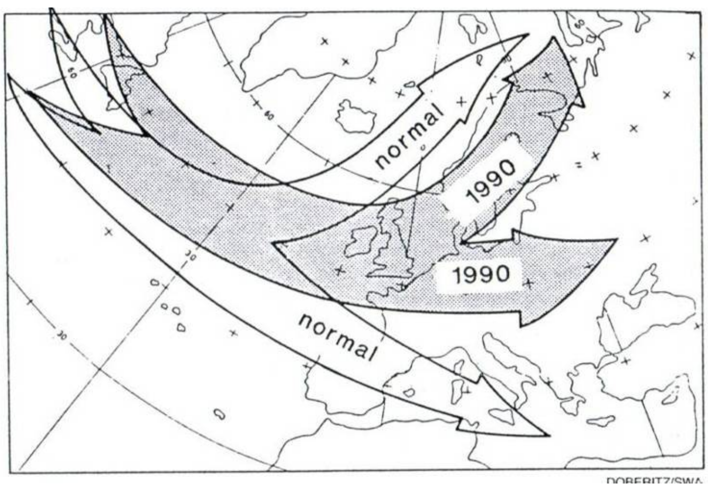


Fig. 1: Schematic illustration of the tracks of cyclones. White paths are the normal while grey describe the direction of the 1990 cyclones. Noticeable are the shift of the branching point from the eastern Atlantic Ocean to western Europe as well as the absence of the track towards the Mediterranean Sea (Kühnel, 1994).

The overall European winter in 1989/1990 was thus characterized by abnormally powerful cyclones in the North Atlantic region. The windstorm areas of these cyclones hit Europe repeatedly. Air temperatures reached record highs. It was stated that 1989/90 winter was one of the mildest during the 20th Century. For instance in Germany more than +20C were measured in several German regions on the 16th of December while in northern Russia a maximum of + 10C was observed. As a consequence soils were not frozen and thawing resulted in high plasticity (Preuhsler, 1991).

Between January 25th and March 1st, eight severe storms hit Europe across geographically widespread areas causing tremendous damages: The storms were namely 'Daria' (25./26.01.1990), 'Herta' (03./04.02.1990), 'Judith' (07./08.02.1990), 'Nana', 'Ottilie' and 'Polly' (13.-15.02.1990), 'Vivian' (25.-27.02.1990) and 'Wiebke' (28.02./01.03.1990).

The cyclone 'Daria' heralded the first winter storm in a series of eight disastrous storms. It began as a cold front over the Northern Atlantic Ocean on January 23rd and made landfall in the morning of the 25th of January over Northern Ireland before tracking to Ayrshire in Scotland. There was an extraordinary low air pressure of 950 hPa measured near Edinburgh around 4 pm. After hitting the United Kingdom, the storm moved rapidly in easterly direction towards Denmark. In some regions of western Germany gusts reached speeds up to 180 km/h. Wind speeds of 120-130 km/h were measured over large areas. 'Daria' was accompanied by strong rains and consequently flooding in some regions. The peak gusts caused extensive damage in monetary terms. The cyclone swept mainly through northwestern Europe and the northern part of Central Europe. The storm is presumed to be the UK's most expensive weather event for insuring companies to date (BBC news, 20.03.2007).

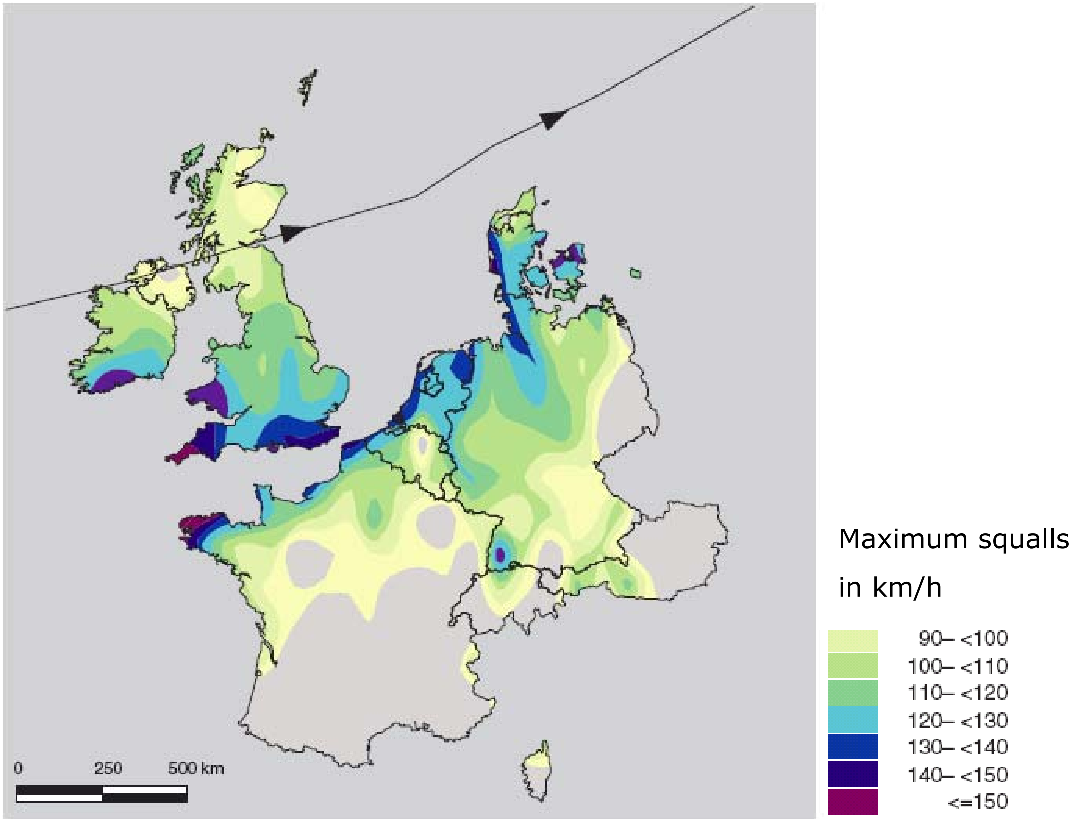


Fig. 2: Wind field of the hurricane 'Daria' (MünchnerRück, 1999).

The second cyclone in this series was 'Herta'. 'Herta' evolved from a little border cyclone over the British channel and caused serious flooding in England. The air temperature was about +12 C and air pressure 1016 hPa until 4 pm. From 4 pm to 6 pm air pressure declined to 1007 hPa and afterwards increased again to 1020 hPa at 10 pm. Despite these relative marginal changes in air pressure, the wind speeds picked up dramatically and reached gale force by 5 pm decreasing again only 3 hours later. Precipitation during the storm was marginal (about 1 mm). 'Herta' reached peak gusts of more than 150 km/h in western Germany (City of Trier) and caused serious damage in the states of Hessen, Rheinland-Pfalz and Saarland. In the Netherlands 'Herta' wind speeds were measured with up to 125 km/h (Dorland et al., 1999).

During cyclone 'Judith' that affected Germany, France, Great Britain, Belgium, the Netherlands and Luxembourg wind speeds with up to 120 km/h were observed. 'Judith' caused economic damages in all concerned countries in equal measures (Münchner Rück, 1999).

The cyclones ‘Ottilie’ and ‘Polly’ also included some peak wind speeds. It is worth mentioning that the two storms were accompanied by strong rains (167 mm/24 h in southwestern Germany), thunderstorms, hail, and snow. Consequently, landslides and flooding along rivers (Rhine, Neckar, Mosel) of western Germany occurred.

During the time period before ‘Vivian’ (before 25th of February) there was almost no precipitation in Germany. Weather conditions were very mild with air temperatures above average and an unusual amount of sun hours. The city of Freiburg in south western Germany measured record temperatures of 22C in February. On 25th February air pressure over the northern North Sea was measured at just 950 hPa. This low air pressure dropped to 940 hPa while the cyclone tracked to north easterly direction. On 26th February the cyclone moved via the North Sea to Scandinavia and evolved rapidly into a winter storm. The windstorm area and its severe impact covered mainly Great Britain and Northern France with Ireland also being affected. Vivian then expanded into larger areas of Central Europe including western Germany, further regions of France, the Netherlands, Belgium and Switzerland. Peak gusts of 180 km/h were measured with an average wind speed of 120 to 140 km/h reported for Germany. In the higher elevations measured wind speeds were even much higher. In the Swiss Alps peak gusts of 268 km/h were recorded, for example at ‘Grosser Sankt Bernhard’ mountain (Z'graggen and Hostettler, 2007). At the Feldberg in the Black Forest (Southwest Germany) peaks of up to 17 Beaufort (>200km/h) were measured (Kronauer, 1990). Compared to Germany and Switzerland wind speeds in the Netherlands were moderate with 95 km/h reported. However, gusts reached up to 150km/h (Dorland et al., 1999). Besides strong winds the storm entailed also heavy precipitation.

Only a few days after ‘Vivian’, the cyclone ‘Wiebke’ emerged, ending an intense series of winter storms between during the first months of 1990. ‘Wiebke’, developed in the Atlantic Ocean region from a so-called wave disruption. ‘Wiebke’ was a disastrous winter storm during the night from 28th of February to 1st of March 1990. Wiebke mainly hit the southern part of Germany, Switzerland, and Austria with wind speeds between 130-200 km/h. For example, at ‘Jungfraujoch’ mountain in Switzerland, peak gusts reached up to 285 km/h (Stringfellow, 2008). At the ‘Feldberg’ (Black Forest) in Southwest Germany peak gusts were also above 200 km/h. In the Netherlands ‘Wiebke’ produced gust speeds of 125km/h at their highest level (Dorland et al., 1999). ‘Wiebke’ was accompanied by heavy precipitation in form of rain and snow.

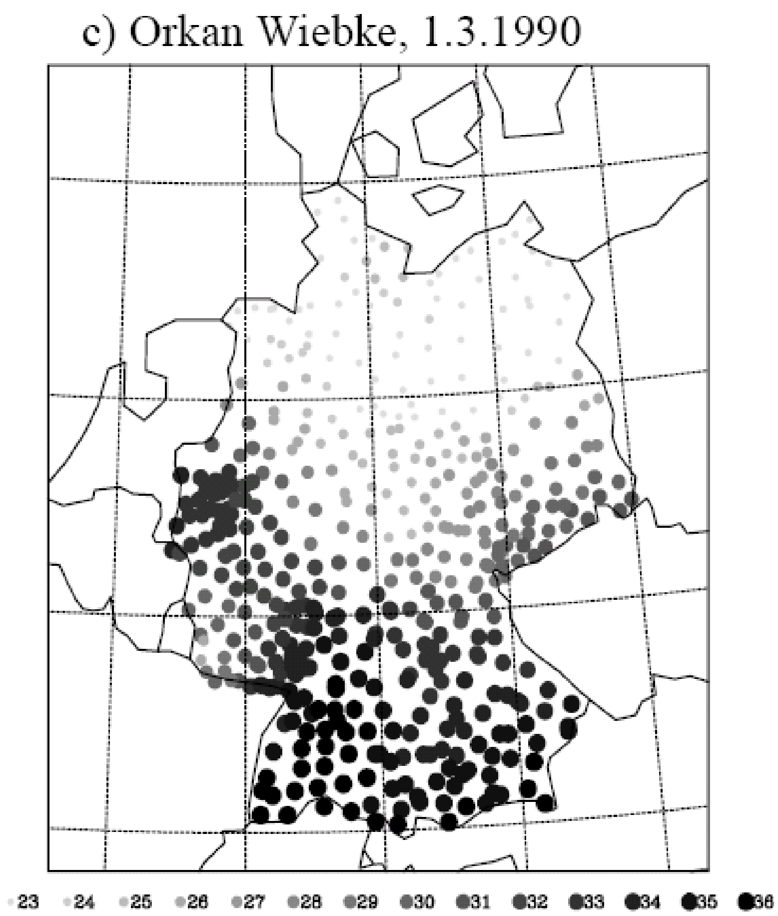


Fig 3: Homogenized peak gusts to the winter storm ‘Wiebke’ in Germany [ms-1]. (Klawa, 2001).

Description of damage

Storm damages are often insured allowing for estimates of the economic loss potential based on insurance data. According to Münchner Rück (1999), ‘Daria’, ‘Vivian’ and ‘Wiebke’ each caused economic damage of about two billion D-mark (approx. 1 billion Euro) in Germany. 50 percent of these damages were insured (Münchner Rück 1999).

The damage for the whole of Europe was determined at 25 billion D-mark (12.5 billion Euro) whereas about 17.3 billion D-mark (approx 7.6 billion Euro) were covered by insurance (values as of 1990) (MünchnerRück, 1999). In Germany 64 people lost their lives due to the winter storms 'Daria', 'Herta', 'Vivian' and 'Wiebke'. 'Wiebke' alone caused 24 fatal accidents in Germany (Münchner Rück, 1999). In the Netherland there were 17 casualties from 'Daria' (KNMI, 1990).

Daria:

'Daria' caused extensive damage to forests. In the state of Schleswig-Holstein, North Germany, more than 3000 trees were broken. The powerful storm affected homes with considerable damages to chimneys and roofs. It also caused flooding of homes in England and western Germany. Moreover, office buildings, cars and gas pipelines were damaged. Roads, tracks and motorways were blocked. Two trains derailed and power lines were disrupted. The southern tip of the German North Sea Island of Sylt lost stretches of coastline due to the high tides (Bissolli et al., 2001). In Great Britain some one million households had no power, 320,000 of them for a few days. Moreover, 'Daria' resulted in extensive structural damage across the UK, with significant coastal flooding and erosion occuring on the south coast (Zou et al., 2008). In France, strong gusts of wind knocked down the chimney of a nuclear power plant. Most deaths during Daria were caused by collapsing buildings, falling debris and trees and storm related traffic accidents. In Great Britain, France and the Netherlands 94 deaths were counted, mostly due to falling trees and traffic accidents. In one case in Sussex, South East England, a class of school children were evacuated just minutes before the entire building collapsed. In Germany eight people died during Daria (Münchner Rück, 1999). Deaths were also reported for Belgium and Denmark.

Compared to previous storm events 'Daria' was considered at the time the cyclone that had caused the highest insured and non-insured damages in Europe. The German insurance company 'Münchner Rück' (2007) specified an insured damage about 4.4 billion Euros whereas the Swiss insurance company 'Swiss Re'(2002) names insured damages above 6 billion USD (Volken, 2003). According to 'Münchner Rück' the insured amount in Great Britain was highest and accounted to 2.6 billion Euros. In the Netherlands 700 million Euro insured damages were reported, for Germany about 0.5 billion Euro. For France, Belgium, Luxembourg, and Denmark a collective insured amount of nearly 0.6 billion Euro was estimated.

Herta:

'Herta' damaged hundreds of rooftops and large numbers of vehicles. Roads and railway tracks were blocked, trains were affected with rail traffic coming partly to a standstill. Power lines needed to be decommissioned resulting in disruptions of electric power supply. 'Herta' also resulted in many persons getting injured but deaths were also reported. In Germany, there were 7 deaths and 50 people injured (Münchner Rück, 1999). The total economic damage was about 0.5 billion Euro, half of which was covered by insurance. Besides Germany, other countries affected included Great Britain, France, the Netherlands, Belgium and Luxembourg with around 0.6 billion Euro worth of insured damage in France.

Judith:

Great Britain, France, Belgium, the Netherlands, Germany and Luxembourg were all affected by 'Judith'. 'Judith' damaged houses and cars, trees were blown down, and traffic was considerably disrupted. The total economic damage including damages to all countries affected were about 50 million Euros with 50 percent covered by insurance.

'Ottilie' and 'Polly':

The cyclones 'Ottilie' and 'Polly' hit Germany, France, the Netherlands, Belgium, Luxembourg, Switzerland, Austria, and Italy. They caused flood damage to houses, and affected roads and railway tracks with landslides. Germany reported ten casualties. The total economic damage in Germany amounted to about 150 million Euros half of which was covered by insurance (Münchner Rück, 1999).

Vivian:

Vivian affected Germany, Great Britain, Ireland, France, the Netherlands, Belgium, Luxembourg, Austria, Switzerland, Denmark, Italy, Sweden, Norway, and Poland. 'Vivian' impaired dikes causing flooding, damaged rooftops, and disrupted traffic significantly especially through wind thrown trees. Hamburg harbor as well as shipping was strongly affected. In Germany more than 10,000 trees were blown down by 'Vivian'. (Münchner Rück, 1999). Overall, in Germany 15 casualties were reported. Across Europe there were 64 fatalities was summed (Swiss Re, 2002). Total economic damage amounted to about 1 billion Euros, 50 percent of which was insured. Other sources estimated the damages caused by ‘Vivian’ to about 4.3 billion USD in Europe (Swiss Re, 2002).

Wiebke:

Wiebke affected Germany, the United Kingdom, France, the Netherlands, Belgium, Luxembourg, Denmark, Austria, Switzerland, Italy, and Greece. Besides damages to infrastructure ‘Wiebke’ induced large amounts of damage to forests with 10 million m^3 of windthrown and broken trees in Germany alone (Münchner Rück, 1999). Many roads and train tracks were blocked. In Germany alone 35 people died. The total economic damage in Germany was estimated at 1 billion Euros. 0.5 billion Euros of which were insured (Münchner Rück, 1999).

Tab. 1: insured storm damage of the storm series 1990 (in million Euros)(Münchner Rück, 2001).

Country / region	**‘Daria’ [million €]**	**‘Herta’ [million €]**	**‘Vivian’ [million €]**	**‘Wiebke’ [mill. €]**
Belgium	220	100	170	50
Denmark	50		30	
Germany	520	260	520	520
France	260	600	90	100
Great Britain	2600		700	280
Luxembourg	50	50	50	50
The Netherlands	700	100	90	30
Austria			70	70
Switzerland			50	50
TOTAL DAMAGE	4400	1110	1820	1180

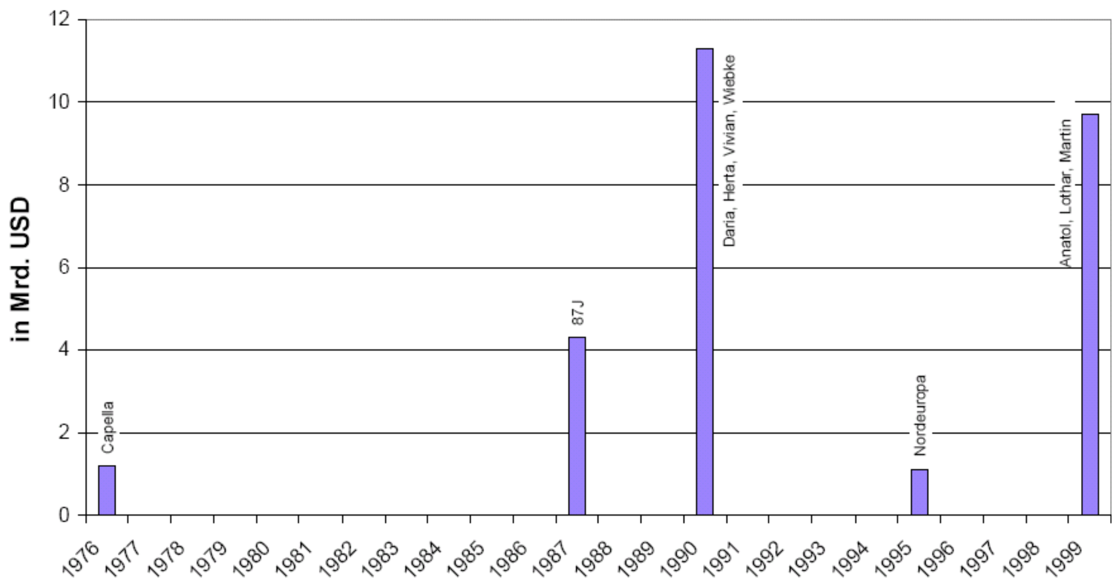


Fig. 4: The most important historic storm events in Europe from 1976 to 1999 with insured damage (SwissRe, 2000; Volken, 2003).

Summary of economic damages and casualties by countries

The series of winter storms from January until March 1990 resulted in 272 fatal causalities Europe-wide. The total economic loss caused by the storms amounted to 12.8 billion Euros (Münchner Rück, 2001). Münchner Rück (2001) reported approximately 8.5 billion Euros in payments for the storm damages caused by Daria, Herta, Vivian, and Wiebke. Goyette et al. (2001) give estimations on storm damages for Daria, Vivian, and Wiebke at around 10 billion USD. Based on these figures these storms represent the most expensive storm catastrophes in the history of European countries.

Country data (Source: Münchner Rück, 2001)

In Belgium, the 1990 storms caused a total economic damage of 870 million Euros and claimed the lives of 15 people.

In Denmark, the total economic loss accounted to 160 million Euros.

64 deaths were reported for Germany while the total economic damage added to 3.8 billion Euros.

In France, 66 fatal casualties were reported with a total economic damage of 1.65 billion Euros.

85 people lost their lives in Great Britain while the total economic loss amounted to 4.1 billion Euros
The total economic damage in Luxembourg amounted to 300 million Euros.
In the Netherlands 21 people lost their lives whilst the total economic loss was 1.5 million Euros.
Switzerland held a total economic damage of 160 million Euros. 4 casualties were reported.
Austria reported 3 fatal casualties and a total economic damage of 200 million Euro.

From January until September 1990 numerous working accidents occurred in conjunction with processing storm windthrown timber in the forests of Southwest Germany (Baden-Württemberg). In private and community forests working there were 3544 accidents of which 10 were fatal. In state forests 1032 working accidents were recorded, three of which were fatal (Kühnel, 1994).

Insurance payments in Switzerland increased about 30 percent in 1990 as compared to the average of previous years. The numerous accidents in salvage logging operations contributed to this increase. This is backed by the fact that accidents in forests (salvage operations and other post storm accidents) were about 13% above average in 1990 (BUWAL, 2000).

As a consequence of the storm series, timber prices declined drastically, due to the loss in wood quality and the high amount of timber available on the market. Forest owners also faced additional costs for timber storage and transport. Administrative work related to storm damaged timber increased for state and community forests. Besides these direct consequences indirect effects were visible in the years following the storms. They included adjustment/changes to management plans and unexpected costs e.g. for regeneration measures, reconstruction of forest roads and combating insect infestations (bark beetle) that could further damage to stands affected by storms or spread to adjacent forests (Volken, 2003).

Primary damage to forests

The Federal Republic of Germany was heavily hit by the storms Vivian and Wiebke with at least a total of 65 million m^3 of storm damaged timber (Wandeler and Günter, 1991). Figures from Gietl (2000) and Kühnel (1994) give a higher figure of approx. 72 million m^3. Schelhaas et al. (2003) top this figure to 72.5 million m^3 for Germany. Due to the storm series, in Bavaria 23 million m^3 wind thrown timber were registered, nearly half of which occurred on private forest lands (Gietl, 2000). The figure of 23 million m^3 relates to a total storm damaged area of about 30,000 ha in Bavarian forests (Preuhsler, 1991).

Vivian und Wiebke

Zwischen dem 26. Februar und dem 1. März 1990 warfen die beiden Orkane „Vivian“ und „Wiebke“ in Bayern rund 23 Millionen fm Holz zu Boden. In ganz Deutschland belief sich die Schadholzmenge auf rd. 72 Mio. fm.

Bayern	23 Mio. fm
Baden-Württemberg	15 Mio. fm
Hessen	14 Mio. fm
Rheinland-Pfalz	12 Mio. fm
Restliche Bundesländer	8 Mio. fm
Summe	72 Mio. fm

Der Sturmholzanfall 1990 in Bayern verteilte sich auf die Besitzarten folgendermaßen:

	Mio fm	% d. Vorrats	% d. Gesamtanfalls	Flächenanteil Waldbesitzart
Staatswald	8,5	4,5	37	33
Körperschaftswald	3,4	4,2	15	15
Privatwald	10,9	3,3	47	52
Bundeswald	0,2	2,5	1	<1

Fig 4. Damaged timber due to Vivian and Wiebke in Germany and Bavaria. Gietl, G., 2000. 72 millionm3 in Germany, 23 millionm3 in Bavaria, Baden-Wuerttemberg 15 million m3, Hessen 14 million m3, Rheinland Pfalz 12 million m3, other states 8 million m3. Lower table present the division of storm damaged timber to ownership classes in Bavaria (State forest of Bavaria: 4.5% of the growing stock (GS) and 37% of the total damaged volume; community forests: 4.2% of GS, 15% of total damaged volume; private forests: 3.3% of GS, 47% of total damaged volume; Federal forests: 2.5% of GS and 1% of total damaged volume).

In the state of Baden-Württemberg about 15 million m^3 of storm-damaged timber occurred equaling 1.8 times the annual harvest. In Rheinland-Pfalz, Hessen, Bavaria, and Baden-Württemberg the total amount of storm damaged timber was 66 million m^3 which equals 91 percent of the annual harvest of these states collectively (Kühnel, 1994). Aldinger et al. (1996) estimated that about 86 percent of the affected timber in the state of Baden-Wuerttemberg was Norway spruce.

The quantity of storm damaged timber in France was about 8.5 million m^3. In Belgium and Great Britain damages were estimated at 4 million m^3, respectively, while in Switzerland estimates were set at 4.3 million m^3 timber and in Austria at 4.8 million m^3. The total amount of storm damaged timber for Europe was estimated at 100 million m^3 representing approximately 30 % of the annual harvest in Europe (Wandeler and Günter, 1991).When applying the estimates for Germany by Gietl (2000) the total damage to forests in Europe is slightly higher (approximately 105 million m^3).

The damage in the Netherlands due to the storm of January 25 ('Daria') was estimated at about 0.4 million m^3, one third or half of the normal annual harvest (Nas, 1990) No clear-felled stands were observed except for poplar and Norway spruce stands. In poplar stands older than 20 years, damage scattered to standwise due to the high groundwater table or low rooting depth related to soil conditions. But usually stands younger than 35 years were not damage except where they had been recently thinned. In stands older than 35 years, there was scattered damage especially in Scots pine, Douglas fir, Norway spruce, and larch stands. In 35 to 80 years old mixed and mono-species stands of broadleaves some individual trees – mostly beech and Scots pine – were damaged while in stands older than 80 years individual trees and rows of beech, oak and Scots pine were damaged. Broken stems and crowns were found in older trees of Norway spruce, Scots pine, Douglas fir, oak and beech.

The amount of storm damaged timber due to 'Vivian' and 'Wiebke' with reference to the annual harvest of Germany was placed at 67%, 18% in France, and 110% in Switzerland (Saidani, 2004).

Table 2: Damage types according to tree species in Switzerland (Schmid-Haas and Bachofen, 1991).

Damage types	**Norway spruce [%]**	**Silver fir [%]**	**Other coniferous wood**	**Beech [%]**	**Other hardwood [%]**	**Total [%]**

			[%]			
Stem break	43	43	20	5	5	37
Root break	47	52	80	74	90	53
Stock break	7	3	-	-	-	5
Throw	3	2	-	21	5	5
Number of trees (100%)	363	54	5	62	19	503

Secondary damage

Despite intensive prevention activities in 1990, in 1991 there was a noticeable beetle outbreak with corresponding damages in Baden-Württemberg. Locally there was extensive reproduction of bark beetles and therefore considerable damages to the stands. This outbreak lasted for several years (Kühnel, 1994). From 1992 to 2000 a high number of Norway spruce trees in the German National park 'Bavarian Forest' on an area of 3700 ha were killed due to bark beetles. Likewise in several other forests bark beetle outbreaks occurred in a similar way (Wermelinger, 2004). Most of the regions with bark beetle outbreak corresponded with those affected by storm. The maximum bark beetle outbreak in Switzerland was registered in 1992 and 1993. As a consequence, Switzerland harvested 500,000 m^3 of timber in addition to its annual felling targets (BUWAL, 2000). From 1990 to 1997 bark beetle damaged timber in Switzerland amounted to 60 percent and corresponded to the thrown timber in 1990 (Engesser et al., 1998).

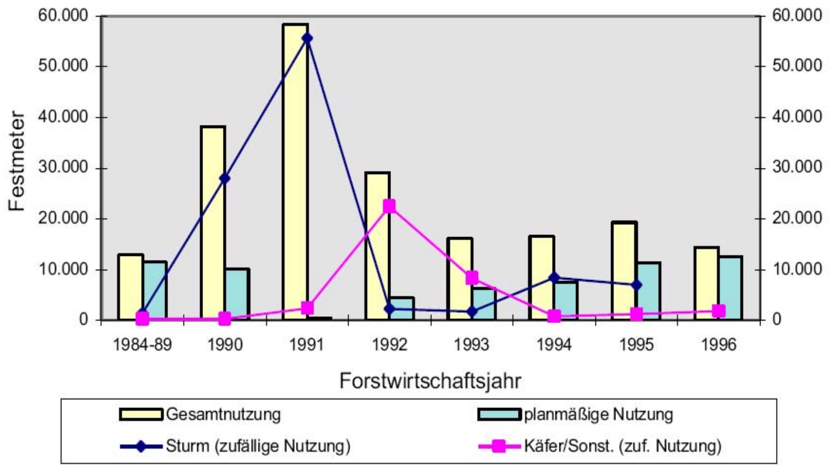


Fig.5: The graph shows a noticeable increase in harvesting as compared to the planned harvesting levels due to storm damages in m^3 in 1991 and 1992. An increase of bark beetle infested timber is obvious in 1992. Fig 5. presents an example of the effects of storm damages and beetle infestations on removals in the state forest area of Sindelfingen, Germany (State forest district office of Sindelfingen).

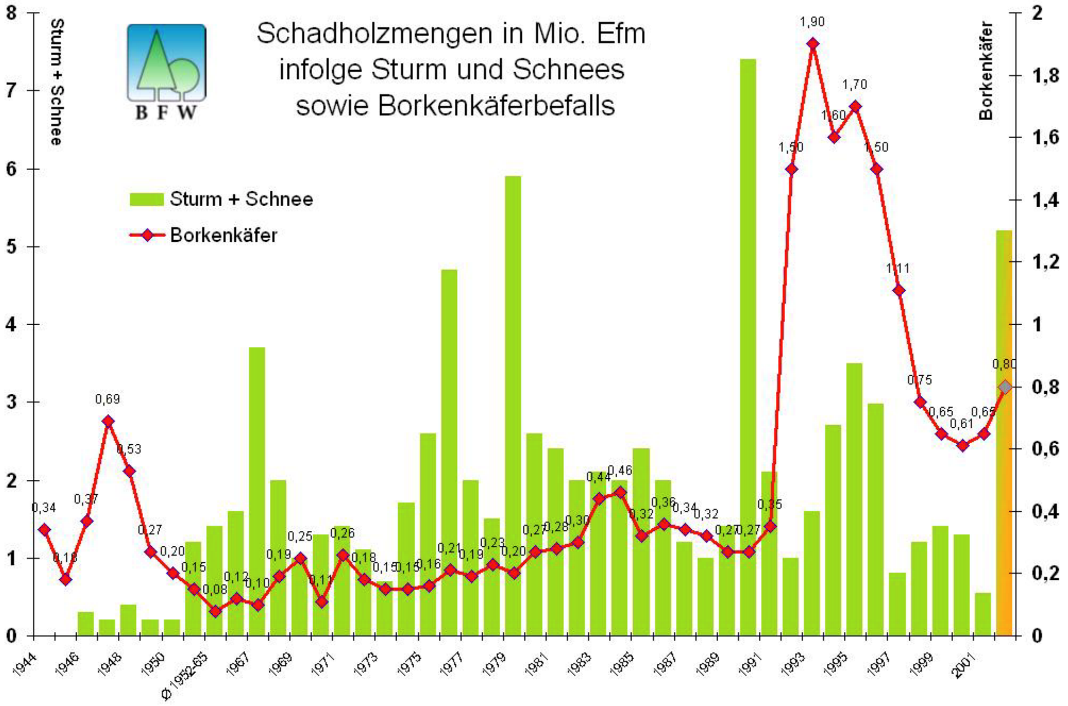


Fig. 6: Amount of damaged timber due to storm, snow, and bark beetle attack in Austria (Tomiczek, 2003).

Policy response

In Germany the states are responsible for financing and executing activities to manage damages relating to natural phenomena. However, due to the severe impacts on forests from the 1990 storms the German Federal government started a Federation-State auxiliary program from which an amount of approximately 30 million Euros was given to the state of Baden-Württemberg (Kühnel, 1994).The federal states of Germany received financial support amounting to 1.7 billion D-mark (0.85 billion Euro) for processing storm damaged timber (Kronauer, 1990). The removal of storm damaged timber from community forests was support by 15 million D-mark (7.5 million Euo) by the State of Bavaria and through 40 million D-Mark (20 million Euro) by the State of Baden-Württemberg. Rheinland-Pfalz approved a sum of 20 million D-Mark (10 million Euro) (Schneider, 1990) for the processing and storage of storm damaged timber protection against bark beetles (Kronauer, 1990).

In Switzerland around 370 million Swiss Francs were made available both by the Federal government and the cantons for extraordinary fellings, tending of young stands, and other provisions. Private forest owners that did not suffer storm damages were advised by the Swiss government to avoid any planned harvests to avoid further strain on the timber market (Wandeler and Günter, 1991). The Swiss Federal Government also provided military personnel and employed foreign contractor to assist in salvage logging and operations . Tangible salvages in form of acquiring and maintaining machines, constructing and preserving timber yards, transportation of storm damaged timber to timber storages, and procurement and purchase of storm damaged timber were supported as well.

Effects on biodiversity

In general, storms have an effect on the occurrence of vegetation (ground vegetation, tree species) linked to open areas and within gaps. Storm hit areas allow plant and animal species not present in closed forests to thrive. High amounts of dead wood create suitable habitats for saproxylic insects and other animals (Schönenberger et al., 2003). The abundance of damaged and dead wood, for example, can also lead to overpopulations as can the open spaces. As a consequence of the storm events, clearings allowed for a noticeable increase in the roe deer population. Roe deer found ample food on offer at the clearing areas where natural regeneration and other thickets increase the possibilities for cover. Moreover, the newly established and yet establishing edges of the forests meet the requirements of the roe deer very well (Kühnel, 1994). This increase affected natural regeneration and protection measures were needed to guarantee successful regeneration.

Effects on timber market

In Germany as well as in the state of Baden-Württemberg a visible decrease in timber prices due to high timber quantities could not be avoided. This is shown in the below graph for Germany. For example, in the Black Forest (Southwest Germany) the timber prices decreased by about 1/3 in the years after the storm due to a higher supply. Furthermore, significant reductions in profits were registered (Brandl, 2000).
In Switzerland the timber prices for Norway spruce and Silver fir roundwood declined after the storm series by about 11%. Prices for Norway spruce and Silver fir sawnwood decreased by about 22 percent (Annex 2).

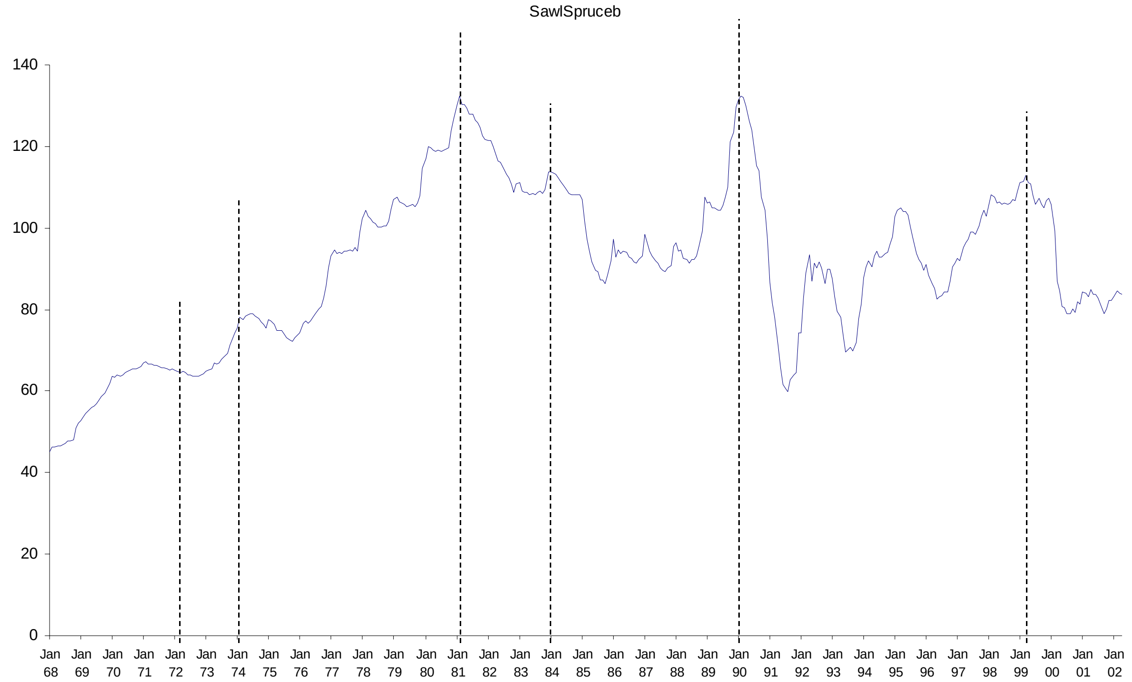


Fig. 4: Development of prices for Norway spruce from 1968 until 2002 in Germany (Hanewinkel).

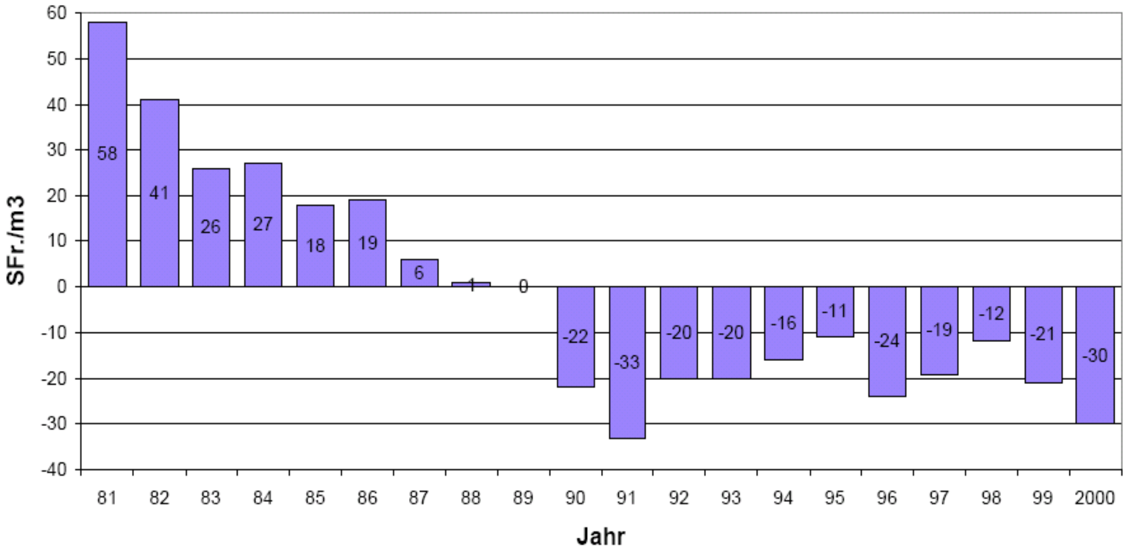


Fig. 5: Price of timber (all species) for Switzerland in Swiss Francs/m^3 during the time period 1981-2000 (Volken, 2003).

Literature

Aldinger, E.; Schreiner, M.; Bantle, P. (1996): Standort und Sturmwurf 1990 im östlichen Odenwald.

Bissolli P., L. Göring, Ch. Levebvre (2001): Extreme Wetter- und Witterungsereignisse im 20. Jahrhundert. Climate Status Report of the German Weather Service (DWD); pp 20-31.

Brandl, H. (2000): Bäuerlicher Waldbesitz in Baden-Württemberg. Der Deutsche Wald.

BUWAL (Eds.) (2000): Handbuch: Entscheidungshilfen bei Sturmschäden im Wald. Bundesamt für Umwelt, Wald und Landschaft, Switzerland; 105 pp.

Dorland, C.; Tol, R.S.J.; Palutikof, J. P. (1999): Vulnerability of the Netherlands and Northwest Europe to storm damage under climate change. Climatic Change 43; pp 513-535.

Dronia, H. (1990) (Seewetteramt Hamburg): "Vivian und Wiebke", in "Sterne und Weltraum", 12/1990, S. 722 - 726

Engesser, R.; Forster, B.; Meier, F.; Odermatt, O. (1998): Forstschutzsituation 1997 in der Schweiz. AFZ, 7; pp. 375-377.

Gietl, G., (2000). Vivian, Wiebke, Lothar. Drei Jahrhundertstuerme in einem Jahrzehnt. In: LWF Aktuell. No. 26/2000. 3-4.

Goyette, S.; Beniston, M.; Caya, D.; Laprise, R.; Jungo, P. (2001): Numerical investigation of an extreme storm with the Canadian Regional Climate Model: The case study of windstorm VIVIAN, Switzerland, February 27, 1990. *Climate Dyn.*, 18; pp 145–168.

Hanewinkel M. (2001): Development of prices for Norway spruce roundwood from 1968 until 2002 in Germany based on original data from the Federal Statistical Office (Destatis).

Karius, K. (1990): Orkanschäden 1990 – Ein Einzelfall? AFZ 30-31; p. 765.

Keller, J. L. (????):Weather risk assessment at the dawn of ensemble numerical weather prediction; 7 pp.

Klawa, M. (2001): Extreme Sturmereignisse in Deutschland: Entwicklung, Zusammenhang mit der Nordatlantischen Oszillation und Auswirkungen auf die Versicherungswirtschaft. Inaugural-Dissertation zur Erlangung des Doktorgrades der Mathematisch-Naturwissenschaftlichen Fakultät der Universität zu Köln; 134 pp.

Kronauer, H. (1990): Ausmass der Sturmschäden 1990 und Massnahmen zur Bewältigung. AFZ 17-18; 434-437.

Kühnel, I. (1994): Dokumentation der Sturmschäden 1990. Verschiedene Autoren. Schriftenreihe der Landesforstverwaltung Baden-Württemberg. Band 75; 190 pp.

Lowinski, L. (2006): Winterstürme und Orkane. Ursachen und Gefahren von aussertropischen Sturmtiefs. Informationsbroschüre; 7 pp.

Münchner Rück (Eds.) (1999): Naturkatastrophen in Deutschland. Schadenerfahrungen und Schadenpotenziale. Eine Veröffentlichung der Münchener Rückversicherungs-Gesellschaft.

Münchner Rück (Eds.)(2001): Winterstürme in Europa (II): Schadenanalyse 1999 – Schadenpotenziale. München, 2001.

Nas, R.M.W.J. (1991): Na de storm. Bosbouwvoorlichting 29;1-3.

Preuhsler, T. (1991): Sturmschäden in einem Fichtenbestand der Münchner Schotterebene. AFZ 21; 1098-1102.

Saidani, N. (2004) Erkennung von Sturmschäden im Wald auf der Basis kleinmaßstäbiger Luftbilder und Entwicklung eines Modells zur Abschätzung der Sturmgefährdung der Wälder auf der Basis von räumlichen Daten. PhD thesis, University of Freiburg, Germany.

Schelhaas, M.J.; Schuck, A., Varis, S. (2003): Database on Forest disturbances in Europe (DFDE) – Technical description. EFI Internal Report 14.

Schmid-Haas, P. (1991): Ursächliche Zusammenhänge zwischen Nadelverlust, Zuwachs, Sturmgefährdung und Fäule. Schweizerische Zeitschrift für Forstwesen, 142 (6), pp 505-512.

Schmid-Haas, P.; Bachofen, H. (1991): Die Sturmgefährdung von Einzelbäumen und Beständen. Schweizerische Zeitschrift für Forstwesen, 142 (6), pp 477-504.

Schneider, E. (1990): Zur Sturmschadenssituation 1990 in Rheinland-Pfalz. AFZ 20, pp. 474-476.

Steller, H. (2003): Schadenverursachende Winterstürme in Baden-Württemberg von 1800 bis 2000. Seminararbeit Institut für Meteorologie und Klimaforschung Universität Karlsruhe, Germany.

Stringfellow, N, (2008): Alpine Weather Forecasting. Presentation HPC User Forum-Tucson-09.09.2008.

SwissRe (2000): Storm over Europe - An underestimated risk, Swissre Publishing, Order No. 201_00239_en,RN,9,00,3000en oder http://www.swissre.com

SwissRe (2002): Natur- und Man-made-Katastrophen 2001: Man-made-Schäden einer neuen

Dimension. Schweizerische Rückversicherungs-Gesellschaft, Sigma Nr. 1: 24 pp.

Tomiczek, C. (2003): Borkenkäfergefahr in den Windwurfgebieten. BFW. Institut für Forstschutz. Presentation April 2003.

Volken, T. (2003): Versicherung von Schäden durch Naturgefahren. Grundlagen und Materialien 03/1. Professur Forstpolitik und Forstökonomie, Eidg. Technische Hochschule, ETH Zürich, 168 pp.

Wandeler, H.; Günter, R. (1991): Sturmschäden 1990: Lagebeurteilung aus der Sicht der Eidgenössischen Forstdirektion. Schweizerische Zeitschrift für Forstwesen, 142 (6), pp. 453-462.

Wermelinger, B. (2004): Ecology and management of the spruce bark beetle Ips typographus—a review of recent research. Forest Ecology and Management 202; pp. 67–82.

Wernli H., Bader S., Hächler P. (2003): Winterstürme. In OcCC (Eds.): Extremereignisse und Klimaänderung. Chapter 2.10. pp. 81-84. ISBN: 3-907630-23-8.

Z'graggen, L.; Hostettler, A. (2007): Starker Weststurm und sehr hohe Temperaturen (Kyrill) – Vergleich zu Vivian und Lothar. MeteoSchweiz, 19.01.2007, retrieved: 08.06.2008. From http://de.wikipedia.org/wiki/Orkan_Vivian

Zou, Q.; Reeve, D.E.; Cluckie, I.; Pan, S.; Han, D.; Lv, X.; Hewston, R.; Chen, Y.; Peng, Z. (2008): Severe extratropical cyclones and their impact on coastal flooding in the UK; past, present and future

Webpages

www.zentrales-wetter.de/html/body_wintersturme_89_90.html (16.03.2010)

http://de.wikipedia.org/wiki/Orkan_Daria (16.03.2010)
http://www.zentrales-wetter.de/html/body_wintersturme_89_90.html (16.03.2010)

http://www.meteoschweiz.admin.ch/web/de/wetter/wetterereignisse/starker_weststurm.html (16.03.2010)

http://de.wikipedia.org/wiki/Orkan_Vivian (16.03.2010)

http://de.wikipedia.org/wiki/Orkan_Wiebke (16.03.2010)

www.meteoschweiz.ch

http://www.geowissenschaften.de/dossier-detail-38-7.html (16.03.2010)

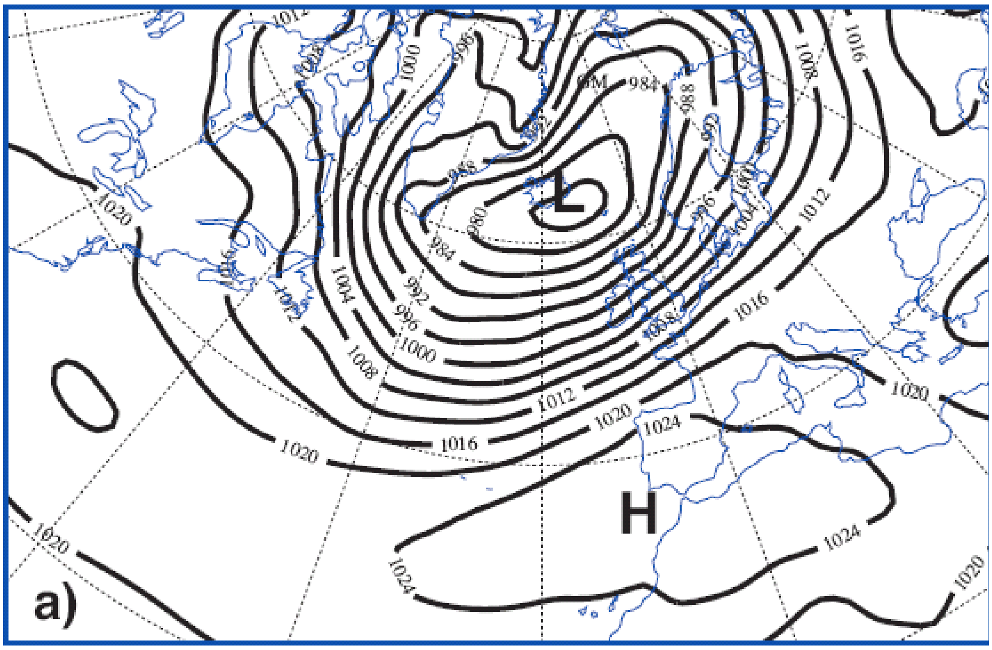
'UK storm payout may hit £350m'. *news.bbc.co.uk* (BBC). 2007-02-20. http://news.bbc.co.uk/1/hi/business/6380123.stm. Retrieved 24.03.2010.

ANNEX 1

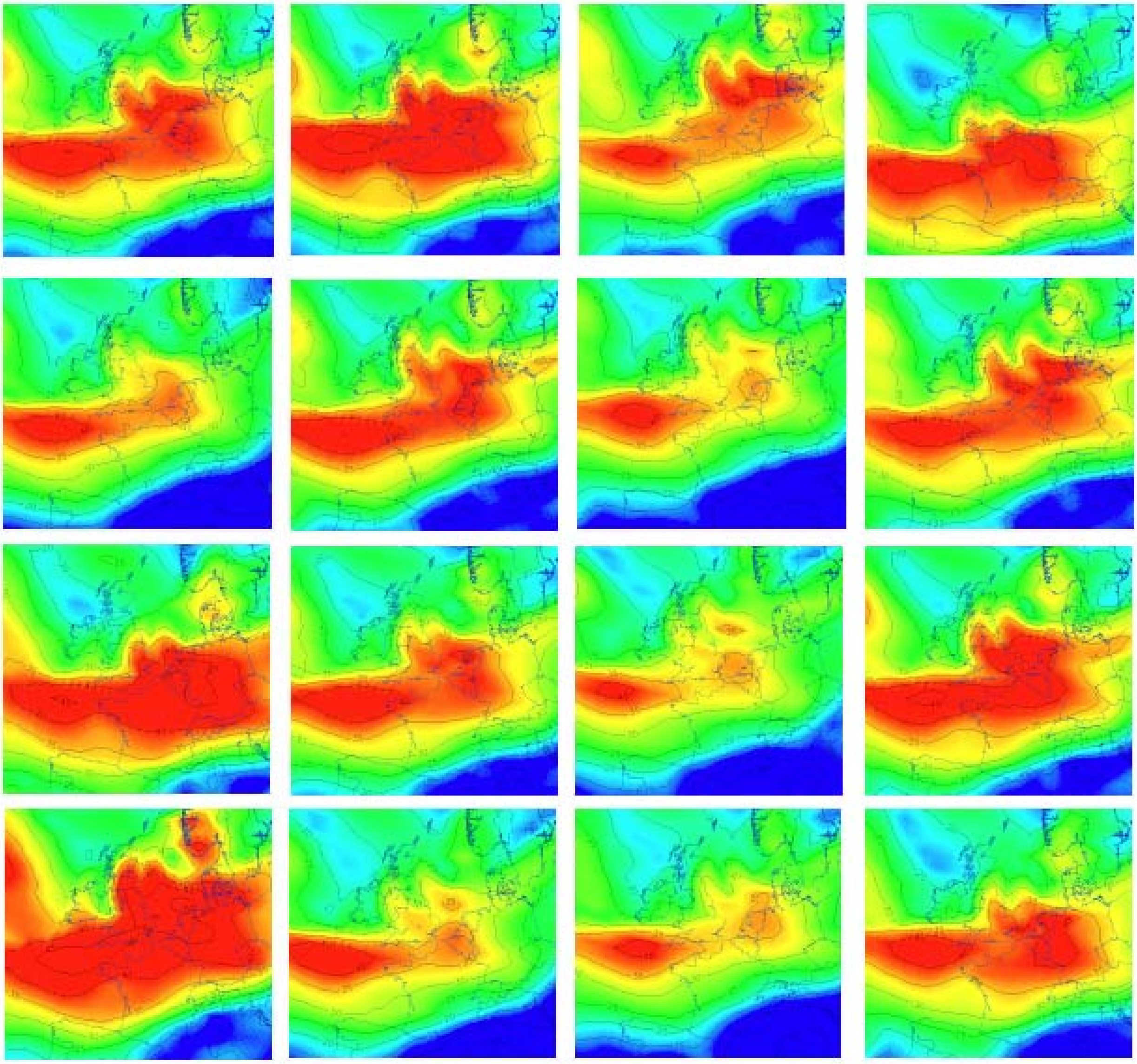
Annex 1.1

The table below shows peak gusts of the whole storm series 1990 for several stations. It shows the maxima of all winter storms in February 1990 (Dronia, 1990). The peak gusts of 'Lothar' 1999 are visible as well for comparison (DWD).

			peak gusts (km/h)	
place	height (m)	state	February 90	Lothar 1999
Trier	265	Rhl.-Pfalz	154	108
Berus	363	Saarland	154	130
Tholey	396	Saarland	130	104
Weinbiet	600	Rhl.-Pfalz	152	184
Wasserkuppe	921	Hessen	178	104
Würzburg	259	Bayern	148	115
Stuttgart	396	Baden-Wrttb.	135	144
Stötten	734	Baden-Wrttb.	135	176
Feldberg	1486	Baden-Wrttb.	172	212
Großer Arber	1445	Bayern	146	162
München	530	Bayern	130	120
Wendelstein	1832	Bayern	265	255

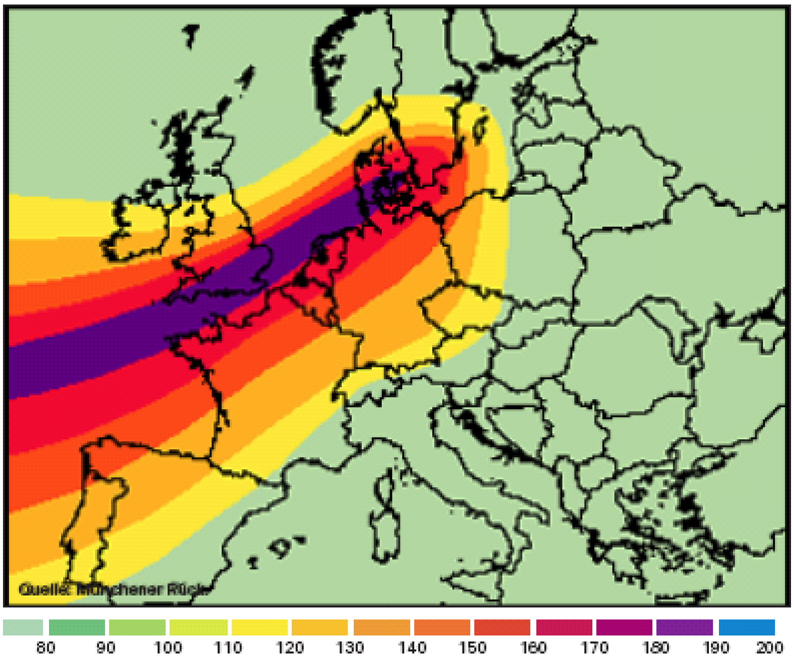


Annex 1.2 Soil pressure dispersion for February 1990, a month with a highly positive NAO Index (Wernli et al., 2003).



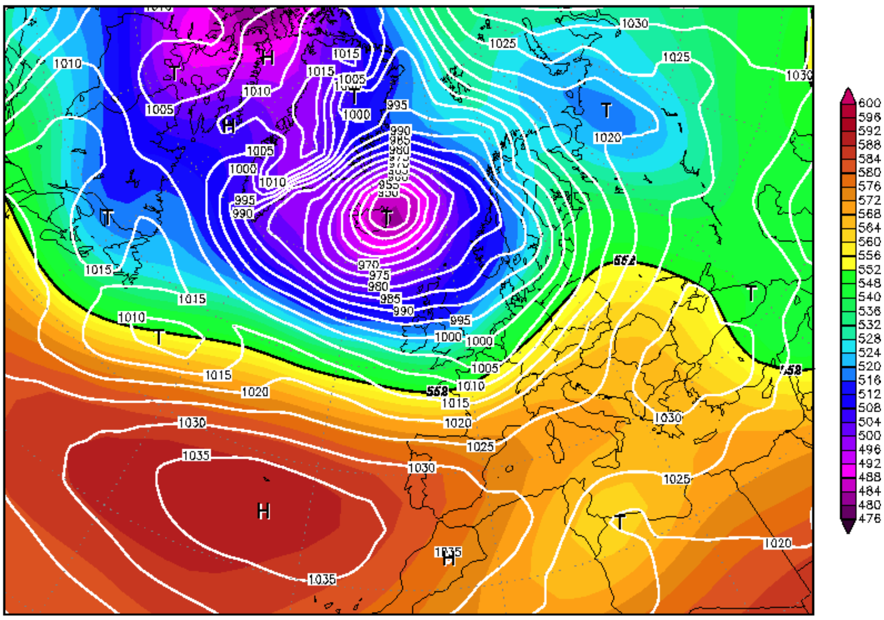
Annex 1.3.

Modelled maximum wind speeds occuring during storm ‚Daria' in January 1990. (Keller).



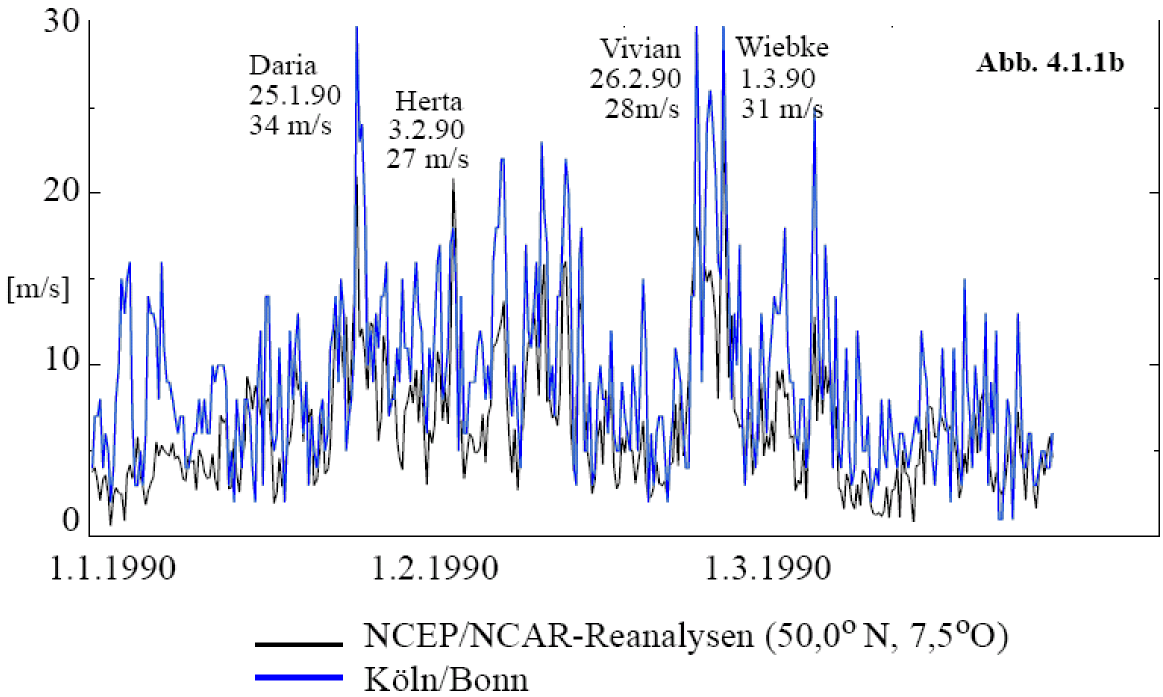
Annex 1.4

Windfield of a possible hurricane (Daria) scenario (MünchnerRück, 2001).



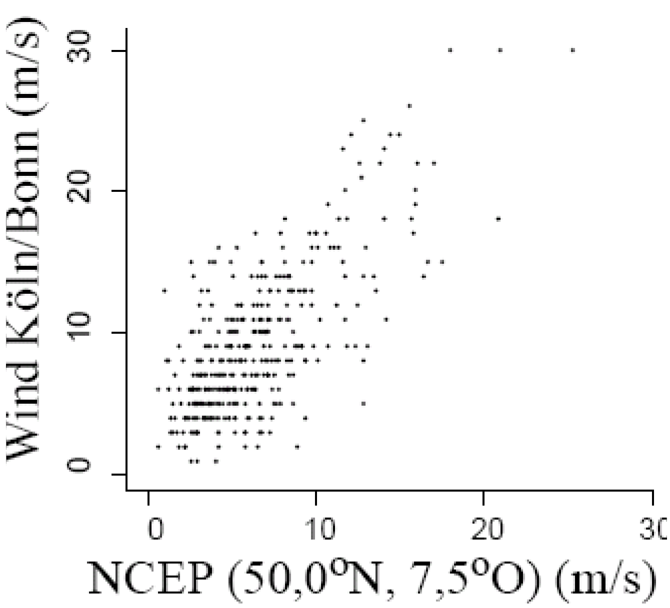
Annex 1.5

500 hPa geo potential (gpdm) and soil pressure (hPa) the 24th of January 1990 (Lowinski, 2006).

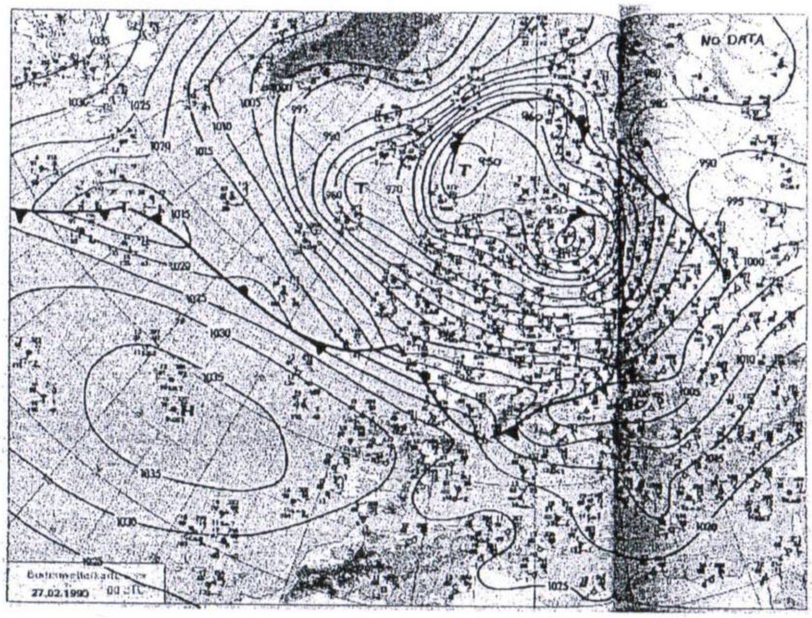


Annex 1.6

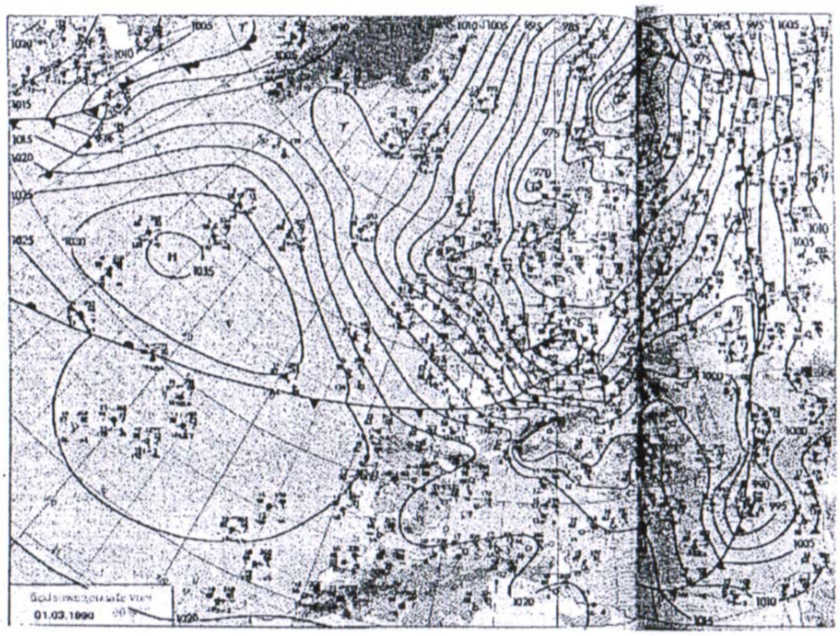
Temporal gradient of the wind speeds at the gauging station Cologne/Bonn (Germany) and the winds at ground level (NCEP/NCAR reanalyzis) at grid point 50ºN, 7.5ºE from January until March 1990. Peak gusts are inscribed in the figure (Klawa, 2001).



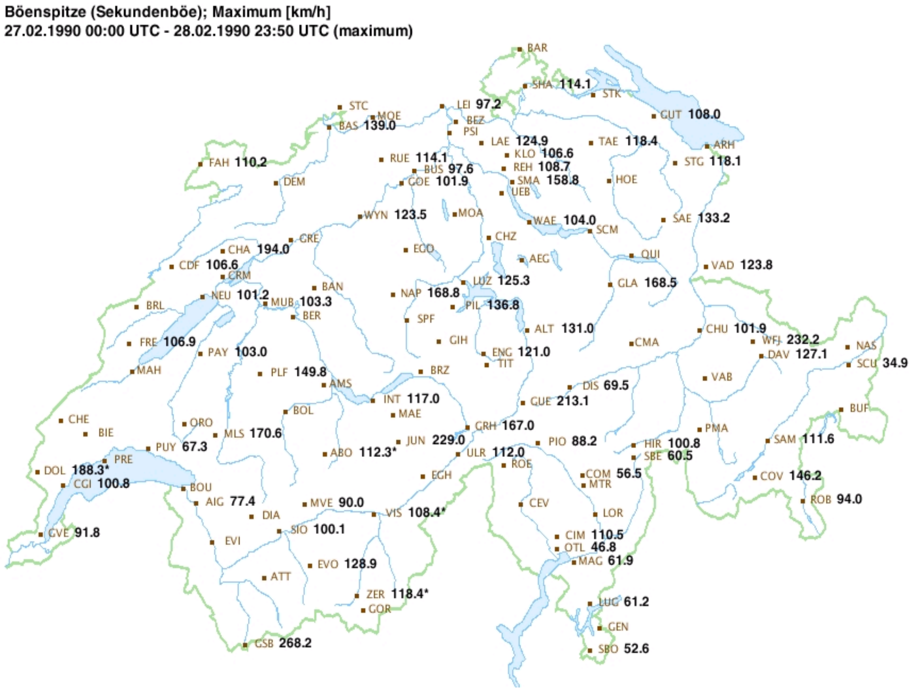
Annex 1.7
Scatter diagram of wind speeds at the measurement station Cologne/Bonn (Germany) and the winds at ground level (NCEP/NCAR reanalyzis) at the grid point 50ºN, 7.5ºE from January until March 1990 (Klawa, 2001).



Annex 1.8: Weather map of the German Weather Service (DWD) from 27.02.1990 (Steller, 2003).



Annex 1.9: Weather map of the German Weather Service from 01.03.1990 (Steller, 2003).



Annex 1.10: Maximum peak gusts (km/h) from 27.02.1990 0:00 UTC until 28.02.1990 23:50 UTC in Switzerland (MeteoSchweiz).

ANNEX 2

Annex 2.1

Facts to winter storm events in Switzerland (Volken, 2003).

	‘VIVIAN’	‘WIEBKE’
DATE	27.02.1990	28.02./01.03.1990
GENERAL WEATHER SITUATION	Core of the cyclone tracks northern direction from Switzerland	
PEAK WIND SPEEDS	140 to 160 km/h	
DURATION	About 8 hours	About 6 hours
CONCERNED REGIONS	Alps and foothills of the Alps	
TOTAL ECONOMIC DAMAGE	About 240 million Swiss francs	
INJURED DAMAGE	75 million Sfr	75 million Sfr
DAMAGE TO FORESTS [m^3]	4.9 million (1.3% of the total supply)	
AREA DAMAGES IN FORESTS	4928 ha	
ESTIMATED ECONOMIC FOREST DAMAGE IN SWISS FRANCS	About 100 million Sfr (rough estimate)	
PERCENTAGE OF FOREST DAMAGE TO TOTAL DAMAGES	About 42 per cent	
FOREST DAMAGE [SWISS FRANCS/m^3]	20	
YEARLY UTILIZATION AT THE GROUND	1.1	
PERCENTAGE OF WIND THROWN CONIFEROUS WOOD	92 per cent	
FINANCIAL AID (COUNTRY/CANTON)	About 370 million Sfr	
DEVELOPMENT OF TIMBER PRICES	-11% (Norway spruce/Silver fir roundwood) -22% (Norway spruce/Silver fir, sawnwood)	

ANNEX 3

Annex 3.1

Averaged timber prices for Swiss raw wood [Sfr/m^3] (surveys from January to April) (Volken, 2003).

ASSORTMENT	1989	1990	1991	1992
Norway spruce/Silver fir stem wood	137	144	128	136
Beech stem wood	152	168	154	158
Pulpwood	69	69	65	62
Norway spruce/Silver fir firewood	50	50	48	74
Beech firewood	63	63	65	64

Storms of 24th – 28th December 1999

24-27 December 1999 - 'Lothar'

25-28 December 1999 - 'Martin'

Meteorological conditions

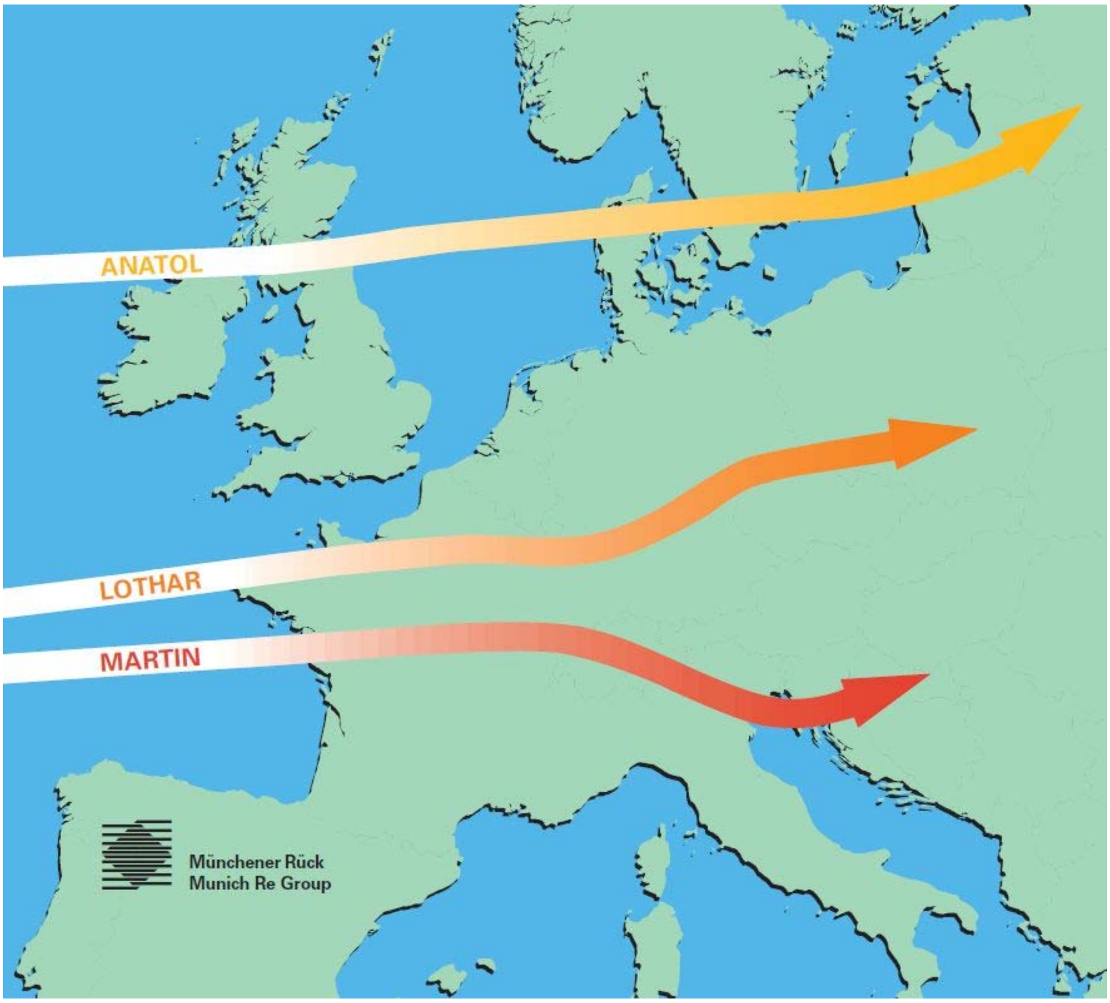


Figure 1 *: The storm's track of Lothar (24-27/12/1999) and Martin(25-28/12/1999). The Anatol's track (02-04/12/1999) is also represented*

Lothar (24-27 December 1999)

The depression named Lothar initially developed on December 24, 0000 GMT off the North American east coast, at about 35N. It was apparently restricted to the lower troposphere, as we found no evidence for an associated upper level disturbance. Subsequently, it entered the exceptionally strong baroclinic zone that had formed across the North Atlantic, where strong temperature gradients throughout the troposphere led to a strong polar jet with core wind speeds of more than 100 m s-1 at 300 mbar and temperatures of about 220 K.

Lothar’s rapid development began when an additional factor set in at the time the storm reached the jet‘s exit region at December 26, 0000 GMT. A strong divergence center associated with upper level diffluence was located between Brittany and Cornwall, north of the jet axis. It was already present at previous dates and thus was not generated by the approaching cyclone. Such areas of intense divergence north of the jet exit (induced by the ageostrophic winds associated with the wind speed reduction) are well known to induce rapid cyclone growth (e.g., Uccellini, 1990; Baehr et al., 1999). An additional amplification of the divergence in this region is expected from the secondary jet maximum reaching from England to the Alps (ageostrophic winds at the secondary jet‘s right entrance region due to acceleration).

When Lothar reached the French coast at 0600 GMT on December 26 its central pressure had fallen to 961 mbar, rising only slowly during its further movement over France to Germany (970 mbar at 0900 GMT) and Poland (980 mbar at 1800 GMT). In general, the extreme pressure tendencies observed at stations along Lothar‘s track were caused by the system‘s high propagation speed which didn’t decrease after leaving ocean (about 120 km/h over the Atlantic and 100 km/h over France and Germany) and its small diameter (Ulbrich et al. 2001).

Station (Météo-France)	wind (ms^{-1})	Station	wind (ms^{-1})	Station	wind (ms^{-1})
Lann-Bihoué	45.4	**Alençon**	46.5	**Paris-Montsouris**	47.3
Ploumanach	41.4	**Strasbourg**	40.3	**Chartres**	40.3
Dijon	35.3	**Rennes**	35.3	**Nancy**	40.3

Rouen	39.2	**Orly**	48.4	**Nantes**	35.3
Troyes	41.4	**Metz**	43.4	**Colmar**	46.0
Pointe du Raz et Ile d'Yeu	45.4	**Chassiron**	55.4	**Cap Ferret**	48.4

Figure 2: Météo-France records of Lothar's gust speed, December 26,1999 (http://www.notre-planete.info/geographie/risques_naturels/tempetes_0.php)

After leaving France, Lothar passed over Germany and Switzerland. Lothar traversed Switzerland within three hours, from 9.00 to 12.00 UTC. Entering over the canton of Jura, it crossed the Swiss Plateau, central Switzerland and northeastern Switzerland. The intra-alpine region as well as south and southwest Switzerland was spared. The top wind speeds exceeded 39.2 ms-1 (10 min. maximum) even in valley areas. In Délémont they reached 47.6 ms-1 and in Brienz 50 ms-1. In the mountains, top wind speeds reached 65 ms-1 on the Säntis and 70 ms-1 on the Jungfraujoch. In the Bernese Oberland and the central part of Switzerland, the drop in pressure in advance of the cold front generated strong foehn winds with speeds as high as those of the storm itself, which increased the overall damage caused by the general meteorological conditions. The extremely high top wind speeds in the lowlands, which set records in many places, were particularly striking. On the other hand, the medium wind speeds were within the range expected for a strong storm (Bründl and Rickli 2002).

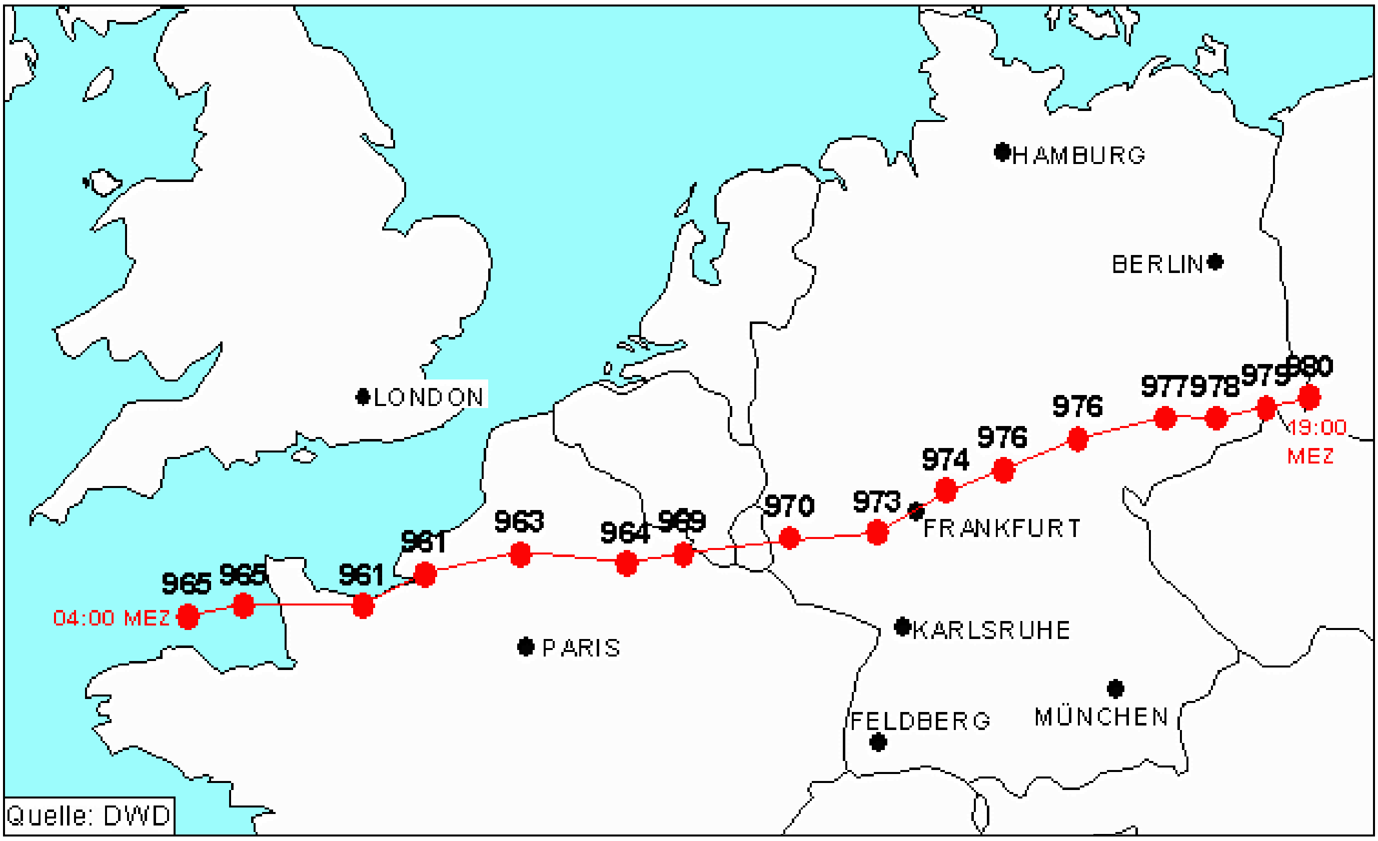


Figure 3 : Path and pressure of the depression center, 26 december 1999

Martin (25-28 December 1999)

The next system, called "Martin", followed Lothar only one day later. As mentioned before, Lothar's shallowness over the Atlantic had left the large-scale situation nearly unchanged. Initially, Martin formed as a surface low on 25 December upstream of a long wave upper air trough over North America. The surface low moved northeastward along the trough's flank, which itself was slowly progressing southeastward over the North American East Coast. A transition phase followed on 26 December. The large-scale trough over North America changed its structure. Its southerly part weakened while farther north a short upper air depression moved eastward from Newfoundland. During this transition phase Martin's structure and track were ambiguous, but when it subsequently interacted with the eastward moving upper air depression (27 December, 0600 GMT), it moved rapidly across the Atlantic. In contrast to Lothar, Martin eventually modified the large-scale airflow. In fact, the polar jet was extremely intense over the latter region. At 0000 GMT on 27 December the radio-sonde at Brest (Brittany) measured a wind speed of 147 m s^{-1} at a height of 8138 m (Hontarrède, 2000), about 700 m below the 300 hPa level. Subsequently, Martin's central pressure fell to 965 mbar by 27 December 1500 GMT, just before it entered the European continent south of Brittany. Violent winds first hit the French Atlantic coast, and, to a lesser extent, northern Spain (gust wind speeds for Spain have not been available to the authors). Westerly gales of more than 36 ms^{-1} were observed between 1500 and 2100 GMT at Bordeaux. The storm led to floodings at parts of the Atlantic coast. Subsequently, severe damage was reported along the track over southern France into the western Mediterranean. (Ulbrich et al. 2001).

Station (Météo-France)	wind (ms^{-1})	Station	wind (ms^{-1})	Station	wind (ms^{-1})
Pointe-du-Raz	45.4	**Ile d'Yeu**	45.4	**Ile d'Oléron**	55.4
La Rochelle	42.3	**Biscarosse**	46.5	**Cap Ferret**	48.4
Bordeaux	40.3	**Pau**	38.4	**Tarbes**	38.4
Lyon	29.1	**Limoges**	148	**Aurillac**	38.4
Perpignan	39.2	**Clermont-Ferrand**	44.5	**Mâcon**	35.3

Figure 4: Météo-France records of Martin's gust speed, december 27,1999 (http://www.notre-planete.info/geographie/risques_naturels/tempetes_0.php)

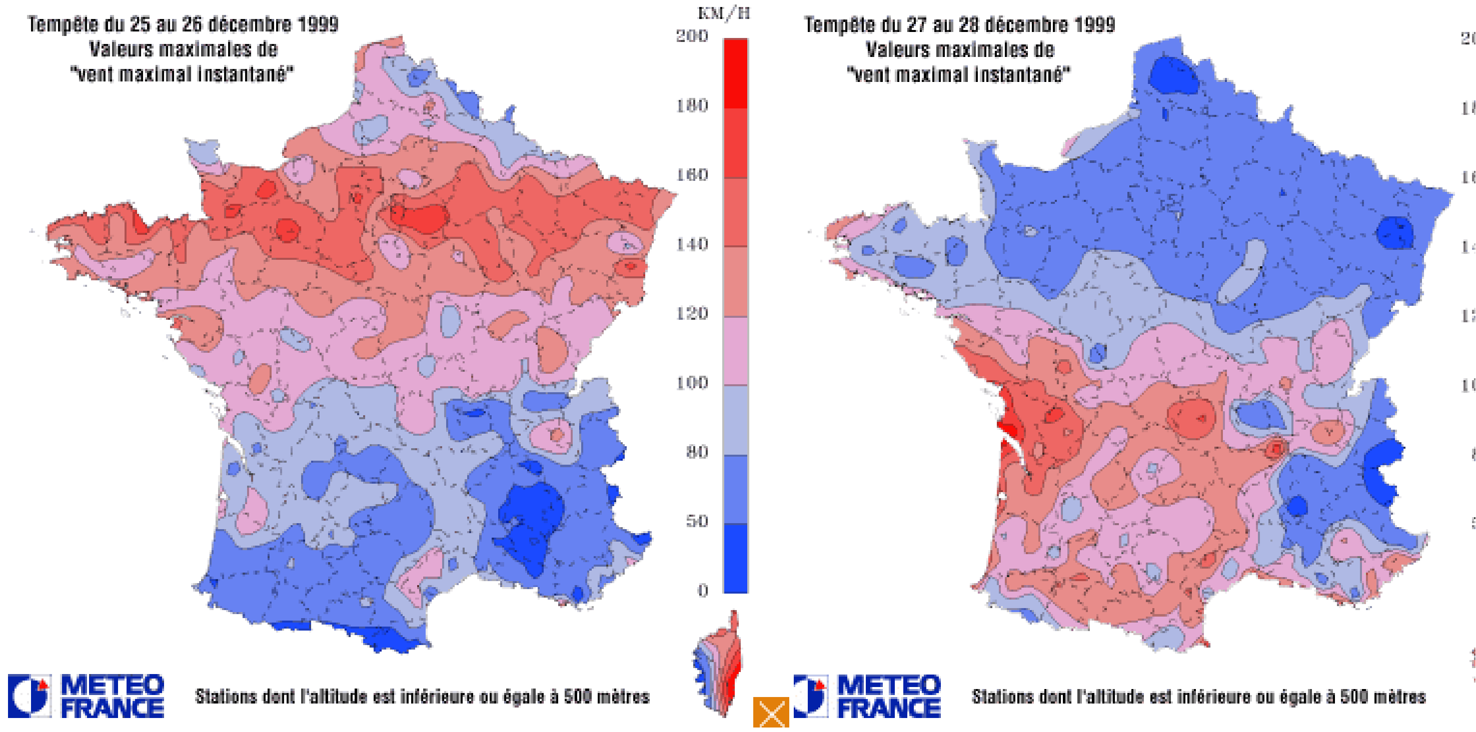


Figure 5: Map of the maximum gust wind speed in km/h, from meteorological stations under 500 m elevation

Short description on damage

The storms had caused over 140 casualties, 88 were in France, which bore the brunt of the two storms. In France, 100 woodcutters died in 2000. Economic damage was estimated at 10 billion Euros. These storms closed the millennium with an exceedingly active year of natural catastrophes.

Europe	**140**
France	**88**
Germany	**18**
Switzerland	**14**
Italy and Spain	**7**

Figure 6 : Casualties in Europe

Germany

Weihnachts-Orkan „Lothar“ richtet in weiten Teilen Mitteleuropas sehr schwere Schäden an, besonders betroffen ist Südwest-Deutschland, größte Waldschäden seit Beginn der Statistik 1879.

Source: http://www.eike-klima-energie.eu/chroniken/wetterchronik/1950-1999/

Switzerland

„Am 26. Dezember 1999 wurden weite Teile der Schweiz von einem der stärksten, je registrierten Stürme heimgesucht.“

„Noch nie hatte in der Schweiz ein Naturereignis Schäden im Umfang von fast 1.8 Milliarden Franken verursacht. Am stärksten betroffen waren der Wald und die Gebäude. 14 Menschen fielen dem Sturm zum Opfer, mindestens 15 starben bei den nachträglichen Räumungsarbeiten.“

Source:

http://www.meteoschweiz.admin.ch/web/de/wetter/wetterereignisse/orkan_lothar - 10.html

Primary damage

France

The first assessment of storm damage (one month later) was 140 million and 500 000 ha of timber blown down. Thanks to satellite imaging « Landsat », the French institute of forest inventory (IFN) could obtain cartography of damages. The comparison between the map of damage and the dendrometric database allows an assessment of the damaged trees volume (between 150 and 170 million cu meters), representing three times the annual harvesting (five times for softwood and twice for hardwood). However this method was not very accurate as we can see on the chart (figure 7), comparing the sampling damaged area. This technique was used in nine french counties and it also allowed for a deviation between the accurate estimations and those from the less precise mapping method. Considering the extent of the damages on French forest, the more accurate method could not have been used everywhere.

Counties	Assessment based on mapping method (x 1000m3)	Assessment based on sampling area (x 1000m3)	First quick assessment (x 1000m3)	deviation between sampling method and mapping method (%)	deviation between sampling method ar first assessment (%
Gironde	14,355	20,825	17,618	45	
Correze	1,732	6,940	7,444	300	
Landes	1,605	5,271	3,500	228	
Yonne	1,868	3,719	1,590	99	
Haut-Rhin	481	2,321	1,102	383	
Lot-et-Garonne	277	1,007	2,004	263	
Cher	no data	462	252	no data	
Sarthe	no data	392	223	no data	
Mayenne	no data	39	51	no data	
Total	20,319	40,976	33,784	102	

Figure 7: Comparisons of differents methods to sampling damaged area.

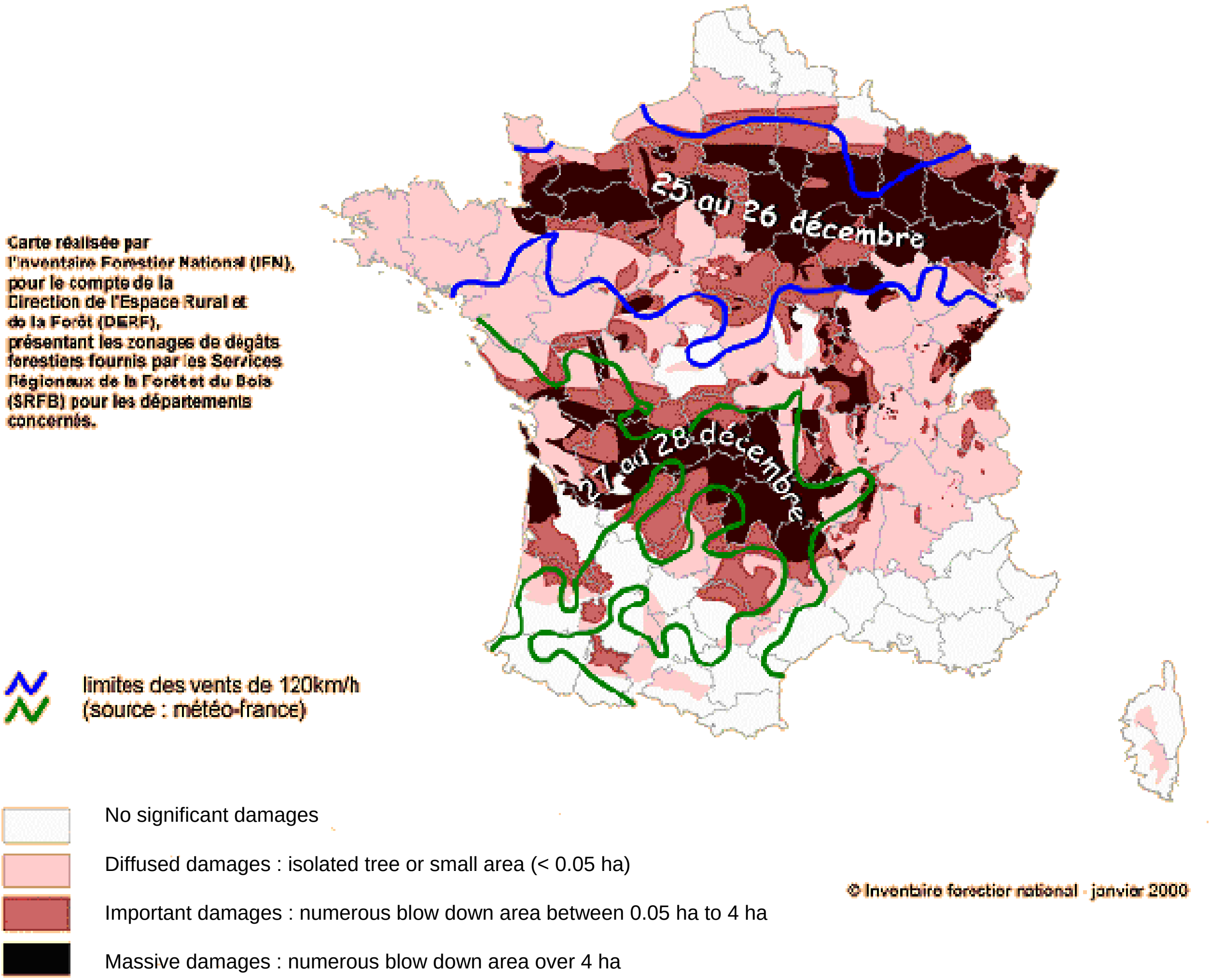


Figure 8: Storms in December 1999: Forest damage and 120 km/h isotachs

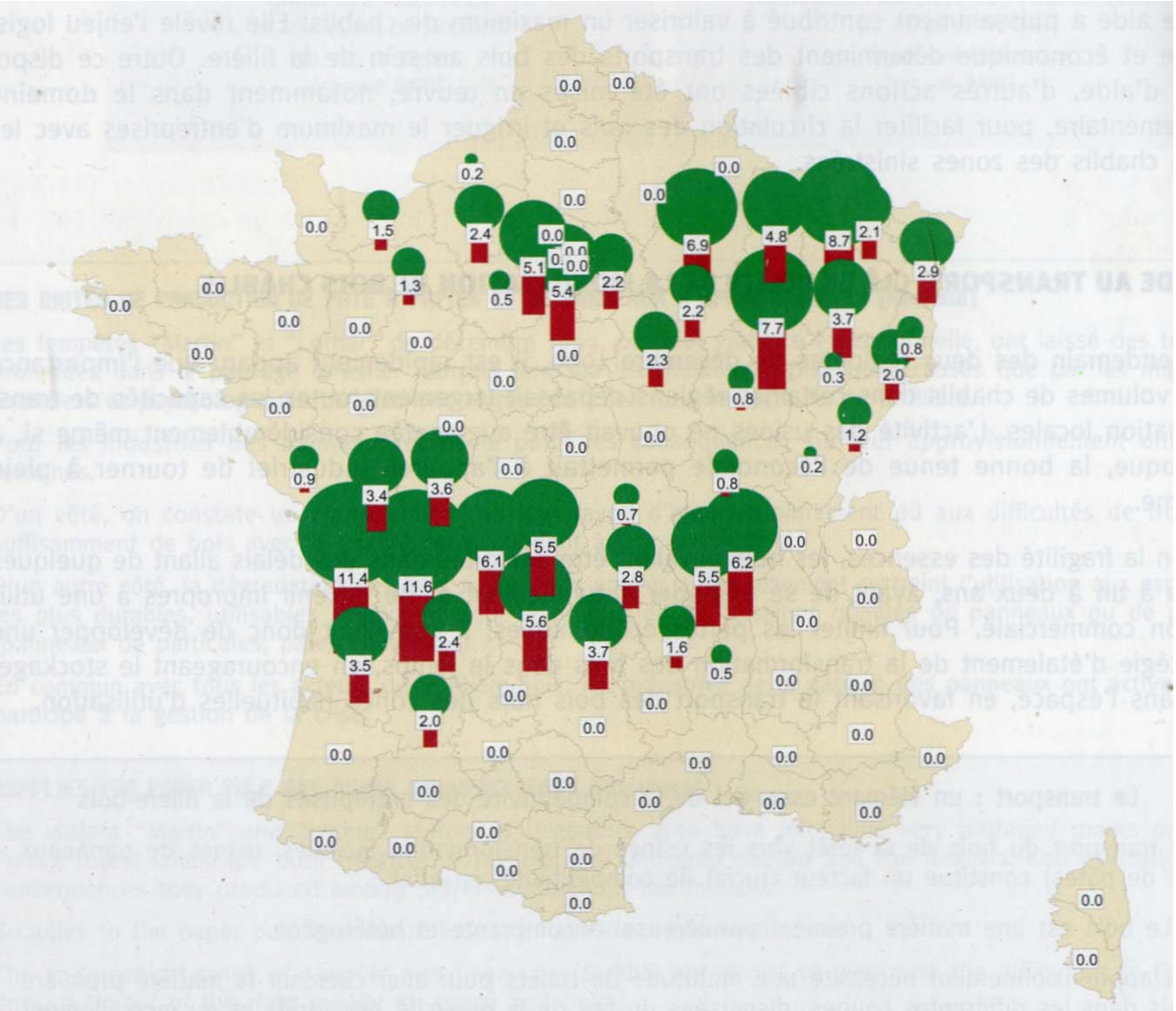
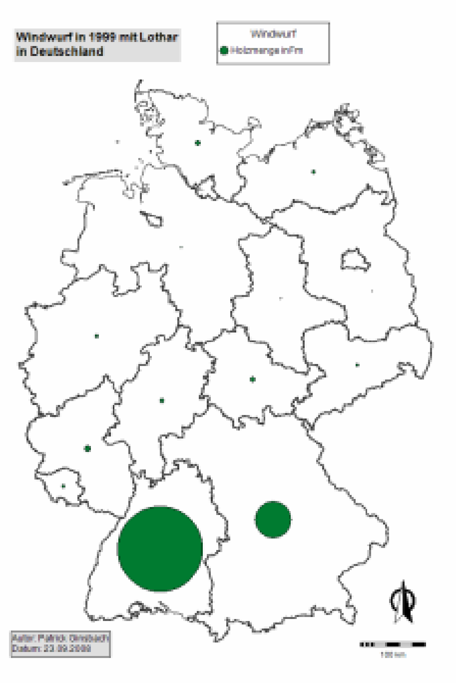


Figure 9: Volume blown down according to the average of annual harvesting.

Germany



Source: http://www.saarlandwetter.de/Website/Lothar.html

Switzerland

13.8 Mm^3

Secondary damage

France

Colonization of trees damaged by wind

The colonisation of timber blown down by insect was very progressive until the end of 2001. The rate of softwood stems (broken trees, windthrow) affected by underbark insects was 24 % in June 2000, 39 % in September 2000, 57 % in June 2001 and 64 % in September 2001. The rate of hardwood affected was lower (42 % of stem in September 2001).

The broken trees were generally more affected than the windthrow. Broken trees had often lost their crown and physiologic activity had stopped and so they were bdefenceless against insects. On the other hand, windthrow had a physiologic activity (they were always rooted) and were more resistant. *Pinus pinaster* and pice*a abies* were the species most colonised respectively by *Ips sexdentatus* and *Ips typographus*.

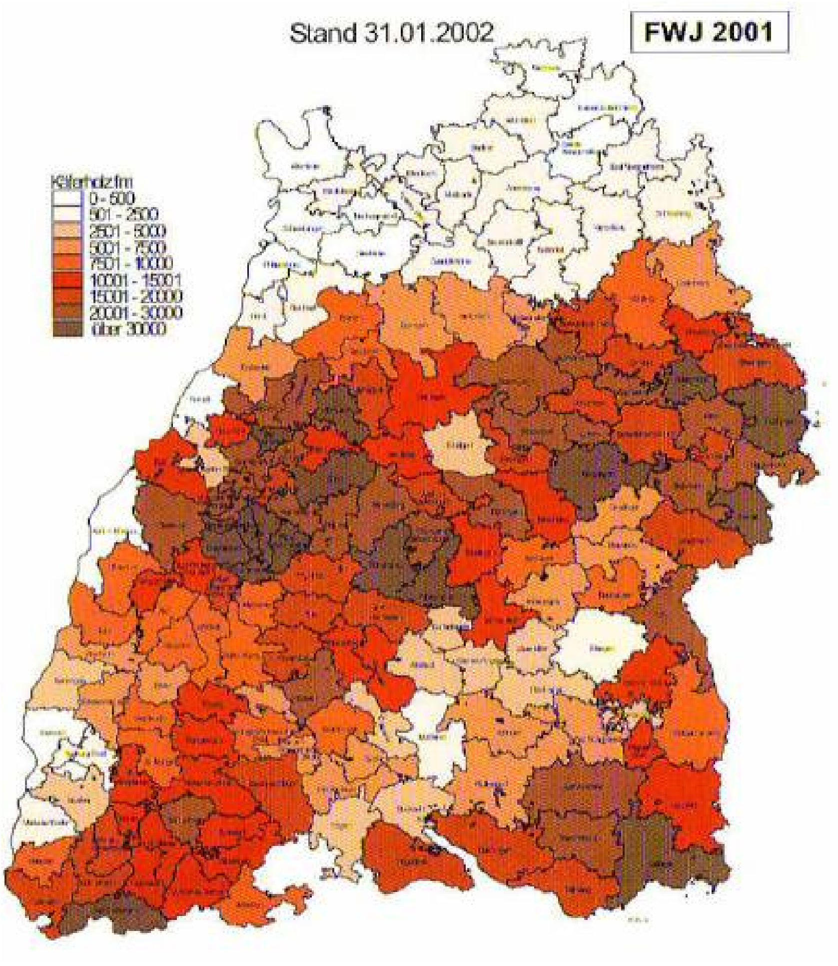
Assessment of standing trees colonized

Insect damage on standing trees began in 2001. *Pinus pinaster* and *picea abies* were still the most colonized species. At least 3.7 millions cubic meters was harvested after insect attacks and this number is certainly under-estimated.

Interaction with summer 2003 drought

The 2003 drought weakened standing trees and revived the colonization of *picea abies* by insects. *Abies alba* suffered from insect attack for the first time.

Germany (Baden-Württemberg)



http://www.fforum.uni-freiburg.de/daten/espro07/grupraes/07_Lothar.pdf

"In Folge des Orkans "Lothar" am zweiten Weihnachtsfeiertag 1999,..., konnten sich die Borkenkäfer aufgrund des grossen Brutangebotes bei gleichzeitig milder Witterung stark vermehren."
Source: http://www.fva-bw.de/publikationen/wzb/ws2002.pdf

„Die Käferholzmenge stieg bis Ende des Jahres 2003 im Vergleich zu den Vorjahren deutlich an. Bisher wurde nur im Jahr 2001 nach dem Orkan „Lothar", in dem die Käfer optimale Entwicklungsmöglichkeiten durch vorhandenes Sturmholz vorfanden, mehr Käferholz aufgearbeitet."
Source: http://www.fva-bw.de/publikationen/wzb/ws2004.pdf

Switzerland

„Die nach dem Sturm "Lothar" vom Dezember 1999 und dem Jahrhundertsommer 2003 aufgetretene Buchdrucker-Massenvermehrung (*Ips typographus*) hat 2008 ihr Ende gefunden. Mit 85'000 m3 lag die befallene Menge Fichtenholz 2008 wieder im Bereich der Jahre vor "Lothar".

Tabelle 1: Buchdrucker: Käferholzmengen, Anzahl Befallsherde und Anzahl gefangener Käfer pro Falle in der Schweiz in den Jahren 2003 – 2008.

Jahr	Zwangs-nutzung Sommer **in m^3**	Zwangs-nutzung Winter **in m^3**	Zwangs-nutzung Total im m^3	Käferholz stehen ge-lassen **in m^3**	Käferholz Total **in m^3**	Anzahl Be-fallsherde	Anzahl Käfer pro Falle
2003	**1'218'000**	**536'000**	1'754'000	**313'000**	**2'067'000**	17'100	22'200
2004	**914'000**	**293'000**	1'207'000	**143'000**	**1'350'000**	12'700	22'500
2005	**740'000**	**189'000**	929'000	**86'000**	**1'015'000**	9'000	22'500
2006	**537'000**	**136'000**	673'000	**54'000**	**727'000**	7'100	20'000
2007	**214'000**	**45'000**	259'000	**26'000**	**285'000**	3'300	18'800
2008	**63'000**	**14'000** *	77'000 *	**8'000** *	**85'000** *	1'150	11'600

*) grau unterlegt: Werte geschätzt. Die Zwangsnutzungen im Winter 2008/2009 sowie das 2008 befallene und im Wald stehen gelassene Käferholz werden erst im Herbst 2009 erhoben.

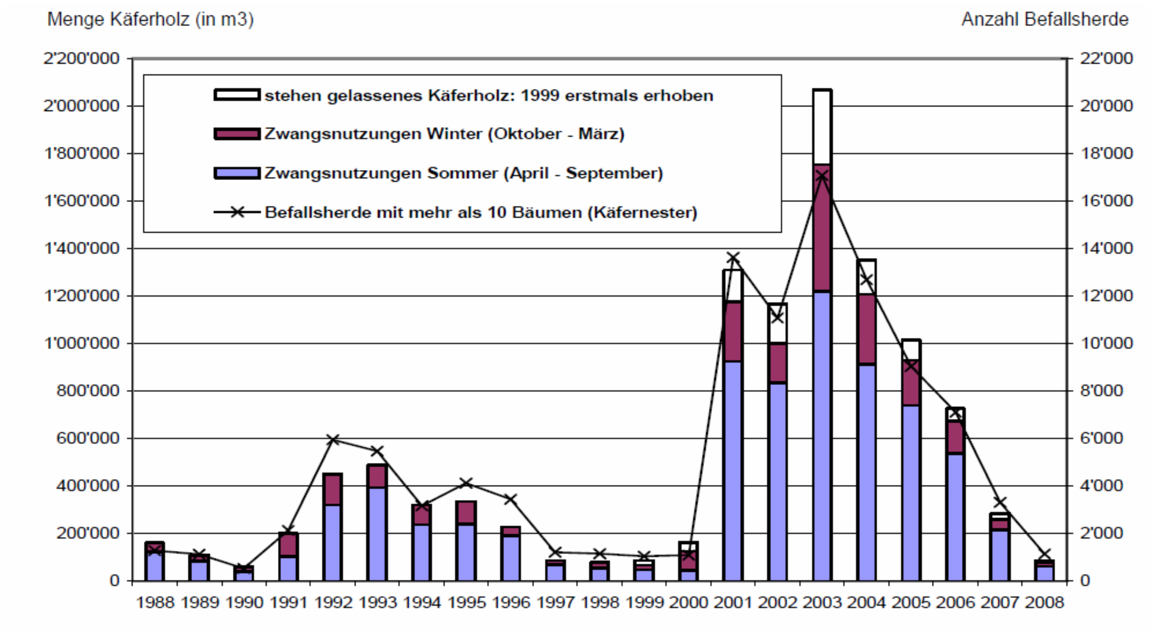


Abb. 2: Buchdrucker: Menge des Käferholzes und Anzahl der Befallsherde in der Schweiz von 1988 – 2008.

Meier et al. (2009)

Tertiary damage

France

Although a difficult exercise, attributing a money value to the storm damage in forests provides an initial broad overview of the situation and is useful for performing a subsequent overall assessment. Figures obviously depend on the stands involved and the extent of damage (violence, range). They approximate the timber's market value within a 50 % margin. For the 1999 storms, losses are estimated to be 6 billion euros. The costs were borne by the public authorities in the years following the storms and by owners over a very long period once windthrows are fully harvested.

Germany (Baden-Württemberg)

„Den geschädigten Waldbesitzern wurde mit einem Bündel von Finanzhilfen und Fördermöglichkeiten geholfen. Für die vielfältigen Leistungen und Belastungen der Forstbetriebe wurden insgesamt 154 Millionen Euro an Fördermitteln ausbezahlt."

Source: http://www.forstbw.de/landesbetrieb-forstbw/forstbw/aktuelles/10-jahre-lothar/

Switzerland

„In der Sommersession bewilligte das Parlament im Rahmen des Nachtrags I zum Voranschlag 2000 124.5 Millionen Franken für die Bewältigung der Lothar-Schäden. Der nicht dringliche Teil wurde von der Bundesversammlung im Oktober beschlossen und gilt bis zum 31. Dezember 2003. Die zweite Parlamentsverordnung (nicht dringlicher Teil) enthält weitgehend die gleichen Massnahmen wie die erste (dringlicher Teil). Zusätzlich wurden Finanzhilfen an die besonders belasteten Kantone Ob- und Nidwalden beschlossen, im Weiteren wurde die Regelung der Ausnahmebewilligung für Holztransporte leicht präzisiert.“ BAFU (2003)

Wie die Lothar-Bundesbeiträge für den Wald verwendet wurden

390 Millionen Franken ausgegeben

Im Frühjahr 2000 wurde der Finanzbedarf zur Bewältigung der Sturmschäden im Wald für die Jahre 2000 bis 2003 auf 509,5 Millionen Franken geschätzt. Darauf abstützend haben die Eidgenössischen Räte 404,5 Mio. Franken Lothar-Sonderkredite gesprochen (davon 110 Mio. Franken rückzahlbare Investitionskredite). Die übrigen 105 Mio. Franken (davon 15 Mio. rückzahlbare Investitionskredite) sollten mit Umlagerungen aus dem ordentlichen Budget und der Finanzplanung aufgefangen werden.

Subventionstatbestand	Geschätzter Bundesbeitrag	Lothar Sonderkredite	Ausbezahlt 2000-03
Aufrüsten Sturmholz, Folgeschäden Käfer, Sturmholzzentralen, Holz 2000 Lothar, holz21, Evaluation, Grundlagenerarbeitung	260.0	200.0	270.0
Holzlagerung, Waldreservate, Sonderfinanzierung NW/OW	40.5	40.5	26.9
Waldpflege	60.0	46.0	24.1
Investitionskredite an die Forstwirtschaft	125.0	110.0	56.9
Schutz vor Naturereignissen (Temporäre Schutzbauten)	13.0	8.0	5.2
Strukturverbesserungen und Erschliessungsanlagen (Waldstrassen)	10.0	0.0	9.7
Bundesbeiträge Lothar Total	**509.5**	**404.5**	**392.8**

Von den geschätzten 509,5 Mio. Franken wurden nur gut 390 Mio. Franken ausgegeben. Dies, weil die Kantone nicht alle Mittel in der geplanten Zeitspanne benötigten. Die Schadenbewältigung ist jedoch noch nicht abgeschlossen. Folgekosten sind insbesondere im Bereich Borkenkäferschäden und Waldpflege zu erwarten.

Source: http://www.news-service.admin.ch/NSBSubscriber/message/attachments/4623.pdf

Summary table

3.3.3 Die finanziellen Anreize im Einzelnen

Tab. 18 Finanzielle Anreize

	Schweiz	Baden-Württemberg	Frankreich
Aufrüsten (nur Jahr 2000): Eingesetzte staatliche Mittel (Kosten für Darlehen sowie À-fonds-perdu-Beiträge) pro m^3	11 €/m^3	0.02 €/m^3	1.5 €/m^3
Laufzeit Lothar-Wiederinstandstellungsprogramm	2000–2003	2000–2004	2000–2009
Gesamter bereitgestellter Betrag für das Lothar-Wiederinstandstellungsprogramm (Verjüngung und Bestandespflege)	70 Mio. €	110 Mio. €	1'000 Mio. €
Wiederinstandstellungsbeitrag pro Jahr und Kubikmeter Sturmholz	1.3 €/m^3	1.1 €/m^3	0.7 €/m^3
Holzlagerung: Gelagerte Menge Anteil der gelagerten Menge am gesamten Sturmholz	1.2 Mio. m^3 10%	4.4 Mio. m^3 15%[79] ()	ca. 7 Mio. m^3 ca. 6%
Unterstützung Holzlagerung (inkl. Transport auf Lagerplätze), Total 2000–2004, pro gelagerten Kubikmeter Holz	10 €/m^3	6 €/m^3	12 €/m^3
Transportbeihilfen (nicht Transporte auf Sturmholzlager)	-	-	106 Mio. €
Forschungsförderung	ja (7 Mio. €)	ja	ja
Förderung der Holzverwendung (À-fonds-perdu-Beiträge)	30.5 Mio. € (2000)	1.2 Mio. € (2000)	100 Mio. € (2000–2010)
Bedeutung der steuerlichen Massnahmen	-	gross	gross

Policy response

France

The following measures were put in place following the storms:

Wood harvesting

- Assistance for clearing forest rides and forest roads to assess the damages amounting to €12.2 millions or 16,000 km of roads.
- Assistance for building landing areaa (1,300), roads and rides (1 200 km) representing €10.52 millions.

- Assistance for restoration of the road damaged by timber Lorries representing €60.7 million.
- Subsidised loans (1.5 %) for three years to help the forest owner with harvesting windthrow. Loans represent €252.1 millions.
- Training courses given to woodcutters to avoid casualties.
- Help with purchasing forest materials (forwarder, skidder...) representing €30 millions.

Wood value optimizing

- Help with building storage places (€20 million).
- Subsidised loans (1.5 %) for six years to help forest owners to store their wood. €351.5 millions has been loaned.
- Help with reporting clearing in forest towns.

Wood transporting

- Assistance with railway transport.
- Help with road transport according to different distance classes (0-100 km; 100-200 km; 200-300 km; more than 300 km), representing € 183 million.
- Increasing of the weight authorised for a lorry (up to 48 tonne, 4 more tonnes than usual).

Forest protection and reconstruction

- Windthrow protection against insects (logging residues grinding, bark removal etc.), which represents €15.24 million.
- Clearing of damaged compartments to protect good natural regeneration of beech in 1999, representing €68.7 million.
- Remedy of young plant blown down, representing € 0.76 million.
- Help for forest crop reconstruction. The help adds up to €915 million over ten years.

Special terms were also applied to land tax, income tax, wealth tax and VAT. Finally, the government set up various accompanying measures such as damage assessment by aerial photography, assignment of additional staff to field organisations, special aid for state forests and establishment of a think tank to explore forest insurance issues.

Germany

„Von Anfang an war in allen drei Staaten unbestritten, dass die Sturmfolgen nicht allein durch die Waldeigentümer und die Forstdienste im Rahmen des ordentlichen Rechts und der ordentlichen Budgets zu bewältigen seien. Der Sturm Lothar wurde in der politischen Diskussion als ausserordentliche Lage10, als Katastrophe oder Krise eingeschätzt. Der Staat, das «politische System», die «Politik» waren gefordert, um die forstlichen Folgen des «Jahrhundertsturms» Lothar zu bewältigen. Ob eine Katastrophe im Sinne der erwähnten Legaldefinitionen oder eine Krise im Sinne der Politikwissenschaften vorlag, kann offen bleiben. Entscheidend ist, dass die Notwendigkeit staatlicher Eingriffe nie in Frage gestellt wurde."

BAFU (2003)

Tab. 3 Prozessanalyse: Untersuchte Ebenen

Prozessanalyse (Schweiz/Deutschland/Frankreich)	Schweiz	Deutschland	Frankreich
-/EU/EU			
Bund/Bund/Zentralstaat			
Kantone/Bundesländer/ Regionen, Dep.			
Gemeinden/Gemeinden/Gemeinden			

Tab. 4 Programmanalyse: Untersuchte Ebenen

Programmanalyse (Schweiz/Deutschland/Frankreich)	Schweiz	Deutschland	Frankreich
-/EU/EU			
Bund/Bund/Zentralstaat			
Kantone/Bundesländer/ Regionen, Dep.			
Gemeinden/Gemeinden/Gemeinden			

Legende
- Eingehend untersuchte Ebene
- Teilweise untersuchte Ebene
- Nicht untersuchte Ebene

„1.4 Synthesebericht und Gesamtbericht

Dieser Synthesebericht ist eine Kurzfassung eines rund 300-seitigen Berichts (Gesamtbericht), der gleichzeitig (unter dem gleichen Haupttitel) in der Veröffentlichungsreihe der Professur Forstpolitik und Forstökonomie, ETH Zürich, publiziert wurde. Der Gesamtbericht umfasst zusätzlich zum Synthesebericht die folgenden Elemente:

- ausführliche Prozessbeschriebe der einzelnen Länder, in welchen das Quellenmaterial sowie Angaben aus den Interviews verarbeitet wurden,
- Einführung in das Forstwesen der drei Länder,
- Einführung in die politischen Systeme der drei Länder,
- Beschreibung der staatlichen Aufgabenverteilung bei der Sturmschadenbewältigung,
- Verzeichnis der Erlasse und Materialien, Begriffsdefinitionen sowie
- Anhang mit Organigrammen, Angaben zu den analysierten Dokumenten und zu den Interviewpartnern; Massnahmen in Frankreich auf regionaler und departementaler Stufe, Rundschreiben Frankreich."

BAFU (2003)

Biodiversity effects

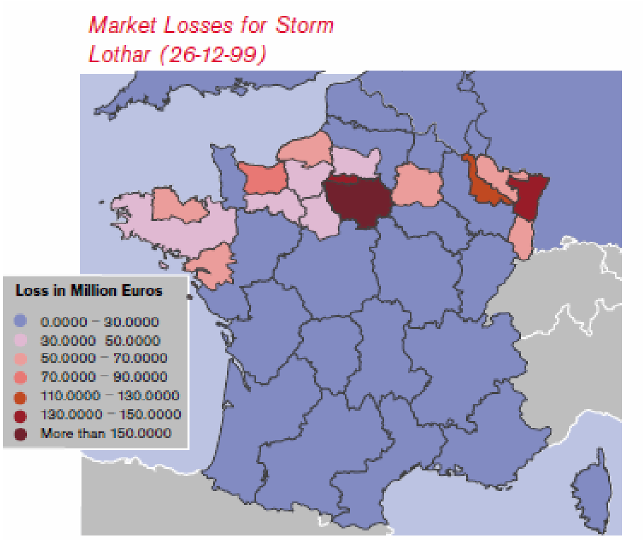
Depending on forest management/policy responses there was an oportunity for (temporal) increasing diversity.

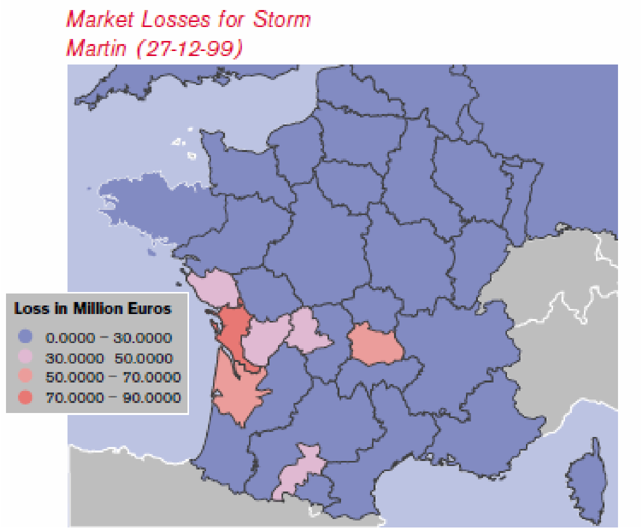
„Aus ökologischer Sicht war Lothar keine Katastrophe für den Wald. Orkan-Schäden bedrohen die langfristige Erhaltung des Schweizer Waldes nicht. Seine Regenerationsfähigkeit ist an den meisten Orten gut, und in vielen Fällen ist es nicht nötig, das Holz aus den Wäldern zu entfernen. Orkane tragen zur Erneuerung der Wälder bei und fördern die Artenvielfalt." BUWAL (2004)

Effects on timber markets

France

In 2000, the ONF (Office National des Forets) sold a volume of timber 49 % higher than in 1999 yet the revenue was 7 % less than in 1999. This can be explained by the unit price, which was 38 % less than in 1999. The oak market suffered less than the others: oak wood can be kept in forest without degradation and the market has good economic conditions. Commercialisation was also less urgent.The beech market suffered a lot and stored beeches had consequences on the market for a long period.


Market Losses for Storm
Lothar (26-12-99)
Loss in Million Euros
0.0000 – 30.0000
30.0000 50.0000
50.0000 – 70.0000
70.0000 – 90.0000
110.0000 – 130.0000
130.0000 – 150.0000
More than 150.0000


Market Losses for Storm
Martin (27-12-99)
Loss in Million Euros
0.0000 – 30.0000
30.0000 50.0000
50.0000 – 70.0000
70.0000 – 90.0000

Germany (Baden-Württemberg)

Entwicklung der Holzpreise

- Im Jahr 2000 wurden in BaWü 17,8 Mio. Fm Holz verkauft
  → doppelte Menge im Vergleich zu normalen Jahren
- starker Preisverfall gegenüber dem Vorjahr:
  - Fichte: -45%
  - Kiefer: -30%
  - Douglasie und Lärche: -25%
- Laubholz weniger stark betroffen

→ 4,6 Mio. Fm Sturmholz (v.a. Fi und Ta) wurden auf über 400 Nasslagerplätzen eingelagert, da der Markt die große Holzmenge nicht aufnehmen konnte.

Source:

http://www.forstbw.de/fileadmin/forstbw_pdf/waldschutz/Praesentation_Lothar_3.pdf

Switzerland

86% des vom Holzhandel im Jahr 2000 gekauften Holzes wurde exportiert. Italien, Österreich und Deutschland, aber auch Länder wie China, Indien und Slowenien nahmen 3 x mehr Holz ab als 1999.

Durch gegenseitiges Unterbieten kam es zu einigen Vertragsbrüchen und einem weiteren Preistrend nach unten.

Preisentwicklung gemäss Holzhändlern:

Rundholzpreise franko Waldstrass Fr/m3	1999	2000
Nadelholz Qualität B/C	97.-	54.-
Nadelholz D	55.-	33.-
Laubholz Sagholz	166.-	109.-
Laubholz Verpackungsmaterial	45.-	35.-

Source: http://www.brainworker.ch/WAP/Holzvermarktung.htm

Literature

Bründl, M., Rickli, C. (2002) http://www.wsl.ch/publikationen/pdf/4769.pdf Ulbrich, U.,

Fink, H., Klawa, M., Pinto, J.G. (2001) http://www.uni-koeln.de/math-nat-fak/geomet/meteo/forschung/abstracts/ulbrich/ufkp_weather_artikel2001.pdf Meier, F.,

Engesser, R., Forster, B., Odermatt, O., Angst, A. (2009) http://e-collection.ethbib.ethz.ch/eserv/eth:26268/eth-26268-11.pdf RMS

(2000) https://www.rms.com/Publications/Lothar_Martin_Event.pdf http://www.als.uhp-nancy.fr/Bulletins/Tome40%281-2%29/vernier%20.pdf Peyron, J.-L. (2002) http://cat.inist.fr/?aModele=afficheN&cpsidt=14577222 Wencelius F (2002) http://cat.inist.fr/?aModele=afficheN&cpsidt=14577221 ONF (2009) http://www.onf.fr/outils/presse/20091113-095328-738053/files/1 EQE (?) http://www.absconsulting.com/resources/Catastrophe_Reports/Lothar-Martin%20Report.pdf BAFU

(2003) http://www.bafu.admin.ch/publikationen/publikation/00242/index.html?lang=de&downloadshop=NHzLpZig7t,lnp6I0NTU042l2Z6ln1acy4Zn4Z2qZpnO2Yuq2Z6gpJCDdH12fmym162dpYbUzd,Gpd6emK2Oz9aGodetmqaN19XI2IdvoaCVZ,s-.pdf BUWAL (2004) http://www.bafu.admin.ch/naturgefahren/01919/01965/index.html?download=NHzLpZeg7t,lnp6I0NTU042l2Z6ln1acy4Zn4Z2qZpnO2Yuq2Z6gpJCEdIF2gGym162epYbg2c_JjKbNoKSn6A--&lang=de

there are loads more… e.g.:

http://www.nat-hazards-earth-syst-sci.net/8/795/2008/nhess-8-795-2008.pdf
http://ams.confex.com/ams/pdfpapers/21776.pdf
http://www.dkkv.org/de/publications/ressource.asp?ID=145
http://129.13.145.4/heneka/files/heneka_davos2006_extabstract.pdf
http://www.atypon-link.coms-1FS/doi/pdf/10.3188/szf.2001.0445 http://www.atypon-link.coms-1FS/doi/pdf/10.3188/szf.2010.0036

http://www.springerlink.com/content/76l5361383n47809/fulltext.pdf
http://www.nrsm.uq.edu.au/SFEMP/journals/Vol%203_2/04%20Hartebrodt.pdf
http://www.fforum.uni-freiburg.de/daten/espro07/grupraes/07_Lothar.pdf
http://www.knmi.nl/cms/content/7259/de_uitzonderlijke_zware_kerststormen_in_europa http://www.notre-planete.info/geographie/risques_naturels/tempetes_0.php
http://www.tempetes.ifn.fr/pages/fr/tempetes/resultats/54/rapport-54.pdf
http://agriculture.gouv.fr/spip/IMG/pdf/foret_1496.pdf http://physio-geo.revues.org/1014 http://www.gip-ecofor.org/docs/tempete/seminaire_5_6_dec_2002/Actes.pdf
http://www.ladocumentationfrancaise.fr/cartotheque/tempetes-lothar-martin-france-decembre-1999.shtml http://www.wsl.ch/publikationen/reihen/wald/016.pdf http://www.anw-baden-wuerttemberg.de/lothar.pdf
http://www.ctba.fr/stodafor/Seminaire%20final/PDF_PRESENTATIONS_Speakers/VON%20TEUFFEL.pdf http://www.cedim.de/1016.php http://www.bad-bad.de/news/lothar.htm
http://www.waldwissen.net/themen/holz_markt/holzmarkt/wsl_oekonomische_auswirkungen_lothar_DE
http://www.waldwissen.net/themen/holz_markt/holzmarkt/wsl_sturmholzzentrale_lothar_DE http://www.brainworker.ch/WAP/Holzvermarktung.htm
http://www.admin.ch/cp/d/3a41fbe9_1@fwsrvg.bfi.admin.ch.html
http://ec.europa.eu/community_law/state_aids/agriculture-2000/n113-00.pdf
http://www.wvs.ch/m/mandanten/159/download/s_27-31_WH_09_LOTHAR_HM.pdf

http://www.scienceblogs.de/weatherlog/2009/09/die-positiven-folgen-von-orkan-lothar.php http://www.forstbw.de/landesbetrieb-forstbw/forstbw/aktuelles/10-jahre-lothar/
http://www.bafu.admin.ch/naturgefahren/01923/01956/index.html?lang=de&download=NHzLpZeg7t,lnp6I0NTU042l2Z6ln1acy4Zn4Z2qZpnO2Yuq2Z6gpJCEdIF5hGym162epYbg2c_JjKbNoKSn6A-- http://www.news.admin.ch/message/index.html?lang=de&msg-id=8389 http://www.news-service.admin.ch/NSBSubscriber/message/attachments/4623.pdf
http://www.cipra.org/pdfs/151_de/

http://www.parlament.ch/d/mm/2000/Seiten/mm_2000-03-01_000_01.aspx

http://www.waldwissen.net/themen/naturgefahren/krisenmanagement/wsl_lothar_bilanz_zusammenfassung_de.pdf

Storm of 19th November 2004 in Tatra Mountains

Meteorological conditions

The center of low air presure was moving west to east direction close to the Tatra Mountains. Along a cold front 50° new cyclons were formed. When air massess approached the Tatra Mountains barrier a so-called downslope wind was formed on a lee side of the Tatra Mts (Simon, Horvath, Vivoda 2006). On the mountain peaks (2630 m a.s.l.) maximum wind gusts reached 170 km/h, in 1750 m a.s.l and 200 km/h and on the tree line (1500 m s.l.) 230 km/h. Strong winds lasted from 15.40 to 21.30. Most of the forest was levelled in first 30 minutes. Practically all fallen trees were oriented N-S (www.lesytanap.sk/08-archiv/clanky/kalamita.php)

Description of damage

The storm on November 19, 2004 impaired forests mostly on the lee side of the central Slovakia mountains. The total volume damaged was 5.3 mil m3 (Kunca-Zubrik, 2006). The annual harvest in the Slovak republic in 2005 was 10,1 mil m3 (Annual Forestry Report-Green Report, Ministry of Agriculture SR, 2008). The Tatra Mountains region was the most heavily affected (2.3 mil m3, 12 000 ha). The storm badly damaged local infrastructure (transport -roads, tourist trails, electric train, electric lines, water pipes). Buildings withstood the storm relatively well, except for broken windows and damaged roofs, thanks to the protective effect of trees during the first storm gusts.

Primary damage

Heavy windstorms are normally part of the local anemo-orographic system (Mrkos, 1925) . The consequence of continuous wind disturbances is the existence of unique larch-spruce communities (*Lariceto-Piceetum*). A risk assessment in the 1990s confirmed a large risk for the integrity of this forest in the near feature. Besides air pollution, climate extremes on uniform forest structure were identified as the key factors for low ecological resistance and high risk of destruction (Fleischer et al., 2005, 2008). The most vulnerable were identified as man-made spruce stands established after windstorms in 1915, 1941 and 1960s. The windstorm of November 19 2004 reached speeds of over 230 km/h, which damaged both man-made and semi-natural stands in the altitudinal belt 800-1300 m a.s.l. Natural stands remained more or less untouched thanks to thier location in higher elevations.

Secondary damage

Large insect outbreaks were forecast immediately after the windstorm. The main reason was large population in the Tatra spruce-dominated (boreal like) forests before the windstorm 2004. In 2005 and 2006 insects remained mostly in the windfall, later expanded into standing forest. According to nature conservation law, large amounts of fallen timber were left on sites (more than 500 000 m3). Annualy, nearly 1000 ha of standing forest was affected and killed by insect (*Ips typographus*, *Ips amitinus*, *Pityogenes chalcographus).* The extent of damaged forest is analysed annually by aerial IR ortophotomaps.

The removal of trunks infected by bark beetle was partly blocked by a decision of the ENV DG relating to disturbance of NATURA 2000 sites by „logging". The infrigement was in operation since 2007 and cancelled in 2009. No conflict with NATURA 2000 was finally reported by EU comission (who visited in July 2007).

High risks of floods, fire and insect outbreaks lead to the decision to clean up windfall. According to nature conservation law and presriptions 10% of windfall area was left totally unmanaged. Also managed windfall wasn´t cleaned up completely. On average, 30% of timber was left on site for improvement of nutrient balance and microclimate. Overall, more than 500 000m3 of wood was left for natural processes. In combination with an extremely warm growing season in 2007 and a warm 2008 combined with a precipitation deficit in spring this decision led to catastrophic insect outbreaks to remaining (standing) forest in altidude above 1300 m a.s.l. (Fleischer, 2008).

Despite fast progress in removing fallen wood, a large fire occured near the administration center of the Tatra Mountains. The fire burnt 200 ha of partly processed windfall. 150 firemen fought the fire for 3 days and 2 helicopters and aircrafts were used. It was extremely difficult to rehabilitate this site (http://www.lesytanap.sk/11-ticha-koprova-dolina).

Tertiary damage

Losses of ecological and environmental forest services were calculated for a test area (Vyskot et al.,2005). The most valuable services provided by forests were health treatment function (10 000 Euro/ha), soil protection (8 000 Euro/ha). The less valuable were productivity function (5 500 Euro/ha) and social-recreational function (4 000 Euro/ha). The analysis for the rest should be available soon.

Policy responses

Storm policy management options were disccussed at the International workshops (organized by SK Government, UNECE and FAO, 18-21 April 2005 in Zvolen and 4-6 May 2009 Strbske Pleso, Slovakia, http://fao.org/regional/SEUR/events/storm/docs). Priority was put on the mitigation of storm consequences on environmental, social and economical functions of forests, considering the protection status of the Tatra Mountains forest (nature reserves, National Park, NATURA 2000).

What was successful included:

- Conception of windfall removal, rehabilitation and protection
- Project of revitalisation of the Tatra Mts forest damaged by windstorm on November 19, 2004 (Jankovic et al. eds., 2007, Project of forest protection (Vakula-Zubrik, 2007)
- Differentiated management of affected area
- Scientific support for forest users
- Small water reservoirs
- Fire risk eliminated in the vicinity of municipalities (Anonymous, Project of fire protection)
- Recreational values renewed
- Programme of research and monitoring

Conflicts and difficulties not successfuly overcome yet include:

- Bark beetle was not clearly identified as the primary component of the after-calamity Management
- Current knowledge of climate change impacts and bark beetle ecology was not fully considered
- There were administrative delays for fallen wood removal and insect outbreaks
- A weakness in the legislation leading to conflict between nature conservation and forestry laws, and highlighting unclear aims and tools of NATURA 2000
- Insufficient communication with media
- Fundamantal principles for management (zoning system) were not prepared
- There was a lack of clarity over responsibilities and competencies between State Nature Conservation, forest owners and NGOs
- Crisis managment plans were missing
- Fire warning systems didn´t exist
- There was poor compensation of non-state forest owners. Non state owners have not been compensated for limited use of their property in National Park. There is a high risk for future management of privately owned forest as there are no financial resources generated from current use and no resources in future for planting and treatment.

The IUCN mission (April 2005) reported the situation after the windstorm from nature conservation point of view (Crofts, Zupancic, Marghescu, Tederko, 2005: IUCN Mission to the Tatra National Park, 43 pp, http://www.wolf.sk/files/dokumenty/IUCN_EN_zaverecna_sprava_2005.pdf)

Effects on biodiversity

Boreal-like spruce dominated forests have very low species diversity. The windstorm forms gaps, niche and many possibilities for diverse life form, species diversity increases. In the Tatra Mountains, in protected areas (nature reserves, National Park, Natura 2000) the aim is not to manage natural resources for higher diversity, but for natural diversity . Species diversity and abundance in many cases increased after the windstorm (microorganisms, soil fauna, small mammals, insect birds). This is one of a key component of coordinated ecological reserach and monitoring named „Windfall research" organized by the Research station of Tatra National Park since 2005 (Fleischer, 2008). Thanks to the warm and wet climate in recent years, rehabilitation of vegetation is very fast, including natural regeneration of forest. Intensive ecological processes (nutrient loss, soil respiration, mineralisation) are limited by intensively grown vegetation. The negative situation persists outside the windfall, in natural or even pristine spruce stands suffering from enormous insect attack. Recently bark beetle badly also affected Swiss pine (*Pinus cembra*) growing along the tree line, very likely as a consequence of elevated temperatures and long-term elevated O3 concentration (Fleischer, Bicarova, Godzik 2009)

Effects on timber market

Most of the wood is exported so effects of the storm is unimportant. However, wood quality was reduced by windfall and postponed approval for extraction led to significant wood degradation (price loss more than 50%)

Literature

Anonymus, 2008: Annual forestry report (Green report), in Slovak. Ministry of Landuse, Bratislava, 168 pp.

Crofts R., Zupancic-Vicar M., Marghescu T., Tederko Z., 2005: IUCN Mission to the Tatra National Park, April 2005, 43 pp, http://www.wolf.sk/files/dokumenty/IUCN_EN_zaverecna_sprava_2005.pdf

Fleischer P., Godzik B., Bicarova S., Bytnerowicz A., 2005: Effects o fair pollution and climate change on forests of the Tatra Mts. In: Omasa K., Nouchi I., deKok L.J. (eds.) Plant responses to air pollution and global change. Springer Tokyo, p.111-121.

Fleischer P., 2008: Current status of forest ecosystems in the Tatra National Park. http://fao.org/regional/SEUR/events/storm/docs/fleischer_en.pdf

Fleischer P.,2008: Windfall reserach and monitoring in the High Tatra Mts, objectives, principles, methods, and current status. Contributions to Geophysics and Geodesy. Vol.38, No.3, p. 233-248, ISSN 1335-2806

Fleischer P., Koren M., Skvarenina J., Kunca V.:, 2009: Risk assessment of the Tatra Mts forest. In: Strelcova et al.,(eds.) Bioclimatology and natural hazards. Springer 2009, p. 145-154

Fleischer P., Bicarova S., Godzik B., 2009: Ten years of monitoring of O3 impact on the Tatra Mts forest (in Slovak). Studies on Tatra National Park, Tatranska Lomnica, Vol 9 (42), p. 17-27

Jankovič J. et. al. (eds.), 2007: Project of revitalisation of the Tatra Mts forest ecosystems damaged by windstorm on Novemeber 19, 2004 (in Slovak). National Forest Center, Zvolen, ISBN 978-80-8093-019-6, 75 pp

Kunca A., Zubrik M., 2006: Windfall from November 19, 2004 (in Slovak: Vetrová kalamita z 19. Novembra 2004. National Forest Center, Zvolen, ISBN 80-8093-006-6, 40 pp.

Mrkos J., 1925: Bora wind in the Tatra Mountains (in Czech). Proceedings of Czech geographical society, Vol. 31, No. 3-4, p.79-81

Simon A., Vivoda J., 2005 Downslope windstorm in High Tatras, High resolution study , http://www.cnrm.meteo.fr/aladin/IMG/pdf/ANDRESIMON.pdf

The Storms of 7th – 9th January 2005 (Gudrun or Erwin)

Meteorological Conditions

An extra-tropical cyclone formed on the evening of January 7, 2005, NW of Iceland. Less that 24 hours later it had developed into the most damaging weather event known to occur in Sweden (Alexandersson & Ivarson, 2005). The damage was done to forests, the electricity supply, tele-communications, and transportation.

The extra-tropical cyclone rapidly deepened when cold air from Greenland met with mild and moist air NW of the British Isles and a westerly jet stream aloft caused rapid air-pressure fall closer to the ground (Alexandersson & Ivarson, 2005). At mid-day of 8 January the center of the low-pressure system reached SW Norway and the wind speed increased to gale force on the Swedish West Coast. The culmination was reached somewhat later during the same day and during the following night when the low-pressure system passed Sweden. The minimum air pressure of approximately 960 hPa was reached close to the border between Norway and Sweden on the evening of 8 January (Alexandersson & Ivarson, 2005).

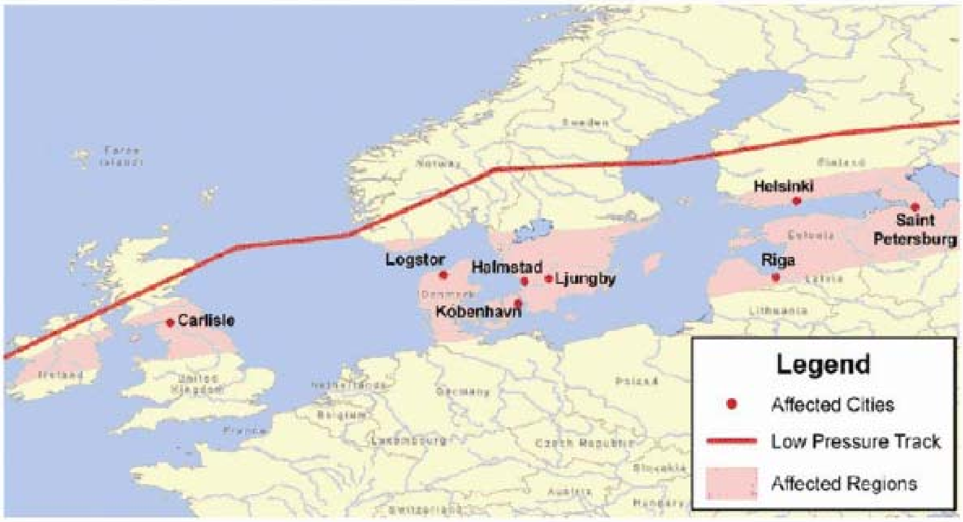


Figure 1: *Storm Track and affected regions. Swedish Meteorological Institute (from SFA, 2006).*

Great Britain

In Great Britain, the maximum gust wind speed recorded during the storm was 45 ms^{-1} at the lighthouse St Bees in Cumbria, NW England (Alexandersson & Ivarson, 2005).

Sweden

In Sweden, the maximum recorded 10 minute average wind speed during the storm was at the coastal station Hanö with 33 ms^{-1}, where also the highest gust wind speed of 42 ms^{-1} was recorded (Alexandersson & Ivarsson, 2005). At inland stations, maximum average wind speed of 15 ms^{-1} and gust wind speed of 33 ms^{-1} was recorded in Ljungby and 17 ms^{-1} and 33 ms^{-1}, respectively in Växjö (Figures 2 & 3) (Alexandersson & Ivarsson, 2005). In Ljungby the maximum wind speed may have been higher later on since observations are lacking after 7 p.m. due to power failure caused by the storm (Alexandersson & Ivarsson, 2005). The storm was preceded by a period of mild weather (Alexandersson & Ivarsson, 2005).

Similarly, strong wind speeds were recorded in Sweden during the storm of 22 September 1969 but that storm was of a somewhat smaller geographical extent and affected areas further to the north (Alexandersson & Ivarson, 2005).

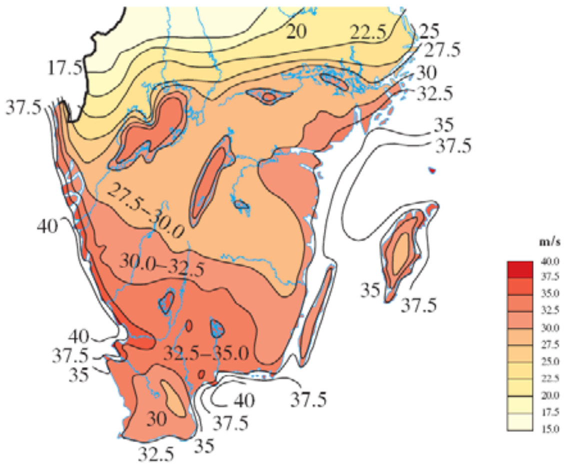


Figure 2: Maximum gust windspeed (m/s at 10 m) on 8-9 January, 2005 (from Alexandersson & Ivarsson, 2005).

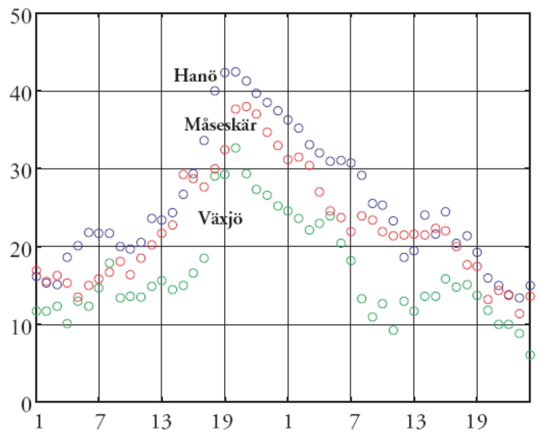


Figure 3: *Maximum gust wind speed (m/s at 10 m) on 8-9 January, 2005, at the meteorological stations Hanö, Måseskär, and Växjö (from Alexandersson & Ivarsson, 2005).*

Denmark

The highest wind speed recorded anywhere during the storm was at Hanstholm, NW Jutland, in Denmark where the maximum average wind speed of 35 ms^{-1} and gust wind speed of 46 ms^{-1} were recorded (Alexandersson & Ivarsson, 2005).

Latvia

In Latvia, the highest recorded gust wind speed was 38 ms^{-1} (Alexandersson & Ivarsson, 2005).

Short description on damage

Great Britain

When the young extra-tropical cyclone passed northern Great Britain during the night of 6 and 7 January very strong cells of thunder storms were formed (Alexandersson & Ivarsson, 2005). In Carlisle, northern England, the river Eden flooded which gave rise to severe water damage to 2900 houses. In the upper parts of this river 227 mm of rain in 72 h was recorded, of which 120 mm fell in 24 h until 8 a.m. on 8 January. The water level was approximately 1 m above the previously recorded all time high level (Alexandersson & Ivarsson, 2005).

Denmark

The northern half of Jutland was most severely affected where approximately 60 000 households were left without electricity (Alexandersson & Ivarsson, 2005). Compared to the storm on 3 December 1999, the storm in 2005 was more severe in the northern half of Jutland whereas the storm in 1999 was more severe to the south (Alexandersson & Ivarsson, 2005).

Sweden

The landscape in the area affected by the storm in many places had been dramatically changed. Roads were blocked, electricity supply and tele-communications were out of order, the trains were at standstill and people were shocked by the devastation. At most 730 000 subscribers were left without electricity as a consequence of the wind damage (FMV, 2006). In urban areas the power was back after approximately one day but for some households the power failure lasted up to 45 days (FMV, 2006).

Following the wind damage, 300 000 subscribers' non-mobile telecommunications system were not functioning following the storm (FMV, 2006) and even 2 months after the storm a large number of subscribers were still without telecommunications. After the storm, all railway lines to and from southern Sweden were also at standstill. On 20

January some traffic had been re-established on the main railway line and on12 February train traffic on all affected railways lines had been re-established (KBM, 2005). The Swedish security system was at its limit and much more severe consequences would have occurred had not a series of favorable circumstances such as mild weather mitigated the situation (KBM, 2005).

Baltic States

The Baltic states were severely affected by the storm, especially Latvia where the electricity supply almost collapsed and 1,4 million people were left without electricity. Extremely high sea water levels occurred along the coast with severe flooding (Alexandersson & Ivarsson, 2005).

Norway

In Norway fairly extensive power failures were caused (Alexandersson & Ivarsson, 2005).

Germany

In Schleswig-Holstein in North Germany many houses were damaged and ferry and train services were cancelled (Alexandersson & Ivarsson, 2005).

Finland

In Helsinki the water rose 1.5 m above normal and in the Gulf of Finland, where the water is trapped, the water rose 2.5 m above normal (Alexandersson & Ivarsson, 2005).

Primary damage

Sweden

In Sweden a total volume of approximately 75 Mm^3 of forest was damaged in Götaland and Svealand (SFA, 2006). The damages were distributed over approximately 270 000 ha, of which the forest on 110 000–130 000 ha was damaged to such an extent that regeneration was required by law (SFA, 2006).

An inventory of the damage by ocular inspection from aircraft was made for Götaland, except for the islands Öland and Gotland, and southern and central Scania and Dalsland (Figure 4) (Claesson & Paulsson 2005). In this inventory the damage was estimated to be 69.7 Mm^3. Damage in Dalsland, Närke and Södermanland, estimated to be 2 Mm^3, and approximately 3 Mm^3 of scattered wind damaged trees, provides a sum total of 75 Mm^3 (SFA, 2006). In the most severely damaged Södra forestry districts more than 20 years of annual harvest was felled during 2004-2008 (Södra, 2010).

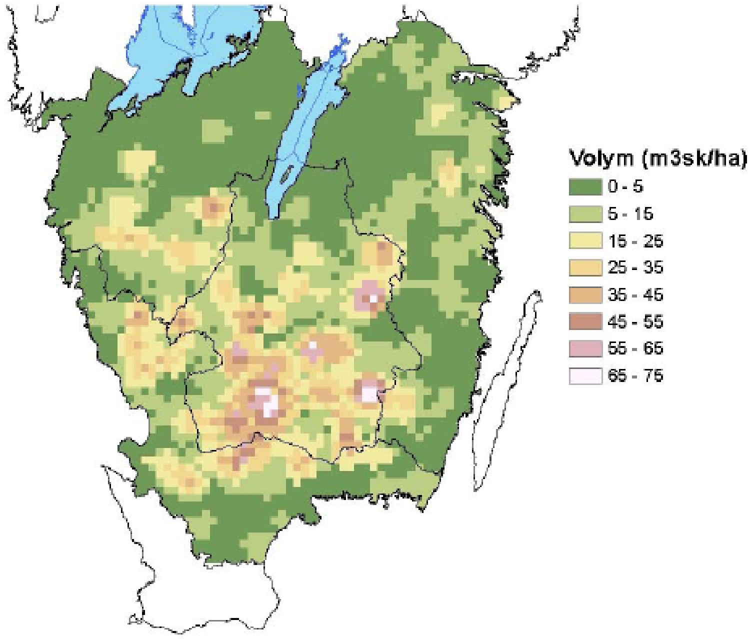


Figure 4: *Damaged volume (m^3/ha) in southern Sweden after the 8 January 2005 wind damage event based on ocular inspection from air craft (Claesson & Paulsson, 2005).*

Damage was most extensive in spruce in all counties except in Östergötlands län. For all of Götaland approximately 80% of the damage was made up of spruce that held 50% of the total standing volume before the storm (SFA, 2006). The volume of damaged Scots pine was 18% of the total damaged volume and Scots pine held 29% of the total standing volume before the storm. The volume of damaged deciduous forest was 2% of the total damaged volume and deciduous tree species held 19% of the total standing volume in Götaland before the storm (SFA, 2006). This means that more damage was done, relatively speaking, to spruce than to the other tree species. The result with respect damage in different tree species is classified as reliable (SFA, 2006).

In all counties where damage was observed the damaged acreage was largest for mature forest (SFA, 2006). 39 % of the acreage of severely damaged forest was of ages where thinnings are made, and 61% of the acreage of severely damaged forest was mature forest (SFA, 2006). No severely damaged acreage was found for young forest (SFA, 206).

Denmark

In northern Denmark extensive wind damage to forest amounted to approximately 2 Mm^3. (Alexandersson & Ivarsson, 2005).

Norway

According to Skogbrand (2010) no extensive damage to forest was caused in Norway.

Latvia

Approximately 5 Mm^3 of forest was damaged in Latvia (Alexandersson & Ivarsson, 2005).

Secondary damage

Sweden

Large efforts were made in Sweden to clear-up the impacts of the storm in order to prevent build-up of populations of insect pests such as spruce bark beetle (*Ips typographus*) and to prevent reduction in quality of the harvested timber. However, large volumes of spruce remained in the forest over the summer of 2005 and some was still suitable as breeding material for beetles in the spring 2006 (Långström et al., 2009). This resulted in increasing beetle populations and tree mortality. After a second wind felling that took place in January 2007 in partly the same area as in 2005, extensive efforts were put in to salvage the fallen timber before the beetle flight in spring 2007. However, many trees remained in the forest over the summer, which led to the production of new beetles (Långström et al., 2009). Considering the large volumes of storm-felled spruce in 2005 and 2007, the resulting tree mortality so far has been lower than was anticipated after the large population build-up especially in 2006 (Långström et al., 2009). Altogether approximately 3 Mm^3 have been killed during three years (Långström et al., 2009). Also in 2009 the population of spruce bark beetle was still augmented (Bergquist, 2009).

Tertiary damage

Sweden

The salvage of wind felled forest progressed more quickly than anticipated. Approximately 87% of the wind felled volume had been salvaged by the end of 2005 (SFA, 2006). For the period 2008-2014 the sustainable level of felling is exceeded for Norway spruce in southern Sweden due to the wind damage that was most extensive in Norway spruce. The total additional costs to society due to the wind damage has been estimated at 1.1-1.2 billion EUR (SFA, 2006).

The forest owner association Södra reports that more than 4000 extra persons were hired to deal with the consequences of the wind damage, mainly logging or transportation entrepreneurs. The figure is to be compared with the total number of employees at Södra amounting to 3900 (Södra, 2010).

An inventory of ancient remains indicate that almost 40% of ancient remains had been damaged (SFA, 2006).

Casualties

Great Britain

Three individuals were killed in Carlisle, and approximately 100 were injured. (Alexandersson & Ivarsson, 2005)

Denmark

Four casualties occured (Alexandersson & Ivarsson, 2005).

Sweden

Eleven individuals in Sweden lost their lives during the storm and through salvage work (Guldåker, 2009). More than 1600 accidents were reported in Sweden (SFA, 2006).

Germany

In Schleswig-Holstein in North Germany two individuals were killed (Alexandersson & Ivarsson, 2005).

Policy response

Europe

The European Solidarity Fund paid EUR 92.88 million to Sweden, Estonia, Latvia and Lithuania as compensation for the consequences of the storm.

Sweden

A new law (2006:544) in 2006 was enacted aiming to reduce the vulnerability of municipalities' and regional councils' activities, and to improve management of risks and crises in peace time, thus reaching a basic level of civil defence.

The law was at least partly enacted in response to that 543 Swedish citizens lost their lives by a tsunami in Asia on 26 December 2004. In total 225,000-300,000 individuals lost their lives to this event, and the Gudrun wind damage event that occurred only a couple of weeks later (cf. SFA, 2006).

The Gudrun wind damage event did not result in any major change in recommended forest management practices although in the aftermath of the event the Swedish Forest Agency (SFA) recommend that risks in Swedish forestry be more actively managed (cf. SFA, 2006). Furthermore, the implementation of policies on adaptation of forestry to climate change was possibly speeded up (cf. SFA, 2006). According to SFA (2006) forestry consultants are to clearly inform forest owners about how the risk of wind and snow damage can be reduced in connection to commercial thinning and early thinning to increase the stability of the forest stand. SFA aims to contribute to improved risk management through quality control of pre-commercial and commercial thinning in order to reduce the risk of wind damage (SFA, 2006). The climate change adaptation policy first adopted by the Swedish Forest Agency in 2003 and distributed widely to forest owners in 2005 (SFA, 2005), recommend forest owners to consider expected consequences of climate change to their own forestry and to consider the need to spread risk.

Immediately following the Gudrun event several forestry-related regulations were temporarily relaxed or new ones introduced:

- During the period 16 March to 30 June 2005 timber lorries from all EU member countries were allowed to carry windfelled timber in southern Sweden.
- To increase transportation of windfelled timber by railway and at sea, fees were temporarily taken away for this kind of transportation.
- A proposition (2005/06:44) by the Swedish Government on temporary regulations (2005-11-07) were enacted in 2006-01-01and included
- Tax reduction of 5 EUR/m^3 damaged timber (solid under bark) to forest owners in Sweden to support salvage harvesting following the wind damage event
- Tax-free diesel for forestry machinery in the wind damaged area.
- Temporary relaxation regarding maximum amount of timber that can be stored in the forest.
- Financial support for mending damages on roads due to transportantion of timber.
- Temporary regulations regarding subsidy for storage of timber were installed (2005:229) for 2006-2008 by EUR 37.4 million. The subsidy could be paid (maximum 50% of cost) for installing or maintaining storage premises for timber and pulpwood from the area where wind damage occurred on January 8 and 9 2005.
- Special regulations were introduced for the period 2006-2010 to subsidize forest regeneration on sites where the damage by the Gudrun storm was severe enough for regeneration to be required by law. In total approximately EUR 37 million has been made available for this purpose.

- Temporary monitoring programmes were carried out for spruce bark beetle and pine weevil infestations, ungulate populations, and mobilization of nitrogen, mercury, phosphorus, and organic matter compounds within the storm damaged area (SFA, 2006).
- Special regulations were introduced in 2007 to combat infestation of insects.
- Insurance companies have changed their insurance policies in response to the wind damage event.
- At present, SFA develops routines for the assessment of extent of damage after a wind damage event has occurred.

Effects on biodiversity and the environment

Sweden

Extensive wind damage with large amounts of dead wood could, if left in the forest at suitable places, be an important component in preserving biodiversity in Swedish forests (Andersson et al., 2006). Numerous uncommon niches of dead wood in combination with large volumes of dead wood in a small area provided by an aggregation of windfallen trees is expected to be beneficial to many threatened species. Wind felled trees that are left in the vicinity of areas with high nature values are expected to be more beneficial to nature conservation than those left scattered (Andersson et al., 2006). Five to 10 percent of nature conservation areas in Kronoberg county was affected by wind damage (SFA, 2006). This is less than in the production forests. In connection to salvage work in key areas for biodiversity, up to 25% of the operations were not preceded by consultation as requested by law (SFA, 2006). Oral reports from SFA personnel refer to problems due to limited time and to lack of information in the appropriate language (a lot of extra personnel was hired from abroad) (SFA, 2006). Results from inventory show that a substantial amount of nature conservation objects have been removed in connection to salvage harvesting (SFA, 2006).

Following the storm substantially increased leaching of mercury and methylmercury has been observed (Munthe et al, 2007). Increased leaching of these compounds leads to increased risk of bioaccumulation in aquatic ecosystems. Also substantially increased leaching of nitrate from wind damaged areas has been observed after wind damage (Hellsten et al., 2009). On the investigated sites, the nitrate leaching was larger from sites with extensive wind damage than from sites with lesser wind damage. Up-scaling of results indicates that the increase in total nitrogen transportation from forest land to the sea amounted to at least 8% as a consequence of the storm damage (Hellsten et al., 2009).

Effects on owners in Sweden

Most of the affected forest land in Sweden is owned by private individuals (77% in Götaland). The average financial loss to individual private forest owners has been estimated at 15 EUR per m^3 sold timber compared to an average year without wind damage (SFA, 2006). Also when including a 5 EUR tax reduction and possible payment from insurance the calculations add up to a financial loss to the majority of forest owners (SFA, 2006). Although the fraction of damaged forest to the total standing volume of forest in Sweden was approximately 2%, the fraction of damaged volume of forest in many cases was substantially higher for individual forest owners (cf. Blennow, 2008). Swedish private individual forest owners only get approximately 12% of the household income from their forestry (Mattsson et al., 2003). This indicates that they have strong motivations for owning a forest other than the financial return from their forestry. It is likely that many of these services were damaged and that they were not covered by insurance or they could not be replaced by financial compensation through insurance. Indeed, after extensive wind damage, the landscape in many places was dramatically changed in many ways. It has been reported that after the Gudrun wind damage event people were unable to find their way home in areas they had spent most of their lives and for some, the forest they had spent a life-time caring for was suddenly was destroyed (Guldåker, 2009). Approximately 1/3 of the respondents to a questionnaire to private individual forest owners one year after the wind damage event on 8-9 January 2005 in Sweden claimed that their wellbeing was reduced (SFA, 2006).

Effects on timber market

Sweden

Average prices of sawlogs of spruce and pine (delivery logs) were affected in southern as well as in central Sweden (Figure 5) (SFA, 2010).

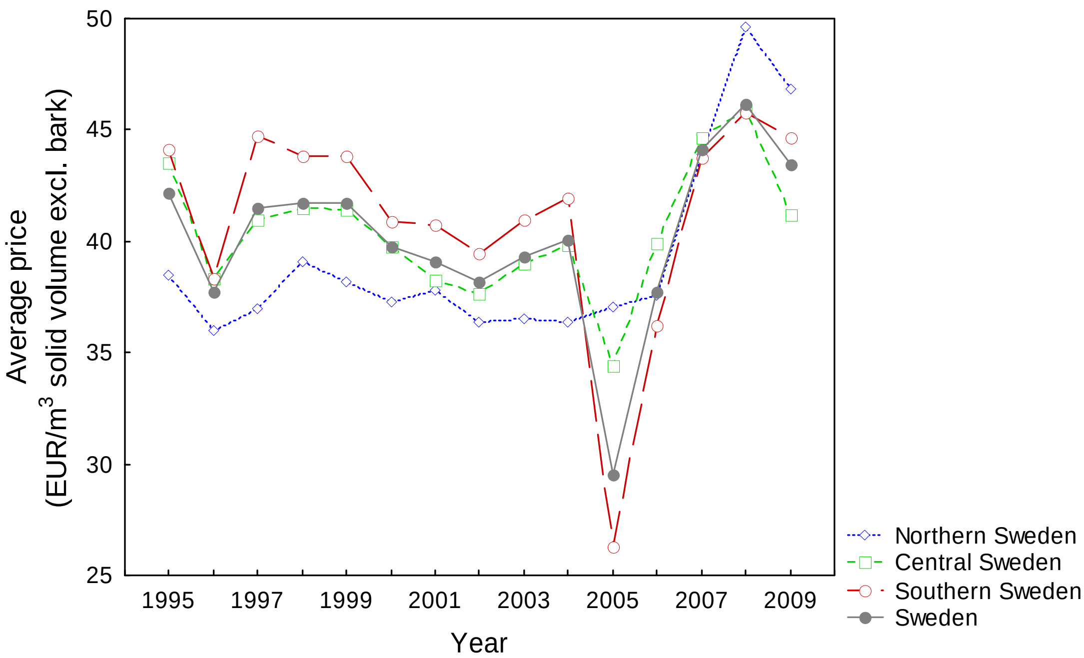


Figure 5. Average prices of sawlogs of spruce and pine, delivery logs, in Sweden during the period 1995 to 2009 (data from SFA, 2010).

Literature

Andersson, M, Appelqvist T, Edman T, Liedholm H, Niklasson M, Norden B, & Paulsson J (2006) Miljökonsekvenser för biologisk mångfald. Underlagsrapport inom projekt Stormanalys. Rapport 11. Swedish Forest Agency, Jönköping.

Alexandersson H & Ivarsson K-I (2005) Januaristormen 2005. Faktablad No. 25, Swedish Meteorological Institute, Norrköping, Sweden.

Bergquist J (2009) Skogsproduktion i stormområdet: Ett underlag för Skogsstyrelsens strategi för uthållig skogsproduktion. Rapport 5. Swedish Forest Agency, Jönköping.

Blennow, K., 2008. Risk management in Swedish forestry – policy formation and fulfilment of goals. Journal of Risk Research 11, 237–254.

Claesson S & Paulsson J (2005) Flyginventering av stormfälld skog – januari 2005. PM 2005-02-02. Swedish Forest Agency, Jönköping.

FMV (2006) Försvarsmaktens telekommunikationsstöd till samhället i samband med stormen Gudrun. Document 26744/2006. www.fmv.se/upload/Bilder%20och%20dokument/Publikationer/rapporter/Stormen%20Gudrun.pdf

Guldåker, N. (2009) Krishantering, hushåll och Stormen Gudrun. Att analysera hushålls krishanteringsförmåga och sårbarheter.(In Swedish.) PhD thes is, Dept. of Social and Economic Geography, Lund university, Series Avhandlingar CLXXXV. ISSN: 0346-6787 ISBN: 978-91-976521-6-2

Hellsten S, Stadmark J, Akselsson C, Pihl Karlsson G & Karlsson P-E (2009) Effekter av stormen Gudrun på kväveutlakning från skogsmark. Rapport till Naturvårdsverket, 2009-12-08.

KBM (2005) Krishantering i stormens spår. Sammanställning av myndigheternas erfarenheter. Krisberedskapsmyndigheten, Dnr: 0257/2005 www.krisberedskapsmyndigheten.se

Långström B, Lindelöw Å, Schroeder M, Björklund N & Öhrn P (2009) The spruce bark beetle outbreak in Sweden following the January storms in 2005 and 2007. Proceedings of the IUFRO Working Party 7.03.10, Methodology of Forest Insect and Disease Survey in Central Europe. November 30, 2009, Zvolen, Slovakia.

Munthe J, Hellsten S, & Zetterberg T (2007) Mobilization of mercury and methylmercury from forest soils after a severe storm-fell event. Ambio, 36: 111-113.

SFA (2005) Klimatförändringar och deras inverkan på skogsbruket. (In Swedish.) Jönköping: Swedish Forest Agency.

SFA (2006) *Stormen 2005 – en skoglig analys*. (In Swedish.) Meddelande Nr 1 Jönköping: Swedish Forest Agency. www.skogsstyrelsen.se/minskog/templates/Page.asp?id=18204

SFA (2010) Skogsstatistisk Årsbok. Swedish Forest Agency, Jönköping.

Södra (2010) Press release 08-01-2010. www.sodra.com/no/Presse-og-nyheter/Nyheter/Nyheter-om-Sodra/Sodra-fem-ar-efter-Gudrun--stormarbetet-ar-avslutat/

The Storms of 14th – 18th January 2007 (Per and Kyrill)

Meteorological conditions

The storm of the 17th to 18th January 2007 brought much destruction to the lives of northern Europeans. It came from the North Sea, making a first landfall over Britain late on the 17th, then passed through all of Germany before heading towards Poland and into the Baltic states. As it passed, wind-speeds of up to 212 km/h were recorded in the Krkonoše Mountains on the Czech / Polish border (Dedrick et al., 2007). These wind speeds reduced as the storm passed over Poland, and finally blew itself out over Russia.

"Kyrill" was not an exceptional storm in the Netherlands. Wind force was 9-10 at the coast, 7-8 more inland. Maximum gusts ranged from 37 ms^{-1} at the coast to 33 at inland stations. In the west and center of the country there was a lot of precipitation, up to 35 mm in 24 hours (Figure 2), and 50-60mm in 36 hours.

(from http://en.wikipedia.org/wiki/European_windstorm)

After making landfall in Ireland and the UK in the late hours of January 17, the storm swept across Ireland and Great Britain on the night of 17 to 18 January, with winds of 160 km/h (99 mph) at The Needles, 149 km/h (93 mph) recorded in Dublin, 130 km/h (81 mph) recorded at Aberdaron on the Llyn peninsula, 122 km/h (76 mph) at Mumbles near Swansea and winds of 101 km/h (63 mph) at St Athan in the Vale of Glamorgan. The German Meteorological Service had advised people to stay indoors and avoid unnecessary trips on 18 January,[7] and wind strengths of up to 12 on the Beaufort scale were seen across the Netherlands and Germany as the storm made landfall. The storm moved across the German states of Lower Saxony, Bremen, Hamburg, Schleswig-Holstein and North Rhine-Westphalia first, then spread across the whole country in the evening hours of January 18. Wind gusts as high as 202 km/h (125 mph) on the Wendelstein and 198 km/h (123 mph) on the Brocken in the Harz mountains were recorded.[8] The storm then moved eastwards, its center crossing Lower Saxony between 18:00 and 19:00 CET, moving toward the Baltic sea, its cold front spawning several tornadoes in Germany, three of which have been confirmed as of February 22.[9] In the Czech Republic the highest wind speed was measured on Sněžka in the Krkonoše mountains, where wind gusts reached 212 km/h (132 mph).[10] In the Czech Republic winds as high as 200 km/h disrupted both rail and air traffic; record high temperatures reached 14 °C (57 °F) in Prague.[11]

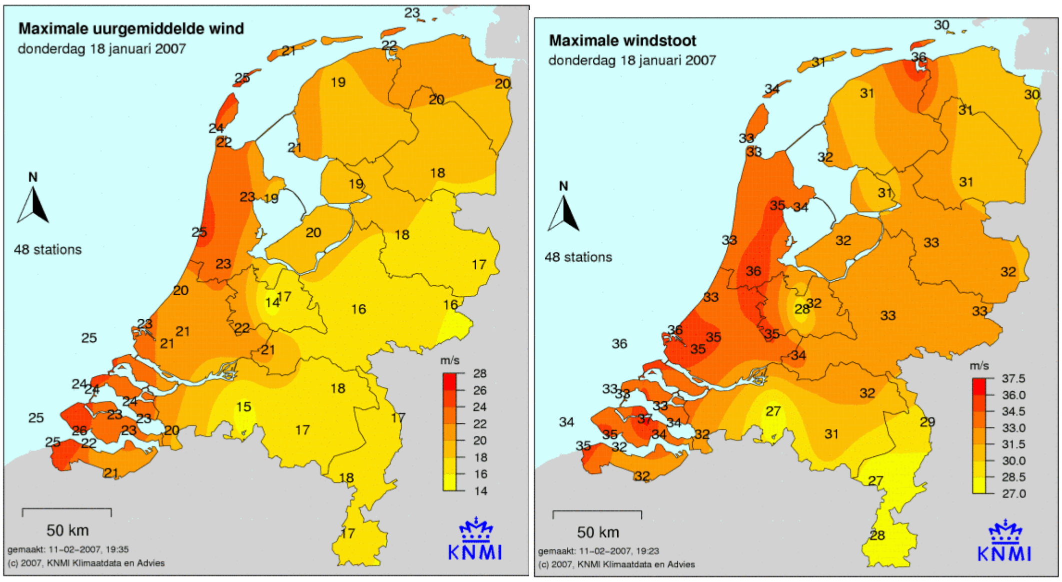


Figure 1. Maximum hourly wind speed (left) and maximum gust speed (right) on Thursday January 18, 2007 in the Netherlands (source KNMI, www.knmi.nl).

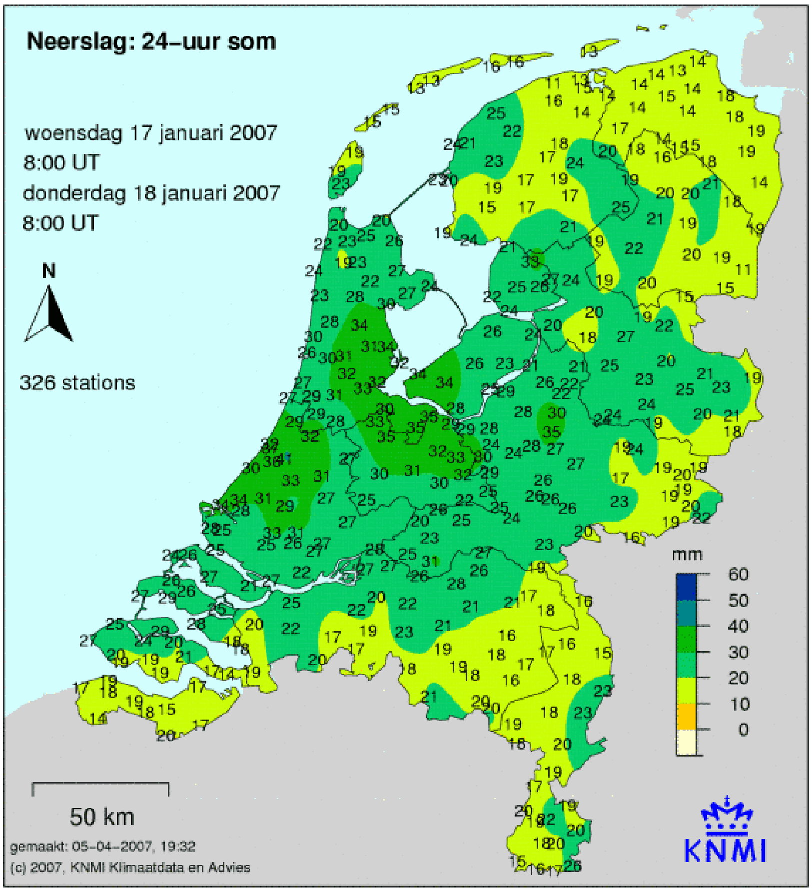
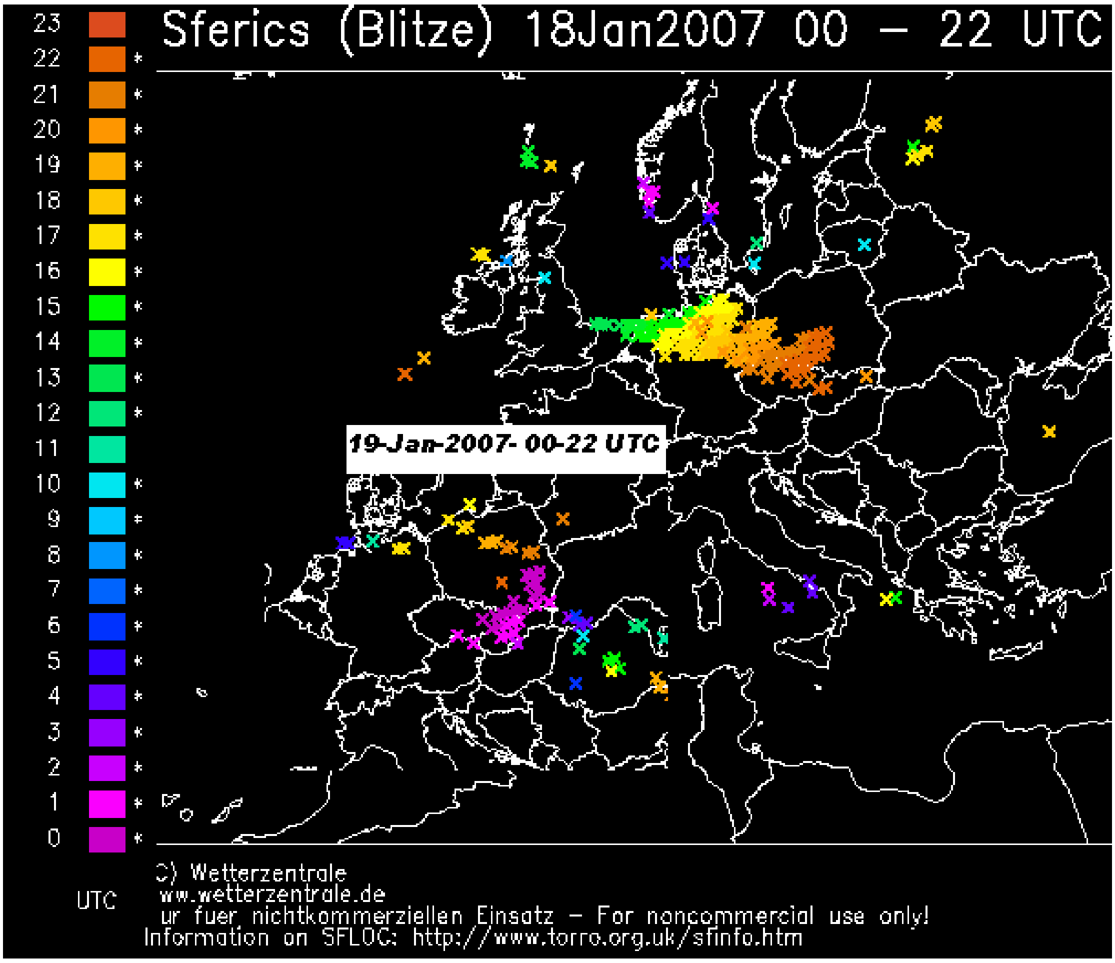


Figure 2. Precipitation on Thursday January 18, 2007 in the Netherlands (source: KNMI, www.knmi.nl).



Lightning strikes by Kyrill, coinciding very well with the most storm damaged parts in NL and Germany. (source http://www.wetteran.de/analysen/kyrill-english-3.html)

Storm Paula

An additional storm hit Austria on 27 January causing damages to forests of 6.2 Mm3 (http://www.fordaq.com/fordaq/news/stormtimber_Austria__16330.html)

Short description on damage

The cost of the damage across Europe to the insurance industry has been estimated by Swiss Re as €3.5bn. In the UK, the cost to the insurance industry could be as high as £350m (€520m). (http://en.wikipedia.org/wiki/Kyrill_(storm) As the event is relatively recent for the insurance industry these are unlikely to be the final costs. There was approximately 200 million Euro insured damage in the Netherlands (Toestand van het klimaat 2008; http://archief.fembusiness.nl/2007/01/27/nummer-4/Stormschade-Stormhelptverzekeraars.htm). The total damage in Germany was probably in the region of 4.7 billion Euro.

Per (Hanno)	January 14, 2007	The powerful storm Per hit south-western Sweden with wind gusts up to about 90 mph. Six people were reported dead in different storm related accidents, and thousands of trees were blown down, as well as thousands of households losing electricity. This storm also caused damage and flooding in Lithuania.
Kyrill	January 18, 2007	In the wake of Kyrill already regarded as one of the most violent and destructive storms in more than a century, storm-warnings were given for many countries in western, central and northern Europe with severe storm-warnings for some areas. Schools in particularly threatened areas had been closed by mid-day, to allow children to get home safely before the storm reached its full intensity in the late afternoon. At least 53 people were killed as violent storms lashed northern and central Europe, causing travel chaos across the region. Britain and Germany were the worst hit with eleven people killed as rain and gusts of up to 99 mph (159 km/h) swept the UK and sustained windspeeds of up to 73 mph were recorded. Thirteen people were killed in Germany, with the weather station on top of the Brocken in the Saxony-Anhaltian Harz mountain range recorded wind speeds of up to 121 mph (195 km/h). Direct damage in Germany was estimated to amount to € 4.7 billion.[4] Five people were killed during the storm in the Netherlands and 3 in France. The gusts reached 151 km/h at the cap gris nez and 130 km/h in many places in north of France. In both Germany and the Netherlands the national railways were closed. At Frankfurt International Airport over 200 flights were cancelled.

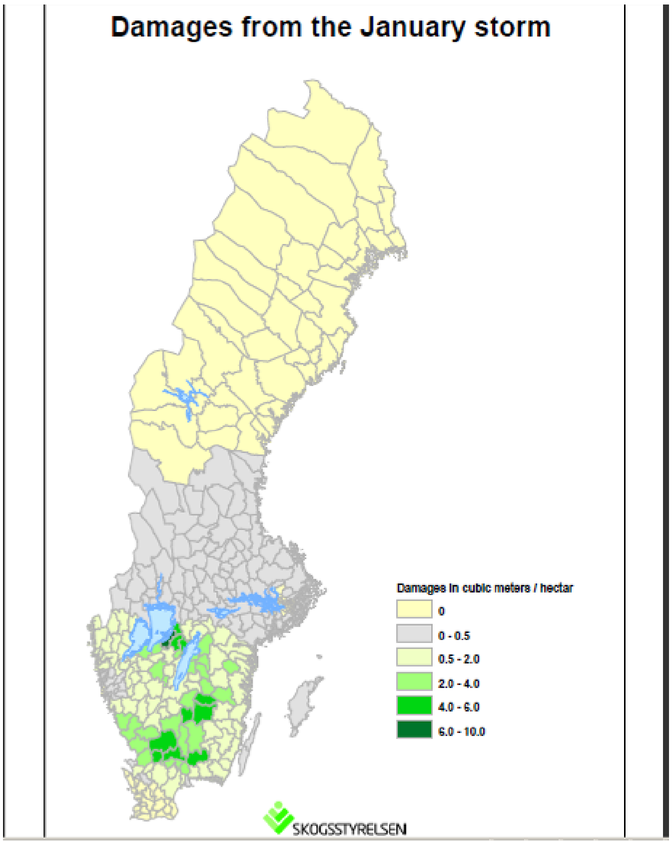
(http://en.wikipedia.org/wiki/Kyrill_(storm))

“Kyrill, which swept across Germany on Jan. 18, was one of the most powerful storms to hit the country in decades. It knocked over even more trees in Germany than another major winter storm, Lothar, did at Christmas 1999. Kyrill left tree farmers, many in the mountainous Sauerland region, wondering what to do with at least 41 million fallen trees. That was half a year ago, and now it has become clear that the damage left in Kyrill's wake hasn't made foresters and tree farmers any smarter. In many places they are planting fast-growing plantations of conifers once again. Feldmann-Schütte is no exception. "I can't afford any experiments," he says, apologetically. Ironically, it was precisely spruce trees that suffered the most damage from the storm's high winds. For decades, environmentally savvy foresters have been preaching the same mantra: "If you want to destroy the forest, plant spruce, spruce and more spruce." Kyrill proved them right. Sixty-five percent of all toppled trees were spruce”.
(http://www.spiegel.de/international/germany/0,1518,491093,00.html)

Primary damage

Per

A preliminary assessment by the Swedish Forest Agency estimated about 12 million cubic metres of damage to forests by the storm. The assessment is based on reports from the agency’s district offices. The area around Mariestad (Western Götaland) was the most affected. The area around Ljungby, that also was the most heavily affected by “Gudrun”, reported extensive damages on the forest.



Damage by storm Per in Sweden (http://www.unece.org/timber/storm/2007-01/sweden-map.pdf)

Kyrill

A first estimate after the storm by Dedrick et al. (2007) suggested that Europe as a whole lost in the region of 45 million cubic metres of standing timber. The most heavily hit countries were Germany with 25 million cubic meters (or 20% of annual allowable cut) and the Czech Republic with 10 million cubic meters (65% of annual allowable cut). An estimate for the Netherlands was placed at 0.25 Mm3 (Neefjes 2007) while the estimate for Wallony (Belgium) was 0.3 Mm3, which is 0.5% of the standing stock of conifers.

Further estimate suggest that "Kyrill" felled a total of 53,850,000 cubic metres of wood in Europe.

"The quantities registered in individual countries, depending on area and forest density, ranged from 12 million cubic metres in Sweden and Czech Republic to 2.5 million in Austria and 1.5 million in Poland. The windfall quantities are smaller in the Baltic states of Latvia (500 000 cubic metres) and Lithuania (300 000) as well as in Slovakia (150 000), France (120 000), Romania (130 000) and England (50 000). In Germany, the states most strongly affected by windbreakage were North Rhine-Westphalia (12 million cubic metres), Bavaria (4 million), Lower Saxony (2 million), Hesse

(2 million), Saxony-Anhalt (1 million) as well as Thuringia and Saxony (1 million each). In Rhineland-Palatinate, Baden-Württemberg and Brandenburg, the storm felled between 600 000 and 500 000 square metres of solid wood. Assuming that the current year removals in Europe will be on level 450 million m^3, then the reported amount of windfall represent just 12% of annual harvest."

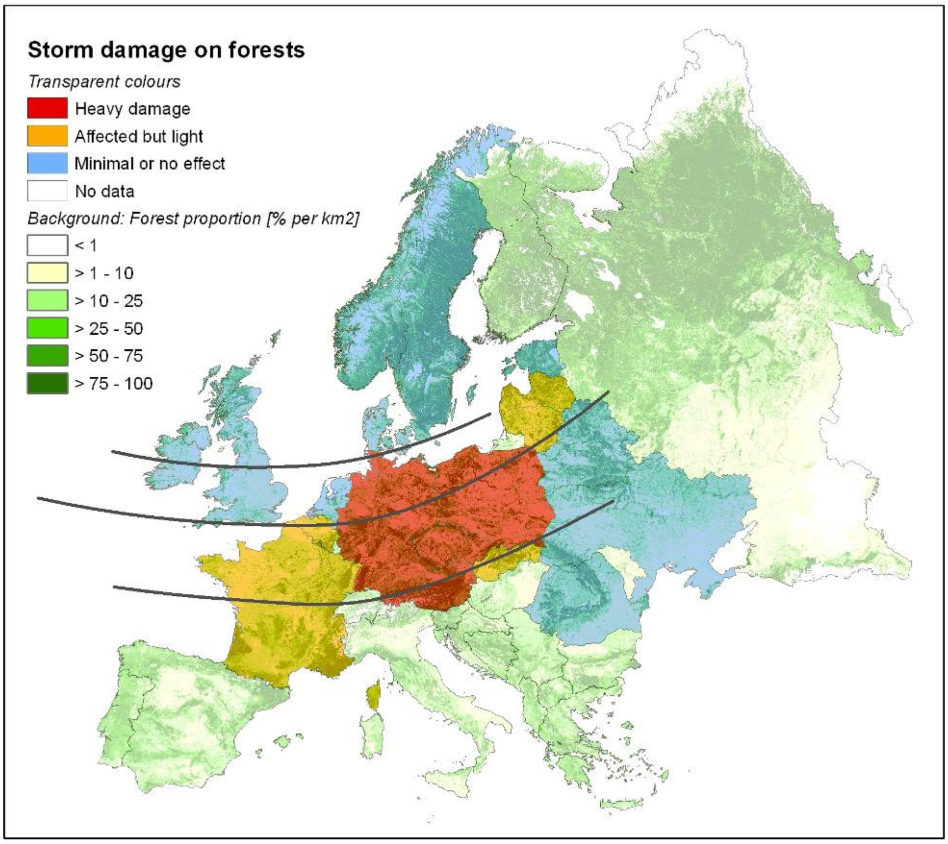
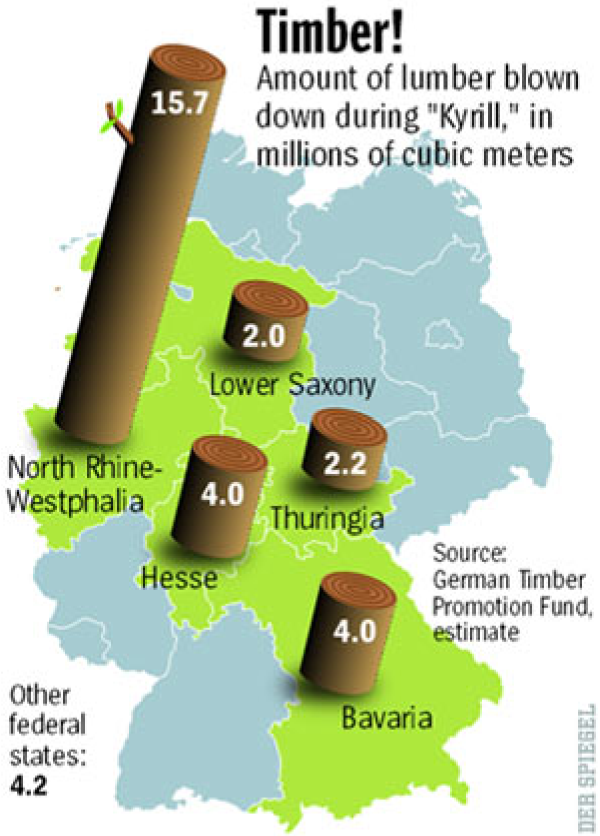


Figure 2: Countries affected by Kyrill and the areas of greatest wind throw. (Note: Ireland, Sweden, Norway, Estonia, Belarus and Ukraine were affected by the storm but no wind throw was reported; lines indicate the main storm track)

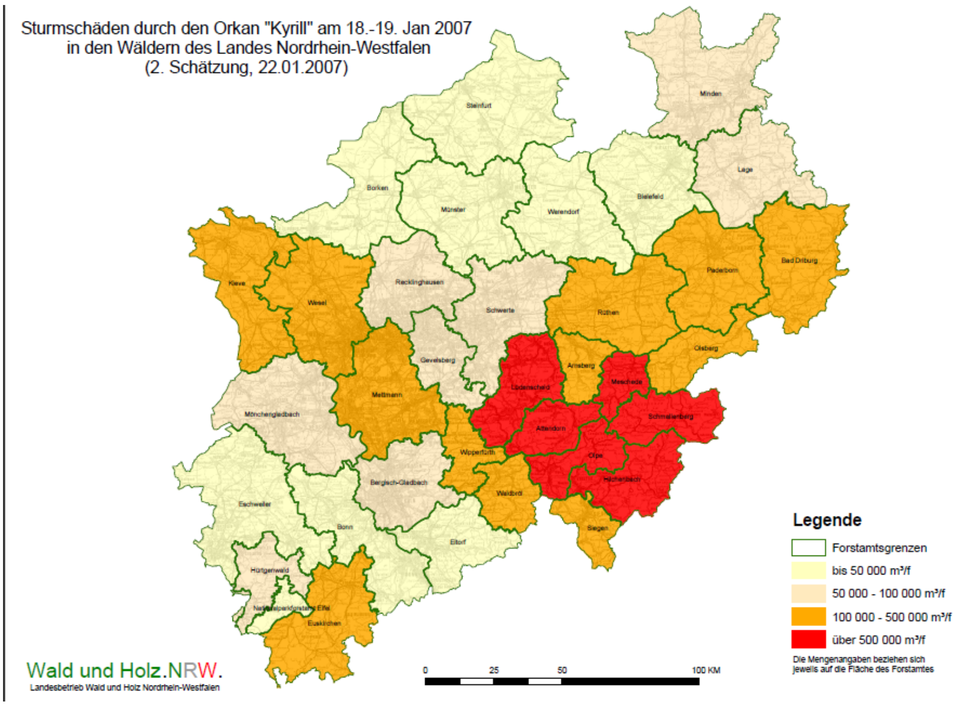
Table 1: A summary of the key quantities of windthrown timber in Europe resulting from Kyrill. Sources CONFOREST expert network; *Office National des Forêts": http://www.onf.fr/rp/index.htm.

Country	Total losses (m^3)	Dominant Species	Site	Percentage of allowable cut
Austria	2 250 000			15
Belgium	220 000			
Czech Republic	10 000 000	Norway spruce	400 – 700 m	65
Denmark	< 5 000	Norway spruce	Coastal	<1
France	200 000			<1
Germany	25 000 000	Norway spruce	> 350 m	20
Latvia*	500 000			
Lithuania*	300 000			
Netherlands	180 000	Pinus sylvestris		20
Poland	2 500 000	Pinus	Mountainous	
Romania*	130 000			
Slovakia	330 000	Norway spruce	Mountain ridges	5
United Kingdom (England)*	50 000			

(http://www.lvm.lv/eng/for_press/press_releases/?doc=4322)

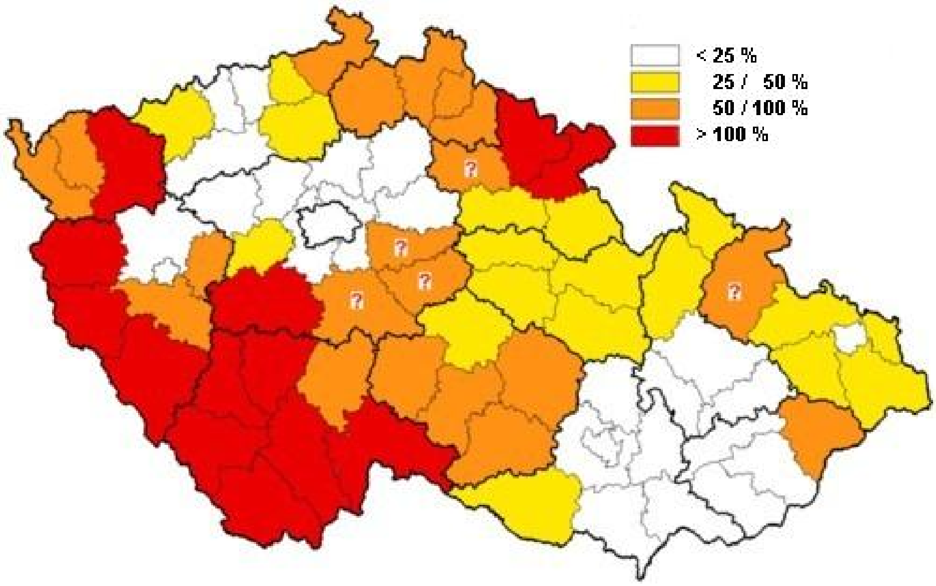


(http://www.spiegel.de/international/germany/0,1518,grossbild-904613-491093,00.html)



Storm damage in Nordrhein-Westfalen (http://www.unece.org/timber/storm/2007-01/germany-map.pdf)

Map No.1 – Storm damage (% of total allowable cut).



Source: FPS of the MGMRI (Knizek, Liska: Lesnicka prace, February 2007).

The damage in Nordrhein-Westfalen was 15.7 Mm^3, with about 50 thousand ha of damaged forest. Early estimates were 9 Mm^3. This is about 3 times the annual harvest and 6.5 to 8.3% of the standing volume. Around 90% is Norway spruce. In total about 15% of the standing volume of Norway spruce was damaged (Ministerium 2010)

Effects on owners in the Czech Republic:

Ownership	Volume of damage (million m^3)	Storm-damaged wood processed (million m^3)	Share of damaged wood that has been processed (%)
Forests of the Czech Republic, S.E.	5.1	2.6	51.0
Military Forests and farms of the Czech Republic, S.E.	1.0	0.48	48.0
Private and municipal	3.2	2.30	71.0
National parks	0.8	0.48	48.0
Total	10.1	5.86	58.7

Source: Ministry of Agriculture of the Czech Republic (15.5.2007).

Secondary damage

Per

In Sweden while the damages are less than those caused by “Gudrun” the geographic area affected by the storm was larger. The entire Götaland (Southern Sweden) was affected, with a concentration in the western and central parts. A major share of the damage occurred in the same areas that were worst hit by “Gudrun” two years ago. This storm therefore aggravated an already severe situation of large-scale attacks by the European spruce bark beetle in Southern Sweden.

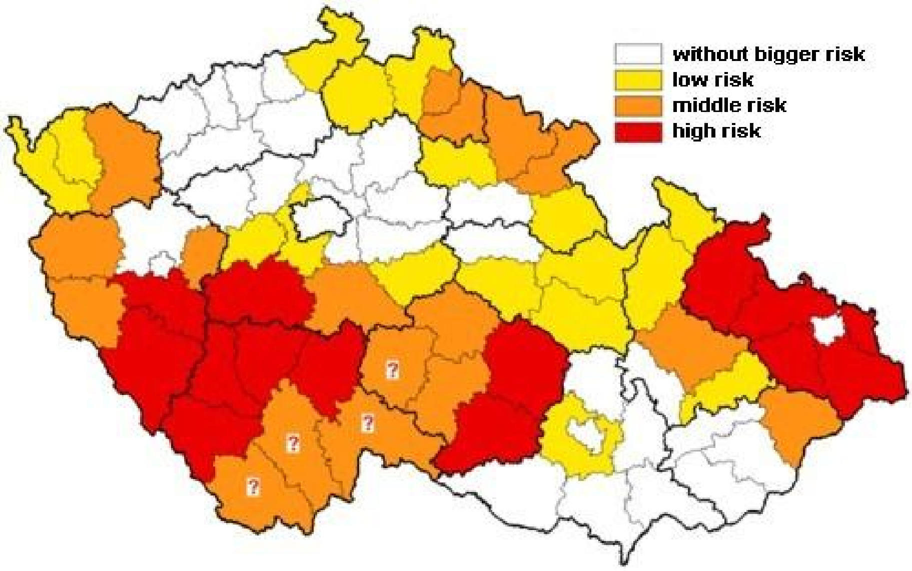
Kyrill

The following sites provide information on secondary damages from the storm “Kyrill”:

Prices for sawn softwood logs in North Rhine-Westphalia have increased significantly, while prices for industrial timber have decreased. Had it not been for the logs placed in water storage after storm Kyrill in January 2007, the log procurement situation for most sawmills in North Rhine-Westphalia would have been even worse. As in other German federal states, the quantity of bark beetle infested logs is far beneath the expected one. However, this situation can easily turn around after a period of warm weather. (http://www.fordaq.com/fordaq/news/LogPrices_NorthRhine-Westphalia_timber__20489.html)

In the Czech Republic The Kyrill windstorm hit mainly sites at higher altitude with “Norway spruce” as a predominant tree species in these locations. The expected consequences were a higher appearance of insects in the summer, especially the bark beetles, mostly *Ips typhographus L.*. (Map No.2) .

Map No.2 – Bark beetle risk.



Source: FPS of the MGMRI (Knizek, Liska: Lesnicka prace, February 2007).

Tertiary damage

The German Forestry Council estimated that the storm toppled some 20 million cubic meters (706 cubic feet) of wood, which would cost the country's forestry industry about 1 billion euros ($1.3 billion) in lost revenue and damages (http://www.dw-world.de/dw/article/0,2144,2323760,00.html)

According to Ministerium (2010) "The net decrease in balance total for the state forest (landeseigene Forstbetrieb) in Nordrhein-Westfalen in 2008 as a consequence of Kyrill was about 17 million Euro. About 3000 ha needed reforestation. Total forest area of state forest service is about 116 thousand ha (13% of the total forest area). In total for 2007 a negative effect due to Kyrill of 1.268 million Euro was estimated for (Landesbetrieb Wald und Holz) and in 2008 a positive effect of 8.806 million Euro".

Direct casualties

The casualties were distributed as follows:
United Kingdom: 13 (8 in North West England)
Germany: 13
Ireland: 7 - lost at sea
The Netherlands: 7
Poland: 6
Czech Republic: 4
Belgium: 2
France: 2
Austria: 1
See: http://en.wikinews.org/wiki/Europe_hit_by_storms,_45_deaths_reported

In Nordrhein-Westfalen, 8 deadly accidents and 795 non-deadly accidents were reported in the clearing-up of storm damage. This is relatively low, probably due to more mechanisation, schooling and measures to control and check working conditions (Ministerium 2010)

Policy response

The following websites and correspondence report policy responses, instruments and measures:

"Until June 15 2007, carriers from the new EU members (E.Europe) and Switzerland will be free to tranbsport logs from the Kyrill storm in the regions of Nordrhein-Westfalen, Niedersachsen, Thüringen, and Sachsen. The regulation which prohibited such transport - to limit competition from the EU new entrants in this industry - is therefore temporarily lifted". (http://www.fordaq.com/fordaq/news/Germany%3A_E._European_carriers_free_14645.html)

"…According to the guidelines for reforestation following Kyrill that the Ministry of the Environment, Conservation, Agriculture and Consumer Protection of the state of North Rhine Westphalia will announce this month, the state will pay a subsidy of 40 euro cents per seedling, even in forests which are 50 percent conifers. "And this despite the fact that in the past conifers were no longer supported," complains Bernd Dierdorf, the head of the forestry office in the north central city of Minden.The subsidy program, at a cost of more than €100 million, is being financed partly from the sale of state-owned forest land. In a memo dated May 8 of this year, the ministry asked its forestry management offices to identify suitable parcels of land. According to internal sources, 26,000 hectares (64,220 acres) of forest have already been registered with the ministry. This is a scandal for Dierdorf. "They want to give away the family silver to promote forestry which is ecologically crazy," he says".
(http://www.spiegel.de/international/germany/0,1518,491093,00.html)

"To finance the reforestation of areas hit by Hurricane Kyrill, forest owners in North Rhine-Westphalia (NRW) can apply for low-interest loans from NRW.BANK's Reforestation Programme. Launched jointly by the State of North Rhine- Westphalia and NRW.BANK, the programme has a volume of EUR 40 million and is targeted at private and municipal forest owners in NRW. The loans range from EUR 5,000 to EUR 1 million and carry an interest rate of 3.25% to 3.35% p.a. depending on maturity. The credits have a term of four or twenty years, with the interest rate fixed for four or ten years, respectively, and one redemption-free year. The interest rate is reduced significantly with the help of funds provided by the North Rhine-Westphalian Ministry for the Environment and Nature Preservation, Agriculture and Consumer Protection and currently stands at a nominal 3.25% p.a. for a four-year term (3.10% for young farmers) and 3.35% p.a. for a 20-year term (3.20% for young farmers). Forestry

cooperatives such as joint forest management companies are also eligible for application. The programme expires on December 30, 2010. 2 NRW.BANK Kavalleriestraße 22 Telefon + 49 211 91741-1846 presse@nrwbank.de Kommunikation 40213 Düsseldorf Telefax + 49 211 91741-1801 As of now, private forest owners can submit their applications to all banks and savings banks in North Rhine- Westphalia. Municipal clients may send their applications directly to NRW.BANK, Düsseldorf. Eligible tree types are spruce, grand fir, noble fir and Caucasian fir, for which a permissible maximum promotion amount of EUR 2,500 per hectare applies. A minimum of 1,700 trees need to be planted per hectare. Douglas fir and larch - which are more expensive to buy and plant - benefit from a maximum promotion amount of EUR 3,200 per hectare, with a minimum of 1,500 trees to be planted per hectare. A mix with other tree types is expressly desired. The credit programme is another element to support the reforestation of areas damaged by the hurricane in North Rhine-Westphalia. It complements the subsidy funding scheme recently established by the State of NRW for the reforestation with deciduous trees. The new programme is based on the special credit programme "Landwirtschaft und Junglandwirte" ("Agriculture and Young Farmers") of Landwirtschaftliche Rentenbank."
(http://nrwbank.com/pdf/presse/2007/070815_pdf_Press_Release_Reforestation.pdf)

"Shortly before the results of the state elections were announced on August 28 in Erfurt, the Ministry of Agriculture announced that € 600,000 will be made available in the coming years for afforestation in Thuringia. The State of Thuringia will support the private and corporate forest owners to continue to overcome the consequences of hurricane Kyrill"
(http://www.fordaq.com/fordaq/news/NATURA2000_Thuringia_forestry_hurricane_reforestation_20807.html)

"The Czech Ministry of Agriculture declared the state of emergency for the particular affected localities from 25th January to 5th February 2007. This decision was required because of security measures. Therefore, quick action was undertaken to select companies for timber removal and for forest regeneration, especially for the main part of state forests, given the extreme situation".

"Prevailing opinion in Germany is that the effects of storm Kyrill in the forests can be managed mainly by market driven instruments. Necessary policy action to support the processing concentrates on some measures, proved to be successful in the past (e.g. easements in taxes, facilitate transport, financial aid)". (email from Mr Dengg at UN-ECE website)

"The most important and effective policy measures (in Nordrhein-Westfalen) were:

- 100 million Euro immediate program of the Landesregierung
- Extra credit programme of the Bundesland with 65 million Euro of credit given to forest owners and the wood industry

- Money from the EU Solidarity Fund of around 101 million Euro for Nordrhein-Westfalen, of which 26 for the street building agency
- Tax and other measures

Very helpful was the opening of a central information centre, which received about 1000 phone calls a day. The clearing of the damage was flanked by exception measures regarding allowed transport weights and working hours. Also helpful was the co-operation of the railroad company in building extra loading docks and having extra wood transport wagons.
Forest fire was seen as an important risk in the areas that were not cleared. Moreover, many roads were damaged and were not suitable for the fire brigade. New maps were created and distributed to fire brigades, indicating major risk areas and accessible roads". (Ministerium 2010)

Biodiversity effects

According to Ministerium (2010) "In Nordrhein-Westfalen the coniferous area has decreased by 47 thousand ha (-12%) and the broadleaved area has increased by 29 thousand ha (+7%). Average growing stock decreased by about 7% to 244 m3/ha, while increment decreased by 10% to 9 m3/ha/yr. The amount of dead wood in the forest increased from 16 to 24 m3/ha. Fresh dead wood is about 10 m3/ha.
In nature protection areas the effects were modest. Most areas consist of broadleaves which suffered hardly damage. Mainly small coniferous groups were hit, which gives good opportunities for natural succession. Conifers are not part of the PNV anyway".

Effects on timber markets

Higher harvesting costs:

"Clearing off the felled trees within short time is a challenge that the forestry enterprises have to meet in the next few months. According to Mr Uher of EUSTAFOR, this is the only effect of the windfall that is actually relevant. "We know that it is more difficult to harvest storm-felled wood. Therefore we expect slightly higher harvesting costs for timber producers in this year. This is the most significant effect that Kyrill has had on the forestry."
(http://www.lvm.lv/eng/for_press/press_releases/?doc=4322)

Strong timber markets:
"Another difference compared with past storm events is that the economic framework conditions are much more favourable. Last year's strong demand for both, timber and fuelwood, is continuing. So timber markets should be able to absorb the volumes". (email from Mr Dengg at UN-ECE website)

Markets are flooded with wind blown timber:

”There was a sudden decrease in demand for wood, and the international banking crisis also pressed on the market and industry. Initially wood prices were rather high. However, the storms Emma and Paula in early 2008 caused an additional 60 Mm3 in Europe and decreased prices by about 15 Euro/m3. Also possibilities to sell wood in Austria and southern Germany decreased due to this additional wood on the market”. (Ministerium 2010).

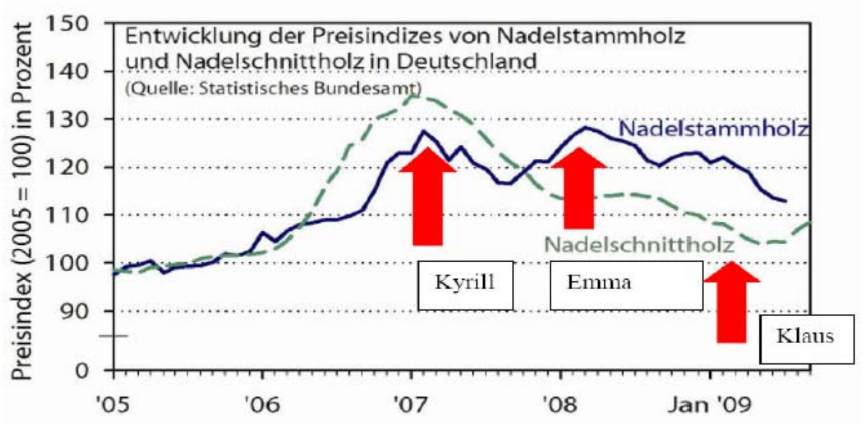


Abb. 6.4: Entwicklung der Preisindizes von Nadelstammholz und Nadelschnittholz in Deutschland (Statistisches Bundesamt, freundlicherweise zur Verfügung gestellt von der „Forst Holz Markt Consulting“, Dr. Franz-Josef Lückge, Bad Wildbad).
Die Pfeile weisen auf die den Holzmarkt beeinflussenden Orkane Kyrill (17.01.2007), Emma (29.02.2008-besonders betroffen war Österreich) und Klaus (23.01.2009 –besonders betroffen waren Südfrankreich und die französische Atlantikküste/Westfrankreich) hin.

Source: Ministerium 2010

Literature

Anonymous (2007). " Der Orkan Kyrill " INFO-DKKV **1+2/07** 8.

Dedrick, Schuck, Spiecker, Päivinen, 2007. The Storm “Kyrill” and its Effect on European Forests. EFI News 2007

Ministerium 2010. Abschlussbericht der Landesregierung von Nordrhein-Westfalen zu den Folgen des Sturmereignisses „Kyrill“ vom 18./19. Januar 2007. Ministerium für Umwelt und Naturschutz, Landwirtschaft und Verbraucherschutz des Landes Nordrhein-Westfalen, Ref. III-1, III-2; III-3 Landesbetrieb Wald und Holz, Fachbereich 6

Neefjes, M., 2007. Krakende kronen en brekende bomen. Vakblad Natuur, Bos en Landschap 4, p. 10-12.

Annexes

Below are a range of extracts from web searches in relation to "Kyrill" and "Per"

1. **Lebensgeschichte**

Tiefdruckgebiet KYRILL
(getauft am 17.01.2007)

Der 18. Januar 2007 wird wohl vielen Menschen der Bundesrepublik Deutschland und Europas in Erinnerung bleiben. Es war der Tag, an dem ein Orkanwirbel mit dem Namen KYRILL Mitteleuropa überquerte und zahlreiche Schäden an Mensch, Infrastruktur und Natur hinterließ. Doch wie kam es zu diesem Ereignis, welche Geschichte steckt hinter dem Tief KYRILL?
In der Nacht vom 16. zum 17. Januar 2007 bildete sich vor der Ostküste Neufundlands ein Tiefdruckgebiet, welches auf den Namen KYRILL getauft wurde. Der Nordatlantik hatte zu diesem Zeitpunkt eine um etwa 1,8°C wärmere Oberflächentemperatur als im Durchschnitt. Dieser Umstand begünstigt in den meisten Fällen eine rasche, teils explosionsartige Entwicklung von Tiefdruckgebieten. Ursache hierfür ist ein höherer Wasserdampf- und somit Energiegehalt, welcher der Atmosphäre zur Verfügung gestellt wird. Energie und Bewegung sind durch physikalische Prozesse miteinander verknüpft. Mehr Energie bedeutet in diesem Fall mehr Windgeschwindigkeit. Weitere begünstigende Faktoren waren große horizontale Temperaturgegensätze auf kleinstem Raum (200-300km) und eine starke ungestörte Strömung im Druckniveau von 500 – 200 Hektopascal, was etwa einer Höhe von 5 – 13km entspricht. Dieses starke Höhenwindband wird in der Meteorologie Strahlstrom oder auch Jetstream genannt. Liegt der Kern eines Tiefdruckwirbels direkt unter dem Jetstream, so hat dies einen verstärkenden Effekt auf die Dynamik des Tiefs. Diese bisher angesprochenen Relationen spielten eine enorme Rolle bei der Entwicklung des Orkantiefs KYRILL.
Am 18.01.07 war Kyrill über Westeuropa angekommen. Das Orkantief hatte also innerhalb von nur 24 Stunden den Nordatlantik von West nach Ost überquert. Ebenso hatte sich der Kerndruck des Wirbels drastisch reduziert. Der Warmsektor des Tiefs lag bereits über Deutschland (Leipzig meldete um 12Uhr eine Lufttemperatur von 13°C) und der Wind frischte in diesem Bereich erheblich auf. So meldeten die Wetterstationen in den Mittelgebirgen bereits gegen Mittag schwere Orkanböen. Der Brocken registrierte um 13Uhr eine „mittlere" Windgeschwindigkeit von 65 Knoten und Spitzenböen von 91kn (168km/h). Doch auch im Flachland kam es verbreitet zu Windstärke 9-10, örtlich auch 11. In dem angesprochenen Warmsektor stieg die Temperatur im Tagesverlauf auf 13-16°C an und somit fast auf Rekordniveau. Die Warmluft wurde aus tropischen Breiten nach Deutschland gelenkt und hatte einen sehr hohen Feuchtegehalt.
Am Nachmittag gelangte dann jedoch eine Kaltfront über die Nordsee hinweg nach Deutschland. Dadurch prägte sich eine markante Luftmassengrenze aus, an welcher starke Gewitterlinien entstanden. Die Gewitter an der Kaltfront hatten zum Teil sommerliche Auswüchse. So meldeten mehrere Wetterstationen Schwergewitter, also

Gewitter mit starken Orkanböen, Hagel und hoher Blitzaktivität. Am Abend erreichte die Kaltfront die Hauptstadt Berlin. Am Flughafen Tegel konnten Spitzenböen der Stärke 12 gemessen werden. Ebenso dramatisch fielen die Niederschlagssummen aus. Innerhalb von nur 30 Minuten wurden in Berlin teilweise bis zu 25 Liter pro Quadratmeter registriert. Die Station Berlin-Dahlem meldete eine 24-stündige Niederschlagsmenge von 40,6 Liter pro Quadratmeter. Dies ist absoluter Rekord, nicht nur für den Monat Januar sondern aller drei Wintermonate.
Am Freitag, den 19.01.07 lag der Kern des Tiefs bereits über Nordpolen. Deutschland befand sich also auf der Rückseite des Tiefs, hatte aber noch immer mit starken Sturmböen zu kämpfen. In den folgenden Tagen zog KYRILL über Russland nach Norden in Richtung Nordmeer. Am 24.01.2007 verschwand KYRILL schließlich aus dem Einzugsgebiet der Berliner Wetterkarte.
Geschrieben am 26.03.2007 von Ronny Büttner
Wetterkarte: 19.01.2007
Pate: Kyrill Genow

2. **Forests in distress**
The windstorm itself will not be the only one to write an invoice, but so will clerks and timber companies. In the short-term horizon nothing dramatic is due to happen with the prices of timber - they will remain high.

Eighty-year old trees broken in half like matchsticks, trunks with cracks foretelling breaks soon to come, clearings in places where a thick forest once stood. Windstorm Kyrill brought a work of destruction, on which timber companies can paradoxically rub their hands, while owners count how much the liquidation of the calamity will cost and how long it will take for the forest to grow back. What will happen to the prices of timber is being speculated.

The Minister of Agriculture Petr Gandalovič proposed to the government the announcement of a state of emergency because of the calamity in the regions most affected by the windstorm. Firstly according to him, this means that other, faster procedures can be selected in tenders (in accordance with the law on public procurement). Invitations to tenders do not have to be announced in great advance, but a shortened procedure is opted for. Forests CR, which manages 60 percent of the total area of forest growth, addresses several potential interested parties and these will submit their price offer. The matter of public procurement in the state of emergency is complicated by the fact that Forests CR has not yet concluded a proper contract with felling companies, even though the tender has already taken place. In order for the processors to have enough raw materials by the beginning of the year, Forests CR permitted service companies to fell ten percent of the timber last year from this years planned capacity. According to Ekonom (the Economist) sources, a large quantity of felled timber is lying in forest stock-piles and its future is not clear. Timber from windbreak will be given priority for processing.

Timber is expensive, even last year the price climbed by an average of 40%. After the most recent windbreak, everything can be different, but does not necessarily have to be either. Provided timber companies would only be hired for work, while the state company would then sell the timber, companies working in the forest would lose, but the price could be decreased. However, provided the lumberjacks would be responsible for tending to the clearance and sale of timber to timber manufacturers, they will try to succeed in the tender with the lowest price offer, and then they will try to shift the price as high as possible. The most probable scenario is that the timber companies will not only be able to fell the timber, but also sell the timber themselves, a part of which would be sold back to Forests CR. Štěpán Pírko, analyst of Colosseum, thinks that the incurred timber surplus in Europe could force local prices down short-term. "Nevertheless, an increase in prices was anticipated before Kyrill, because the demand is continually strong and the offer was limited, therefore a significant decrease in prices is improbable," says Pírko. "According to estimates of timber companies from Germany, France, Belgium and Switzerland , damages will not be as extensive as in 1999. Thus, European prices should not be pushed down significantly and instigate timber export to the CR, which would mean a decrease in local prices." Czech businessmen in the timber processing industry also do not anticipate a great decrease in prices. If the price falls, it will only decrease by a maximum of 10%. You see, demand is still high - and will stay high with regards to high quality timber. Timber, which originates from windbreak, is damaged to a significant part and will find use in pulp-mills. "The local industry is prepared to process calamity timber, we do not have to export it," states Ivo Klimša, Director of the North Moravian Pulp-mill Biocel Paskov.

Timber is traded in the CR on the Timber Exchange, which is a part of the Czech Moravian Commodity Exchange Kladno. The volume of these trades totalled 459 500 m3 of timber last year. Their price practically reached 751 million CZK. If we compare the value of last year's transactions with the total annual felling of timber, which reaches 14-15 million m3 in the CR, the amount in question is almost three percent. This is related to the fact that one dominant player exists on the Czech market - Forests CR, which partake in the felling of timber by about half. Brokers from the Kladno exchange imply that the recent windstorm only damaged part of the forest growth. The majority of timber, which needs to be felled, can therefore belong to high quality timber. The Head Broker of FIN-servis Petr Havelka claims that in individual parts of 2007, the price of timber was influenced by a number of factors. Last year's prices indicate a clear growing trend, while the necessity to quickly fell salvage timber brings pressure to decrease prices. "The price development will be implied by the exchange market during the course of the following one or two months," says Havelka. "There will definitely not be a surplus on the local market, because there has been an insufficient amount of timber in the Czech Republic until now. The gap will be filled thanks to the calamity," anticipates Jiří Pohloudek, Chairman of the Association of Suppliers of Mounted Family Homes and the General Director of RD Rýmařov. "The foresters, manufacturers and builders regard this calamity as a gift from heaven with a certain dose of cynicism. They hope that the tense atmosphere will be eased by this, which began with the publication of Forests CR tender results for forestry work providers. Now there will suddenly be work for everyone, who is authorised to do so," adds Pohloudek. However, timber is only used marginally in blocks of flats according to Pohloudek timber does not exceed three percent of the total volume of implemented materials.

While one group of forest experts warn of possible bark beetle attacks, others belittle this threat. In spring, freshly hewn timber can become a breeding ground for bark beetles - if they survive. If the bark beetle were confused by the warm first half of January and began working on a new generation, the ensuing wave of snow and frosts would help us by safely liquidating them. With regards to frosts, lumberjacks also know that it will not cause harm to the timber. On the contrary, the frozen timber will survive the winter better than "wet" timber. Quick actions are also required for another reason. It is also necessary to calm the situation down and give felling companies a clear message. Some of then were heard saying that they will go to work in Germany or Austria , where they will earn more money.
(http://www.burzakom.cz/cmkbk/portal/media-type/html/user/anon/page/default.psml/js_pane/pomocne?docid=1349)

3. (**UNECE storm page)**
The Storm in the Czech Republic (18.01.07).

During the night of January 18th, forest land in the Czech Republic was ravaged by the wind storm "Kyrill", and caused extensive damage to the forest areas, especially in the South-West part of the country. In the whole of Central Europe, the total damage is estimated around 55 million m^3. In the Czech Republic the estimated damage is around 10 million m^3.

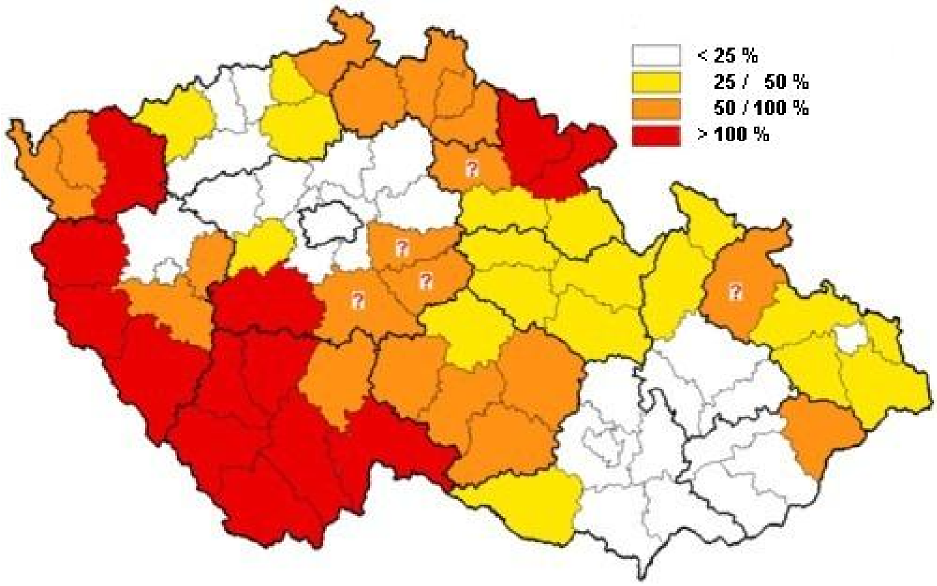
The Czech Ministry of Agriculture declared the state of emergency for the particular affected localities from 25th January to 5th February 2007. This decision was required because of security measures. Therefore, quick action was undertaken to select companies for timber removal and for forest regeneration, especially for the main part of state forests, given the extreme situation.

The wind damage has affected many forest owners, mostly state forests, which are generally under the administration and management of the Ministry of Agriculture (more than 5.1 million m^3).

One of the most damaged areas is the Šumava National Park, with about ca. 700 thousand m^3 lost in this important natural green border between the Czech Republic, Germany, and Austria. Wood in the most highly protected (first zone of protection) area will not be processed (zones without control measures). This area is under the administration and management of the Ministry of Environment. Also significant damage is registered in other state forests; for example in forest under care of the Ministry of defence (ca. 980 thousand m^3).

The quantity of wood damaged is in many of these areas considerably bigger than the total allowable cut. (Map No.1)

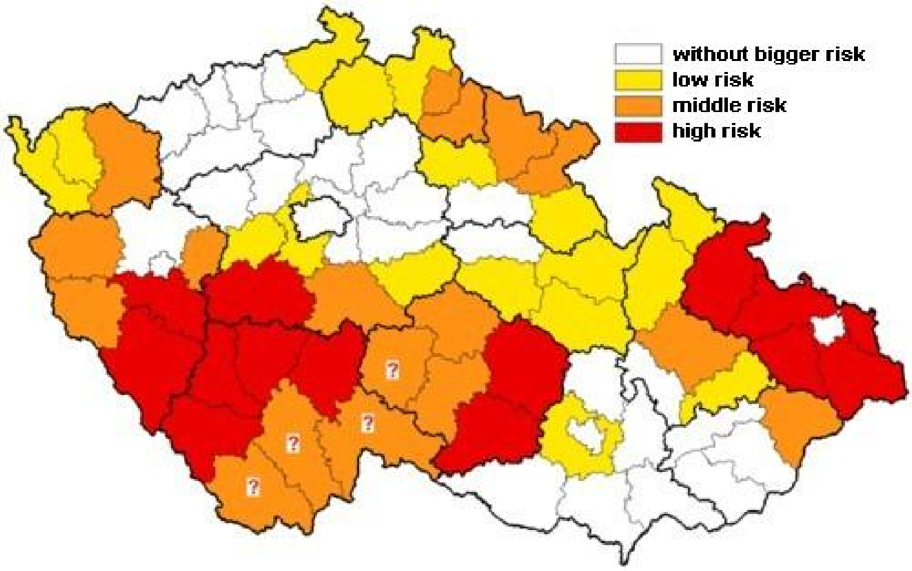
Map No.1 – Storm damage (% of total allowable cut).



Source: FPS of the MGMRI (Knizek, Liska: Lesnicka prace, February 2007).

The Kyrill windstorm hit mainly sites at higher altitude with the "Norway spruce" as a predominant kind of tree for these locations. Consequences to be expected are a higher appearance of insects this summer, especially the bark beetles, mostly *Ips typhographus L.*. (Map No.2) All responsible institutions and officials are monitoring carefully the development around this matter and will carry out special measures as needed.

Map No.2 – Bark beetle risk.



Source: FPS of the MGMRI (Knizek, Liska: Lesnicka prace, February 2007).

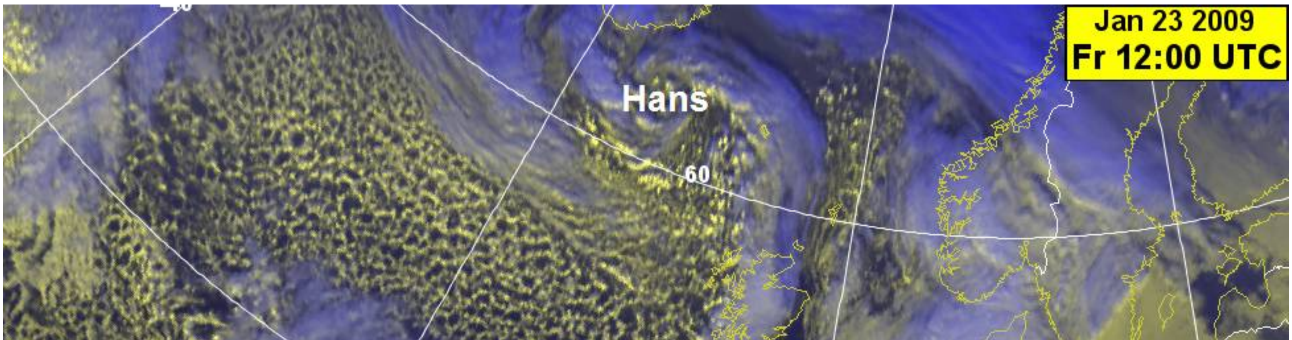
This report has been done on the basis of articles from the Czech forest magazine "Lesnicka prace" (Forestry labour), the information from the editors, Forest protection service of The Forestry and Game Management Research Institute (FPS of the MGMRI) and Ministry of Agriculture of the Czech Republic

Storm of 24th January 2009 (Klaus)

Meteorological conditions

"Klaus", was a European windstorm or cyclone which made landfall over large parts of southern France, northern Spain, Andorra and parts of Italy. The date of formation is the 23rd and it lasted until 25th of January 2009. "Klaus" was preceded by "Joris" on the 23rd of January in Switzerland which caused no forest damage.

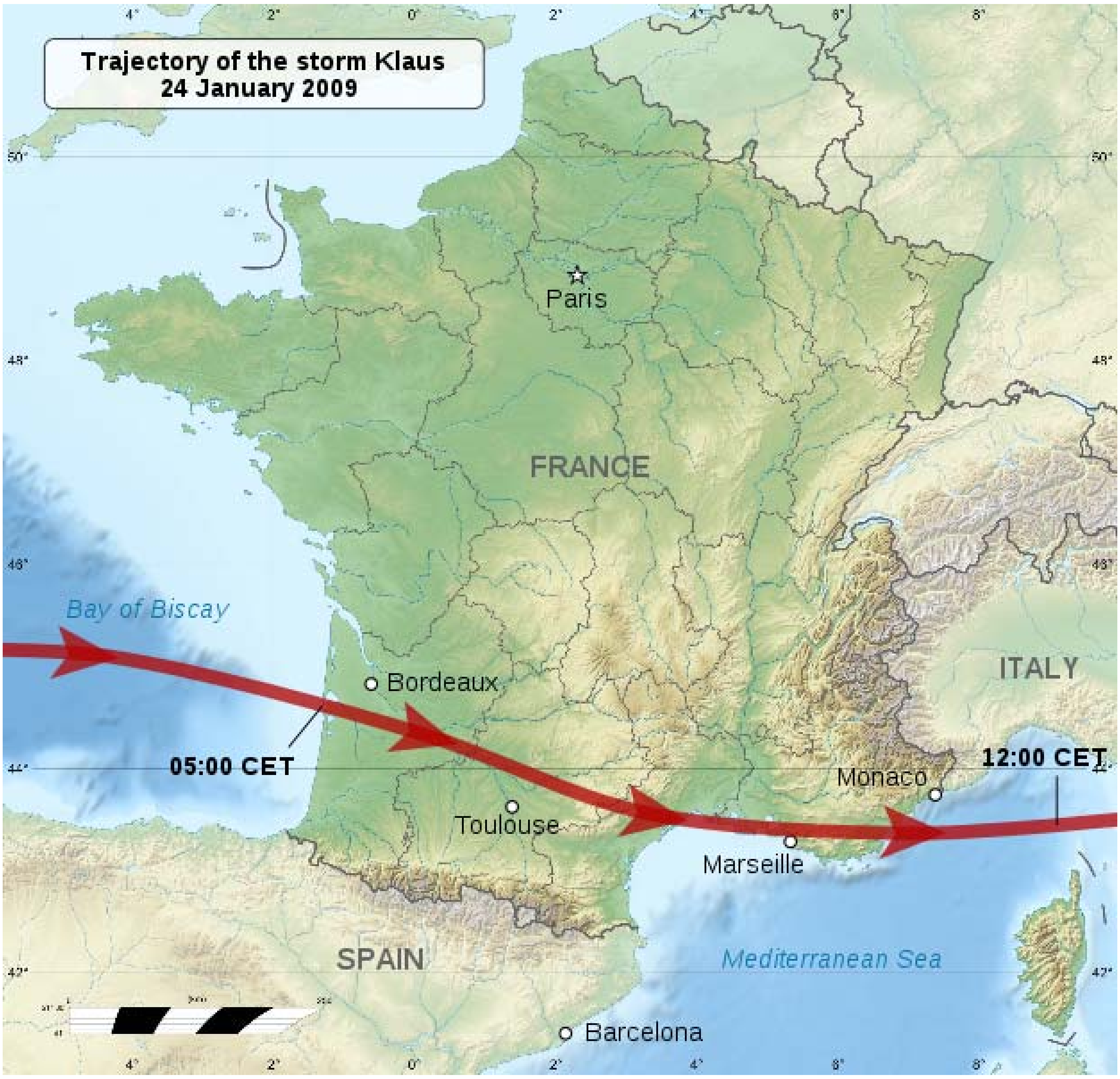
Map showing Joris and Klaus storms



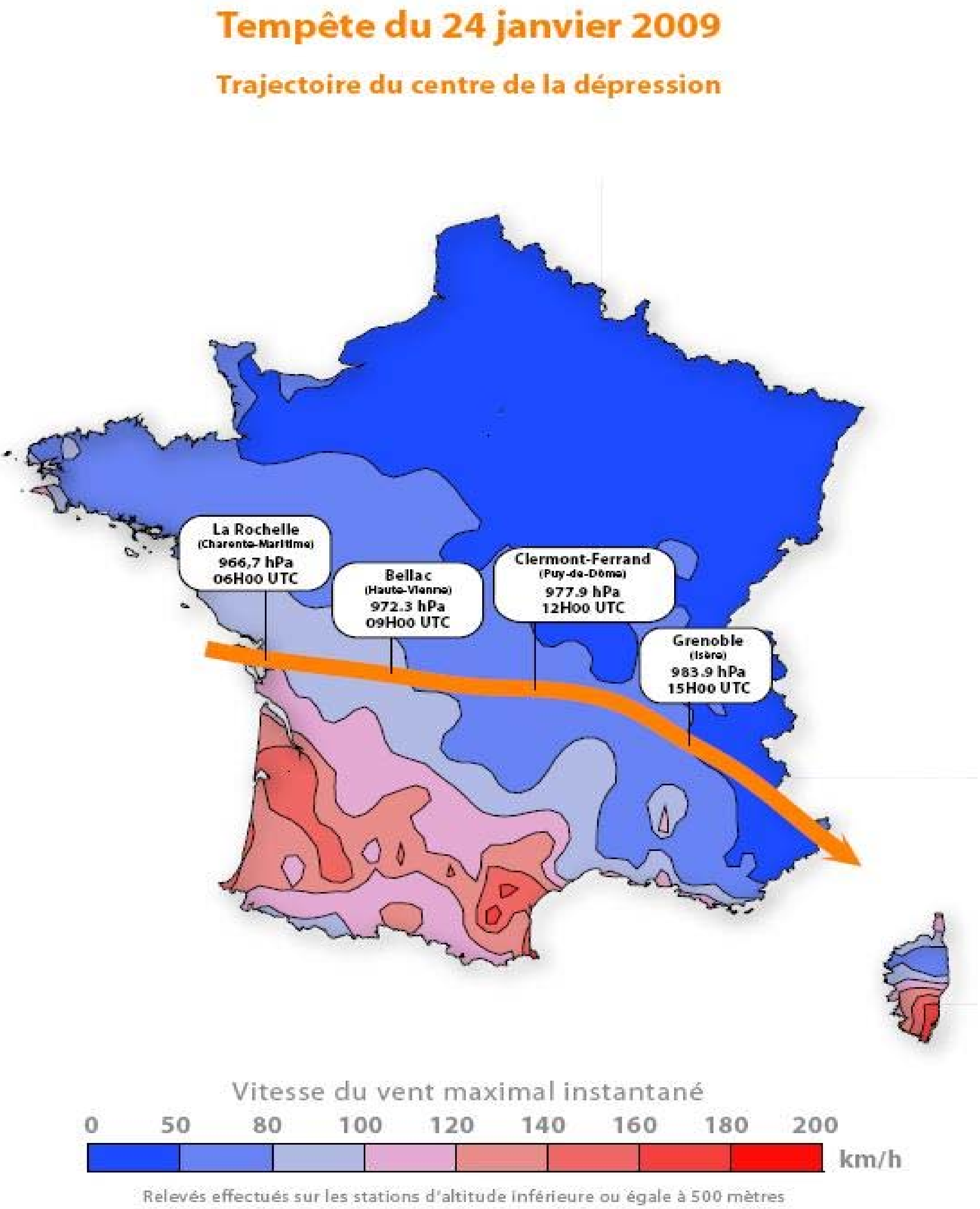
Low pressure systems are regarded as fairly common in Europe during winter but “Klaus” was the most damaging storm since “Lothar” and “Martin” in December 1999. The storm caused widespread damage across southern France and northern Spain.

Some reports called it the storm of the decade. The BBC meteorologist Alex Deakin said "*Saturday's storm is being described as the most damaging since that of December 1999 which killed 88 people*."

Map showing path of highest winds - red line shows trajectory, marked with local times



Map showing winds speeds (instantaneous maximum) and trajectory with local times



The effects of "Klaus" were felt from the Channel Islands south to Barcelona. The most damaging impacts of the storm's rain and heavy winds were located in the south-west of

France. The storm originated in the Bay of Biscay and made landfall near to Bordeaux, France at 5:00 am CET on Saturday 24th January. It tracked south-eastward through southern France, until 13:00. During the evening of 24 January the storm headed towards northern Italy and the Adriatic, where minimal damage was caused.

Peak gusts were over 200 km/h and sustained hurricance-force winds of over 170 km/h (110 mph) were observed. The table below documents the highest winds.

Country	**Place**	**Speed km/h**	**Speed ms^{-1}**
FRANCE	Formiguères* (66)	193 km/h	54 ms^{-1}
	Port-Vendres (66)	191 km/h	53 ms^{-1}
	Mont Aigoual* (30)	185 km/h	51 ms^{-1}
	Perpignan (66)	184 km/h	51 ms^{-1}
	Biscarosse (40)	172 km/h	48 ms^{-1}
	Bordeaux (33)	161 km/h	45 ms^{-1}
ANDORRA	Port d'Envalira*	216 km/h	60 ms^{-1}
SPAIN	Portbou*	200 km/h	56 ms^{-1}
	Cerezo de Arriba	198 km/h	55 ms^{-1}
	Machichaco	193 km/h	54 ms^{-1}
	Malpica	183 km/h	51 ms^{-1}
	Ocón	183 km/h	51 ms^{-1}

*Montagne areas with special effects

Short description of damages

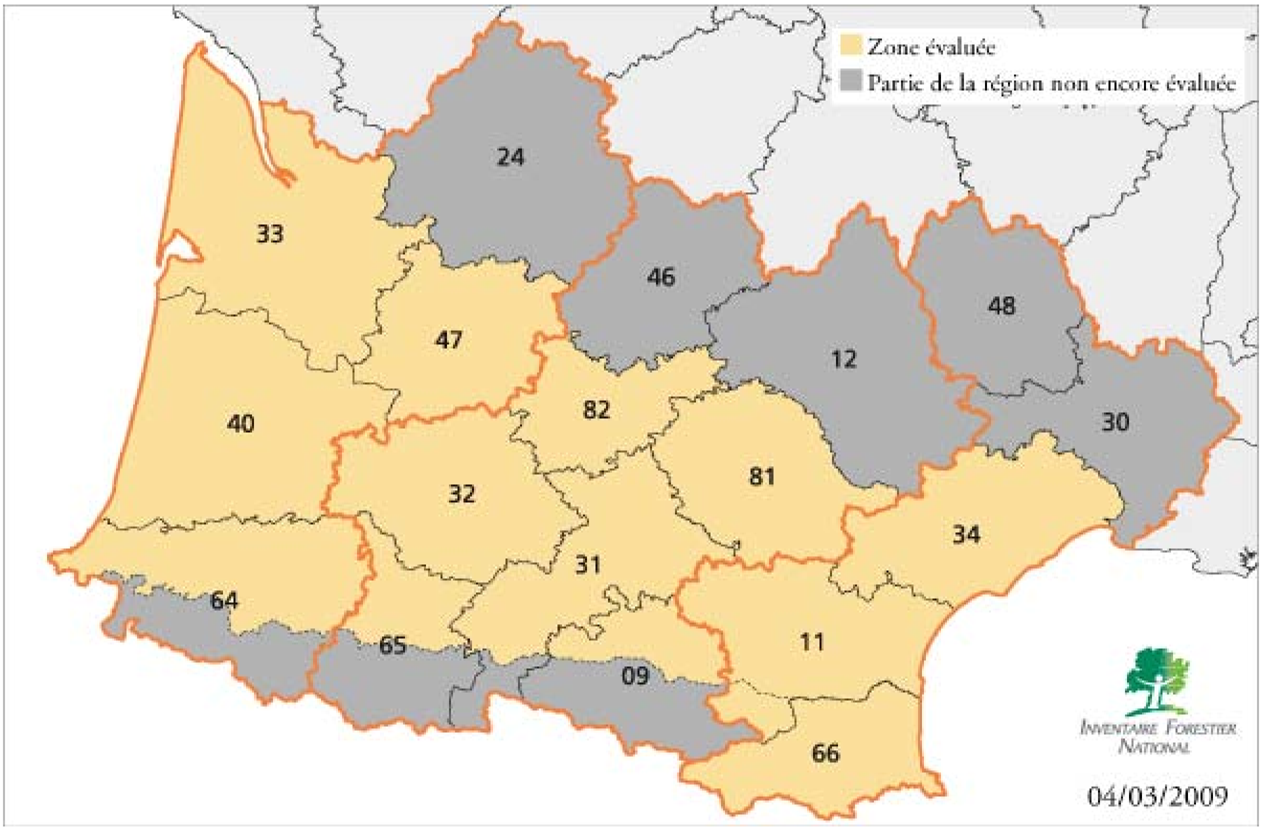
The storm caused 31 fatalities (12 in France, 15 in Spain, 4 in Italy), as well as extensive disruptions to public transport and power supplies, with approximately 1.7 million homes in south-west France and tens of thousands of homes in Spain experiencing power cuts. The storm caused severe damage to property. Forests also suffered major damage.

Primary damages

In France, 684 000 ha of forest have been affected in the three south-west regions (Aquitaine, Midi-Pyrénées and Languedoc-Roussillon) and 234 000 ha had more than 40% damaged trees. Aquitaine was the most affected region.

FRANCE (IFN data, 2009)	Aquitaine (west on the map, orange border)	Midi-Pyrénées (middle on the map, orange border)	Languedoc-Roussillon (east on the map, orange border)
Standing volume	175 Mm^3	78 Mm^3	57 Mm^3
Damaged volume	40.7 Mm^3	1.8 Mm^3	0.6 Mm^3
% Damaged volume	23%	2%	1%
Annual harvest	7,4 Mm^3	1 Mm^3	0,5 Mm^3
Number of harvest	5,4	0,6	0,8
Affected forest area	595 000 ha	61 000 ha	30 000 ha
Of which more than 40% damaged	223 000 ha	7 000 ha	4 000 ha

Map of the damaged south-west region of France



The total affected volume was 43,1 million of cubic meters (14% of the standing volume before the storm which is 310 million of cubic meters in these three regions). In Aquitaine, 41 out of 175 millions of cubic meters were affected.

The private forest sector was mainly affected, while the public forest estate along the coastal zone suffered only 3% damages. Most of the trees (62%) were uprooted and 14% were broken.

The maritime pine stands were the most severely affected with more than 40% damaged stands, an area of 200 000 ha. The total estimate of damaged maritime pine is 38.6 million of cubic meters. The proportion of affected trees were in the age class - 20-40 years old.

FRANCE	Damaged volume (Mm^3)	Damaged volume (%)
Broadleaves	4,5	10,00%
Conifers	38,6	90,00%
Maritime pine	37,8	88,00%

Other	0,8	2,00%
Total	43,1	100,00%

In Spain, the two most affected regions with the most damaged forests were Galicia and Euskadi. The total affected volume wass 1,1 million of cubic meters with 1.025 in Galicia (source: Dirección Xeral de Montes de la Consellería de Medio Rural. Xunta de Galicia) and 0.075 in Euskadi (source: Confederación de Forestalistas del País Vasco).

SPAIN	Galicia	Euskadi
Standing volume	133.1 Mm^3 (IFN data, 2000)	54.8 Mm^3 (IFN data, 2005)
Damaged volume	1.025 Mm^3	0.075 Mm^3
% Damaged volume	0.77%	0.14%

Secondary damages

A detailed evaluation of secondary damages on over 1 millions ha of maritime pine forests has been conducted by the Department of Forest Health (DSF) from the French Ministry of Agriculture the end of June 2010. This evaluation, based on road sampling, shows a high level of damaged trees by bark beetles on stands with storm damage above 40%. The temporary figure for total volume of wood damaged by bark beetles is 1,4 million m^3 (source DSF) 1.5 yr after the storm. However, it is predicted that this figure will increase substantially during the current year with a second generation of beetles. Those secondary damages are also combined in many areas with a high degree of defoliation by pine processionary moths.

Tertiary damages

Klaus has largely affected the wood-based markets in south-west of France. Depending on wood quality, the prices of maritime pine were between 1 to 45 € per cubic meter before the storm. In 2009, the prices fell to 1 to 10 € per cubic meter. The regional sector has been very attractive (in particular with grants for transport) to wood buyers from Germany and Austria, in relation to the rapid development of energy-wood markets in those countries. The consequences on sawmills and local wood-based industry have not yet been fully assessed, but preliminary predictions show that a gap will appear in regional wood supply for industries in the next 10 to 15 years.

On the basis of previous studies of production indicators (FORSEE - ,http://w3.pierroton.inra.fr/IEFC/index.php?page=activites/FORSEE/Indicateurs/Aquitaine.3.2.1.fr.html) providing an average value of 25€ per cubic meter of standing volume, the primary damages related to "Klaus" can be evaluated at around 1 billion €.(loss of market value). If other direct (loss of future value, increased restoration costs) or indirect costs (secondary damage, delayed exploitation) are included, the total loss for the forest owners is in the range of 1.6 to 2 billion € (Peyron JL *et al.* in CIAG 2009; Lecocq M, et al, 2009).

When other damages to the wood processing industry and to climate regulation services (carbon sequestration capacity) are added, the total economic loss is in the order of 3 billion € (Rapport d'Information Parlementaire, 2009).

Policy responses

The policy responses (Plan Tempête 2009, rapport d'information parlementaire, 2009) were rapid, using mechanisms and procedures set up from previous storm "Martin". The measures were taken at national (Ministry for Agriculture) and regional level (Regional Council of Aquitaine) and are summarised in the following table:

Measures	**State**	**Region**
Emergency (road clearing, damage inventory, support of organisations, human resources...)	grants	grants
Post storm forest operations (construction of storage infrastructures, wood extraction, transportation and storage, support of forest enterprises..)	grants, loans	grants, training

Forest protection and restoration (forest cleanup, restoration of infrastructures, pest control, forest regeneration, support of nurseries…)	grants, loans	grants
Storm prevention (insurance system, emergency plan, expertise and foresight studies, research programmes…)		carbon fund

One innovative measure taken and which is currently under implementation is a new voluntary mechanism for compensation of GHG emissions at the regional level. The funds come from local authorities and industries to compensate for their emissions on the basis of carbon market prices. This money will be used for forest planting and protection in the region in addition to other measures.

Short-term impacts on the forest sector

- Forest owners were not adequately covered: most of the forest owners were not insured for storm risks as it is too expensive. After the storm, there was a lot of social disagreement in Aquitaine, because the government did not set up any "natural disaster" mechanisms to compensate forest owners for the damaged wood, although this exists in agriculture.
- Very low wood prices : the storm happened at the same time as the economic crisis with depressed markets for wood products, and prices remained very low during the first year after the storm.
- Delays in implementation and loss of value: there were some delays in implementation of some measures (e.g. loans for storage) and as a consequence, loss wood value with the development of blue stain.
- Nevertheless, a total volume of 14 Mm3 was exploited for maritime pine in 2009 (compared to a "normal" annual harvest of 8 Mm^3) with 25% of the volumes exported out of the region. One and a half year after the storm (mid-2010), a volume of 7 Mm^3 had been stored under water spraying and a total area of 40000 ha had been cleaned-up.

Ecological, Economic and Social effects

The ecological, economic and social effects have been analysed and reviewed within the framework of a large collective of experts coordinated by GIP ECOFOR on the future of the Landes of Gascony Forest. A state of the art report was produced for a range of indicators, and future options for forest management and forest-wood chains were elaborated and analysed by expert groups. Preliminary documents are available at http://landes.gip-ecofor.org/ .

Literature

Météo FRANCE
http://france.meteofrance.com/jsp/site/Portal.jsp?page_id=11330&page_id=10539
http://www.alertes-meteo.com/hiver-08-09/vague-de-froid-hiver-2008-2009-24-01-2009.php

La forêt française - les résultats issus des campagnes d'inventaire 2005, 2006, 2007 et 2008. IFN, 2009, 136 pages. Inventaire Forestier National

CIAG, 2009. Proceedings, 30 June 2009 « Sylviculture, Forêts et Tempêtes », INRA, 119 p. http://www.inra.fr/ciag/colloques_agriculture/forets_et_tempetes.

Lecocq, M; Costa, S; Drouineau, S; Peyron, JL; 2009. Estimation du préjudice monétaire dû à la tempête Klaus pour les propriétaires forestiers. Forêt Entreprise n° 189, Novembre 2009, p 58-52.

Rapport d'Information Parlementaire, 2009. Rapport n°1836 sur les conséquences de la tempête du 24 janvier 2009 dans le sud-ouest, présenté par Nicolas, JP. http://www.assemblee-nationale.fr/13/rap-info/i1836.asp#P343_76954