P4.17 SEVERE THUNDERSTORM WIND DAMAGE SOCIETAL IMPACTS AND PREPAREDNESS

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1. INTRODUCTION

Understanding the consequences of severe convective storms on society helps develop preparedness for such events. First, understanding the severity and type of accidents caused by past events can guide the formulation of general guidance for authorities and the public. This information may be also used to draft call-to-action statements, which may be included in a warning message. Second, knowing the typical impacts of events can help authorities make site-specific action plans for people, private and public properties, and outdoor venues. All these preparedness measures may be used during a severe-weather event to prevent casualties. Additionally, if severe weather is forecast, impact information can be used to mitigate property damage and ensure society's faster recovery by planning ahead for the resources needed for both rescue work and repairing damaged infrastructures.

The potential impacts of a specific severe-weather event are also influenced by local effects like topography, vegetation, construction standards, and local human behavior. Therefore, the local effects should be considered when defining the typical impacts or safety rules for a certain area. This study defines localized general guidance and call-to-action statements and impact descriptions of convective storms producing wind damage in Finland.

This presentation consists of two parts. In the first one, we study two convective storms that caused major wind damage in Finland to understand the impacts onto society of such types of convective windstorms. The data comes from the rescue operations of the Finnish Rescue Services and the statistics of paid compensations from the Finnish Motor Insurers´ Centers. In the second part, we categorize the description of the impacts and derive general guidance and call-to-action statements for convective wind storms (assessed in co-operation with the Emergency Services College)

2. IMPACTS OF CONVECTIVE WINDSTORMS: CASE STUDY EXAMPLES

2.1 Southwestern Finland, 26 August 2005

On 26 August 2005, a severe frontal rainband caused widespread wind damage in western Finland. Most of the damage was caused by straight-line winds, although 9 short-lived tornadoes were also reported (Fig.1, Rauhala and Punkka 2008). The reported damage mostly corresponded to F1 intensity. The Finnish Rescue Services performed 377 weather-related rescue operations across five provinces. The number of rescue operations was 3–4 times the daily average. Most (62% or 234 cases) of the rescue operations during the event were due to danger caused by fallen trees. Most often (53% or 124 cases), the fallen trees blocked road traffic, but many cases implied fallen trees over electric power line (21% or 49 cases), over a building (12%, 28 cases), or on top of a car (3% or 6 cases).

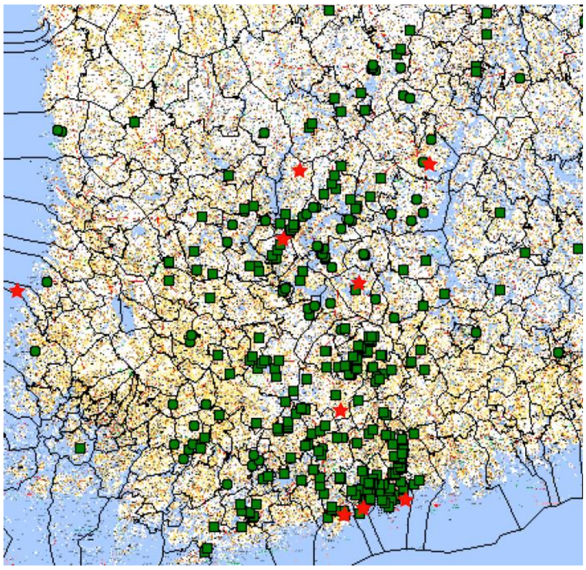

FIG. 1. Thunderstorm wind damage (green) and tornado (red) reports on 26 August 2005 in southwestern Finland (Rauhala and Punkka 2008).

Apparently, the 26 August storm did not have an impact on the number of road accidents, as the statistics from the Finnish Motor Insurers´ Centers did not show higher than average number of accidents in the affected area. However, coincident with the squall-line passage, four traffic accidents with four injuries were reported to the Rescue Services. This included a truck crashing into a falling tree and a tank truck falling over.

2.2 Eastern Finland, 5 July 2002

On 5 July 2002, a severe thunderstorm outbreak caused a 450-km-long damage area in Finland (Fig 2, Punkka et al. 2006). Most of the reported wind damage was of F1 intensity, although a few small areas of F2 damage were also reported. The Rescue Services performed 445 weather-related rescue operations. In the worst-hit province, the total number of rescue operations was 14 times the average (compared to the average of the first Friday of July 1999–2001 and 2003–2005), and the number of Rescue Services rescue operations stayed high for a

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few days; the next day had a four-fold number of reports and the second day after the event still had a double number of reports (Fig. 3). Similar increase in the number of rescue operations was observed also in other provinces along the damage track.

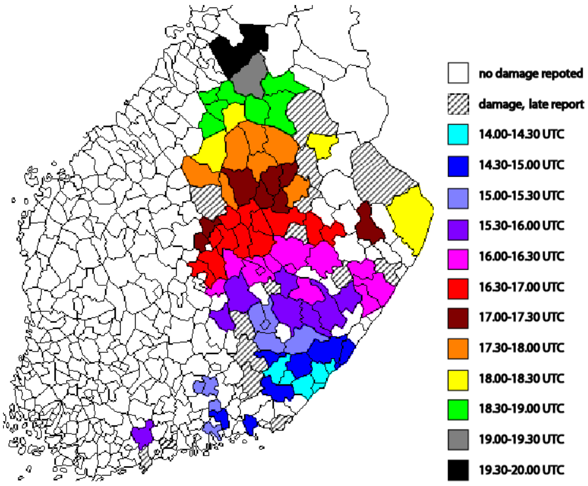

FIG. 2. Area of wind damage reports on Friday 5 July 2002. The time indicates the first emergency report at each municipality (Punkka et al. 2006).

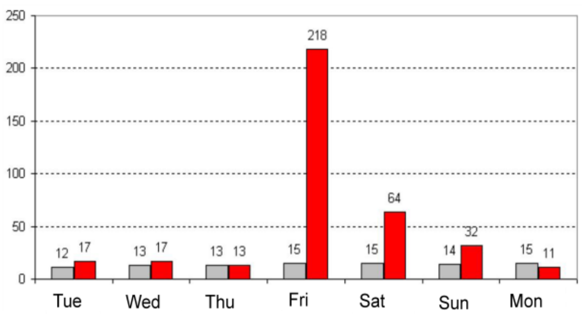

FIG. 3. Rescue operations in the worst-hit province (Pohjois-Savo). Red columns depict daily rescue operations between 2–8 July 2002, while the grey ones the daily average of the first week of July from 1999–2001 and 2003–2005.

Of the 445 rescue operations on 5 July 2002, 325 (73%) were related to falling trees, most commonly trees on road (54% or 178), trees on electric power lines (20% or 65), and trees on buildings (20% or 65). In some instances, the trees were blocking a 100-m long part of the road, making the rescue work difficult.

On 5 July, the insurance statistics showed an increase in the number of accidents in the worst-hit area, where there was a 70% increase compared to the average (first Friday of July). The traffic accidents included two cases of cars crashing into fallen trees on the road and, in several cases, a car was trapped between fallen trees. The 5 July outbreak also included two cases where the railway was blocked by fallen trees.

2.3 Casualties and property damage

Most of the other reported casualties were also related to falling trees. On 26 August, one person was reported injured during tree-clearing work and, on 5 July, one person was injured when hit by a falling tree. In another location, an electric shock was reported shortly after the wind damage. On 5 July, 5 cases of small boaters on lakes were reported in distress, a common summertime problem on the more than 180,000 lakes in Finland.

The rescue operations related to building damage were similar in both events and included detached roofs, an overturned tent, and, in one case, a collapsed outbuilding. Several people were trapped in elevators because of power failures. On 5 July, the Emergency Response Centers suffered a power failure, telephone-line overload, and the incapacity to transfer all assignments.

3. CONVECTIVE WIND STORM PREPAREDNESS

On the basis of the reported damage in these case studies, we have developed preparedness measures for future storms such as impact descriptions, general guidance and call-to-action statements.

3.1 Impact descriptions

Impact information (Table 1) may be used to prevent casualties and to mitigate property damage by planning ahead when severe weather is forecast.

TABLE 1: Convective wind storm impact damage chart in Finland for F1 (33 m/s) and F2 (50 m/s) wind gusts.

F1	• Risk for humans to be hit by a falling tree or get an electric shock from fallen power line. • Trees fall over buildings. Some detached tin roofs. Tents may collapse. Flagpole may fall down. • A lot of trees fall down on roads. Also electric power lines, telephone lines and street lights may fall down and cause danger, especially for road traffic. • In road traffic, there is a risk for collision with fallen trees on roads. Wind gusts may push cars off the roads. Trees can fall down on cars. • Small boaters may get in distress. Boats may come loose from mooring. • Trees may fall over railway lines. • Power failures may cause problems such as people trapped in elevators.
F2	• A lot of trees fall over buildings, felt and tile roofs become detached, lightweight outbuildings may collapse. • A lot of fallen trees over roads. Trees may block 100 m wide sections of roads. • A lot of people trapped on roads and in buildings because of fallen trees. • Rain water system, such as manholes and roof outlets may become blocked, damage of drainpipes or detached construction tarpaulins can cause risk for water damage.

3.2 General guidance

General guidance on how to behave in convective wind storm situations may be distributed to authorities and to public before onset of the event. They mainly aim to prevent casualties, but also to mitigate property and environmental damage. General guidance (Table 2) may be distributed for example through web-pages, books or brochures.

TABLE 2: Convective wind storm general safety rules for Finland.

Before the event

- Avoid non-necessary travel, don't go boating.
- Charge mobile phones, reserve drinking water and check flash light batteries.
- Collect garden furniture or other property from the yard.
- Close doors and windows. Check that balcony glazing is closed.
- Keep pets and cattle inside.
- Drive car away from trees or into a garage.
- Switch off electrical devices that you can get access to.
- Check boat moorings.

During the event

- Move indoors to sturdy building, away from windows.
- Tents, lightly built structures or outbuildings are not safe.
- The safest place in a building is the lowest floor or a cellar.
- Avoid using elevators since power failures may occur.
- Look out for falling trees and power lines.
- If outside, take cover from falling trees in between rocks, to foot of a precipice or into a ditch.
- Wind gusts may push cars off the roads or overturn two-wheeled vehicles. Drive carefully if you drive from forest to open area, since wind gusts may be there stronger. Park car into a cover or stop away from trees and power lines.
- Don't go boating. Go to nearest harbor. Lower sails and moore the vessel.

After the event

- Avoid non-necessary travel.
- Look out for fallen trees on roads. If the road is blocked, use for example warning triangle to warn other people.
- Stay at least 20 meters away from damaged power lines.
- Partly or crosswise fallen trees may have stress.
- If you don't need help, help the neighbor.
- Check boat moorings.
- Check roof structures, possibly damaged stovepipes and windows.
- Clean the rain water system if blocked.

3.3 Call-to-action statements

Call-to-action statements (Table 3) may be included in the warning message, when the threat is imminent. Their purpose is to prevent casualties by providing localized guidance on what to do (Troutman et al. 2001), and thus, are kept as compact and clear as possible. Introducing a two-level structure gives the possibility to highlight the most dangerous events (Smith 2000). Currently, only a few European countries include call-to-action statements in their severe thunderstorm warning messages (Rauhala and Schultz 2009).

TABLE 3: Convective wind storm call-to-action statements for Finland.

General	Move indoors away from windows. Look out for falling trees and power lines.
Extremely dangerous situation	This is a very dangerous situation. Move immediately indoors away from windows. Look out for falling trees and power lines.

4. CONCLUSION

The study of two severe thunderstorm events, which caused major wind damage in Finland, showed that most of the emergency calls during these events concerned danger caused by fallen trees. Most often the fallen trees blocked road traffic, and in some cases caused traffic accidents, encircled vehicles or isolated buildings. Falling trees also typically damaged buildings and electric power lines and the reported casualties were also related to them. Several small boaters were reported in distress on lakes, which seems to be another locally typical consequence for Finland besides falling trees.

Information of local consequences for Finland was used to formulate preparedness measures such as impact descriptions, general guidance and call-to-action statements. These measures may be used in future severe storm events to mitigate their impacts.

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