# HAIL AND WIND DAMAGE IN FINLAND: SOCIETAL IMPACTS AND PREPAREDNESS

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## I. 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 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 behaviour. Therefore, the local effects should be considered when defining the typical impacts or safety rules for a certain area. This study describes the basis for defining localized call-to-action statements and impact descriptions of convective storms producing wind or hail damage in Finland.

This presentation consists of two parts. In the first part, we studied two convective storms that caused major wind damage in Finland to understand the impacts to society of these types of convective windstorms. In the second part, we studied media reports of the damage from 60 large-hail cases and one severe-hail outbreak case in detail. In both parts, the data comes from the rescue operations of the Finnish Rescue Services and the statistics of paid compensations from the Finnish Motor Insurers´ Centres. The impact description is followed by convective wind storm and severe-hail call-to-action statements.

## II. IMPACTS OF CONVECTIVE WINDSTORMS

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 (Rauhala and Punkka 2008). The reported damage was mostly 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) of the rescue operations during the event concerned danger caused by fallen trees. Most often (53% or 124) the fallen trees blocked road traffic, but cases also concerned 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).

On 5 July 2002, a severe thunderstorm outbreak caused a 450-km-long damage area in Finland (Punkka et al. 2006). Most of the reported wind damage was 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 few days; the next day had four-fold the number of reports and the second day after the event still had double the number of reports.

Of the 445 rescue operations during 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 wide area of the road, making the rescue work difficult.

Apparently, the 26 August storm did not have an impact on the number of road accidents, as the statistics from the Finnish Motor Insurers´ Centres did not have higher than the 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. On 5 July, the insurance statistics showed an increase in the number of accidents at 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.

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 Centres suffered a power failure, telephone-line overload, and the incapacity to transfer all assignments.

## III. IMPACTS OF HAIL STORMS

Regardless of size, hail can flatten crops or make roads hazardous to drive on with slippery conditions and rapidly decreasing visibility. At least seven injuries and one death have been reported in traffic accidents caused by hail in Finland since 2006.

Based on damage caused by 60 separate severe-hail cases in Finland during the past 10 years (from the climatology by Tuovinen et al. (2009)), we have classified the typical reported damage for different hail sizes (Table 1). The impact of the hail is not solely dependent on hail size, but also on the duration of the hail fall and the accompanying winds (e.g. Parker et al. 2005). The most commonly reported hail damage in Finland includes broken plastic or glass shields and windows, and dented cars. Injuries caused by falling hailstones have been bruises, wounds or mild concussions. A hail impact damage chart (Table 1) shows similarities with other reported damage elsewhere (e.g. Hohl et al. 2002).

The hail damage and its socioeconomic impacts are studied in detail for the 10 July 2006 severe-hail episode, one of the most violent severe-hail outbreaks in recent history in Finland. This event was well documented and it raised questions about society's vulnerability to severe hail. During 10 July, numerous splitting supercell storms swept through small cities and communities in the eastern Finland (Tuovinen 2007), producing hail up to 7-cm in diameter and damaging winds. The right-moving supercells were the strongest hail producers. Altogether, 8 different storms produced severe hail with over 50 individual reports of severe hail.

These storms caused multimillion-euro property damage as over 1000 cars were damaged, and some were beyond repair. Also, numerous windows in buildings and tile roofs were shattered in the worst-hit areas. A few people were injured at the local athletics meeting when the hail fall suddenly started. The total amount of the insured property losses was estimated to be 2–2.5 million euros. The Finnish Motor Insurers´ Centres statistics did not show an increase in the number of accidents in most of the affected provinces, except for one province where the number of accidents was double the average.

TABLE 1: Hail impact damage chart for Finland.

| **Size** | **Impacts** |
|---|---|
| ≥1,5 cm/ long duration | - Slippery roads and poor visibility<br>- Crop and plant damage |
| 2–3 cm | - Occasional damage to car sheet metal |
| 3–5 cm | - Scratches from sharp hail edges, bruises, swellings, and mild concussions for humans and animals<br>- Damage to car sheet metal and windshields cracked<br>- Tin roofs dented, felt roofs damaged, building windows broken, holes in plastic roof decks, paint comes off of exterior walls |
| 5–7 cm | - Crushing for humans<br>- Tile roofing broken, two-light frame windows broken |
| ≥7 cm | - Car windshields completely broken, large dents in sheet metal |

## IV. CALL-TO-ACTION STATEMENTS

Call-to-action statements should provide localized guidance on what to do in response to the forecast (Troutman et al. 2001), although only a few European countries surveyed said that they included such statements in their severe thunderstorm warning message sent to the public (Rauhala and Schultz 2009). Based on the observed impacts in Finland, and, in co-operation with the Emergency Services College, we have developed convective wind and hail storm call-to-action statements that can be included in warning messages (Table 2). The purpose of the call-to-action statements is to save lives, and they are intended to be used only when the threat is imminent. The aim is to keep them as compact and clear as possible so that they are easily understandable when heard on the radio. Two levels of statements have been developed to highlight the possibility of extremely dangerous events (Smith 2000).

TABLE 2: Thunderstorm wind and hail call-to-action statements for Finland.

| | |
|---|---|
| **Large hail** | |
| General | Move indoors away from windows and glass roofing. |
| Extremely dangerous situation | This is a very dangerous situation. Large hail can cause crushing and wounds. Move immediately indoors away from windows and glass roofing. |
| **Thunderstorm wind gusts** | |
| 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. |

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