HISTORICAL HAIL CASES IN FINLAND: 1833–1909

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I. INTRODUCTION

Newspapers from the past centuries can reveal amazing stories of severe storms with striking detail. Hail storms and hail damage provide especially dramatic stories. In the past, the amount of food produced during the summer had to be sufficient for the following six or seven months, enabling survival through the sometimes harsh winters at high-latitude locations such as Finland. A storm with a hail cell of just few kilometres wide could easily destroy the complete annual income or food source of a farm owner in the 19th Century. After such devastation, villagers or local spokesmen were often left to appeal for some relief from the governor. This explains why newspapers reported on hail incidents.

In the past five years, we have gathered more knowledge about hail occurrence in Finland. Although one might think that because Finland is situated between 60˚N and 70˚N latitude, atmospheric conditions favourable for hail-producing convective storms are not likely. In fact, hail occurs an average of 40 days a year (based on the 2008–2010 average; Tuovinen and Schultz 2010). Even damaging severe hail (2 cm or larger) occurs an average of 20 days a year, with at least one report of tennis-ball or larger-size hailstones (6.7 cm or larger) (Tuovinen et al. 2009).

In a previous study (Tuovinen et al. 2009), we constructed a climatology of severe hail mostly from newspaper articles and other historical archives from 1930 to 2006. We continue to grow our climatology every year since 2006 by collecting reports from the public and from a radar-data-based hail-detection algorithm (Tuovinen et al. 2009, 2010). Our goal is to continue to build a climatology back into the past before 1930.

The purpose of this presentation is to describe the construction of a database of hail reports over a 77-year period from 1833 to 1909. This dataset begins in 1833 because this year was the earliest available during our search (between autumn 2010 and spring 2011). This dataset ends in 1909 because copyright law restricts the online use of newer material. (During summer 2011, newspapers starting in the 1770s were added to the database. Future work will entail searching those newspapers, as well.) We compare this database to the more recent database of severe hail from Tuovinen et al. (2009) (1930–2006), which coincidently happens to be a 77-year period of length also, and the more recent hail dataset (2006 to present) (Tuovinen et al. 2009, 2010).

II. DATABASE SEARCH

Before describing the method of obtaining reports, a bit of history is warranted. Finland was part of Sweden during 1300–1809 and part of the Russian Empire during 1809–1917 before declaring independence in 1917. Under Russian rule, Finland was given the special autonomous status of Grand Principality of Finland, allowing the use of Finnish and Swedish languages in the press and among the population. This resolution guaranteed the continuity of over a hundred-year tradition of printing media in Finland.

We used the user-friendly interface of the National Library's Internet database (http://digi.lib.helsinki.fi), called the Historical Newspaper Library. This public utility is free of charge and available to everybody. Altogether 250 different newspapers are stored in the Internet database, covering both Finnish and Swedish language newspapers. The system operates with a keyword search, and the completed search highlights parts of each newspaper article where the keyword(s) occurred (Fig. 1). This convenience means that there is no need to look for the article containing the keyword amidst the whole newspaper (typically 4–8 pages with small font size). The text is old typeface and letters differ a lot from the present (see Fig. 1). The text is read with an OCR (Optical Character Recognition) program, which minimizes misspelling errors in scanned images of printed text. This same technique also recognizes the searched words. In the beginning, progress of reading the text was slow as we had to understand the text around our keywords. By the end, experience enabled faster processing of the text.

We made searches using multiple hail-related keywords in two languages (e.g. *raekuuro, raesade, hagel hagelskur*), dating between May and September because damaging hail tends not to occur outside this time period (Tuovinen et al. 2009). Moreover, we focused our search upon the period between 1 May and 15 October, because there was an up to two-week lag between the actual event and the published hail article. Sometimes pinpointing the actual day of occurrence was not straightforward. Hail event days were mostly mentioned as days of the week, not as the date. So, old calendars listing religious holidays helped to determine the date of occurrence from the article.

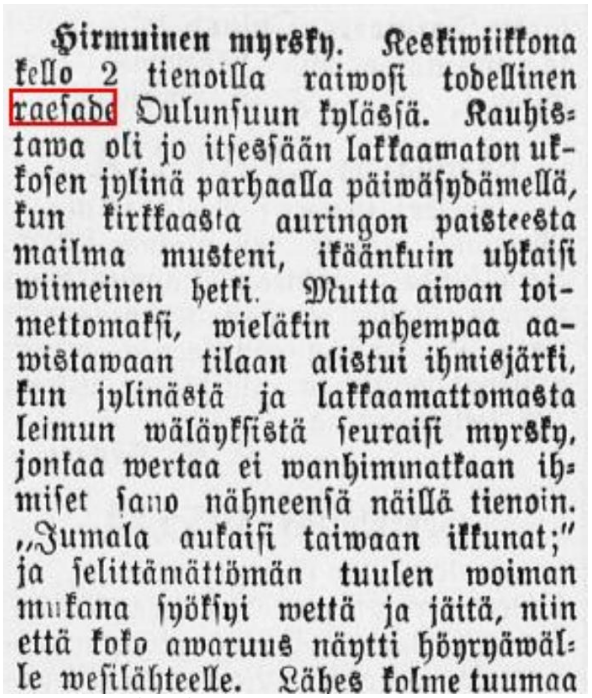
The oldest references to a damaging hail fall we found occurred in summer 1776 in Eura, Vesilahti and Pori areas. This report comes from a newspaper article (*Borgå Tidning*) from June 1838 discussing remarkable historical natural phenomena in Finland 1770–1820. We decided not to include these few isolated events. Occasionally, the newspaper articles would include stories about hailstorms across Europe and North America, as well.

Articles about hail storms typically possessed certain characteristics. First, the intensity of the hail storms were described by comparing the hailstone size to some known object (most commonly different bird eggs, berries, potatoes,

peas, rocks, thumbs or fingertips). When quantitative size information was provided, measurements were given in inches. Second, the weight of hailstones was often mentioned, measured in grams or bullets (around 15 g). Weight however is not a good indicator of hail size alone. The shape and inner structure of hailstone (liquid water or air bubbles trapped inside) is independent of weight. That is why an elongated hailstone 6 cm in diameter does not necessarily weigh a lot. Third, a common characteristic mentioned in the article was how long the hail stayed on the ground before melting ("*…hail was still found in the shade on the following morning"; "… five hours after the hail fall, the hail was still covering the ground";* etc.). Fourth, the fear and respect for Nature's power is emphasized in many articles and eyewitness stories, as in the example below.

This hail event description was published on 31 July 1882 in *Sanomia Turusta*. The hailstorm occurred in the city of Oulu on 19 July 1882. According to our database, these are the largest hailstones that have occurred near Oulu.

Last Wednesday started out with beautiful and warm weather. In the early mid-day, a tiny dark cloud appeared to the northern sky, and grew bigger. Around noon, it turned into a thunderstorm, with black clouds sending heavy rain from high above. After a while, it cleared but the heat did not go away, and the air didn't feel fresh either, as is typical after rain. An hour and a half after that heavy rain, around 13.30 LT, the sky started to darken, twice as dark as it was earlier. The ground and the sky turned dark and thunder started to rumble with such force that many feared that doomsday would arrive. The storm pounded rain and hail, turning city streets into streams. That kind of hail-fall has never been felt here before. All the windows on the windward side were broken into thousands of pieces because of the wind and the egg-sized hail. The largest hailstones were 3 inches wide. Inside the old Pharmacy Store, a few hailstones weighed as much as a bullet (15 g), but some hailstones were as heavy as seven bullets (100 g). The barometer decreased 20 mm within a matter of minutes, a rare event of nature in a scientific light. The scene on the streets was unreal; hail and glass was everywhere. On the subsequent days, citizens of Oulu cleaned up after the damage and filled the broken windows with anything suitable, if glass was not available. No less than 41 000 windows were broken, hundreds of felt-covered roofs were filled with holes, and the interiors of many rooms were destroyed by heavy rain.



Hirmuinen myrsky. Keskiwiikkona kello 2 tienoilla raiwosi todellinen raesade Oulunsuun kyläss̈ä. Kauhistawa oli jo itsesään lakkaamaton ukkosen jylinä parhaalla päiwäsydämellä, kun kirkkaasta auringon paisteesta mailma musteni, ikäänkuin uhkaisi wiimeinen hetki. Mutta aiwan toimettomaksi, wieläkin pahempaa aawistawaan tilaan alistui ihmisjärki, kun jylinästä ja lakkaamattomasta leimun wäläyksistä seuraisi myrsky, jonka wertaa ei wanhimmatkaan ihmiset sano nähneensä näillä tienoin. „Jumala aukaisi taiwaan ikkunat;" ja selittämättömän tuulen woiman mukana syöksyi wettä ja jäitä, niin että koko awaruus näytti höyryäwälle wesilähteelle. Lähes kolme tuumaa

Fig. 1: A part of text from the newspaper describing recent hailstorm in Oulu. Typeface of letters differs quite a lot from the present. The highlighted word *raesade* means hailfall.

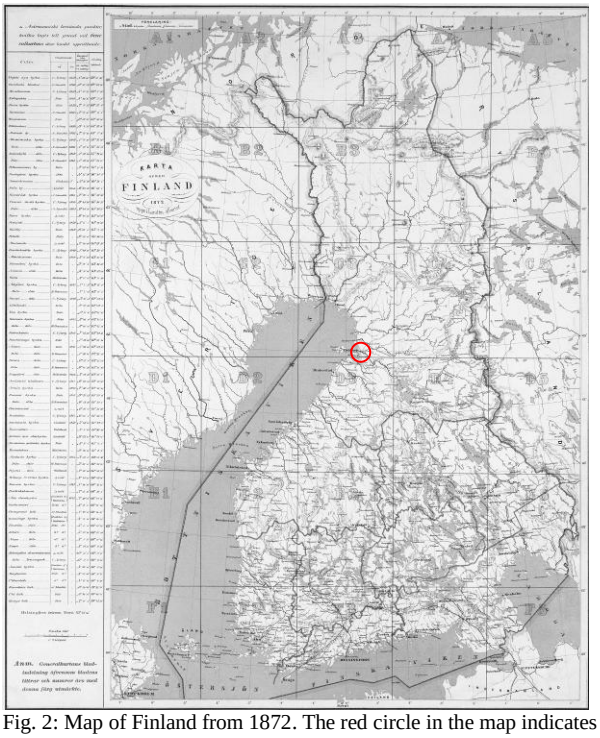


Fig. 2: Map of Finland from 1872. The red circle in the map indicates the location of the city of Oulu. (Courtesy of the University of Jyväskylä.)

III. HAIL STATISTICS AND DAMAGE

We found 399 different hail cases where the hail size varied from 1 cm to 7.5 cm in diameter. The cases were spread from the south coast to southern Lapland, generally in the agriculturally intensive area. The collected dataset includes all hail sizes, of which 70% are severe-hail size (2 cm and larger). The hail size was indeterminate in 41% of

the cases.

As expected, year-to-year variation was considerable. Most of the years had 2–5 cases each and only three years (1845, 1867 and 1880) were without a single event. The summer of 1896 was very active with 40 hail cases during 16 hail days.

Altogether, 77% of cases occurred during noon (27%; 10–14 LT) or afternoon (50%; 14–18 LT). The time of occurrence was indeterminate in 46% of cases. By comparison, Tuovinen et al. (2009) found that 74% of 1930–2006 severe hail cases occurred at 14–20 LT, although a few nocturnal events occurred as well.

The monthly distribution showed that 94% of cases occurred during summer months (Jun–Aug), and July had 37% cases alone. The peak two-week period occurred during 16–30 June (85 cases), which might be because of the societal importance of Midsummer (the summer solstice holiday). The database of severe hail (1930–2006) had exactly the same percentage of cases occurring in Jun–Aug (94%), although July had many more (66%) hail occurrences (Tuovinen et al. 2009).

Overall, in 85% of the cases, some sort of damage occurred. The most typical damage was broken windows (50%) and crops (44%), whereas human injuries were described in only 3% of the cases, mostly bruises and bleeding cuts (Fig. 4). Only 9% of the cases did not cause damage or any damage caused was unreported. However, over 100 years ago, windows were not as hail-resistant as they are today. Our database indicates that a hail size of around 1.5 cm was enough to cause some windows to break, especially when downdrafts were accompanied with hail.

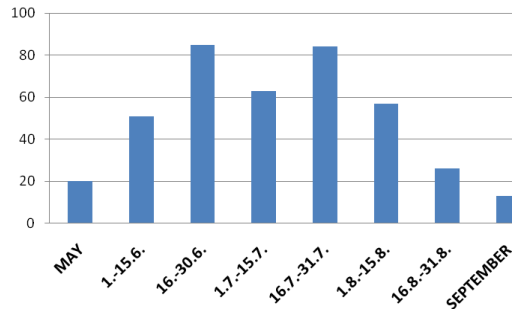


Fig. 3. Monthly distribution of hail. Number of cases (y-axis) and time period (x-axis). Months of June, July and August are divided into two-week periods.

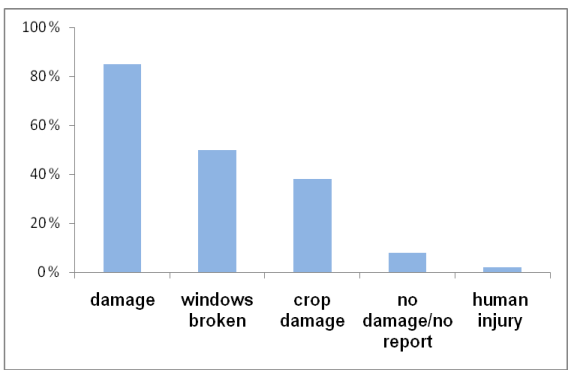


Fig 4. 399 hail cases with damage data (339 cases with damage, 200 cases of broken windows, 174 cases of crop damage, 36 cases with no damage or damage unknown and 10 cases with human injuries.

IV. ACKNOWLEDGMENTS

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V. REFERENCES

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