Hail Climatology for the Netherlands (and impact on solar panels)

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Background

- Severe Hailstorms are in the Netherlands one (of not the) most damaging natural hazard
- Most damaging event was due to hail
- 6 events in the top 20 associated with hail

...but there is actually little know about hail probabilities and geographic distribution
Objective

Develop a hail climatology for the Netherlands

- Derive return periods for hail events with certain hail stone sizes
- Derive spatial differences in hail occurrence within the Netherlands

Omroep Brabant
Schadeoplossing.nl
How

Combine multiple sources

- Radar data from KNMI
- European Severe Weather Database
- Weerspiegel Magazine (back to 1975)
Return Periods of Hailstone Sizes

- Total of ~650 observations of hail with hailstone sizes over period 1975-2019

Table 1. The total amount of observations included in the observed-hail dataset from Weerspiegel-magazine and the ESWD.

<table>
<thead>
<tr>
<th>Source</th>
<th>Total observations</th>
<th># of hail sizes</th>
<th># of hail sizes ≥ 2 cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weerspiegel</td>
<td>7,393</td>
<td>503</td>
<td>173</td>
</tr>
<tr>
<td>ESWD</td>
<td>166</td>
<td>150</td>
<td>148</td>
</tr>
</tbody>
</table>

Seiersberg, Steiermark, Austria (47°00'N, 15°30'E) 30-06-2016 (Thursday) 19:40 UTC (+/- 6 min.)

- Based on information from: an eye-witness report, a report on a website, photo or video of the event
- Maximum hail diameter: 2 cm
- Event duration at place of observation: 30 minutes
- Seiersberg, Steiermark, Austria

Hitzebod, Steiermark, Austria (47°30'N, 15°30'E) 30-06-2016 (Thursday) 13:33 UTC

- Based on information from: an eye-witness report
- Maximum hail diameter: 2.5 cm
- Event duration at place of observation: 30 minutes

Klobočky, South Moravian Region, Czech Republic (49°13'N, 17°02'E) 30-06-2016 (Thursday) 18:50 UTC (+/- 15 min.)

- Based on information from: a report received by e-mail, an eye-witness report, photo or video of the event
- Maximum hail diameter: 3 cm

Weerspiegel

ESWD
Return Periods of Hailstone Sizes

Probability of certain hail sizes for whole of the Netherlands

- 1/10 years return period is >7cm
Return Periods of Hailstone Sizes

South has highest probability, North the lowest

Return periods of max. hail sizes (GEV) for NUTS regions

- Nuts3 (West)
- Nuts4 (Zuid)
- Nuts2 (Oost)
- Nuts1 (Noord)
Spatial Distribution

- Doppler radar in two locations (reflection)
- HiRLAM NWP model (for temperature in atmosphere)
- Maximum Estimated Hailstone Size (MESH) derived using method of Witt et al. (1998)
- Period 2008-2019
- 1 km$^2$ grid
Spatial Distribution

- Overall, 328 hail days selected
Spatial Distribution

- South-eastern provinces have seen higher hailstone sizes as opposed to the North of the Netherlands
  - In line with the return periods found earlier

Days with size >2 cm

Days with size >1 cm

Maximum MESH (cm) over the period 2008-2019 averaged per province
Spatial Distribution

Annual Hail Risk
- Using 50km radius due to limited length of time series

- Coastal regions clearly lower probability
- Probability increases towards the south-east
  - Again in line with return periods
Impact on Solar Panels

Damage starting at 2-3 cm hailstone size
> Visible damage dominating from 4cm

- Larger angle indicates somewhat less damage
- Orientation is very important
  > Orientation away from direction of the storm (SW) significantly reduces damage

Angle of solar panel

<table>
<thead>
<tr>
<th></th>
<th>Average damage / total SP (%)</th>
<th>Average mean hail size (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flat</td>
<td>18.1</td>
<td>4.2</td>
</tr>
<tr>
<td>Pitched</td>
<td>12.6</td>
<td>4.0</td>
</tr>
</tbody>
</table>

Orientation of solar panel

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<th>Average mean hail size (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>17.0</td>
<td>4.1</td>
</tr>
<tr>
<td>SE</td>
<td>8.4</td>
<td>4.1</td>
</tr>
<tr>
<td>SW</td>
<td>13.6</td>
<td>3.7</td>
</tr>
<tr>
<td>W</td>
<td>15.7</td>
<td>4.4</td>
</tr>
</tbody>
</table>
Concluding Remarks

- First hail climatology for the Netherlands created
- Return periods determined for various hailstone sizes
- Clear spatial pattern of hail occurrence
- Damage to solar panels linked to hailstone size, orientation and (to lesser degree) angle of solar panels