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Freie Universität Berlin

Utilization of fire brigade data in the impact analysis of extreme precipitation events over Berlin

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Motivation:

- Large cities and urban regions are highly sensitive to impacts caused by extreme events, e.g. heavy rainfall.
- Adequate adaptation planning of urban infrastructure not only requires further research on potential impacts under changing precipitation patterns, but also practical feasibility for end users like fire brigades.

Goal:

- Make an improved assessment of the evolution of severe precipitation events over Berlin with use of spatially and temporally highly resolved data.
- Analyze potential relations between fire brigade operations and extreme precipitation events over Berlin.

Method:

- Identify 100 most severe precipitation events.
- Compare available observational data sets with each other.
- Quantify certain observed precipitation features (intensity and duration) with corresponding fire brigade operations for those events.

Data

Station based data

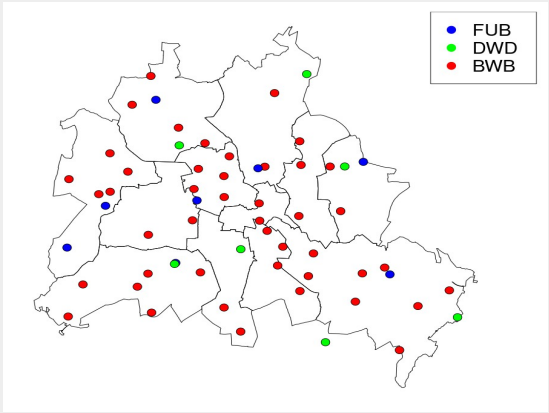


Fig. 1: Overview of available precipitation stations.

Freie Universität Berlin (FUB):

- 8 stations
- 1-min temporal resolution

German Weather Service (DWD):

- 7 stations
- 1-min temporal resolution

Berliner Wasserbetriebe (BWB):

- 45 stations
- 5-min temporal resolution

Radar-Climatology

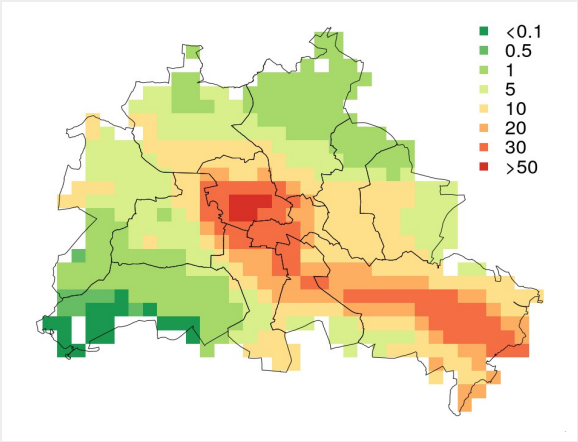


Fig. 2: DWD Radar-Climatology precipitation sum (mm) for 02.08.2015 15:00-18:00 CET

German Weather Service (DWD):

- since 2002
- 5-min temporal resolution
- ~1-km spatial resolution

Reference:
Winterrath, Tanja; Brendel, Christoph, Hafer, Mario; Junghänel, Thomas; Klameth, Anna; Lengfeld, Katharina; Walawender, Ewelina; Weigl, Elmar; Becker, Andreas (2018): RADKLIM Version 2017.002: Reprocessed quasi gauge-adjusted radar data, 5-minute precipitation sums (YW)

Fire brigade data

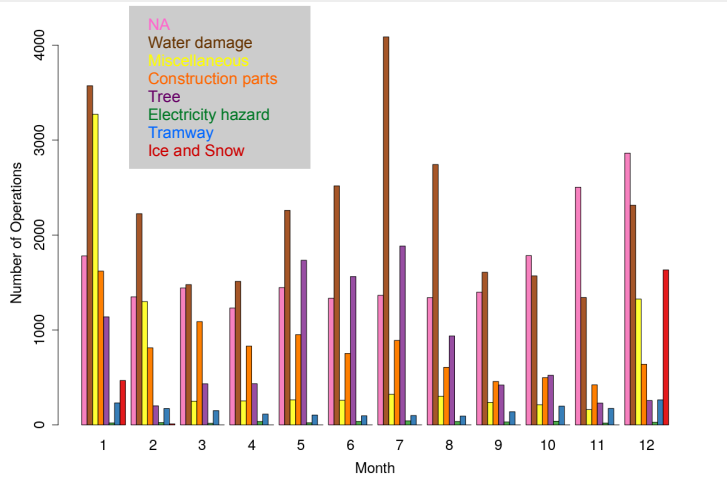


Fig. 3: Monthly operation number of Berlin fire brigade for different operation types.

- 2002-2012
- address-specific resolution
- Information about operation type
  (e.g. ice and snow, water damage, etc.)

Method

- Aim: Relate observed extreme precipitation (top 100 events) with fire brigade operations.

Step 1: Identify 100 most severe summer (MJJAS) events.

- Calculate area mean (station based) over Berlin.
- Identify event (definition: >0.1 mm of the area mean for more than 2 consecutive time steps).
- Rank according to the precipitation sum per event.

Step 2: Assign station based data to Radar-Climatology for every event.

- Identify nearest grid point (with Euclidean distance) of radar data to the corresponding station.

Step 3: Assign fire brigade operation location to Radar-Climatology.

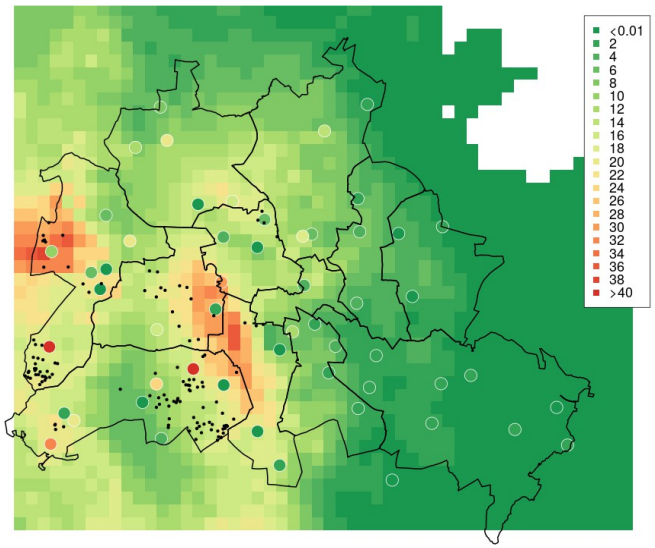
- Identify nearest grid point (with Euclidean distance) of radar data to corresponding fire brigade operation with the key word „water damage“.

Number	Date and Time (CET)	Prec. sum (mm)	Total number of operations
1	29.07.2007 02:00 – 01.08.2007 02:00	74	162
2	25.09.2010 11:00 – 28.09.10 07:00	48	35
3	05.07.2005 04:00 – 06.07.2005 21:00	40	23
...	...	...	...
6	07.07.2006 15:00 – 08.07.2006 20:00	37	1338
7	15.06.2007 22:00 – 16.06.2007 15:00	36	562
...	...	...	...
100	01.7.2005 04:00 – 01.07.2005 13:00	8	5

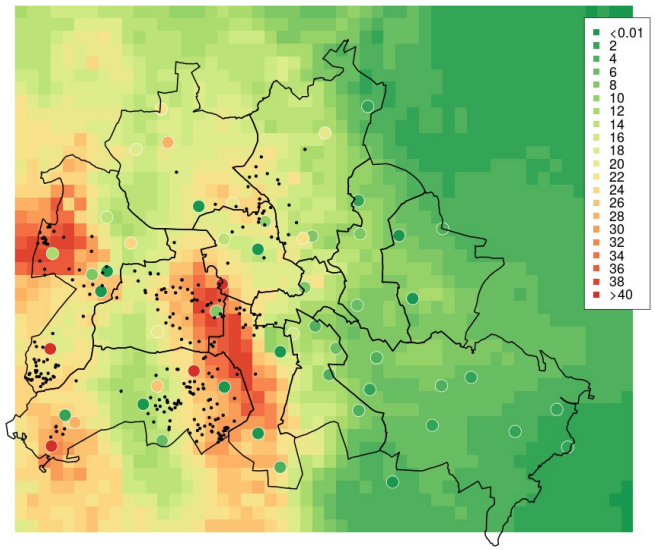
Example Event

- 15.06.2007
- 335 operations in 4h.
- >40 mm precipitation in 4h.

a) 23:00-01:00 CET prec. sum [mm]



b) 23:00-02:00 CET prec. sum [mm]



c) 23:00-03:00 CET prec. sum [mm]

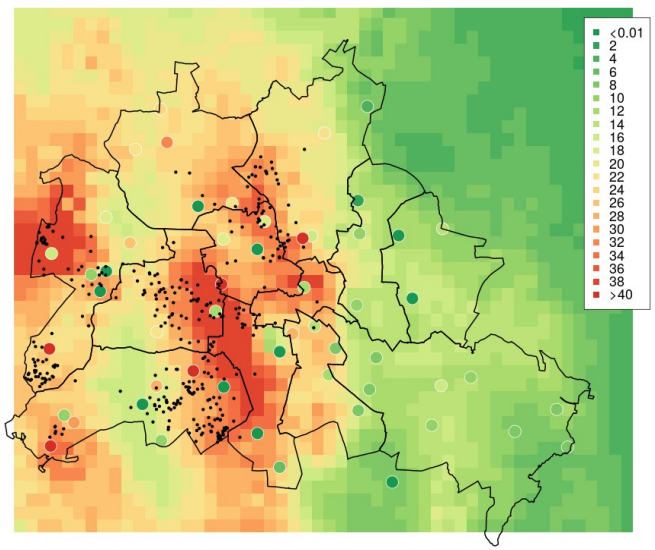


Fig. 4: Precipitation sum (mm) of DWD Radar-Climatology (colored grid boxes) and stations (colored dots) as well as locations of fire brigade operations over Berlin (black dots) during the 15.06.2007, accumulated from 23:00 CET to a) 16.06.2007 1:00 CET b) 16.06.2007 2:00 CET and c) 16.06.2007 3:00 CET.

Preliminary results

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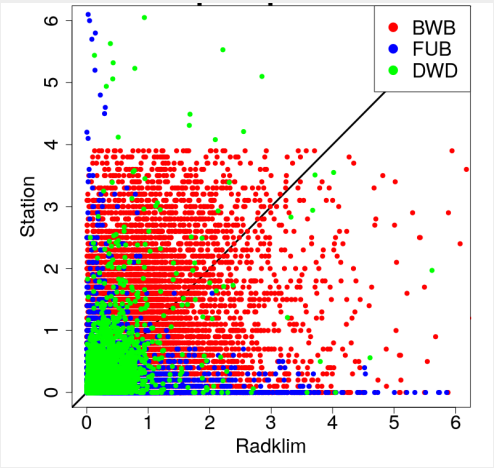
Comparison: Station vs. Radar

a) 5-min prec. sum (mm)



b) QQ-plot of 5-min prec. sum

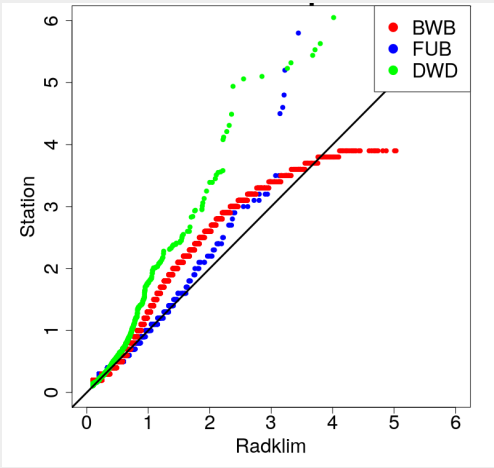
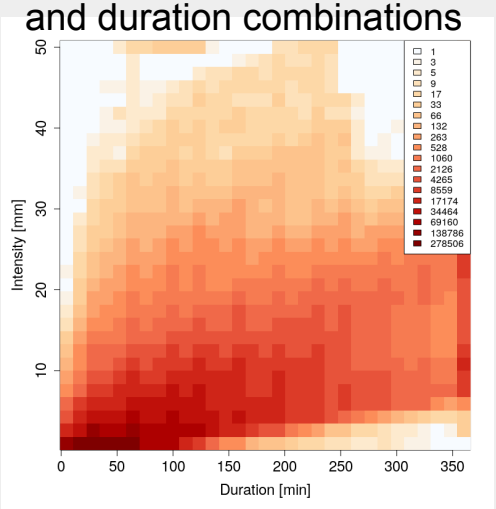


Fig. 5a): Scatterplot of station based precipitation w.r.t. nearest grid point of Radar-Climatology (RadKlim). Here every 5-min sum within the identified top 100 events is taken into account. Fig. 6b) shows the corresponding QQ-Plot where values <0.1 mm are omitted. The dot color indicates the station provider.

- Many stations do not register precipitation.
- The measurements of the stations are higher than the Radar-Climatology.
- However, until approx. 12 mm/h stations and Radar-Climatology values agree.
- **Outlook:** Design and apply approaches to harmonize these different data sets.

Number of operations and precipitation

a) Total number of intensity and duration combinations



b) Operation number w.r.t. intensity and duration

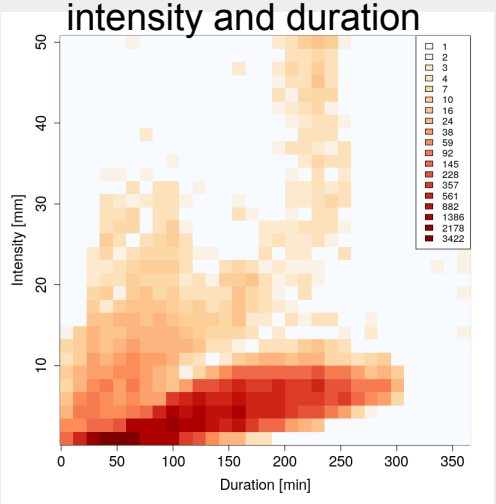


Fig. 6a): Total number of Radar-Climatology precipitation intensity and duration combinations. The duration is derived from the number of consecutive minutes with precipitation >0.1 mm at a grid point. The intensity is the accumulated precipitation sum for the corresponding duration. Here every 5-min sum within the identified top 100 events is taken into account. Fig. 6b) shows the number of operations that occurred with the corresponding intensity and duration.

- Fire brigade operations seem to occur more frequently at certain intensity-duration combinations.
- **Outlook:** Use operation number as proxy for precipitation observation.
- **Outlook:** Develop an impact model.

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