Local Area Weather Radar (LAWR) System to Approve Drainage Systems Capacity
Case Study from Egedal - Denmark

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The aim of the paper

1. Reviewing the first LAWR implementation in Egedal
2. Identifying flooding service level of a drainage system through LAWR rain data implementation
3. Evaluating LAWR data for further optimization
~35 km west of Copenhagen
Population: 40,000
Area: 125 km²
722 km rainwater pipes
100 detention tanks/basins
173 pump stations
2 rain gauges in 2008
Now 7 rain gauges

www.egedalforsyning.dk
The objectives of the LAWR project

1. Rising the level of response in flood management
2. Obtaining online spatial rain data for every catchment
3. Dividing the service catchment to the desired number of sub-catchments
4. Detailed rain data for hydraulic simulations
5. Identifying the service level of the sewer catchments
6. SMS warning system
7. LAWR website
8. Forecasting
The LAWR Project in Egedal
LAWR website – Rain Information System
11-13 June 2009

Rain event 11-13 June 2009

111 mm in approx. 1½ day
11-13 June 2009

Layers

- Danmark
- Veje
- Bygninger
- Oplande
- OplandsNavne
- Kommunegrense
**11-13 June 2009**

Over 100-year return period

**Return period (T) estimation of Radar calibrated data**

Rain event 11-13 June 2009 in Egedal

- **Intensity (mm/s)**
- **Duration (min.)**

Graph showing the relation between intensity and duration for different return periods (T).

- **Radar Calib.**
- **T=100**
- **T=50**
- **T=20**
- **T=10**
- **T=5**
- **T=2**
- **T=1**
11-13 June 2009 - Calibration

\[ I = C \times R \]

*\( I \) is calibrated radar count of intensity (mym/s)*

*\( C \) is calibration factor \( \rightarrow 0.655 \)

*\( R \) is radar count of intensity (mym/s)*

**Selected rain data in Egedal on 11-13 June 2009**

<table>
<thead>
<tr>
<th>Depth (mm)</th>
<th>Stenløse</th>
<th>ST1_Radar Calib. (mm)</th>
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Return period (T) estimation of rain event in Egedal
11-13 June 2009

Duration (min.)
Intensity (mym/s)

Ganløse
GA4_Radar Calib.

T=1
T=2
T=5
T=10
T=20
T=50
T=100
11-13 June 2009 - Calibration

Return period (T) estimation of rain event in Egedal 11-13 June 2009

Duration (min.)
Intensity (mm/h)

- Stenløse
- ST1_Radar Calib.
- T=1
- T=2
- T=5
- T=10
- T=20
- T=50
- T=100

07-09-2010 Mike by DHI 2010 - Copenhagen
11-13 June 2009

79 mm
97 mm
115 mm
132 mm
150 mm
What happened on 11-13 June 2009?

SVK 27 allows water level to raise up to the terrain level under T=5 as a maximum level.

Design of rainwater system is full-flow pipe under T=1

According to SVK 27 the allowed maximum water level is to the terrain level under T=10

Design of combined system is full-flow pipe under T = 2

Maximum capacity before flooding in liter/m² according to SVK27 compared to the rainfall event on 11-13 June 2009

- Most affected catchments on 11-13 June 2009: 150
- Average depth of rainfall 11-13 June: 111
- Least affected catchments on 11-13 June: 79
- Combined sewer SVK27: 53
- Rainwater sewer SVK27: 46

Category of capacity:

- Most affected
- Average
- Least affected
- Combined
- Rainwater
Catchment validation

• No flooding in $T \geq 5 \rightarrow$ RS catchment approved
• No flooding in $T \geq 10 \rightarrow$ CS catchment approved
• Future $T=5$ and $T=10$ can be used on the same catchments.
• The above screening tool can be validated by calibrated and verified hydraulic models of the same catchments.
Uncertainties of the case study

- The LAWR was located more than 20 km northeast of Egedal \( \rightarrow \) 250X250m spatial pixel
- Locally installed LAWR \( \rightarrow \) 100X100m pixel
- Just two available rain gauges have been used in the calibration
- Calibration approx. 20 ha catchment against one spatial point (Rain gauge)
- One spatial pixel (250 X 250 m) against a rain gauge would have been more reliable
- Linear and static calibration
- Using the same factor of calibration on all catchments without considering the differences in catchment areas, location from radar antenna, etc.
Radar signal errors

- Permanent echoes
- Spurious echoes
- High radar beam
- Drop size – wrong reflection
- Snow effect - bright band
- Bent radar beam due to temperature change
Advantages of the case study

- Effective visual informative online tool during the rain event
- Supported faster decision making
- Detailed, instantaneous and integrated rainfall intensities
- 5-minute real time data → 1-minute real time
- Data for each and every sub-catchment
- Spatial rainfall estimates over a wide area instead of depending on just a few rain gauges in Egedal
- First time privilege of online monitoring of the rain event
- Online high resolution detection of locations of frontal showers
Future perspectives

1. **Numerical forecast models** are an essential function that has to be developed for future implementation for scenarios drawing of event from flooding down to the outlet of the catchment
2. Developing **warning systems** and reducing at the same time false warnings
3. **Online dynamic calibration** is a necessary integration with **online data validation**
4. Well calibrated radar counts to be used in **hydraulic modelling** for each catchment
5. Integrating data from a **net of LAWR** can be more reliable than data from single radar. Thus, organising radar data administration is a future task to optimize local and regional radar data system
Conclusions

• Calibrated radar data can help to *identify the capacity problems*, as local flood events could be related directly to local intensity and depth of rain.

• Preliminary *tool of risk assessment* for evaluating drainage system capacity in accordance with the service standards.

• Online data from radar *supported effectively decision making* during the storm event.

• An overall image of the event *assisted explaining why flooding has happened*.

• Calibrated data supported the basis of *decision making in future events* in terms of priorities.

• Radar is an instantaneous spatial integrated *data source need to be optimized* to be reliable for more accurate estimations compared to data from point located non-spatial rain gauges.

• Radar is a larger scale of *quantitative data source* for hydraulic simulations and *need to be optimised* to be also qualitative data source
Thank you for your attention
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