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Vipuvoimaa EU:lta 2014–2020

Optimal rain products for water industry - today and tomorrow

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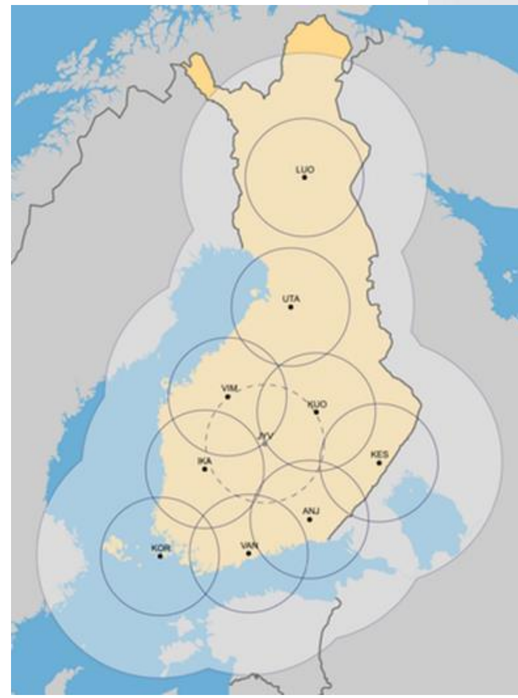
Älykäs Vesi -työpaja
June 16, 2015

Outline

- **Radar- based measurements and prediction**
- **Utilization of rain products today**
- **Development in OSAPOL-project**
- **Future vision of rain products for the adaptive water supply and sewerage systems**

Radar measurements

- **9 C-band Doppler Radars (8 with dual polarization)**
- **Data utilization rate 98.5 % incl. maintenance and telecommunications**
- **9 x 500 x 360 = 1620000 measurements with one sweeps**
- **whole Finland with resolution 5min/1 km².**



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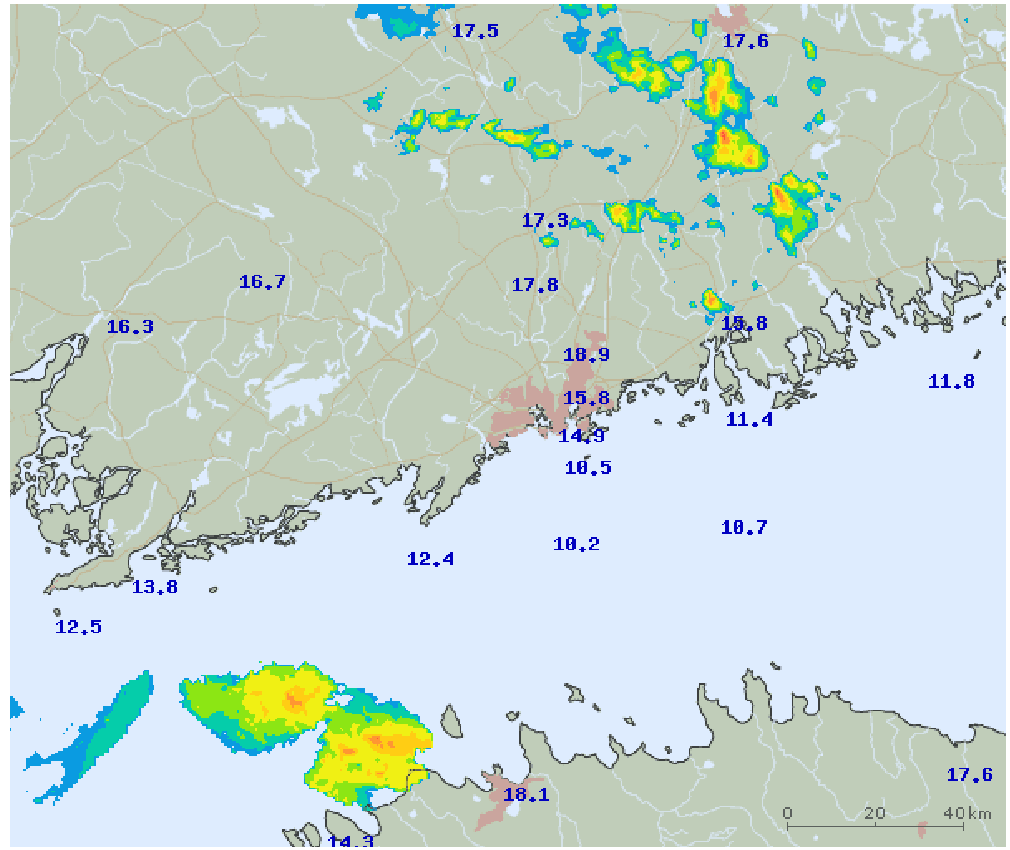
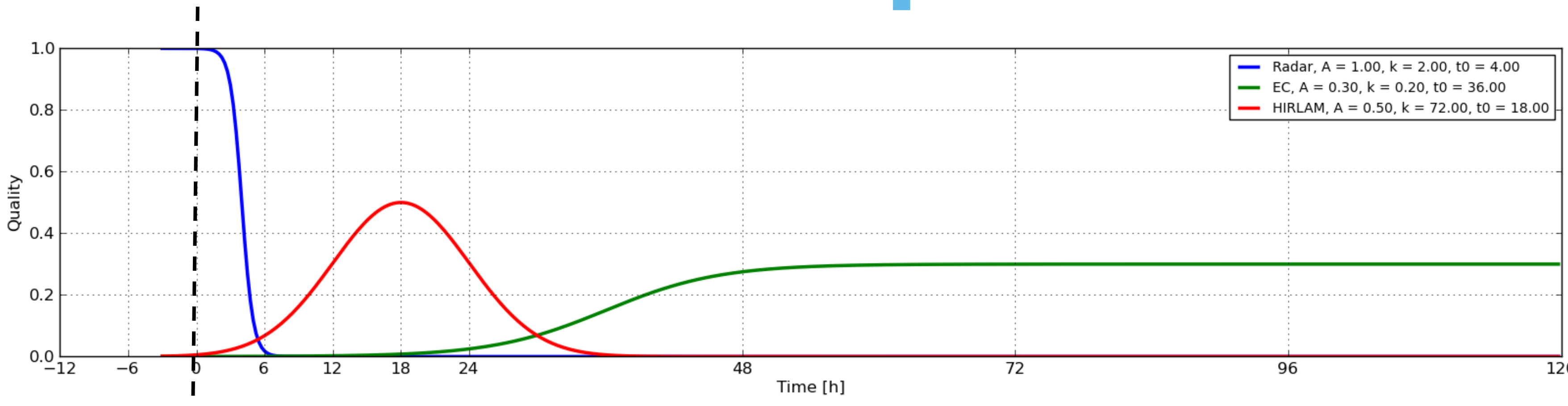
Benefit of radar measurements

- Convective systems often small and short living (5 km, 1 h)
- Only weather radars have the needed resolution for measuring the time-space patterns of rain generating storm water flooding
- Weather radar is not as accurate as a rain gauge.
- With radar measurements reasonable predictions are possible



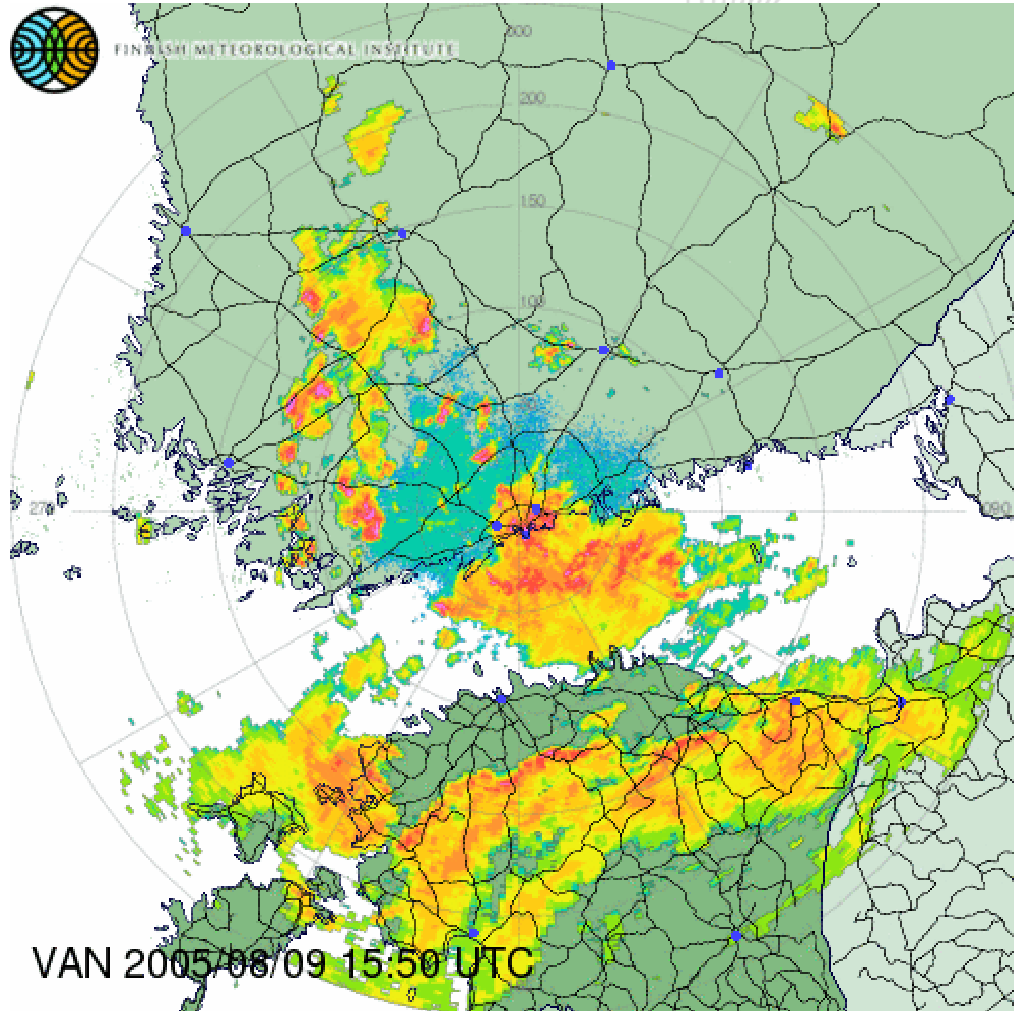
Seamless rainfall prediction



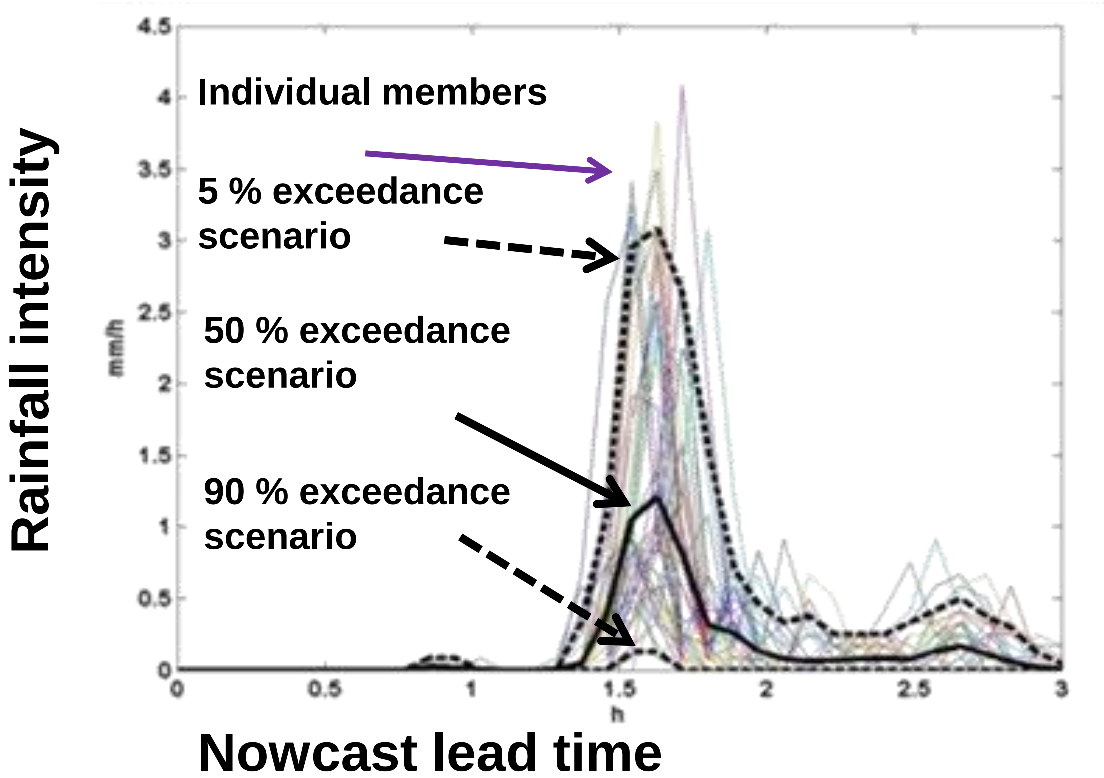
- 0-2 h (0-6 h) prediction is based on movement vectors of rainfall obtained from radars
- 2 h – 15 d forecasting is based on numerical weather prediction models (HIRLAM/ECMWF)
- Seamless blending of the different sources is a recent development
- Pilot projects: Tekes/RAVAKE, 2009-12 and EU HAREN & EDHIT 2012-2015

Spatially accurate prediction

- **Numerical weather prediction models are reasonable good regionally**
- **In urban scale radar predictions are more precise**
- **For optimization and risk management of rain water impacts probabilistic predictions are more beneficial than single predictions (deterministic)**
- **Ensemble Prediction Systems (EPS) will provide such estimates**
- **FMI: 51 members of ensemble forecasts (Koistinen et al. 2012)**



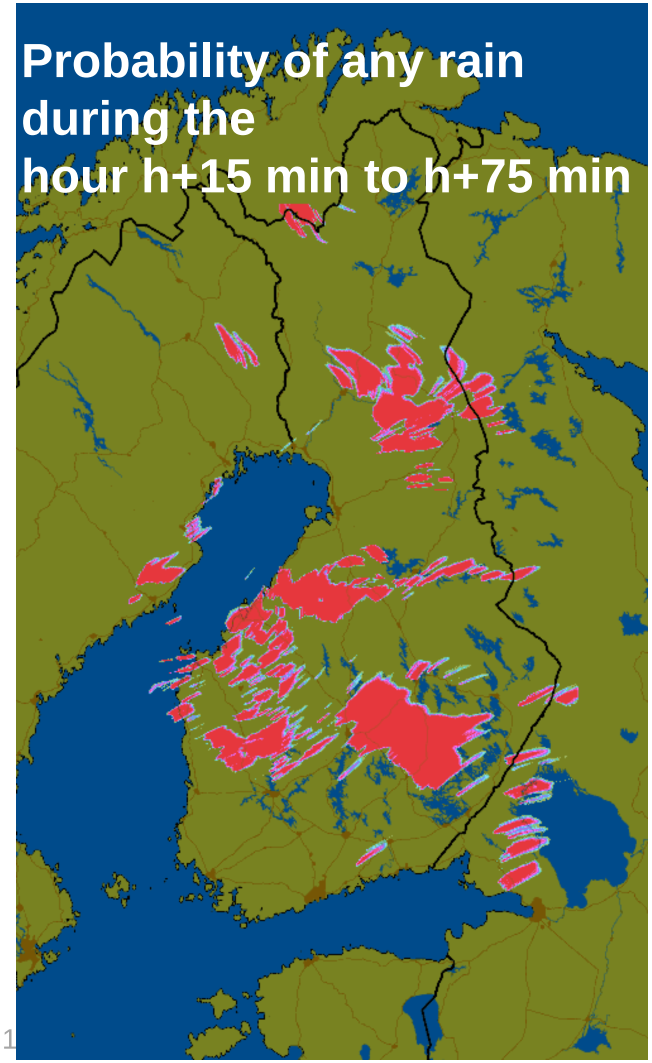
Exceedance probabilities of intensity and accumulation for each location from ensembles

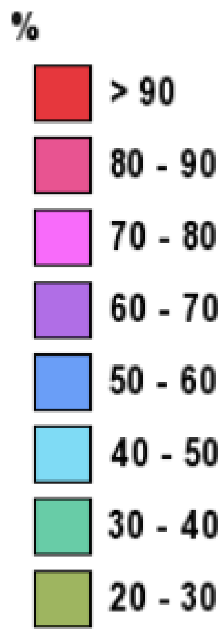


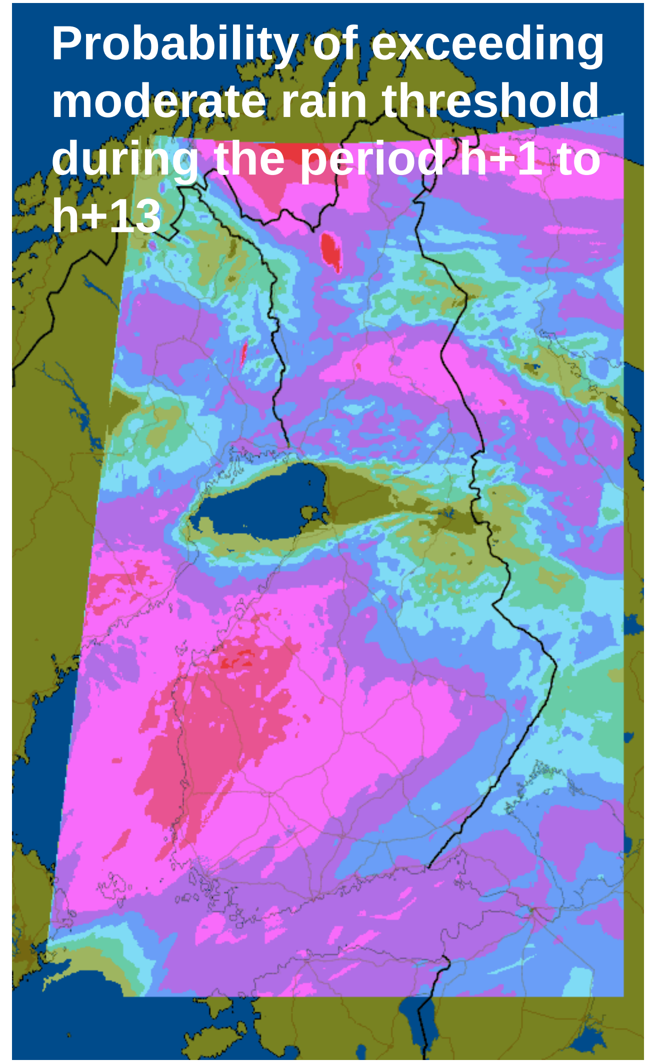
Practical output: exceedance probabilities of hourly accumulation (product update interval 5-15 min)

Courtesy of Ville Pietiläinen, VTT Research Centre

Examples of exceedance probability data







Heavy rainfall alert service for any user

Interactive SMS user interface

- Ordering (1400 customers in 2012)
- Receiving alert messages (á 30 or 60 c)

Selections

Large areas should not be used

- Location (~~city~~, village, suburb)
- On-off switch any time
- Two class thresholds (any rain, heavy rain)

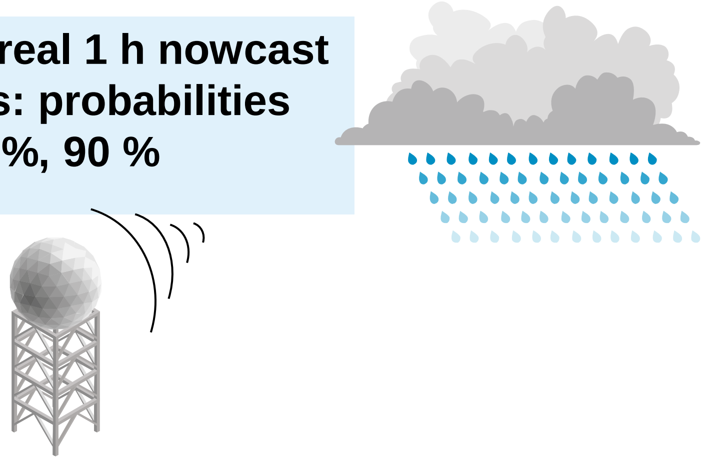
Not selectable

- Accumulation period (now 1 h, 3 h and 12 h combined)
- Threshold amount (e.g. 1 mm or 62 mm)
- Number of alerts (max 5/day)
- Dissemination threshold for exceedance probability (e.g. small, moderate, large or 75 %) – now fixed at **50 %**

**Example message:
Weak rain at suburb Leppävaara will start at 18:15. The probability of rain is 60 %.
(radar map available from an other application)**

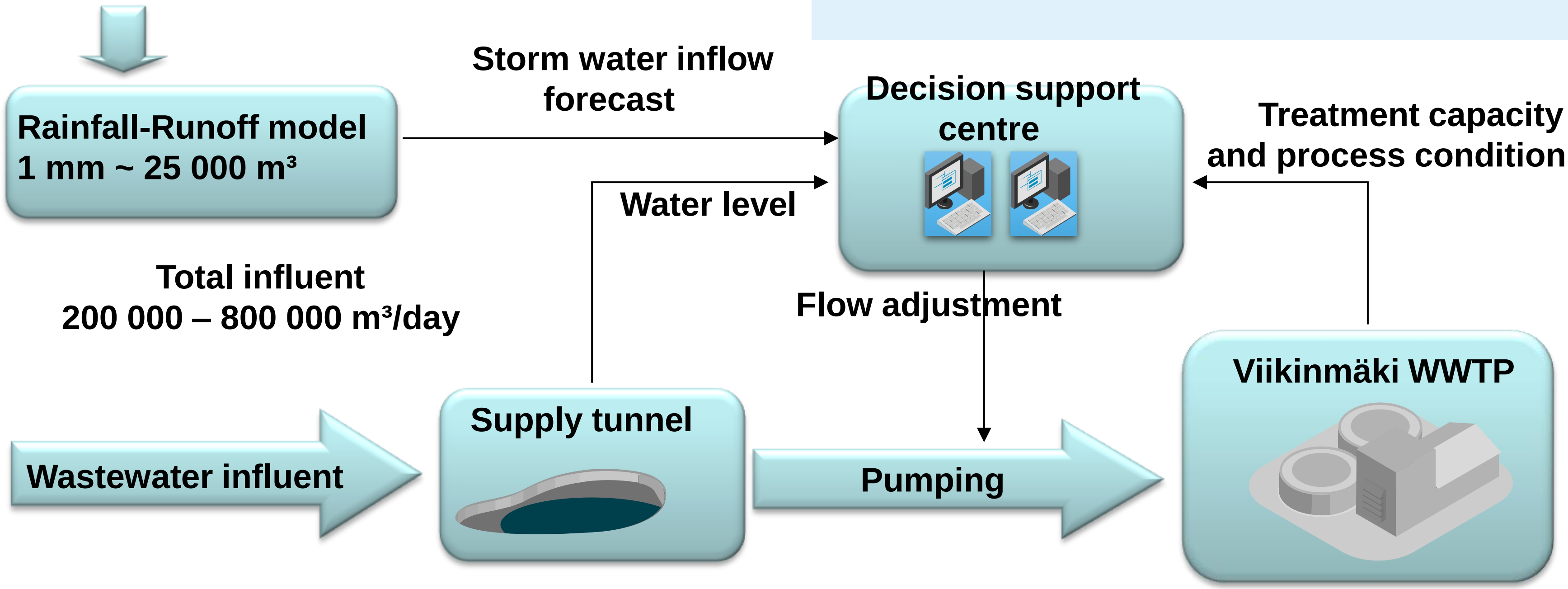
Professional application: Influent management at Helsinki WWTP

Three areal 1 h nowcast scenarios: probabilities 5 %, 50 %, 90 %



Objectives

- Alarming of predicted influent increase (capacity problems possible in extreme cases)
- Bypass flow minimization (environment risk)
- Operative actions to optimize influent tunnel volume (pumping)



Heinonen et al., 2013: Water Sci. Technol., 68, 499-505.

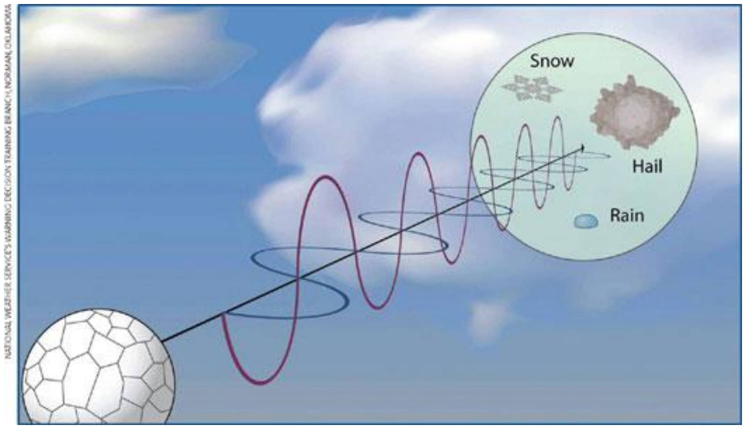
Development in progress

- Improve the quality of radar measurements
- Increase the spatial resolution to 50-500 m scale and time resolution to 1 min scale in urban areas
- Nowcasting is computationally demanding, denser observations in time scale are needed (motion interpolation) for more realistic predications
- Practical user interfaces developed with the stakeholders
- Clearer understanding of the concept of probability and tools for utilizing it to decision making
- As long time challenge the growth and decay of rainfall systems

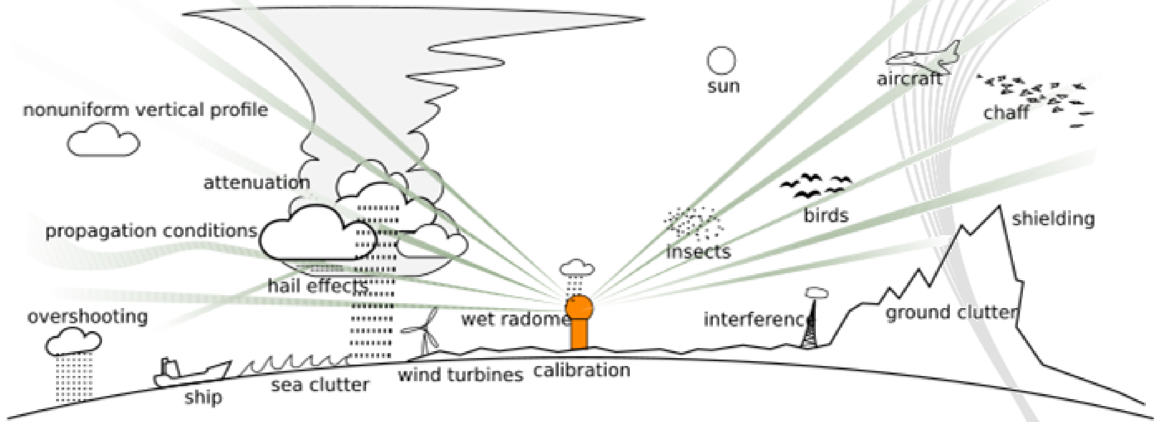
OSAPOL – Optimal Rain Products with Dual-Pol Doppler Weather Radar

- Duration 1.1. 2015 - 31.10.2016
- Funded by the European Regional Development Fund and the Finnish Funding Agency for Technology and Innovation (Tekes)
- Goal is to develop high quality rain products based on the optimal use of dual-pol radar measurements
- Objective is to demonstrate the potential of the radar-based rain products and to promote that these would contribute and integrate into water industry
- Linked with Tekes program INKA – Smart city and renewal of industries and closely co-operating with HSY project INKA – Smart water.

Targeted results in OSAPOL

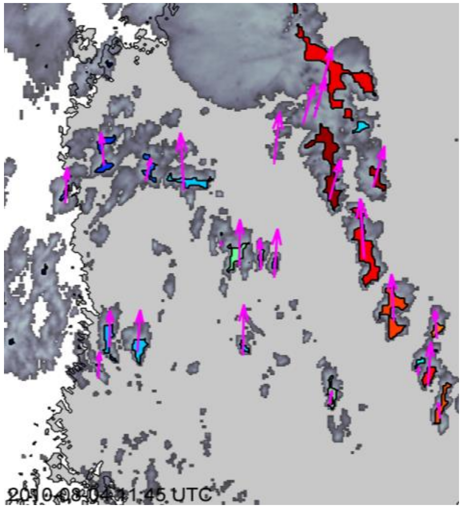


More precise identification of different hydrometeors



Removal of false echoes

Improvement of reflectivity-radar conversion with gauge comparison and optimal radar measurements



Time and space resolution are increased with virtual measurements utilizing motion interpolation

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Future vision of active and adaptive water supply and sewerage system

- Probability prediction based on radar measurements
- Application and location – tailored forecasts, warnings and actions are needed
- Networks would automatically be adaptive to prevailing weather prediction and measurements
- As result the cost effective and resource neutral optimization and risk management

Active storm water impact mitigation

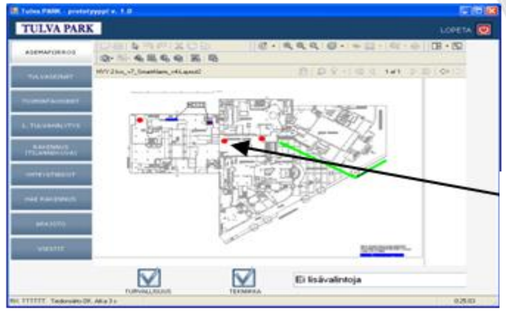
1. Adaptive measurements and rainfall ensemble predictions

Pilot project:
J. Korkealaakso (VTT), Tekes/SmartAlarm
ISTO/IRTORISKI: 1/100 y rain => 110 M€

2. Water flow and level ensembles on and under the ground

Worst case simulation at downtown Helsinki with the severe rain in Pori (hydrology and hydraulics)

3. Impact modeling monitoring, adaptation and mitigation processes



Real estate level risks (upper)
City level risks (lower)

”Traffic light” flood risk monitoring and forecasts at critical points

Summary

- **Radar-based rain products can be beneficial for the optimization and risk management of water industry**
- **Probabilistic forecasts have a great potential in adaptive water systems prone to rainfall impacts**
- **Coupling of rainfall ensembles with hydraulic & hydrologic models and, finally, with impact models will give even better tools for society**

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