SoilWeather:

In-situ wireless sensor network

for agriculture and environment

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Markku Järvenpää, Agrifood Research Finland (MTT)

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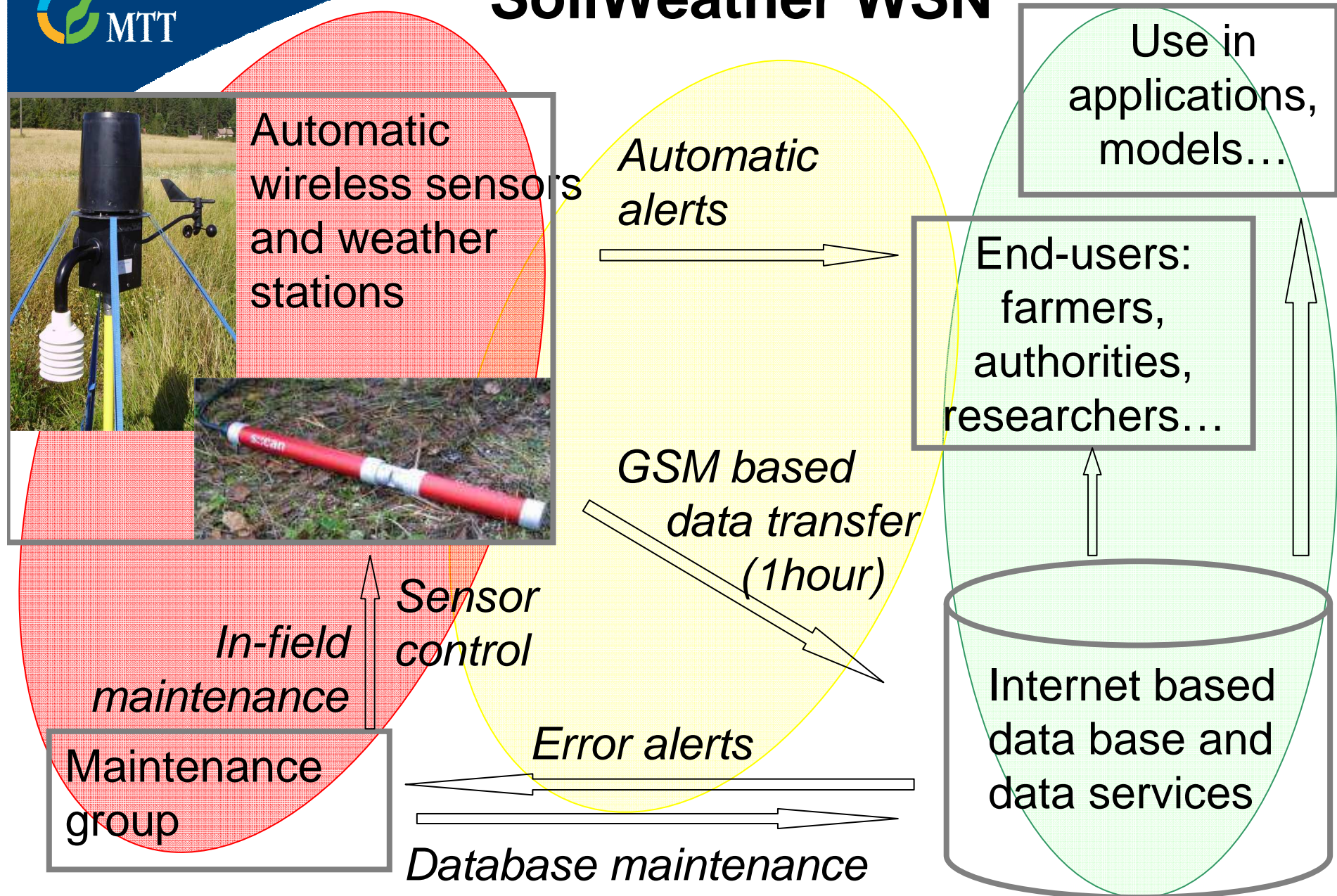Photo: Jani Poutiainen / Finnish Meteorological Institute

SoilWeather: Wireless Sensor Network and a research project

- Build up a sensor network for agriculture and water monitoring

- Provide data on local weather, soil moisture and water quality at high temporal resolution

- Develop automatic sensors and data services

- Develop agricultural applications and environmental monitoring

- Support new business opportunities

SoilWeather WSN

Automatic wireless sensors and weather stations

Maintenance group

In-field maintenance

Sensor control

Automatic alerts

GSM based data transfer (1hour)

Error alerts

Database maintenance

Use in applications, models…

End-users: farmers, authorities, researchers…

Internet based data base and data services

Photos: Jani Poutiainen /FMI, Sirpa Thessler /MTT

Kuva: Lippo Sundberg, MTT

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Sensors, measurements and data

55 A-Weather station:
Air temperature, humidity,
precipitation,
wind direction and velocity

**10 FDR- and 20 ECH$_2$O -
sensors**: soil moisture

18 Obs3+ -sensors: turbidity

4 S::can spectrometer:
turbidity, nitrate content

4 Keller 0.25 bar: water level

Kuva: Lippo Sundberg / MTT

→

- Near-real time (time lag 15 min – 4 hours)

- High temporal resolution (15 min - 1 hour)

- Spatially accurate

- Different scales: catchment – sub catchment – field parcel

- Year-round monitoring

Sensor locations

- Covers Karjaanjoki river basin (2000 km^2)

- Field parcel level measuring in Hovi

- Intensive monitoring of lake Hiidenvesi

- Leaching model for River Vihtijoki

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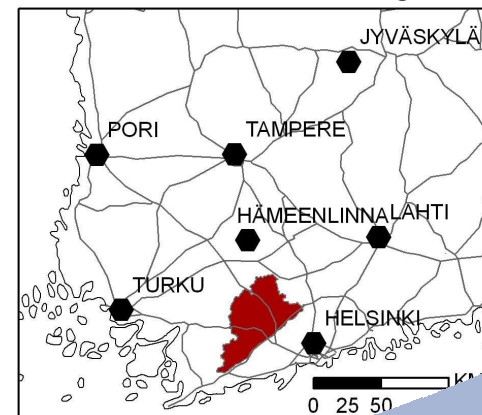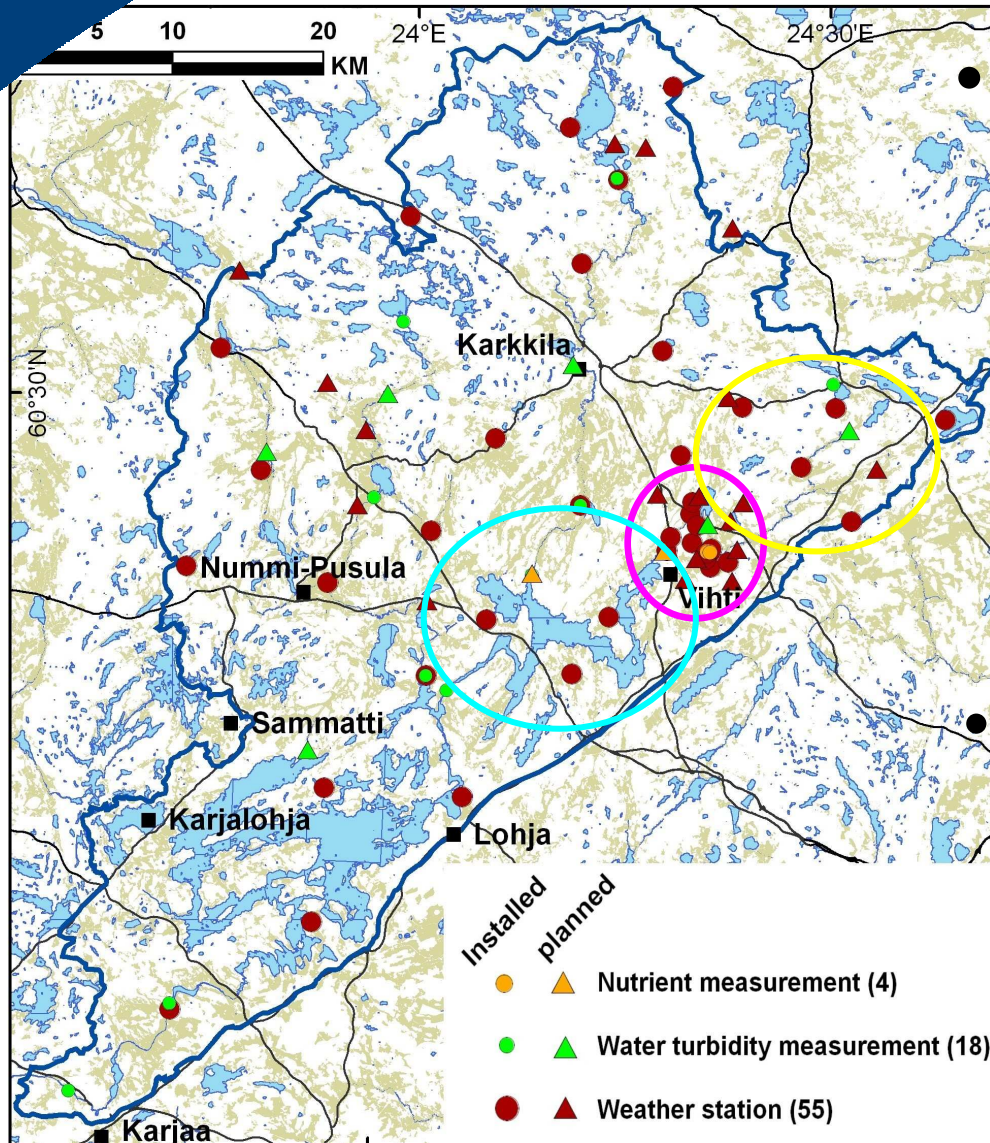
Data quality

- Representativiness of sensor location

- Water and soil samples to calibrate the sensors and to monitor data quality

- Automatic algorithms developed to alert on missing and erroneous measurements

- Automatic cleaning for sensors in water by compressed air or wipers

- Regular / when needed cleaning and maintenance in the field

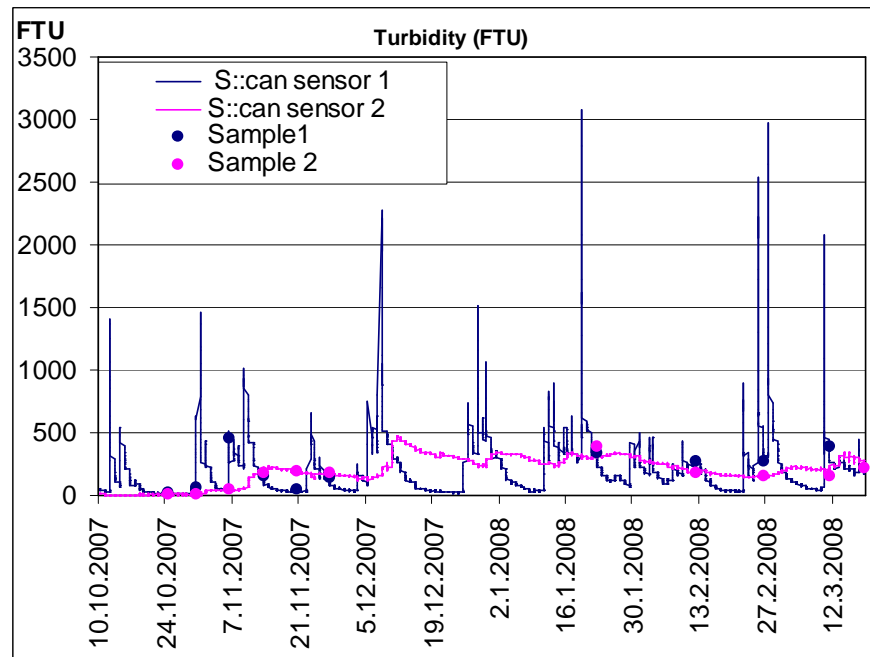- Log collected on maintenance activities

Automatic data quality control
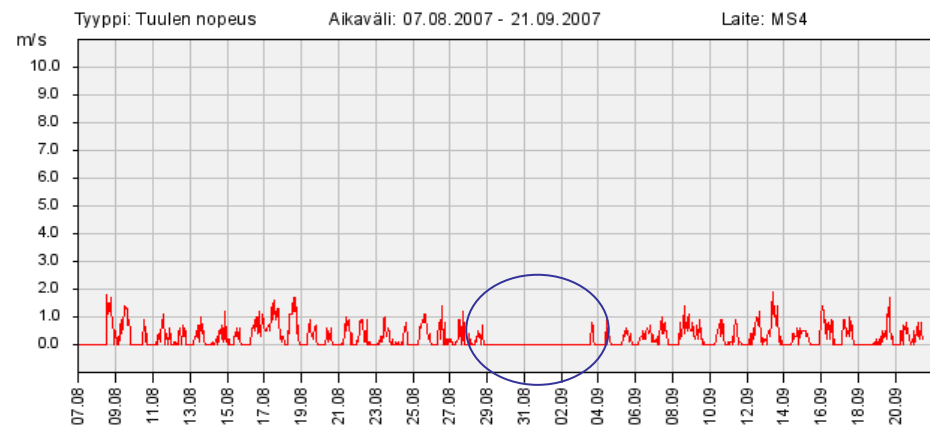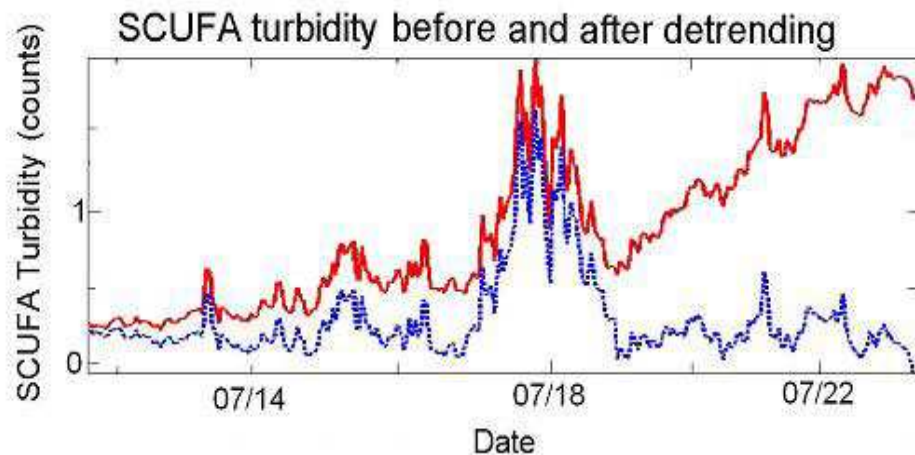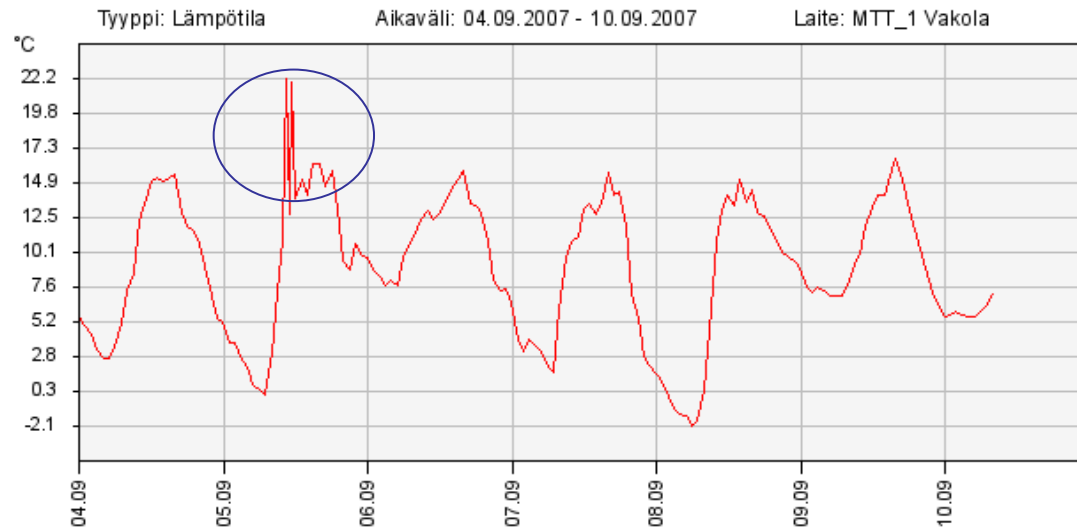
Advantages of SoilWeather WSN (1/2)

- More detail information on the temporal variation and peak values of nutrient loading through seasons

Detail input data for models → More accurate estimates of nutrients leaching and water quality

Advantages of
SoilWeather WSN (2/2)

• Detailed information on influences of cultivation practices and water protection activities on water quality

• Decision support for cultivation management practises (e.g. irrigation, pesticide spraying etc) through detail monitoring and models (crop diseases risk predictions)

•Multipurpose WSN: possible applications in many other sectors e.g. in tourism or in food chain (traceability, estimating environmental impacts of food products)

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Pre-conditions for automatic monitoring

- Maintenance regularly and when needed (e.g. change battery or broken parts)

- Regular cleaning for sensors in waters

- Calibration samples

↓

Regular maintenance in the field

- Huge data amount

- Erroneous measurements

- Missing measurements

↓

Well-developed data services

Applications

Soil moisture modelling

Plant protection forecasts
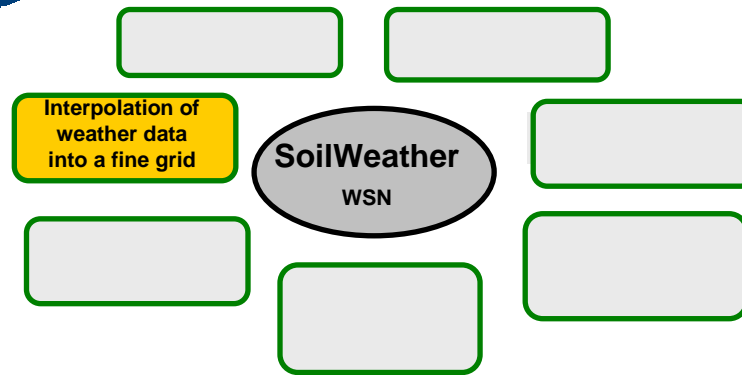
Interpolation of weather data into a fine grid

SoilWeather

Wireless Sensor Network

Precision agriculture

Hydrological and leaching models

Monitoring the efficiency of constructed wetlands

Development of sensor technology and data services

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Interpolation of
weather data
into a fine grid

SoilWeather
WSN

Ari Venäläinen, Finnish Metereological Institute:

Interpolation of weather data into a fine grid
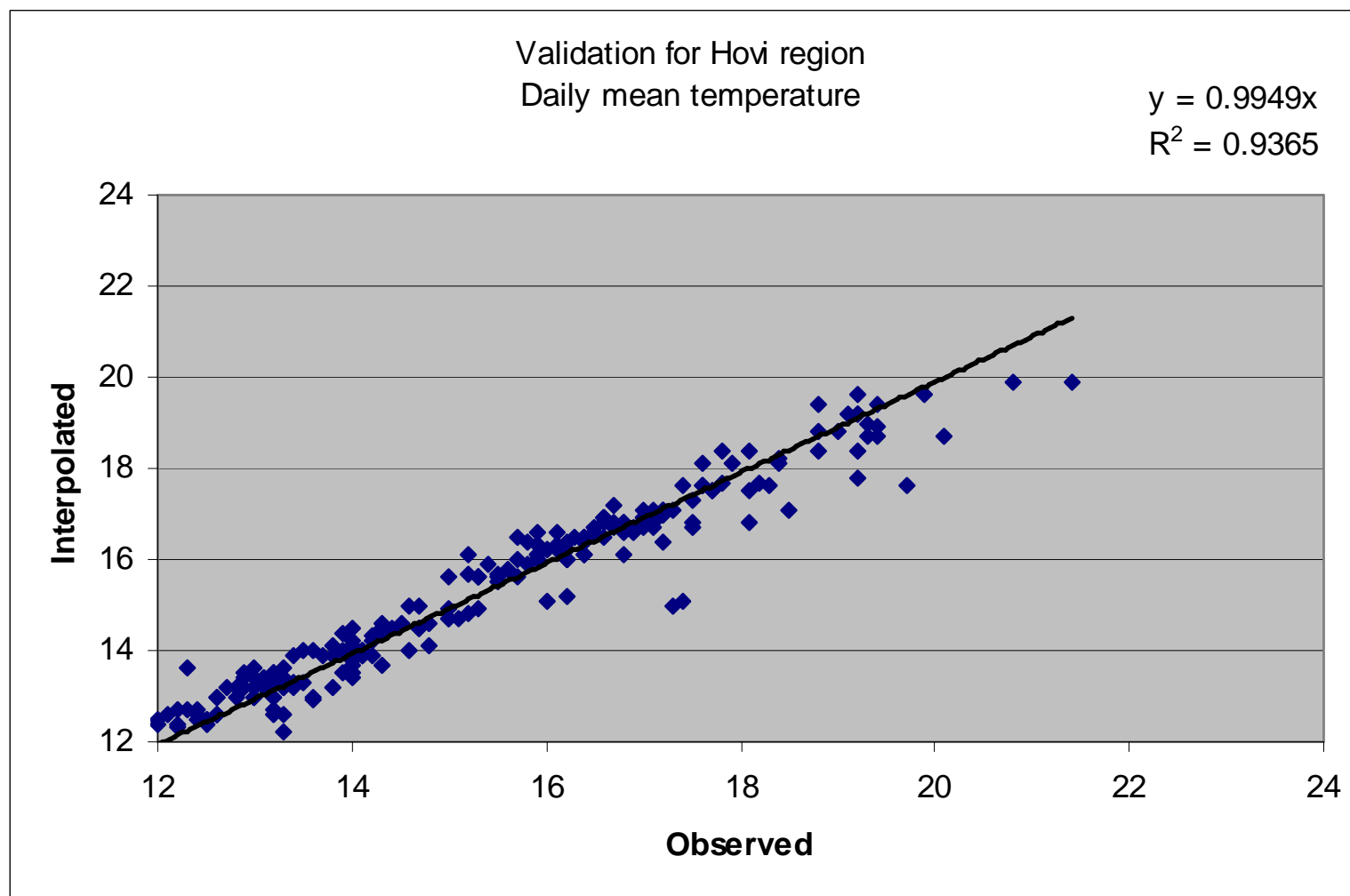
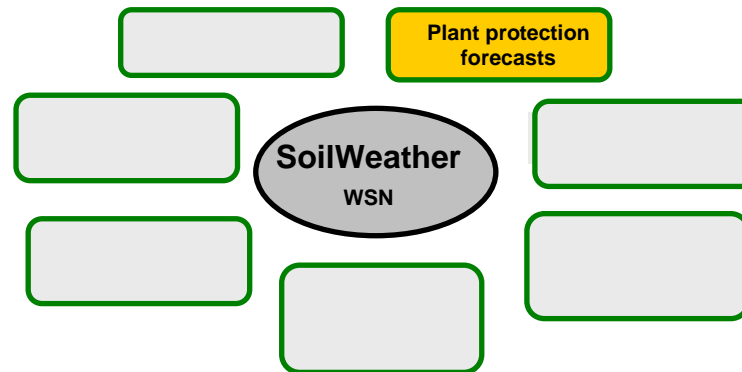Hovi, Vihti, size of test area 7*7 km^2

Land use

Elevation
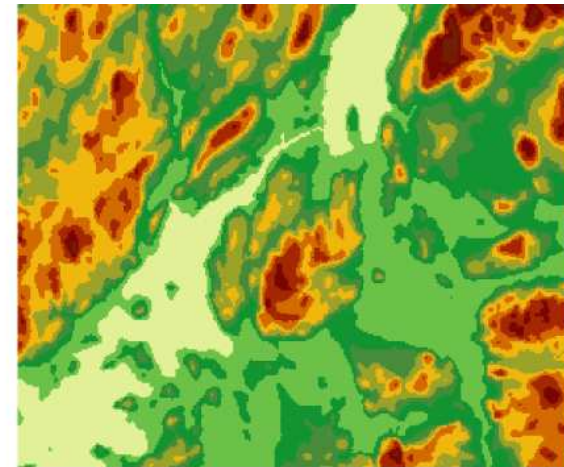
Meteorological parameters in 25 m * 25 m grid

Validation for Hovi region
Daily mean temperature

$y = 0.9949x$
$R^2 = 0.9365$
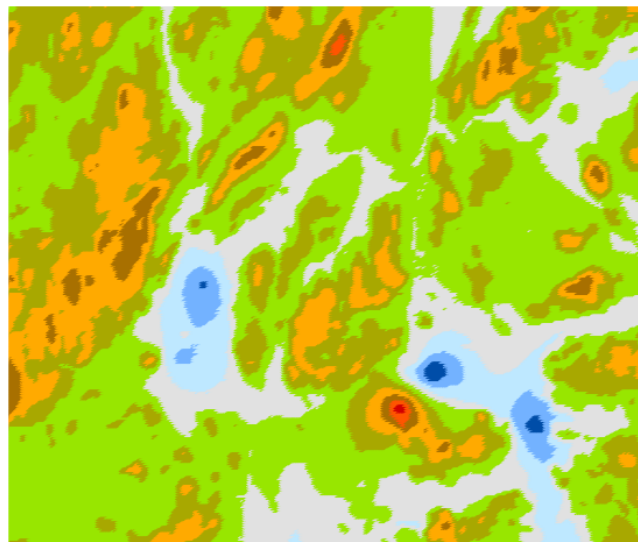
Asko Hannukkala,

MTT Agrifood Research Finland:

Forecasting potato late blight
Phytophtora infestans

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Forecasting potato late blight *Phytophthora infestans*

- Chemical control is necessary in conventional farming
- 4 – 9 consecutive sprayings are needed/season
- Correct timing according to blight risk is essential

Chemical control

Untreated

Forecasting potato late blight *Phytophthora infestans*

- Current blight forecast provided by A-lab : Based on NegFry model developed for old clonal blight population, risk values in internet, warnings by mobile phone

• System is functional

• Model needs updating

## Forecasting potato late blight *Phytophthora infestans*

- Blight risk forecast is based on LB2004 simulation model
  - Developed at the Cornel University
  - Parameterized for the epidemiology of Nordic blight population in NorPhyt project in 2003-2006
- Sub-model estimating spore formation is simple and relatively reliable to estimate the timing of fungicide application
  - Spores are formed (=HSPO) if RH is over 90 % and temperature is over 8 degrees C continuously for more than 10 hours
  - Fungicide application is needed, if HSPO > 10 h and there is more than 7 days since last fungicide application

Forecasting potato late blight *Phytophthora infestans*

- Verifying spore formation

- Good correlation with HSPO and blight infections, as has been shown earlier in Jokioinen

- HSPO can be applied in blight forecast
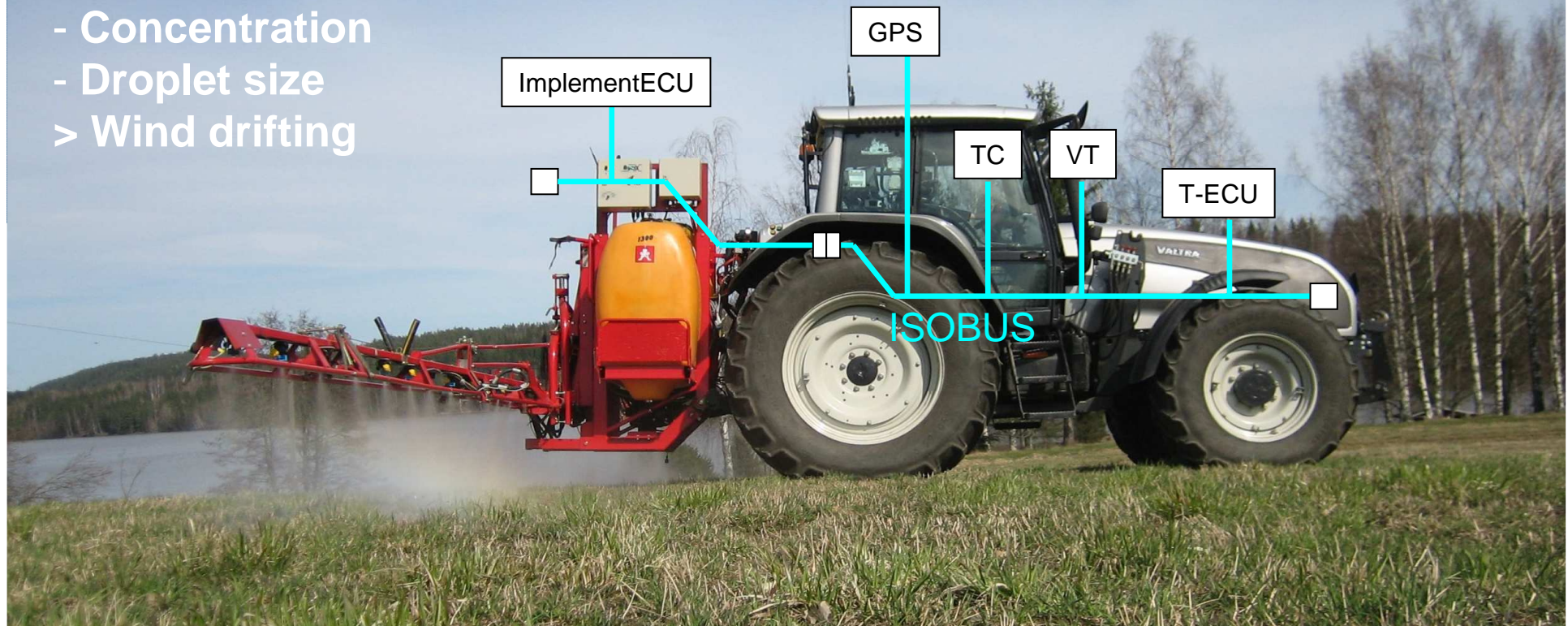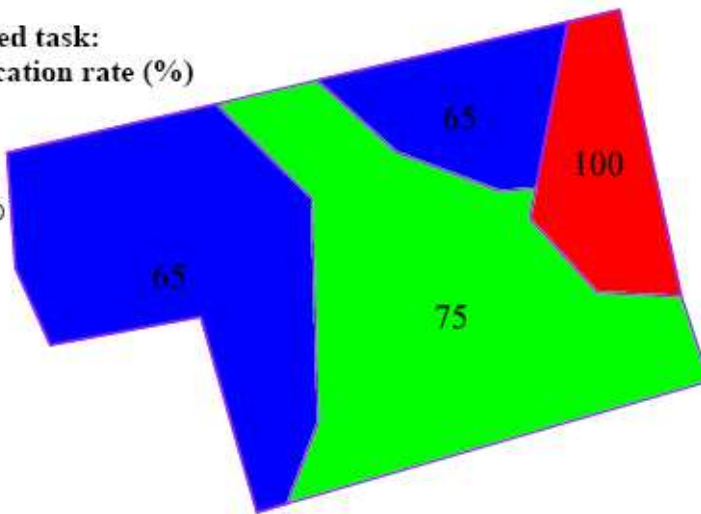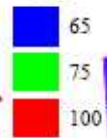- NegFry model in current A-lab forecast should be replaced by HSPO

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SoilWeather
WSN

Precision
agriculture
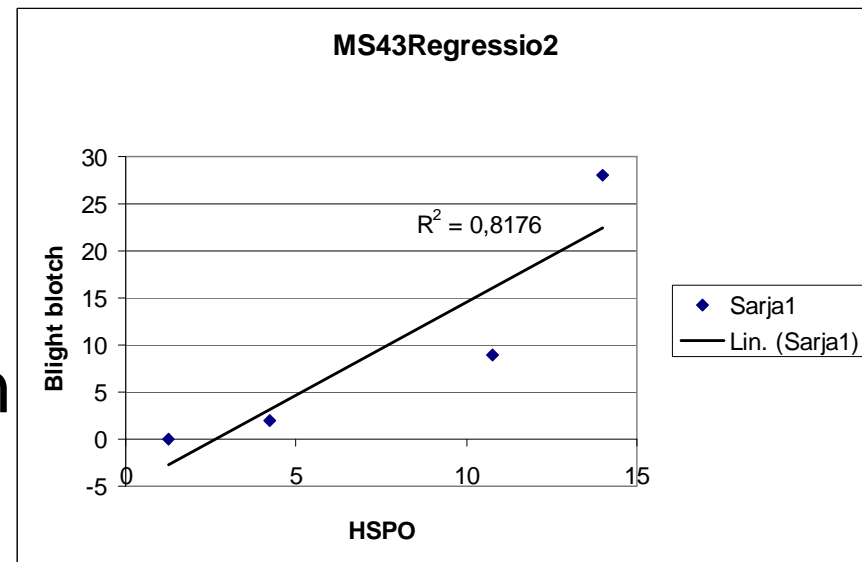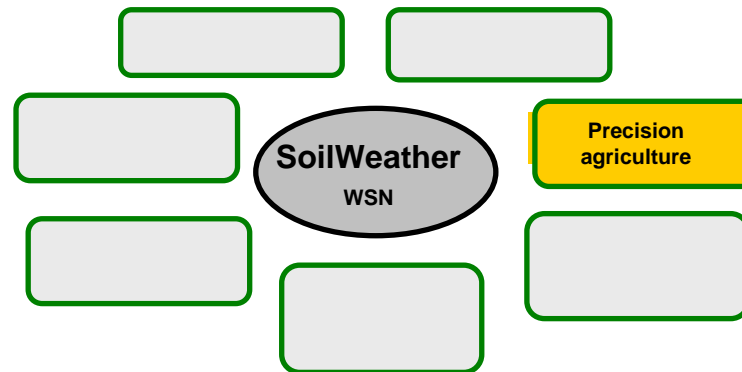
Liisa Pesonen,

MTT Agrifood Research Finland:

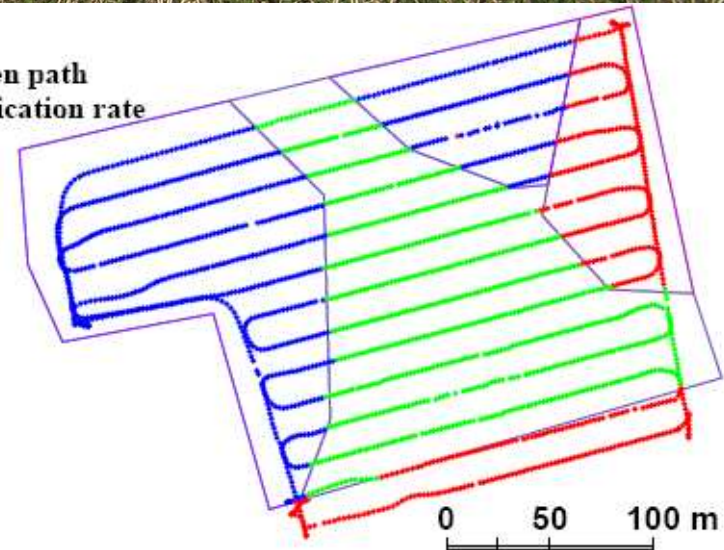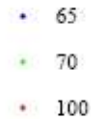# Precision farming

Real-time adjusted precision application
- Concentration
- Droplet size
> Wind drifting

GPS · ImplementECU · TC · VT · T-ECU · ISOBUS

Planned task:
Application rate (%)
65
75
100

Driven path
Application rate
65
70
100

0   50   100 m
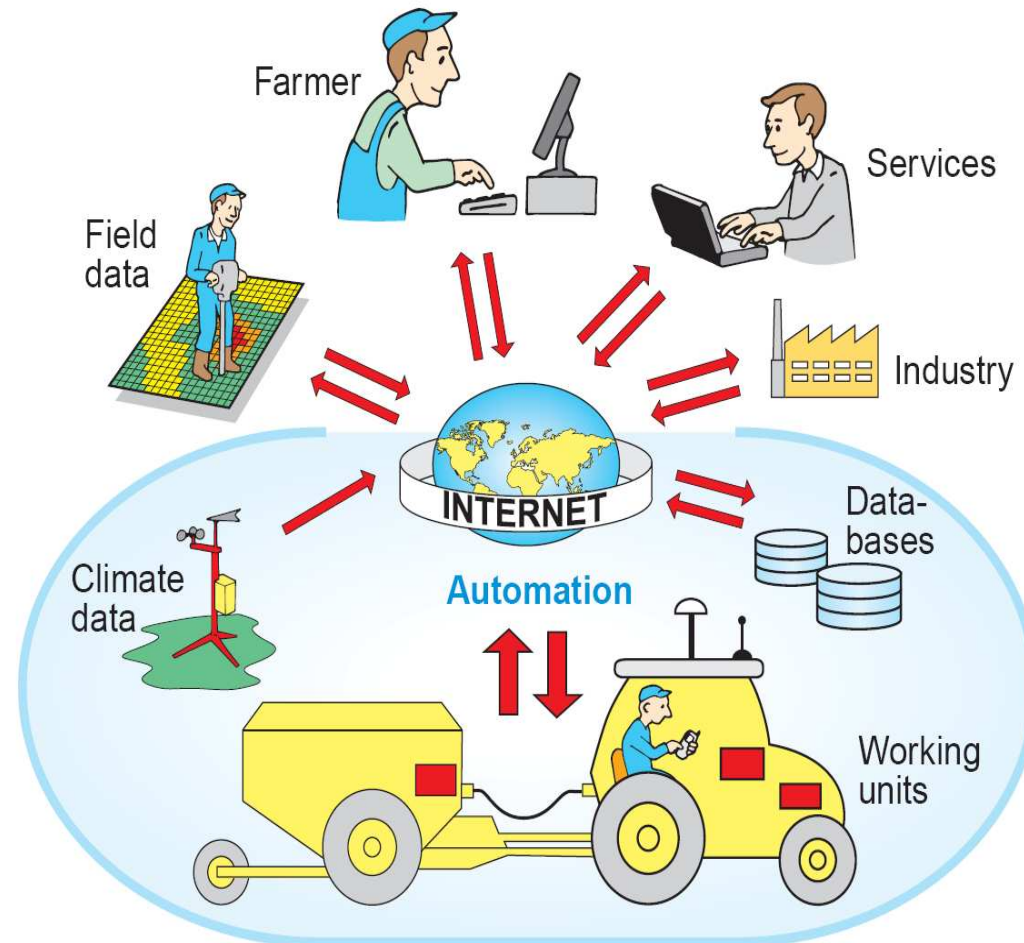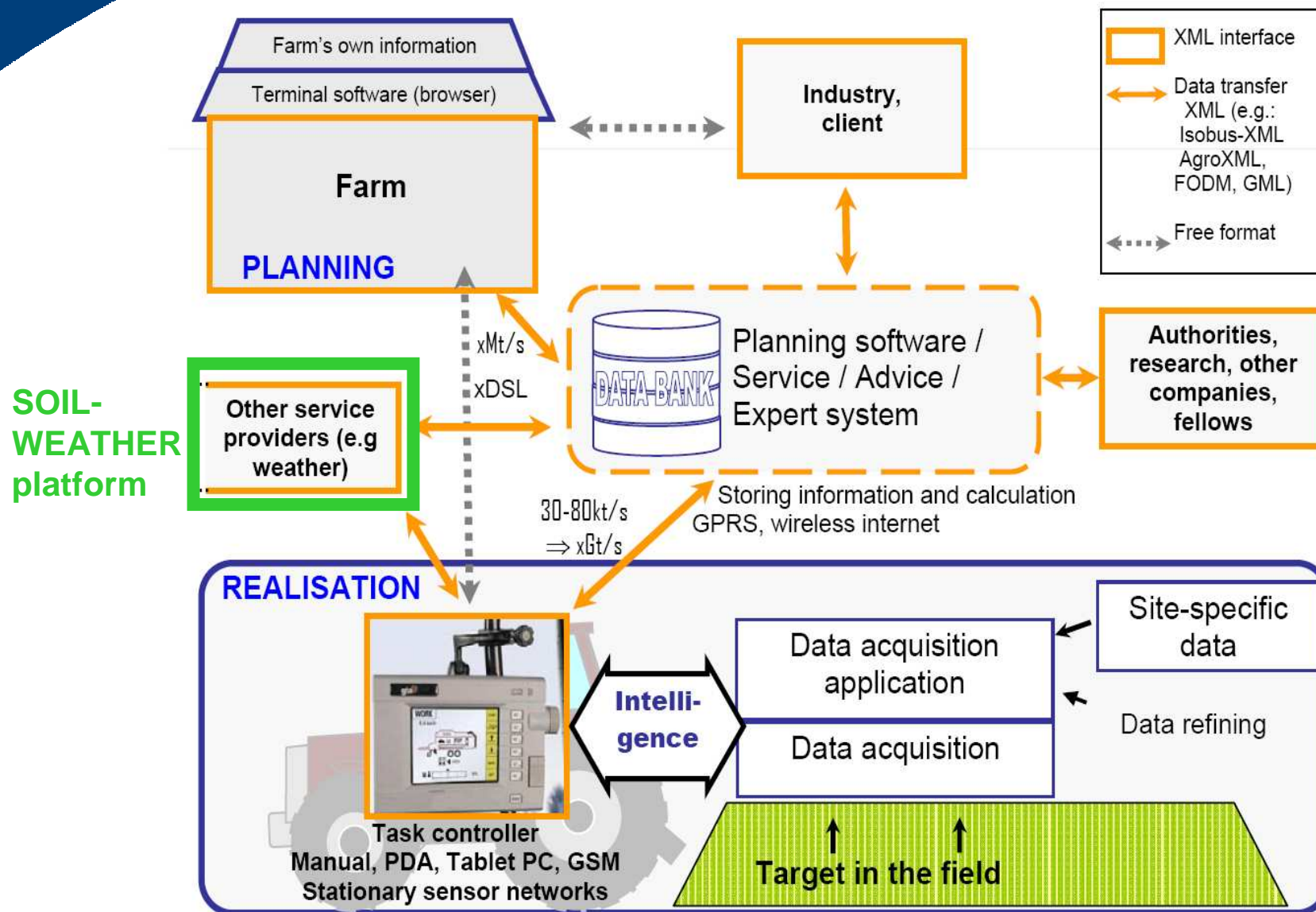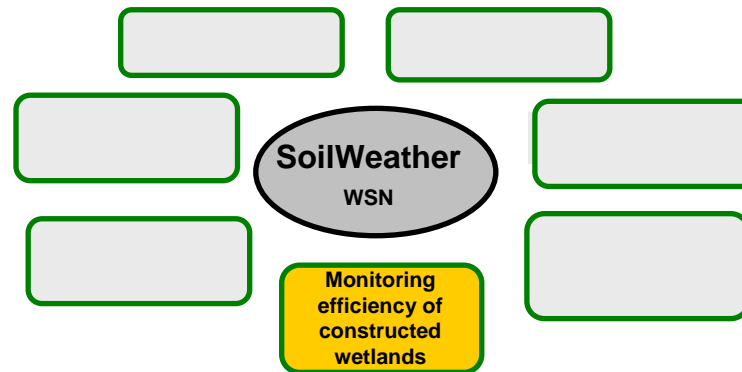
User-centric mobile information management in automated plant production utilises real-time weather and environmental data (InfoXT)

# Functional architecture of InfoXT

Jari Koskiaho,

Finnish Environment Institute (SYKE):

# Monitoring efficiency of constructed wetlands

Measurements at Hovi wetland

- Continuous (hourly data) monitoring of inflow and outflow with water height-, turbidity-, NO3- and temperature probes

- Frequent data recording coupled with water samples for probe calibration -> estimates of wetland performance

- Suspended solids and total P retentions can be calculated by high correlations with turbidity (R^2 = 0.96 and 0.93, respectively)

- By now, almost 1-year non-stop data
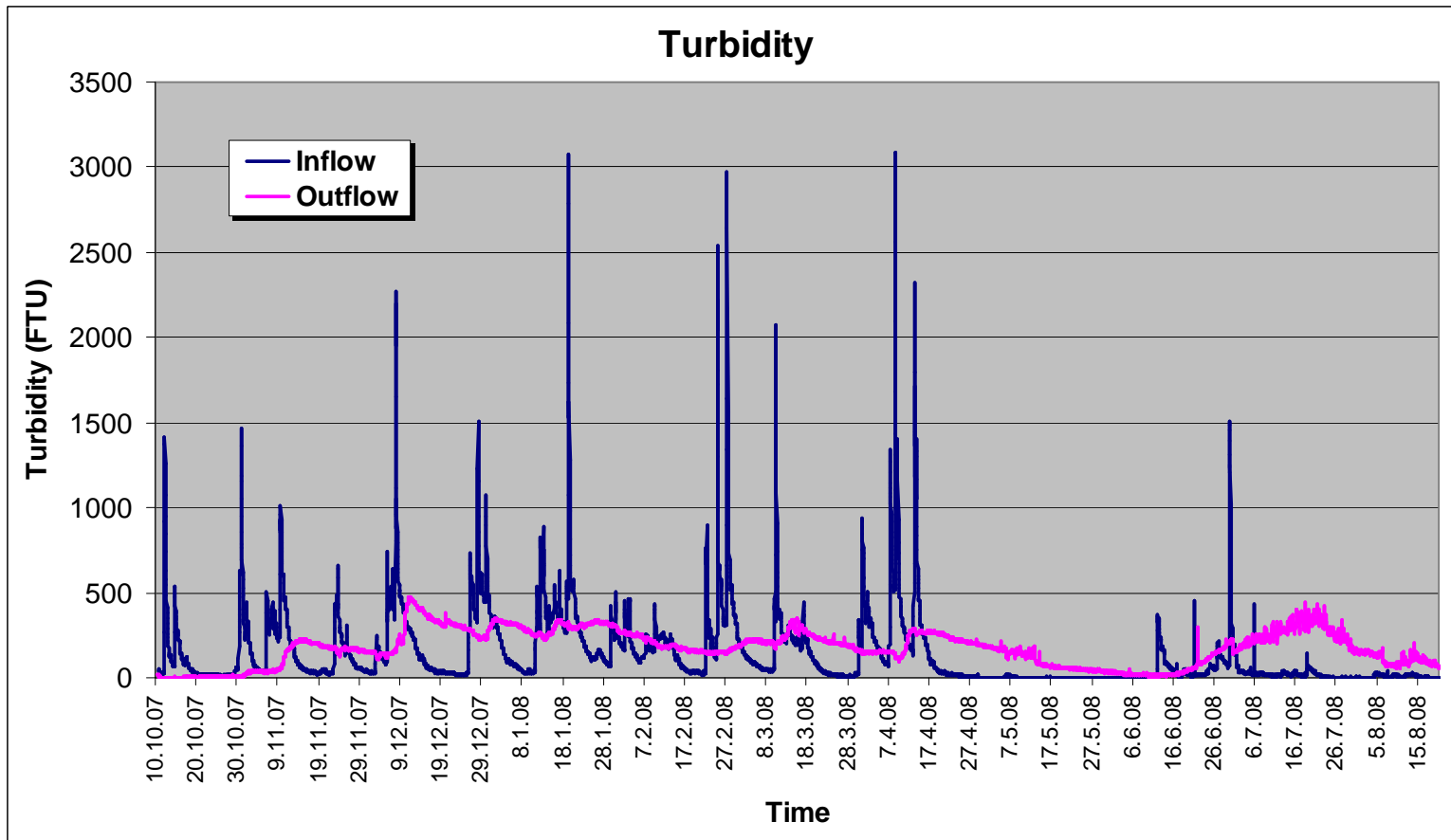
Suspended solids and total P retentions during this period both 68%
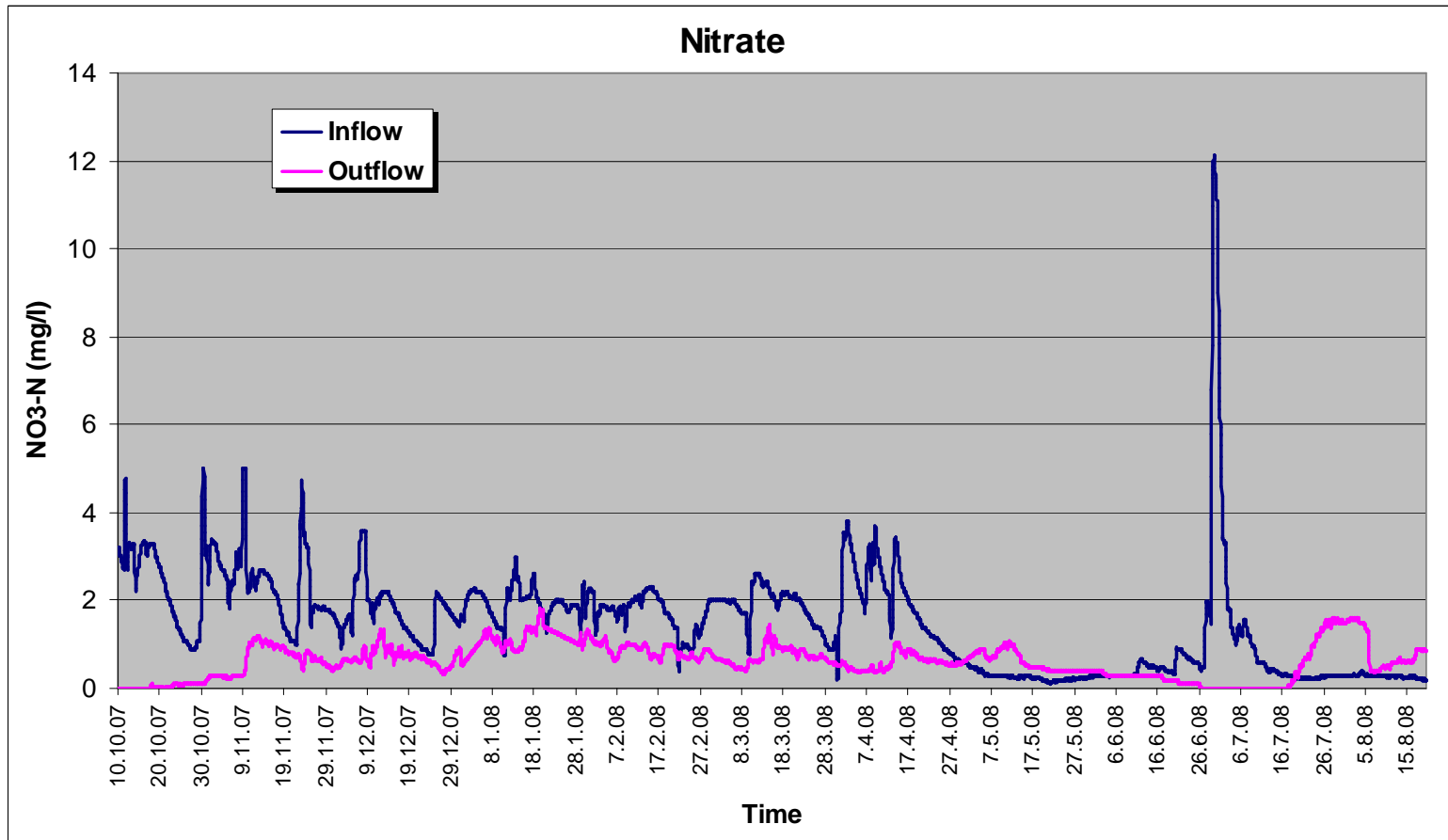
Nitrate-N retention during this period 65%
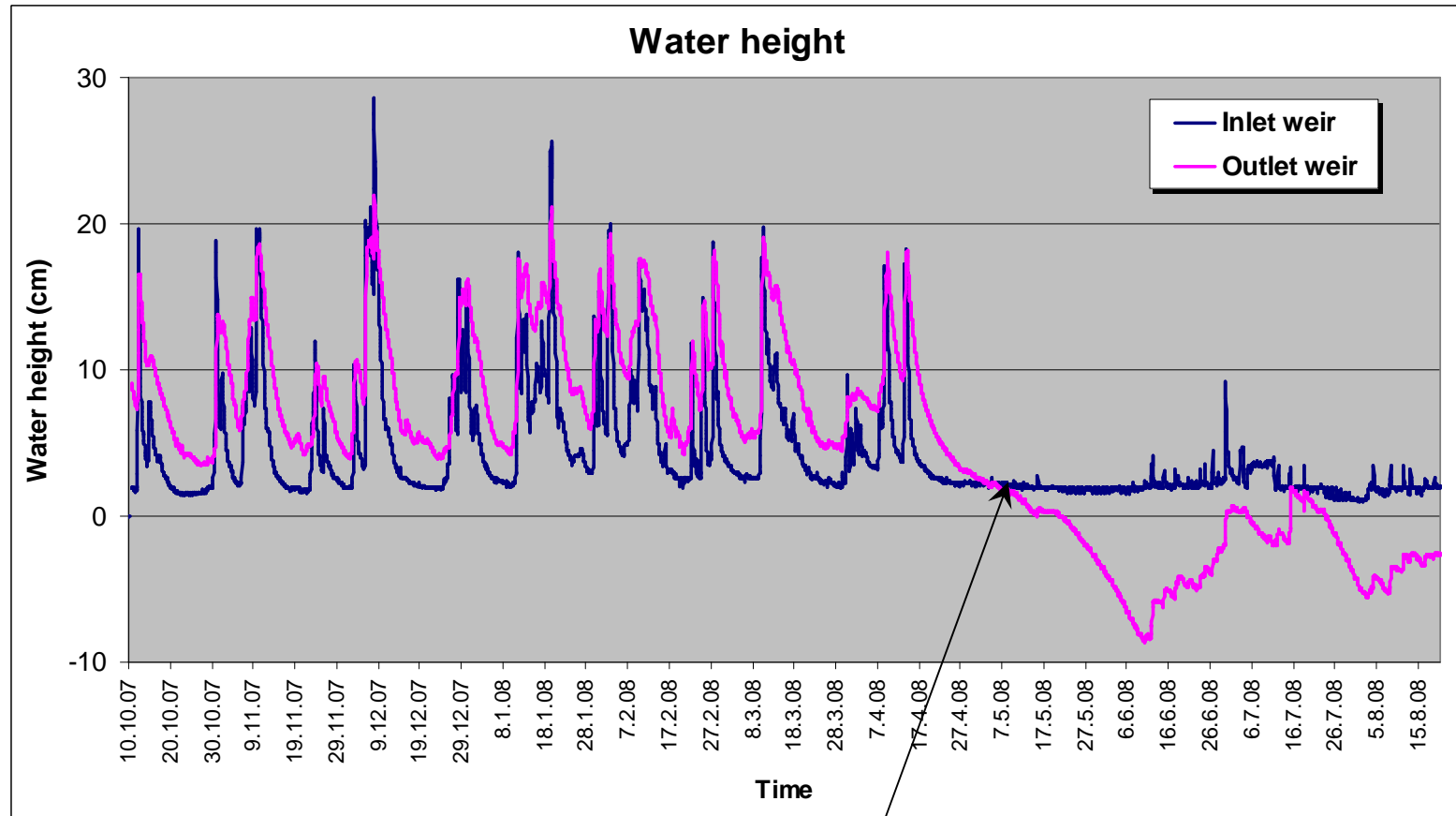
No outflow in summer when water height less than 0 !

Future plans for SoilWeather WSN development

- Open access

- Increase collaboration between WSNs
  - → increase spatial coverage and support joint use of data sets
  - → increase interoperability of WSNs
  - → avoid overlapping development work

- Open for different sensors, testbed for sensors and data services

- Well-developed data services (DQ, automatic computations, visualisation and mapping servic

Participants

MTT Agrifood Research Finland

Finnish Environment Institute (SYKE)

Finnish Institute of Meteorology

University of Aarhus

Association for Water and Environment of Western Uusimaa ry

Yara Finland

a-Lab Ltd

Biota BD Oy

The Finnish Drainage Centre

Luode Consulting Oy

Logica

Pro Agria

TeliaSonera Finland Oyj

Pohjoisen Kantaperuna Ltd

Water and Environment Research of South-West Finland Oy

TEKES

Ministry of Agriculture and Forestry

Ministry of Environment

Maa- ja elintarviketalouden tutkimuskeskus | Agrifood Research Finland | Forskningscentralen för jordbruk och livsmedelsekonomi

More information:

www.mtt.fi/soilweather

THANK YOU!

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