

Optimisation of Groundwater Well Field Management

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Well field optimisation

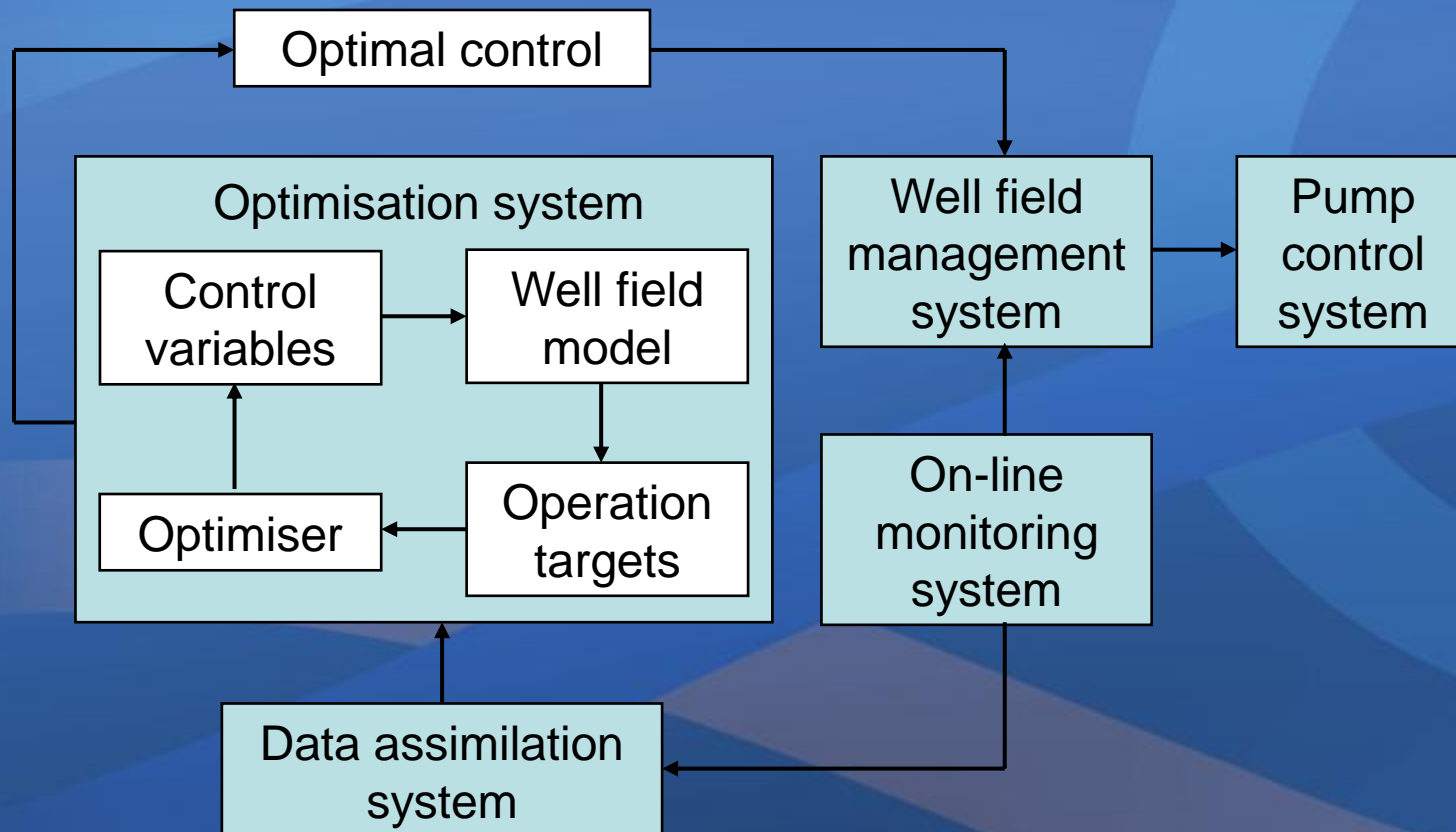
- Research grant from the Danish Strategic Research Council, Sustainable Energy and Environment Program (2007-2010)

Energy optimisation of well fields

- DANVA R&D project on energy savings in the water sector (2008-2009)



- Mathematical modelling
- Optimisation of well field operation
- Pump control
- Well field management and decision support system



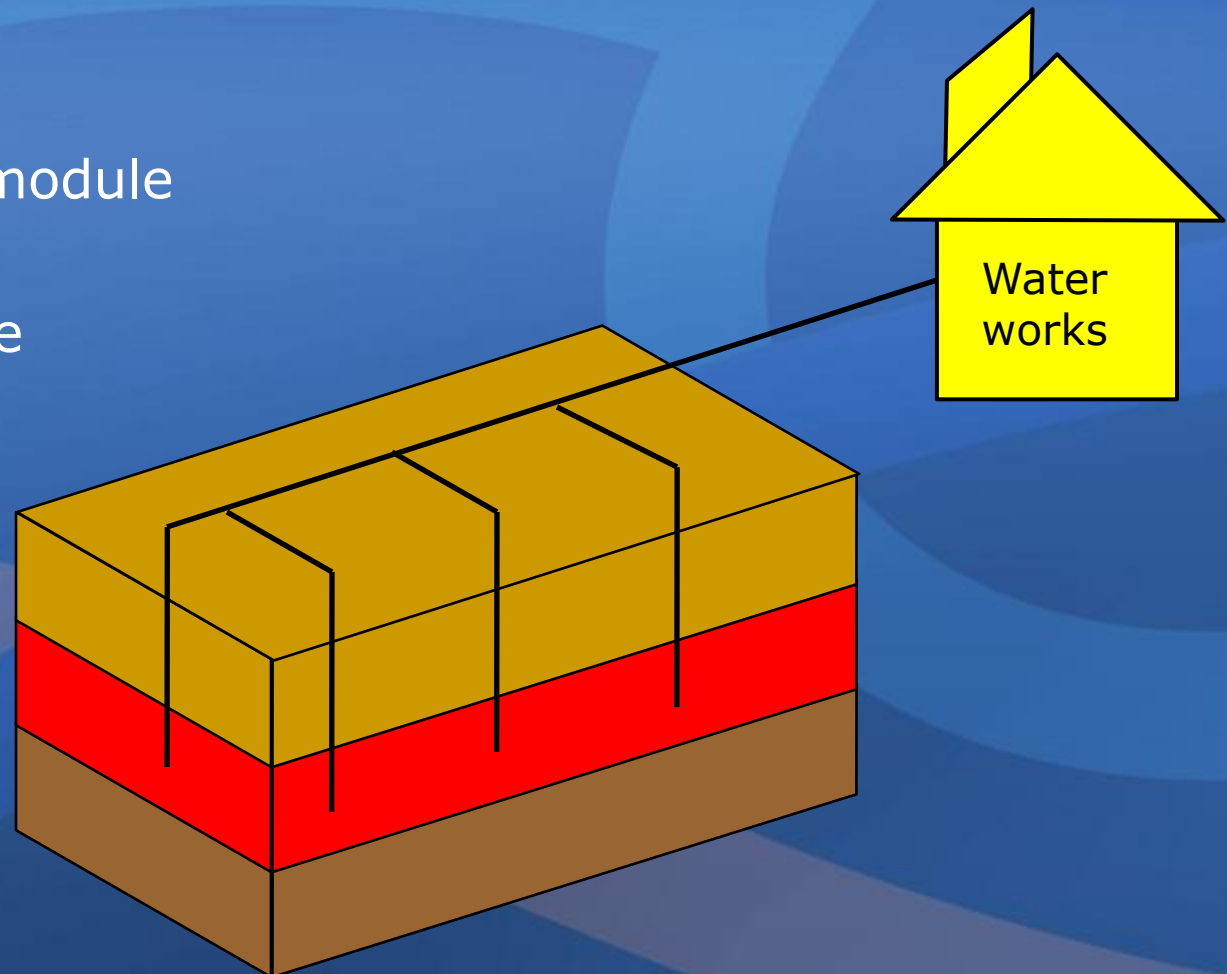
- Well field planning (off-line applications)
 - Design/extension of well fields
 - Change of pump configurations
- Real-time control and optimisation of pump scheduling (on-line applications)
- Management objectives:
 - Energy consumption
 - Operation and maintenance
 - Water quality
 - Well field contamination
 - Environmental impacts
 - ...

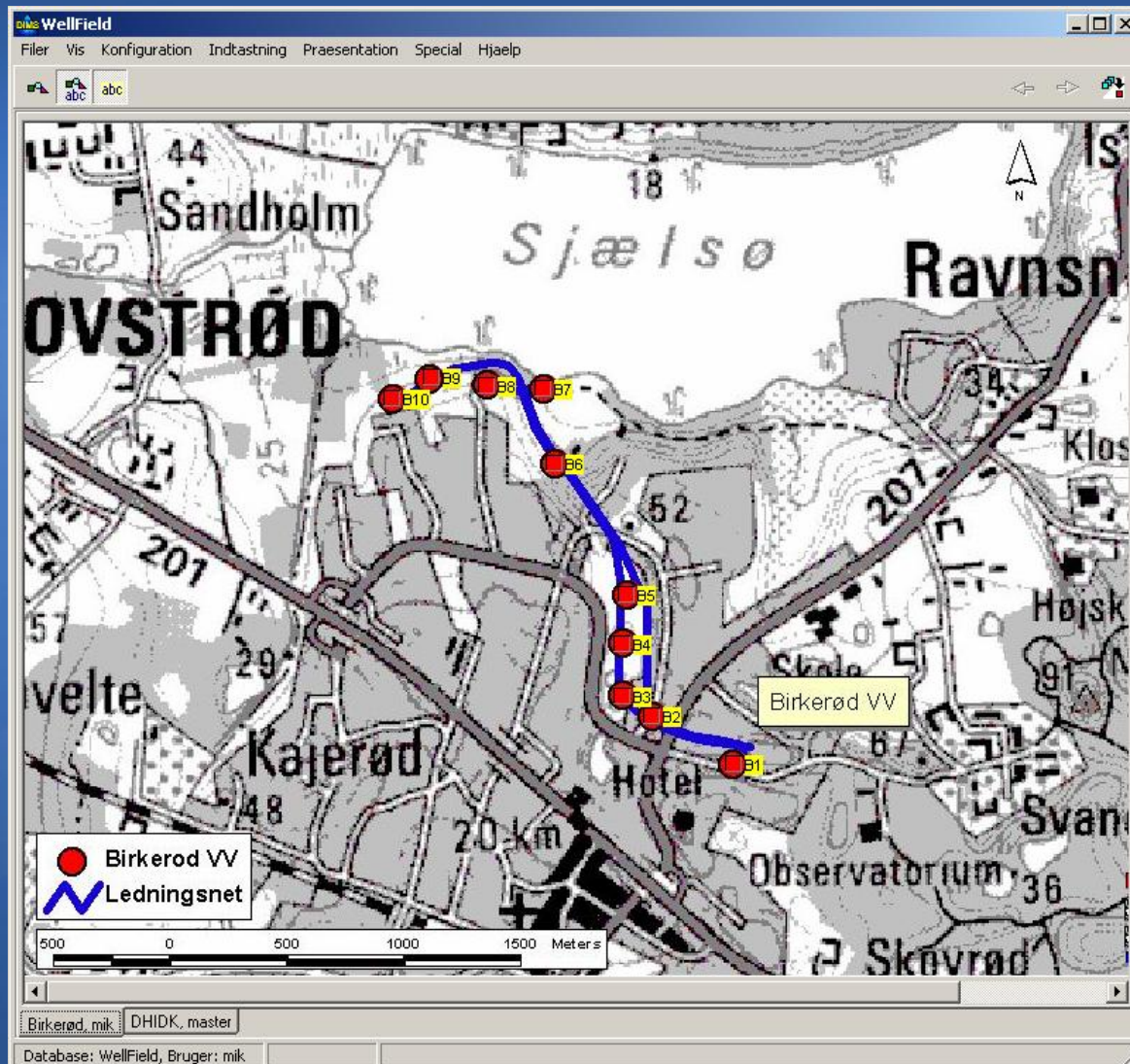
Core model:

- Groundwater model - MIKE SHE
- Pipe network model - EPANET
- Well model

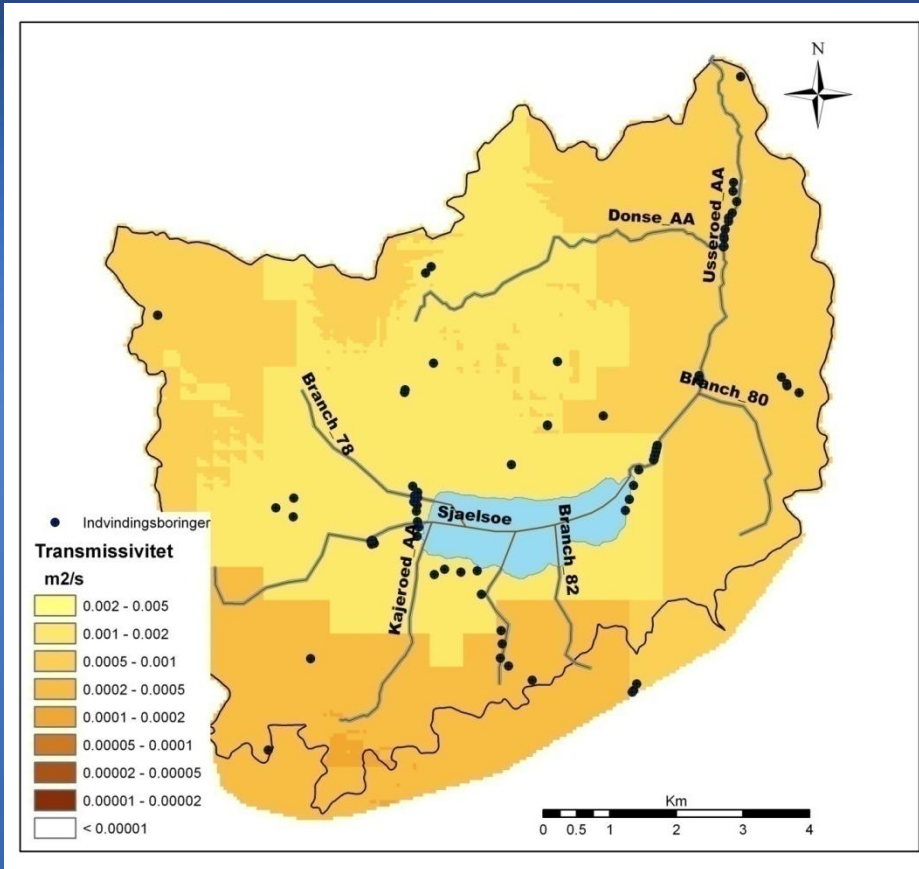
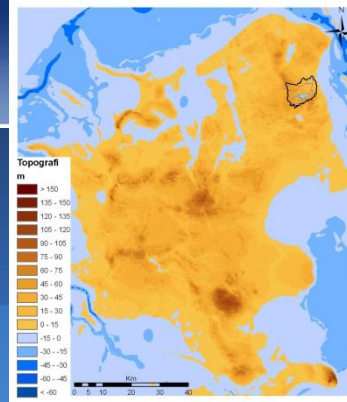
Add-ons:

- Energy calculation module
- Control module
- Optimisation module
- Data assimilation



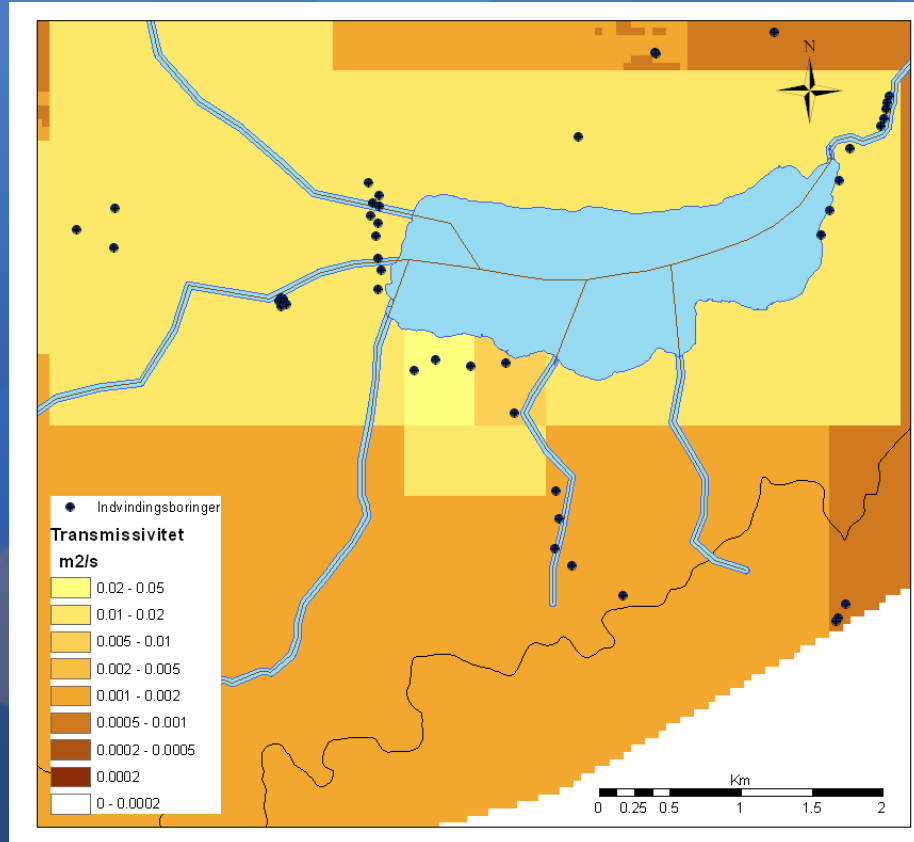


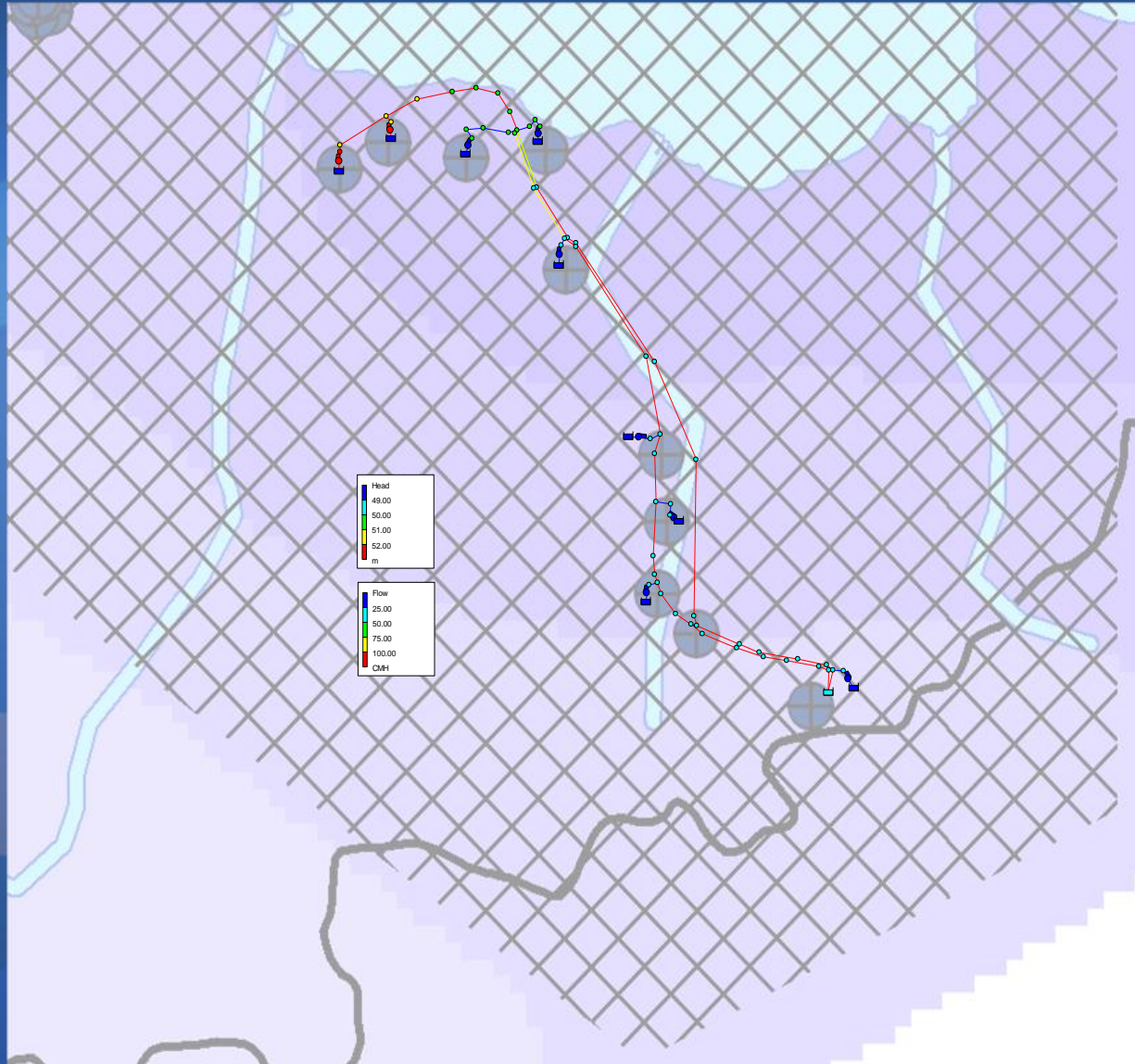
Groundwater model



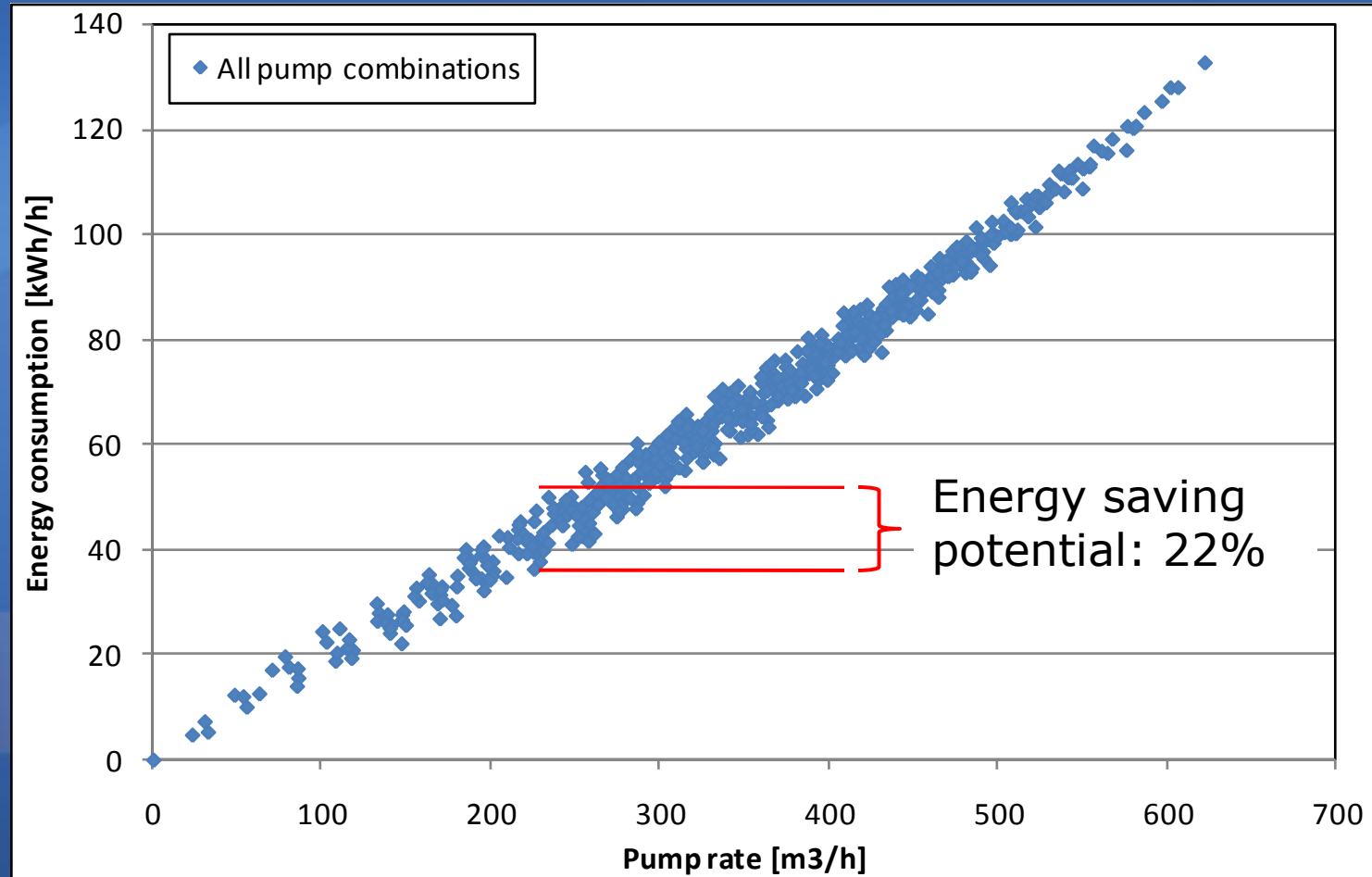
Usserød Å
catchment model

Local well field model





Evaluation of pump scheduling

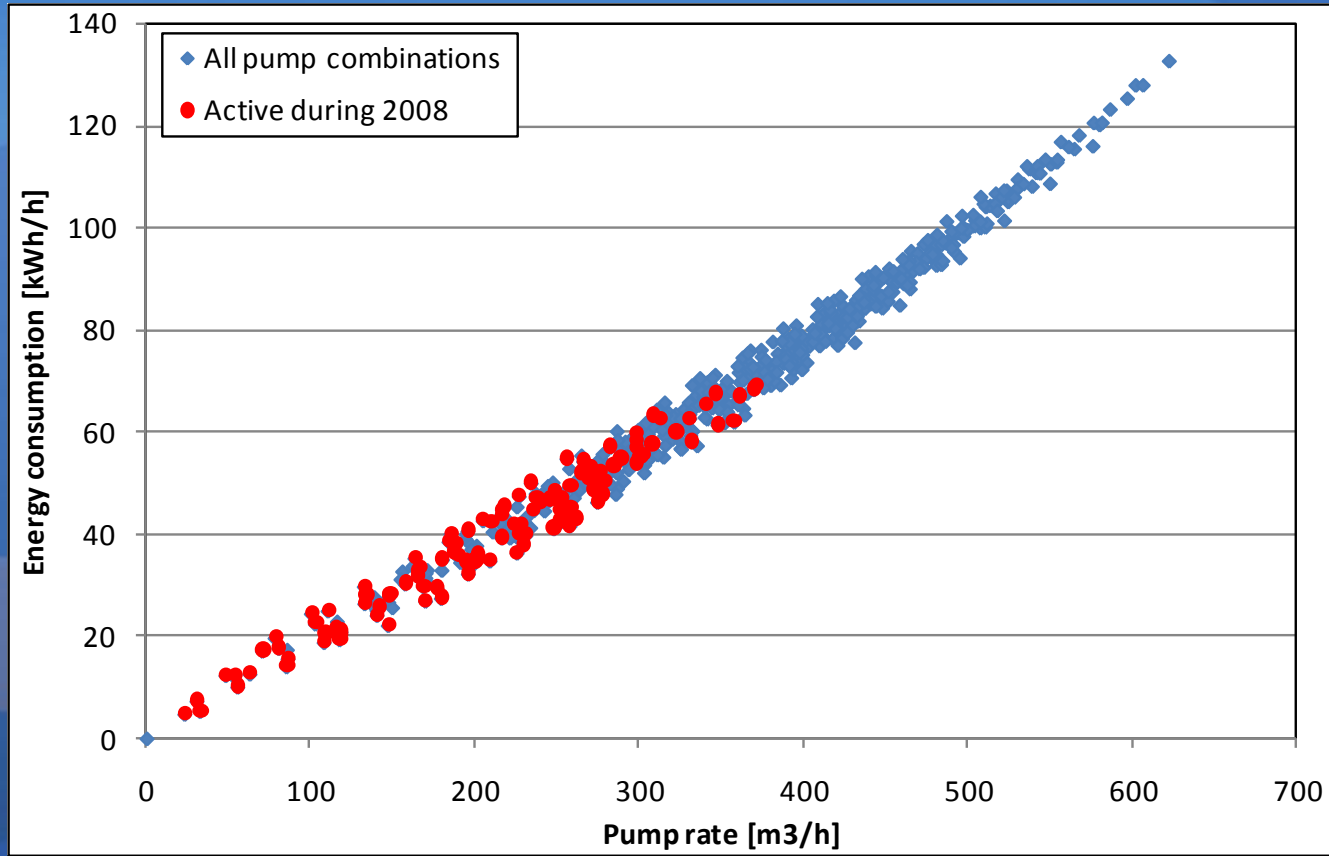


Evaluation of 2008 operation



Annual yield: 1.455.000 m³

Annual energy consumption: 267.000 kWh

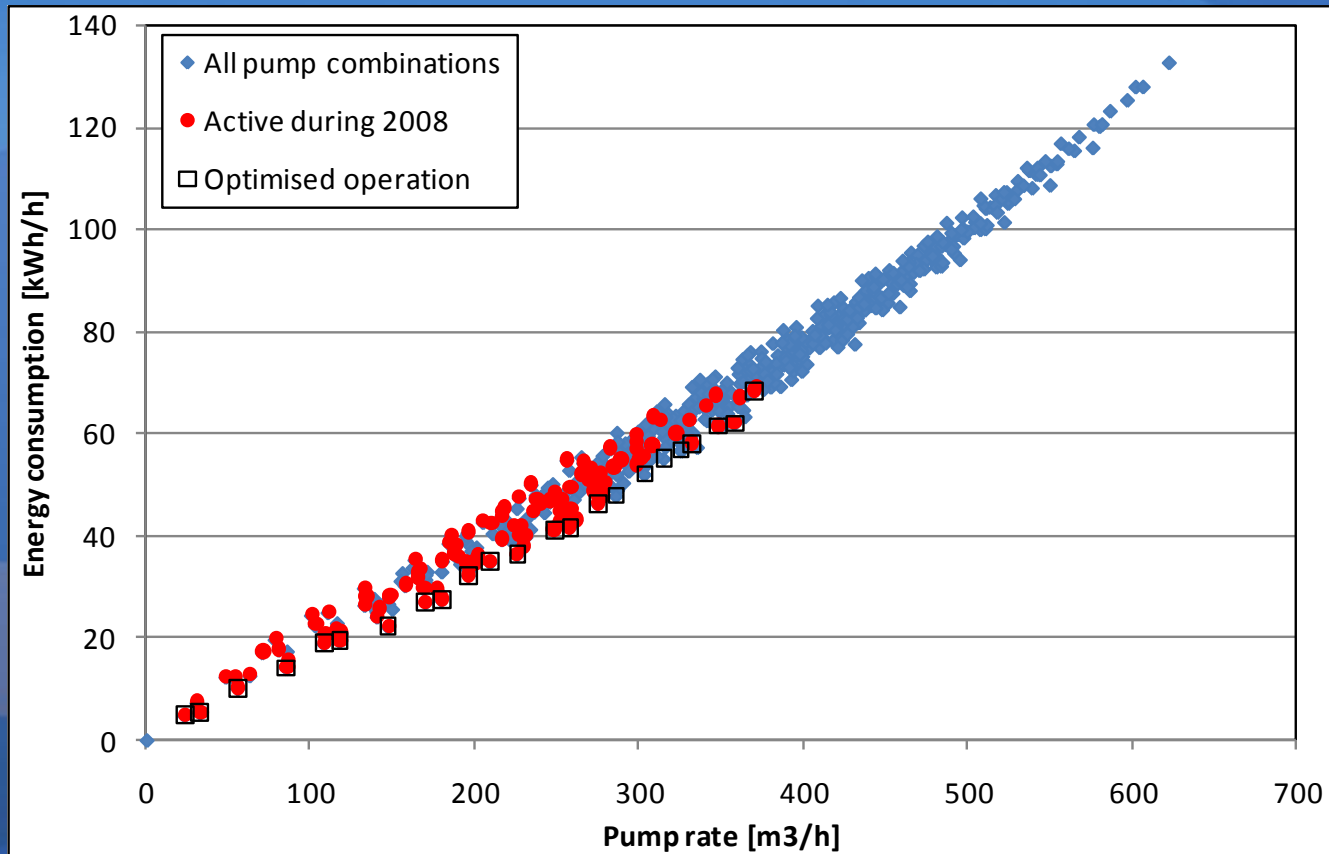


Energy optimisation of 2008 operation



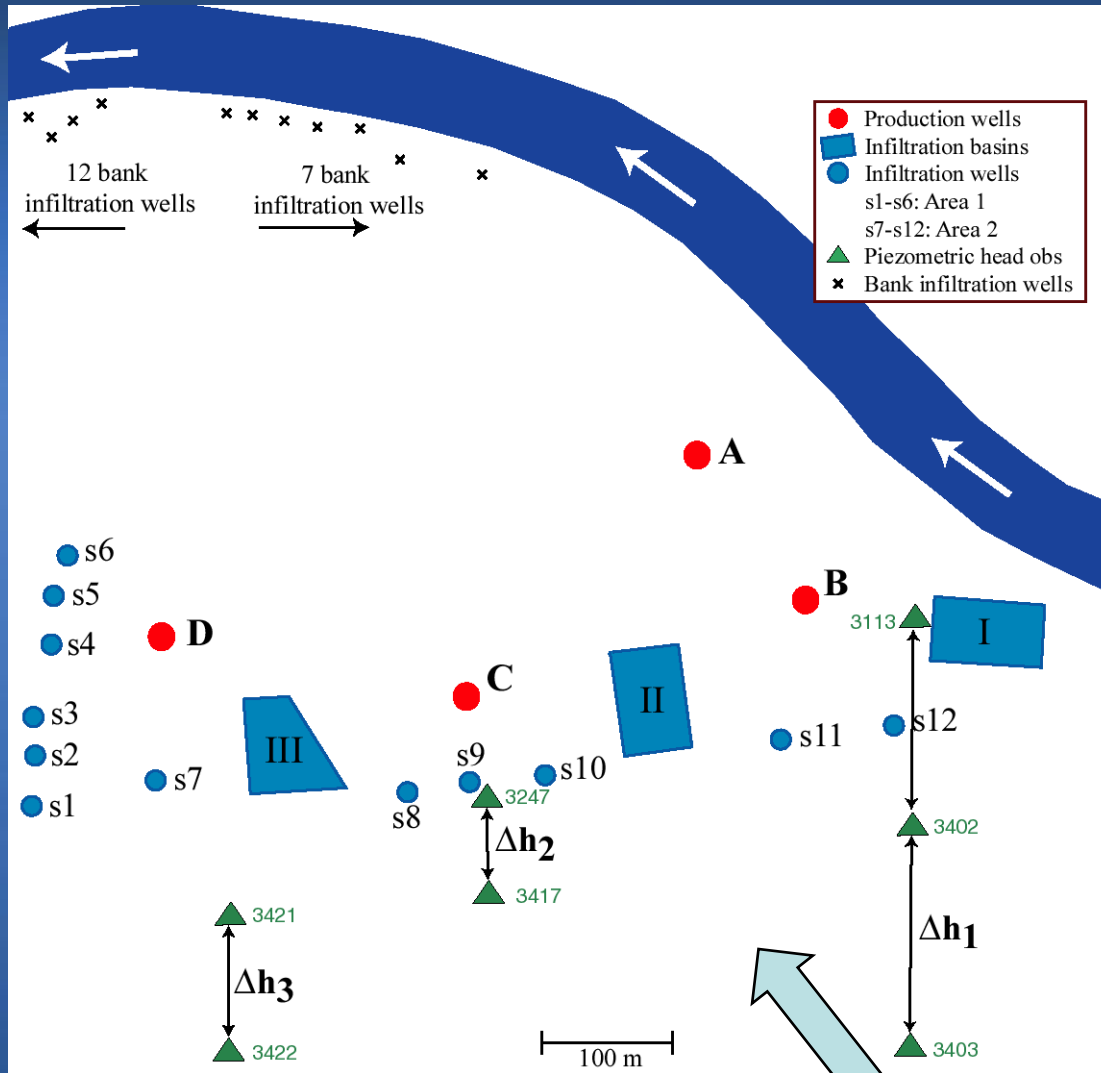
Annual Energy consumption: 249.000 kWh

Reduction compared to 2008 operation: 7 %



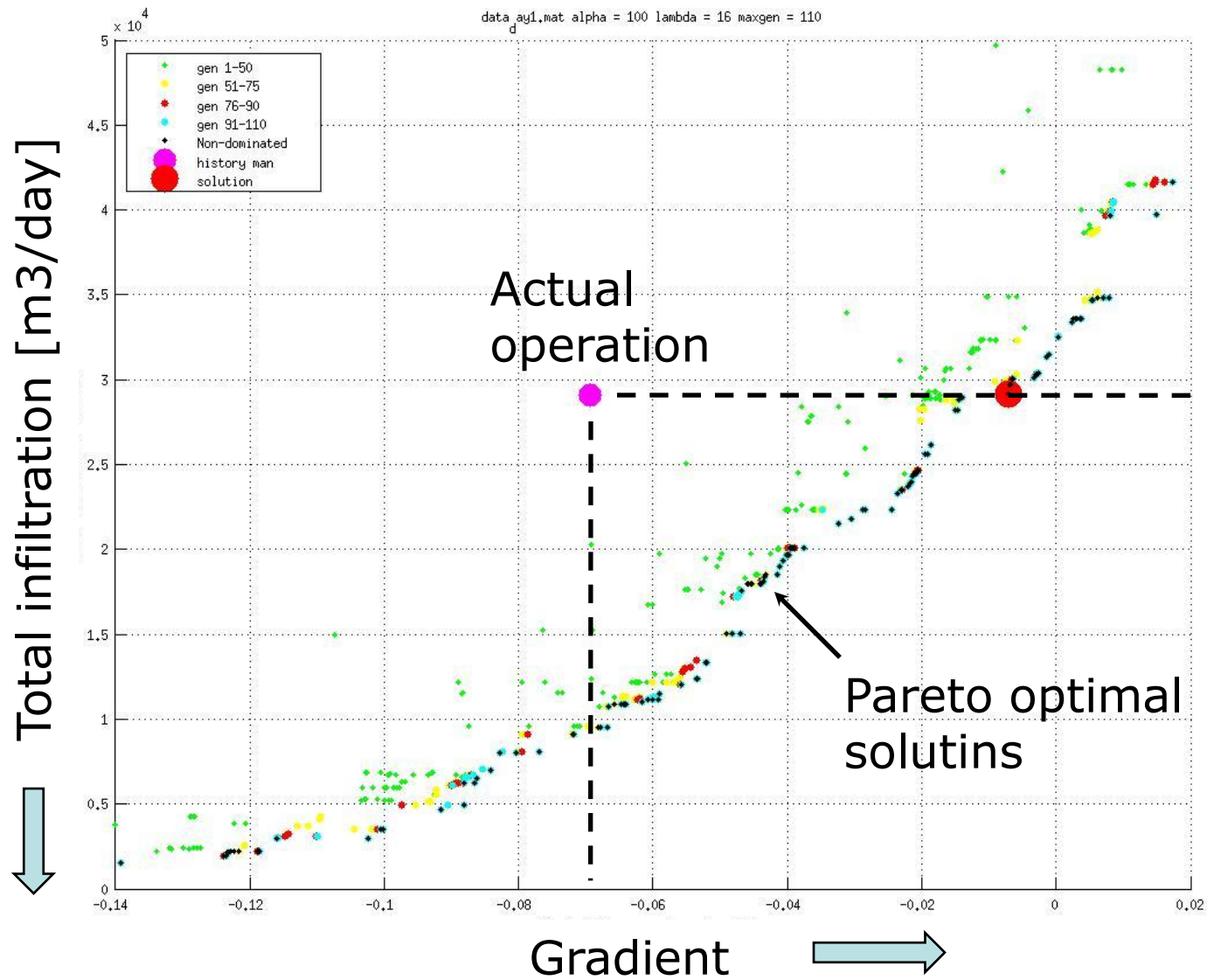
Scenario	Energy consumption [kWh]	Reduction compared to 2008 operation [%]
Operation during 2008	267.000	-
Optimised operation with present pumps	249.000	7
Optimised operation with new pumps	192.000 - 200.000	25-28

Real-time control Hardhof water works, Zürich

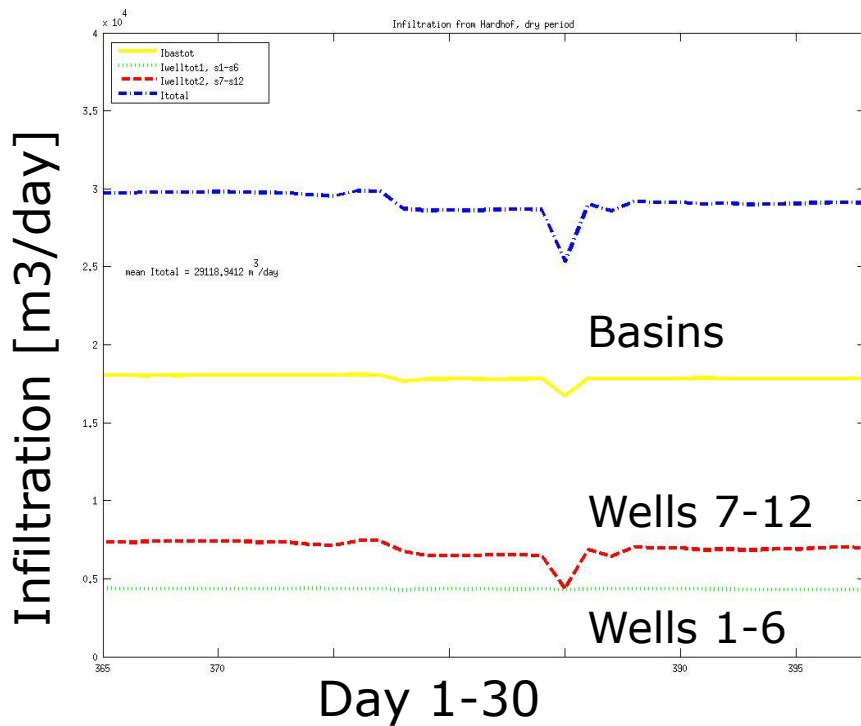


- 4 production wells
- 20.000 m³/day
- 18 extraction wells along river
- 3 infiltration basins
- 12 infiltration wells

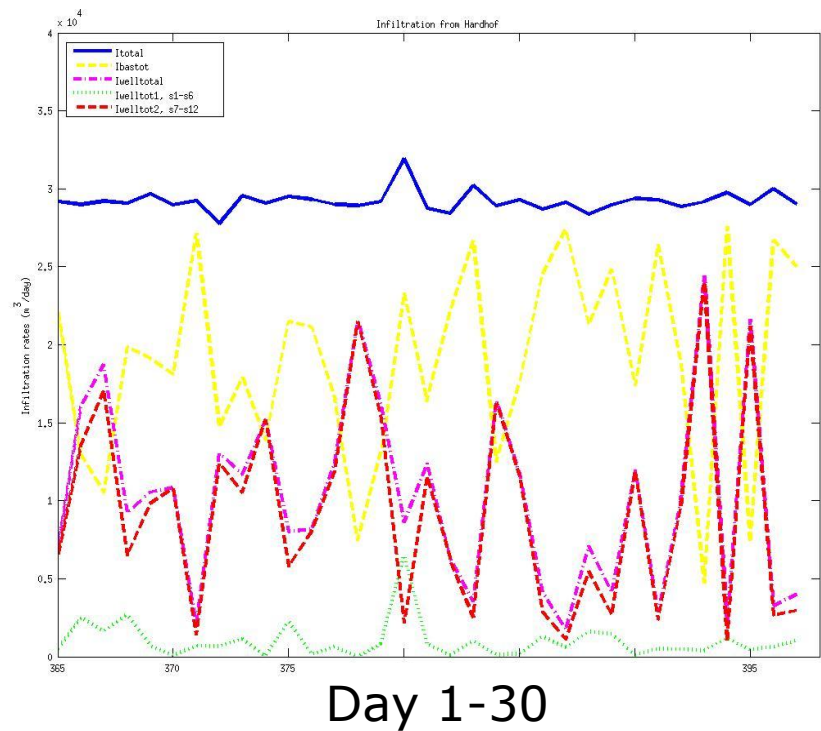
Contaminated groundwater



Historical management



Optimised management



- Integrated hydrological and hydraulic well field model developed for management of groundwater well fields
- Real-time management system combining monitoring, modelling and optimisation can significantly improve operations of well fields
- Applications
 - Energy optimisation Birkerød water works: Up to 28% energy savings by changing to more energy efficient pumps and optimising pump scheduling
 - Hardhof water works: Real-time control provide optimal solutions with better protection and less infiltration than present operation.

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Well field optimisation

There is an urgent need for sustainable and efficient exploitation of the groundwater resources of the world in order to ensure high quality drinking water in the future.

Well field optimisation puts focus on optimising the operation of well fields to meet the following criteria:

- High **water supply liability**
- High **water quality**
- Low **energy consumption**
- Low **environmental impact**

Well field optimisation is a research project that introduces mathematical modelling of well fields and combines with information from sensor networks within a management system to optimise pump scheduling and water withdrawal.

The project includes the following developments:

- [Mathematical models](#) for simulation of the well field
- [Water quality sensors](#) which are placed directly in the wells for on-line detection of water quality
- [Hardware for pump control](#)
- A [Well field management system](#) which integrates the mathematical models of the well field with the SCADA system at the waterworks into a real-time control and decision support system

The developed tools will be tested and demonstrated at the Sønderlø well field in Denmark.

An overview of the project in danish can be found at [Kildeplads optimering](#)

Well field optimisation • Research project on optimal real-time control of groundwater abstraction • 2007-2010

