Swedish experience on data analysis and modeling of inflow/infiltration in sewer systems

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The Presentation

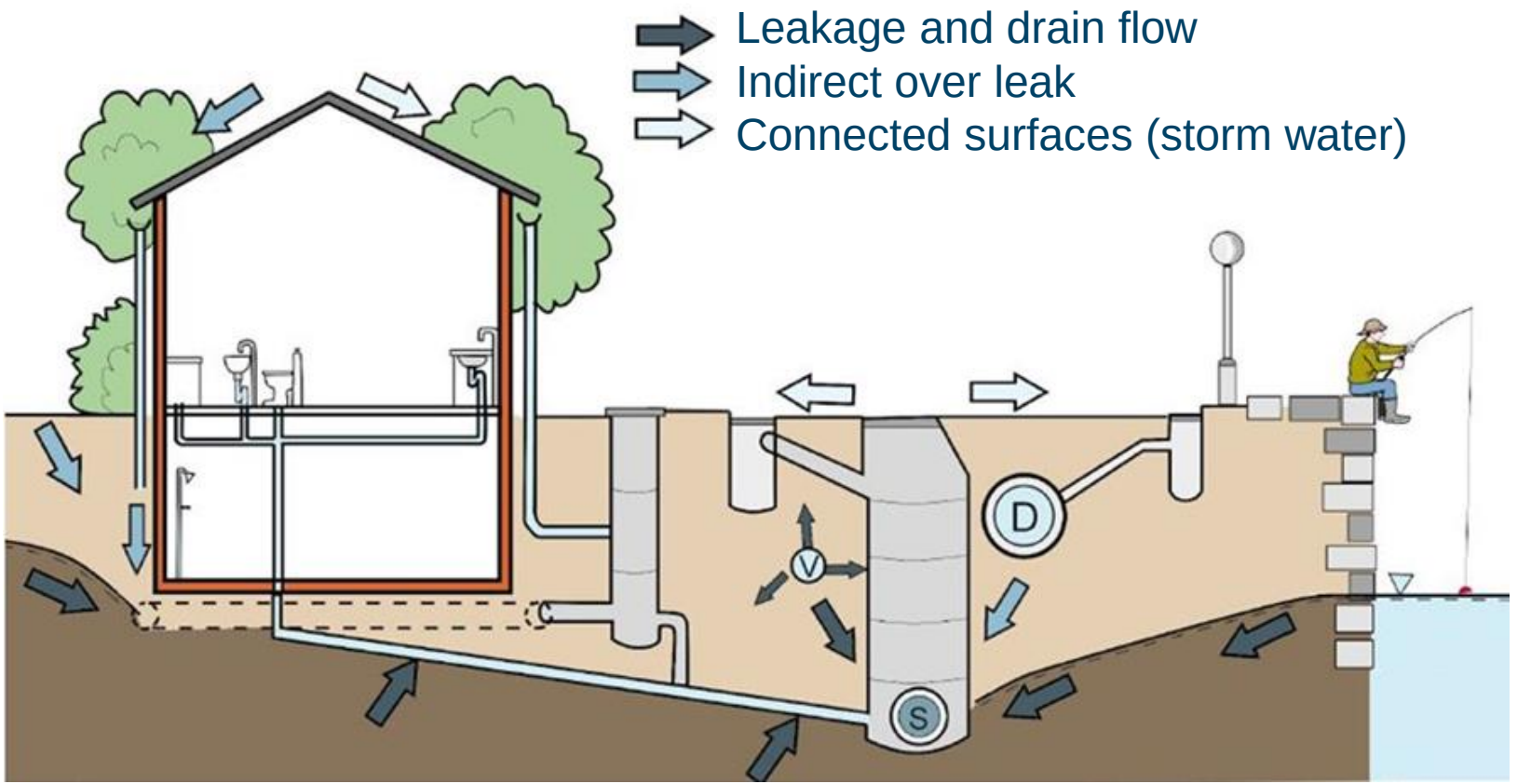
1. The physics behind the problem
2. The status of the problem in Sweden
3. Real time flow data analysis New
4. Hydrological modelling
5. Simulator for planning of actions New

1.

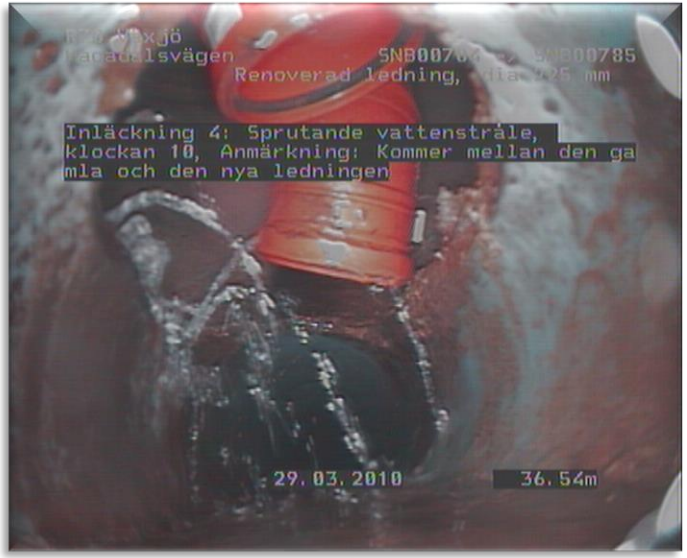
The physics behind the problem

Why do we have inflow/infiltration and what is the problem?

The physics behind the problem with “uvedkommende vand”



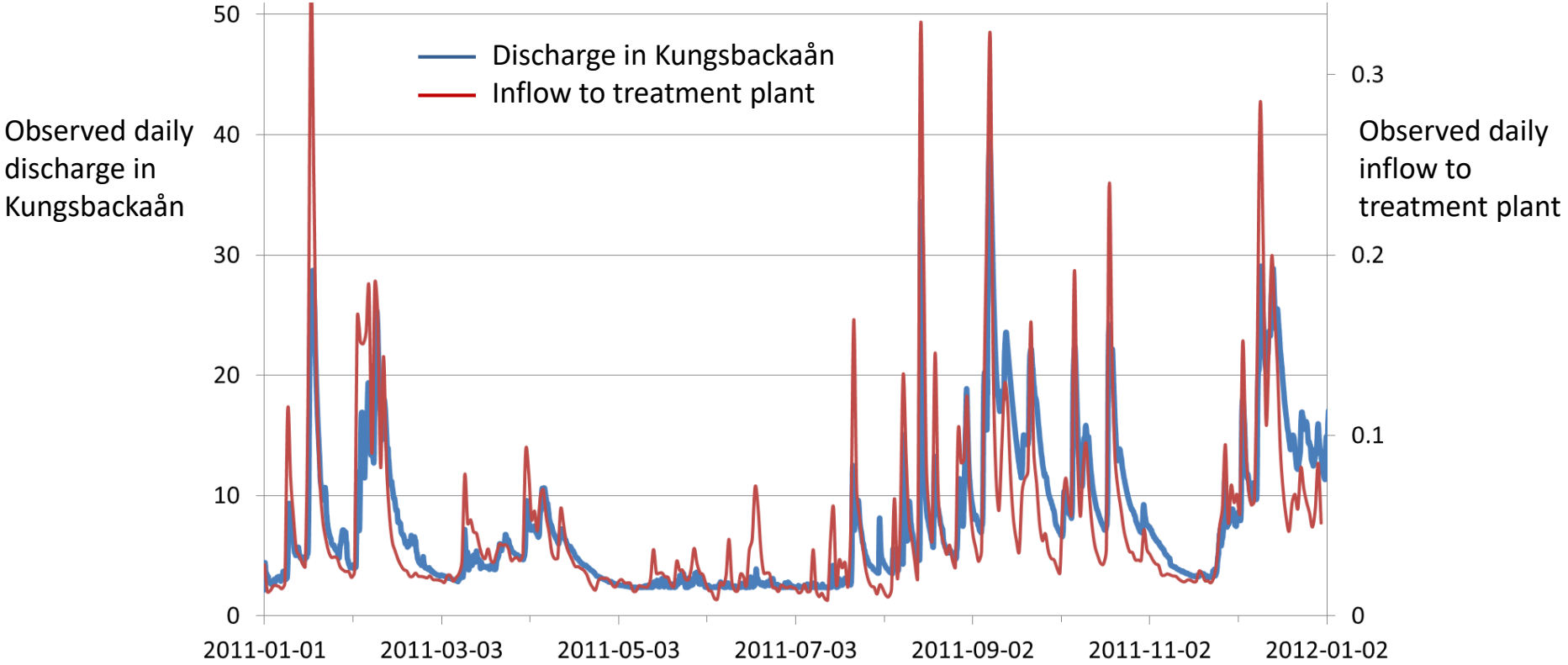
Rural versus Urban hydrology – Any similarities?



A natural river stream versus a leaking pipe?

Rural versus Urban hydrology – similarities!

Seasonal variation for a year



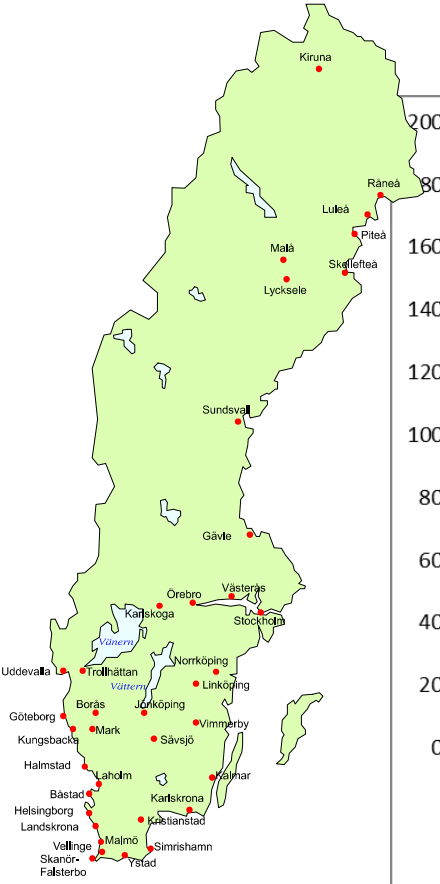
What influences the extent and amplitudes?

- Condition of sewer system (cracks, joints,…)
- Type of drainage system (C/D/S)
- Status/connections of private properties (storm water, drain pipes)
- Topography (discharge areas)
- Geology (soil thickness and permeability/hydraulic conductivity)
- Meteorology (seasonal variation, temperature)

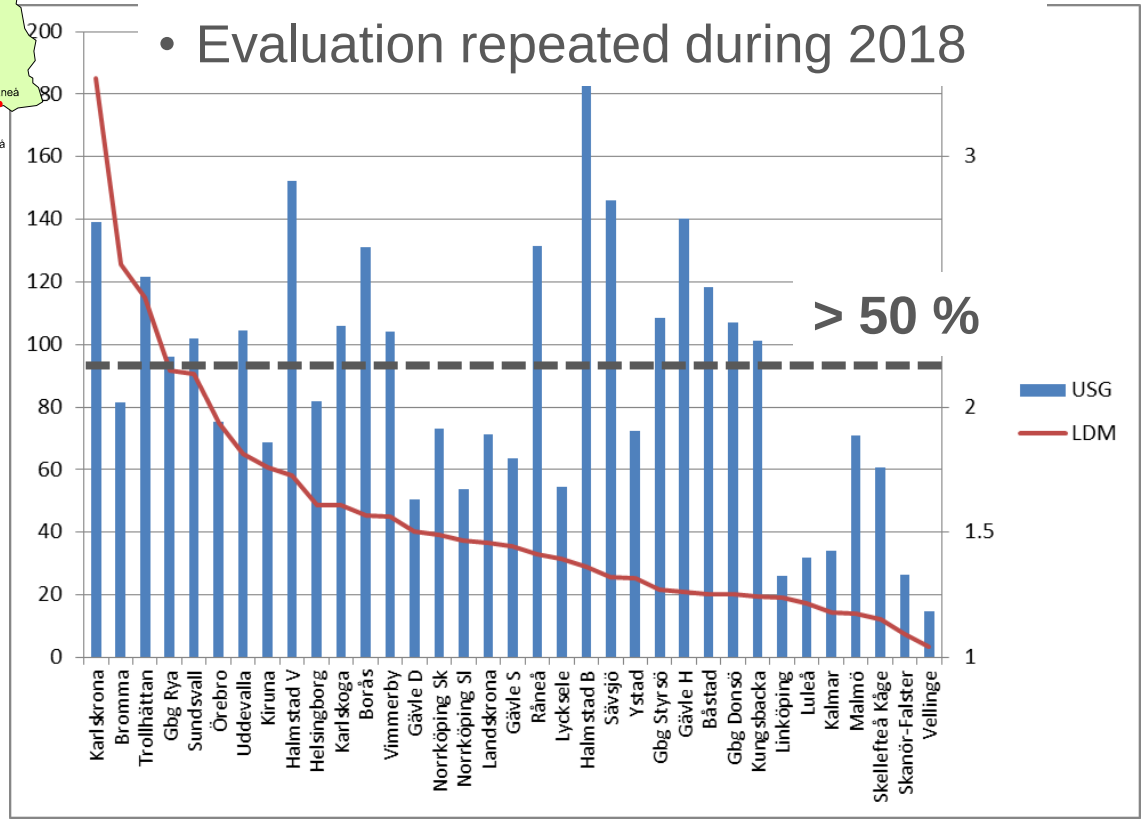
2.

The status of the problem in Sweden

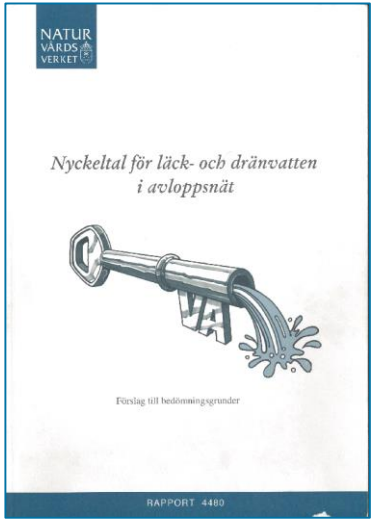
The extent of the problem in Sweden



- 40 cities evaluated 1995
- Evaluation repeated during 2018



Källa: Naturvårdsverket
Rapport 4480 (1995)



The problem (in Sweden – and elsewhere)

- Overloaded wastewater treatment plants
- Sewer overflow of untreated wastewater to receiving waters
- Overloaded sewer networks with flooding problems
- High energy consumption (pumping stations and treatment)

The extent (in Sweden)

- Yearly volume >50 % of total wastewater volume (in average)
- Daily extremes >90 % of total wastewater volume
- Growing problem (+50 % over 30 years in some areas)

3.

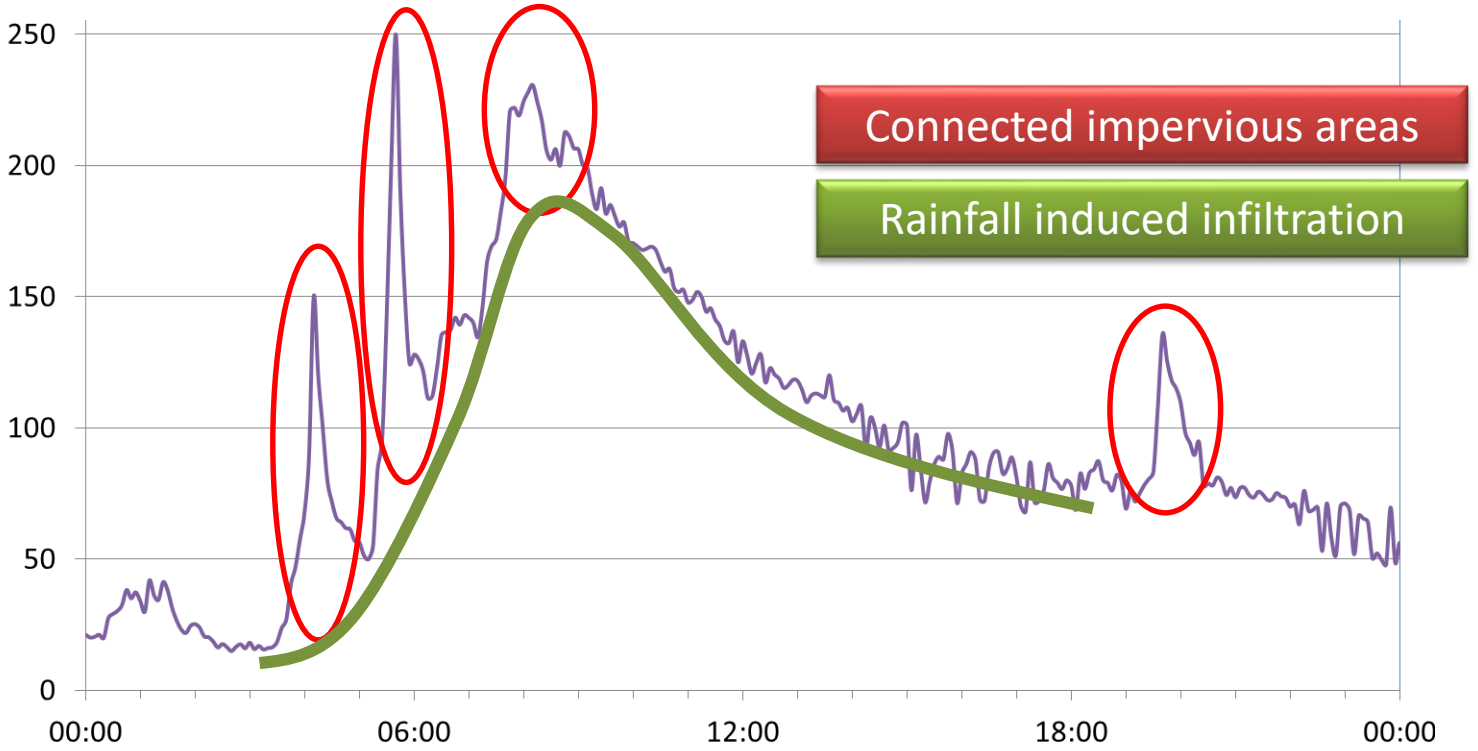
New

Real time flow data analysis

Careful analyses shows what's behind, and the trends

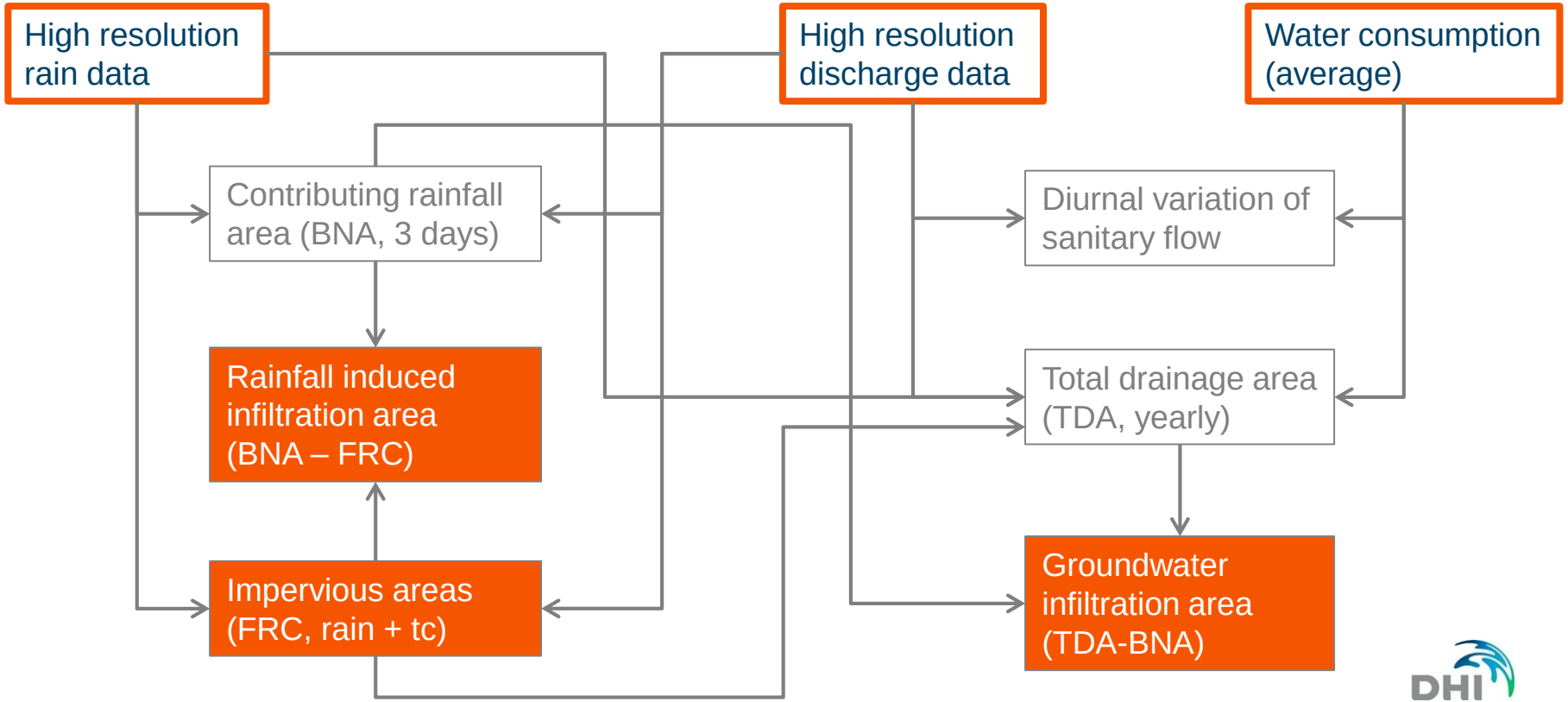
Response time to rain affected by the type of source

Observed high resolution discharge (l/s)

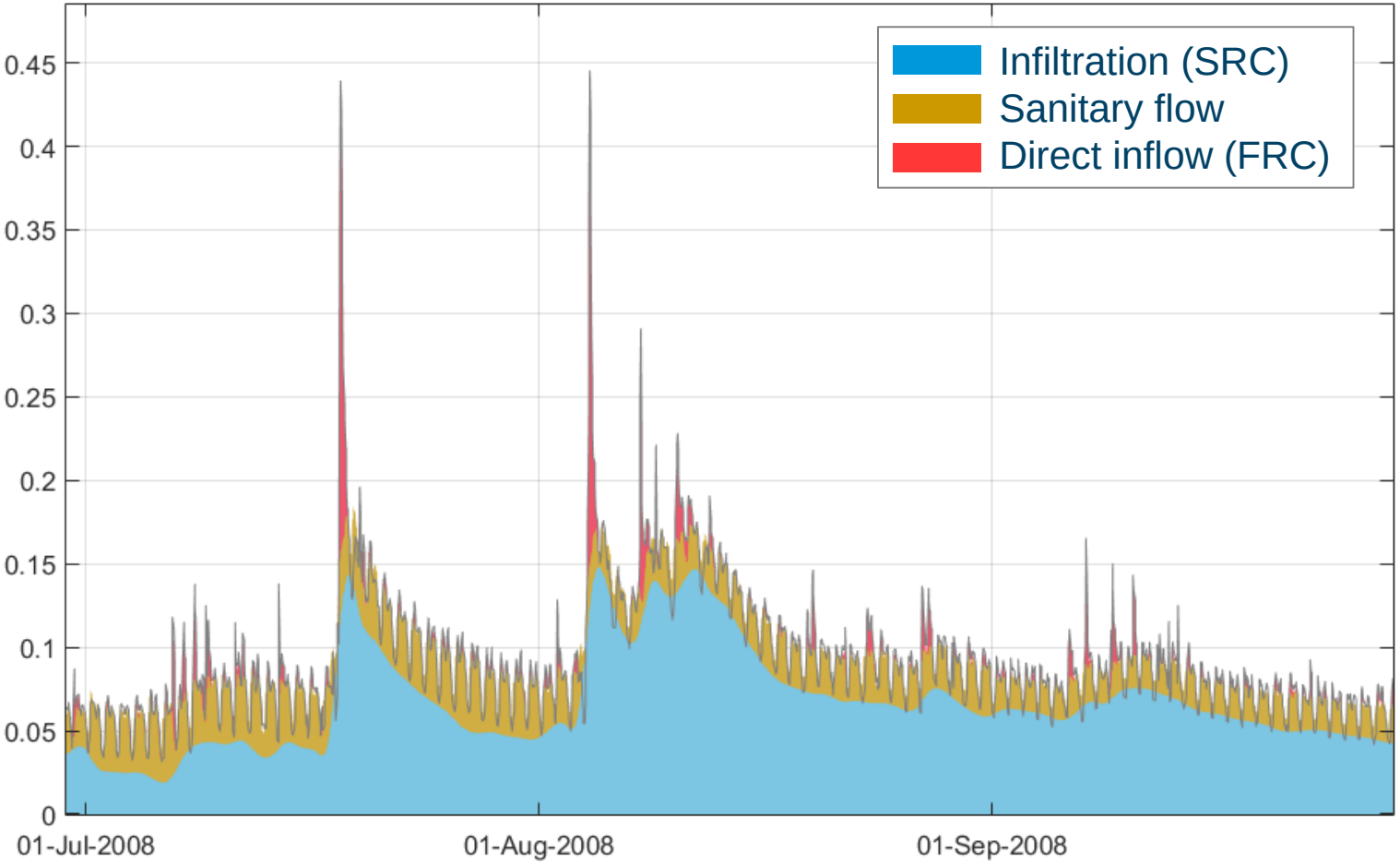


Automatic split of discharge into flow components and KPI's

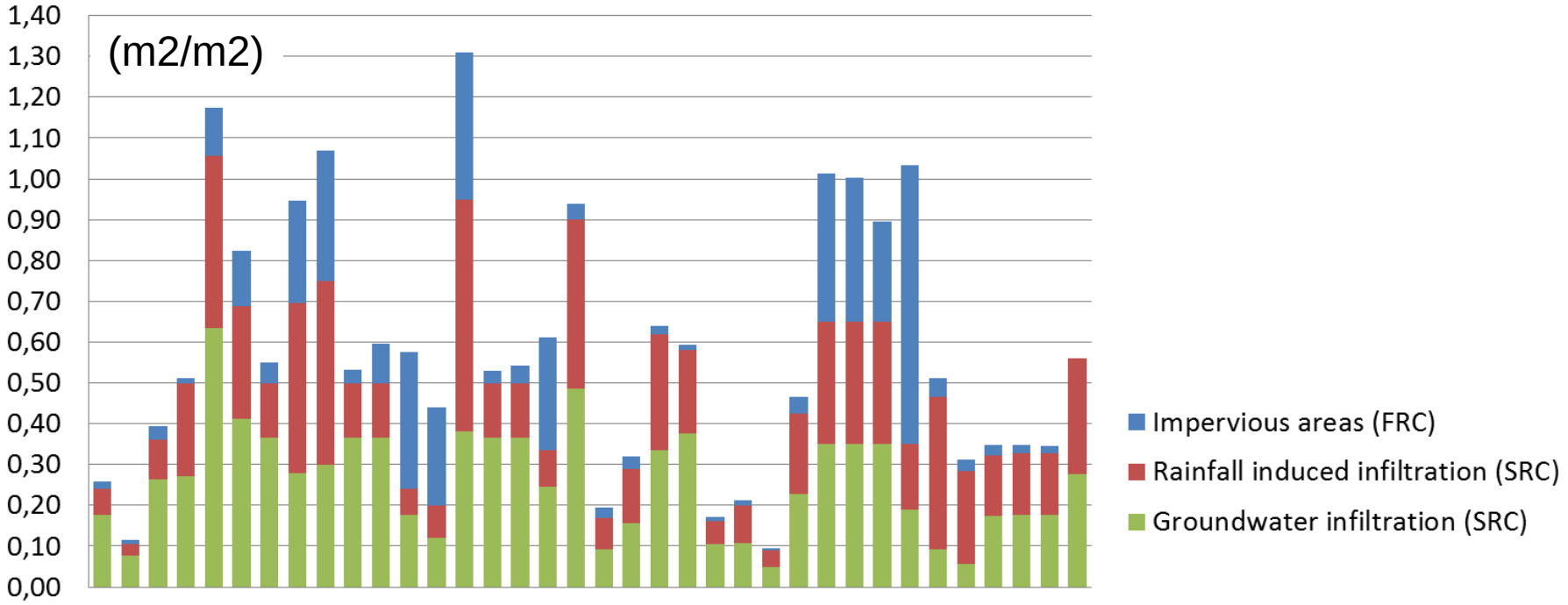
Scheme for real time processing based on physics and machine learning



Automatic split of observed discharge into flow components



Transferring flow components to key performance indicators



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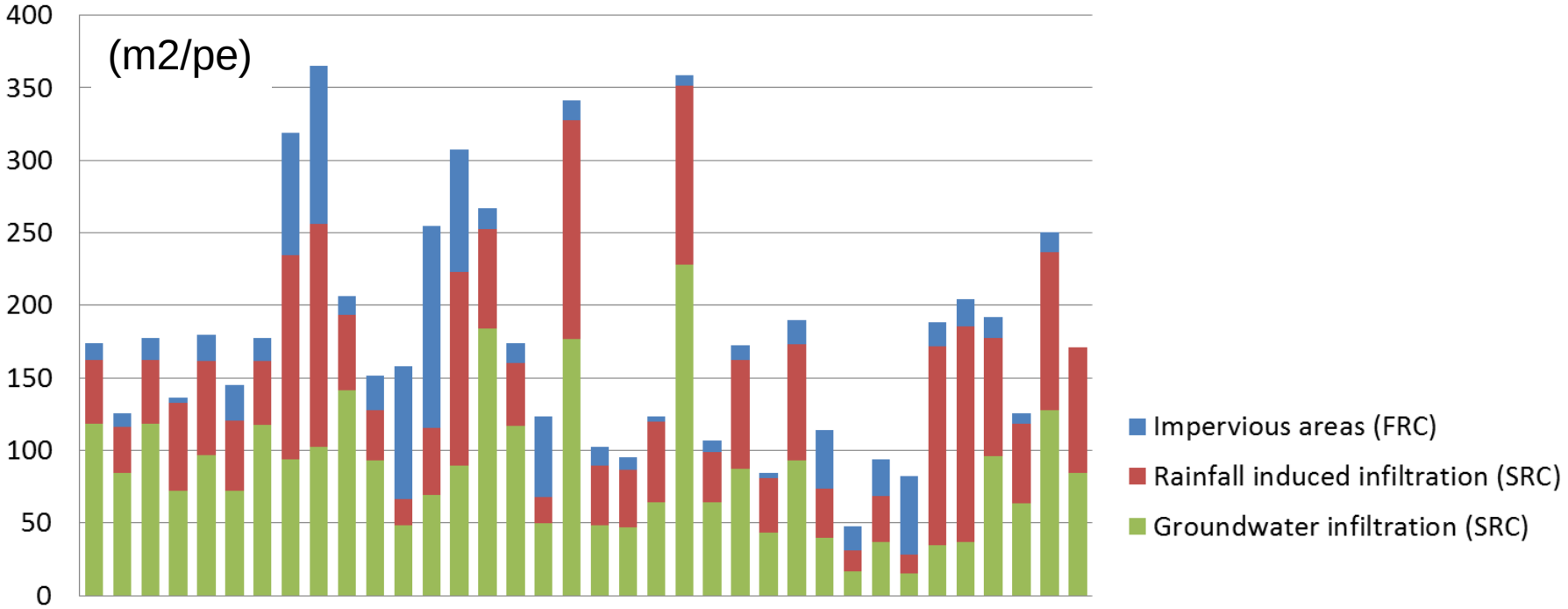


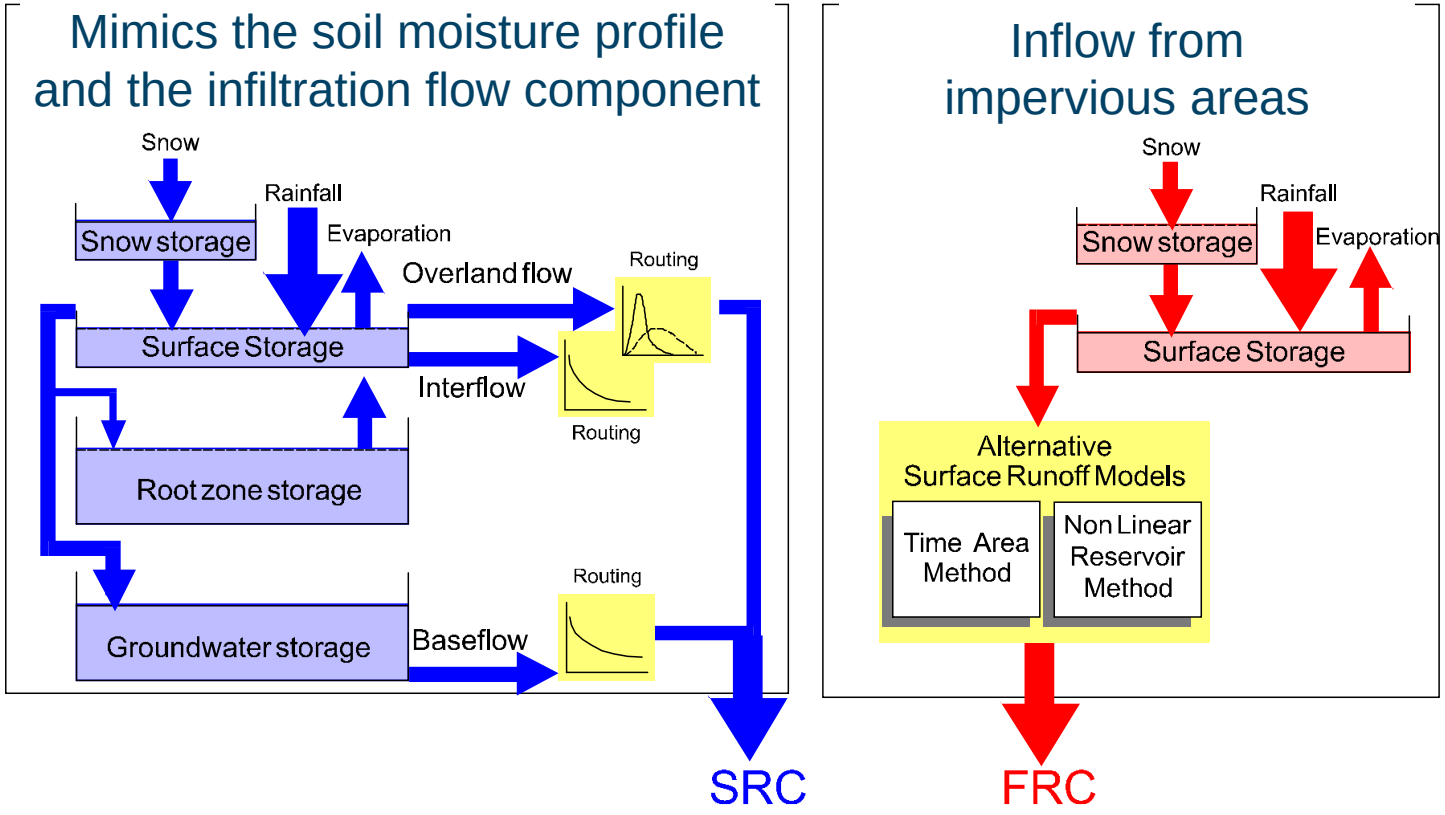
4.

Hydrological modelling

Increasing the value of monitoring - analysing cause and effect

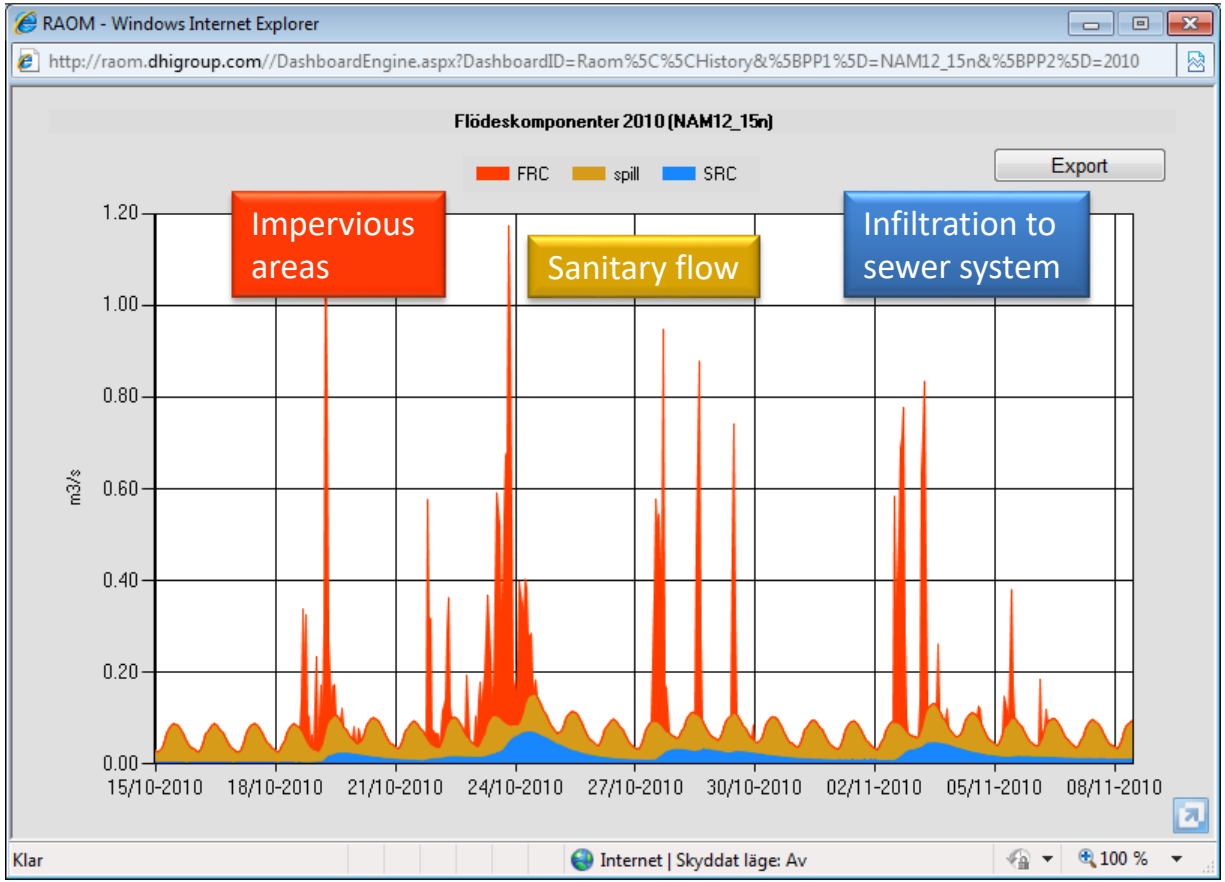
A lumped conceptual modeling approach

MIKE URBAN RDI-module – specifically developed for "uvedkommende vand "



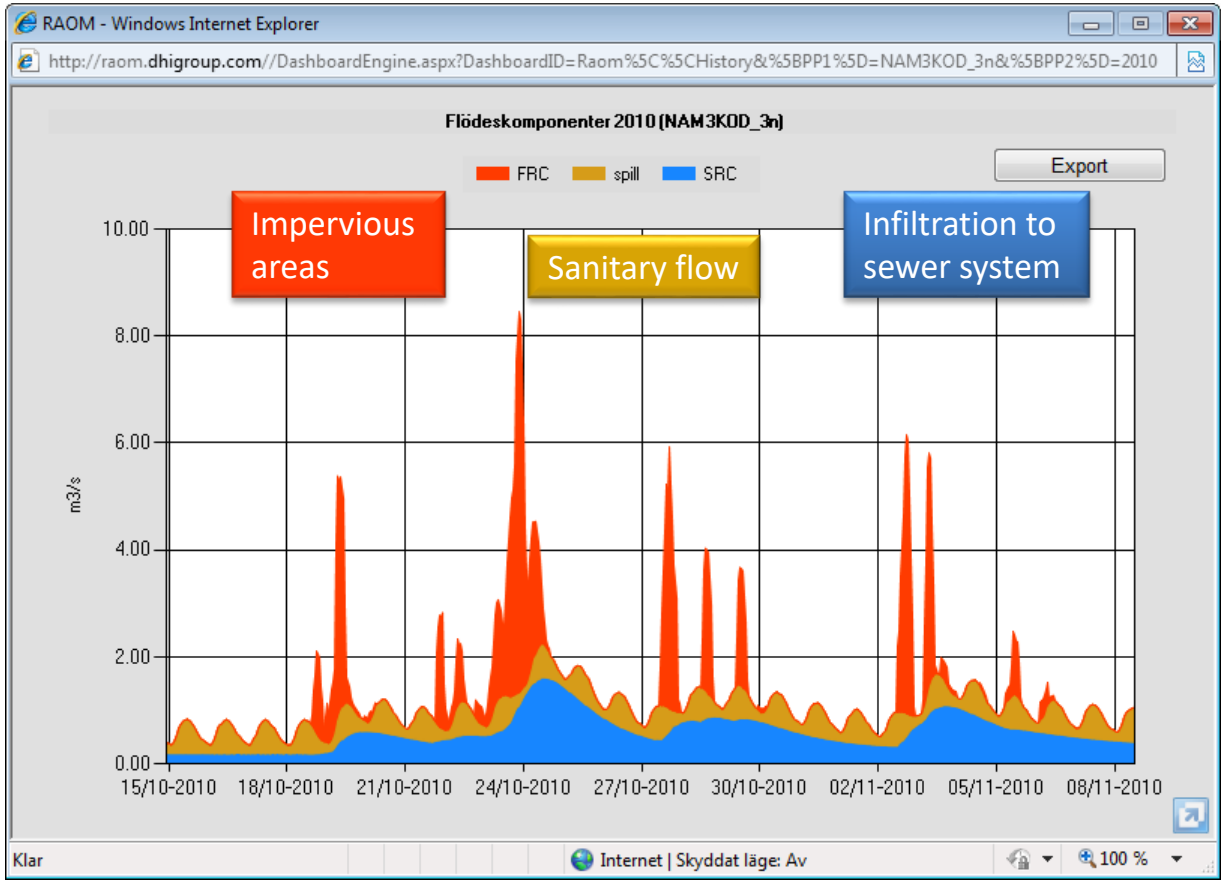
Extending and interpolating flow component analyses

Combined sewer system in a city center



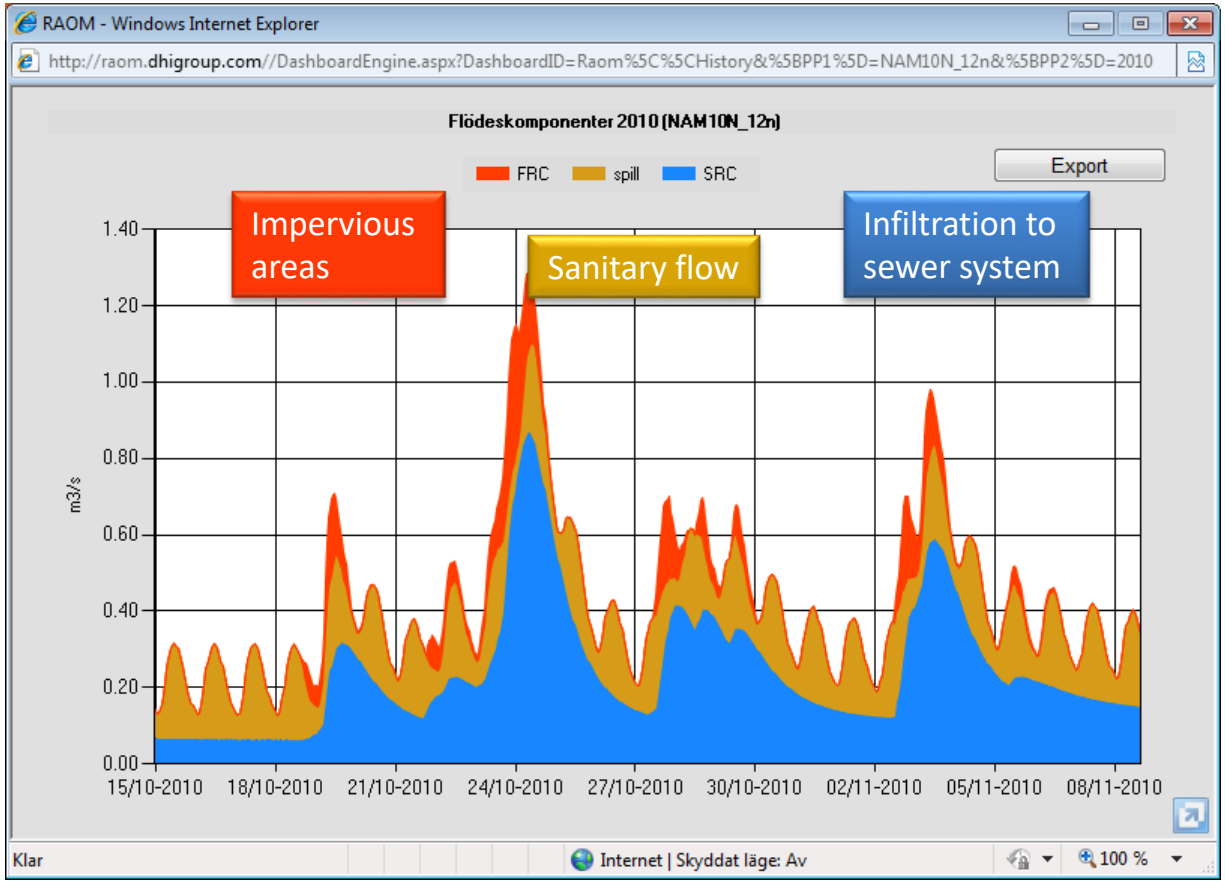
Extending and interpolating flow component analyses

Combined sewer system located in discharge area along a river

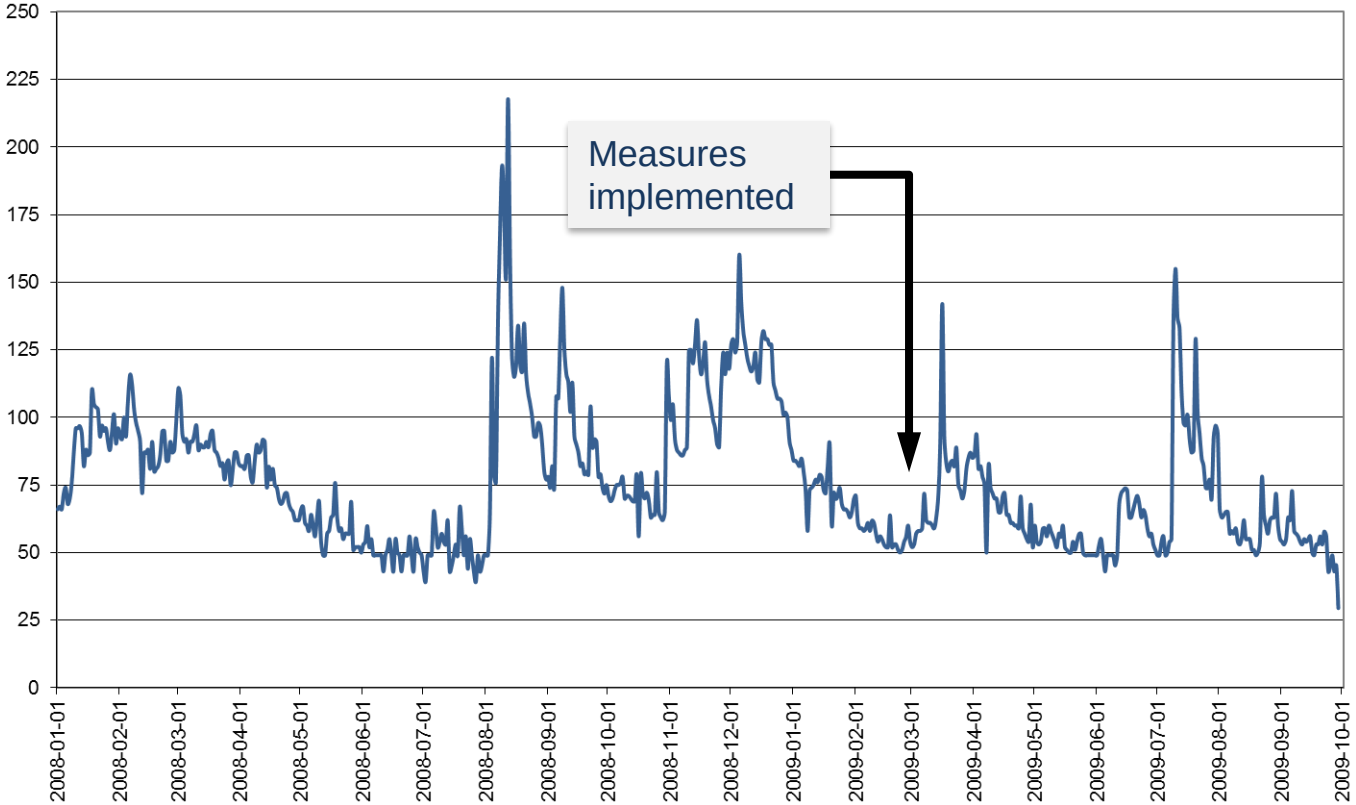


Extending and interpolating flow component analyses

Old sanitary sewer system in bad condition



… and for follow up after actions and measures



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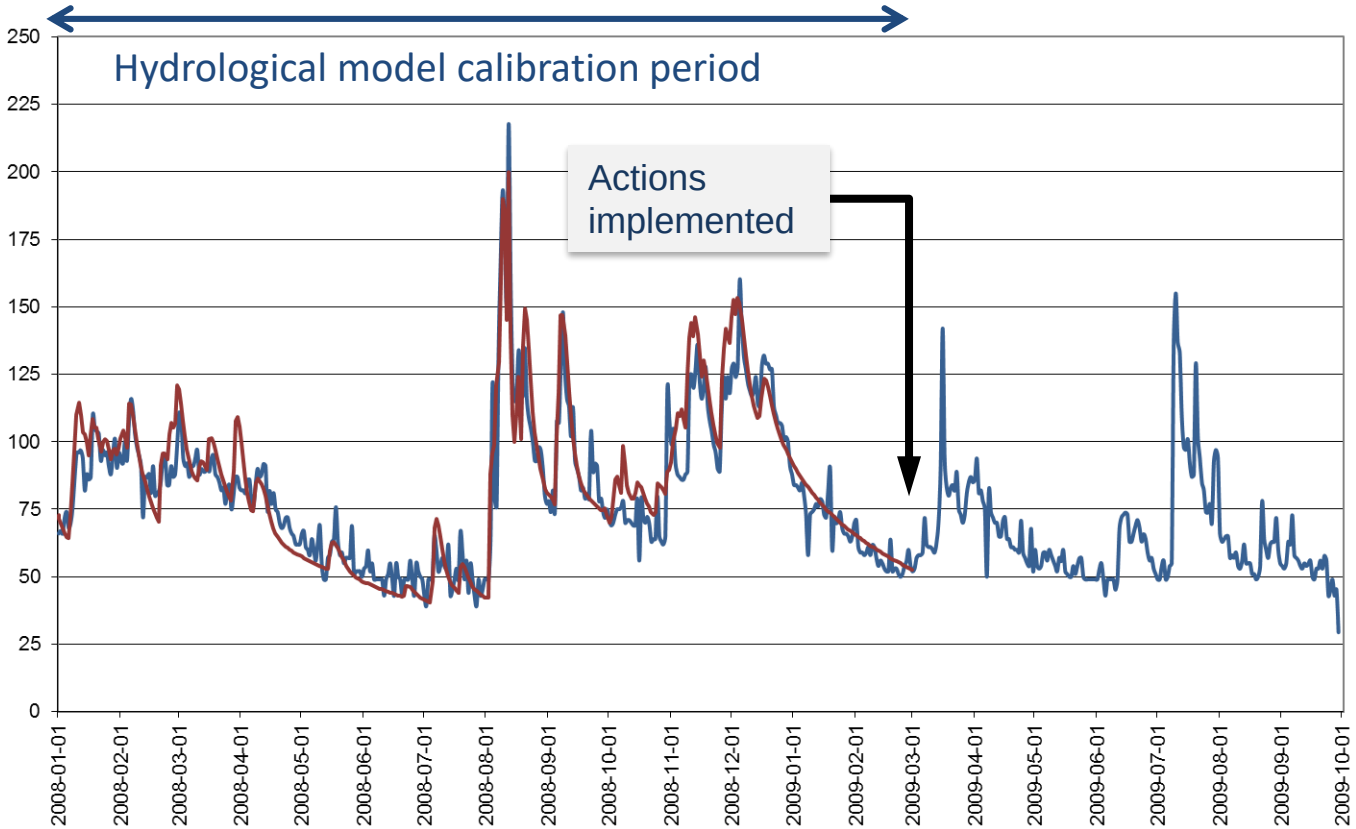

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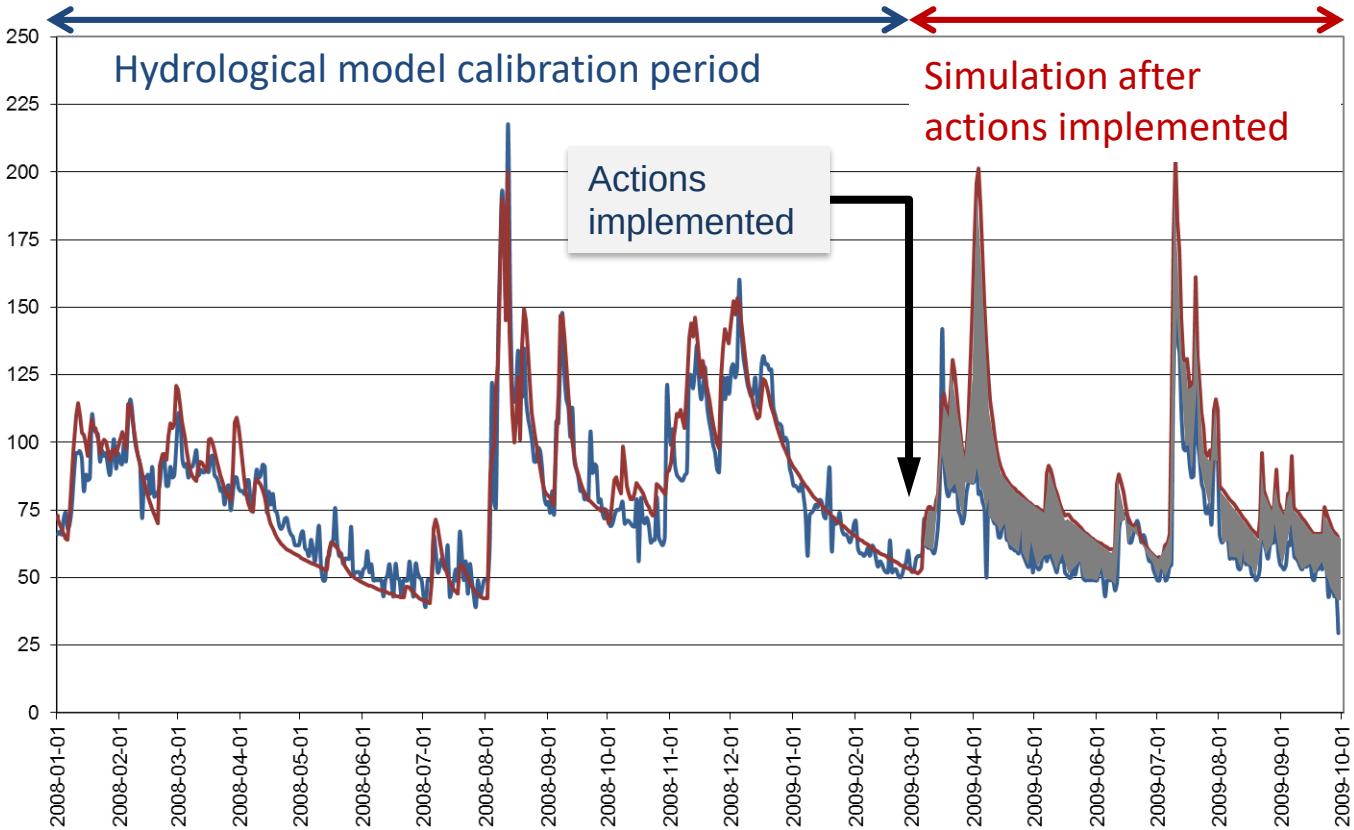
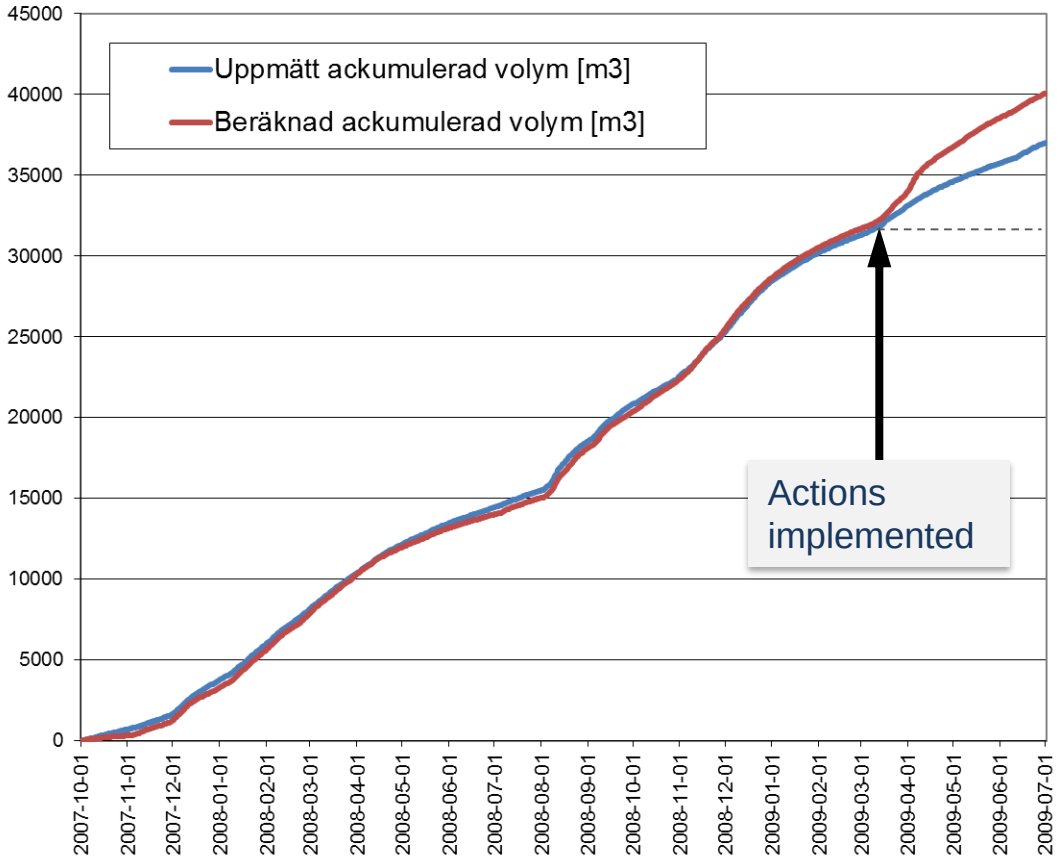


Difference interpreted as effect of actions

… and for follow up after actions and measures

Observed and simulated cumulative volumes, Oct 2007 – June 2009



Effect of actions = 35 %

5.

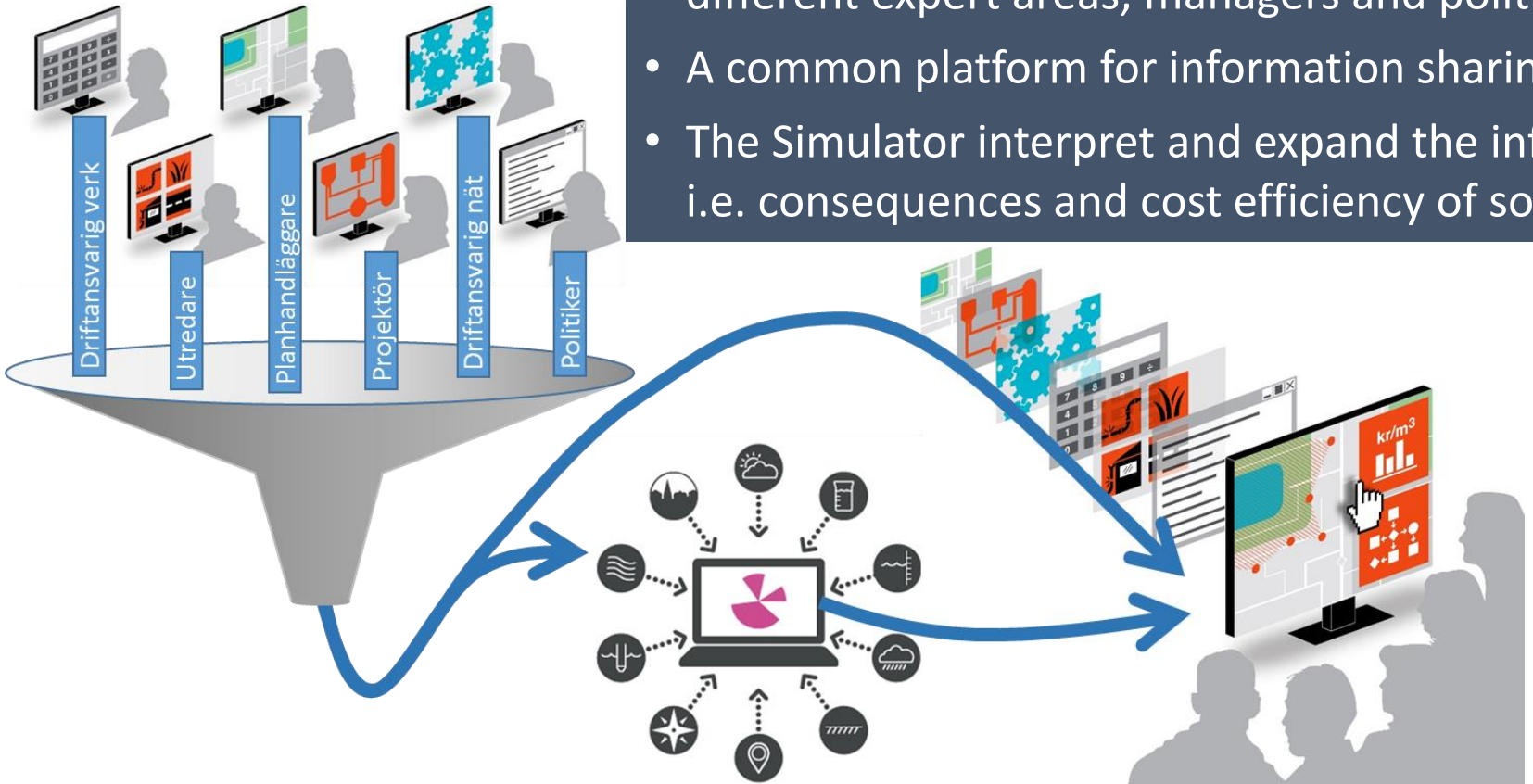
New

Simulator for planning of actions

A part of The “FutureCityFlow” project

The *"FutureCityFlow"* decision support system

- Integrates information and creates a link between different expert areas, managers and politicians
- A common platform for information sharing
- The Simulator interpret and expand the information, i.e. consequences and cost efficiency of solutions



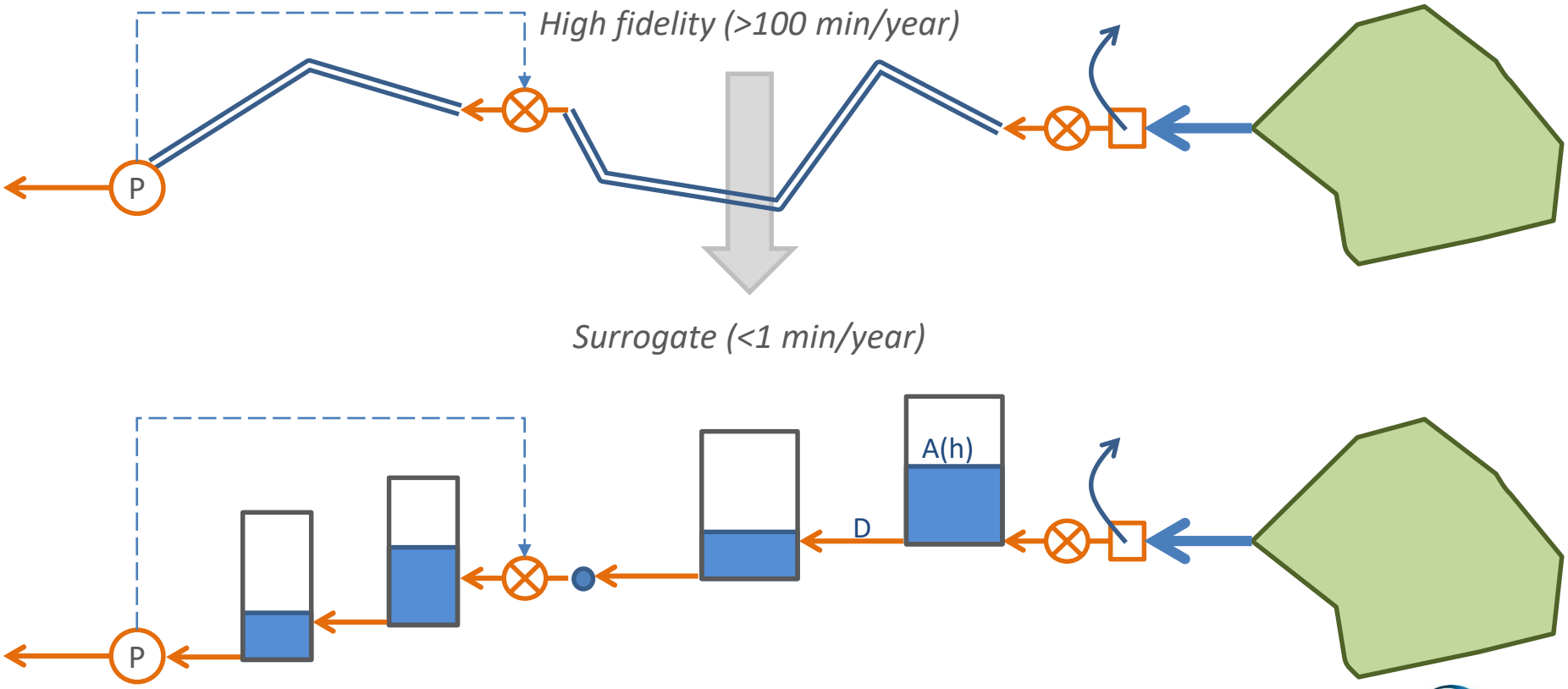
Simulator for screening and planning of actions and changes

Decision on physical actions in sewer systems demands knowledge about:

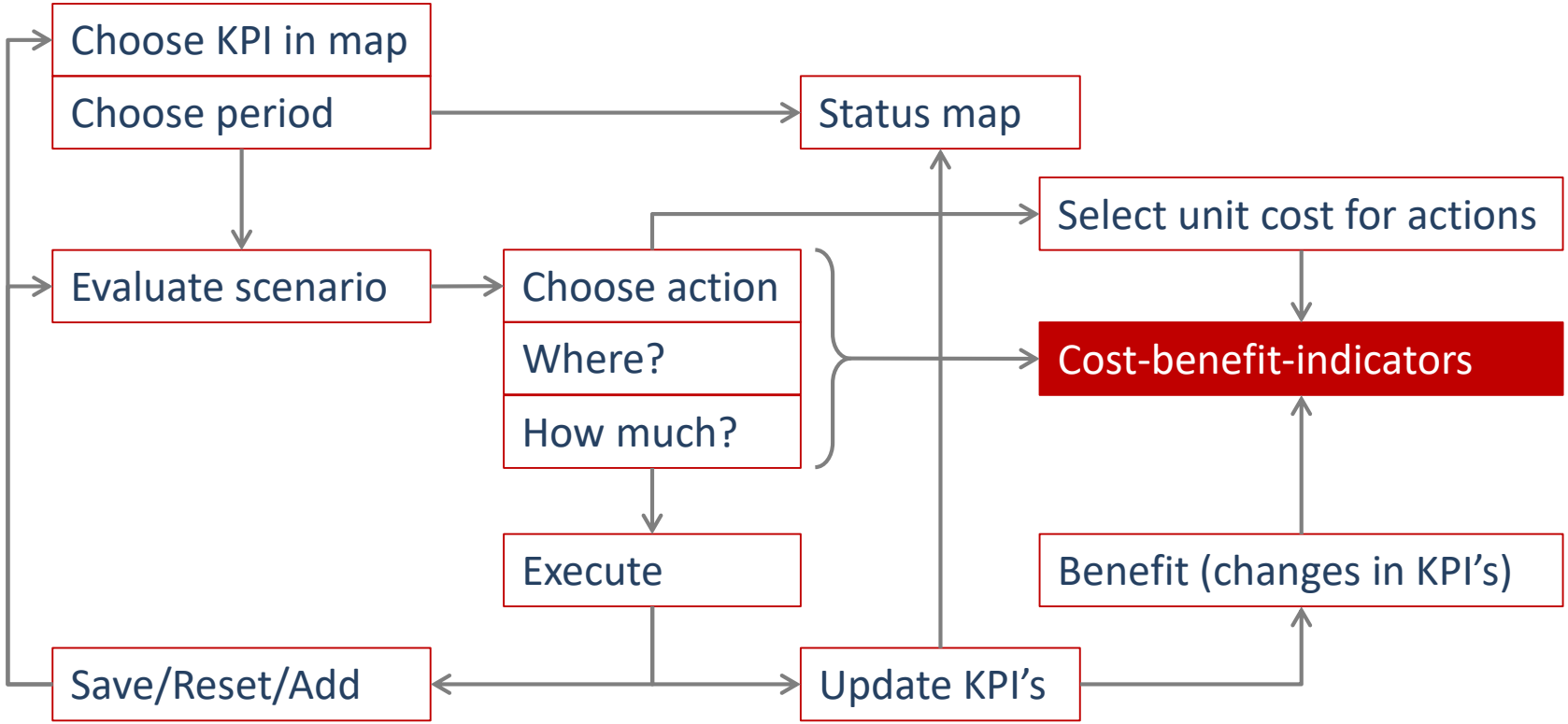
- the state and conditions from different perspectives
- the cost efficiency of different potential actions
- the effects/benefits from different potential actions

- ➢ Develop automatic routines for key performance indicators and cost-benefit indicators
- ➢ Develop a fast simulator where actions can be tested interactively

Surrogate model 100x faster providing an interactive feeling



Principle operation schedule for the Simulator



Göteborgs Stad

FUTURE CITY FLOW

Simulator for analyses and planning of actions in drainage system

Gryaab

Chose KPI: Dilution extent

Period: 2016

Chose action: Sewer relining

Chose area/object

Size/extent: 7000 m

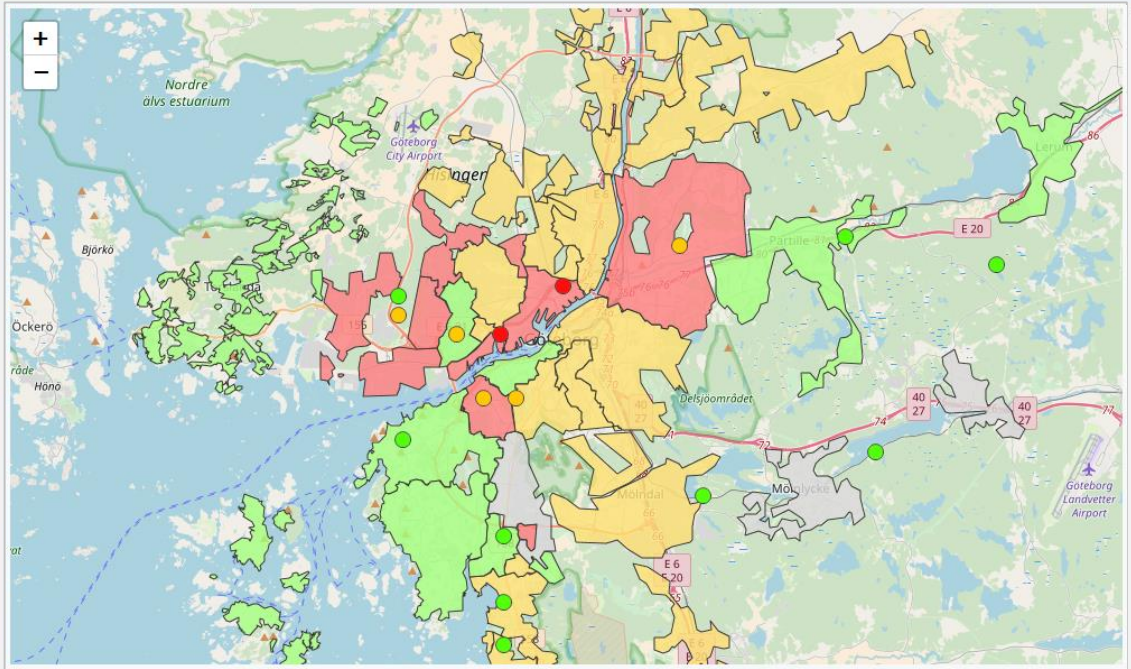
Simulate

Sim running

Save

Reset

Add action



Overall KPI's

USG 2.1

TDA 53 m2/m

CSO 3.7%

BNA 7.8 m2/m

Cost/benefit indicators

123 kr/m^2 BNA

234 kr/m^3 CSO

Göteborgs Stad

FUTURE CITY FLOW

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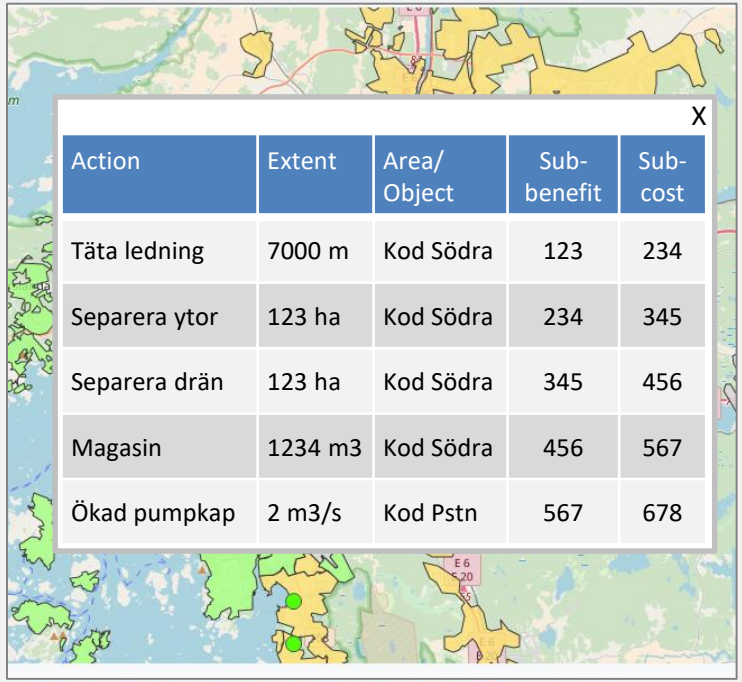
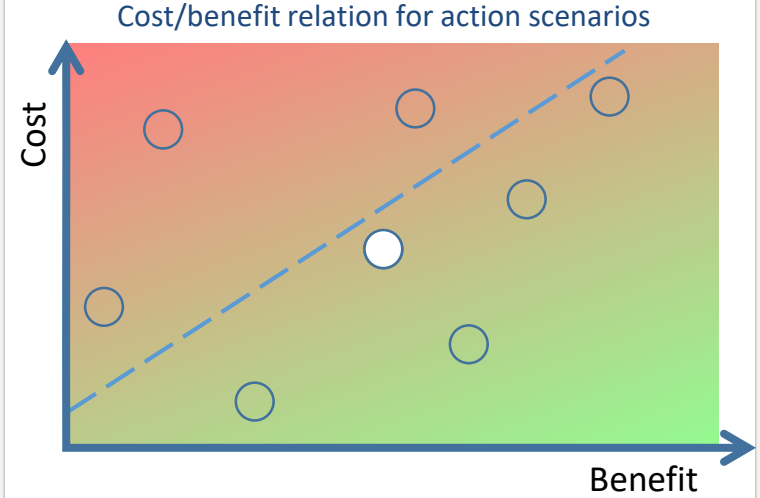


X

Action	Extent	Area/ Object	Sub-benefit	Sub-cost
Täta ledning	7000 m	Kod Södra	123	234
Separera ytor	123 ha	Kod Södra	234	345
Separera drän	123 ha	Kod Södra	345	456
Magasin	1234 m3	Kod Södra	456	567
Ökad pumpkap	2 m3/s	Kod Pstn	567	678

Chose KPI: Dilution extent

Period: 2016



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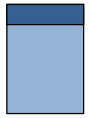

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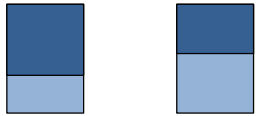

Cost/benefit indicators

123 kr/m^2 BNA

234 kr/m^3 CSO


Thank You !