VINNOVA
Sweden's Innovation Agency

Future City Flow. Helps you reducing the impacts of rain in your city.

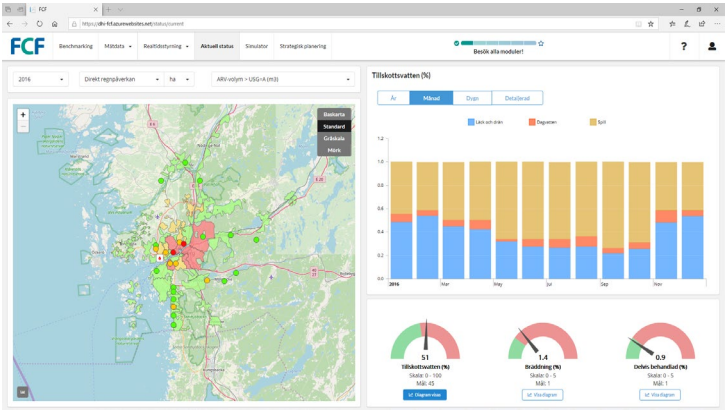
Presented by Sten Lindberg, DHI

DHI


Flooding
Overflow
Bypass

Future City Flow

The right measures at the right time, with digital twins.



Two integrated tools:

- Short term: Control your flows in real time using weather adapted control strategies
- Long term: Plan and invest in with best cost/benefit ratio

Both tools use the Historical time series data repository

The way we do it

Prioritize

Reveal which areas of your city are contributing the most negative impact and conduct real-time target-based performance evaluations to execute weather adapted, model control-based strategies.

Strategize

Formulate a comprehensive mitigation plan based on modelled and measured data including a cost-benefit assessment of actions in different locations.

Monetize

Put an end to spending time and money on ineffective reactive assessments and mitigation measures without proper insight of cost efficiency and expected ROI.

DHI

References

VA SYD, City of Malmö
Sweden

NSVA, City of Helsingborg
Sweden

Gryaab, City of Gothenburg
Sweden

BIOFOS, City of Copenhagen
Denmark

Sydney Water, Sydney
Australia

City of Gold Coast
Australia

Tauranga City Council
New Zealand

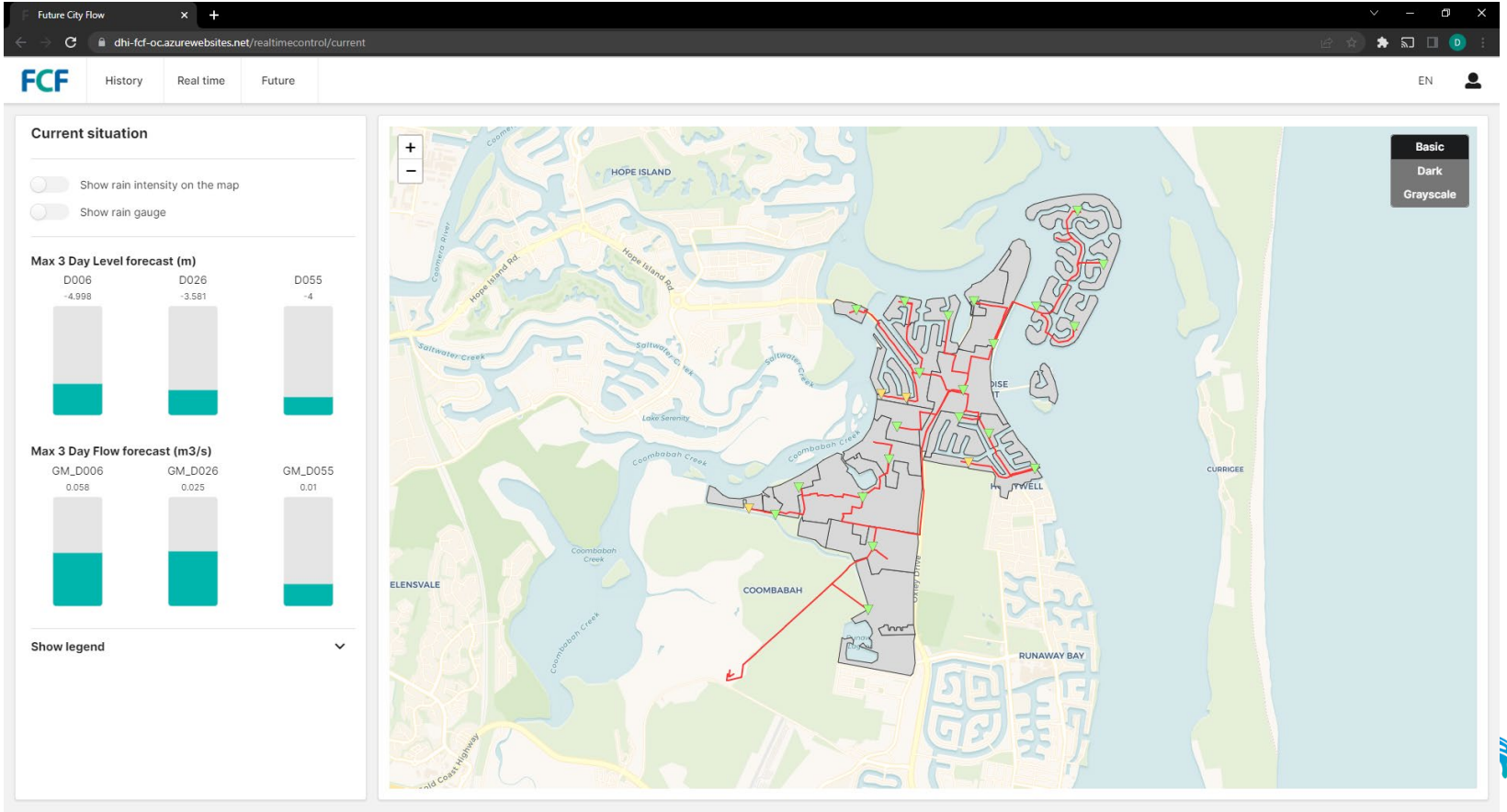
VEAS, City of Oslo
Norway

Client implementation

Model Predictive Controls @ City of Gold Coast

- Improve operational efficiencies today.
- Predictability in the face of storms tomorrow.
- Understand logistical issues in the future.

System snapshot

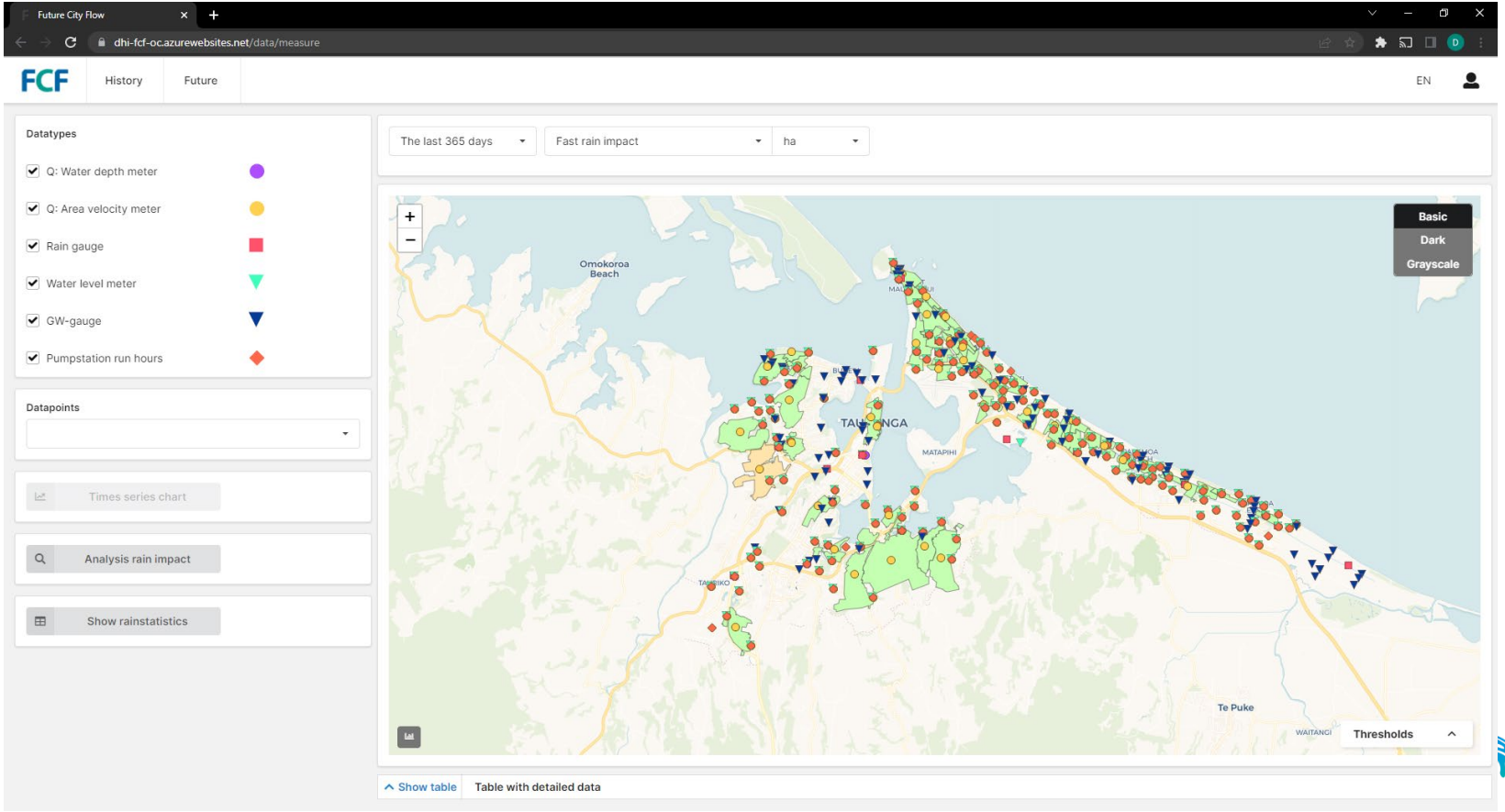


Client implementation

Strategic planning @ Tauranga City Council

- Identify the most effective remedial solution
- Defer marine outfall capital expenditure
- Meet legislative and community expectations

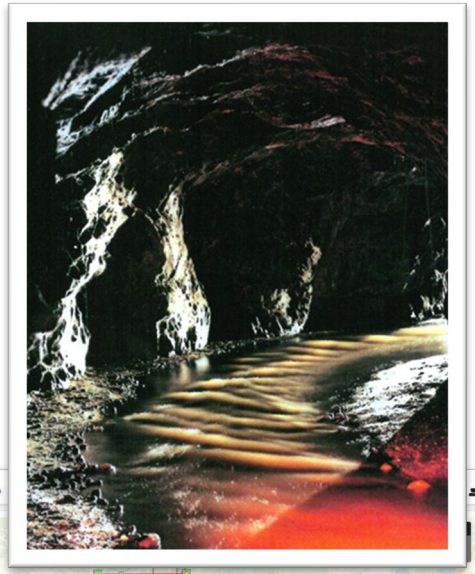
System snapshot



Client implementation

Real time control@ Gothenburg, Sweden

Length of tunnels and pipes included	100 km
Tunnel volume modelled - attenuation	700 000 m^3 (of 1 000 000) approx. 250 00 m^3
Number of sub-catchments modelled	47
Impervious surface	20 km^2
Total drainage area - from I&I	250 km^2 approx. 50 %
Sewer overflow structures modelled	40
Pumping stations modelled	10
Valves and gates modelled	8
Control	13 structures controlled by 7 model sensors 7 defined overall conditions 50 control actions in total



FCF | History | Real time | Current situation | Forecast/Control | Control strategies | FOD | Future | EN

ALL MODULES | DASHBOARD

HISTORY

- Rain statistics
- Monitoring data
- Reports
- Capacity Analysis

REAL TIME

- Current situation
- Forecast/Control
- Control strategies
- FOD

FUTURE

- Planning
- Targets
- Methodology
- Benchmarking

Future City Flow

dhi-fcf.azurewebsites.net/realtimecontrol/current

FCF | Historik | Realtid | Aktuellt läge | Prognosdiagram | Styrstrategier | FOD | Framtid | SV

Aktuellt läge

Visa regnintensitet på kartan

Visa regnmätare

Nivå (m), max i prognos

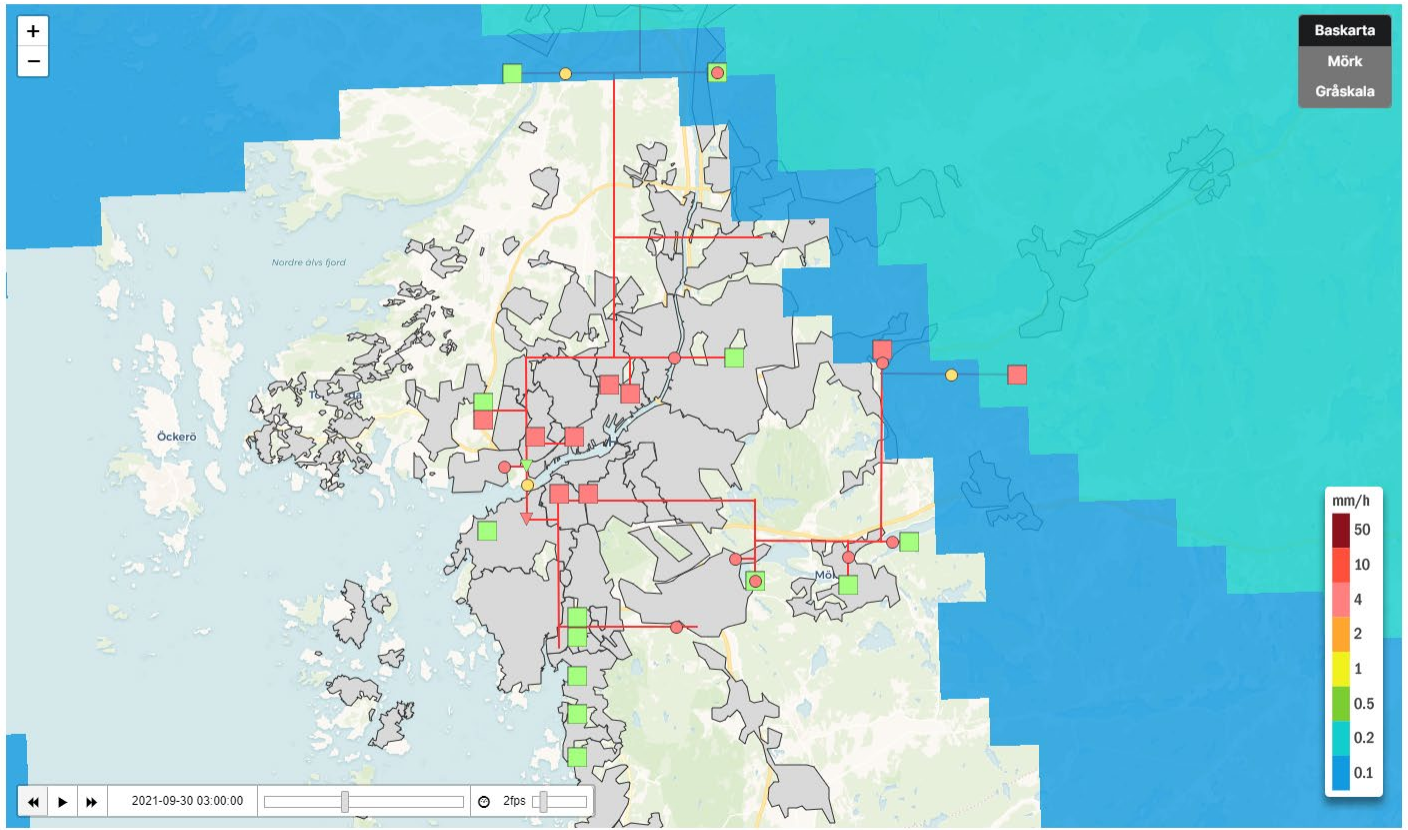
Ryaverket	Rödasten
-10.031	-1.78

Flöde (m3/s), max i prognos

Ryaverket	Rödasten
12.549	4.989

Total magasinering (m3)

Nu (TOF)	Max i prognos
123332	331255



https://dhi-fcf.azurewebsites.net/#

Type here to search

12°C

14:34
2021-09-29

Future City Flow

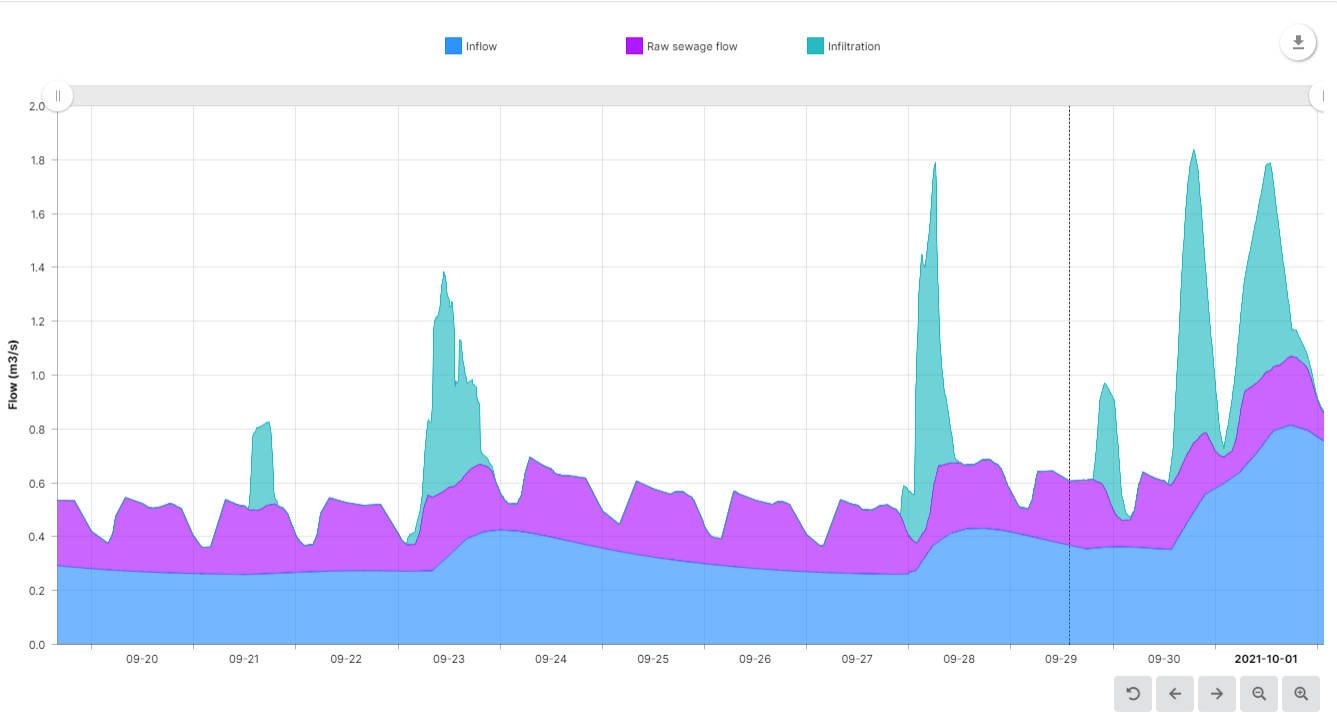
dhi-fcf.azurewebsites.net/realtimecontrol/current

FCF | History | Real time | Future | EN

Use fixed scale

Timelines

- Ale
- Angered
- Askims Industriområde
- Askimsviken
- Backa
- Barlastplatsen
- Björlandavägen
- Bulycke
- Frölunda Norra
- Frölunda Västra
- Grundsö
- Götabergsgatan
- Herkulesgatan Norra
- Herkulesgatan Södra
- Kindesvarv
- (●) Kodammarna Norra
- Kodammarna Södra
- Krokängsparken
- Kungälv Kastellgården
- Kungälv Älvparken
- Landvetter
- Lerum
- Majorna
- Mölndal Järnvägsgatan
- Mölndal Knapegården



Type here to search

12°C

14:35
2021-09-29

Future City Flow

dhi-fcf.azurewebsites.net/realtimecontrol/forecast

FCF | History | Real time | Current situation | Forecast/Control | Control strategies | FOD | Future | EN

Forecast/Control

Use fixed scale

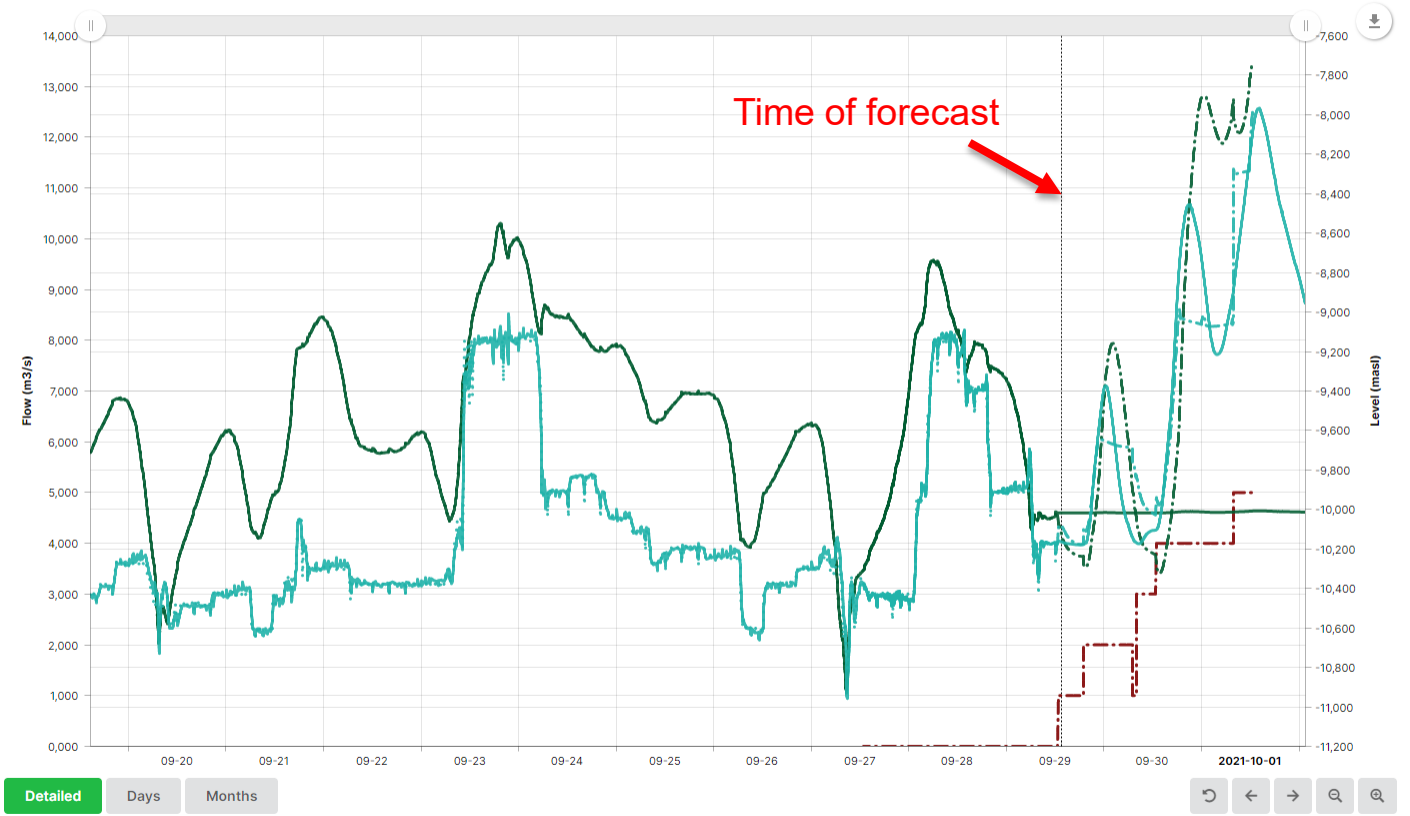
View meteorological data

Chosen simulations

- [ ] Forecast F1 catchment without DA
- [x] Forecast F2 catchment with DA
- [x] Forecast control strategy with DA
- [ ] Forecast F4 ensemble
- [ ] Forecast FOD with DA
- [x] Measured data
- [ ]
- [ ] History S1 without DA
- [x] History S2 with DA

Chosen data

- [ ] Bräddflöden
- [ ] Kodammarna
- [ ] Tillflöden
- [x] Ryaverket
  - [x] Flow Ryaverket
  - [x] Level Ryaverket
  - [ ] Flow Flödesprognos 0-1h
  - [ ] Flow Flödesprognos 1-3h
  - [ ] Flow Flödesprognos 3-6h
  - [ ] Flow Flödesprognos 6-12h
  - [ ] Flow Flödesprognos 12-24h
  - [x] Flow Styrstrategi
  - [ ] Flow Bräddpunkt
- [ ] Röda Sten
- [ ] Vattenbalans



Detailed | Days | Months

Type here to search

12°C

14:38
2021-09-29

Future City Flow

dhi-fcf.azurewebsites.net/realtimecontrol/forecast

FCF | History | Real time | Current situation | Forecast/Control | Control strategies | FOD | Future | EN

Forecast/Control

Use fixed scale

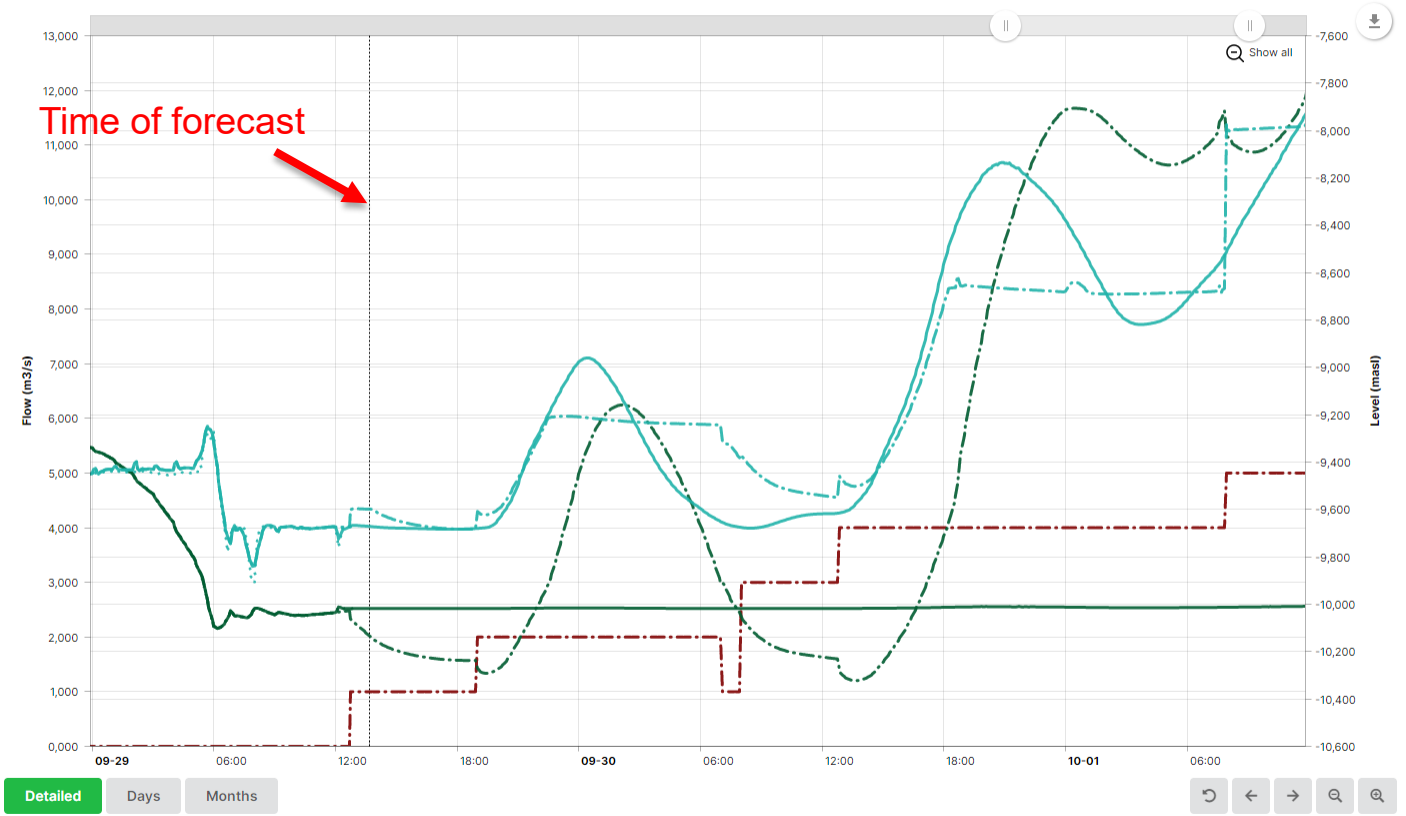
View meteorological data

Chosen simulations

- [ ] Forecast F1 catchment without DA
- [x] Forecast F2 catchment with DA
- [x] Forecast control strategy with DA
- [ ] Forecast F4 ensemble
- [ ] Forecast FOD with DA
- [x] Measured data
- [ ]
- [ ] History S1 without DA
- [x] History S2 with DA

Chosen data

- [ ] Bräddflöden
- [ ] Kodammarna
- [ ] Tillflöden
- [x] Ryaverket
  - [x] Flow Ryaverket
  - [x] Level Ryaverket
  - [ ] Flow Flödesprognos 0-1h
  - [ ] Flow Flödesprognos 1-3h
  - [ ] Flow Flödesprognos 3-6h
  - [ ] Flow Flödesprognos 6-12h
  - [ ] Flow Flödesprognos 12-24h
  - [x] Flow Styrstrategi
  - [ ] Flow Bräddpunkt
- [ ] Röda Sten
- [ ] Vattenbalans



Type here to search

12°C

14:41

2021-09-29

Future City Flow

dhi-fcf.azurewebsites.net/realtimecontrol/forecast

FCF | History | Real time | Current situation | Forecast/Control | Control strategies | FOD | Future | EN

Forecast/Control

Use fixed scale

View meteorological data

Chosen simulations

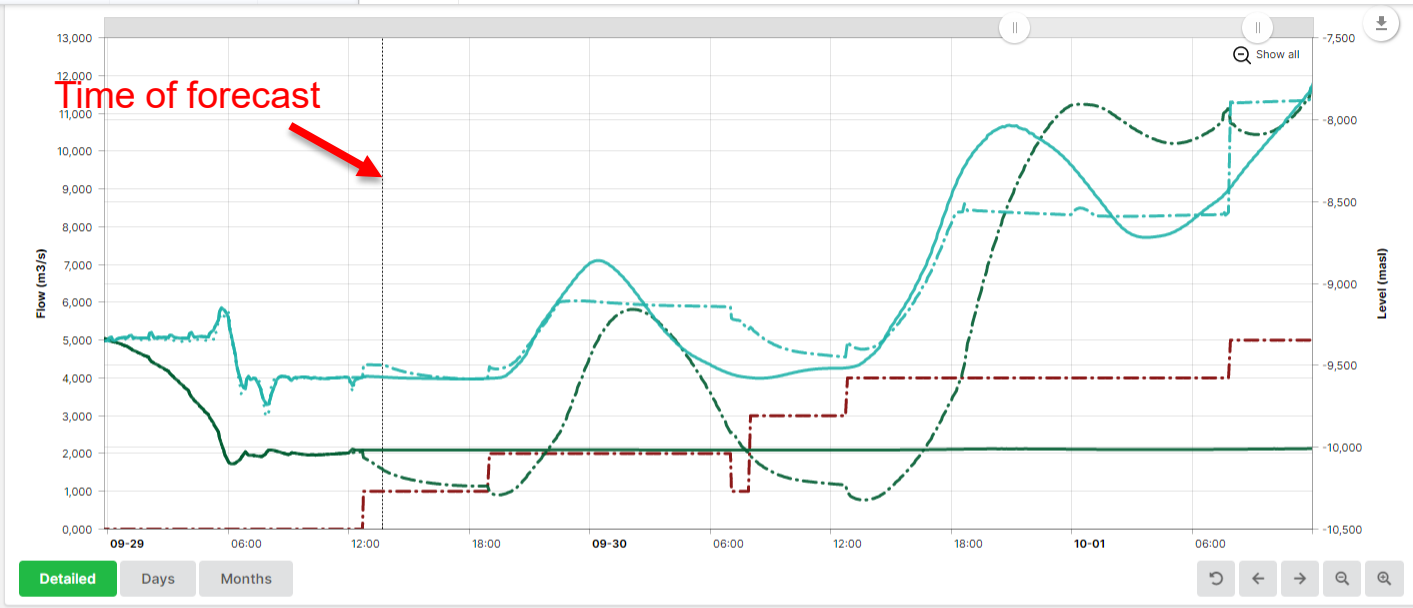
- [ ] Forecast F1 catchment without DA
- [x] Forecast F2 catchment with DA
- [x] Forecast control strategy with DA
- [ ] Forecast F4 ensemble
- [ ] Forecast FOD with DA
- [x] Measured data
- [ ]
- [ ] History S1 without DA
- [x] History S2 with DA

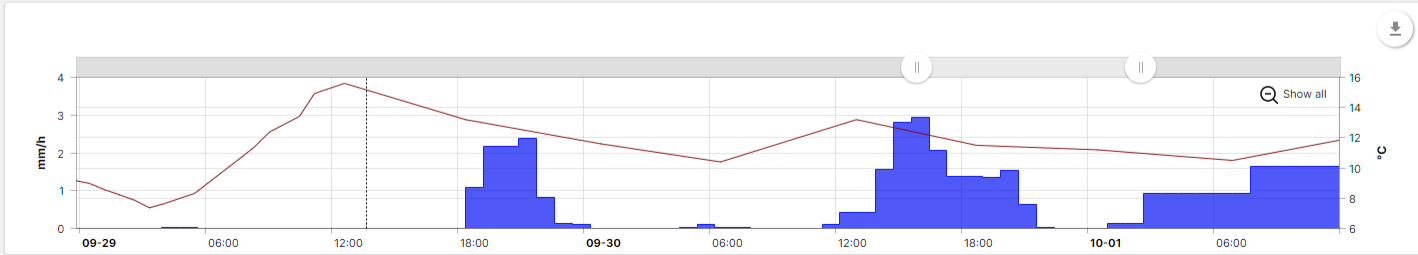
Chosen data

- [ ] Bräddflöden
- [ ] Kodammarna
- [ ] Tillflöden
- [x] Ryaverket
  - [x] Flow Ryaverket
  - [x] Level Ryaverket
  - [ ] Flow Flödesprognos 0-1h
  - [ ] Flow Flödesprognos 1-3h
  - [ ] Flow Flödesprognos 3-6h
  - [ ] Flow Flödesprognos 6-12h
  - [ ] Flow Flödesprognos 12-24h
  - [x] Flow Styrstrategi
  - [ ] Flow Bräddpunkt
- [ ] Röda Sten
- [ ] Vattenbalans

Meteorology

- [x] Rainfall
- [x] Temperature





Type here to search

12°C

14:40

2021-09-29

FCF

dhi-fcf.azurewebsites.net/realtimecontrol/forecast

FCF | Real time control | Planning | Monitoring data | Benchmarking | Besök alla moduler!

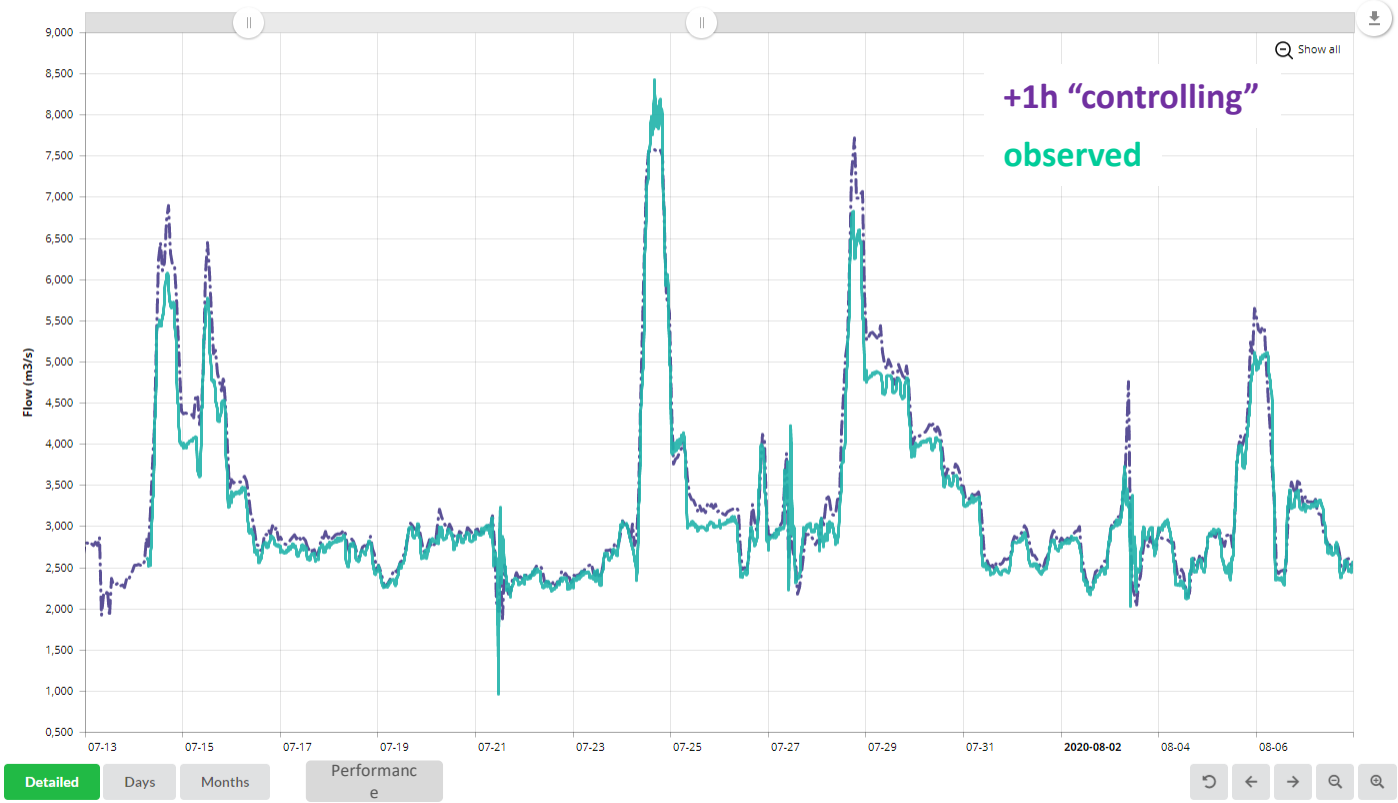
Forecast graph

Chosen simulations

- [ ] Forecast F1 catchment without DA
- [ ] Forecast F2 catchment with DA
- [x] Forecast control strategy with DA
- [ ] Forecast FOD with DA
- [ ] Measured data
- [ ] History S1 without DA
- [x] History S2 with DA

Chosen data

- [ ] Bräddflöden
- [ ] Kodammarna
- [ ] Tillflöden
- [x] Ryaverket
  - [x] Flow Ryaverket
  - [ ] Level Ryaverket
  - [x] Flow Flödesprognos 0-1h
  - [ ] Flow Flödesprognos 1-3h
  - [ ] Flow Flödesprognos 3-6h
  - [ ] Flow Flödesprognos 6-12h
  - [ ] Flow Flödesprognos 12-24h
  - [x] Flow Styrstrategi
- [ ] Röda Sten
- [ ] Vattenbalans



11:24
2020-09-12

FCF

dhi-fcf.azurewebsites.net/realtimecontrol/forecast

FCF | Real time control | Planning | Monitoring data | Benchmarking | Besök alla moduler!

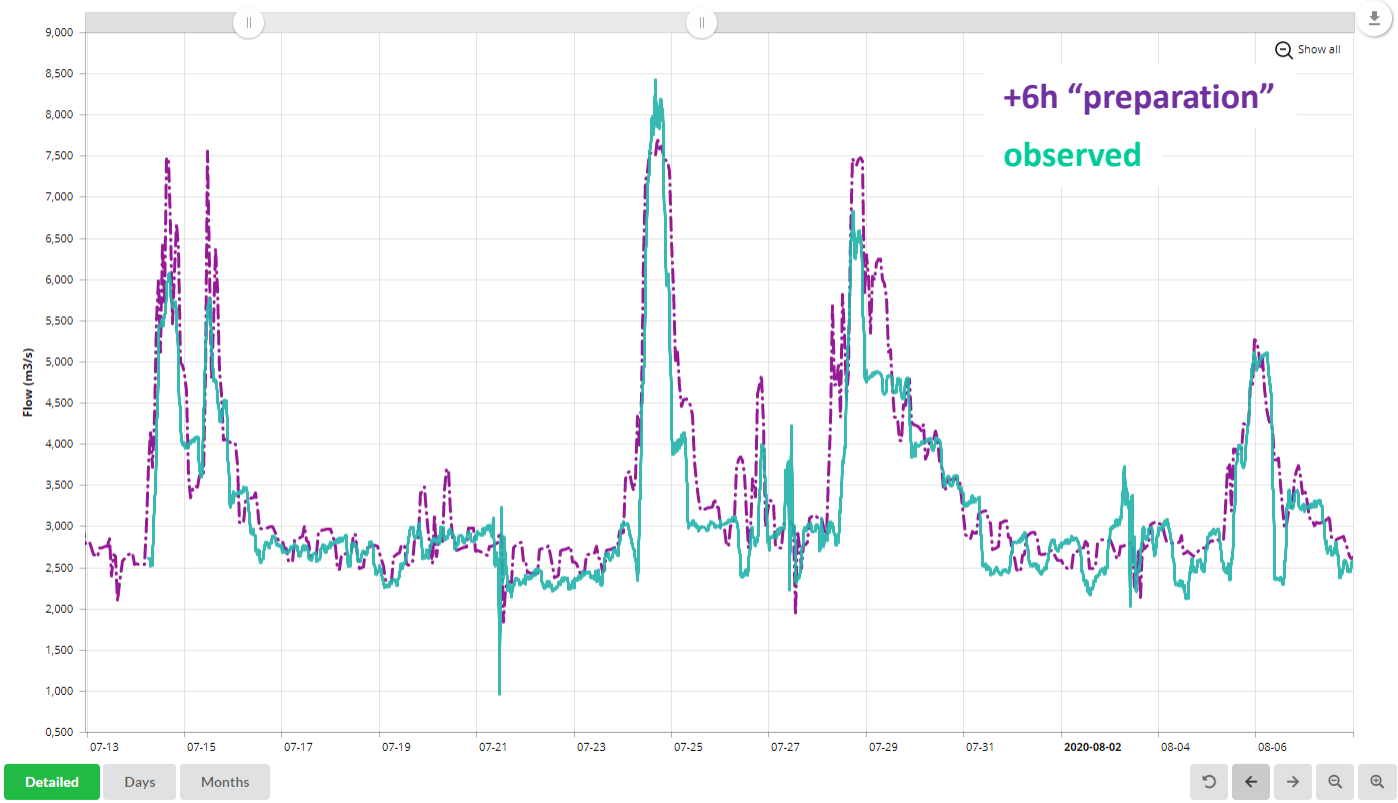
Forecast graph

Chosen simulations

- [ ] Forecast F1 catchment without DA
- [ ] Forecast F2 catchment with DA
- [x] Forecast control strategy with DA
- [ ] Forecast FOD with DA
- [ ] Measured data
- [ ] History S1 without DA
- [x] History S2 with DA

Chosen data

- [ ] Bräddflöden
- [ ] Kodammarna
- [ ] Tillflöden
- [x] Ryaverket
  - [x] Flow Ryaverket
  - [ ] Level Ryaverket
  - [ ] Flow Flödesprognos 0-1h
  - [ ] Flow Flödesprognos 1-3h
  - [x] Flow Flödesprognos 3-6h
  - [ ] Flow Flödesprognos 6-12h
  - [ ] Flow Flödesprognos 12-24h
  - [x] Flow Styrstrategi
- [ ] Röda Sten
- [ ] Vattenbalans



11:35
2020-09-12

FCF

dhi-fcf.azurewebsites.net/realtimecontrol/forecast

FCF | Real time control | Planning | Monitoring data | Benchmarking | Besök alla moduler!

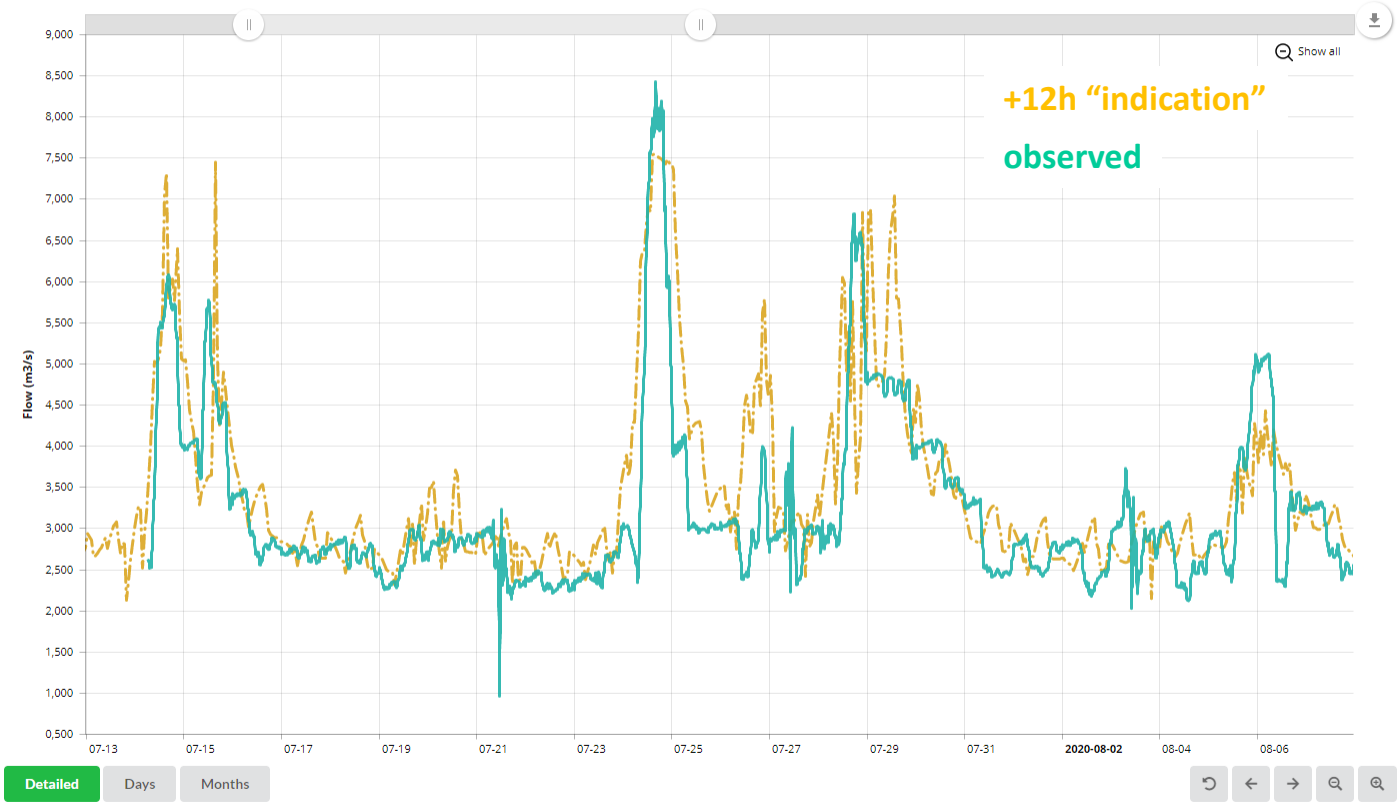
Forecast graph

Chosen simulations

- [ ] Forecast F1 catchment without DA
- [ ] Forecast F2 catchment with DA
- [x] Forecast control strategy with DA
- [ ] Forecast FOD with DA
- [ ] Measured data
- [ ] History S1 without DA
- [x] History S2 with DA

Chosen data

- [ ] Bräddflöden
- [ ] Kodammarna
- [ ] Tillflöden
- [x] Ryaverket
  - [x] Flow Ryaverket
  - [ ] Level Ryaverket
  - [ ] Flow Flödesprognos 0-1h
  - [ ] Flow Flödesprognos 1-3h
  - [ ] Flow Flödesprognos 3-6h
  - [x] Flow Flödesprognos 6-12h
  - [ ] Flow Flödesprognos 12-24h
  - [x] Flow Styrstrategi
- [ ] Röda Sten
- [ ] Vattenbalans

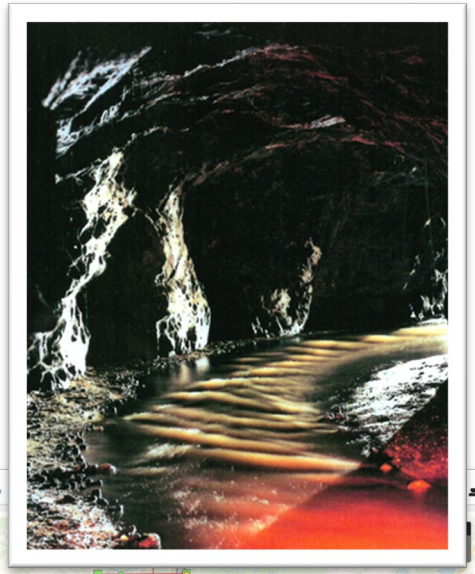


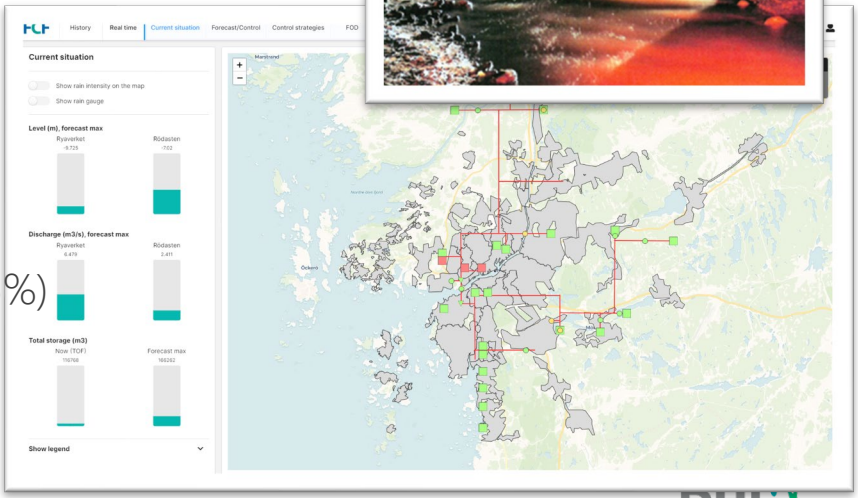
11:31
2020-09-12

Client implementation

Real time control@ Gothenburg, Sweden

- More robust operations, around the clock (plant only manned part-time)
- Better planning for operations (collection system and WRRF) during large rain events
- Able to quantify CSO's throughout the system
- Facilitates CSO optimization to minimize CSO impact on the recipients (estimated potential 2.5%)





THANK YOU

More info:
Dennis Wanninger dewa@dhigroup.com
Cecilia Wennberg cew@dhigroup.com
Sten Lindberg sl@dhigroup.com

Real Time Control behind the scenes

Step 1	1.	Data import of measurement data and processing/filtering
	2.	Data import of weather forecasts and transfer to model input
	3.	Quality control for measurement data with respect to anomalies and data mismatches
	4.	Data import of other relevant control variables (RISK model input)
Step 2	5.	Run hindcast (and forecast) without data assimilation and validate data assimilation input
	6.	Run simulation with data assimilation (-24h/+72h), including weather ensemble
	7.	Evaluate forecast conditions and adapt control strategy to latest forecast
Step 3	8.	Run forecast calculation with selected/customized control strategy
Step 4	9.	Export set points and settings, as well as forecast results to SCADA/PLC
Step 5	10.	Update web interface with latest results and push out any alerts/alarms (mail push)

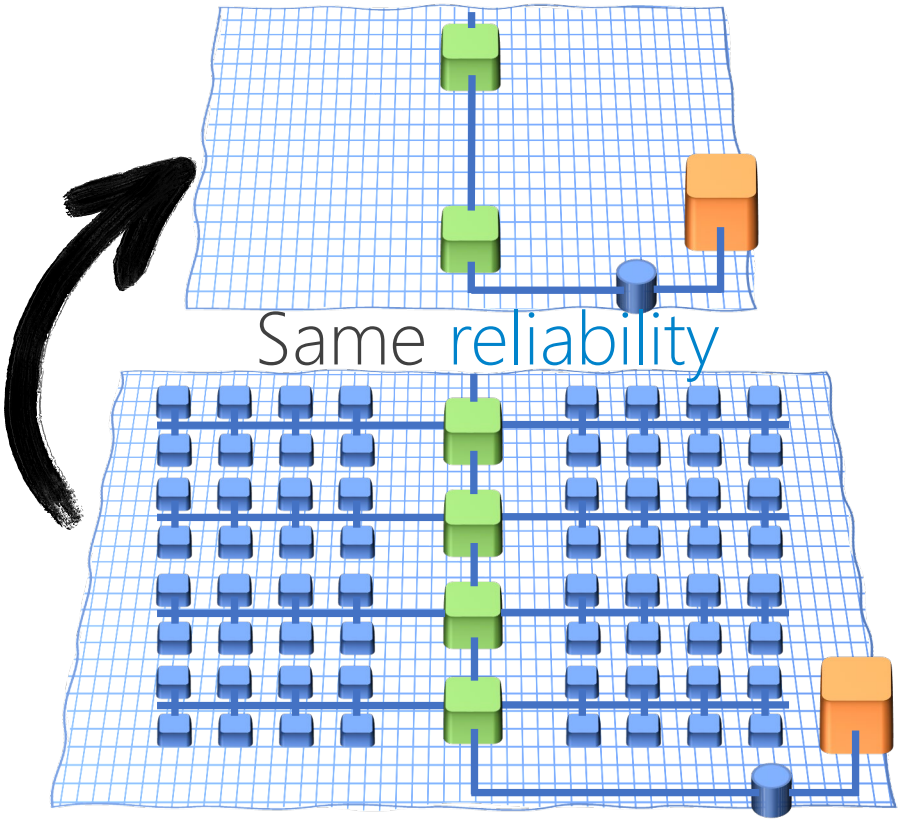
FCF modelling concept

Focused MIKE+/Urban

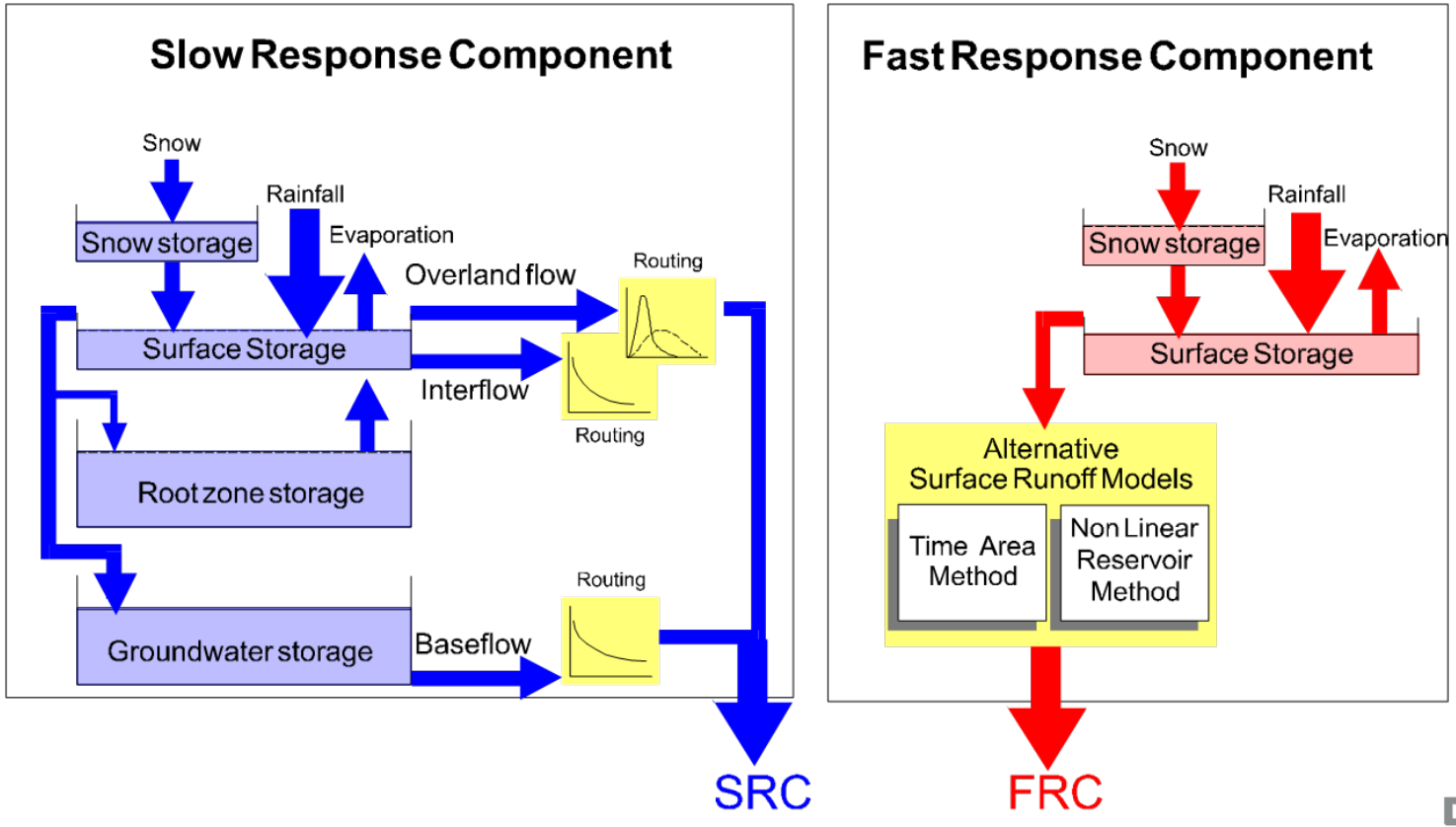
- Scheduled model executions
- Automatic connection to meteorological data
- Automated forecasts and data analysis
- Collect measurement and modelled data in one place

Detailed MIKE+/Urban

- Integrate, model and simulate detailed collection systems, rivers, flooding and treatment plants.
- Hydraulic network conditions
- Pollution transport
- Sedimentation



Inflow and infiltration components



Inflow and infiltration sources