STØTTET AF

Promilleafgiftsfonden for landbrug

TREX – AP2: Geophysics and water dynamics

Current status and future plan

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GEUS

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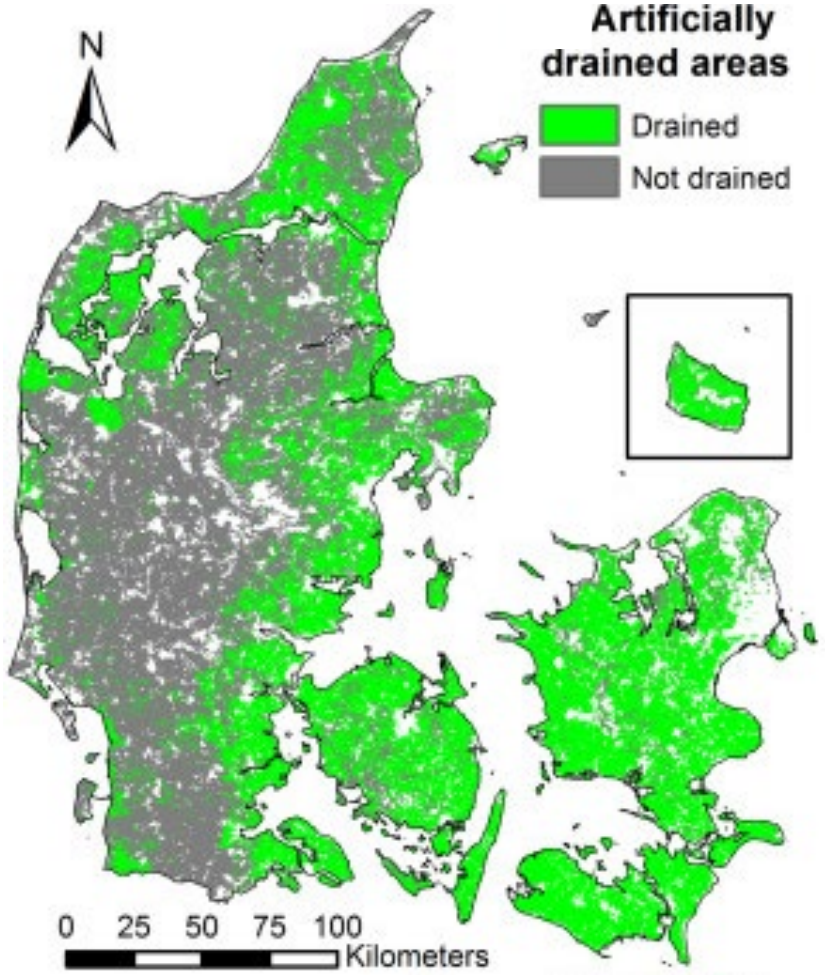
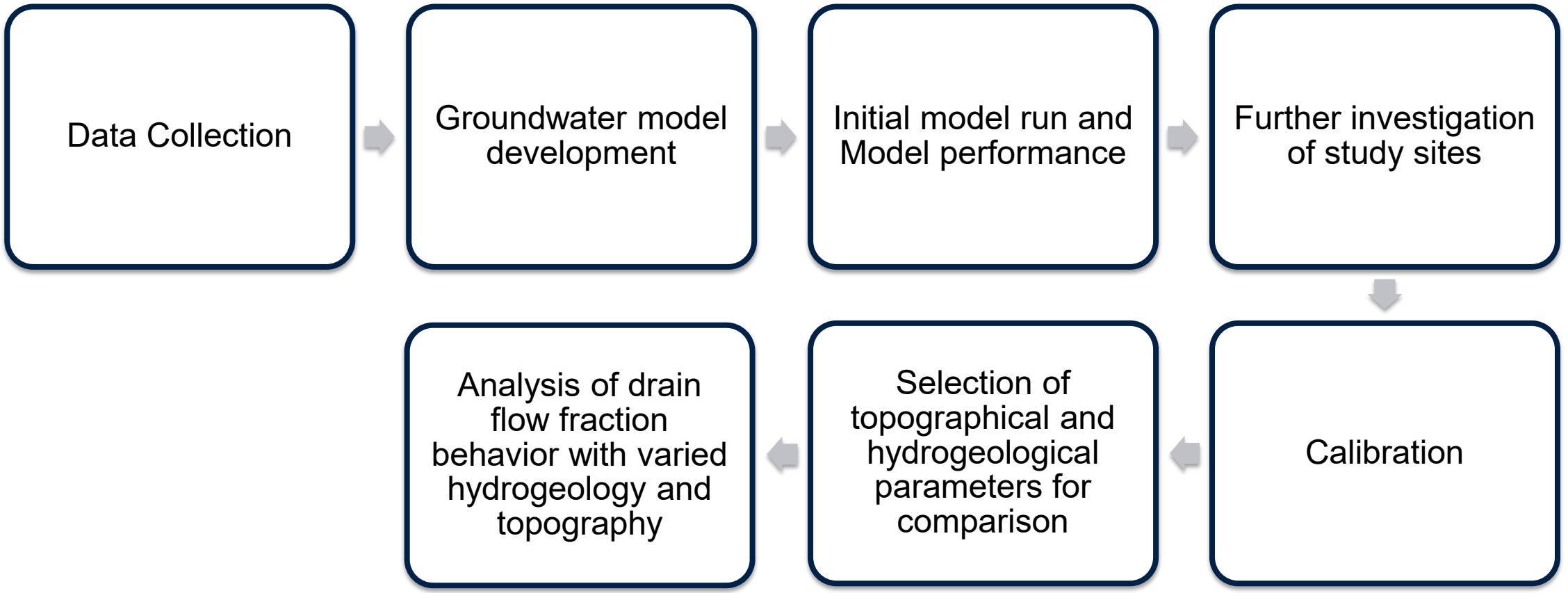
Background

- 50% of Denmark's agriculture area with tile drains (spanning over a wide range of hydrogeological and topographical conditions)
- Need to assess drain flow dynamics with varied topographical and hydrogeological setting – to get a bigger picture
- Multiple sites in Denmark from different locations are selected for the evaluation

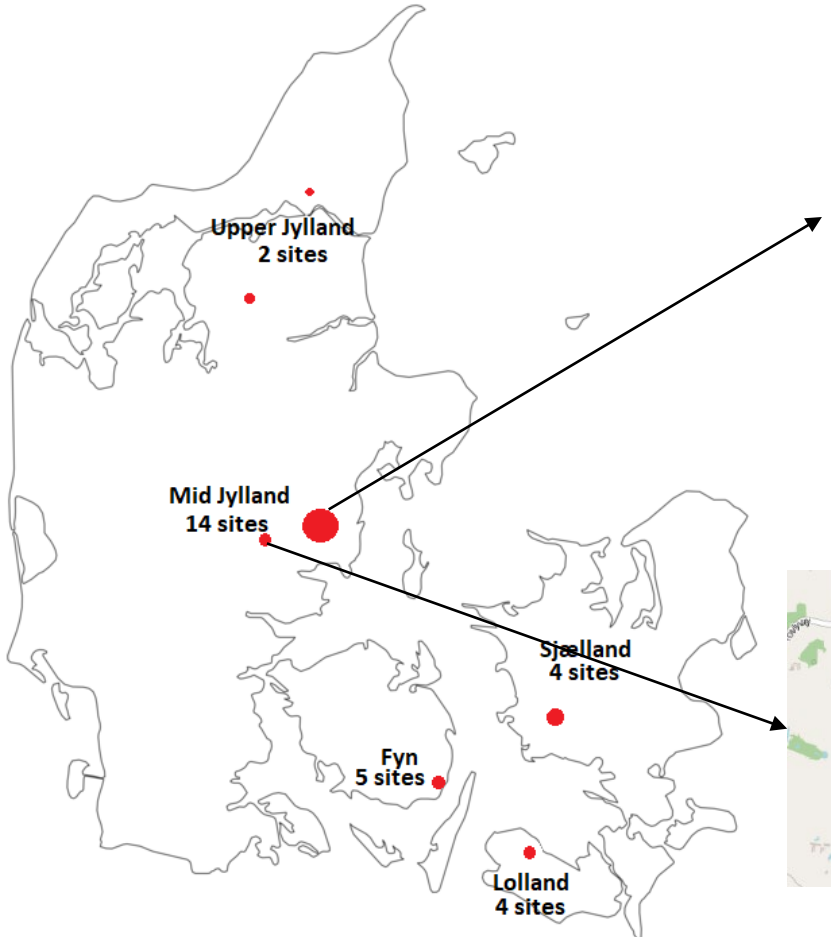


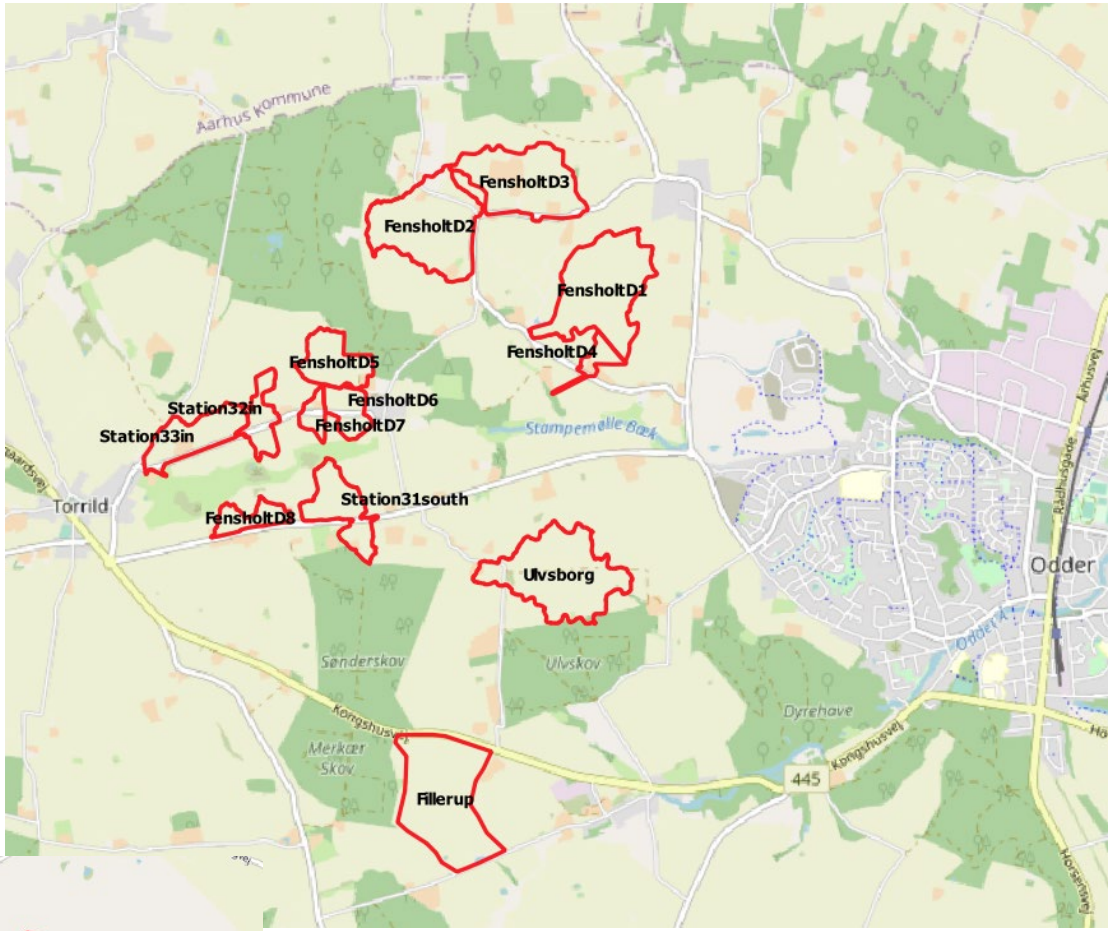
Møller et al, 2018

Workflow


Data Collection
Groundwater model development
Initial model run and Model performance
Further investigation of study sites
Calibration
Selection of topographical and hydrogeological parameters for comparison
Analysis of drain flow fraction behavior with varied hydrogeology and topography

Data collection and selection of catchments





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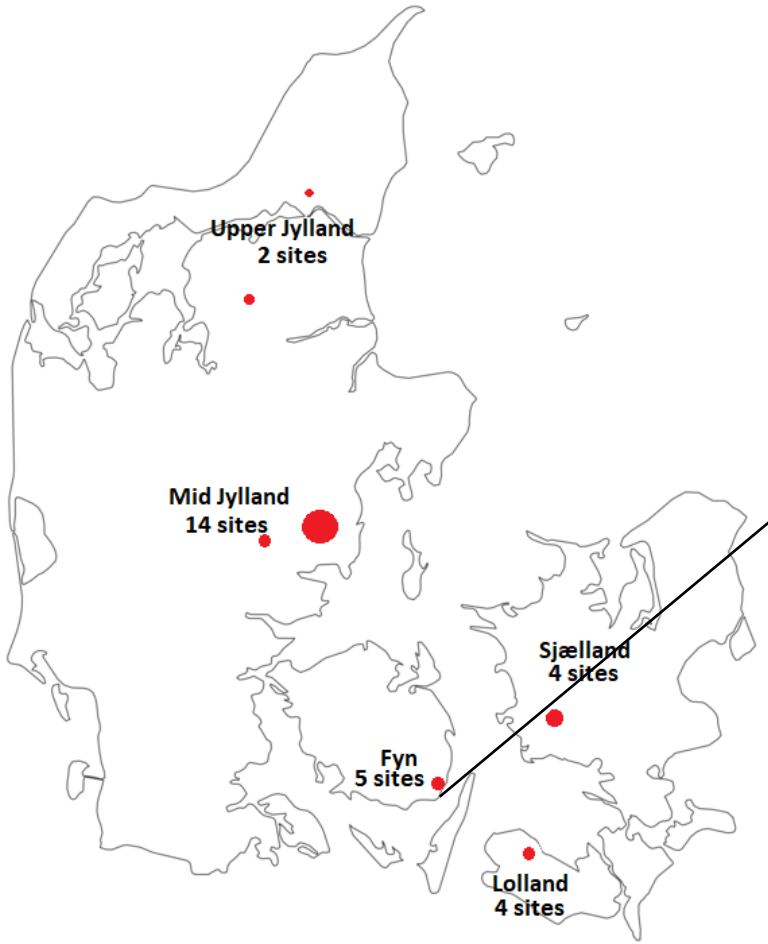
Data collection and selection of catchments

29 different sites in Denmark with Tile drain system



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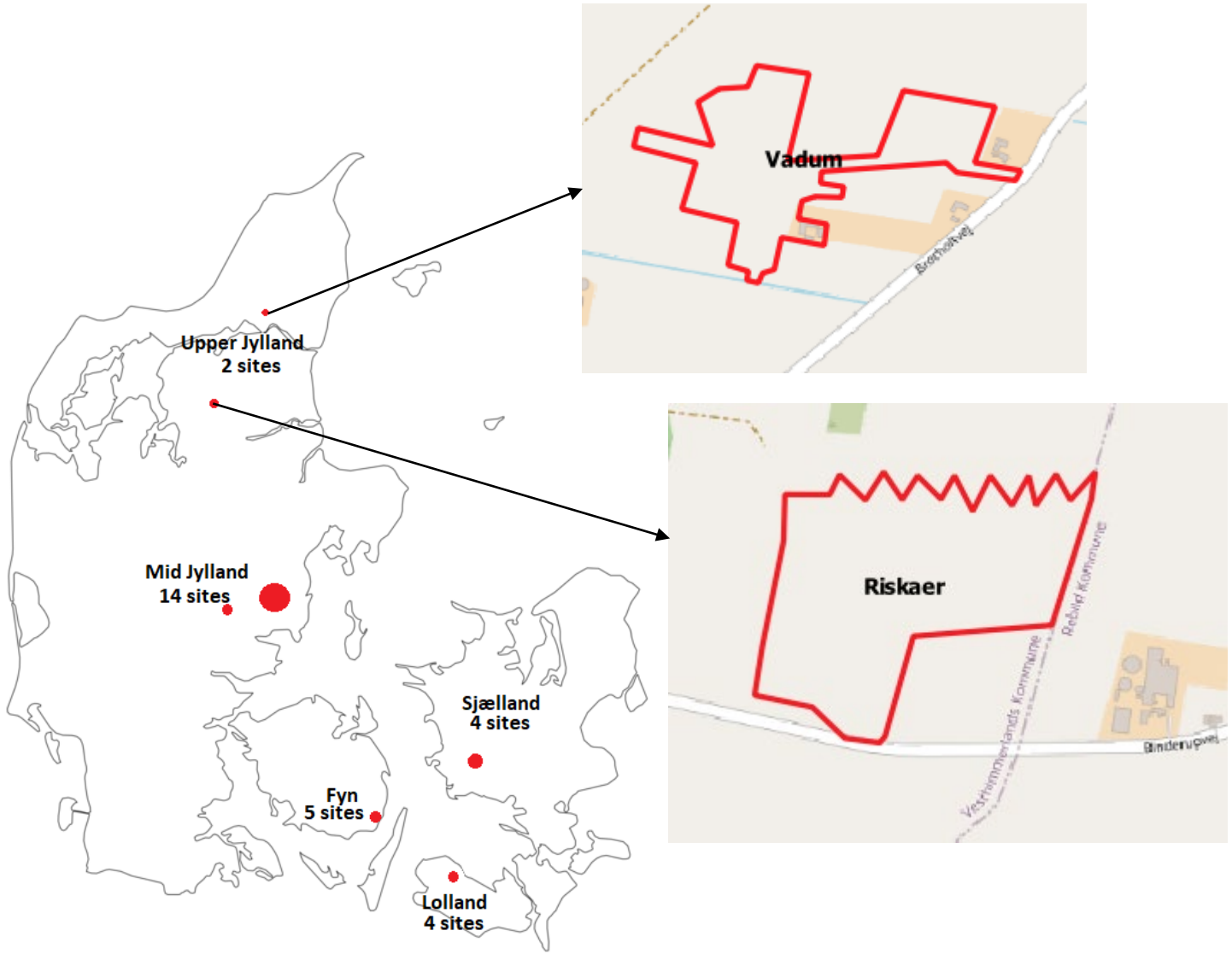

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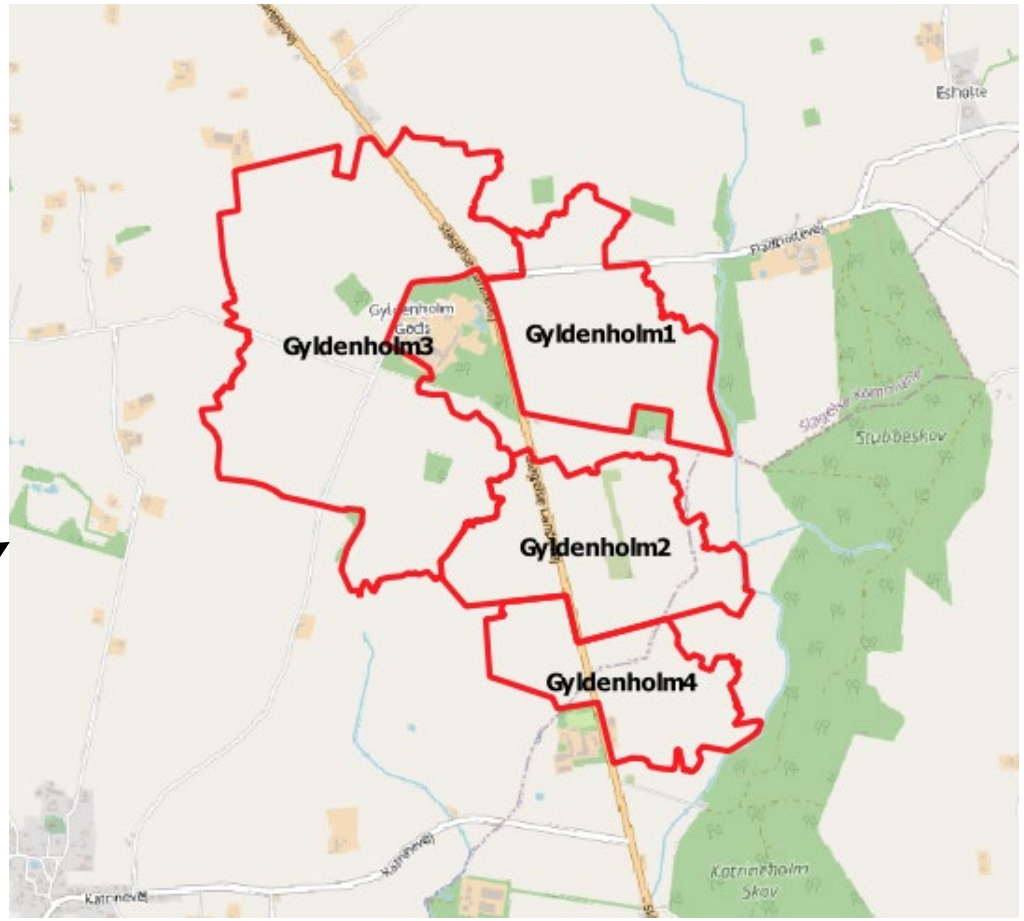

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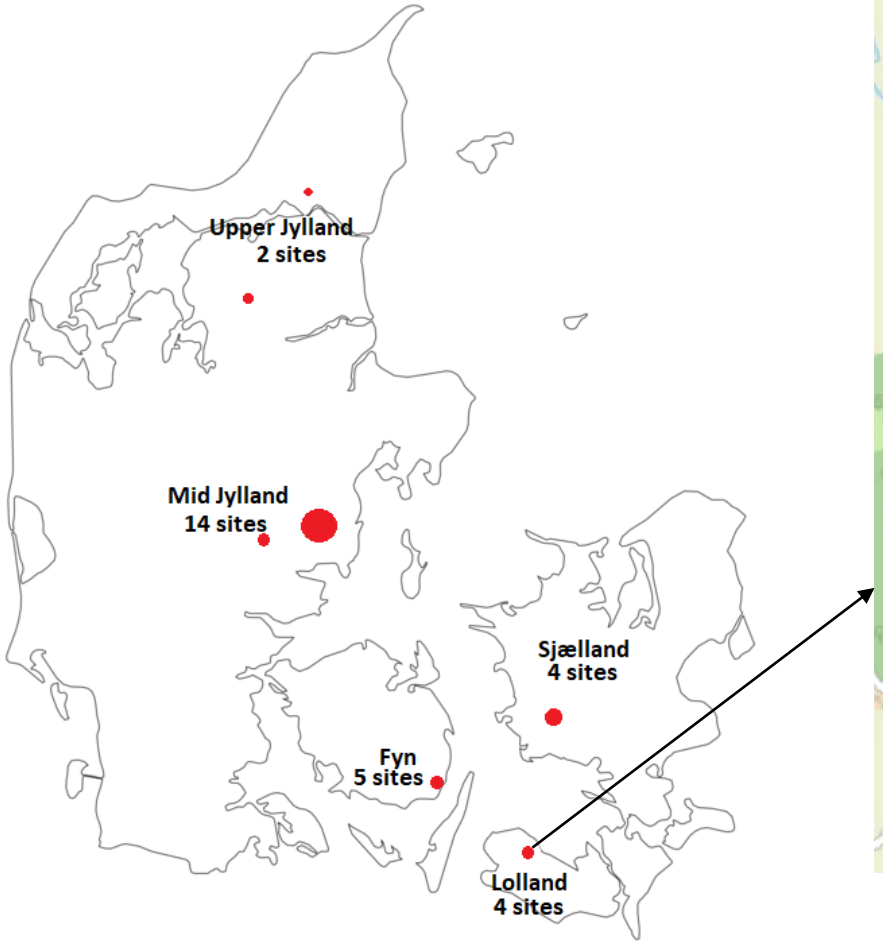
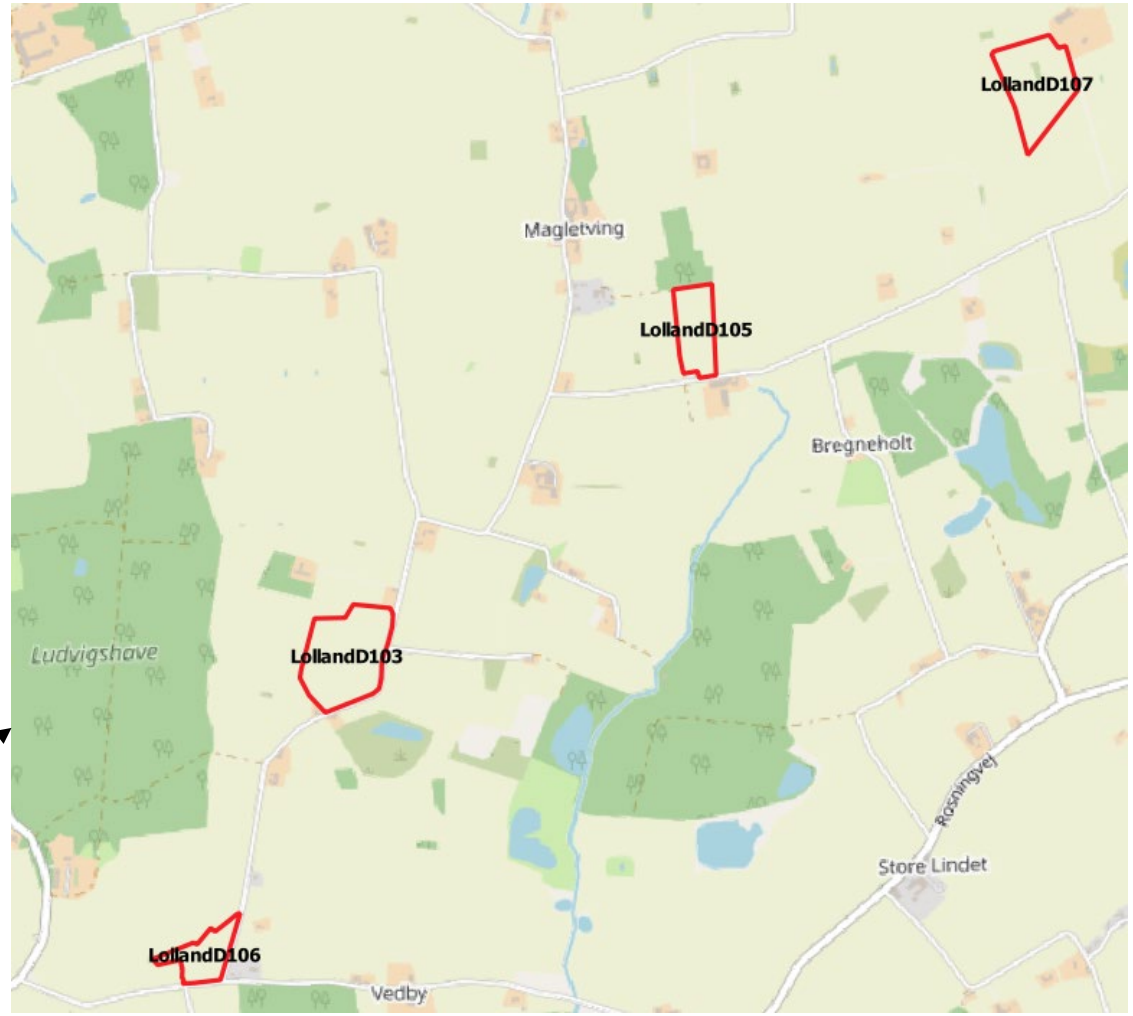
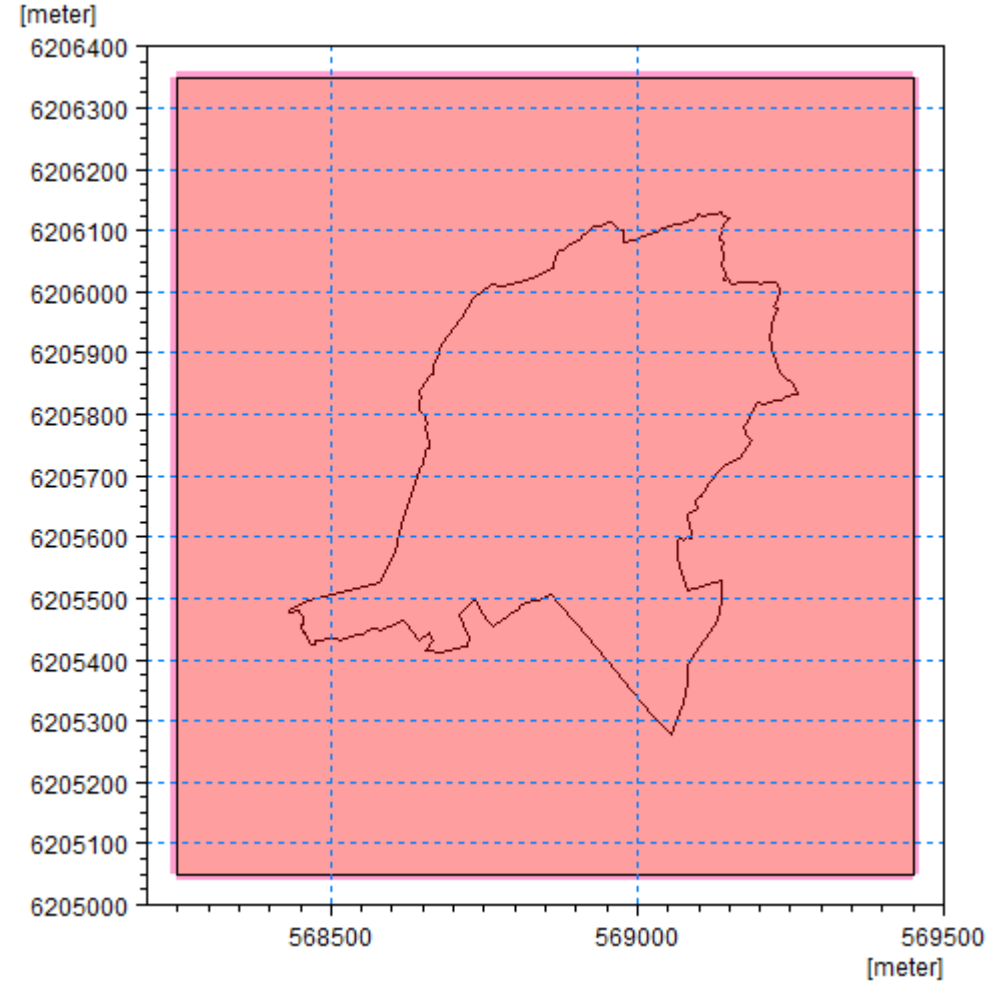




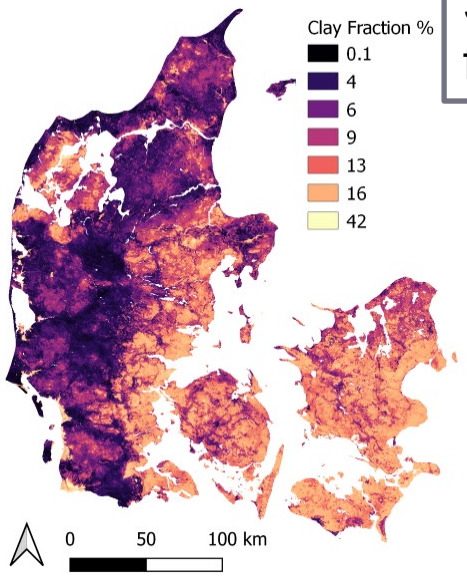
Groundwater model setup

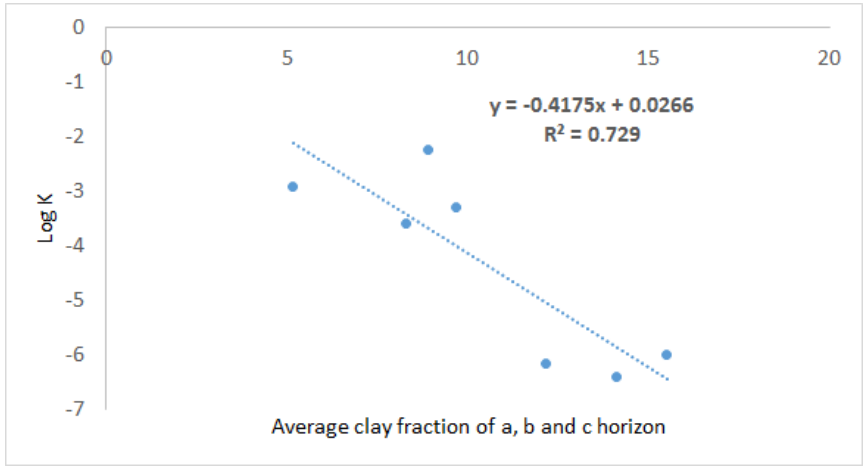
- Using pre-existing national hydrological **MIKE-SHE** model of Denmark.
- Model resolution **10 m*10 m**
- **Downscaled input variables** to increased model resolution (Drain time constant, hydraulic conductivity, geological layers depth, drain depth, boundary conditions)
- Assumption: No interfering rivers and lakes, no pumping wells, no irrigation.
- 200 m buffer added to study area to incorporate the affect of boundary conditions



Generation of hydraulic conductivity map

30 m resolution clay fraction map

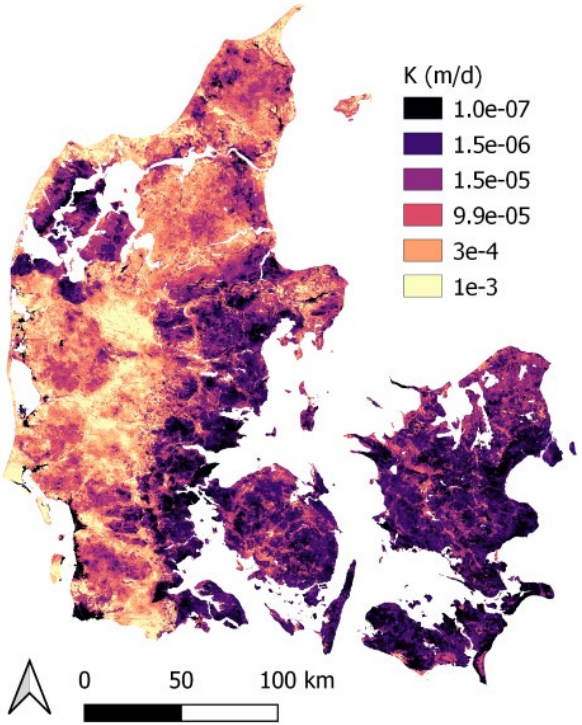


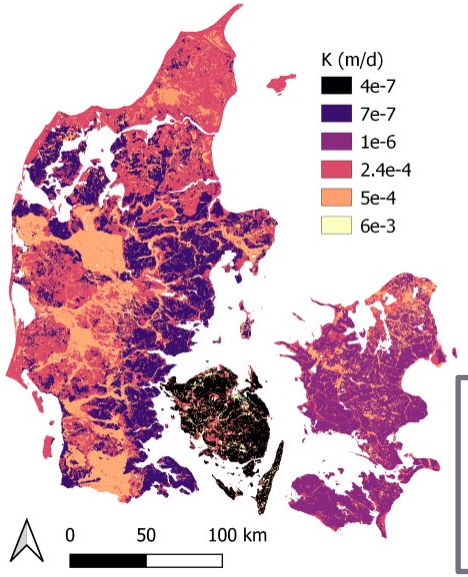


Optimized function based on RMSE = 1.15 and MAE= 0.84

Log(K) = 0.217*Clay fraction (%) - 2.48

30 m resolution K maps





100 m resolution Calibrated national model K map

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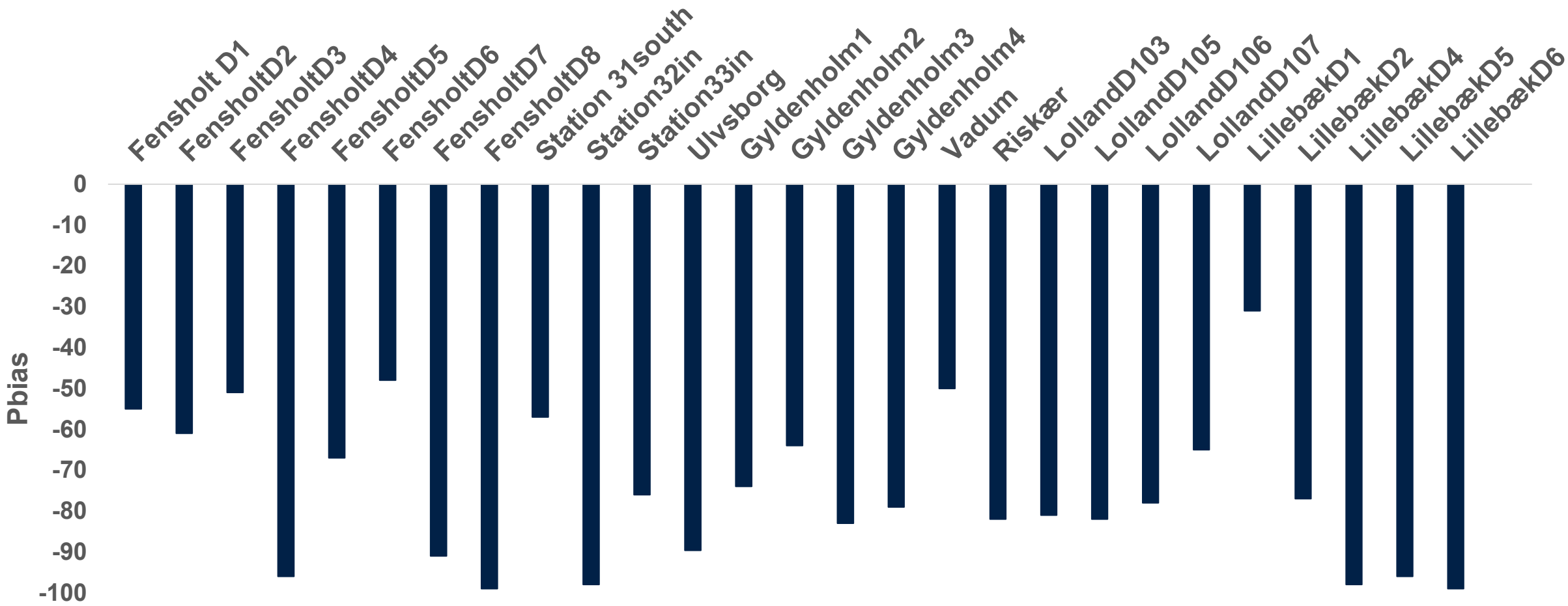
Initial model statistical Analysis

Model Name	R^2	pbias	Nash sutcliffe	Mean observed discharge (l/s)	Mean simulated discharge (l/s)	Mean recharge (l/s)
Fensholt D1	0.25	-55	0.07	3.2	1.4	2.6
FensholtD2	0.25	-61	-0.04	4.8	1.9	2.3
FensholtD3	0.3	-51	0.09	3.9	1.9	2.1
FensholtD4	-	-96	-0.66	0.85	0.03	0.28
FensholtD5	0.25	-67	-0.066	2	0.67	0.8
FensholtD6	0.23	-48	0.1	0.82	0.43	0.58
FensholtD7	0.09	-91	0.06	0.09	0.03	0.28
FensholtD8	0.22	-99	-1.0	0.81	0.009	0.5
Station 31south	-	-57	-0.1	0.7	0.3	0.5
Station32in	-	-98	-0.2	0.5	0.02	0.4
Station33in	-	-76	-0.07	1.5	0.3	0.93
Ulvsborg	0.12	-89.6	-0.53	4.1	0.42	2.5
Gyldenholm1	0.26	-74	-0.06	3.4	0.86	1.3
Gyldenholm2	0.23	-64	0.05	2.79	0.99	1.22
Gyldenholm3	0.19	-83	-0.1	8	1.4	3.2
Gyldenholm4	0.2	-79	-0.08	2.8	0.57	0.81
Vadum	0.2	-50	-0.4	1.2	0.6	´0.74
Riskær	0.02	-82	-1.04	15	2.7	1.45
LollandD103	0.1	-81	-0.08	0.3	0.05	0.16
LollandD105	0.13	-82	-0.05	1.5	0.03	0.065
LollandD106	0.22	-78	0.064	0.05	0.01	0.06
LollandD107	0.07	-65	0.03	0.23	0.08	0.13
LillebækD1	0.15	-31	0.15	0.02	0.01	0.07
LillebækD2	0.18	-77	0.027	0.3	0.07	0.4
LillebækD4	0.12	-98	-0.08	0.04	0.0024	0.069
LillebækD5	0.066	-96	-0.03	0.06	0.0024	0.23
LillebækD6	0.13	-99	-0.08	0.07	0.0008	0.23

Initial model performance



All catchment discharge are underestimated (Systematic bias)

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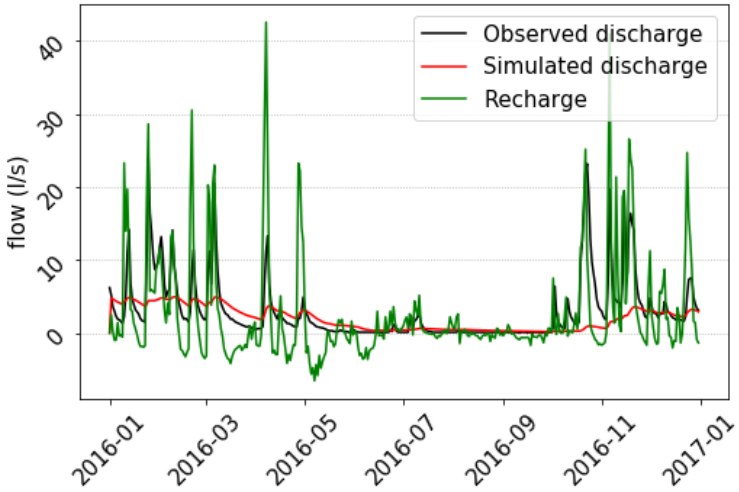
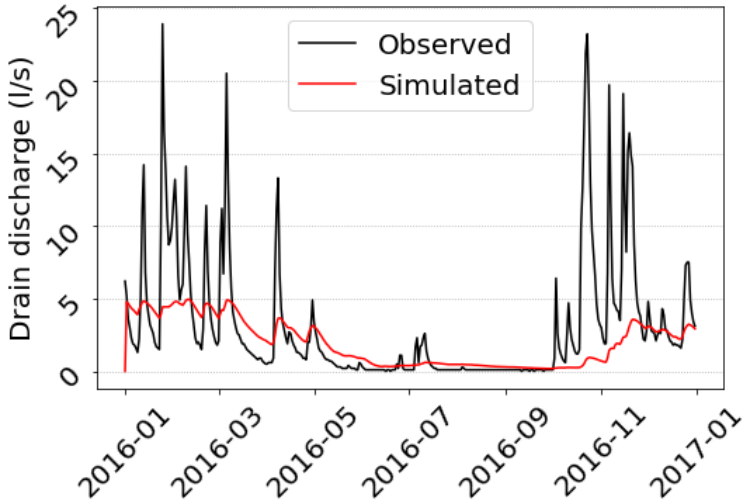
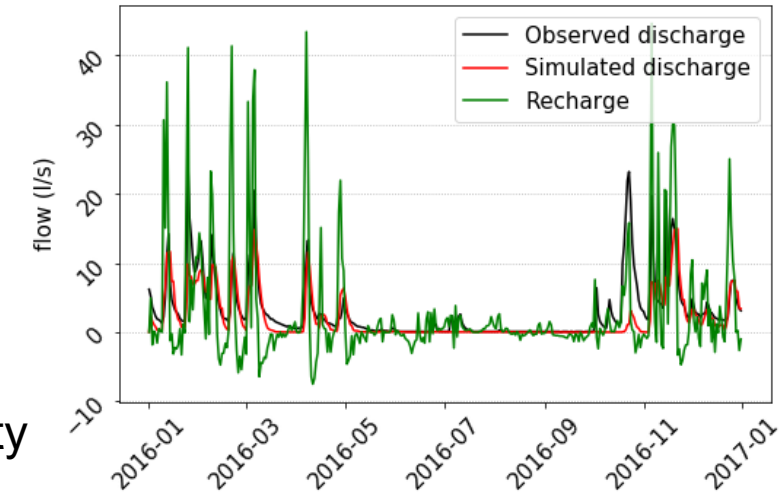
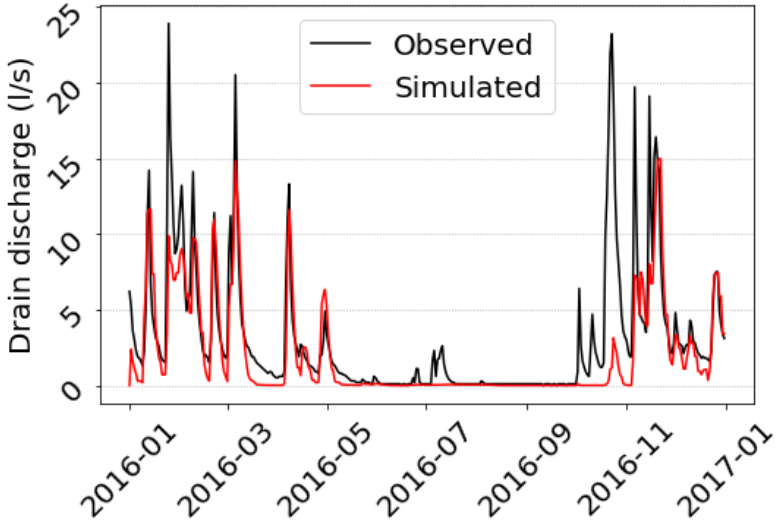
Initial Model Performance





Changing hydraulic conductivity and drain time constant





Future plan

Further investigation of study site

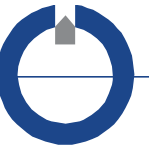
- Correlation between precipitation and observed discharge
- Shape and size of catchment
- Ratio of groundwater boundary inflow to precipitation

Calibration

- Important parameters for calibration (K, Drain time constant)
- Ostrich calibration tool
- Joint calibration across all 30 drain-sites, to get one common parameter set
- Test of different calibration targets, focusing on drain fraction

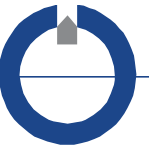
Comparison of topographical and hydrogeological parameters with drain flow fraction

- Topographical index (TPI, TWI, slope, curvature etc)
- Hydrogeological parameters (K, clay fraction, lateral inflows and outflows)



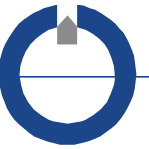
Expected output

- **Better understanding of drain flow fraction behavior with varied topographical and hydrogeological settings**
- **A reliable calibrated model to predict reasonable drain flow dynamics**
- **Resultant model will be used for upscaling drain flow fraction for all of Denmark**

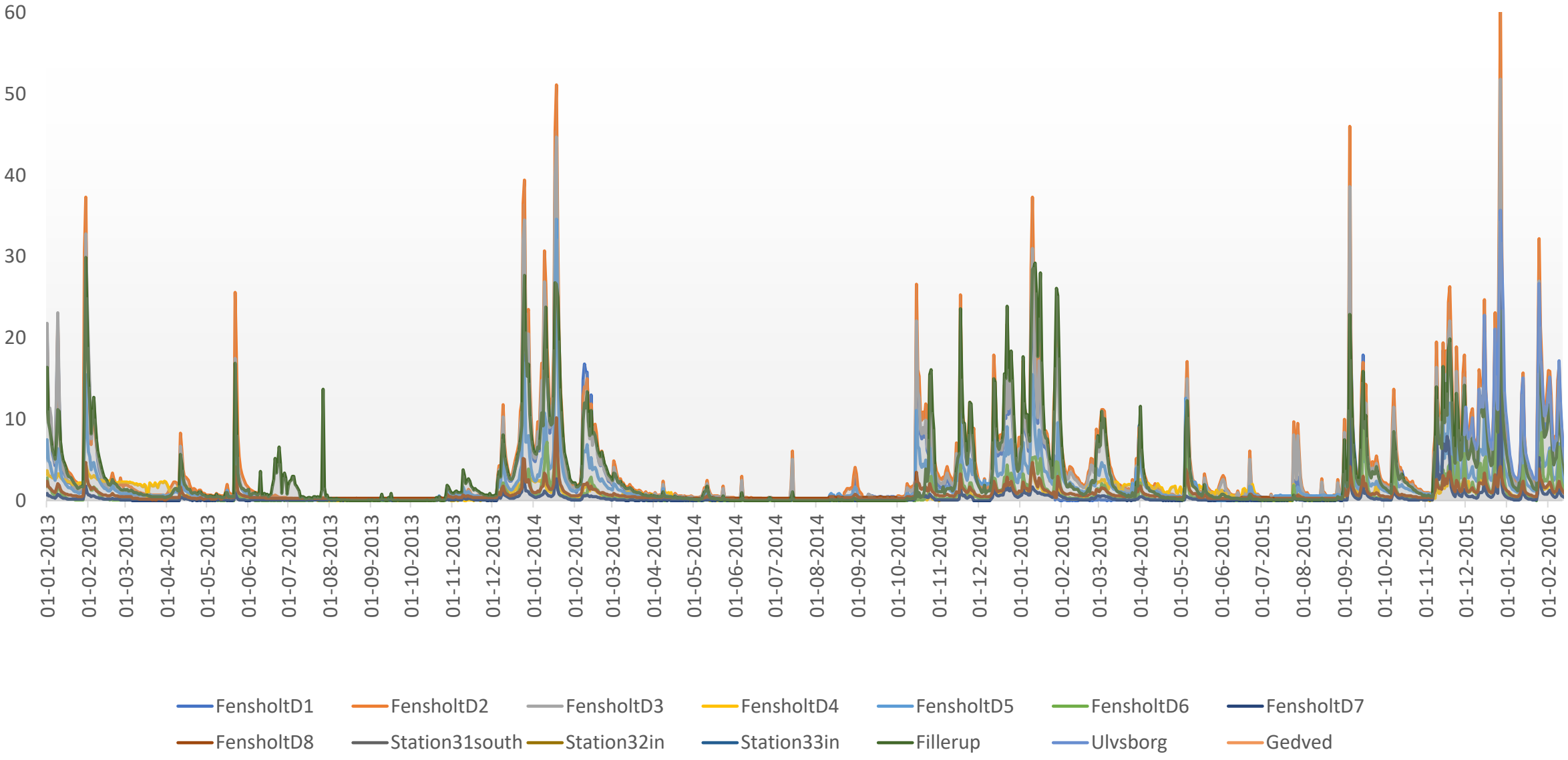


References

- Predicting artificially drained areas by means of a selective model ensemble, A. B. Møller, A. Beucher, B .V. Iversen, M. H.Greve, 2018



Drain discharge (l/s)



Drain discharge (l/s)