STØTTET AF

What controls the drain flow dynamics?

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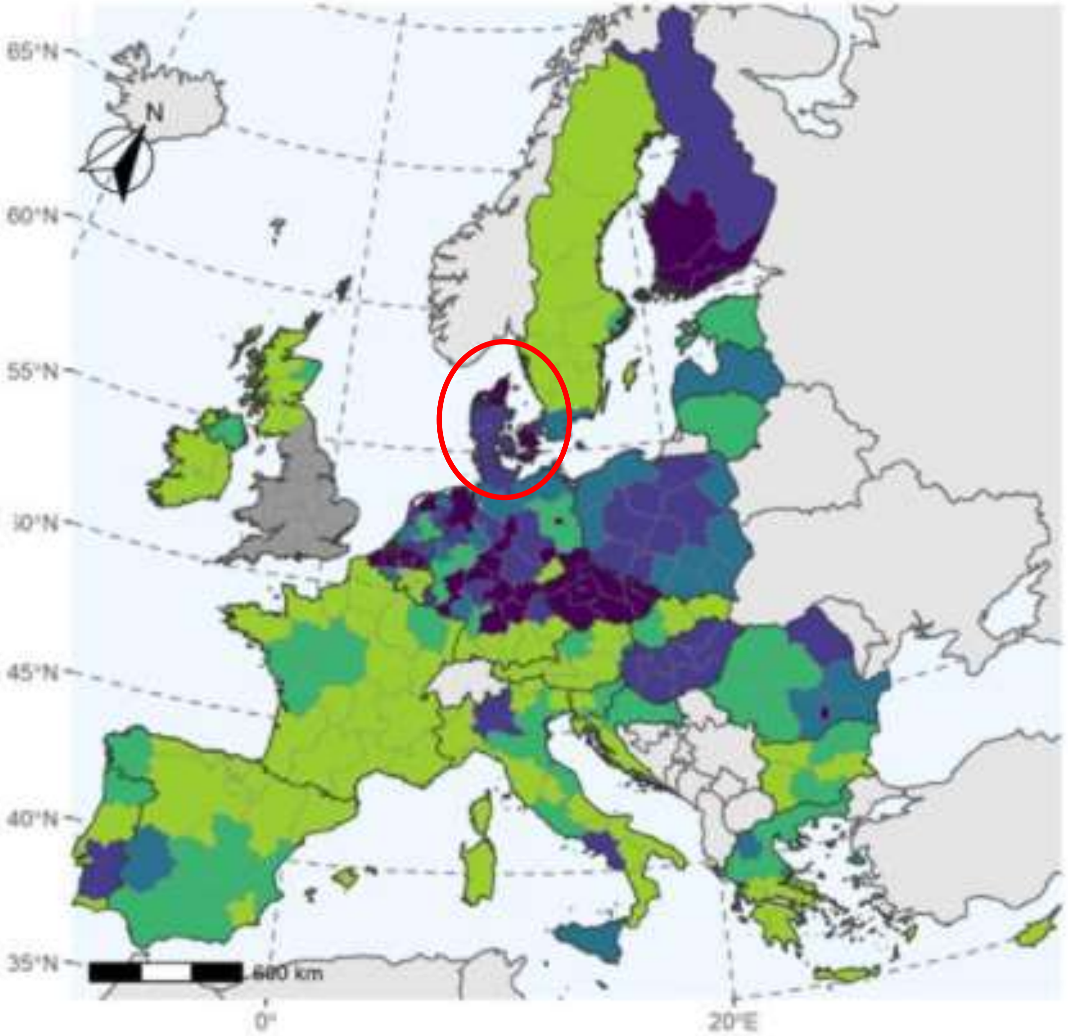
Background

- Nitrate pollution in surface water

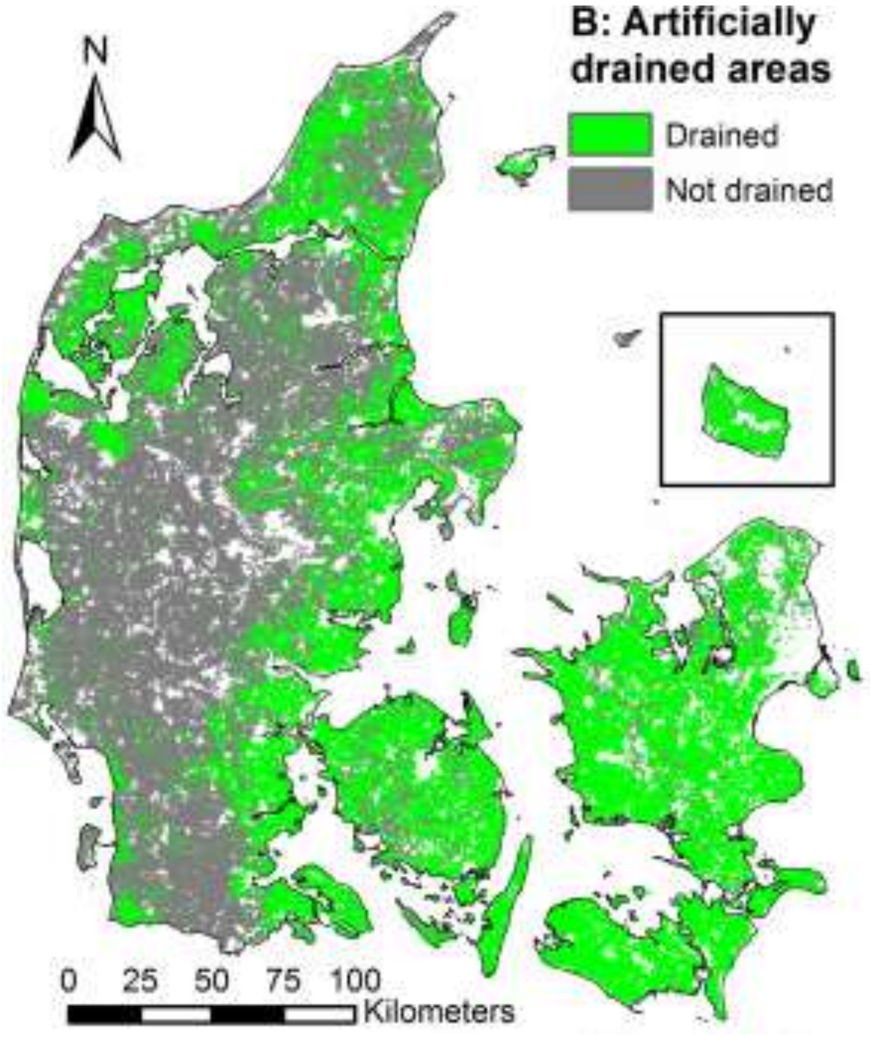
- Nitrate pollution – links to agricultural surplus in Denmark



Surface waters in eutrophic status (EU, 2021)

% [0,20] (20,40] (40,60] (60,80] (80,100] NA

Subsurface drains in Denmark



(Møller et al, 2018)

- 50% of Denmark’s agricultural area has subsurface drains

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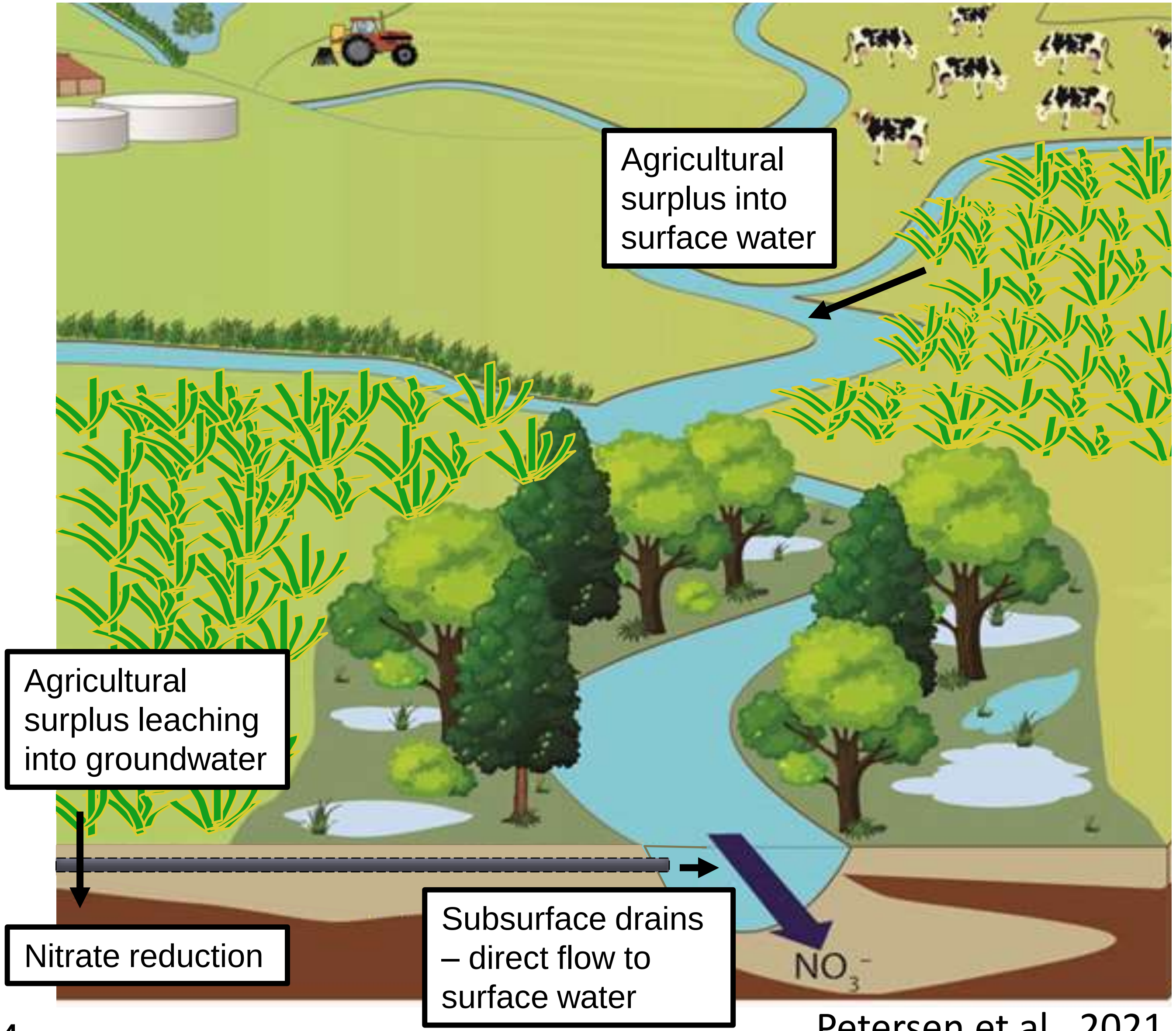
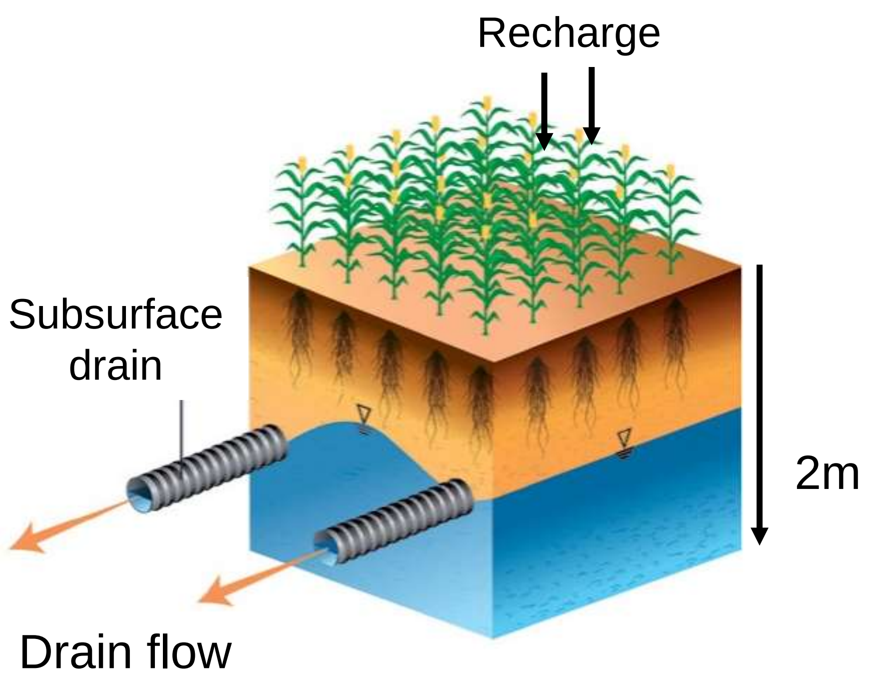
Why subsurface drains are important ?



Petersen et al., 2021

- Subsurface drains increase contribution to nitrate pollution
- Need to study subsurface drain flow dynamics

Drain fraction (DF)

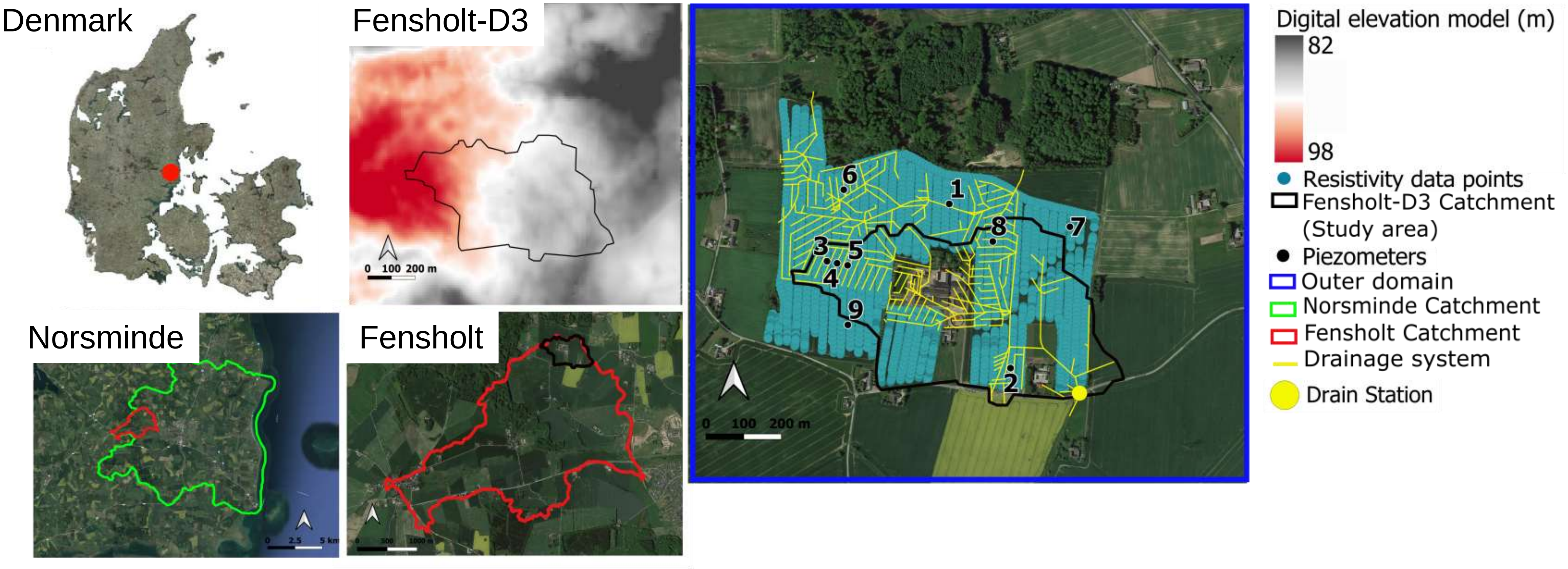


$$Drain\ fraction(DF) = \frac{volume\ of\ drain\ flow}{volume\ of\ recharge}$$

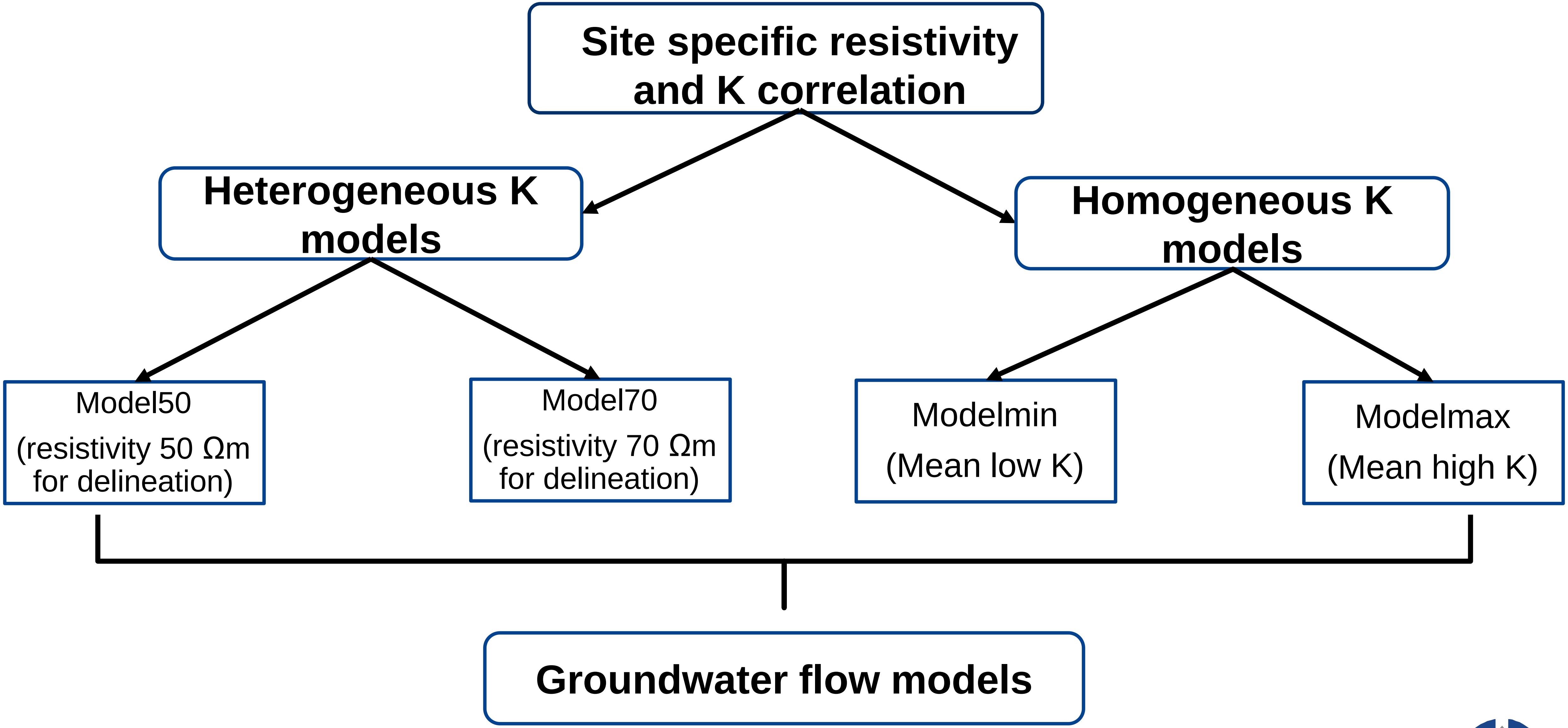
Objective

What drives drain flow generation?

Study area: Fensholt-D3



Hydrogeological models: translation of Ωm to K



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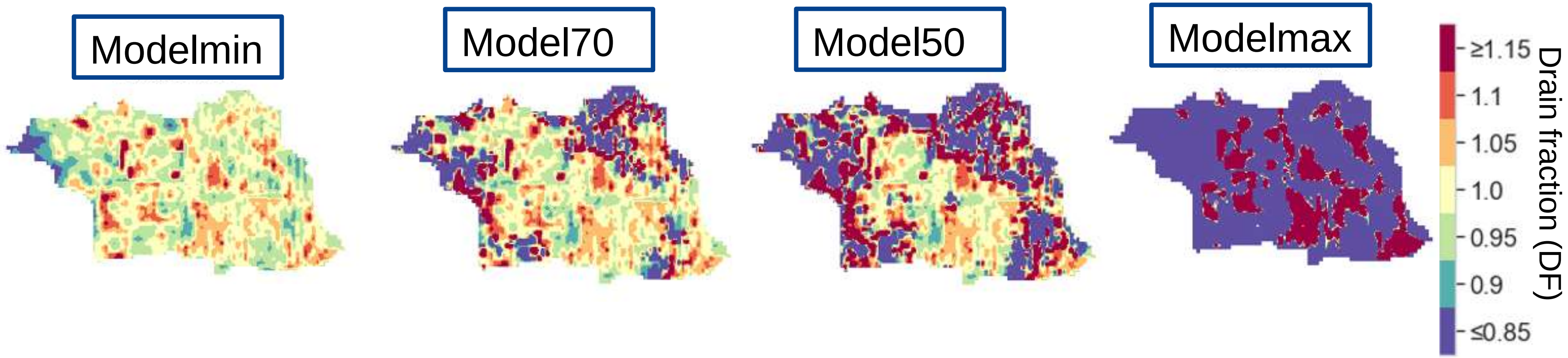
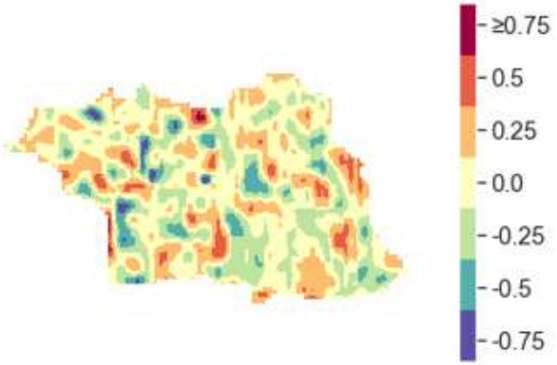
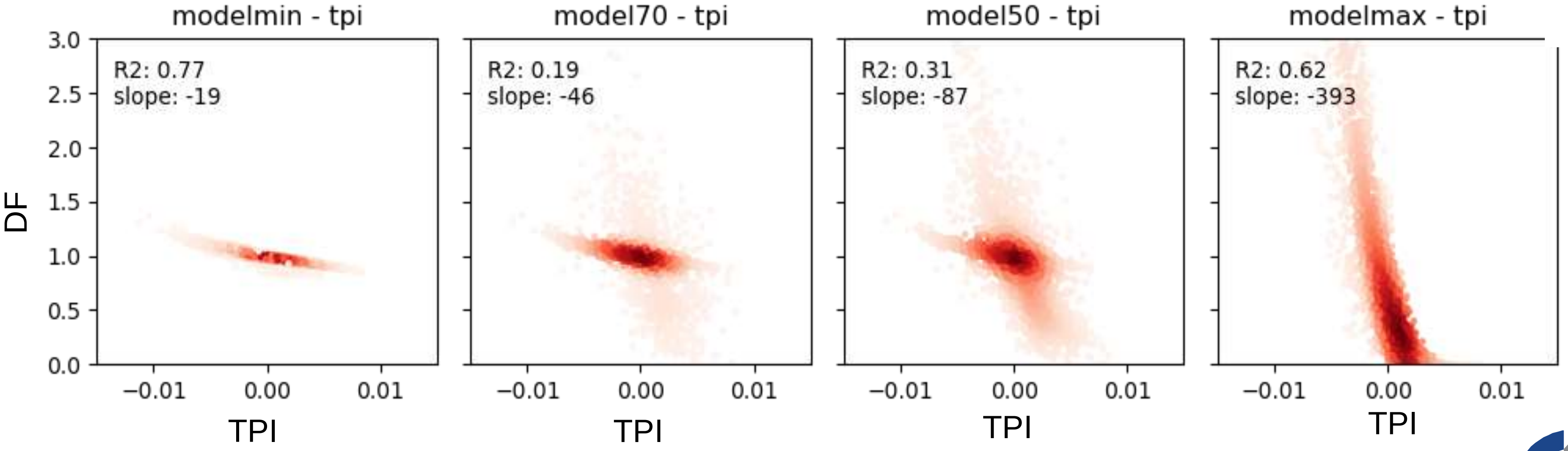
Correlation of Topographical position index and drain fraction



Topographical position index (TPI)



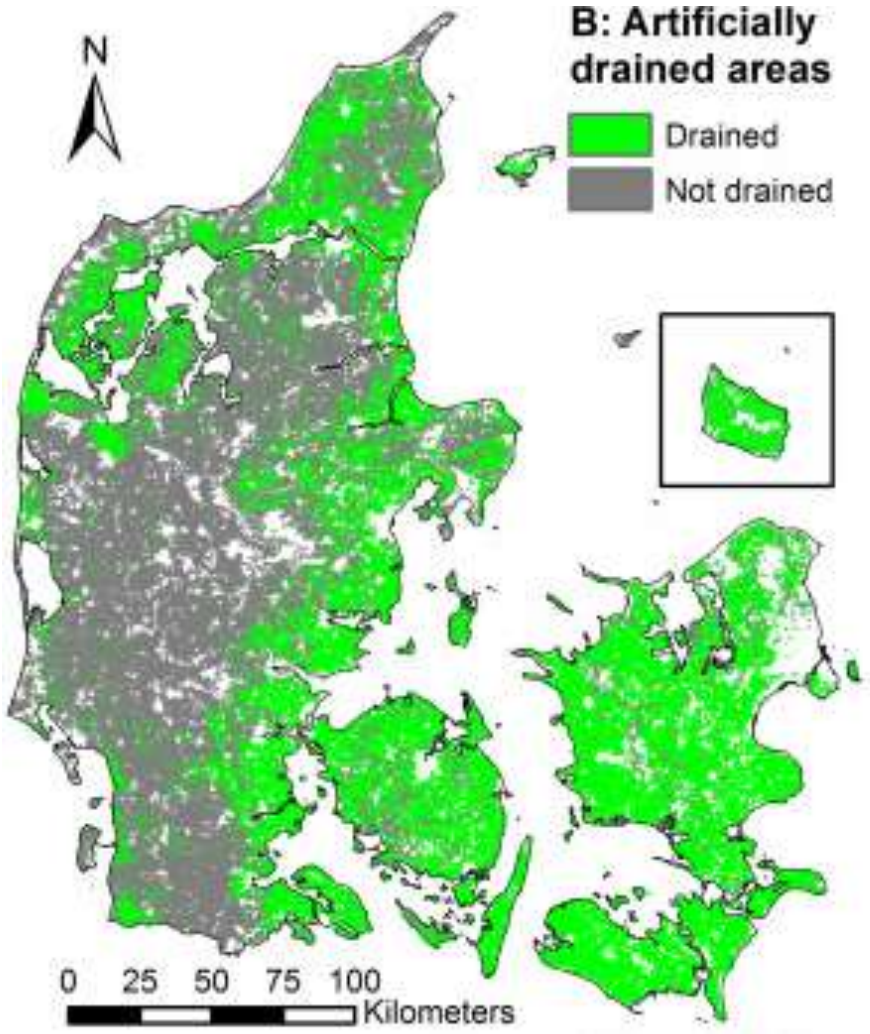


Conclusion

- **Topographical position index identifies regions of high drain flow and low drain flow**

- **Geology (Clay or sand) identifies the magnitude of drain flow in region with relative differences in topography**

Subsurface drains in Denmark



(Møller et al, 2018)

- 50% of Denmark's agricultural area has subsurface drains

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Objective

What drives drain flow generation?

1. Establish a groundwater flow model that can simulate drain flow dynamics for several drain catchments in Denmark

2. Investigate the physical control on generated drain fraction

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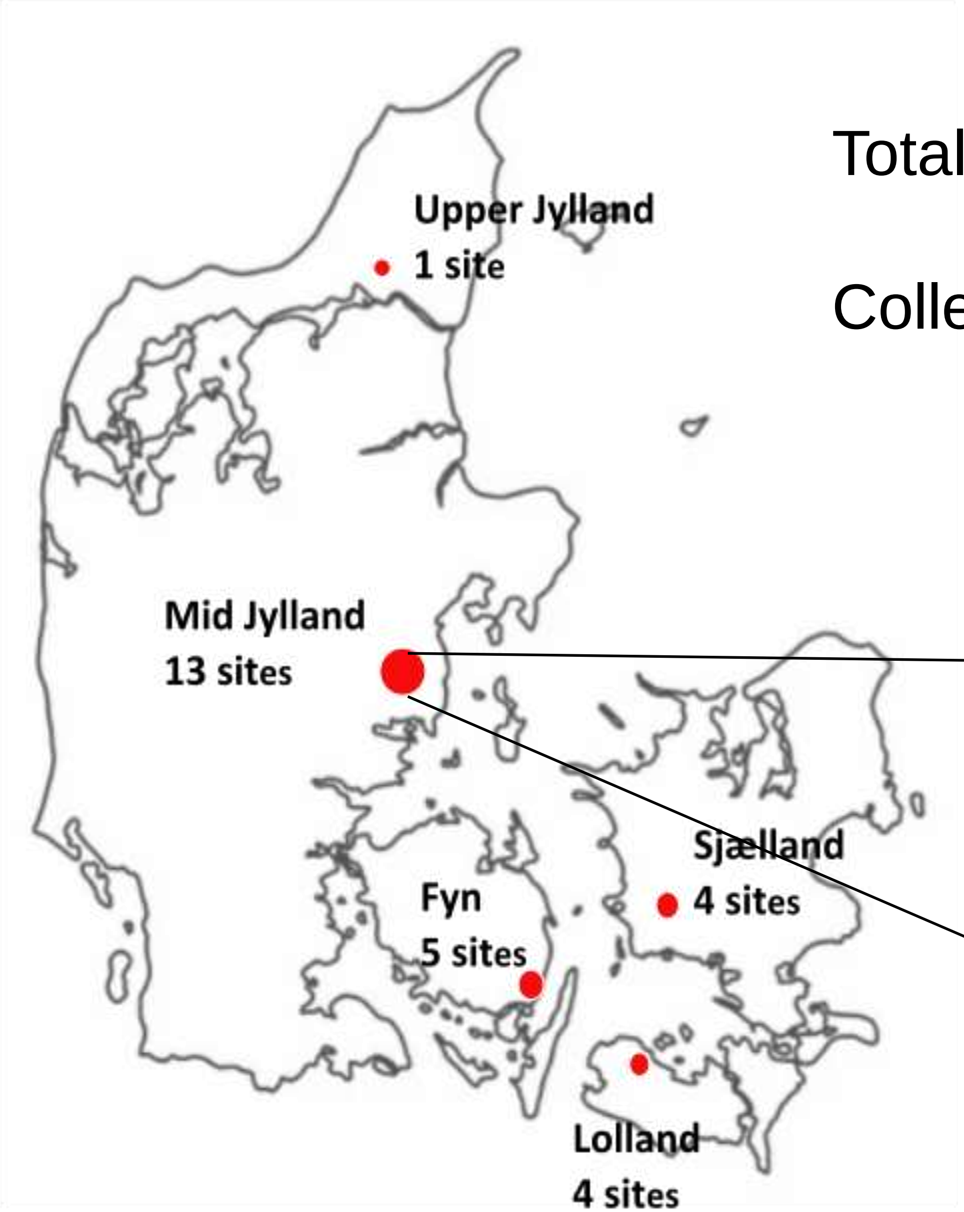
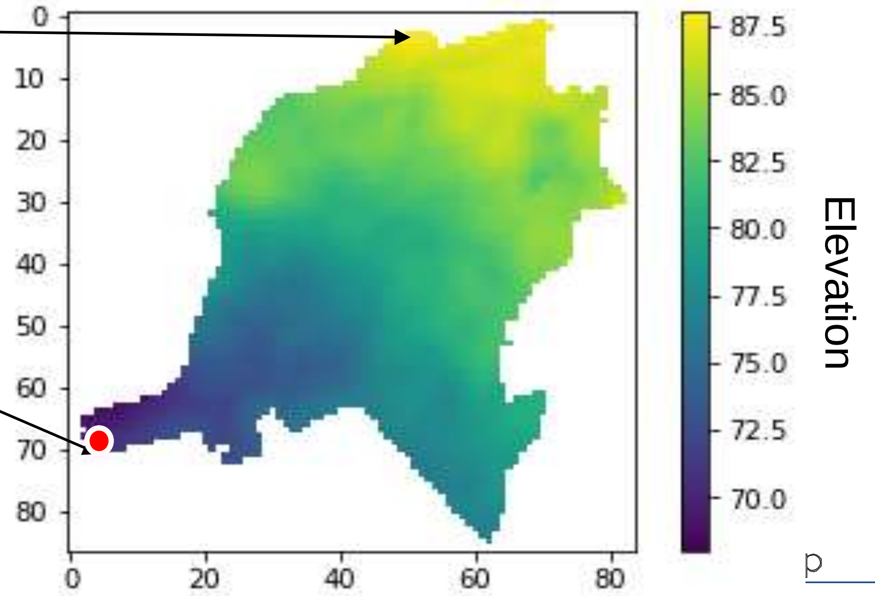
Data collection and selection of drain sites



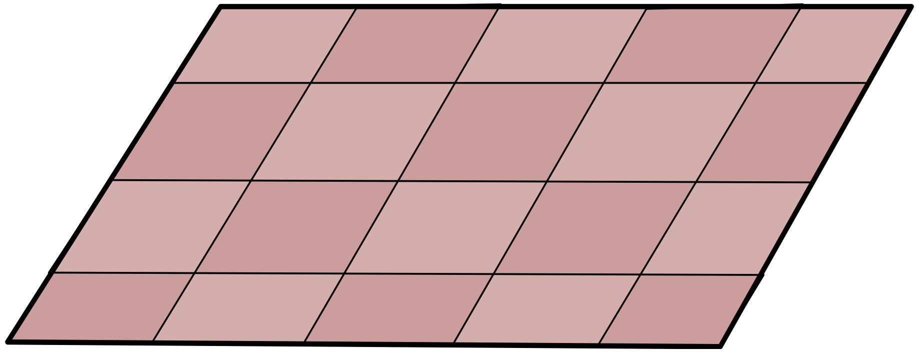
Total 26 field scale (<1km^2) drain catchment

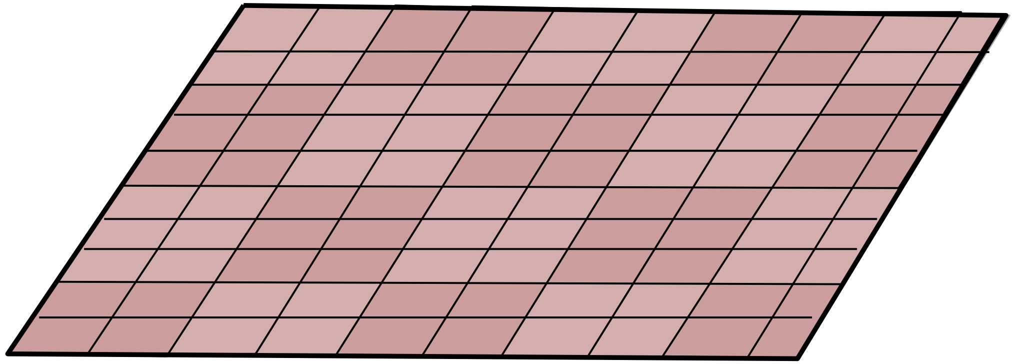
Collected observed drain flows data

Drain site



Groundwater flow model (MIKE-SHE)





Pre-existing DK-HIP model
(100*100m)

Modified DK hydrological model
(10*10m)

Drain conductance
Hydraulic conductivity (0-2m)
Geological layers depth
Drain depth

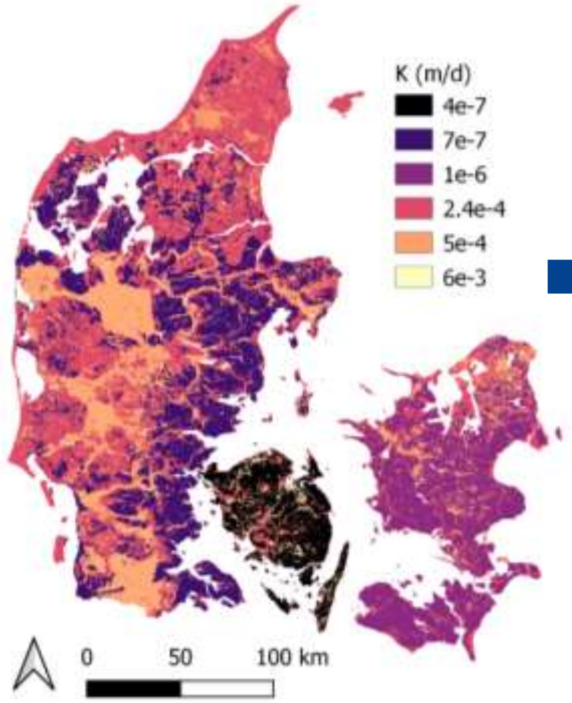
Generation of hydraulic conductivity map

100 m resolution National model K + 30 m resolution Clay fraction

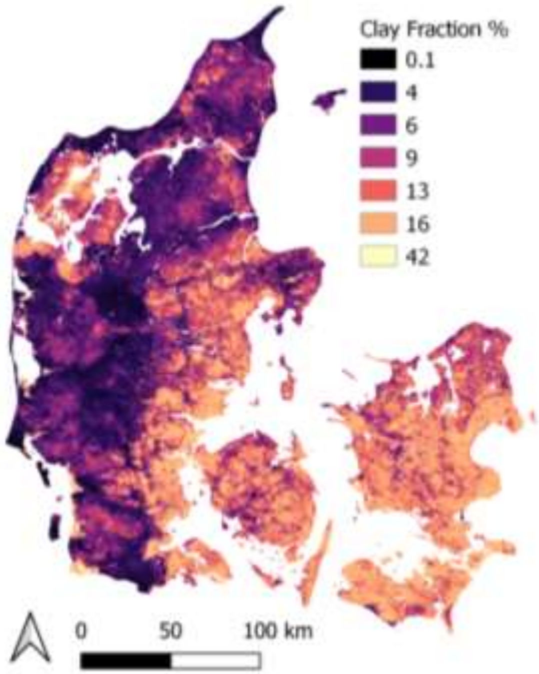
Linear Correlation →

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

30 m resolution K



+



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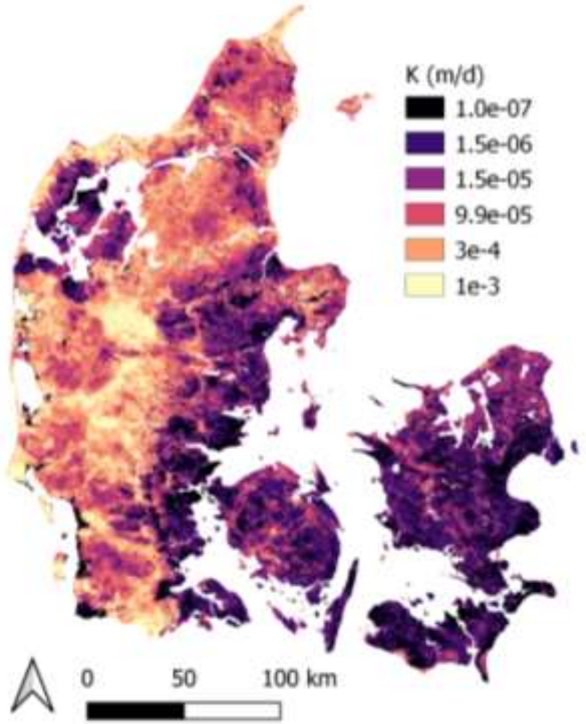

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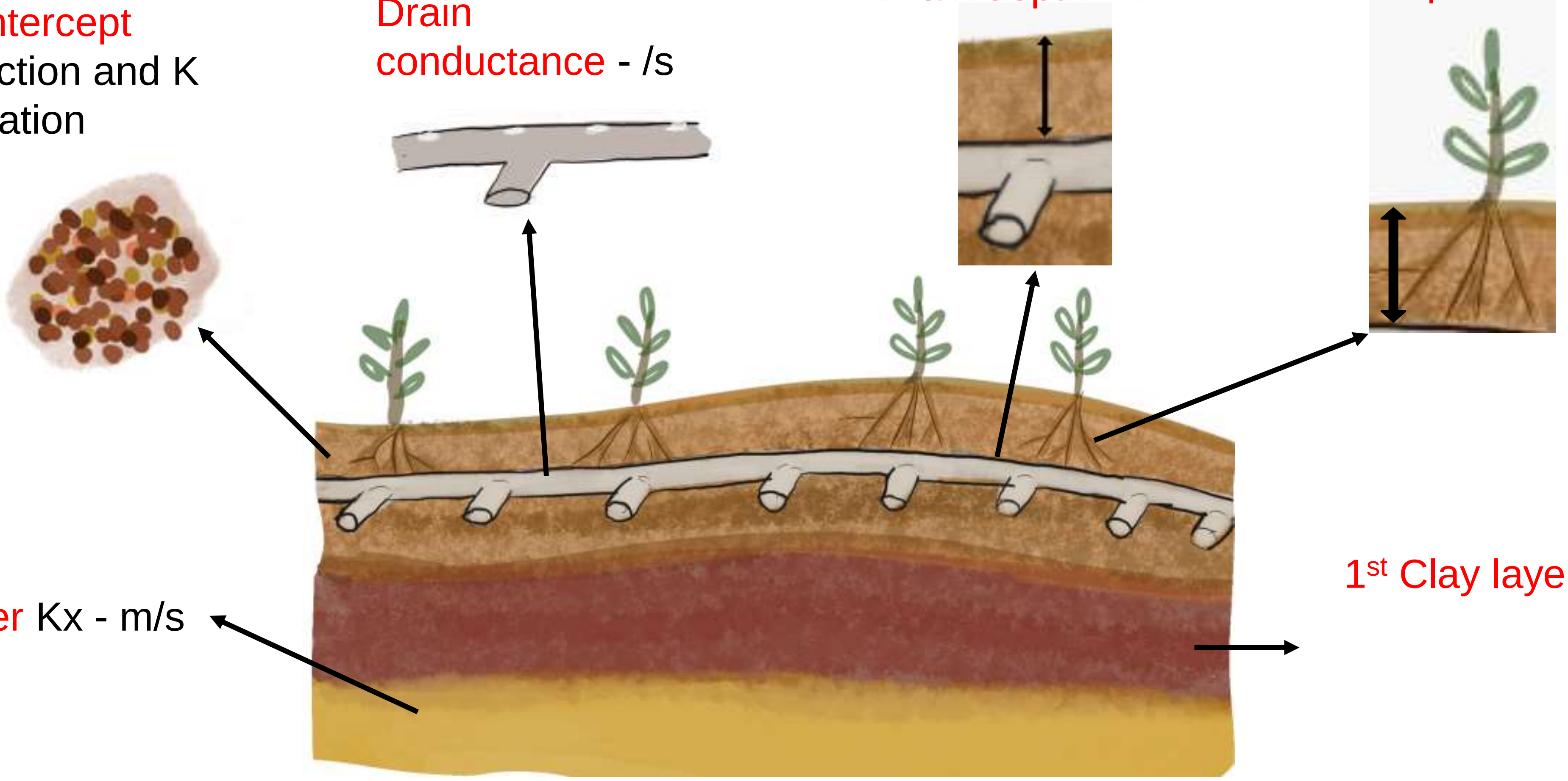
Calibration parameters

Slope & Intercept of clay fraction and K linear equation

Drain conductance - /s

Drain depth - m

Root depth - mm



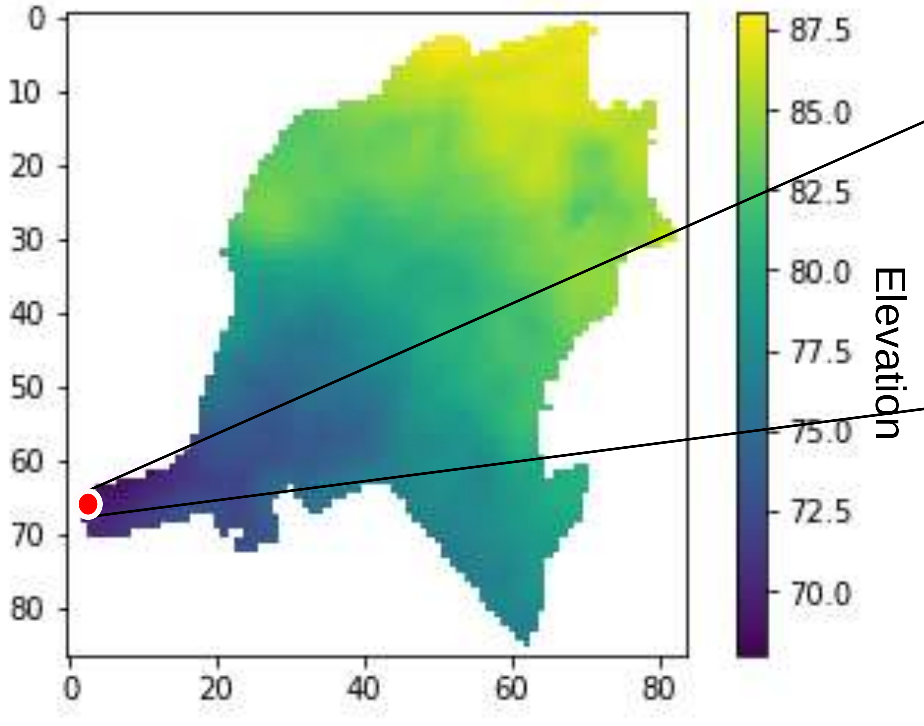
1st Sand layer Kx - m/s

1st Clay layer Kx - m/s

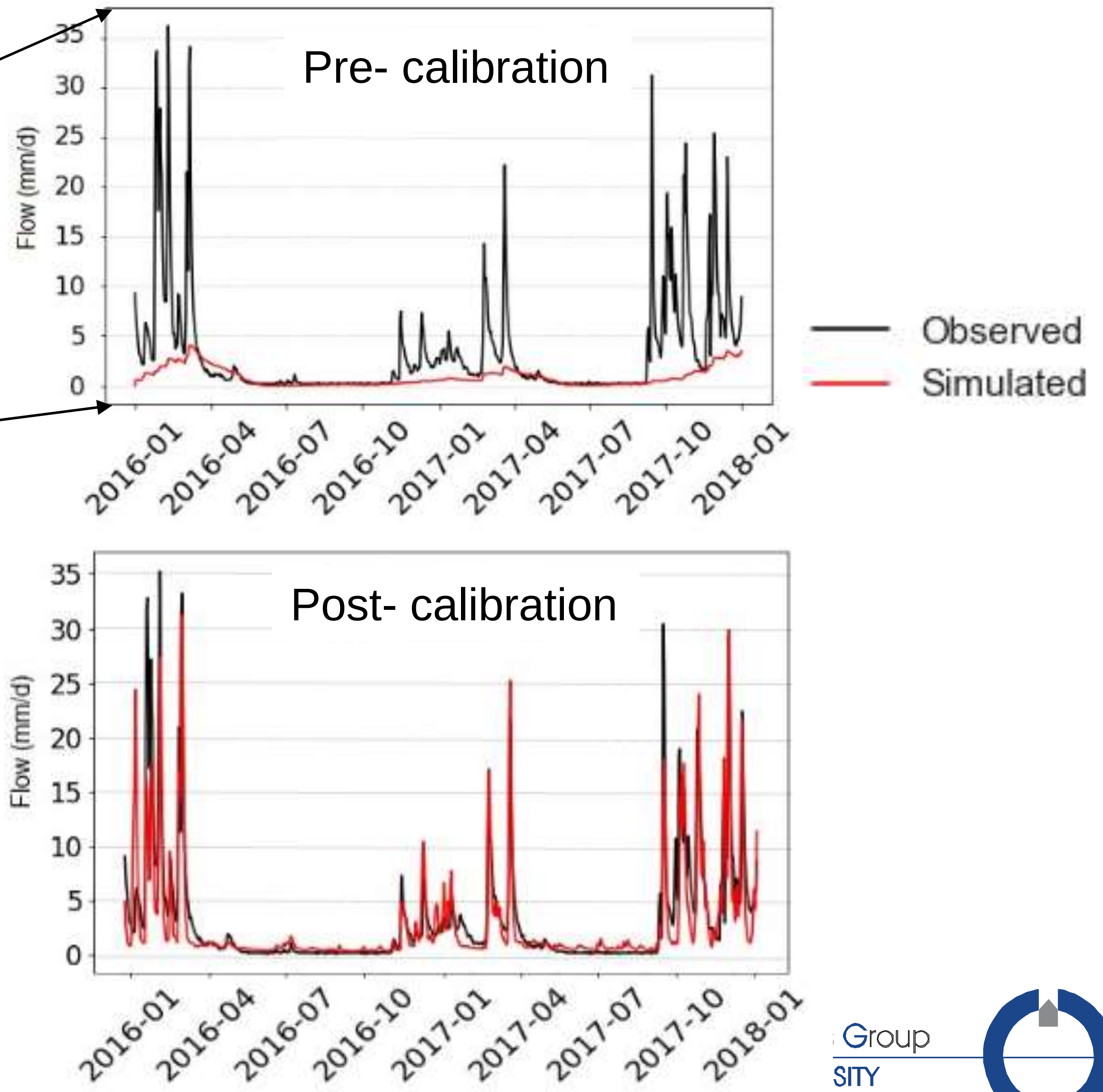
Joint calibration – spatial distribution of parameters

Calibration performance

Drain Catchment area

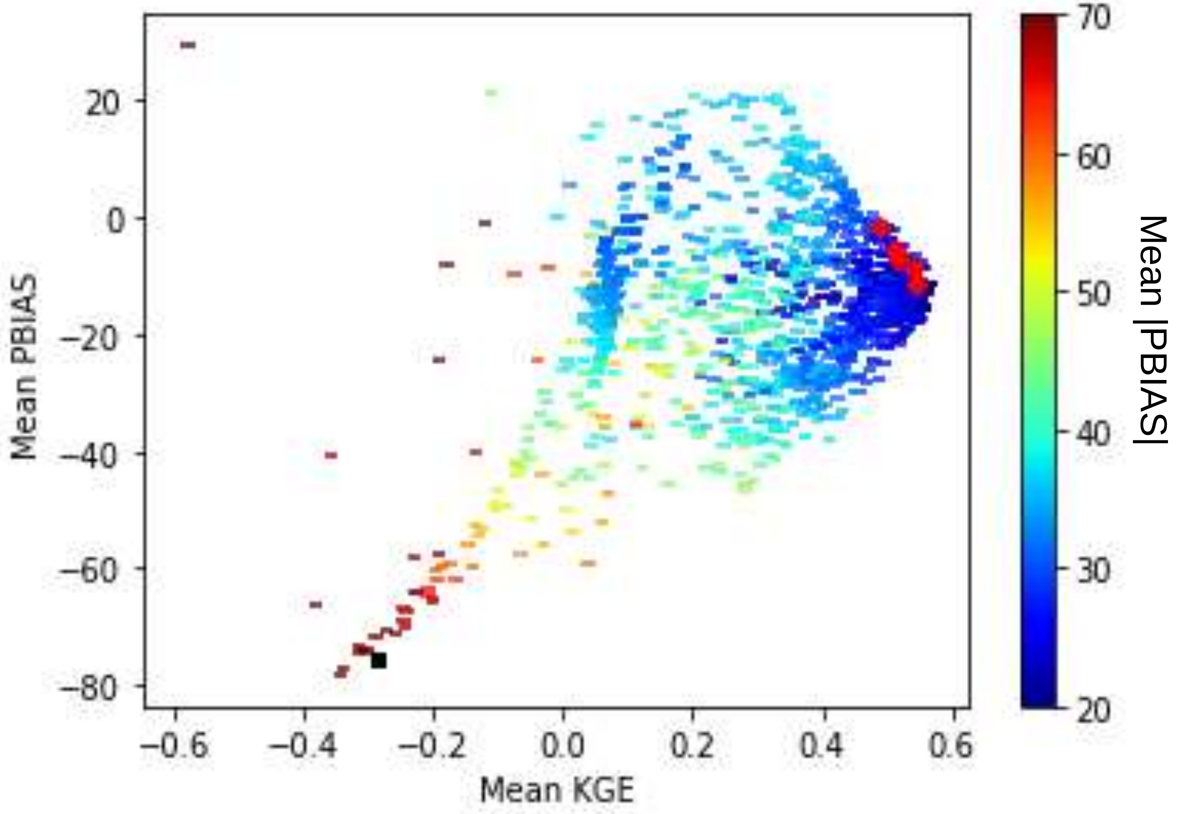


Drain flow hydrographs

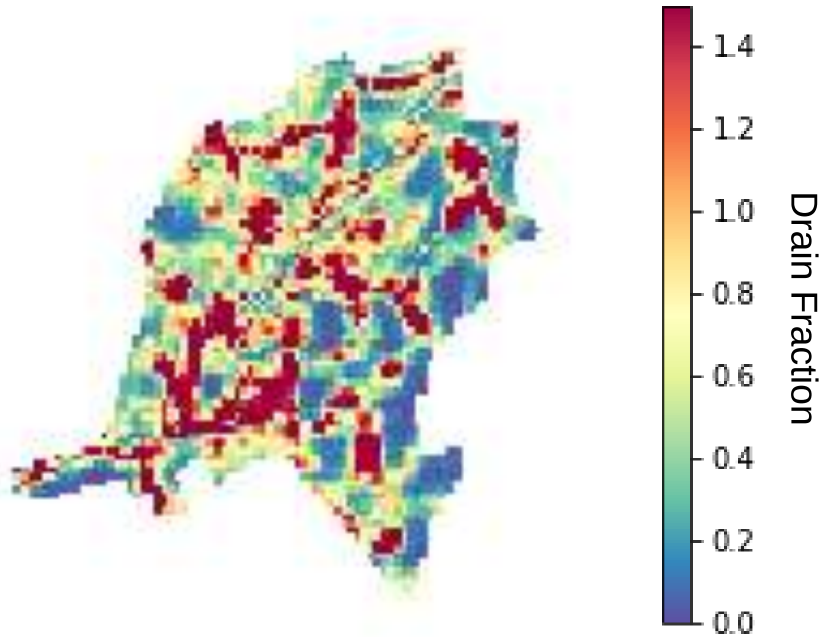


Calibration performance

Mean performance of all 26 drain catchment



Model produced drain fraction



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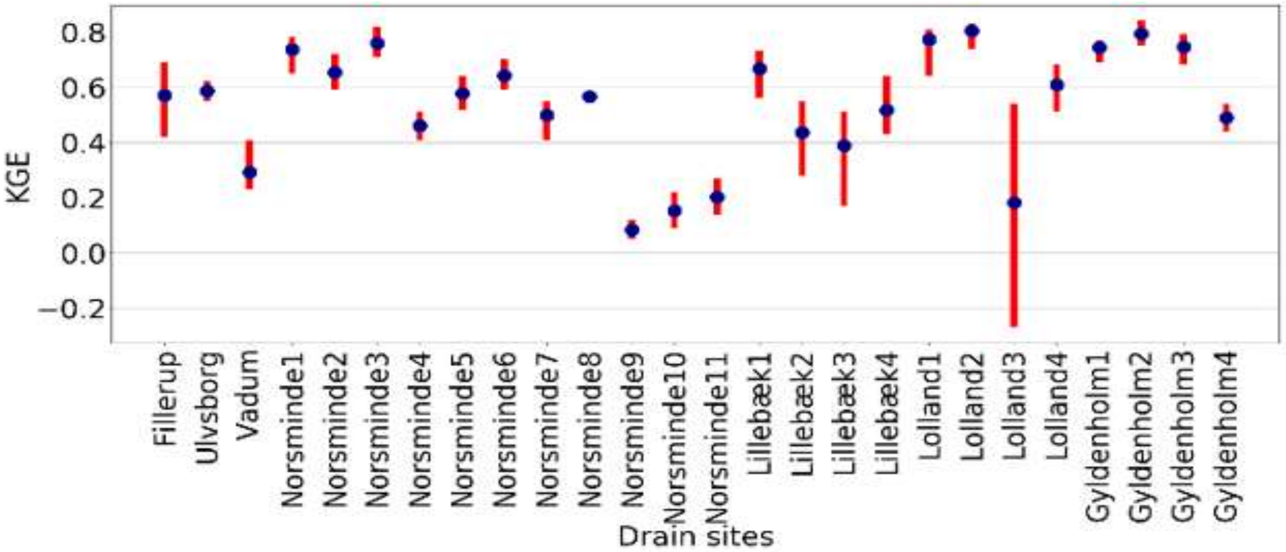
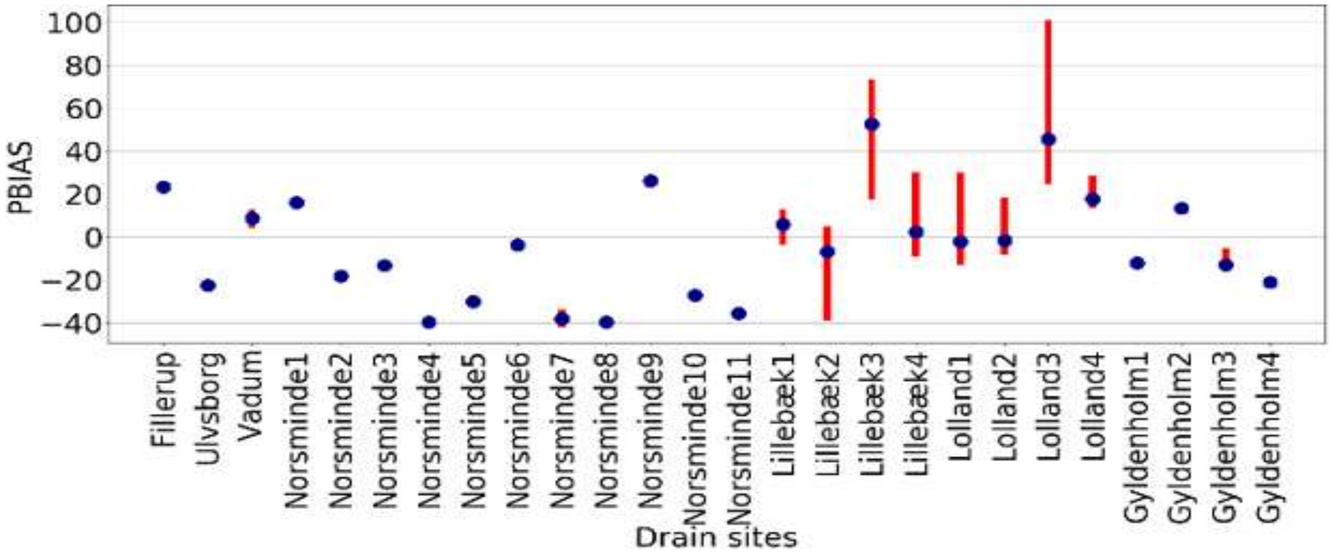
KGE and PBIAS across drain catchments





Objective

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1. Establish a groundwater flow model that can simulate drain flow dynamics for several drain catchments in Denmark

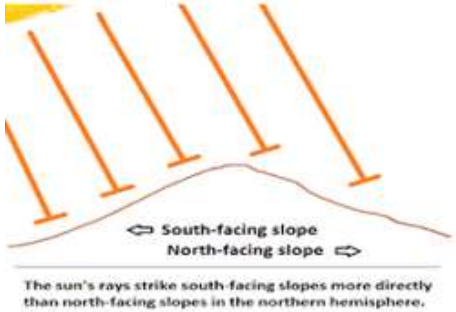
2. Investigate the physical control on generated drain fraction

Identified physical variables

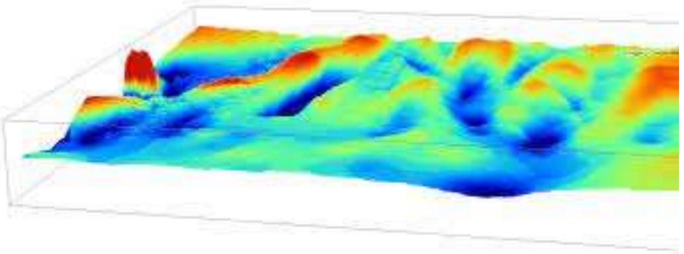
Topographical wetness index

Clay fraction

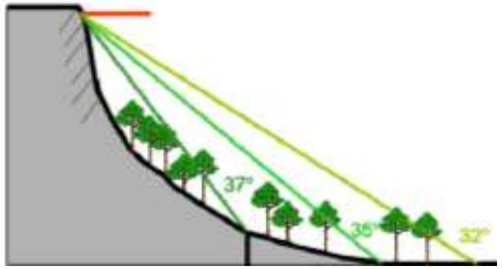
Aspect



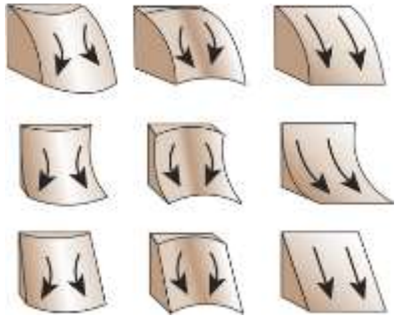
Topographical position index



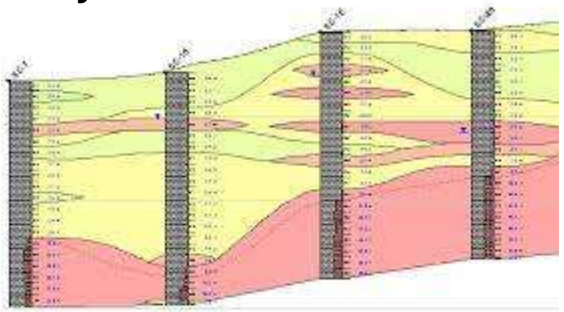
Slope



Curvature



Clay/Sand thickness



Roughness

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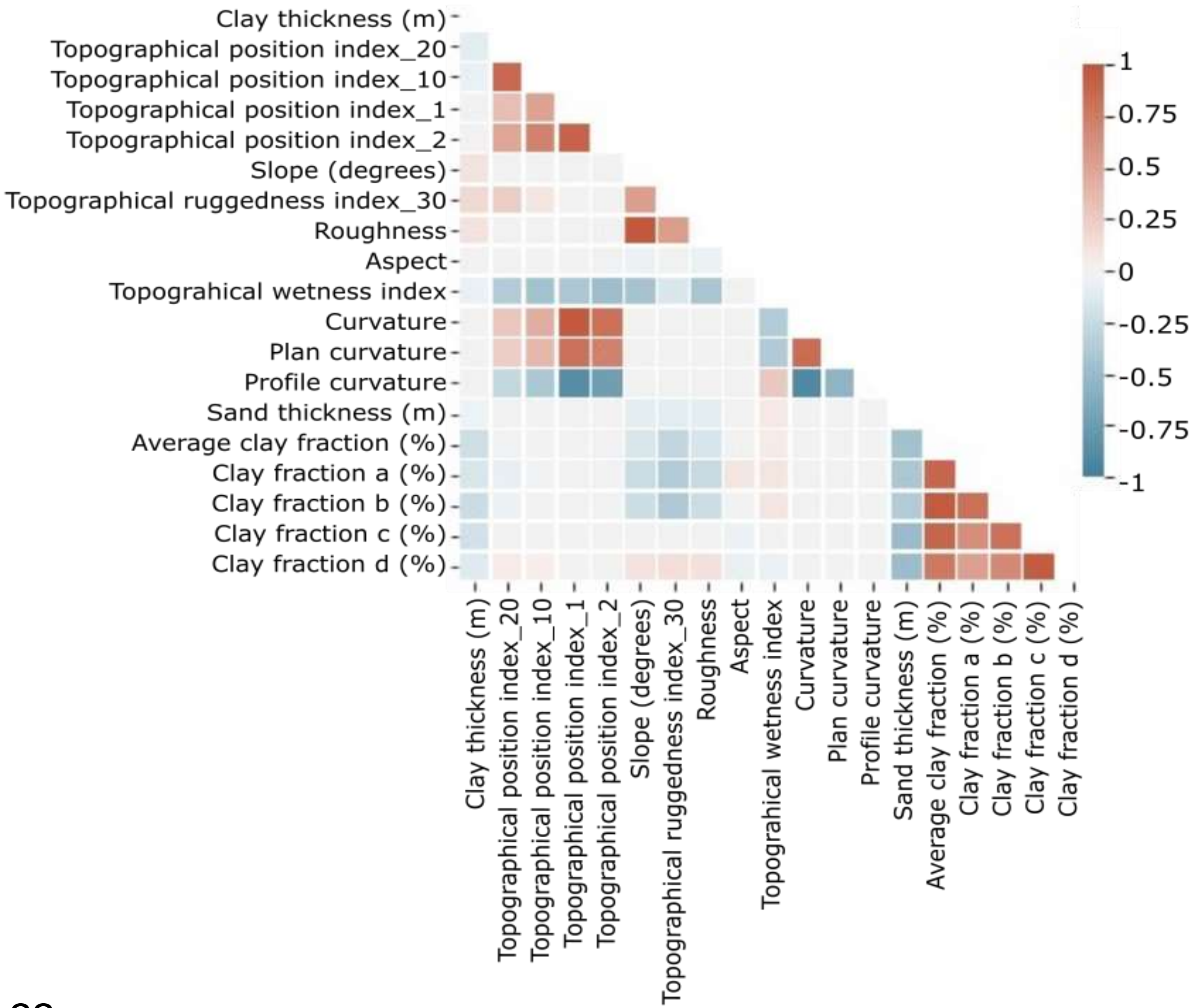
Covariance of identified physical variables



Removal of redundant variables

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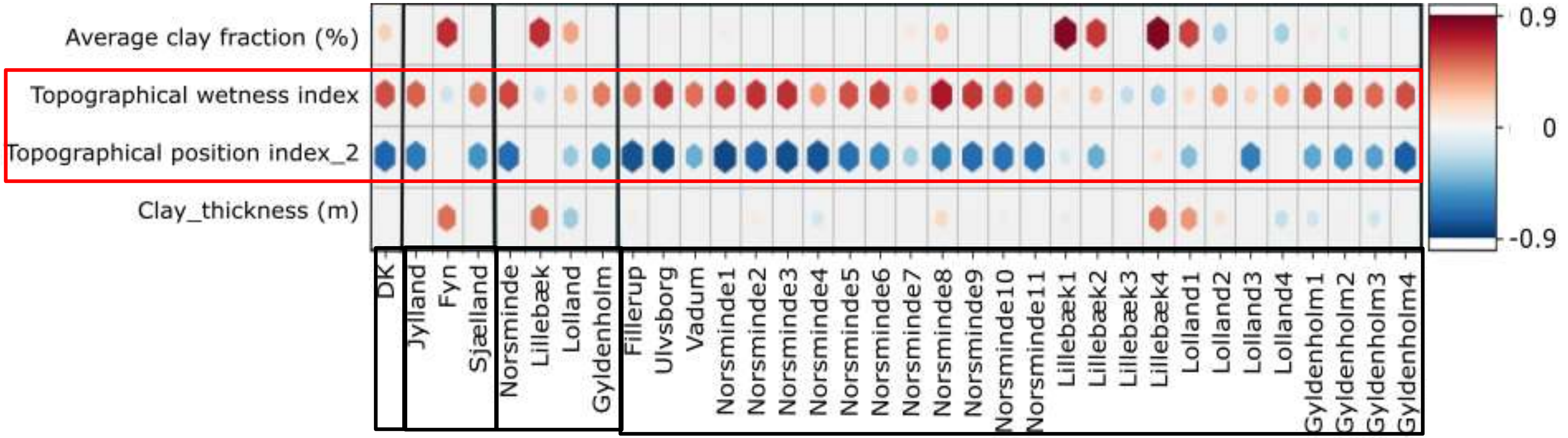
Scale based correlations

10^4 km^2 — $\leq 10^1$ km^2

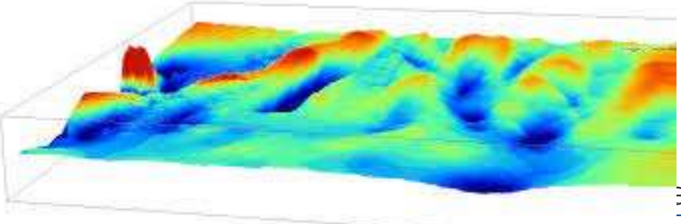


National scale Regional scale Catchment scale

Field scale

Topographical wetness index

Relative Topography



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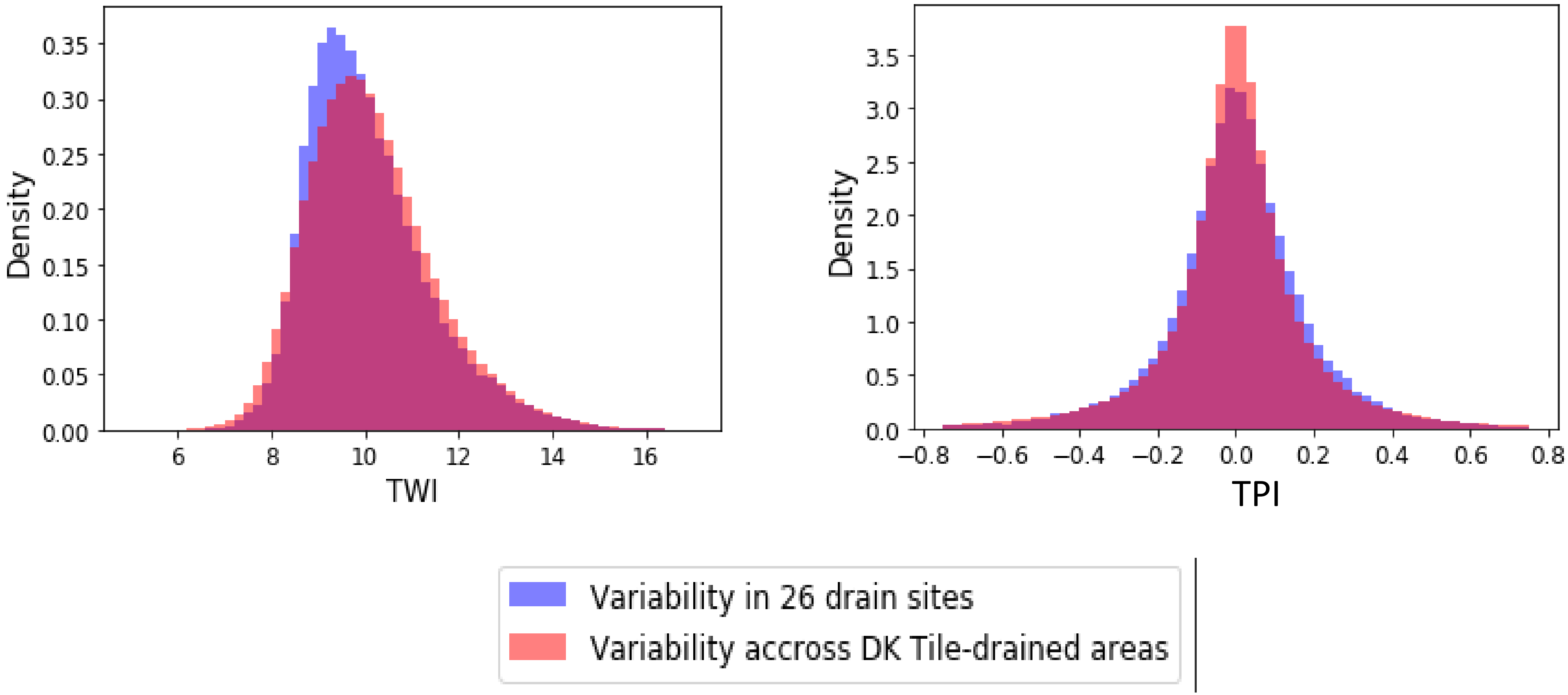
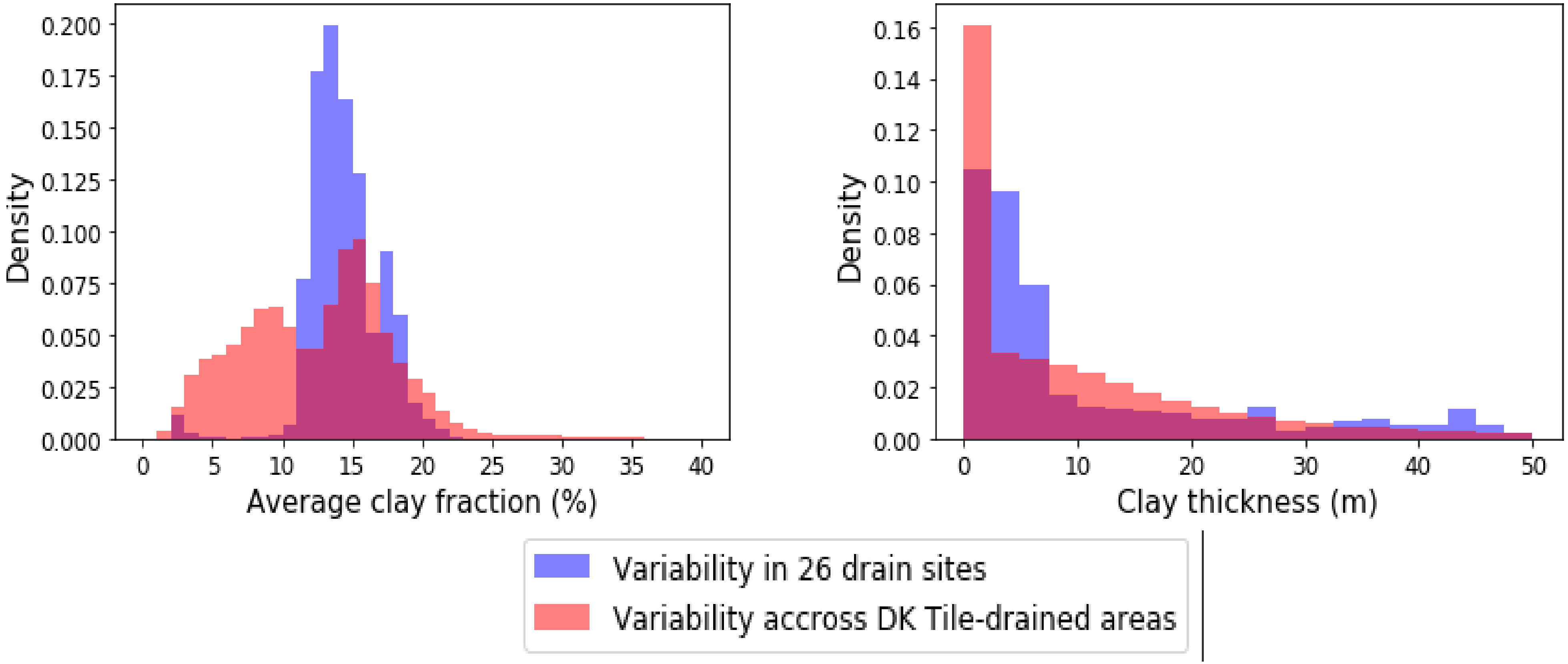
Variability covered across Denmark



Variables variability covered across Denmark



- Clay fraction below 10% not represented in our study

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Conclusion

- A reliable calibrated model that can predict drain flow dynamics accurately
- Topographical wetness index and relative topography has control over drain flow dynamics

Thank you