

# Intro til SWAT+ model og mulige virkemiddel-scenarier for oplandet til Vejle Fjord

WateriTech i samarbejde med Aarhus Universitet og SEGES:

- Et oplandsanalysenotat (baggrundsnotat)
- Opsætning af oplandsmodel (SWAT+) (model-protokol/notat)
  - Indarbejdelse af detaljeret landbrugspraksis
  - Indarbejdelse af spildevandsdata
- Design og kørsel af en række virkemiddel-scenarier med SWAT+ model (scenarie-notat)

Aarhus Universitet:

- Design og kørsel af en række virkemiddel-scenarier fokuseret på fosfor

- At give en grundlæggende forståelse for konceptet bag SWAT+ modellen
- At give en grundlæggende forståelse for det lokale data der ligger til grund for SWAT+ modellen for Vejle Fjord oplandet
- At give indsigt i de forskellige muligheder der findes for at simulere en række forskellige typer af virkemiddel-scenarier med SWAT+ modellen
- At give mulighed for spørgsmål og åben diskussion af både model-konceptet og datagrundlaget

|                                    | År 2025 |    |    |    |     |    |    |    |     |    |    |    |     |    |    |    | År 2026 |    |    |    |     |    |   |   |     |   |   |   |     |   |   |    |     |    |    |    |    |    |    |  |
|------------------------------------|---------|----|----|----|-----|----|----|----|-----|----|----|----|-----|----|----|----|---------|----|----|----|-----|----|---|---|-----|---|---|---|-----|---|---|----|-----|----|----|----|----|----|----|--|
| Aktiviteter                        | 3       |    |    |    |     |    |    |    | 4   |    |    |    |     |    |    |    | 1       |    |    |    |     |    |   |   | 2   |   |   |   |     |   |   |    |     |    |    |    |    |    |    |  |
|                                    | aug     |    |    |    | sep |    |    |    | okt |    |    |    | nov |    |    |    | dec     |    |    |    | jan |    |   |   | feb |   |   |   | mar |   |   |    | apr |    |    |    |    |    |    |  |
|                                    | 31      | 32 | 33 | 34 | 35  | 36 | 37 | 38 | 39  | 40 | 41 | 42 | 43  | 44 | 45 | 46 | 47      | 48 | 49 | 50 | 51  | 52 | 1 | 2 | 3   | 4 | 5 | 6 | 7   | 8 | 9 | 10 | 11  | 12 | 13 | 14 | 15 | 16 | 17 |  |
| AP 1.1 Analyser af oplandet        |         |    |    |    |     |    |    |    | M1  |    |    |    |     |    |    |    |         |    |    |    |     |    |   |   |     |   |   |   |     |   |   |    |     |    |    |    |    |    |    |  |
| AP 1.2 Opsætning af oplandsmodel   |         |    |    |    |     |    |    |    | M2  |    |    |    |     |    |    |    | M3      |    |    |    |     |    |   |   |     |   |   |   |     |   |   |    |     |    |    |    |    |    |    |  |
| AP 1.3 Modelscenarier - opland     |         |    |    |    |     |    |    |    |     |    |    |    | M4  |    |    |    |         |    |    |    |     |    |   |   |     |   |   |   | M5  |   |   |    |     |    |    |    |    |    |    |  |
| AP 3.1 Spildevands og dambrugsdata | M6      |    |    |    |     |    |    |    |     |    |    |    |     |    |    |    |         |    |    |    |     |    |   |   |     |   |   |   |     |   |   |    |     |    |    |    |    |    |    |  |

M1

Notat med en beskrivelse af oplandets karakter, herunder næringsstoftransporter.

M2

Kort notat, som beskriver modelinputs, datatyper og kilder.

M3

Notat med modelbeskrivelse og -dokumentation.

M4

Scenarieworkshop.

M5

Notat og GIS filer med scenarieresultater for op til max. 10 scenarier. Evt. udestående scenarier (ud af de max. 10) kan køres senere i 2026.

M6

Løbende kommunikation, hvor der præsenteres og diskuteres mulige metoder og data formater for forbedrede spildevandsdata fra de vigtigste forsyningsselskaber og dambrug. Første version af input data er klargjort.

## SWAT Soil & Water Assessment Tool

- SWAT+ er en procesbaseret agro-hydrologisk oplandsmodel
- Modellen er holistisk og omfattende med mange procesinteraktioner
- Open source og med et kæmpestort netværk af forskere og brugere, som løbende tester og forbedrer modellen
- Et af modellens hovedformål er at simulere mængden og kvaliteten af overfladevand, og herudfra at forudsige de miljømæssige konsekvenser af ændringer i arealanvendelser, landbrugspraksis samt effekter af klimaforandringer



# Eksempler på spørgsmål som typisk søges besvaret med SWAT+

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- Hvad er effekten af et ændret klima på tilgængeligheden af vand?
- Hvad er effekten af reduktion i punktkilder sammenlignet med effekten af ændret arealanvendelse og landbrugspraksis på tabet af kvælstof og fosfor til vandmiljøet?
- Hvordan kan afgrødeproduktionen ændre sig under fremtidige klimaforhold?
- Hvilke virkemidler kunne være mest effektive ift. at reducere transporten af N og P?
- og mange flere spørgsmål...

# Historien bag SWAT+

**SWAT** Soil & Water  
Assessment Tool



- SWAT+ er udviklet af USDA i samarbejde med Texas A&M University, og en lang række internationale samarbejdspartnere

- Første version udgivet i begyndelsen af 90'erne (Arnold et al. 1998 er citeret > 6000 gange)

- Blandt verdens mest gennemtestede og publicerede modeller (>6500 publikationer)

- Løbende under udvikling igennem forskning, som tilsigter at model altid er state-of-the-art

- Har været anvendt i forskellige forskningsprojekter i Danmark igennem de seneste 10-15 år

**Hvorfor:** fordi 1) den simulerer både kvælstof og fosfor, 2) den er open source og under løbende udvikling af stærke forskningsgrupper, 3) den har en stærk landbrugskomponent, og 4) den kan simulere effekter af både ændret klima og arealanvendelse

Vi har en  
internationalt  
anerkendt gruppe  
af SWAT+ eksperter i  
Danmark



# 2023 SWAT Conference

Aarhus University, June 28-30, 2023

# Nogle forsknings-eksempler fra Danmark

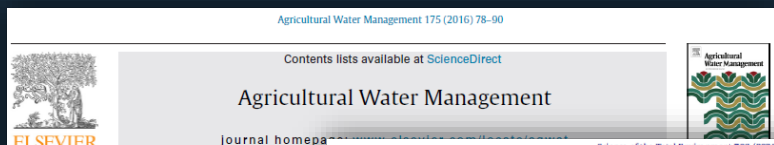
Hvilken rolle spiller dræn i transporten af opløst og partikelbundet fosfor til vandmiljøet?

Har niveauet af grundvandsindvinding betydning for vandløbsbiologien?

Hvilke områder er hotspots ift. næringssalttransport?

Hvad betyder fremtidens klima for N & P transporter?

Hvor er de største kilder til usikkerheder når der simuleres både ændret landbrugspraksis og et ændret klima?



## Extended SWAT model for dissolved tile-drained fields and catchments

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Soil TP accumulation  
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Leaching  
Langmuir isotherm

### 1. Introduction

Phosphorus (P) is often an important factor for eutrophication and a key concern regarding the ecological status in freshwater systems (Sharpley et al., 1994; Carpenter et al., 1998). P in aquatic systems consists of mixed soluble and particulate, and turnover among different P pools is dynamic (Correll, 2000; Blann et al., 2009). In some areas, tile drains have been widely installed to drain excessive water (Smedley et al., 2000; Blann et al., 2009). In some areas, tile drains have been found to contribute 30–60% of the stream flow (Xue et al., 2010; Koch et al., 2013). Moreover, intensification of agriculture has led to increased P inputs to the environment (Haygarth et al., 1998; Heathwaite and Kronvang et al., 2007). Therefore, it is important to understand the ability to quantify the transport and track the sources of P in those areas. In lowland agricultural catchments, tile drains have been widely installed to drain excessive water (Smedley et al., 2000; Blann et al., 2009). In some areas, tile drains have been found to contribute 30–60% of the stream flow (Xue et al., 2010; Koch et al., 2013). Moreover, intensification of agriculture has led to increased P inputs to the environment (Haygarth et al., 1998; Heathwaite and Kronvang et al., 2007). Therefore, it is important to understand the ability to quantify the transport and track the sources of P in those areas.

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<http://dx.doi.org/10.1016/j.agwat.2015.12.008>  
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## Assessing the impacts of groundwater abstraction on stream biota: Combining SWAT-MODFLOW and empirical models

Wei Liu<sup>a,\*</sup>, Ryan T. Bailey<sup>b</sup>, Hans Estrup Andersen<sup>a</sup>, Anders Nielsen<sup>a</sup>, Eugenio Molina-Navarro<sup>a,d</sup>, Dennis Trolle<sup>a</sup>

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<sup>b</sup> Department of Civil and Environmental Engineering, Colorado State University, Fort Collins, CO, USA  
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<sup>d</sup> Department of Geology, Geography and Environment, University of Alcalá, Alcalá de Henares, Spain

### HIGHLIGHTS

- We took an integrated approach combining SWAT-MODFLOW with flow-biota models.
- Current groundwater abstractions had minor impacts on flow regime and stream biota.
- An extreme abstraction level had significant impacts on small streams.
- The fish index was most affected by groundwater abstractions.

### GRAPHICAL ABSTRACT



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Groundwater abstraction  
Ecological quality  
Stream biota  
Flow-biota empirical models

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Vol. 65, No. Supplement 2, 217–227, <http://dx.doi.org/10.1080/09064710.2015.1010564>

## The combined effects of fertilizer and increased fertilization on low risk SWAT model for a Danish catchment

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Department of BioScience, Aarhus University, Vejlsøvej 25, 8000 Århus C, Denmark  
(Received 25 June 2014; accepted 17 January 2015)

Some agricultural areas lose considerably more than others, IRAs) and others considerably less than the interest when river catchment managers seek to both allow intensive agriculture. If IRAs were farmed would be larger here than from any other areas, and if done here causing less environmental damage than at the same catchment they might counter balance the without causing environmental deterioration. We use IRAs and LRAs in an intensively farmed lowland catchment of the agricultural area leaching, respectively, the most (reduced fertilizer input by 20%) and LRAs (increased where both IRAs and LRAs were included). The decrease (3.3%) in nitrate river load at the catchment increase (0.9%). The combined scenarios showed an

**Keywords:** hydrological modelling; nitrogen; Odense

### Introduction

Attempts to reduce agricultural N losses have been on the political agenda in many European countries for several years and resulted in several pieces of international legislation. The increases in N consumption in European agriculture which took place during the 1940s to the 1980s (Windolf et al., 2012) have deteriorated the water quality in both groundwater and surface water bodies (Kronvang et al., 1993) and has been considered an increasing threat to European drinking water supplies (EEA 2007). In response, the European Community adopted the Nitrates Directive in 1991 to assist in the protection of drinking water quality (EC 1991). The eutrophication problems in the Baltic Sea were addressed by the Helsinki Commission (HELCOM), and plans to monitor, manage and reduce nutrient loads to the Baltic Sea by 50% before 1995 were adopted in 1988 by the countries around the Baltic Sea (HELCOM

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## Quantifying the combined effects of land use change on stream flow and nutrient loads: A model-based study of the Fjord catchment (Denmark)

Eugenio Molina-Navarro<sup>a</sup>, Hans E. Andersen, Anders Nielsen

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## Effects of changes in land use and climate on aquatic ecosystems: Coupling of models and decomposition of uncertainties

Dennis Trolle<sup>a,b,\*</sup>, Anders Nielsen<sup>a</sup>, Hans E. Andersen<sup>a</sup>, Hans Thodsen<sup>a</sup>, Jørgen E. Olesen<sup>c,d,e</sup>, Christen D. Børgesen<sup>c</sup>, Jens Chr. Refsgaard<sup>d</sup>, Torben O. Sonnenborg<sup>d</sup>, Ida B. Karlsson<sup>d</sup>, Jesper P. Christensen<sup>f</sup>, Stig Markager<sup>g</sup>, Erik Jeppesen<sup>a,b,e</sup>

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## SWAT Soil & Water Assessment Tool

I kystvandrådsregi arbejdes der parallelt med opsætninger af SWAT+ oplandsmodellen for:

- Vejle Fjord
- Kolding Fjord
- Holckenhavn Fjord
- Haderslev Fjord
- Roskilde Fjord
- Isefjord
- Odense Fjord (første generation af KVR)
- Ringkøbing Fjord (første generation af KVR)

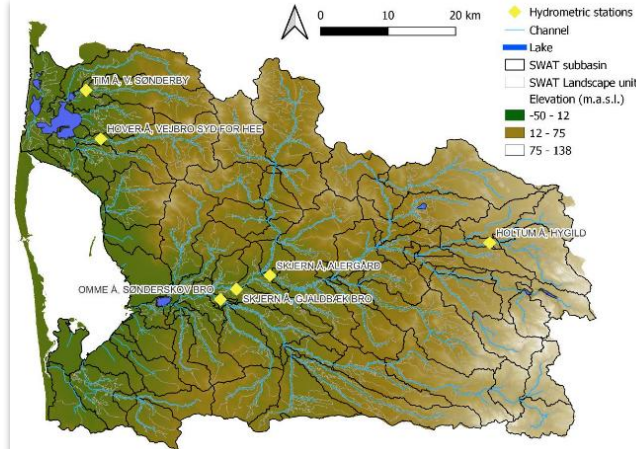


### Modelling of Ringkøbing Fjord to support policy-makers for compliance with the EU Water Framework Directive

DRAFT REPORT

DECEMBER 2023

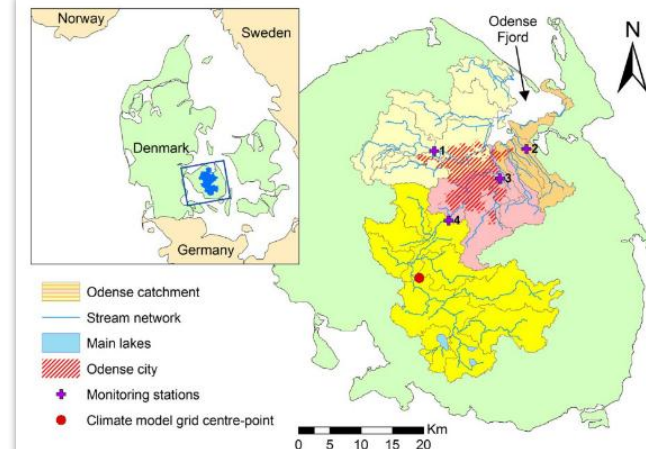
Leonard Bernard-Jannin, Joao G. Ferreira, Joao Lencart e Silva,  
Alhambra M. Cubillo, Gerhardus Diedricks



DATE: June 2024  
FOR: NORDBALT-ECOSAFE

### SWAT+ model protocol for Odense Fjord Catchment, Denmark

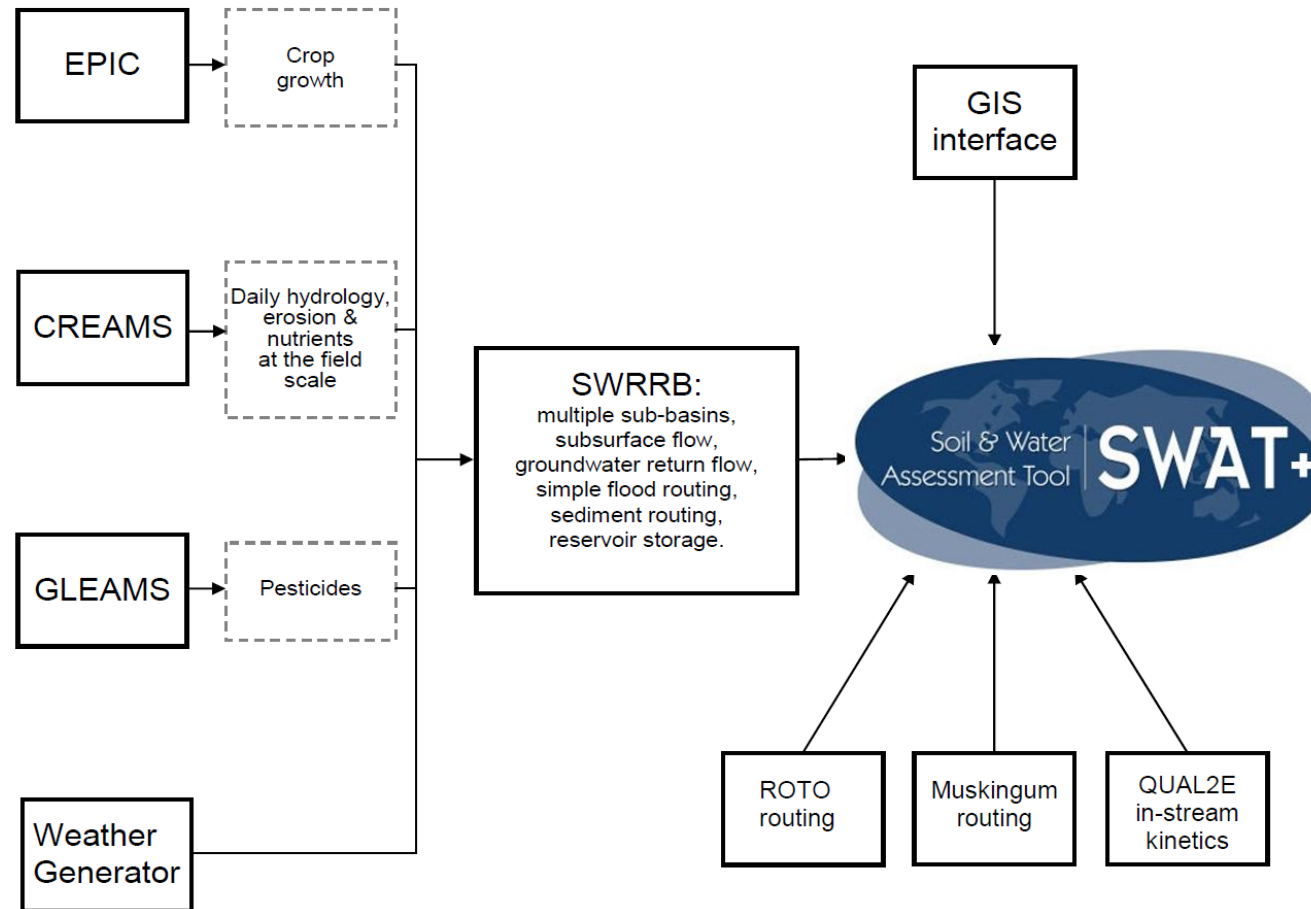
DATE: June 29, 2024  
AUTHORS: Katrin Bieger, Brian Kronvang  
CITE AS: Bieger, K. and Kronvang, B. 2024. SWAT+ model protocol for Odense Fjord Catchment, Denmark. 14 pp.



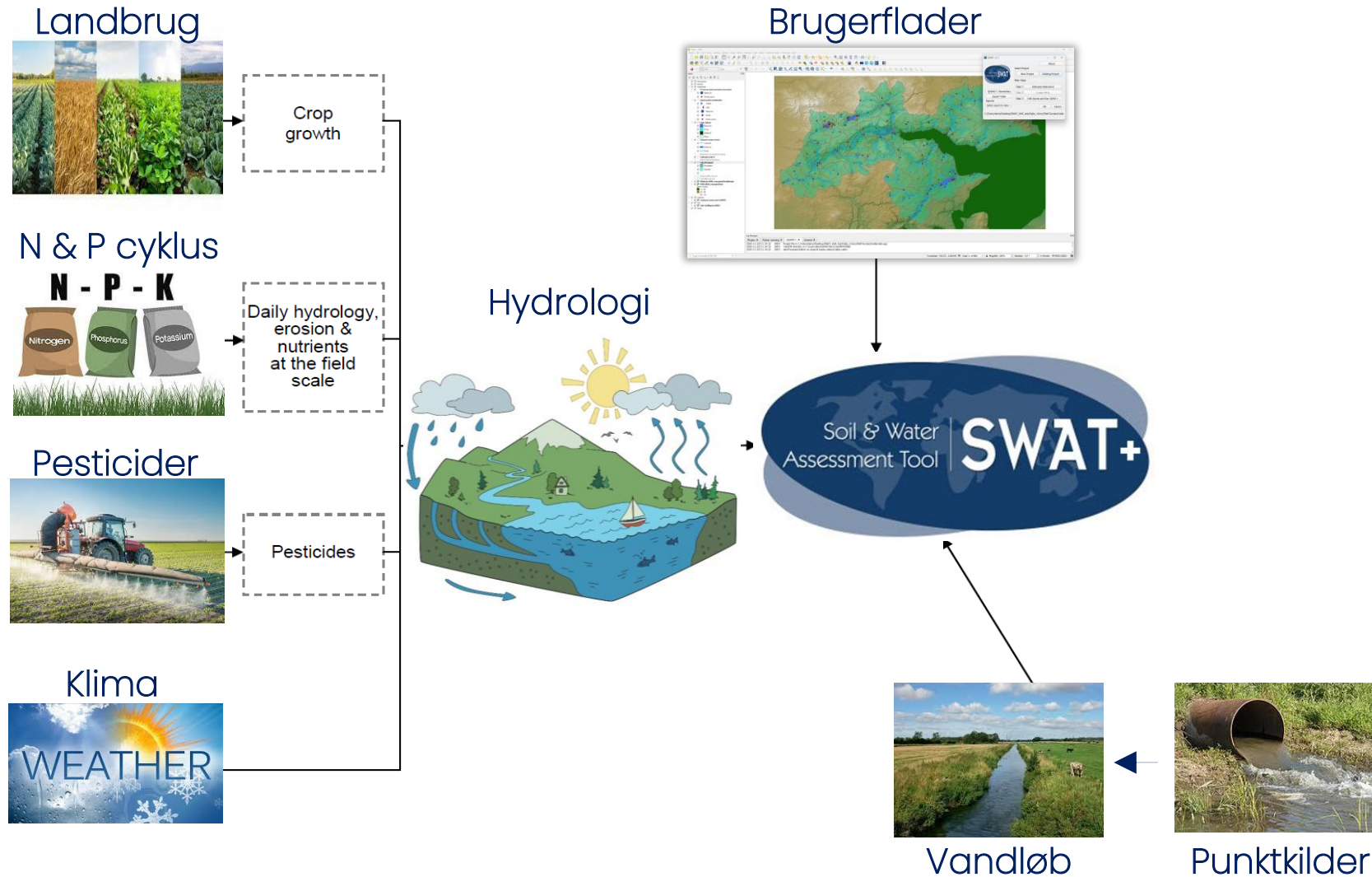
# Komponenterne i SWAT+



# Komponenterne i SWAT+



# Komponenterne i SWAT+



## SWAT Soil & Water Assessment Tool

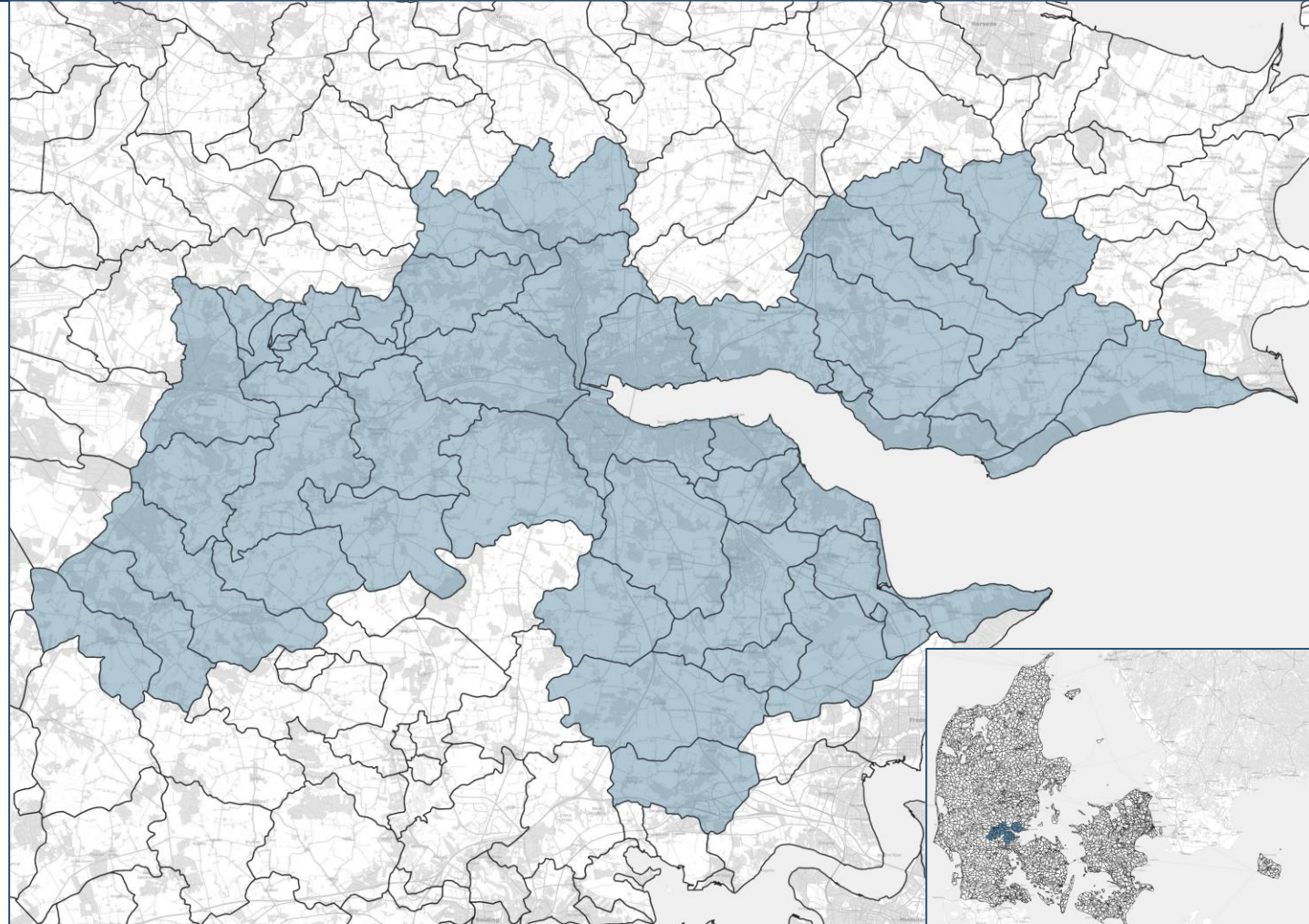
ID15 oplande til Vejle Fjord

### Grundlæggende inputs

- Højdemodel (terrænkort)
- Arealanvendelseskort
- Jordtypekort
- Vejrdata

### Supplerende inputs

- Nationale oplandsgrænser og deloplande
- Stationsobservationer
- Punktkilder
- Landbrugspraksis og rotationer
- Afgrødedatabase





Modelopsætning



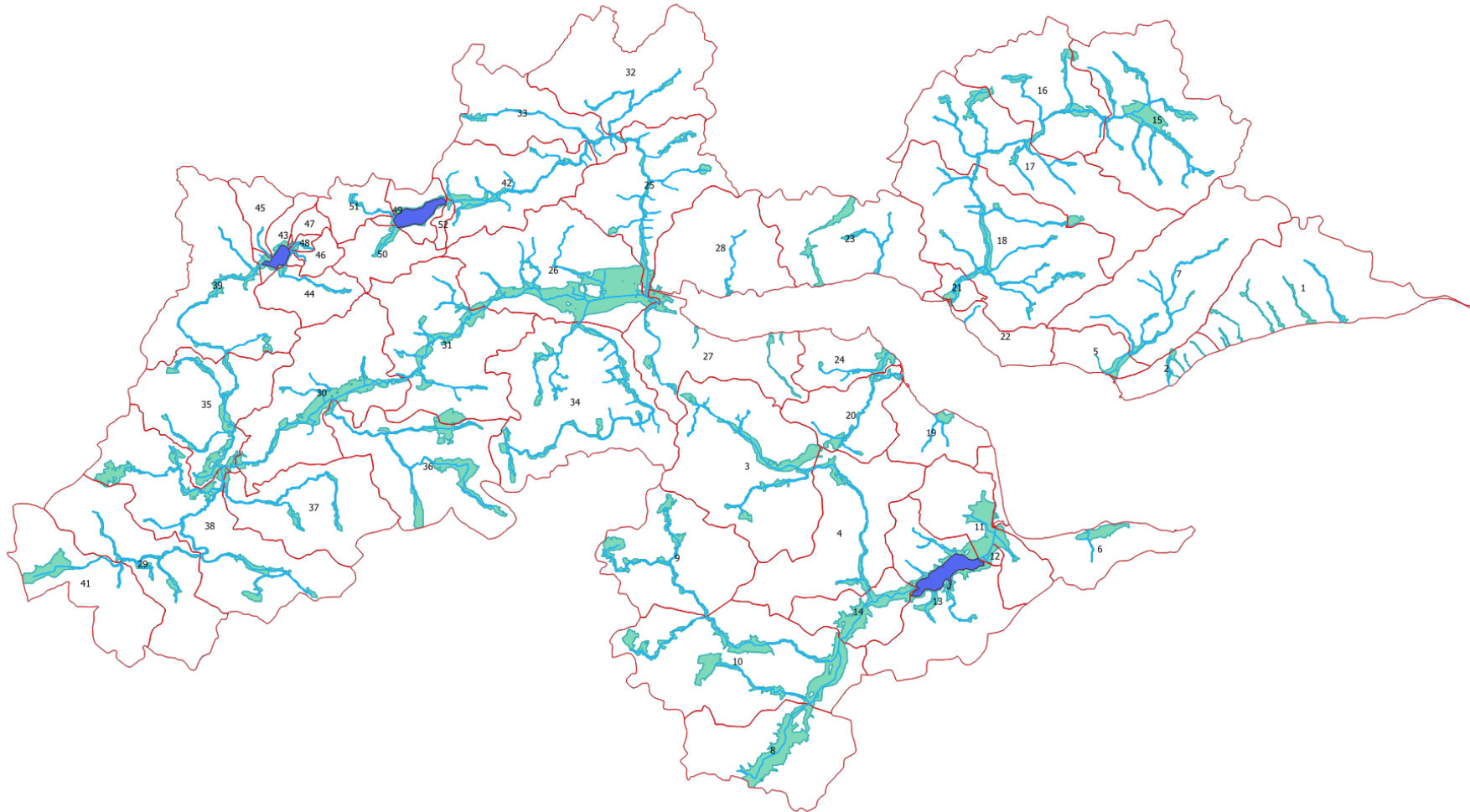
Kalibrering og validering (stadig i proces)



Forberedelse, kørsel og analyse af virkemiddel-scenarier  
(f.eks. punktkilder, vådområder, arealomlægning)

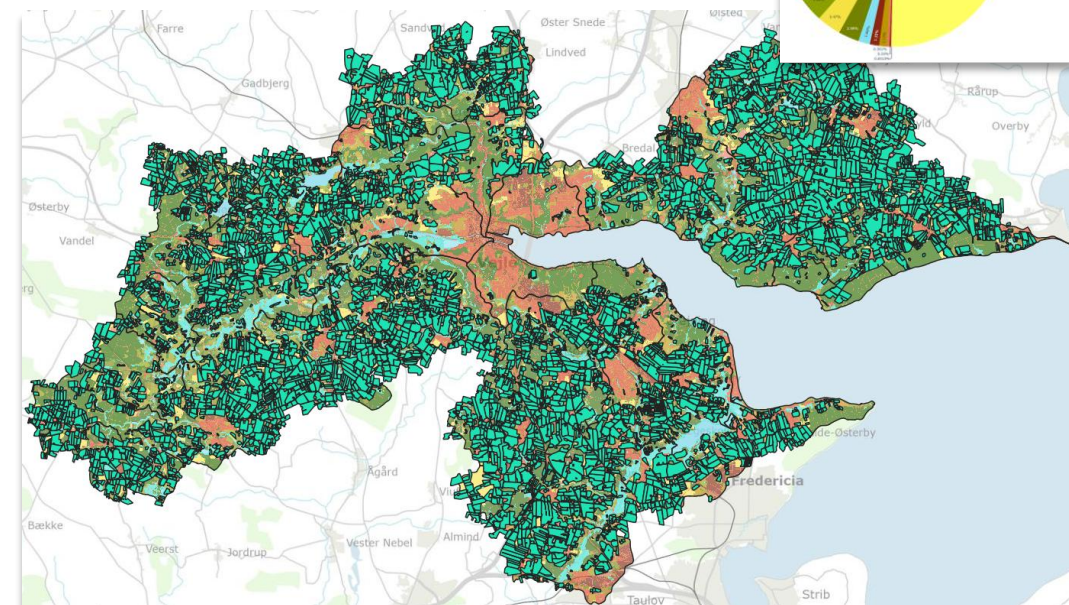
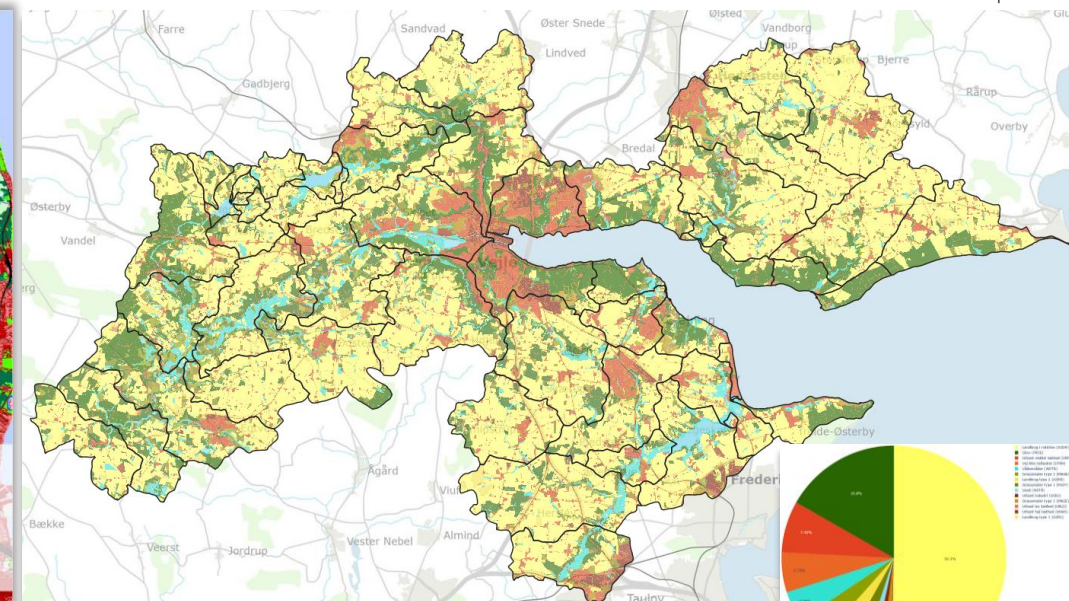
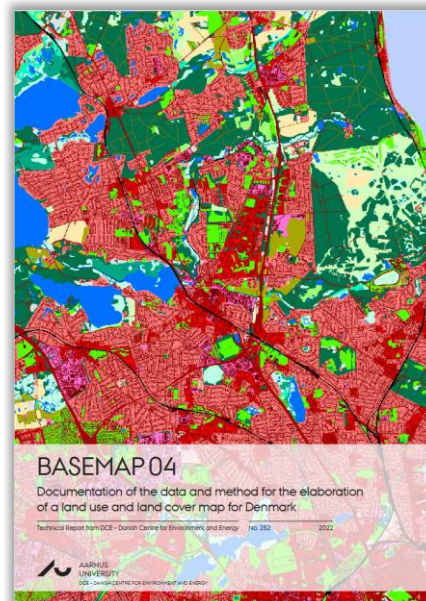
# Model-inputs: højdemodel og oplandsgrænser

- Seneste nationale højdemodel fra dataforsyningen.dk
- Officielle id15 deloplande og vandløb
- Ådale afgrænsning beskrevet af Sechu m.fl. 2021 (AU og GEUS)



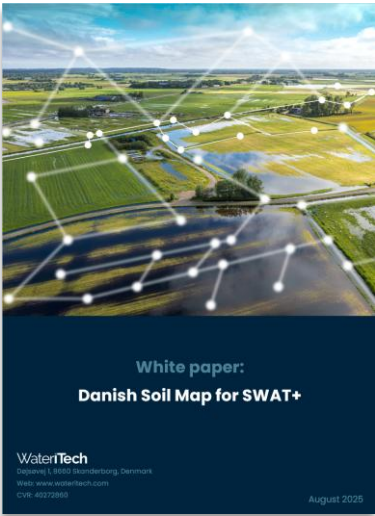
## Arealanvendelse

- Baseret på **Basemap4** (2022) fra Aarhus Universitet med supplerende informationer om arealer i om drift fra SEGES.

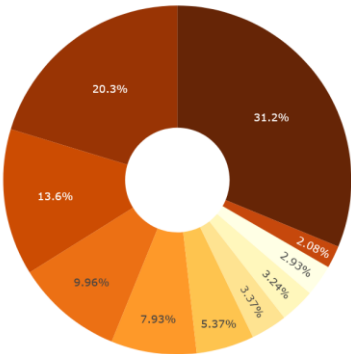
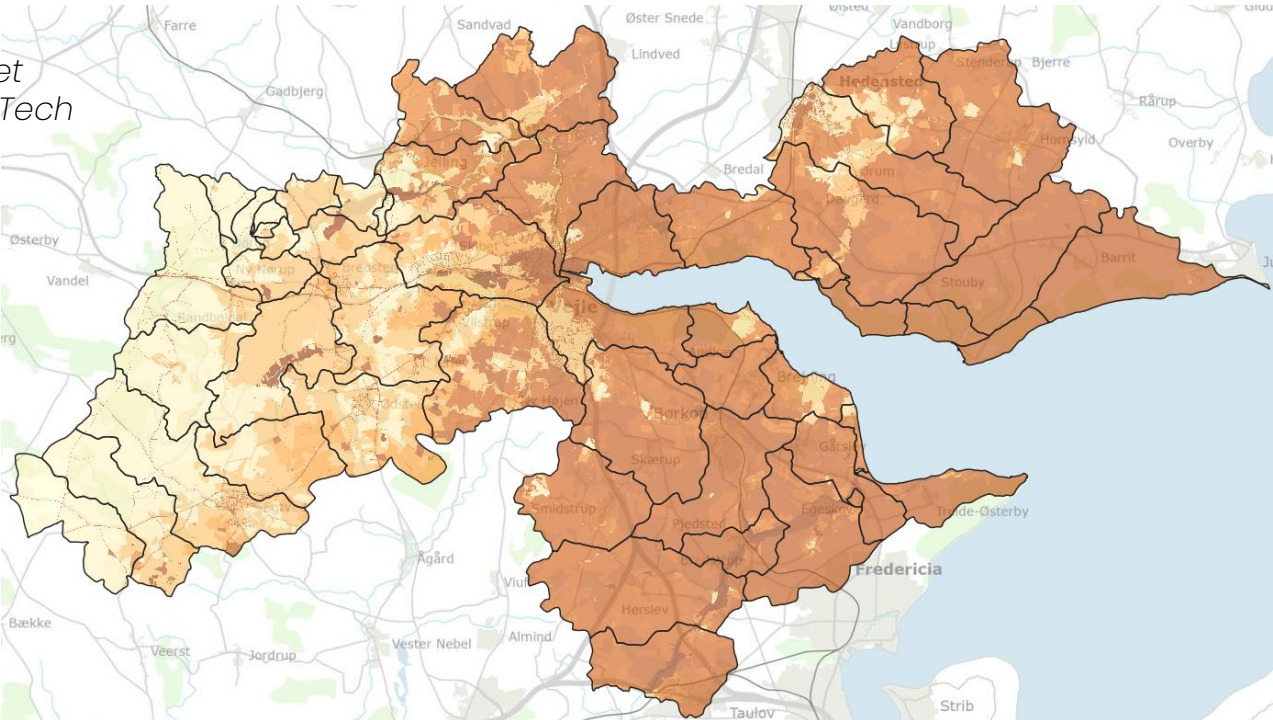


Jordtypekort

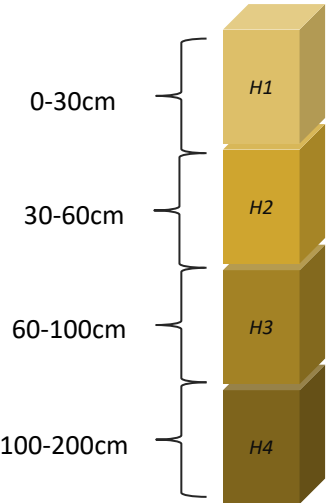
- Baseret på "Tekstur2024" fra Aarhus Universitet
- Hydrologiske egenskaber beregnet af WaterITech



| OBJECTID | HYDGRP                  | Hydrologic soil group | Depth | 1895   | 2005  | 2073   | 3445  | 3447   | 20725 | 20727 |
|----------|-------------------------|-----------------------|-------|--------|-------|--------|-------|--------|-------|-------|
| A        | A                       | A                     | A     | A      | A     | A      | A     | A      | A     | A     |
| SOL_BD1  | Bulk density            | 0-30 cm               | 139   | 135    | 142   | 137    | 138   | 123    | 129   |       |
| SOL_AWC1 | Available water content |                       | 0.15  | 0.16   | 0.16  | 0.16   | 0.16  | 0.16   | 0.16  |       |
| SOL_K1   | Hydraulic conductivity  |                       | 83.30 | 110.80 | 75.50 | 103.00 | 83.30 | 93.80  | 90.50 |       |
| SOL_CBN1 | Organic carbon content  |                       | 1.95  | 3.31   | 1.68  | 3.80   | 3.41  | 14.51  | 11.81 |       |
| CLAY1    | Clay                    |                       | 3.47  | 3.02   | 4.25  | 3.27   | 3.86  | 3.57   | 4.86  |       |
| SILT1    | Silt                    |                       | 4.83  | 3.61   | 5.29  | 3.97   | 5.72  | 4.16   | 5.60  |       |
| SAND1    | Sand                    |                       | 51.00 | 58.20  | 50.94 | 56.00  | 49.72 | 56.10  | 48.66 |       |
| SOL_ALB1 | Moist soil albedo       |                       | 0.23  | 0.22   | 0.23  | 0.22   | 0.22  | 0.21   | 0.22  |       |
| USLE_K1  | USLE erodibility factor |                       | 0.14  | 0.13   | 0.13  | 0.13   | 0.13  | 0.12   | 0.12  |       |
| SOL_BD2  | Bulk density            | 30-60 cm              | 149   | 149    | 151   | 137    | 142   | 0.94   | 136   |       |
| SOL_AWC2 | Available water content |                       | 0.15  | 0.16   | 0.15  | 0.17   | 0.16  | 0.19   | 0.18  |       |
| SOL_K2   | Hydraulic conductivity  |                       | 76.25 | 85.84  | 72.80 | 96.76  | 61.12 | 121.80 | 80.40 |       |
| SOL_CBN2 | Organic carbon content  |                       | 1.88  | 3.98   | 1.59  | 9.27   | 10.45 | 20.83  | 16.69 |       |
| CLAY2    | Clay                    |                       | 3.14  | 2.24   | 5.31  | 2.78   | 5.45  | 3.07   | 5.91  |       |
| SILT2    | Silt                    |                       | 4.01  | 2.73   | 4.47  | 3.06   | 4.63  | 3.34   | 4.55  |       |
| SAND2    | Sand                    |                       | 52.78 | 61.16  | 55.88 | 55.88  | 49.89 | 59.30  | 51.84 |       |
| SOL_ALB2 | Moist soil albedo       |                       | 0.23  | 0.22   | 0.23  | 0.22   | 0.22  | 0.21   | 0.21  |       |
| USLE_K2  | USLE erodibility factor |                       | 0.14  | 0.13   | 0.14  | 0.12   | 0.12  | 0.12   | 0.12  |       |
| SOL_BD3  | Bulk density            | 60-100 cm             | 156   | 151    | 144   | 149    | 153   | 1.09   | 131   |       |
| SOL_AWC3 | Available water content |                       | 0.15  | 0.17   | 0.15  | 0.18   | 0.17  | 0.19   | 0.18  |       |
| SOL_K3   | Hydraulic conductivity  |                       | 75.64 | 103.70 | 89.44 | 94.20  | 69.30 | 119.50 | 79.06 |       |
| SOL_CBN3 | Organic carbon content  |                       | 0.94  | 1.77   | 0.84  | 13.20  | 14.63 | 20.38  | 18.17 |       |
| CLAY3    | Clay                    |                       | 3.69  | 2.70   | 4.50  | 3.20   | 6.47  | 3.19   | 6.23  |       |
| SILT3    | Silt                    |                       | 2.69  | 2.64   | 2.74  | 2.42   | 3.68  | 2.96   | 3.58  |       |
| SAND3    | Sand                    |                       | 56.90 | 65.50  | 59.97 | 62.60  | 55.28 | 63.22  | 56.80 |       |
| SOL_ALB3 | Moist soil albedo       |                       | 0.23  | 0.21   | 0.23  | 0.21   | 0.21  | 0.21   | 0.21  |       |
| USLE_K3  | USLE erodibility factor |                       | 0.15  | 0.12   | 0.14  | 0.11   | 0.11  | 0.12   | 0.11  |       |
| SOL_BD4  | Bulk density            | 100-200 cm            | 156   | 151    | 144   | 149    | 153   | 1.09   | 131   |       |
| SOL_AWC4 | Available water content |                       | 0.15  | 0.17   | 0.15  | 0.18   | 0.17  | 0.19   | 0.18  |       |
| SOL_K4   | Hydraulic conductivity  |                       | 73.84 | 98.56  | 87.10 | 91.25  | 58.36 | 120.06 | 78.60 |       |
| SOL_CBN4 | Organic carbon content  |                       | 1.64  | 5.61   | 0.60  | 4.52   | 3.63  | 5.72   | 3.27  |       |
| CLAY4    | Clay                    |                       | 4.07  | 3.42   | 4.34  | 3.68   | 6.40  | 3.57   | 6.38  |       |
| SILT4    | Silt                    |                       | 3.17  | 2.81   | 2.71  | 2.40   | 3.72  | 3.06   | 3.56  |       |
| SAND4    | Sand                    |                       | 56.06 | 63.25  | 58.78 | 60.88  | 47.47 | 61.38  | 54.72 |       |
| SOL_ALB4 | Moist soil albedo       |                       | 0.23  | 0.22   | 0.23  | 0.22   | 0.22  | 0.22   | 0.22  |       |
| USLE_K4  | USLE erodibility factor |                       | 0.14  | 0.12   | 0.14  | 0.12   | 0.16  | 0.12   | 0.13  |       |



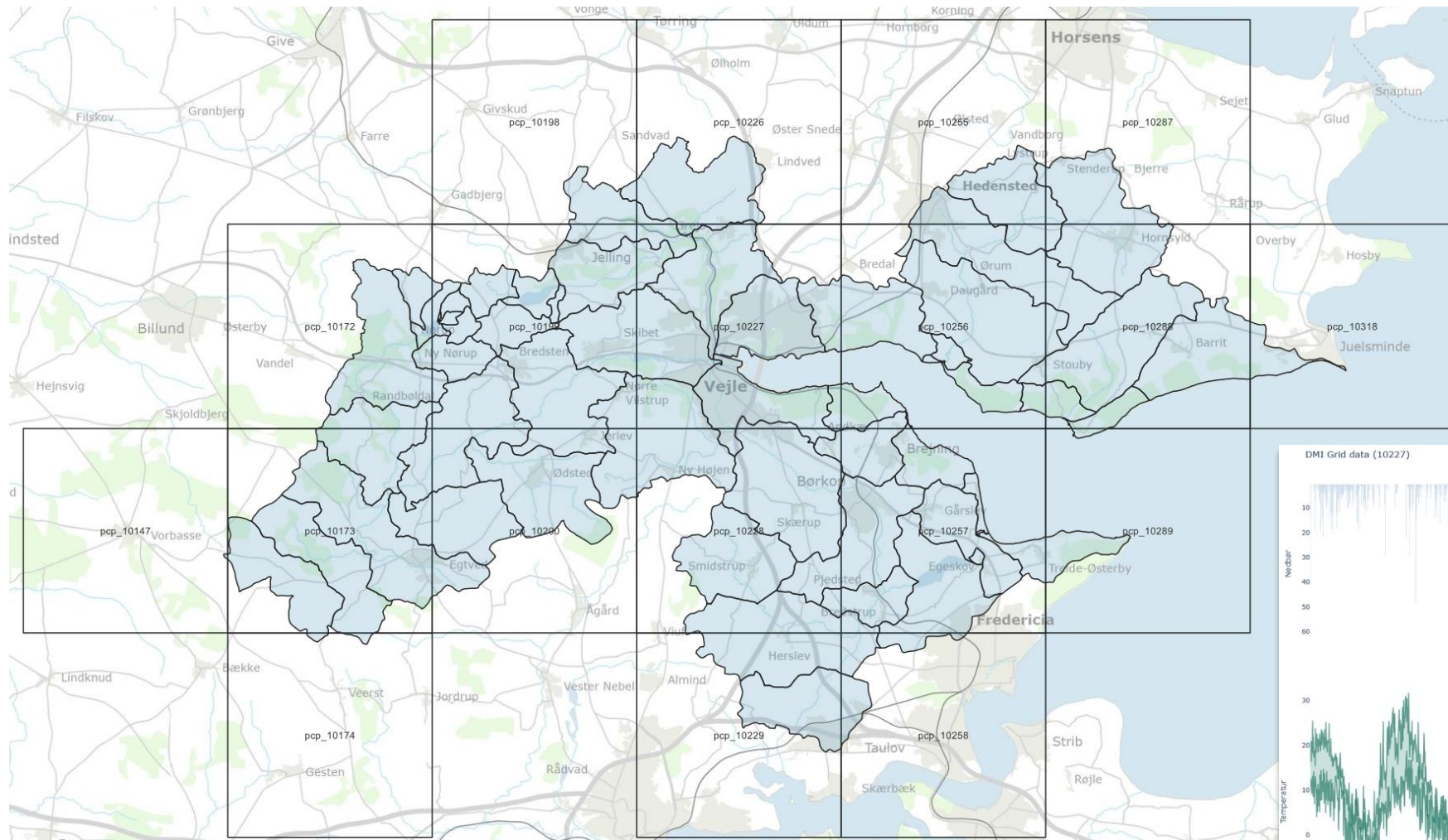
- 13195
- 11467
- 9425
- 5655
- Other
- 11323
- 9739
- 5681
- 5969
- 11310



| SoilID | Horizon_1                        | Horizon_2                        | Horizon_3                        | Horizon_4                        |
|--------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|
| 13195  | (JB-07) Lerjord                  | (JB-07) Lerjord                  | (JB-07) Lerjord                  | (JB-07) Lerjord                  |
| 11467  | (JB-06) Fin sandblandet lerjord  | (JB-07) Lerjord                  | (JB-07) Lerjord                  | (JB-07) Lerjord                  |
| 9425   | (JB-05) Grov sandblandet lerjord | (JB-05) Grov sandblandet lerjord | (JB-05) Grov sandblandet lerjord | (JB-05) Grov sandblandet lerjord |
| 5655   | (JB-03) Grov lerblandet sandjord | (JB-03) Grov lerblandet sandjord | (JB-03) Grov lerblandet sandjord | (JB-03) Grov lerblandet sandjord |
| 11323  | (JB-06) Fin sandblandet lerjord  | (JB-06) Fin sandblandet lerjord  | (JB-07) Lerjord                  | (JB-07) Lerjord                  |
| 9739   | (JB-05) Grov sandblandet lerjord | (JB-07) Lerjord                  | (JB-07) Lerjord                  | (JB-07) Lerjord                  |
| 5681   | (JB-03) Grov lerblandet sandjord | (JB-03) Grov lerblandet sandjord | (JB-05) Grov sandblandet lerjord | (JB-05) Grov sandblandet lerjord |
| 5969   | (JB-03) Grov lerblandet sandjord | (JB-05) Grov sandblandet lerjord | (JB-05) Grov sandblandet lerjord | (JB-05) Grov sandblandet lerjord |
| 11310  | (JB-06) Fin sandblandet lerjord  | (JB-06) Fin sandblandet lerjord  | (JB-06) Fin sandblandet lerjord  | (JB-06) Fin sandblandet lerjord  |
| Other  | blandet                          | blandet                          | blandet                          | blandet                          |

## Vejrdata: 10km grid

10x10km opløsning

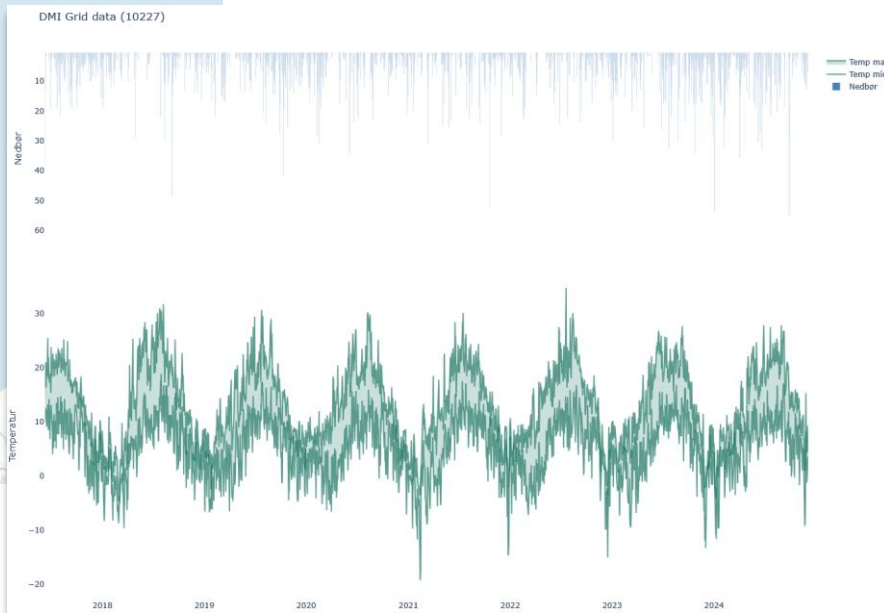


Danmarks  
Meteorologiske  
Institut



AARHUS UNIVERSITY

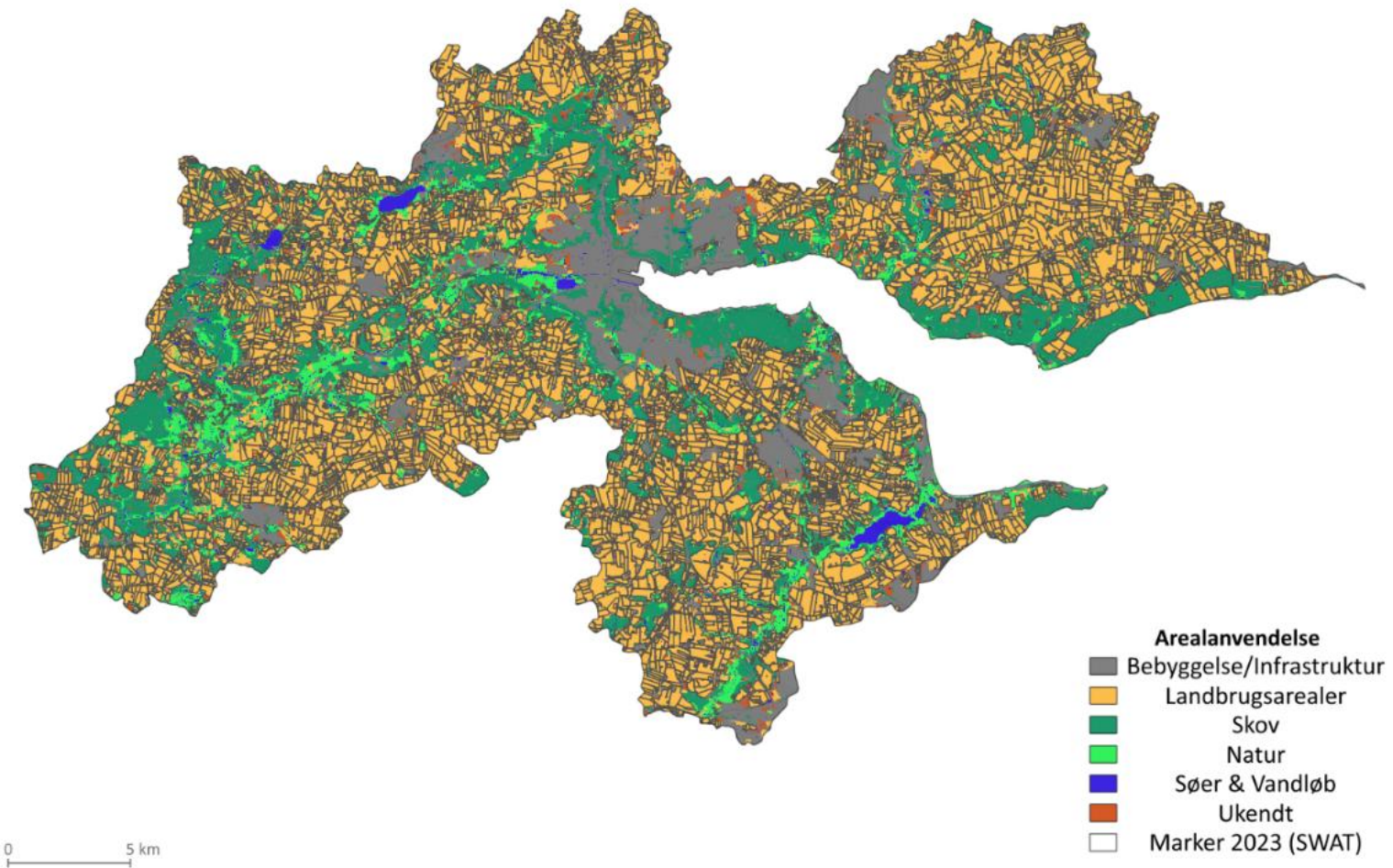
- Nedbør
- temperatur
- Relativ fugtighed
- Vind
- Indstråling



# Model-inputs: landbrugspraksis

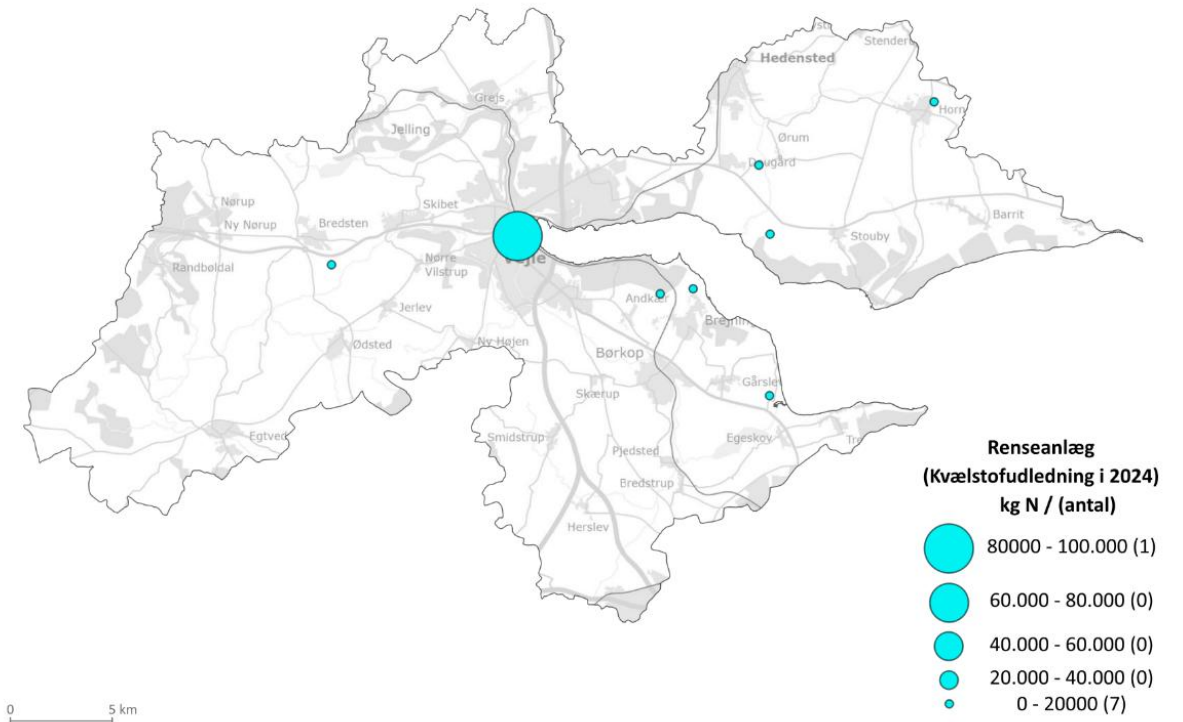
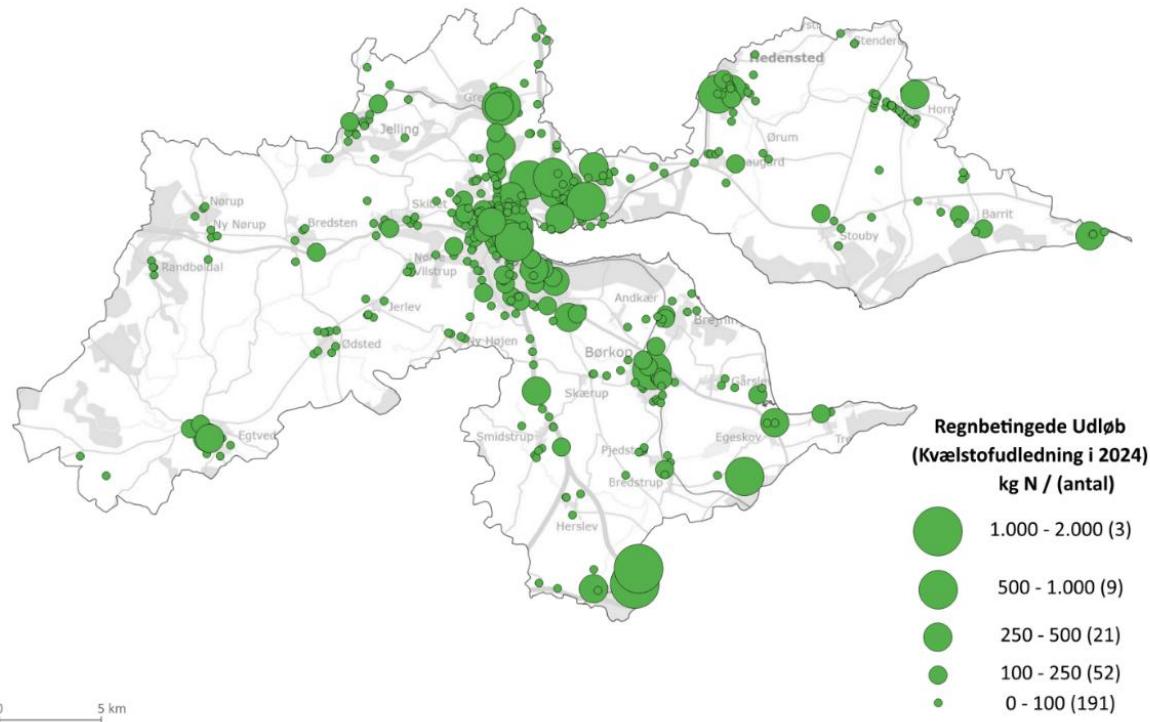
- +7.000 marker for Vejle Fjord oplandet fra Internet Markkort (IMK).
- Markdata (LandbrugsGIS), gødningsregnskaber og GKEA-data er integreret af SEGES, og anvendt til at lave 5-årige afgrøde-rotationer per mark.
- Inkl. såning af specifikke afgrøder, N & P gødskning, pløjning, efterafgrøder m.m.

|      |   |    |       |          |           |           |
|------|---|----|-------|----------|-----------|-----------|
| till | 4 | 1  | 0.000 | fallplow | null      | 0.00000   |
| plnt | 4 | 2  | 0.000 | barl     | null      | 0.00000   |
| fert | 4 | 15 | 0.000 | elem_n   | broadcast | 10.00000  |
| fert | 5 | 1  | 0.000 | elem_n   | broadcast | 118.49894 |
| fert | 5 | 15 | 0.000 | elem_n   | broadcast | 34.71024  |
| fert | 5 | 15 | 0.000 | org_n    | broadcast | 20.40484  |
| harv | 8 | 10 | 0.000 | barl     | grain     | 0.00000   |
| kill | 8 | 10 | 0.000 | barl     | null      | 0.00000   |
| skip | 0 | 0  | 0.000 | null     | null      | 0.00000   |
| till | 4 | 1  | 0.000 | fallplow | null      | 0.00000   |
| plnt | 4 | 2  | 0.000 | barl     | null      | 0.00000   |
| fert | 4 | 15 | 0.000 | elem_n   | broadcast | 10.00000  |
| fert | 5 | 1  | 0.000 | elem_n   | broadcast | 61.45882  |
| fert | 5 | 15 | 0.000 | elem_n   | broadcast | 78.21989  |
| fert | 5 | 15 | 0.000 | org_n    | broadcast | 47.83751  |
| harv | 8 | 10 | 0.000 | barl     | grain     | 0.00000   |
| kill | 8 | 10 | 0.000 | barl     | null      | 0.00000   |
| skip | 0 | 0  | 0.000 | null     | null      | 0.00000   |
| till | 4 | 1  | 0.000 | fallplow | null      | 0.00000   |
| plnt | 4 | 2  | 0.000 | barl     | null      | 0.00000   |
| fert | 4 | 15 | 0.000 | elem_n   | broadcast | 10.00000  |
| fert | 5 | 1  | 0.000 | elem_n   | broadcast | 37.81885  |
| fert | 5 | 15 | 0.000 | elem_n   | broadcast | 55.61875  |
| fert | 5 | 15 | 0.000 | org_n    | broadcast | 51.88006  |
| harv | 8 | 10 | 0.000 | barl     | grain     | 0.00000   |
| kill | 8 | 10 | 0.000 | barl     | null      | 0.00000   |
| skip | 0 | 0  | 0.000 | null     | null      | 0.00000   |
| till | 4 | 1  | 0.000 | fallplow | null      | 0.00000   |
| plnt | 4 | 2  | 0.000 | barl     | null      | 0.00000   |
| fert | 4 | 15 | 0.000 | elem_n   | broadcast | 10.00000  |
| fert | 5 | 1  | 0.000 | elem_n   | broadcast | 41.27637  |
| fert | 5 | 15 | 0.000 | elem_n   | broadcast | 67.98206  |
| fert | 5 | 15 | 0.000 | org_n    | broadcast | 60.89132  |
| harv | 8 | 10 | 0.000 | barl     | grain     | 0.00000   |
| kill | 8 | 10 | 0.000 | barl     | null      | 0.00000   |

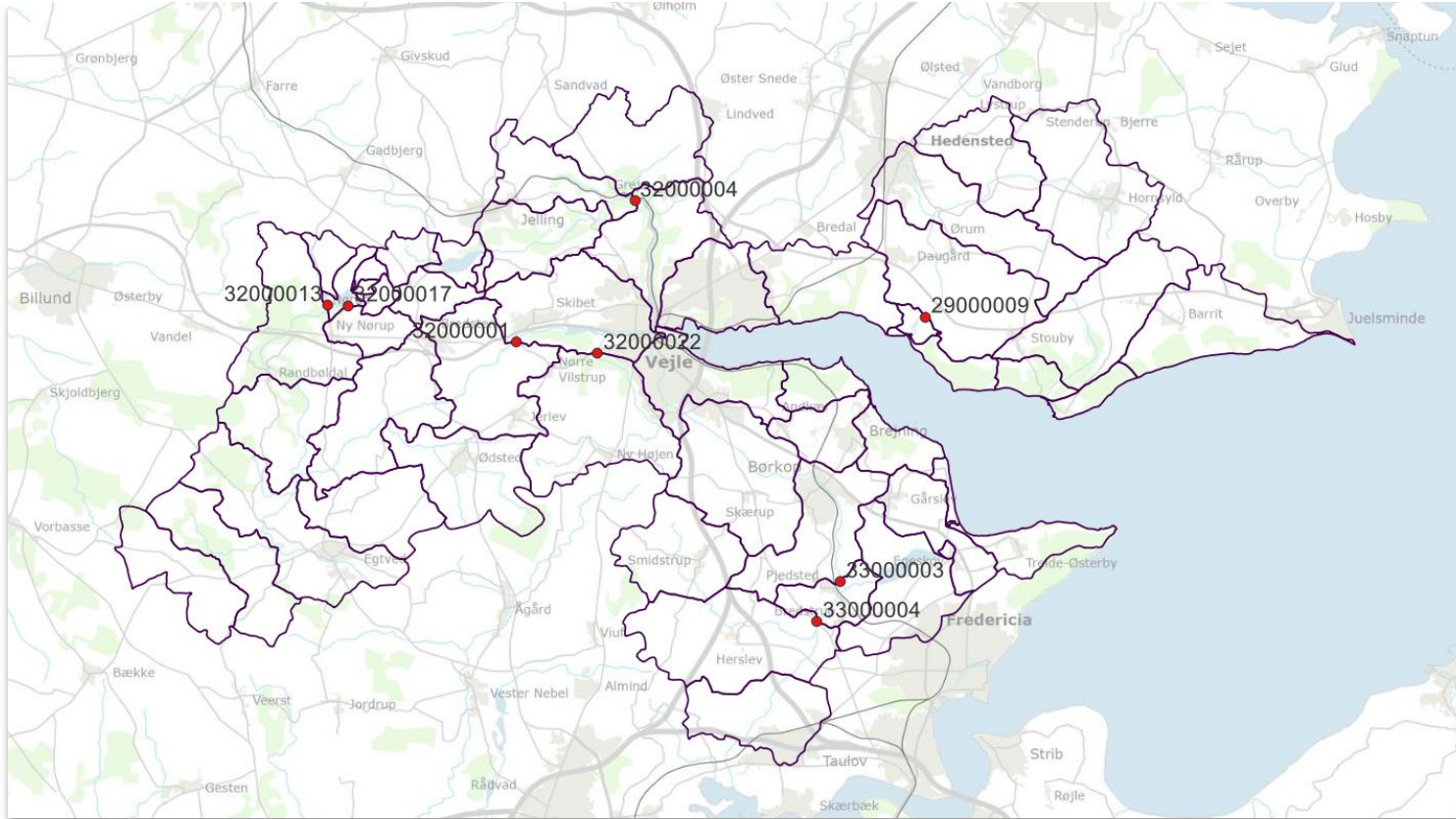


# Model-inputs: punktkilder

- Der er rekvireret data fra DCE/AU på punktkilder (alt i PULS er med + estimerer på spredt bebyggelse)  
> 2000 individuelle punktkilder for perioden 1990-2024  
(regnvandsbetingede udledninger, renseanlæg, industri og dambrug)
- Der er afholdt flere møder vedr. punktkilder med spildevandsselskaberne
- Der er fremsendt detaljerede (daglige) dataserier for nogle punktkilder (dette arbejde fortsættes)

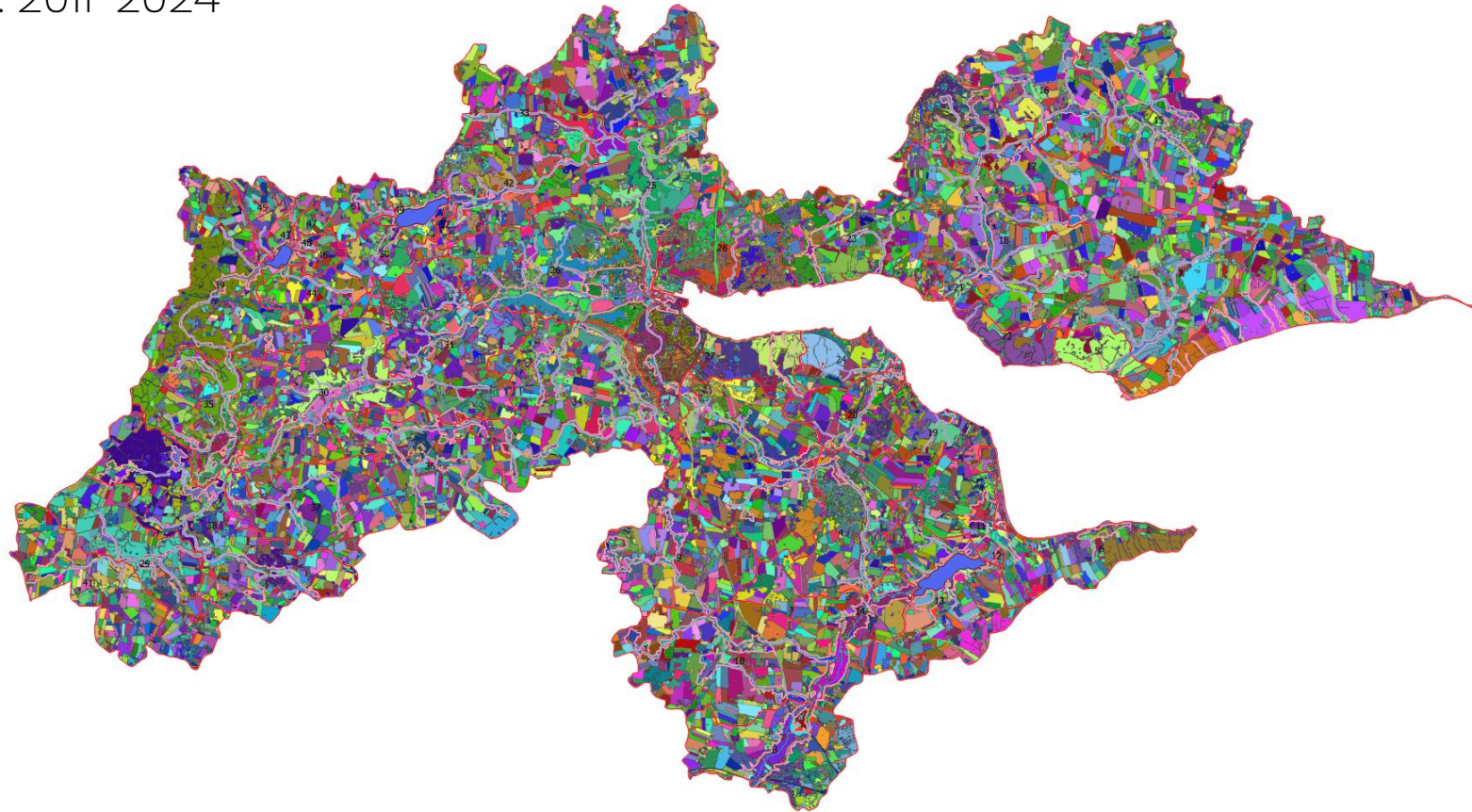


- Observationsdata fra vandløb (fra odaforalle.dk)



Der eksisterer 6-8 stoftransportstationer i ODA data med gode tidsserier. Disse bliver brugt til kalibrering og validering af modellen.

- Total areal: 727 km<sup>2</sup>
- HRUer: 14.355
- LSUer: 104
- Vandløbsstrækninger: 52
- Modelperiode: 2011-2024





Modelopsætning



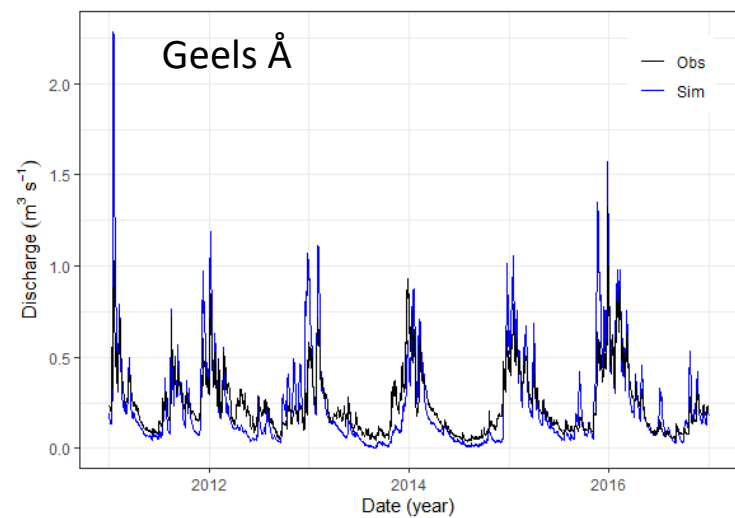
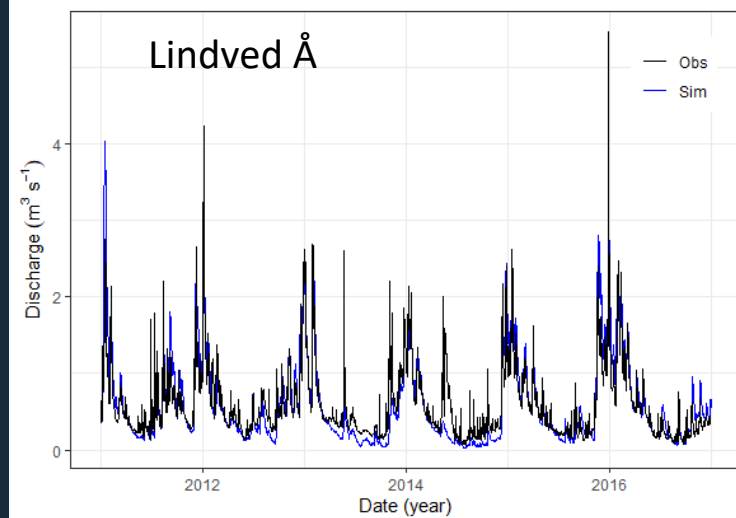
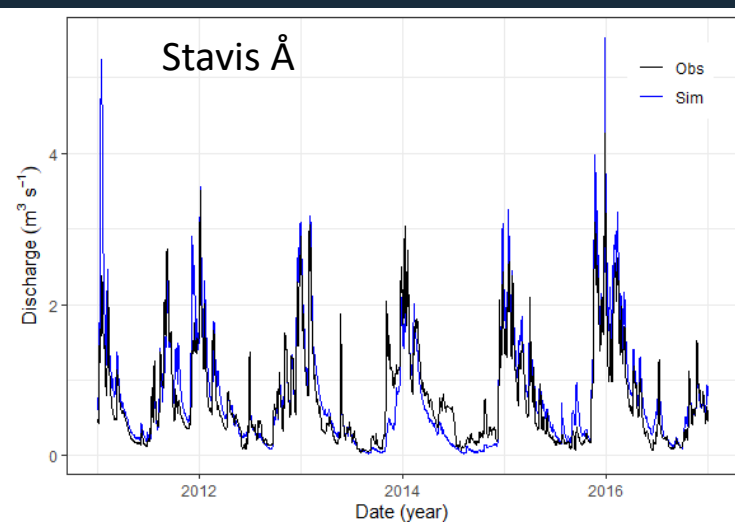
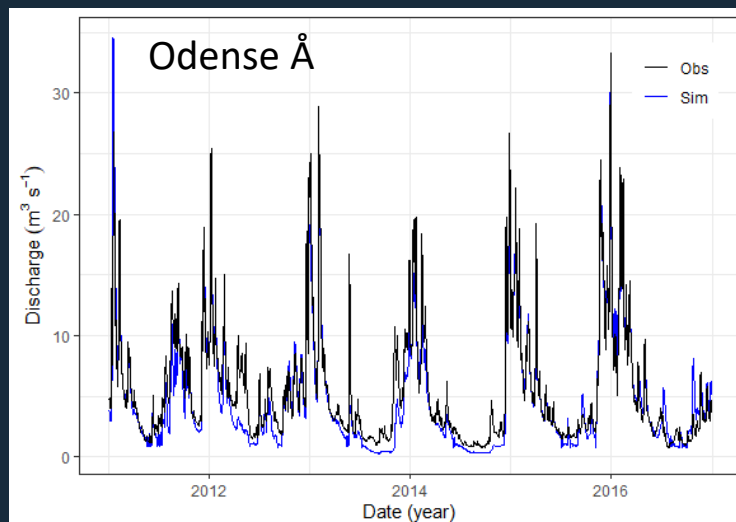
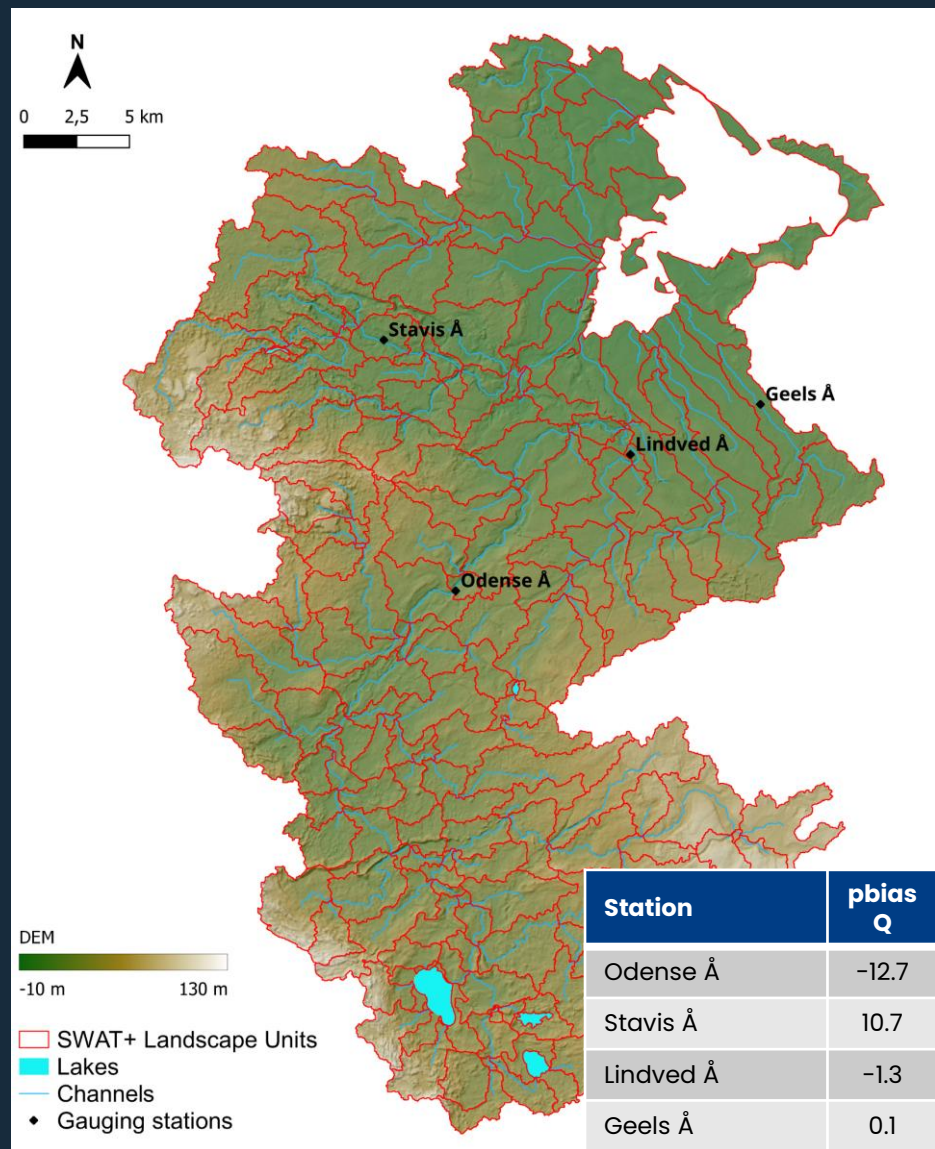
Kalibrering og validering (stadig i proces)



Forberedelse, kørsel og analyse af virkemiddel-scenarier  
(f.eks. punktkilder, vådområder, arealomlægning)

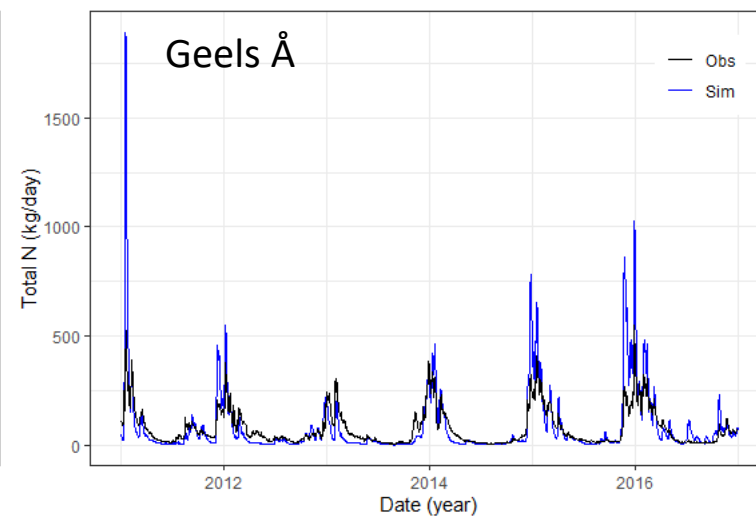
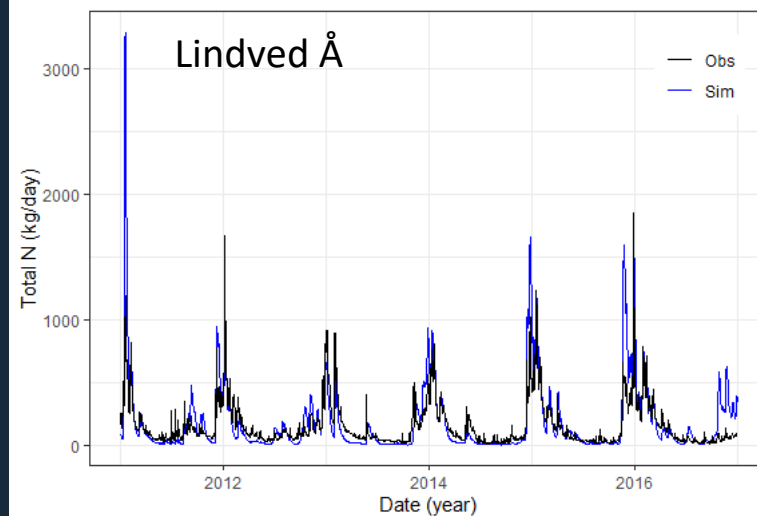
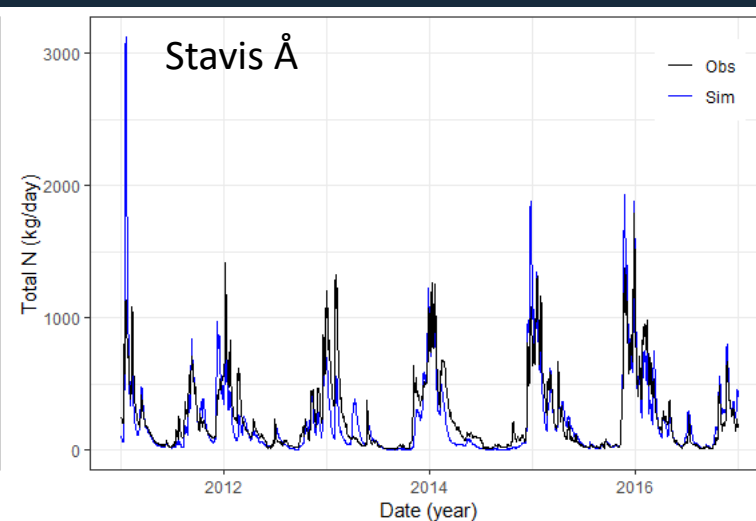
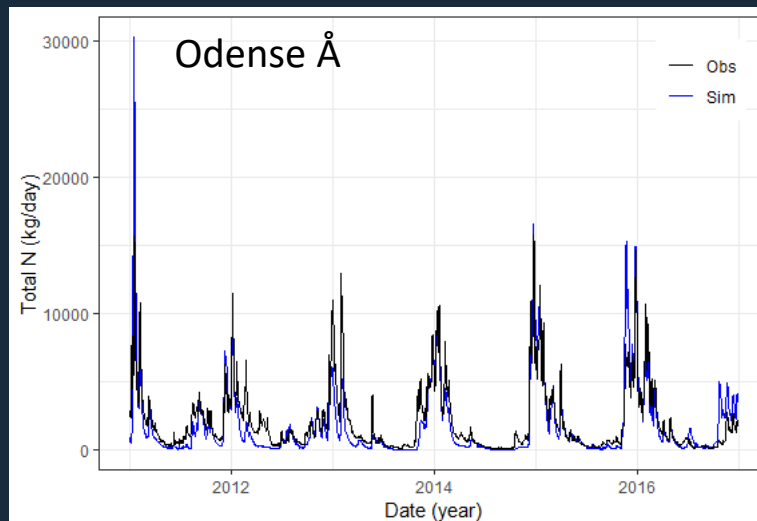
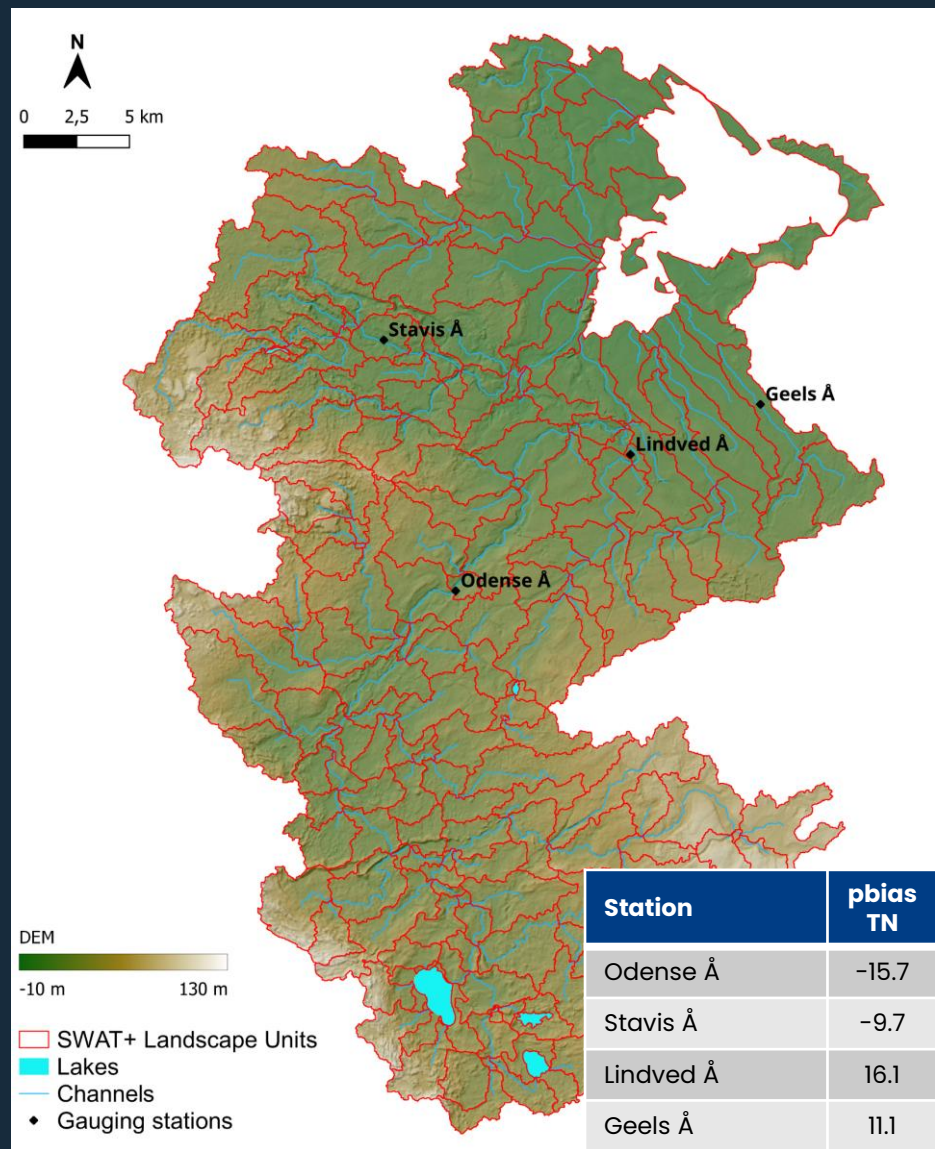
# Et SWAT+ eksempel fra kystvandråd-arbejdet

- Odense Fjord (et af fire oprindelige kystvandråd)
- Tak til Katrin Bieger (AU)



# Et SWAT+ eksempel fra kystvandråd-arbejdet

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# Et SWAT+ eksempel fra kystvandråd-arbejdet

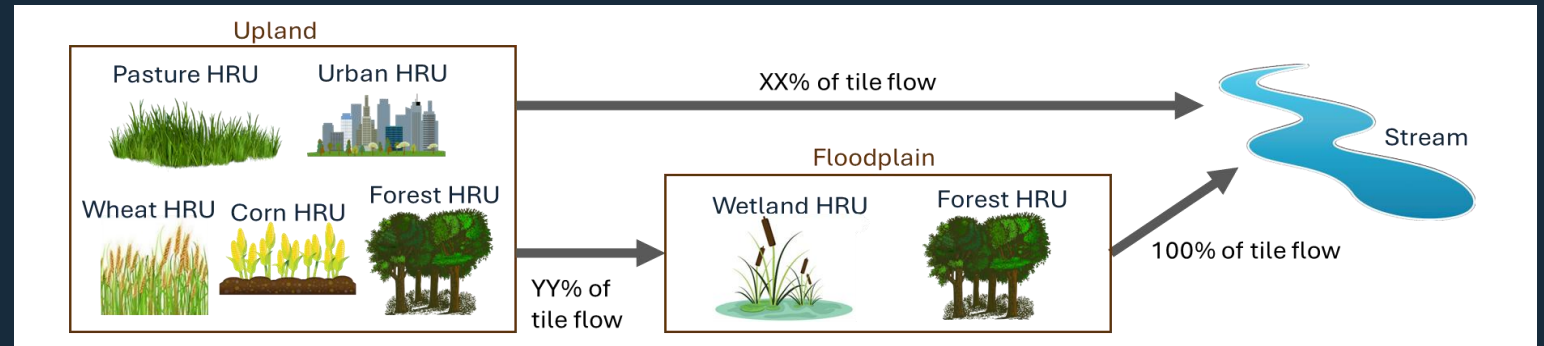
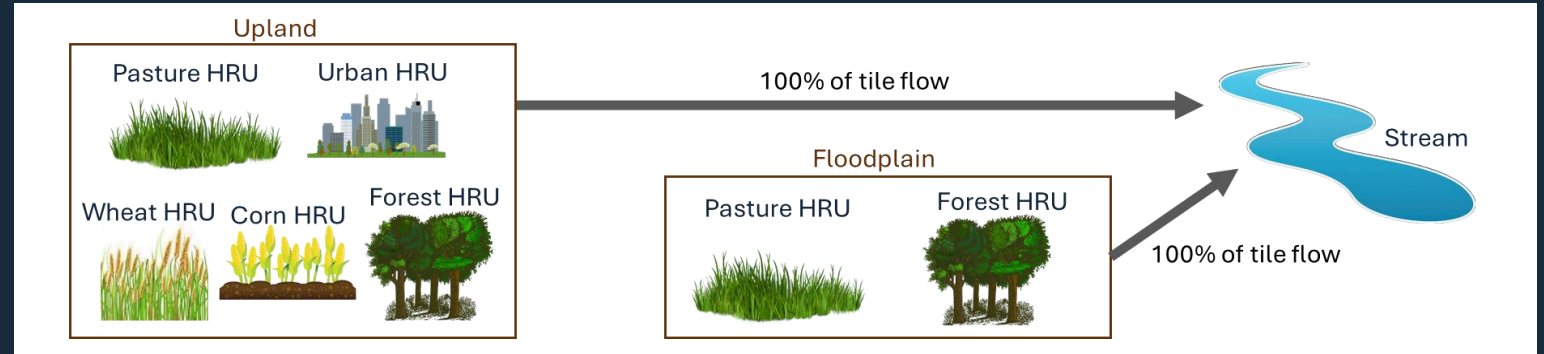
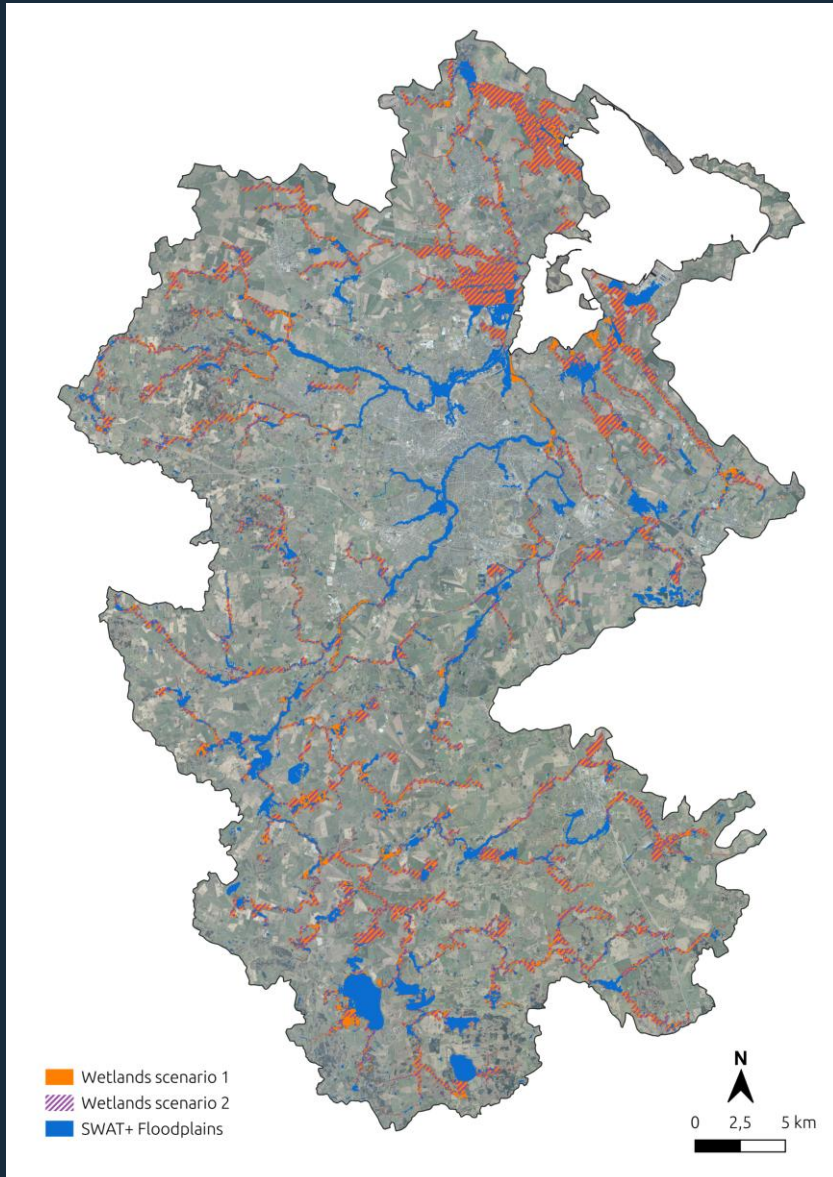
- Odense Fjord (et af fire oprindelige kystvandråd)
- Tak til Katrin Bieger (AU)

Workshop og diskussion af mulige scenarier i Odense Kystvandråd

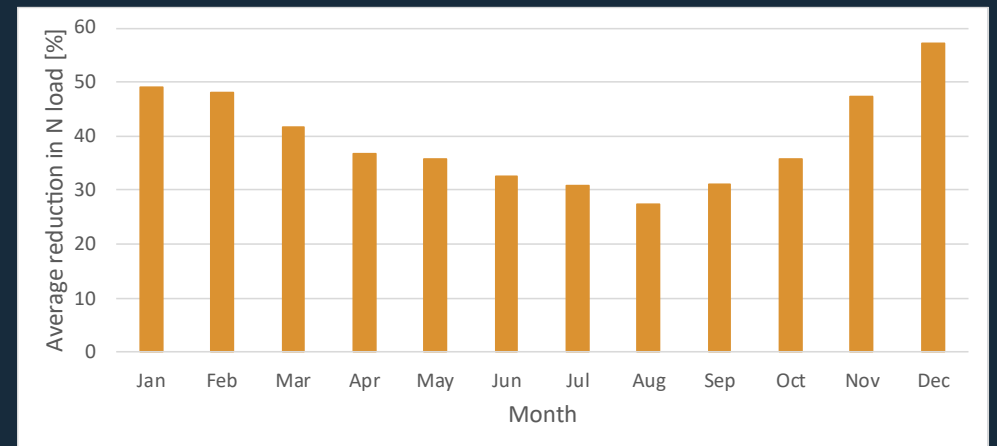


# Et SWAT+ eksempel fra kystvandråd-arbejdet

- Odense Fjord (et af fire oprindelige kystvandråd)
- Tak til Katrin Bieger (AU)



*Simuleret effekt på kvælstoftransporten til Odense Fjord*



- Hvilke virkemidler kan analyseres igennem SWAT+ og fosfor-modellerne?

# Mulige virkemidler i oplandsscenarioer

vådområder



mini-vådområder



punktkilder



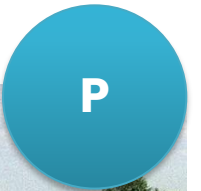
skovrejsning



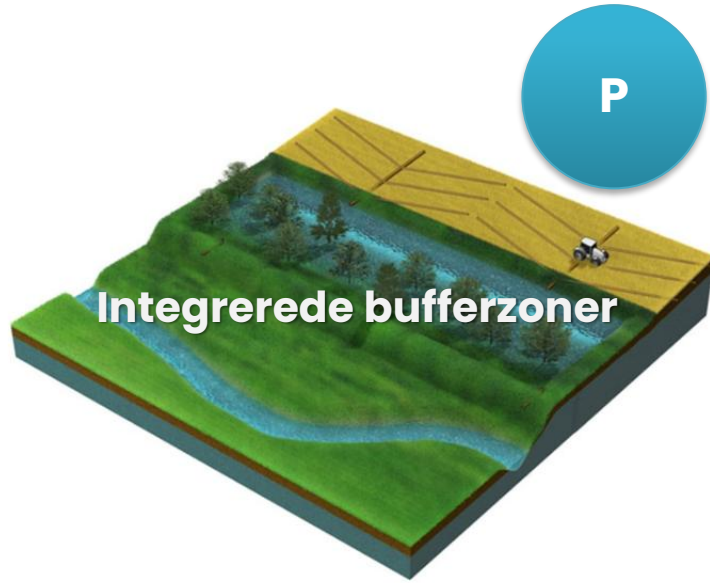
Ekstensivering



Randzoner



# Mulige virkemidler i oplandsscenarier





- Give en grundlæggende forståelse for og diskussion af model-tilgangene og datagrundlaget.
- Forståelse for hvilke typer virkemidler der ønskes analyseret.
- En idé om hvor i oplandet virkemidlerne ønskes implementeret i modellerne.