

Introduktion til SWAT+ oplandsmodel og eksempler på virkemiddel-scenarier

Dennis Trolle og Anders Nielsen (WateriTech)

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 Roskilde Fjord og Isefjord oplandene
- 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

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+

- 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 oprindeligt udviklet af USDA i samarbejde med Texas A&M University, og en lang række internationale samarbejdspartnere
- Første version udgivet i begyndelsen af 90erne (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

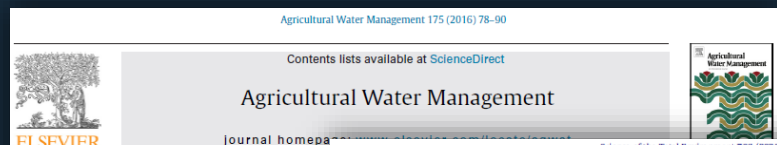
Hvilken rolle spiller dræn i transporten af opløst og partikelbundet fosfor til vandmiljøet?

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

Shenglan Lu^{a,*}, Hans Estrup Andersen^a, Ha Dennis Trolle^a

^a Department of Bioscience, Aarhus University, Vejlsøvej 25, P.O. Box 314, 8000 Århus C, Denmark

ARTICLE INFO

Article history:
Received 2 October 2015
Received in revised form 2 December 2015
Accepted 12 December 2015
Available online 22 December 2015

Keywords:
Tile drain
DRP
Soil TP accumulation
Lowland
SWAT
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.

* Corresponding author.
E-mail addresses: slt@bios.au.dk (S. Lu), heal@bios.au.dk (H.E. Andersen), hdt@bios.au.dk (H. Thodsen), gitte.ruback@agro.au.dk (G.H. Rubæk), trolle@bios.au.dk (D. Trolle).
<http://dx.doi.org/10.1016/j.agwat.2015.12.008>
0378-3774/© 2015 Elsevier B.V. All rights reserved.



Assessing the impacts of groundwater abstraction on stream biota: Combining SWAT-MODFLOW and empirical models

Wei Liu^{a,*}, Ryan T. Bailey^b, Hans Estrup Andersen^a, Anders Nielsen^a, Eugenio Molina-Navarro^{a,d}, Dennis Trolle^a

^a Department of Bioscience, Aarhus University, Silkeborg, Denmark
^b Department of Civil and Environmental Engineering, Colorado State University, Fort Collins, CO, USA
^c Blackland Research & Extension Center, Texas A&M AgriLife, Temple, TX, USA
^d 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.

ARTICLE INFO

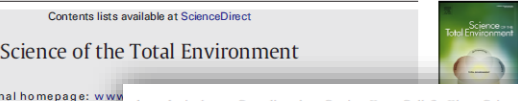
Article history:
Received 6 July 2019
Received in revised form 10 November 2019
Accepted 21 November 2019
Available online 23 November 2019

Editor: Jürgen Mahlknecht

Keywords:
SWAT-MODFLOW
SWAT
Flow regime
Groundwater abstraction
Ecological quality
Stream biota
Flow-biota empirical models

* Corresponding author.
E-mail address: wei@bios.au.dk (W. Liu).

<https://doi.org/10.1016/j.scitotenv.2019.135702>
0048-9697/© 2019 Elsevier B.V. All rights reserved.



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

Hans Thodsen^a, Hans Estrup Andersen, Gitte B. Hansen

^a Department of Bioscience, Aarhus University, Vejlsøvej 25, P.O. Box 314, 8000 Århus C, Denmark
(Received 25 June 2014; accepted 17 January 2015)

HIGHLIGHTS

- We calibrated a SWAT model for discharge and four nutrients in the Odense catchment.
- We downscaled three future storylines focusing on climate and land use changes.
- Changes in land use alone showed an impact on NO₃ loss due to changes in fertilization.
- Discharge, organic nutrients and PO₄ loads will increase under high emissions.
- Both land use and climate changes will interact regarding nitrate loads.

ARTICLE INFO

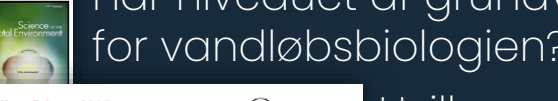
Article history:
Received 19 May 2017
Received in revised form 7 November 2017
Accepted 21 November 2017
Available online 1 December 2017

Editor: Jürgen Mahlknecht

Keywords:
Catchment management
Climate change
Eco-hydrological modelling
Nutrients
Scenario simulation
SWAT

* Corresponding author. E-mail: hth@bios.au.dk

<https://doi.org/10.1016/j.scitotenv.2017.11.054>
0048-9697/© 2017 Elsevier B.V. All rights reserved.



Quantifying the combined effects of land use change and increased fertilization on stream flow and nutrient loads: A model study of the Odense catchment (Denmark)

Eugenio Molina-Navarro^a, Hans E. Andersen^a, Hans Thodsen^a, Jørgen E. Olesen^{a,b,c}, Christen D. Børgesen^c, Jens Chr. Refsgaard^d, Torben O. Sonnenborg^d, Ida B. Karlsson^d, Jesper P. Christensen^f, Stig Markager^f, Erik Jeppesen^{a,b,e}

^a Department of Bioscience, Aarhus University, Silkeborg, Denmark
(Received 25 June 2014; accepted 17 January 2015)

HIGHLIGHTS

- We calibrated a SWAT model for discharge and four nutrients in the Odense catchment.
- We downscaled three future storylines focusing on climate and land use changes.
- Changes in land use alone showed an impact on NO₃ loss due to changes in fertilization.
- Discharge, organic nutrients and PO₄ loads will increase under high emissions.
- Both land use and climate changes will interact regarding nitrate loads.

ARTICLE INFO

Article history:
Received 19 May 2017
Received in revised form 7 November 2017
Accepted 21 November 2017
Available online 1 December 2017

Keywords:
Catchment management
Climate change
Eco-hydrological modelling
Nutrients
Scenario simulation
SWAT

* Corresponding author. E-mail: hth@bios.au.dk

<https://doi.org/10.1016/j.scitotenv.2017.11.054>
0048-9697/© 2017 Elsevier B.V. All rights reserved.



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

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

^a Aarhus University, Department of Bioscience, Silkeborg, Denmark
^b Sino-Danish Center for Education and Research (SDC), Aarhus, Denmark
^c Aarhus University, Department of Agriculture, Aarhus, Denmark
^d Geological Survey of Denmark and Greenland (GEUS), Copenhagen, Denmark
^e Sino-Danish Center for Education and Research (SDC), Beijing, China
^f Aarhus University, Department of Bioscience, Roskilde, Denmark

HIGHLIGHTS

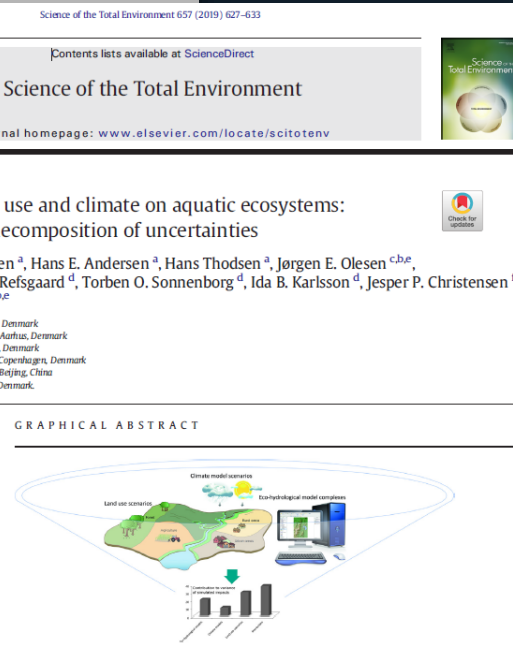
- We analysed uncertainties in future projections of the state of aquatic ecosystems.
- We decomposed and ranked the individual sources of uncertainties.
- Uncertainties were future land use > eco-hydrological models > climate models.
- Future projections should be based on an ensemble of models and scenarios.

ARTICLE INFO

Article history:
Received 19 May 2017
Received in revised form 7 November 2017
Accepted 21 November 2017
Available online 1 December 2017

* Corresponding author. E-mail: hth@bios.au.dk

<https://doi.org/10.1016/j.scitotenv.2017.11.054>
0048-9697/© 2017 Elsevier B.V. All rights reserved.



SWAT Soil & Water Assessment Tool

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

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



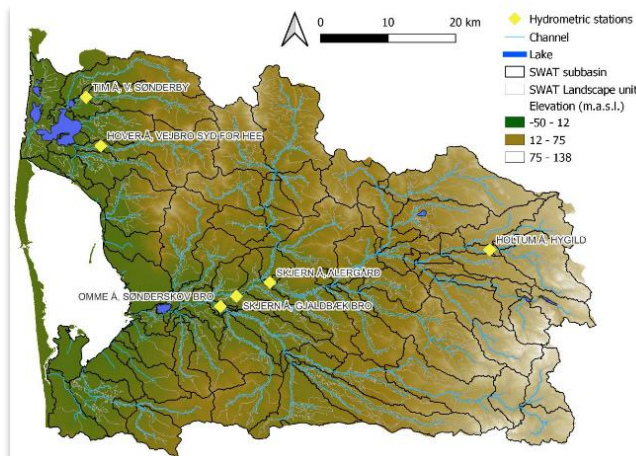
LONGLINE
ENVIRONMENT

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

DRAFT REPORT

DECEMBER 2023

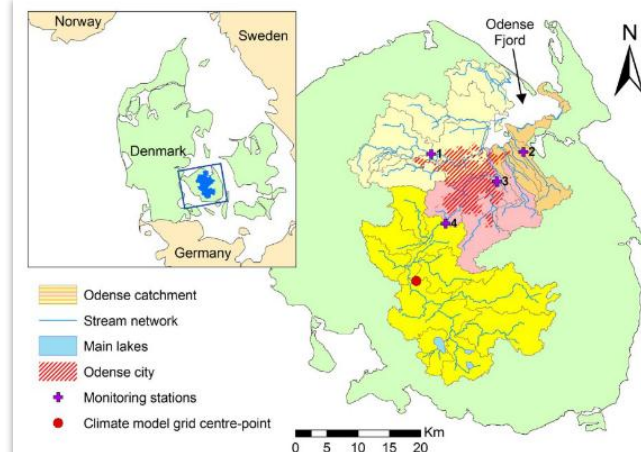
Leonard Bernard-Jannin, Joao G. Ferreira, Joao Lencart e Silva,
Alhambra M. Cubillo, Gerhardus Diedricks



DATE: June 2024
FOR: NORDBALT-ECOSAFE

SWAT+ model protocol for Odense Fjord Catchment, Denmark

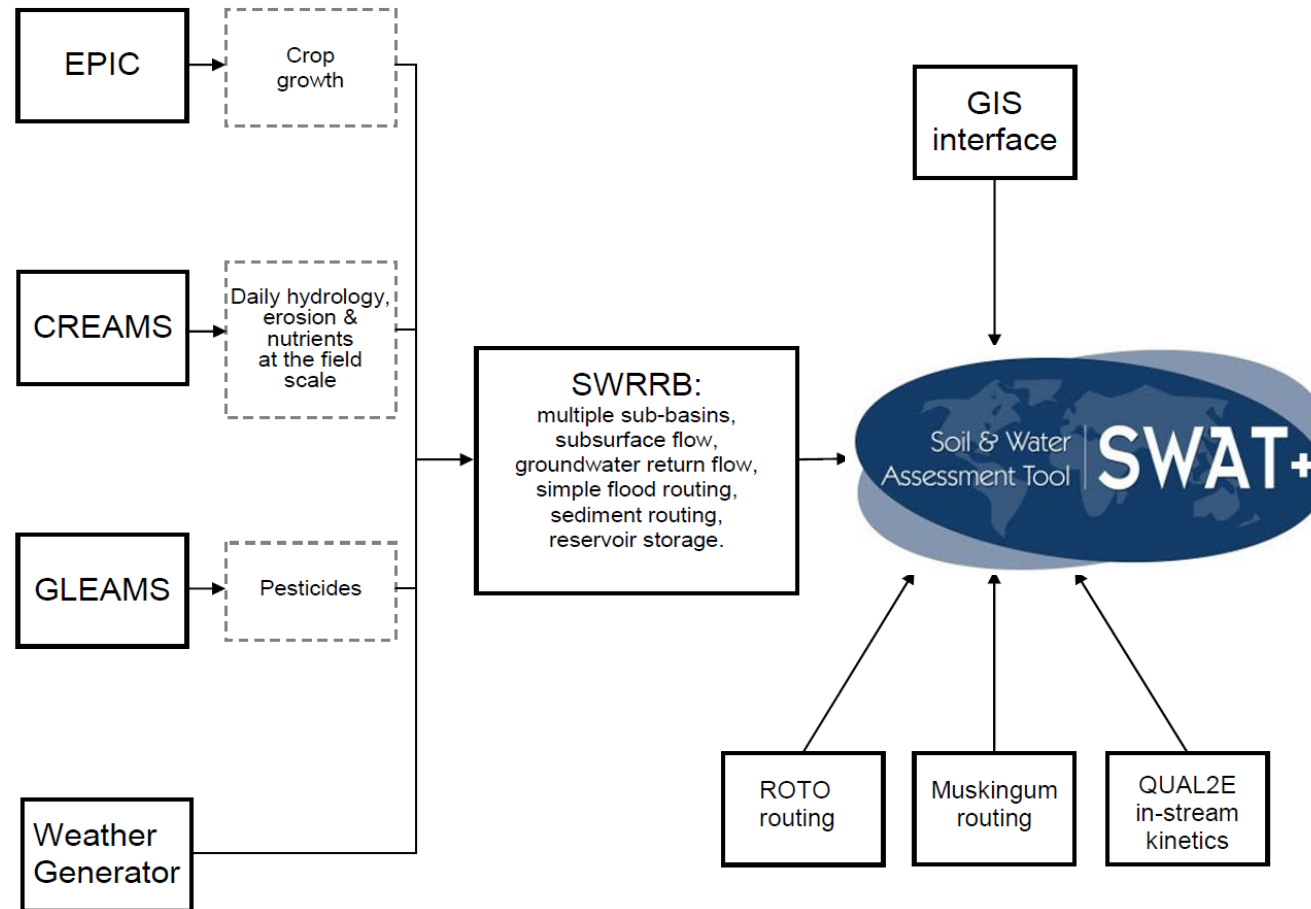
DATE: June 29, 2024
AUTHORS: Katrin Bieger, Brian Kronvang
CITE AS: Bieger, K. and Kronvang, B. 2024. SWAT+ model protocol for Odense Fjord Catchment, Denmark. 14 pp.



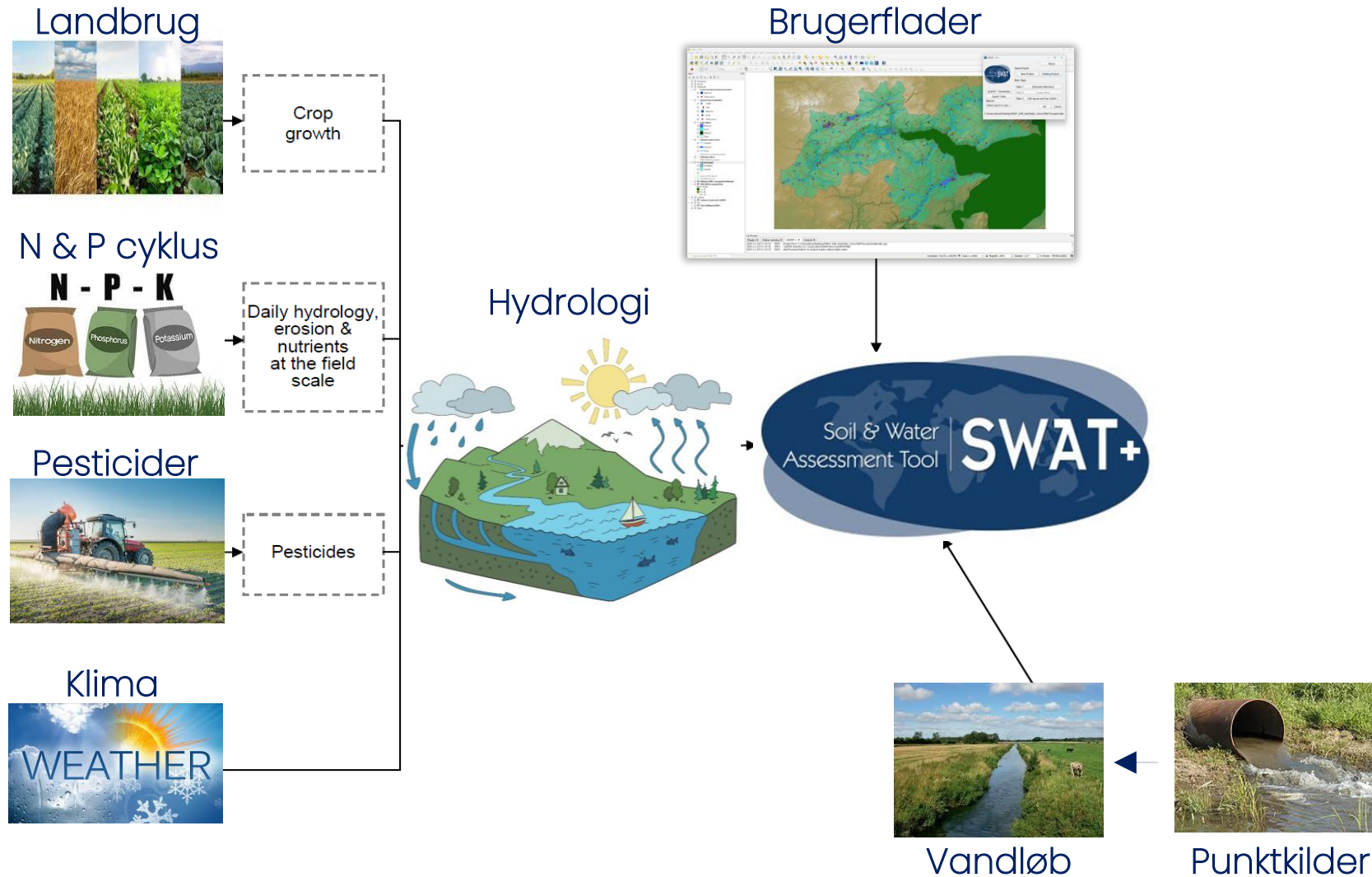
Komponenterne i SWAT+



Komponenterne i SWAT+



Komponenterne i SWAT+



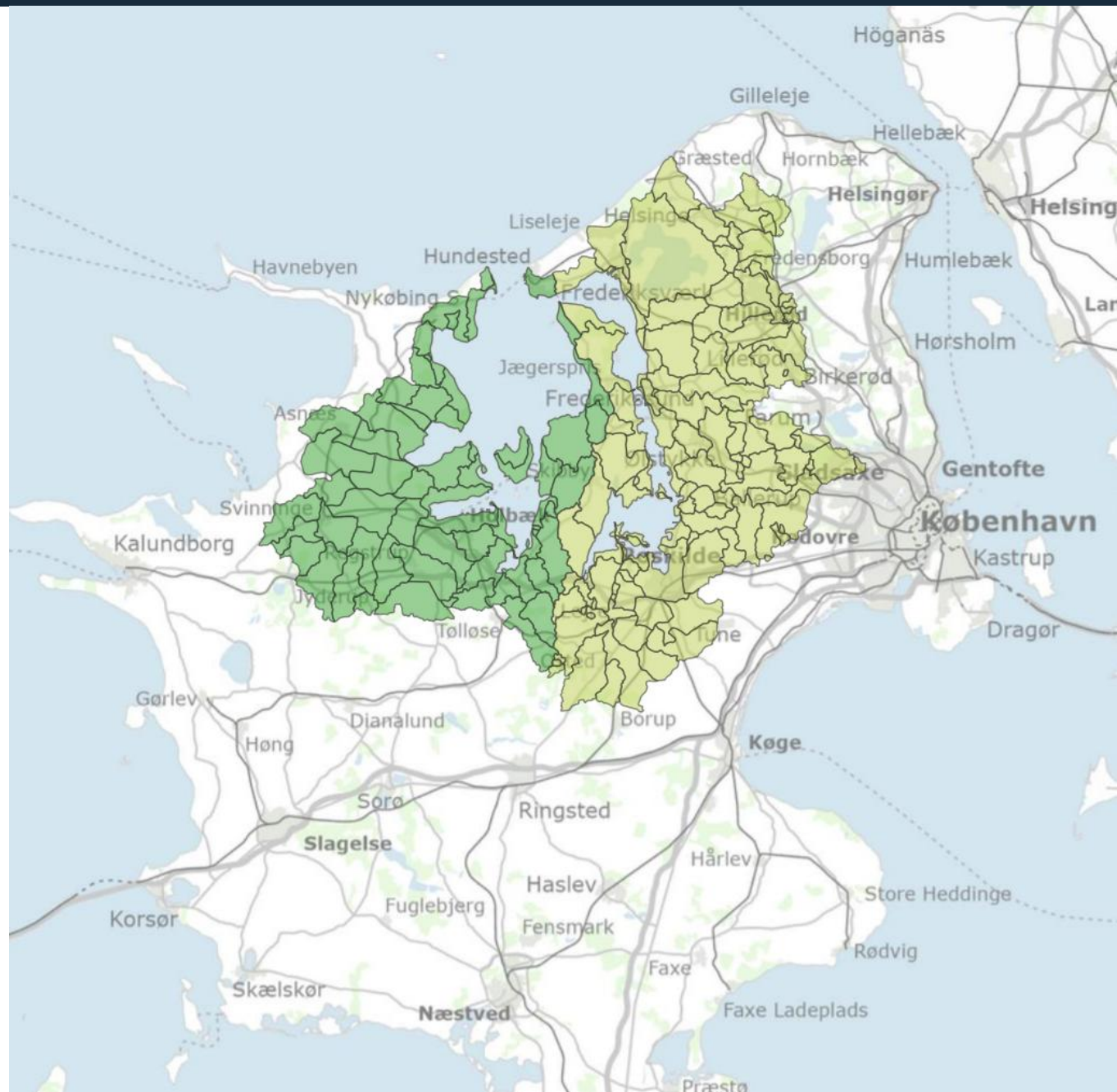
SWAT Soil & Water Assessment Tool

Grundlæggende inputs

- Højdemodel (terrænkort)
- Arealanvendelseskort
- Jordtypekort
- Vejrdata

Supplerende inputs

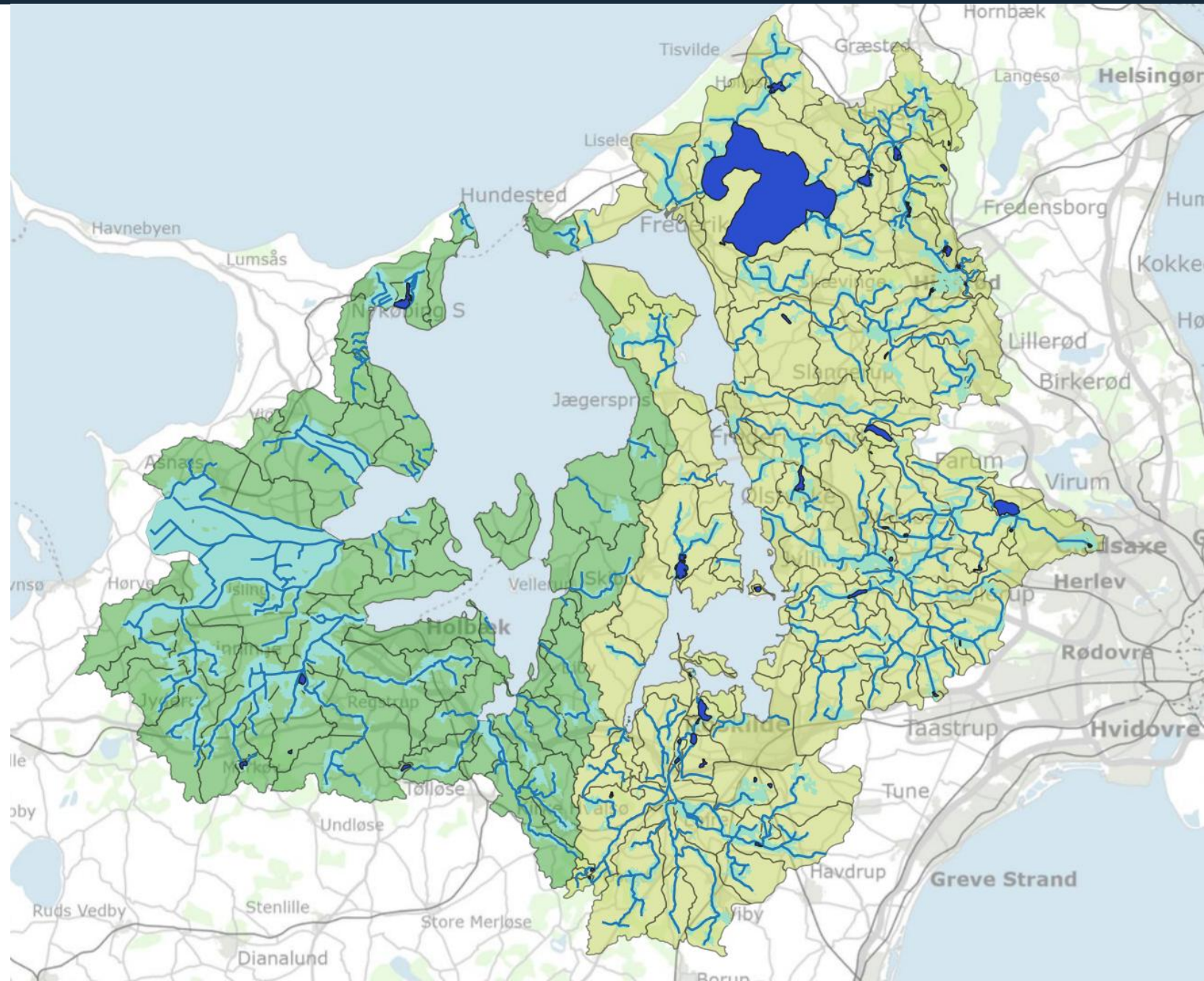
- Nationale oplandsgrænser
- Stationsobservationer
- Punktkilder
- Landbrugspraksis og rotationer
- Afgrødedatabase



-  Modelopsætning
-  Kalibrering og validering (stadig i proces)
-  Scenarie-workshop i januar 2026 (SEGES er tovholder)
-  Forberedelse, kørsel og analyse af virkemiddel-scenarier (f.eks. punktkilder, vådområder, arealomlægning)

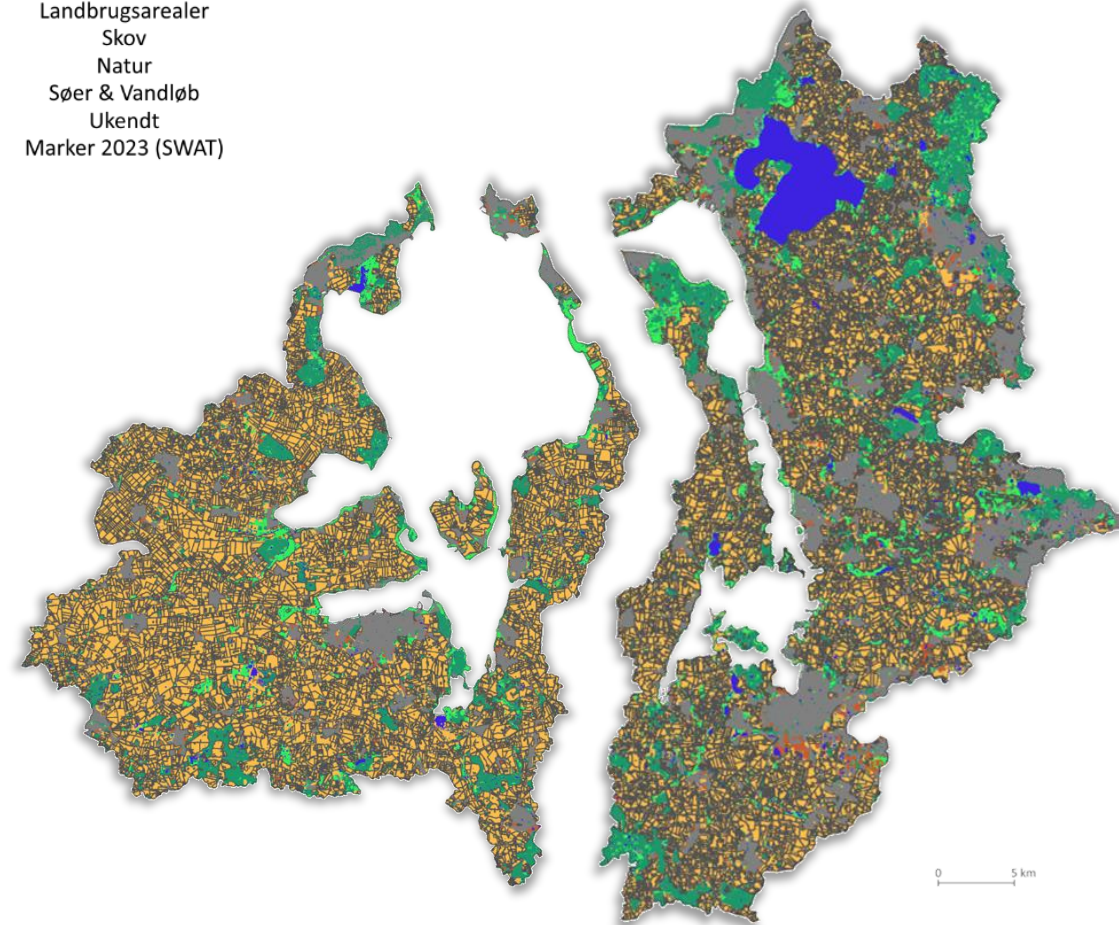
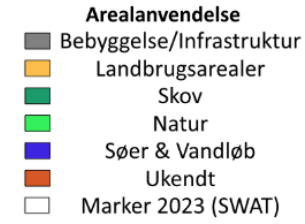
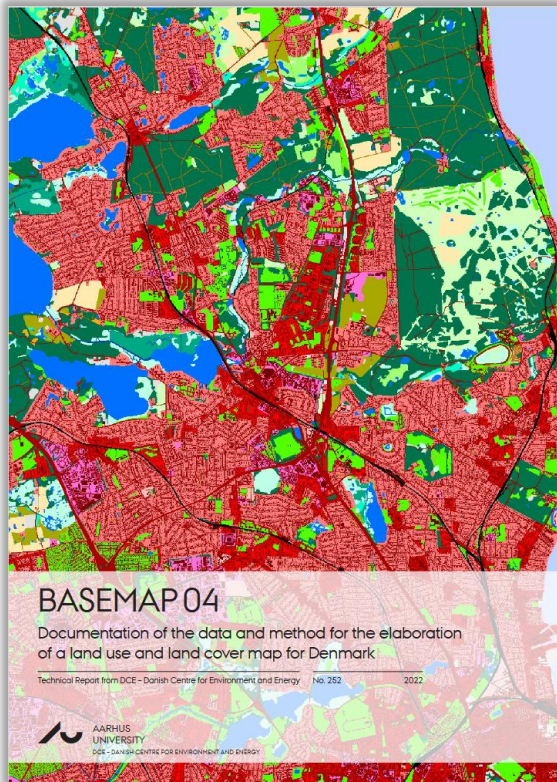
Model-inputs: højdemodel og oplandsgrænser

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



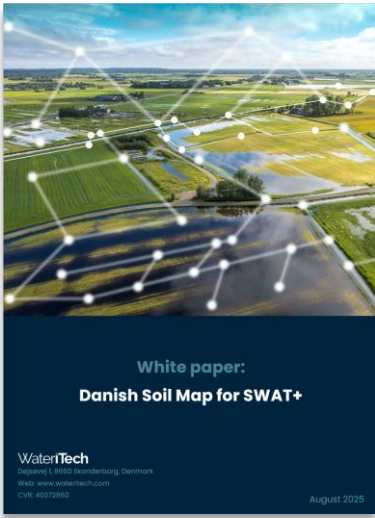
Arealanvendelse

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



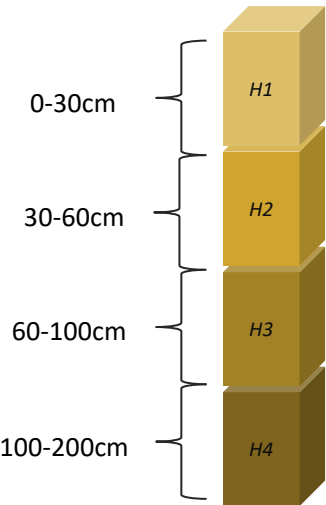
Jordtypekort

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



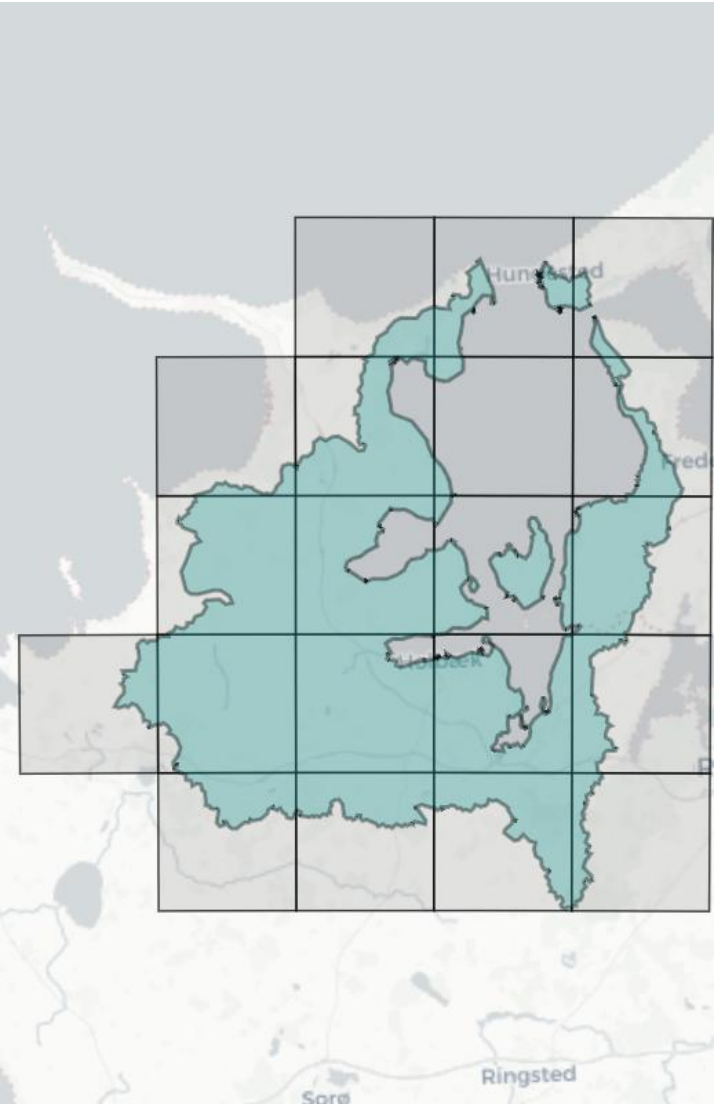
OBJECTID	Hydrologic soil group	Depth	1885	2005	2173	3445	3447	20725	20727
HYDGRP			A	A	A	A	A	A	A
SOL_BD1	Bulk density	0-30 cm	1.39	1.35	1.42	1.37	1.38	1.23	1.29
SOL_AWC1	Available water content		0.15	0.16	0.16	0.16	0.16	0.18	0.16
SOL_K1	Hydraulic conductivity		83.30	10.90	75.50	103.00	83.30	113.80	90.50
SOL_CBN1	Organic carbon content		1.95	3.31	1.68	3.80	3.41	14.51	11.01
CLAY1	Clay		3.47	3.02	4.25	3.27	3.66	3.57	4.86
SILT1	Silt		4.83	3.61	5.29	3.87	5.72	4.16	5.60
SAND1	Sand		51.00	58.20	50.14	50.00	49.72	58.10	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	1.49	1.49	1.51	1.37	1.42	0.94	1.16
SOL_AWC2	Available water content		0.15	0.16	0.15	0.17	0.16	0.19	0.18
SOL_K2	Hydraulic conductivity		75.25	85.84	72.80	86.75	61.12	121.60	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	2.79	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	58.66	49.80	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	1.56	1.51	1.44	1.49	1.53	1.09	1.31
SOL_AWC3	Available water content		0.15	0.17	0.15	0.18	0.17	0.19	0.18
SOL_K3	Hydraulic conductivity		75.94	103.70	89.44	94.20	69.10	119.50	79.06
SOL_CBN3	Organic carbon content		0.84	8.77	0.84	13.20	14.83	20.38	18.17
CLAY3	Clay		3.69	2.70	4.50	3.20	6.47	3.19	6.23
SILT3	Silt		2.99	2.64	2.74	2.42	3.65	2.96	3.58
SAND3	Sand		56.90	65.50	58.97	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	1.51	1.51	1.44	1.49	1.53	1.09	1.31
SOL_AWC4	Available water content		0.15	0.17	0.15	0.18	0.15	0.17	0.16
SOL_K4	Hydraulic conductivity		73.94	98.56	87.15	91.25	58.16	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	3.66	6.40	3.57	6.38
SILT4	Silt		3.17	2.81	2.71	2.40	3.72	3.06	3.66
SAND4	Sand		66.06	63.25	58.78	60.68	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

- Jordbundskort (2024)
- Fin lerblandet sandjord
 - Fin sandblandet lerjord
 - Finsandet jord
 - Grov lerblandet sandjord
 - Grov sandblandet lerjord
 - Grovsandet jord
 - Humusjord
 - Lerjord
 - Svær lerjord



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

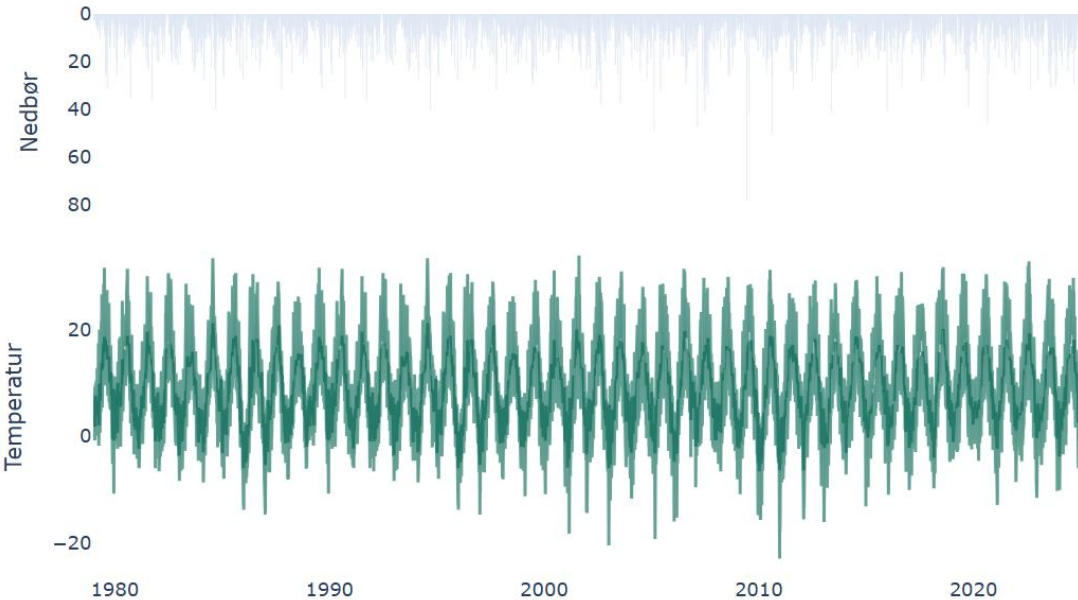


Danmarks
Meteorologiske
Institut



AARHUS UNIVERSITY

- Nedbør
- Temperatur
- Relativ fugtighed
- Vind
- Indstråling



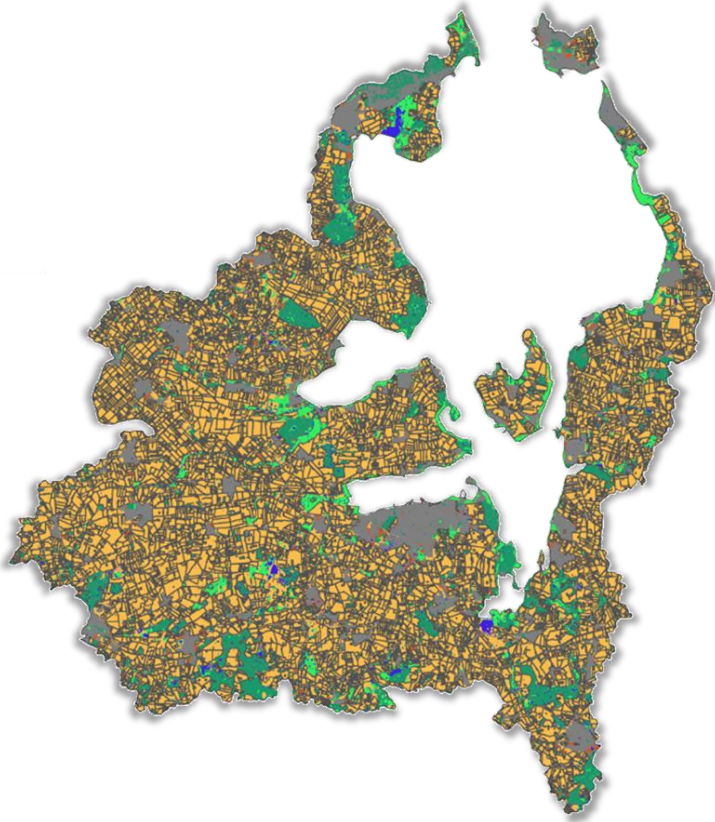
Model-inputs: landbrugspraksis

- +8.000 marker for Isefjorden og +11.000 marker for Roskilde Fjord 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.



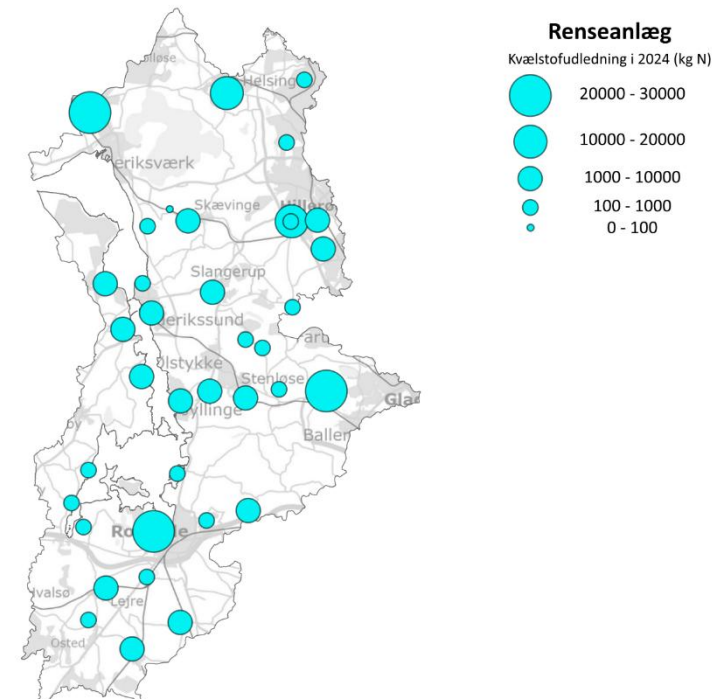
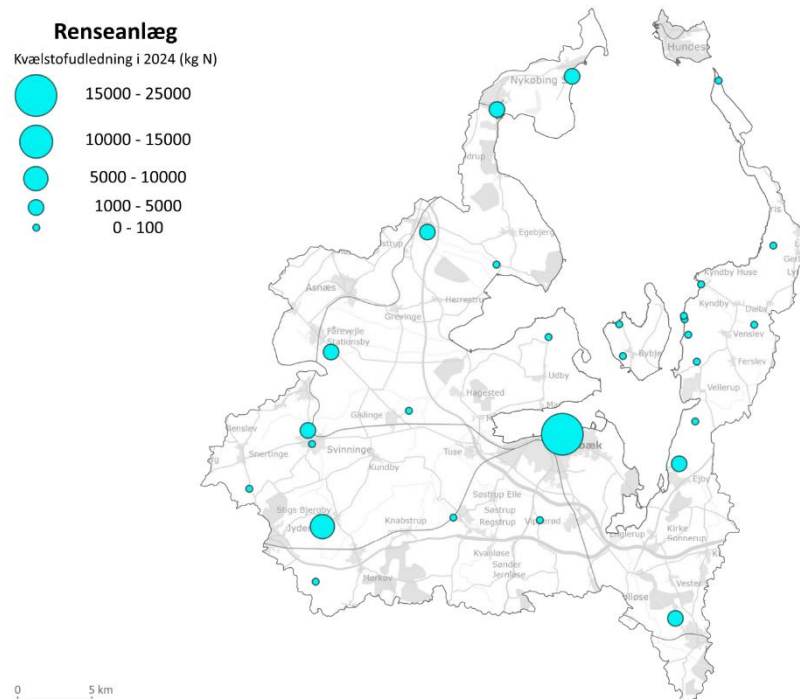
fert	3	15	0.000
fert	3	15	0.000
fert	3	28	0.000
fert	3	28	0.000
fert	3	28	0.000
fert	3	28	0.000
till	4	1	0.000
plnt	4	2	0.000
fert	4	15	0.000
fert	4	15	0.000
harv	8	10	0.000
kill	8	10	0.000
till	9	19	0.000
plnt	9	20	0.000
skip	0	0	0.000
fert	3	10	0.000
fert	3	10	0.000
fert	3	10	0.000
fert	3	15	0.000
fert	3	15	0.000
fert	4	15	0.000
fert	4	15	0.000
fert	5	15	0.000
fert	5	15	0.000
harv	8	15	0.000
kill	8	15	0.000
skip	0	0	0.000
fert	3	15	0.000
fert	3	15	0.000
fert	3	28	0.000
fert	3	28	0.000
fert	3	28	0.000
fert	3	28	0.000
till	4	1	0.000
plnt	4	2	0.000
fert	4	15	0.000
fert	4	15	0.000
harv	8	10	0.000
kill	8	10	0.000

elem_n	broadcast	80.00000
elem_p	broadcast	4.00000
elem_n	broadcast	0.41721
elem_p	broadcast	0.02086
org_n	broadcast	1.25164
org_p	broadcast	0.22530
fallplow	null	0.00000
dk_barl	null	0.00000
elem_n	broadcast	37.84532
elem_p	broadcast	1.89227
dk_barl	grain	0.00000
dk_barl	null	0.00000
fallplow	null	0.00000
dk_wwht	null	0.00000
dk_wwht	null	0.00000
elem_n	broadcast	0.45467
elem_p	broadcast	0.02273
org_n	broadcast	1.36402
org_p	broadcast	0.24552
elem_n	broadcast	80.00000
elem_p	broadcast	4.00000
elem_n	broadcast	100.00000
elem_p	broadcast	5.00000
elem_n	broadcast	0.38137
elem_p	broadcast	0.01907
dk_wwht	grain	0.00000
dk_wwht	null	0.00000
dk_wwht	null	0.00000
elem_n	broadcast	80.00000
elem_p	broadcast	4.00000
elem_n	broadcast	0.34683
elem_p	broadcast	0.01734
org_n	broadcast	1.04050
org_p	broadcast	0.18729
fallplow	null	0.00000
dk_barl	null	0.00000
elem_n	broadcast	29.47876
elem_p	broadcast	1.47394
dk_barl	grain	0.00000
dk_barl	null	0.00000

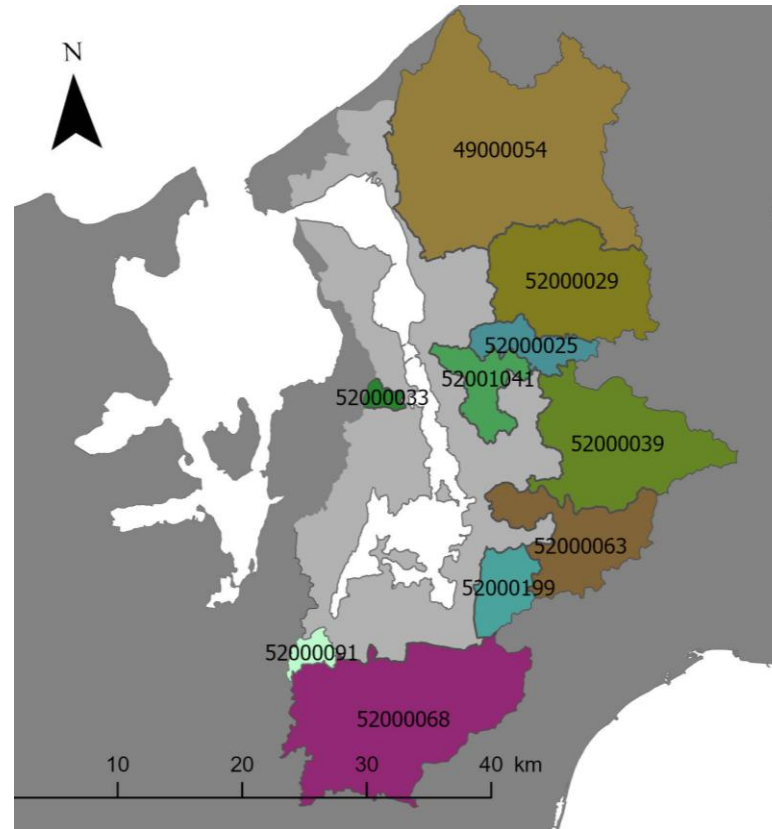
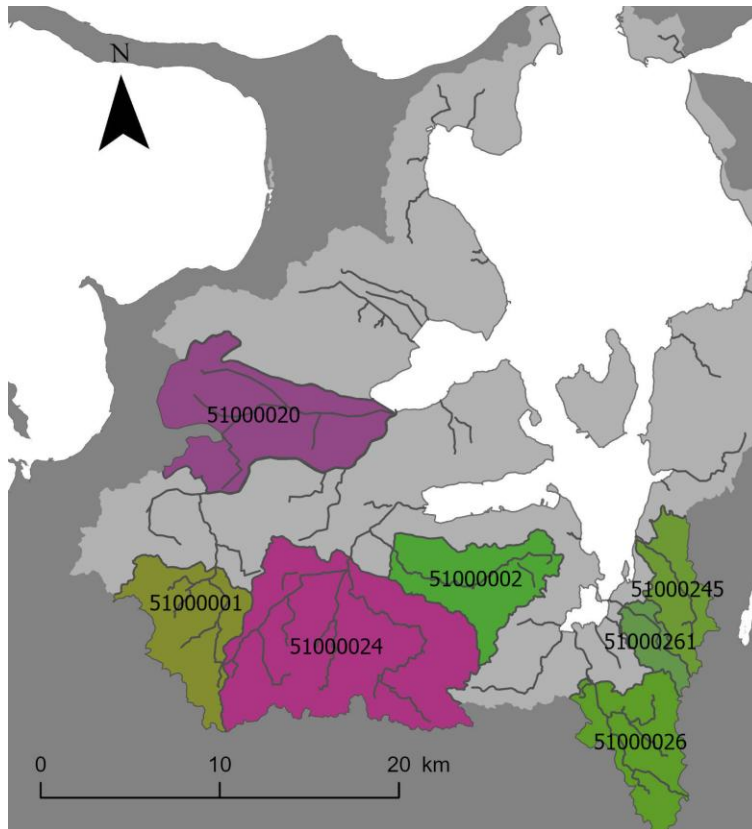


Der er rekvireret data fra DCE/AU på punktkilder (alt i PULS er med + estimerer på spredt bebyggelse)
> 1.000 individuelle punktkilder for Roskilde Fjord og ~ 300 for Isefjorden for perioden 1990-2024
(regnvandsbetingede udledninger, renseanlæg, industri og dambrug)

Der er dialog med spildevandsselskaberne vedr. punktkilder (mhp. daglig opløsning af de væsentligste)



- Observationsdata fra vandløb (fra odaforalle.dk)



Der eksisterer 3-4 stoftransportstationer i ODA data med gode (lange) tidsserier for Isefjorden og 5-6 for Roskilde Fjord. Disse bliver brugt til kalibrering og validering af modellen.



Modelopsætning



Kalibrering og validering (stadig i proces)



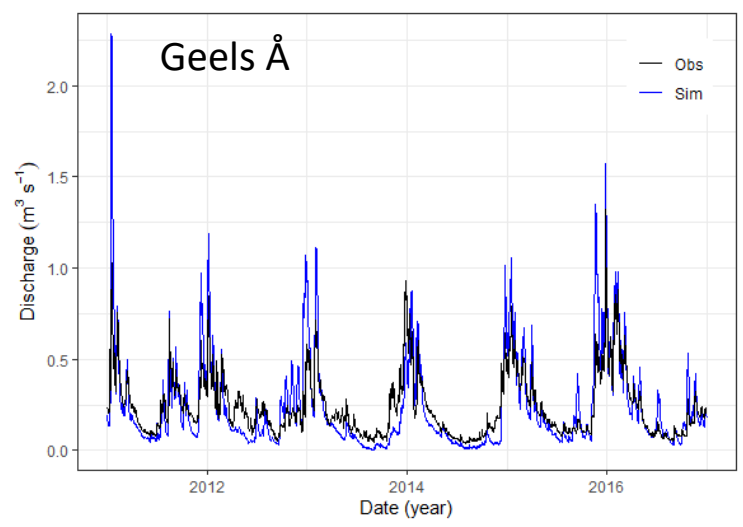
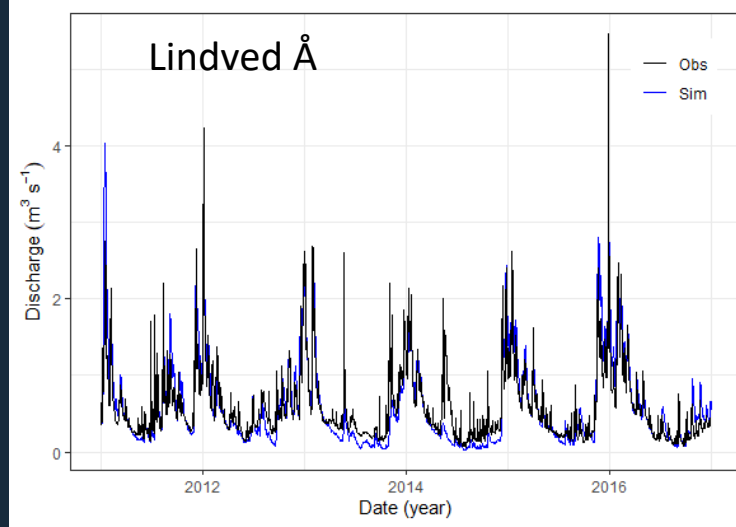
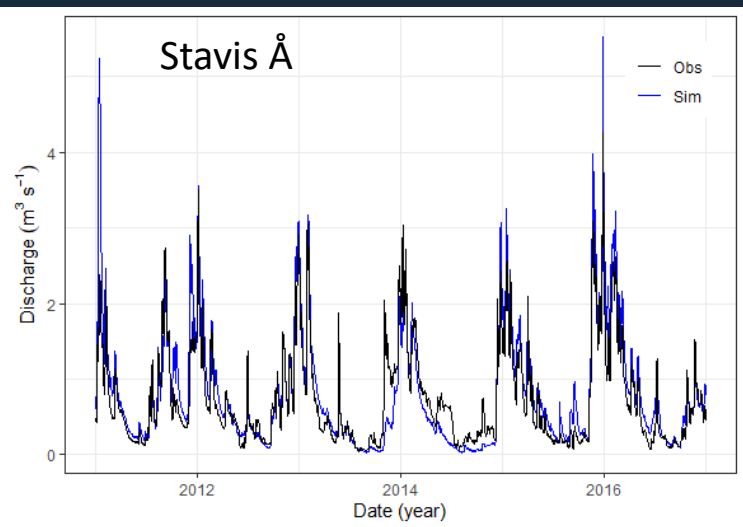
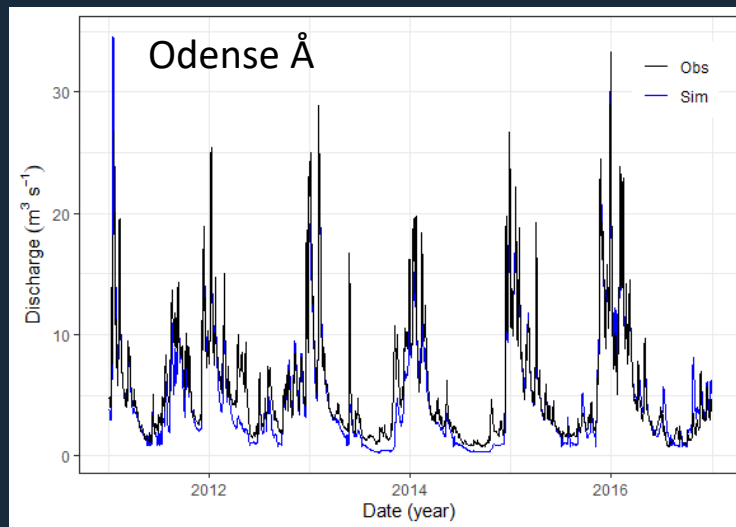
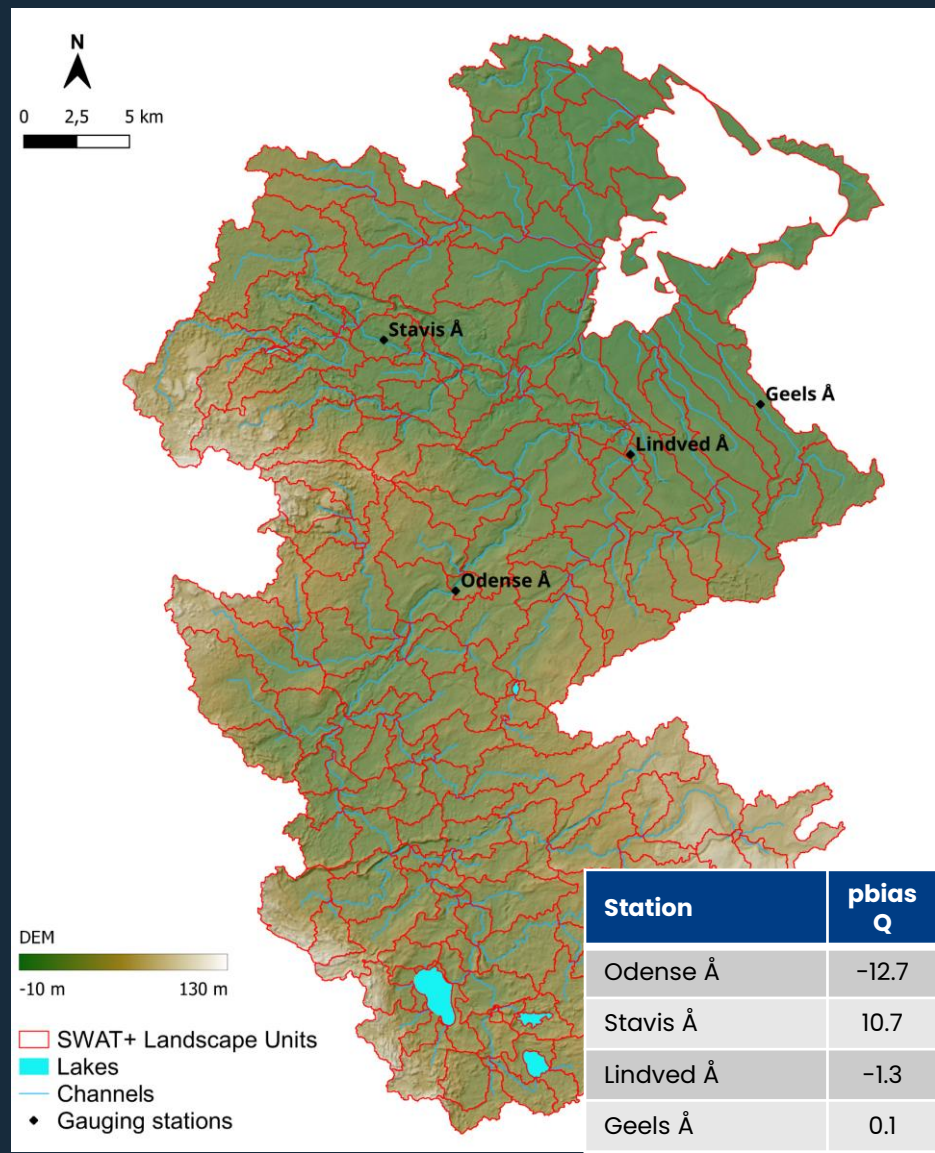
Scenarie-workshop i januar 2026 (SEGES er tovholder)



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

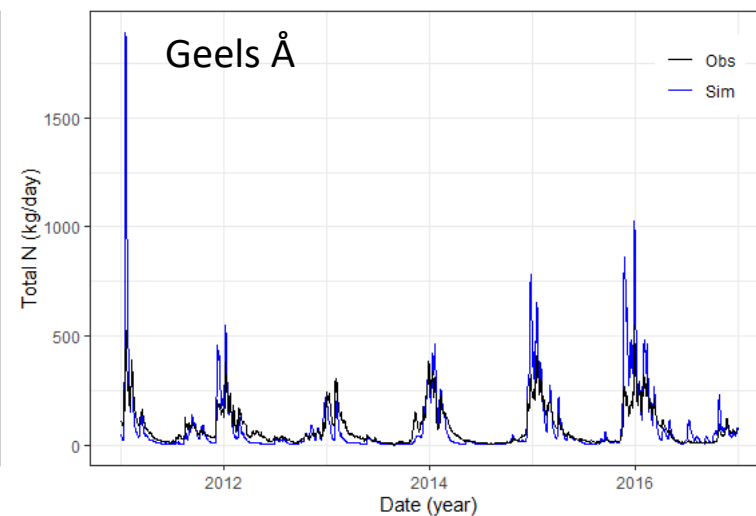
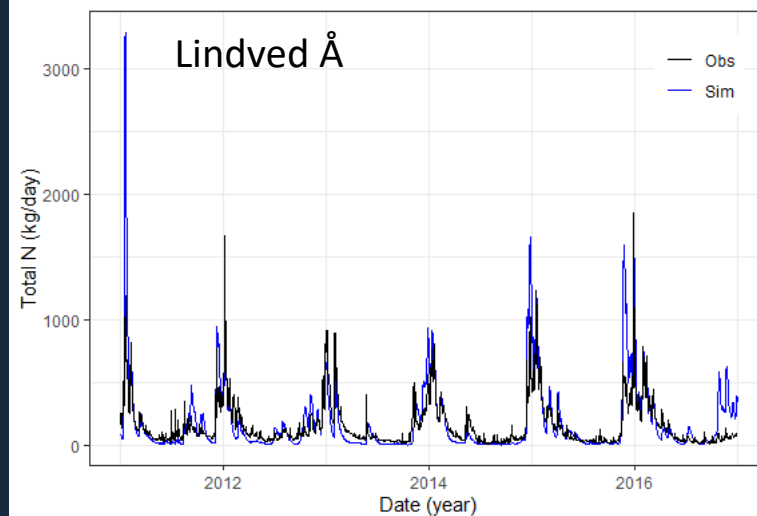
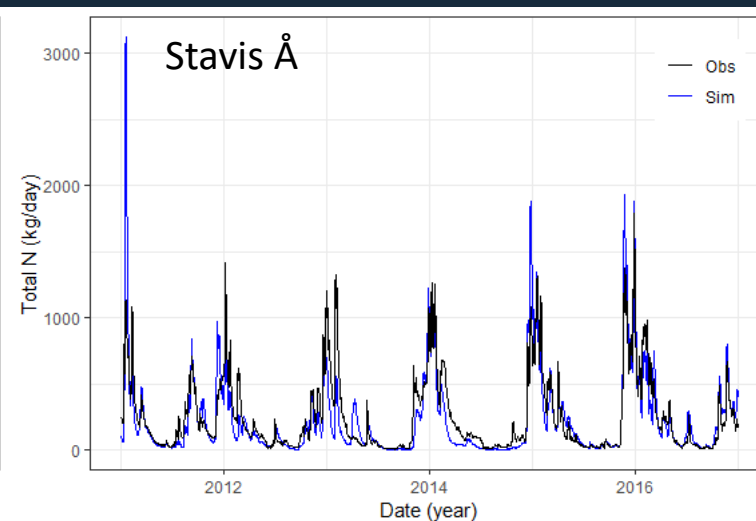
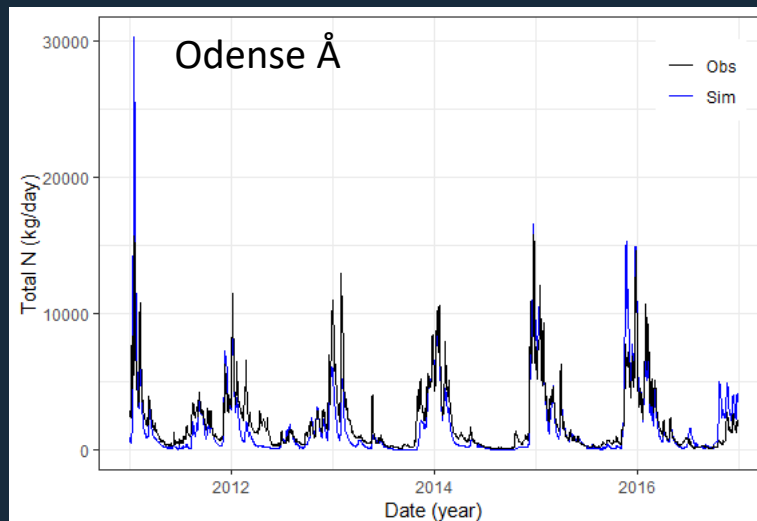
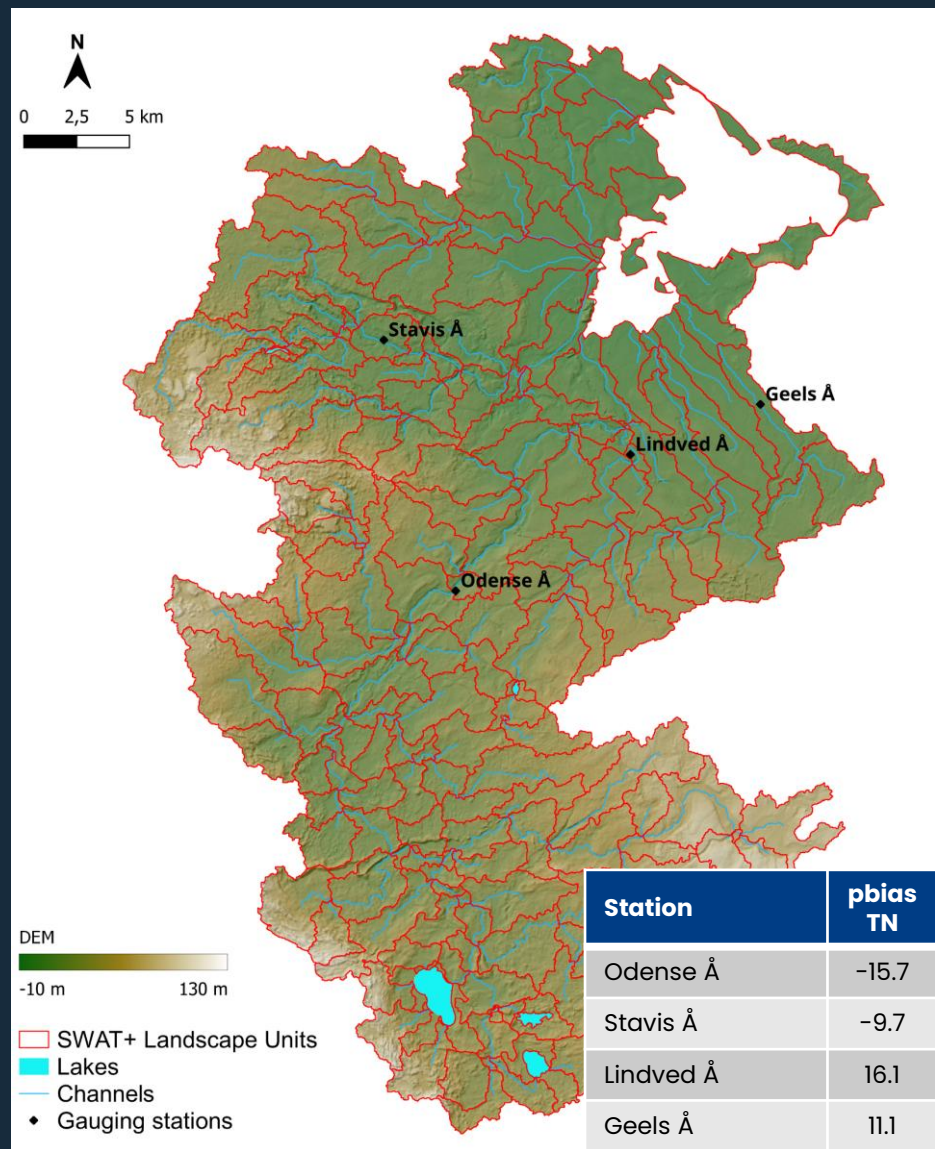
Et SWAT+ eksempel fra kystvandråd-arbejdet

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



Et SWAT+ eksempel fra kystvandråd-arbejdet

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



Et SWAT+ eksempel fra kystvandråd-arbejdet

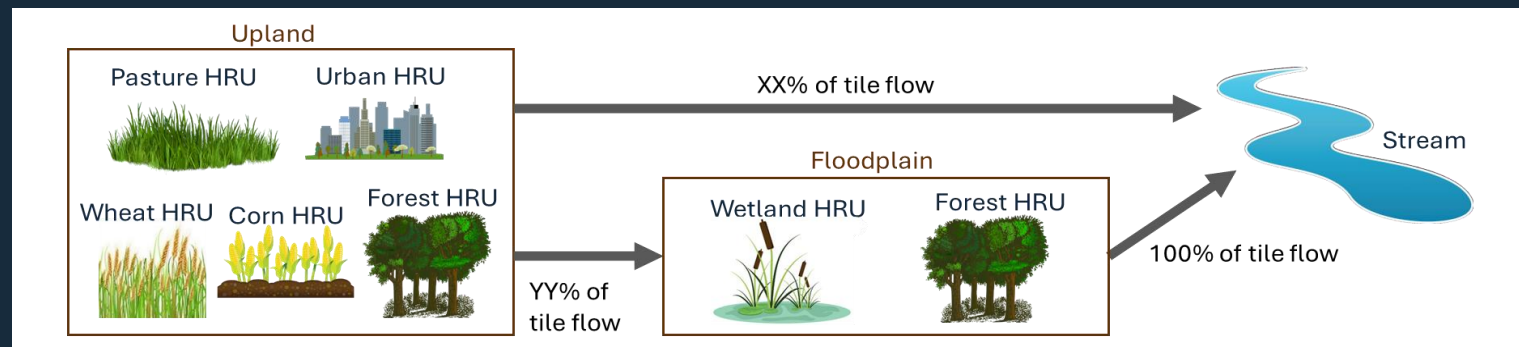
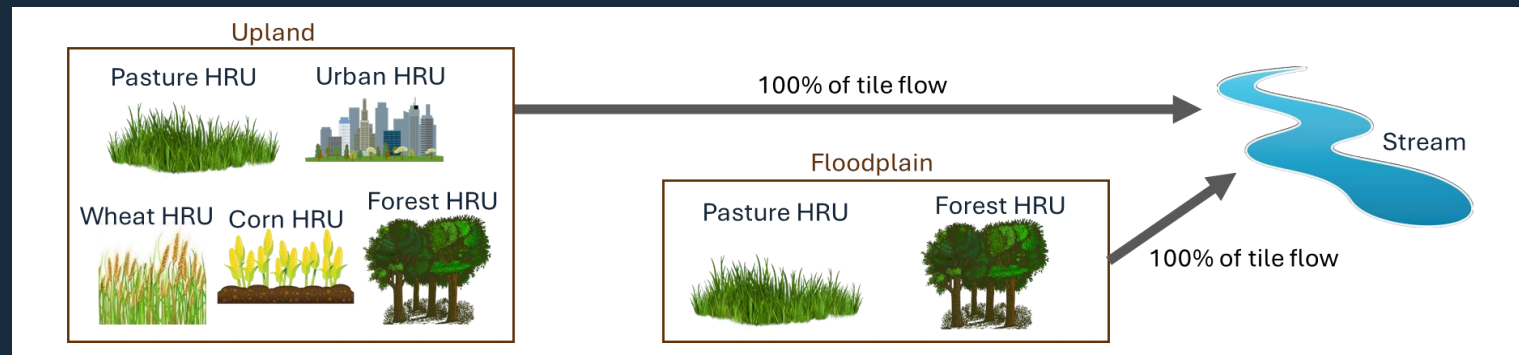
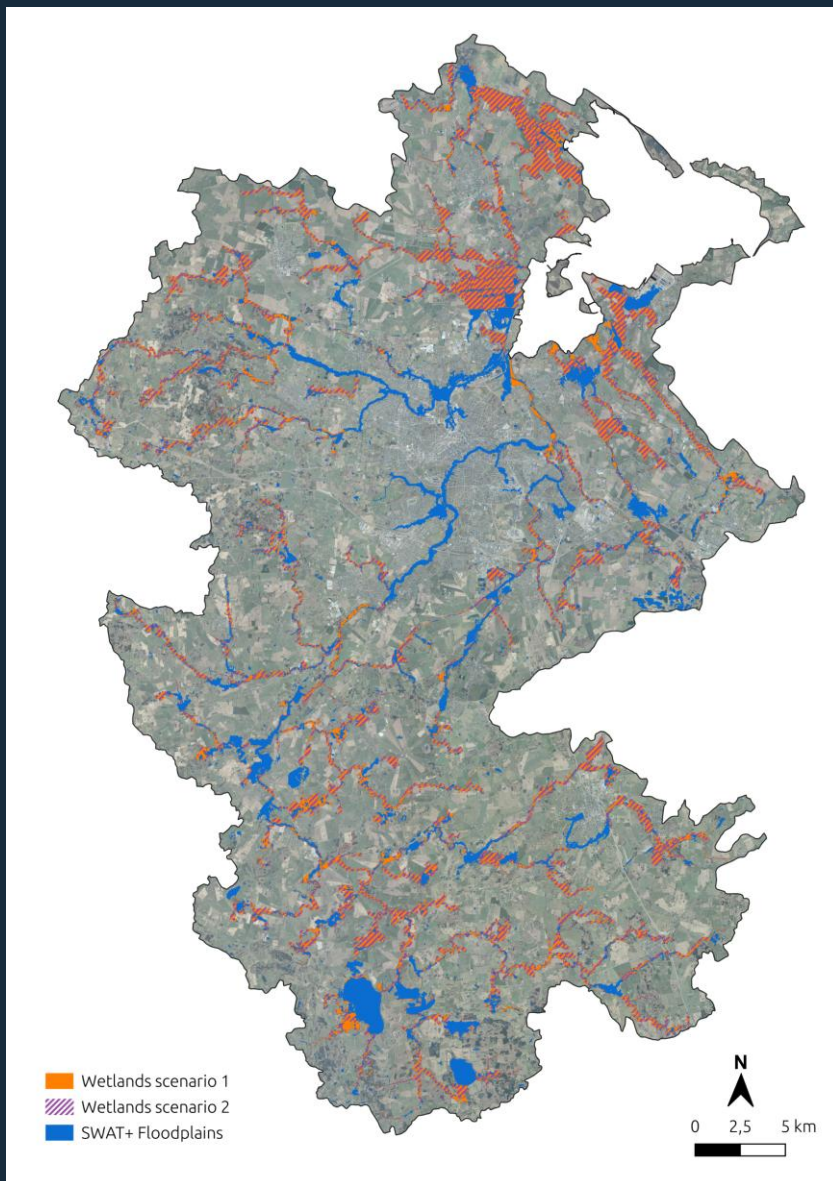
- Odense Fjord (et af fire oprindelige kystvandråd)
- Tak til Katrin Bieger (AU)

Workshop og diskussion af mulige scenarier i Odense Kystvandråd

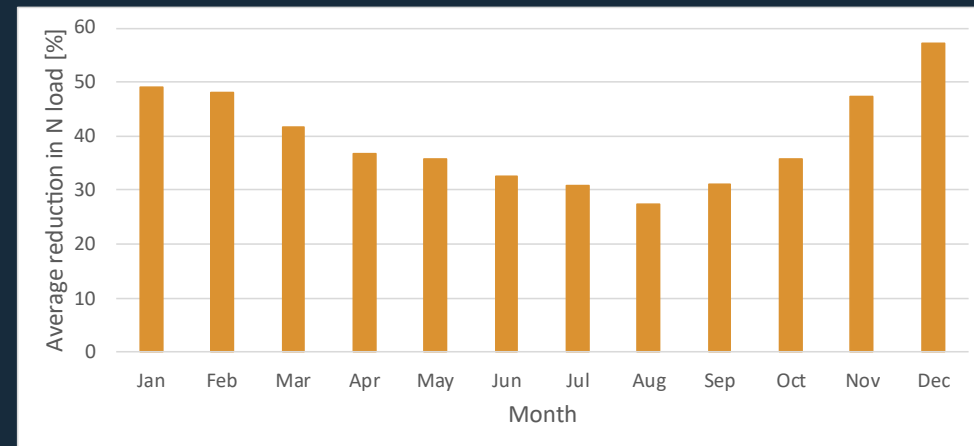


Et SWAT+ eksempel fra kystvandråd-arbejdet

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



Simuleret effekt på kvælstoftransporten til Odense Fjord



- Hvilke virkemidler kan analyses igennem SWAT+ modellen?

Eksempler på mulige virkemidler i oplandsscenarier

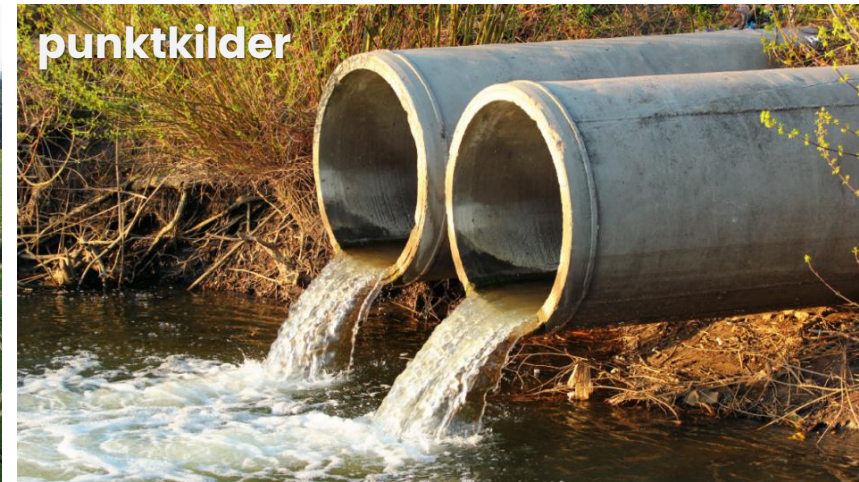
vådområder



mini-vådområder



punktkilder



skovrejsning



Ekstensivering



Randzoner





Workshop i Vejle Fjord kystvandråd, 24. nov. 2025

- Genbesøg af koncept: 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 oplandene virkemidlerne ønskes implementeret i modellerne.