
SLU
SCIENCE AND EDUCATION FOR SUSTAINABLE LIFE

Effects of historical hydrological structures on water balance alteration in present agricultural landscapes and climate conditions - An example from south western Sweden

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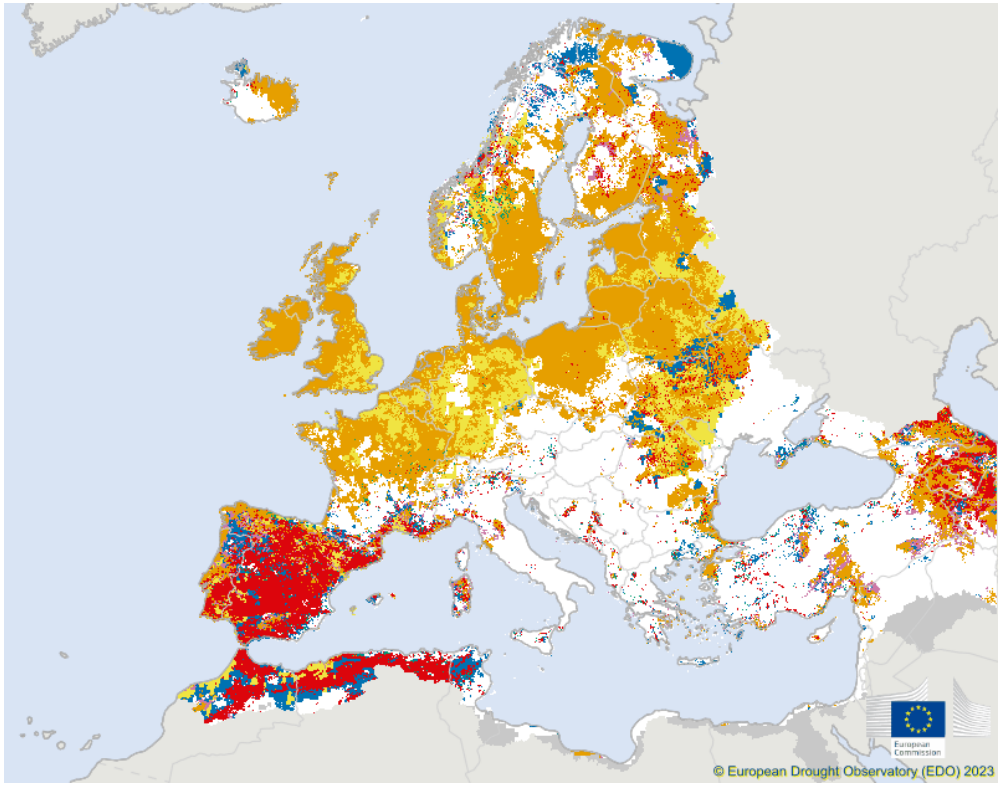
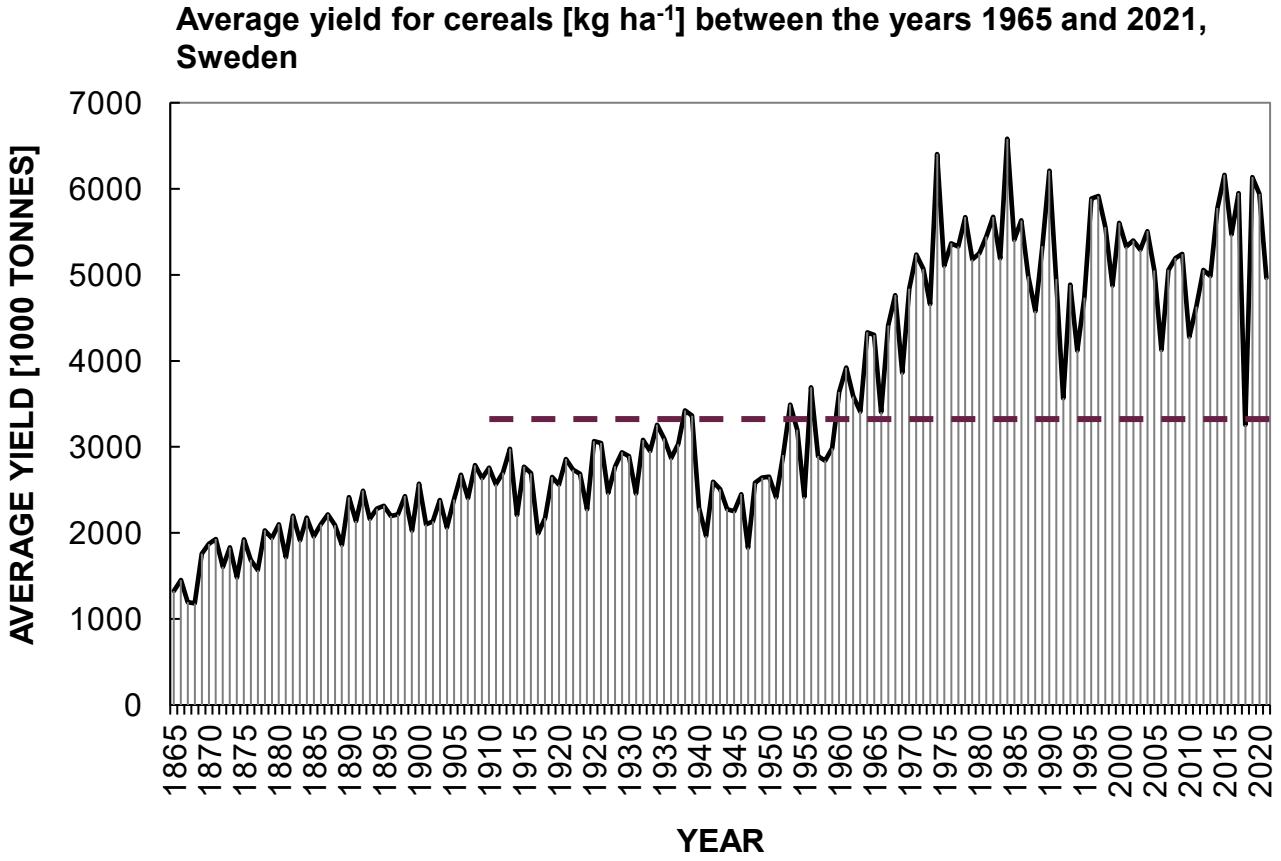
Swedish University of Agricultural Sciences

Extreme- and compound weather events affecting water availability is a precursor for reduced crop yield and food security

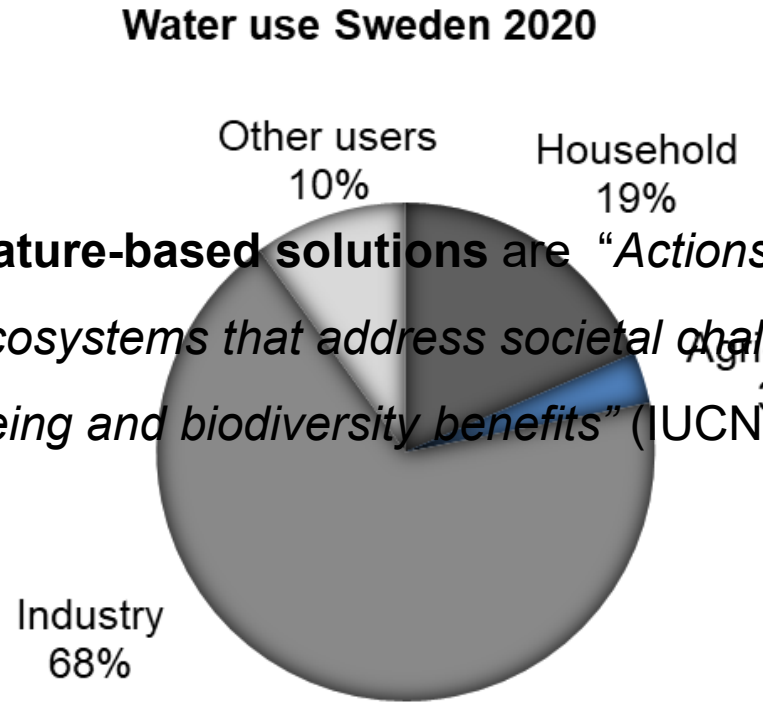


European Drought Observatory 2023,
https://edo.jrc.ec.europa.eu/edov2/php/index.php?id=1000



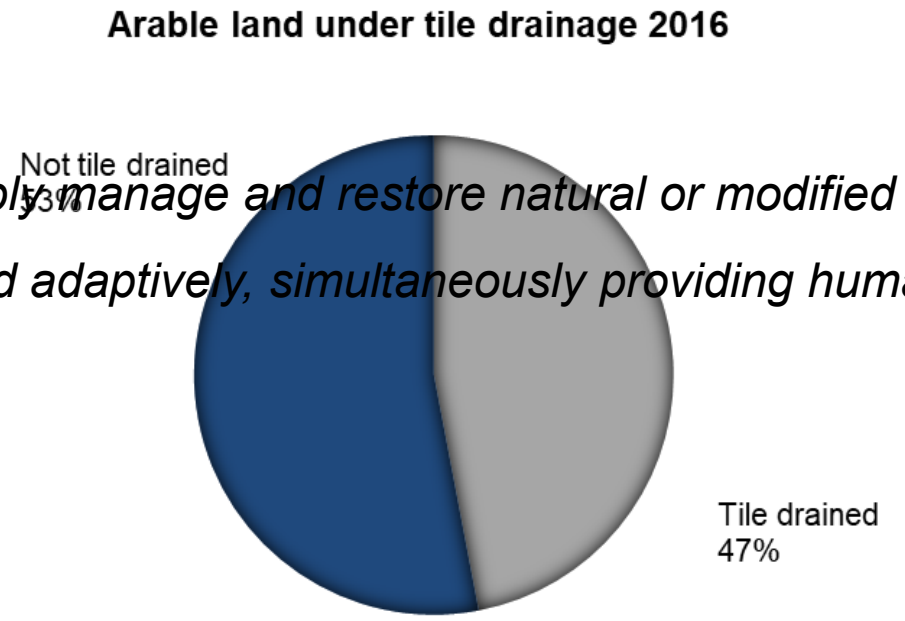
Adapted from Karlsson, A-M (2019).

Landscape water allocation is a legacy of historic (anthropogenic) landscape changes. Current alteration is governed by policies, individuals' good-will and priorites of water resources.



(Statistics Sweden, 2020,2022)

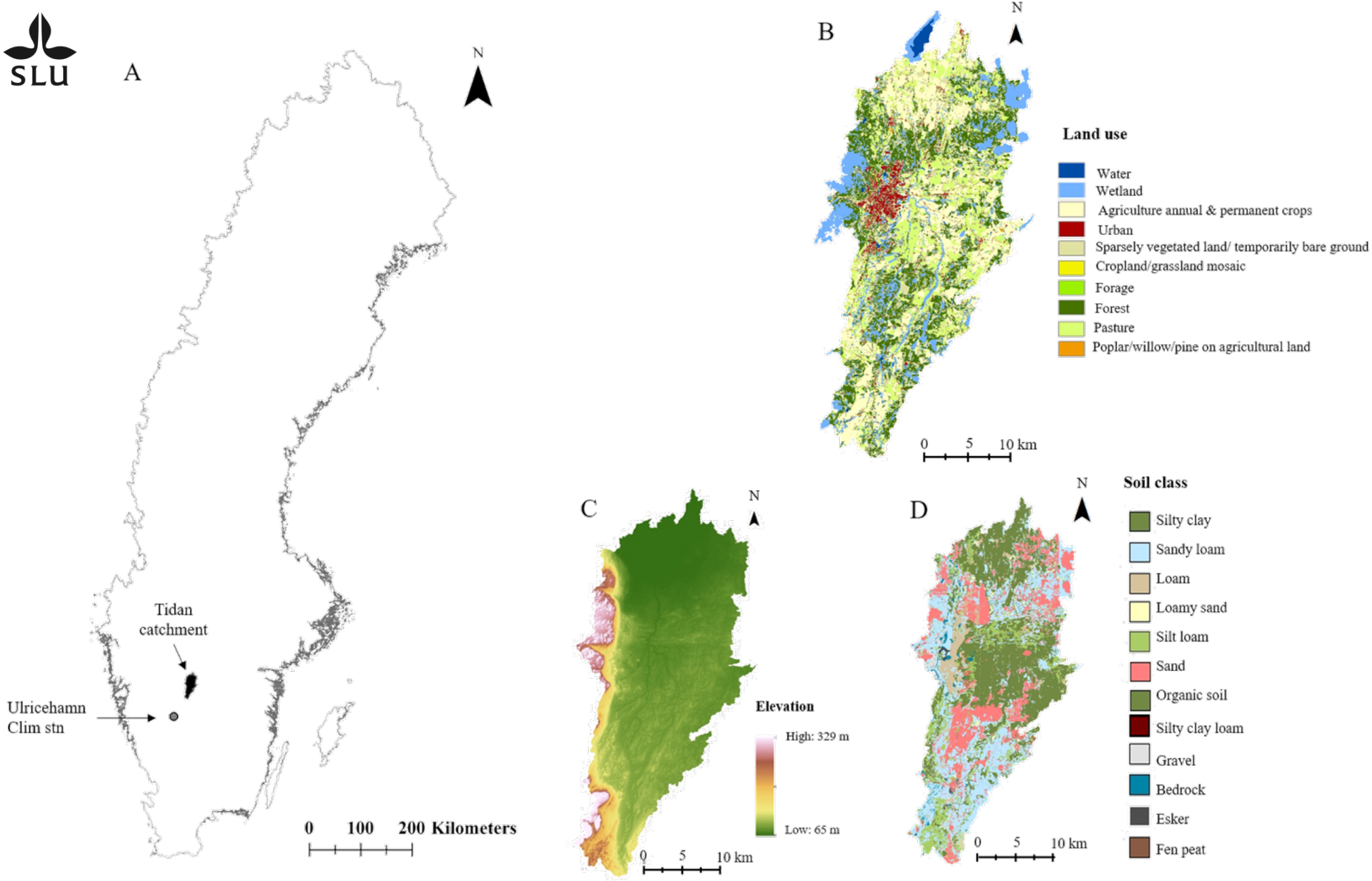
Nature-based solutions are *"Actions to protect, sustainably manage and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits"* (IUCN 2016)



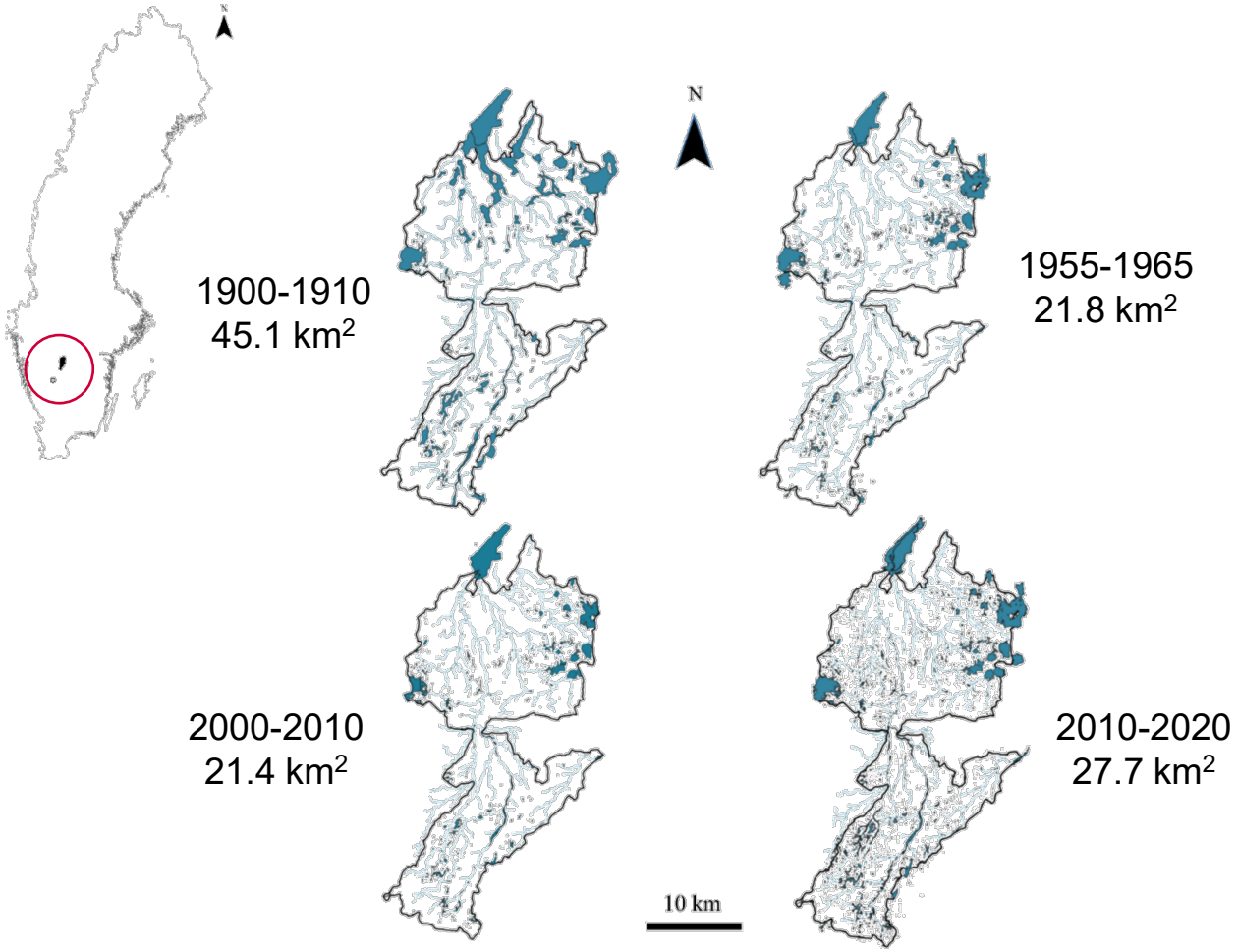
20 % of wetland unaffected by anthropogenic activites

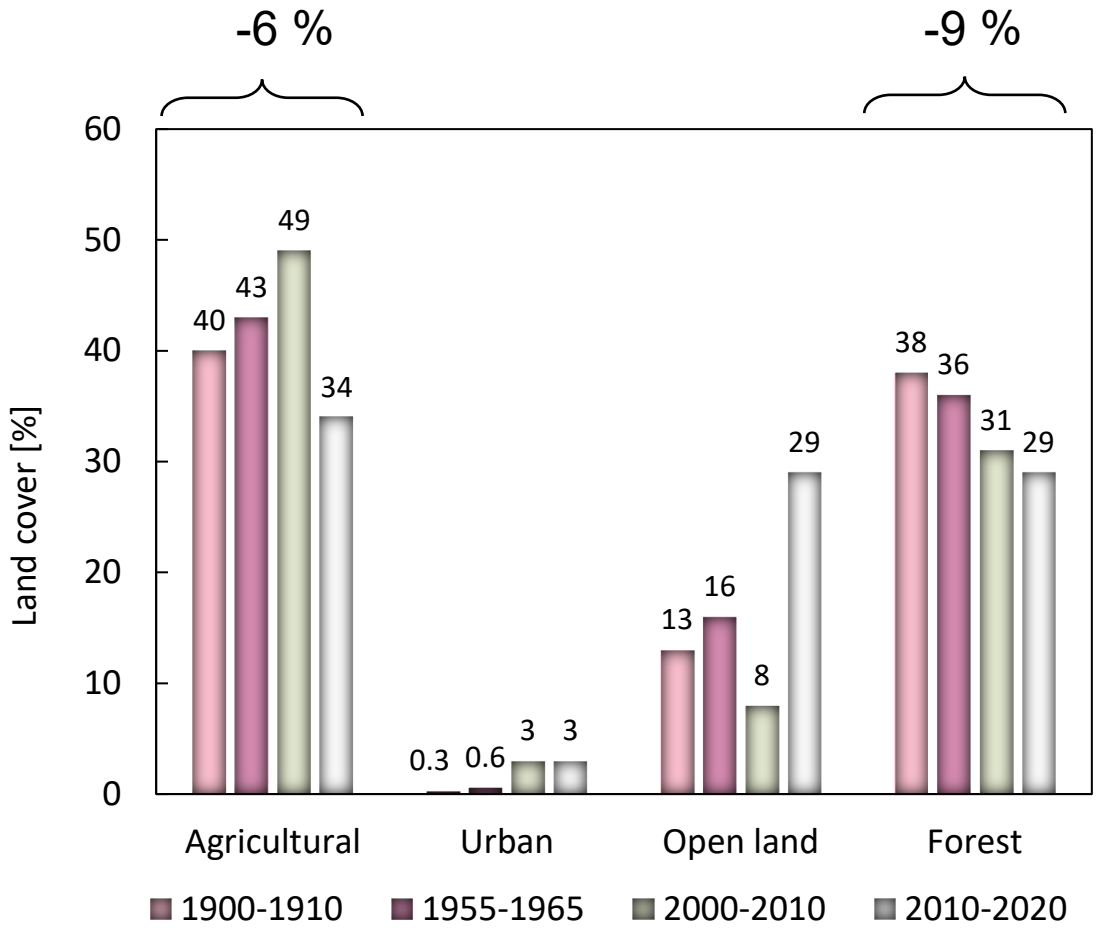
Objectives

- Explore water balance changes between 1900 to 2020
- Determine effects of restoring historical water bodies and possibility to restore historic water balance and crop water availability


A
N
Tidan
catchment
Ulricehamn
Clim stn
0 100 200 Kilometers
B
N
Land use
Water
Wetland
Agriculture annual & permanent crops
Urban
Sparsely vegetated land/ temporarily bare ground
Cropland/grassland mosaic
Forage
Forest
Pasture
Poplar/willow/pine on agricultural land
0 5 10 km
C
N
Elevation
High: 329 m
Low: 65 m
0 5 10 km
D
N
Soil class
Silty clay
Sandy loam
Loam
Loamy sand
Silt loam
Sand
Organic soil
Silty clay loam
Gravel
Bedrock
Esker
Fen peat
0 5 10 km

Agricultural land, forest and wetland area has decreased since 1900, while number- and area of lakes was higher in 2020 – affected by map resolution

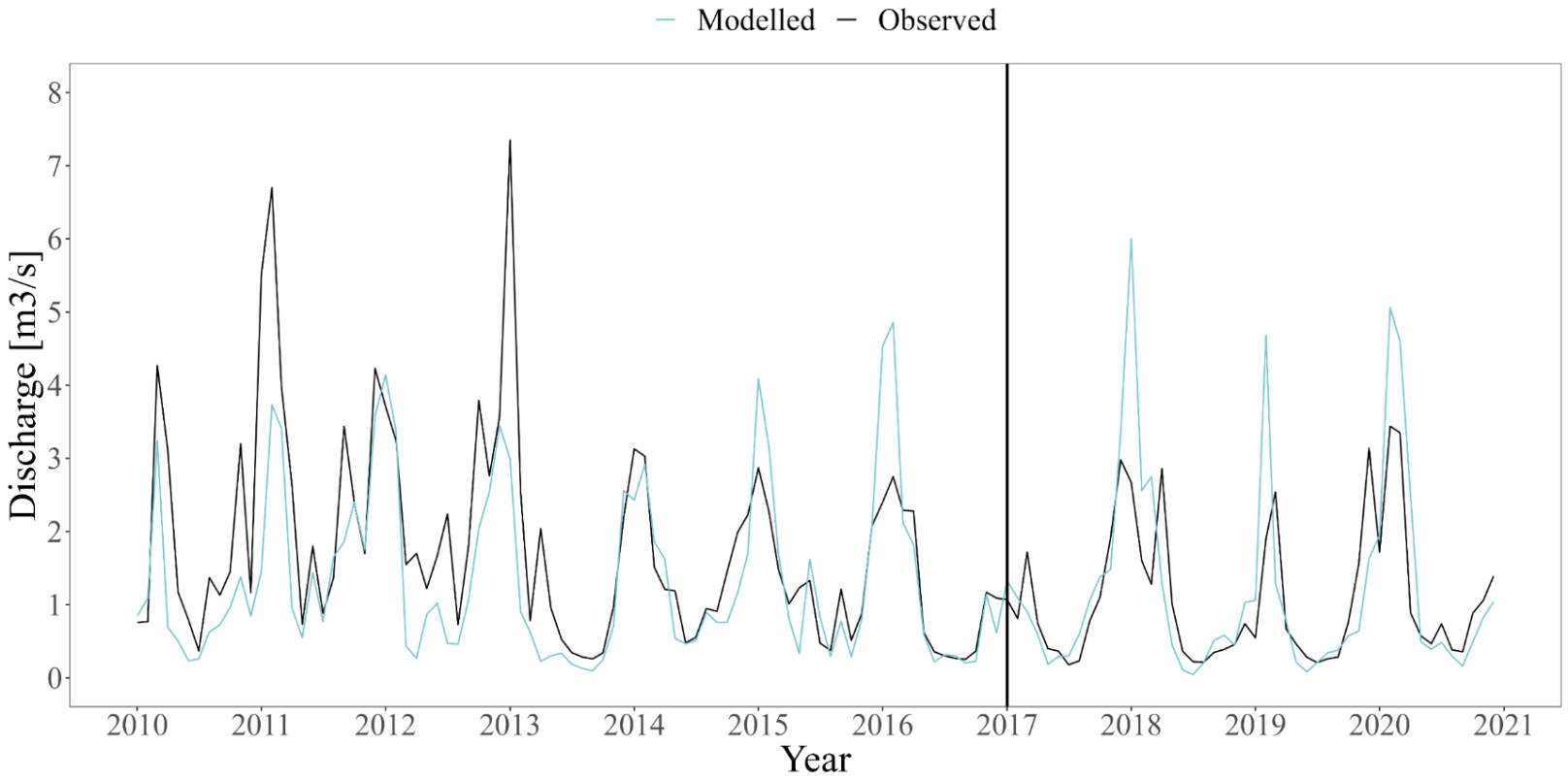


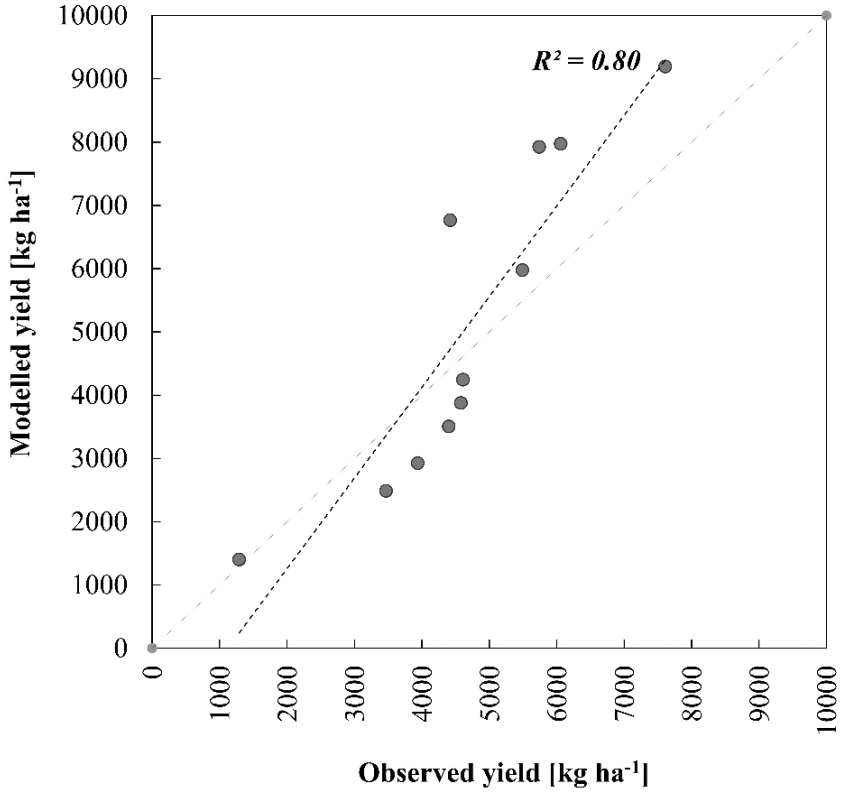


Model setup in SWAT + adapted to historical map resolution – 11 Scenarios one-by-one changing parameter

	Reference	Baseline			Hydromorhpology and water bodies				Climate change		
	B0	**B1**	**B2**	**B3**	**WB1**	**WB2**	**WB3**	**WB4**	**C1**	**C2**	**C3**
Land use	2010-2020	1900-1910	1955-1965	2000-2010	2010 - 2020				2010 - 2020		
Water bodies	2010-2020	1900-1910	1955-1965	2000-2010	1900-1910	1955-1965	2000-2010	1900-1910	2010 - 2020		
								2010-2020			
Climate	2010-2020	1900-1910	1955-1965	2000-2010	2010 - 2020				1900-1910	1955-1965	2000-2010

Soft calibration/validation against stream flow, additional validation against crop yield and ground water level

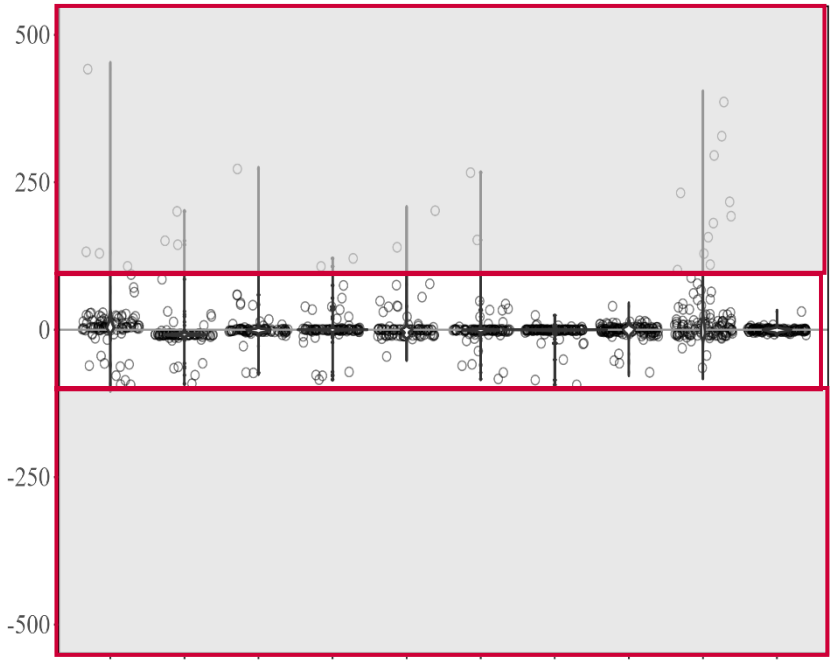




Parameters	Observed average (median)	Modelled (2010-2020 Full catchment area[a])	Modelled (2010-2020 Small catchment area[b])
Streamflow/precipitation	0.5 (0.4)	0.33	0.33
Baseflow/total flow	0.78	0.65	0.74
Evapotranspiration/Precipitation	0.7 (0.6)	0.60	0.59

Small absolute changes with historical waterbodies and streams. Main differences due to weather fluctuations between time periods

δ Evapotranspiration [%]

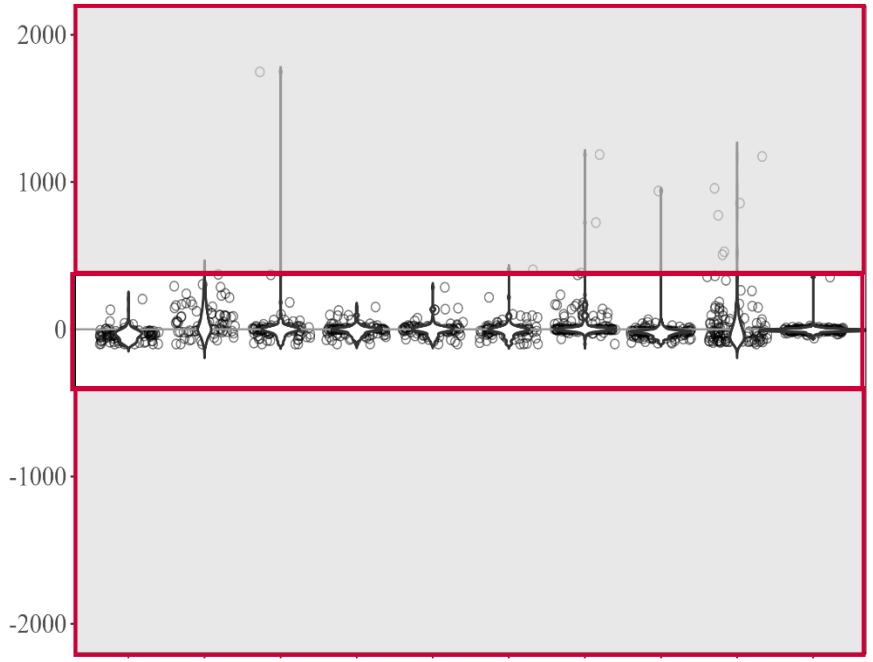


~ Same range

-2% to +4 %

-37 %

δ Water yield [%]



-41 %

-5%

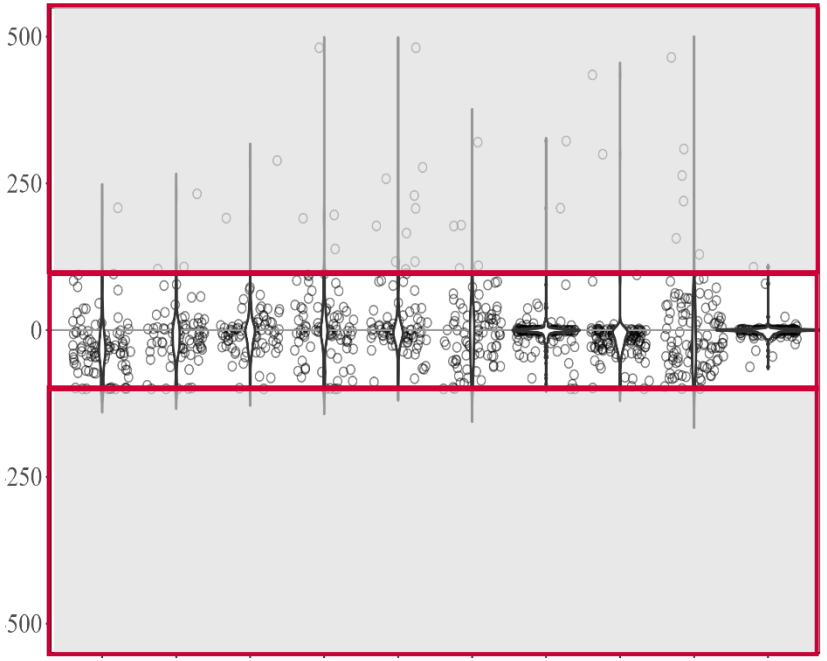
- 8 %

-12 %

-1%

- 33 %

δ Average soil water [%]



= -37 % (604 mm)

+ 1 %

+6 %

+ 12 %

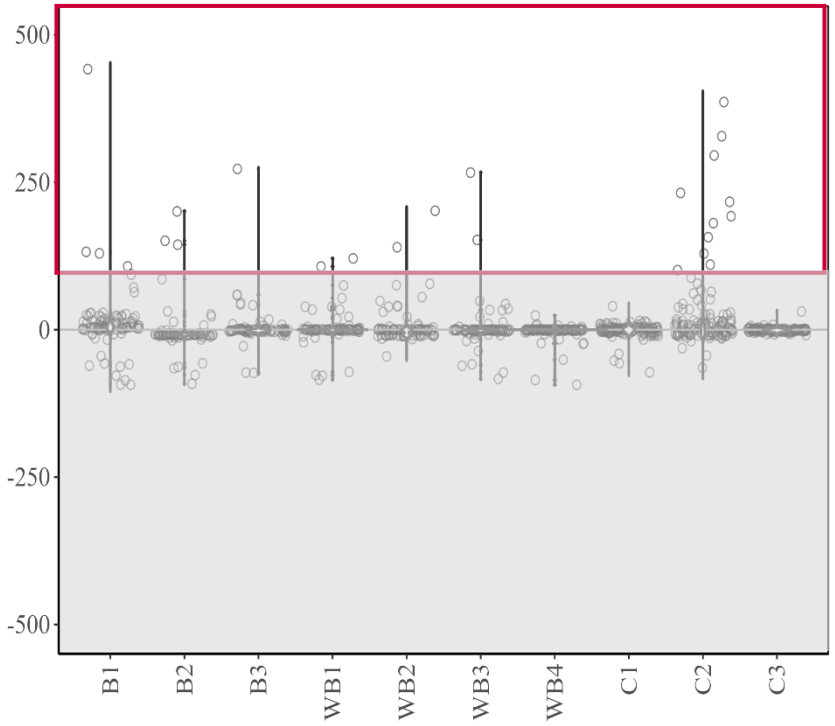
- 22 %

- 4 %

- 2 %

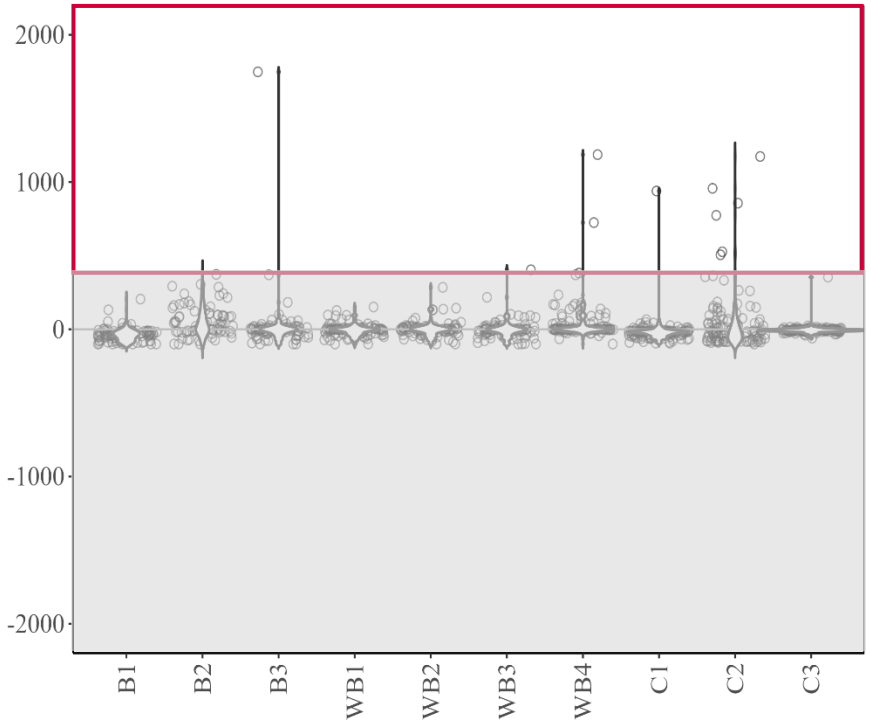
Small absolute changes with historical waterbodies and streams. Main differences due to weather fluctuations between time periods

δ Evapotranspiration [%]



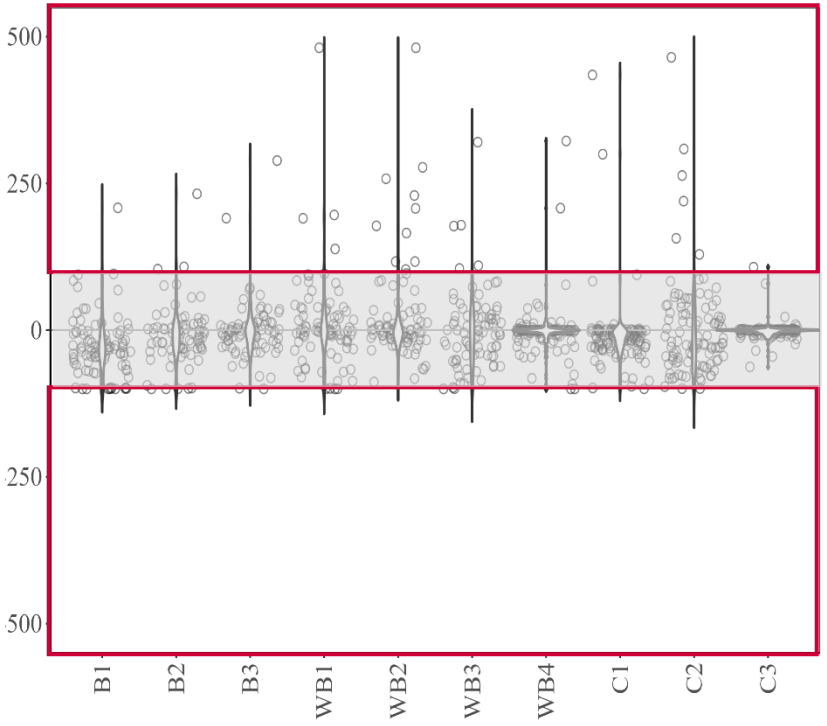
urban, wetlands
sand, silty clay, block, bedrock and loam

δ Water yield [%]



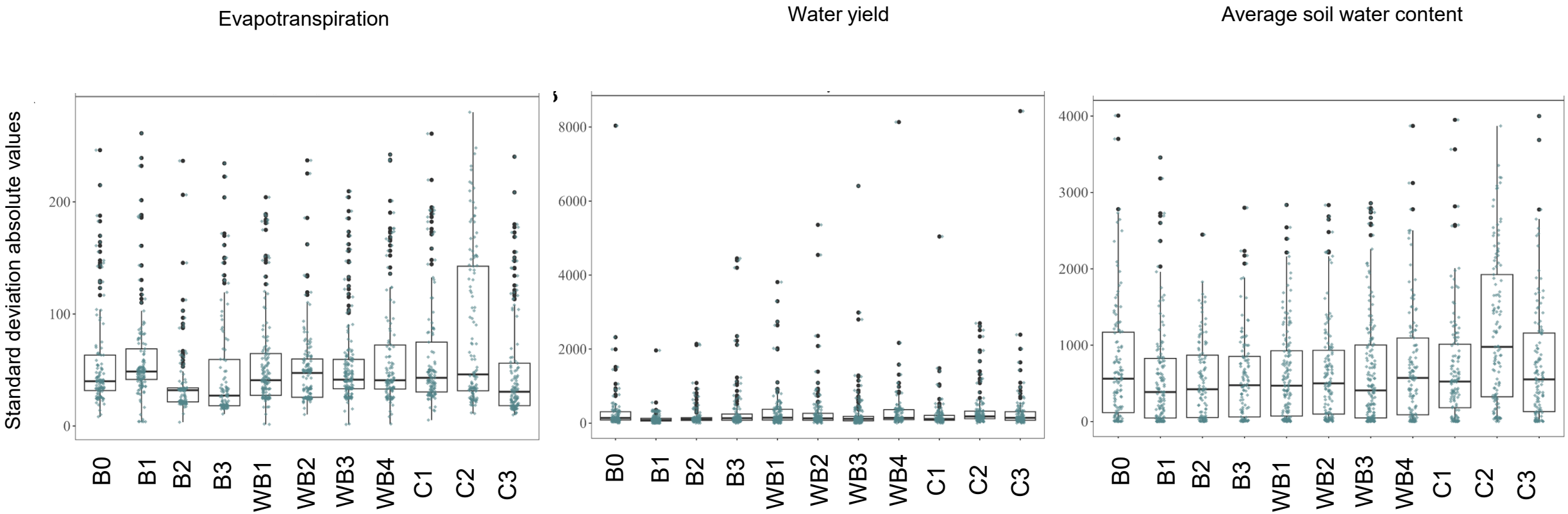
grassand/shrubland, mixed forest, annual agricultural crops
inconsistent soil types

δ Average soil water [%]



wetlands

Change in climate driving parameter for water balance alterations – small absolute changes



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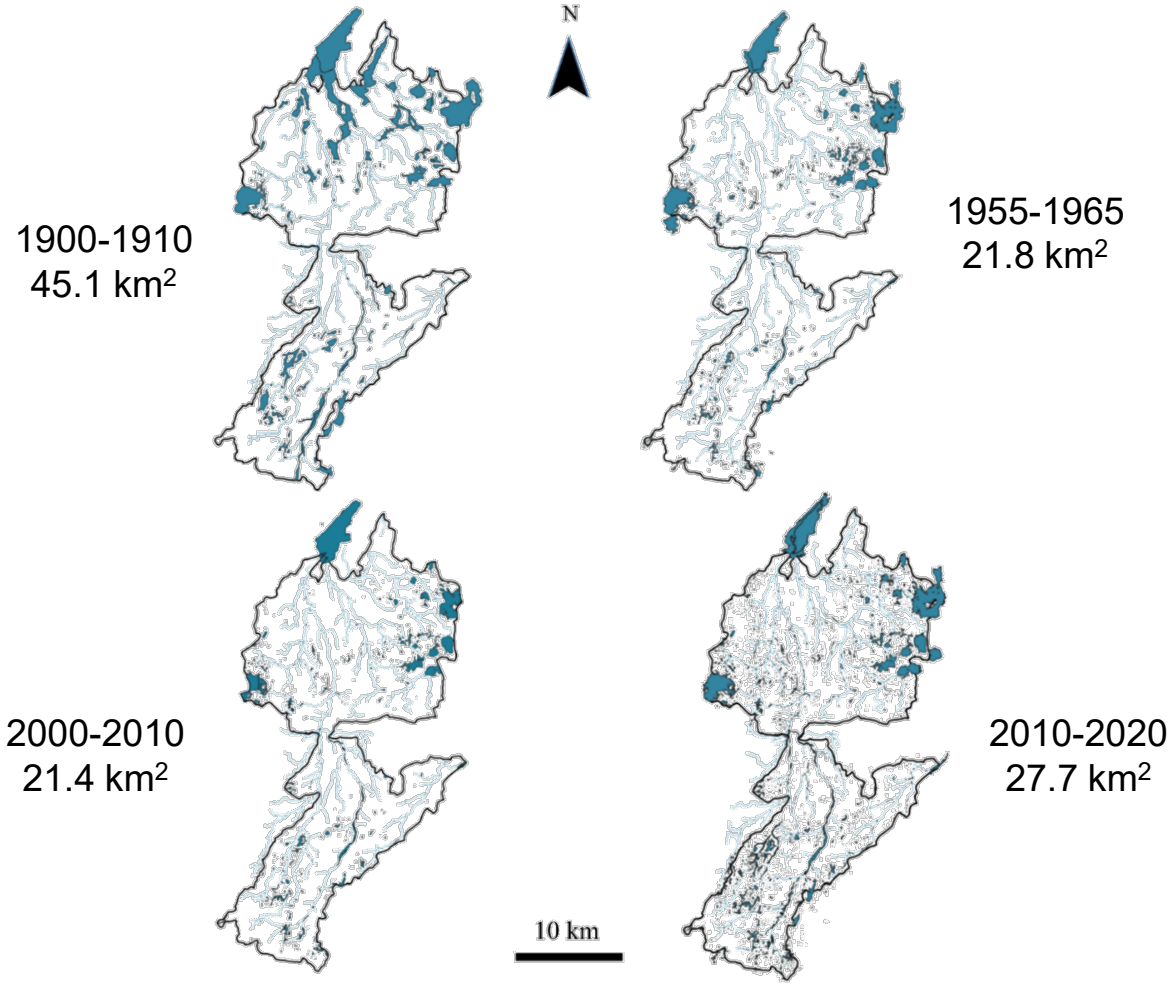

Take home message

- Main changes in water balance parameters in Tidan catchment due to climate variability over the four time periods + wetlands and grassland/shrubland

- Historical data on surface structures valuable discussion tool for hydrological functioning – require clear definition on restoring processes or structures. Required further exploration from multiple catchments

Thanks for your attention!

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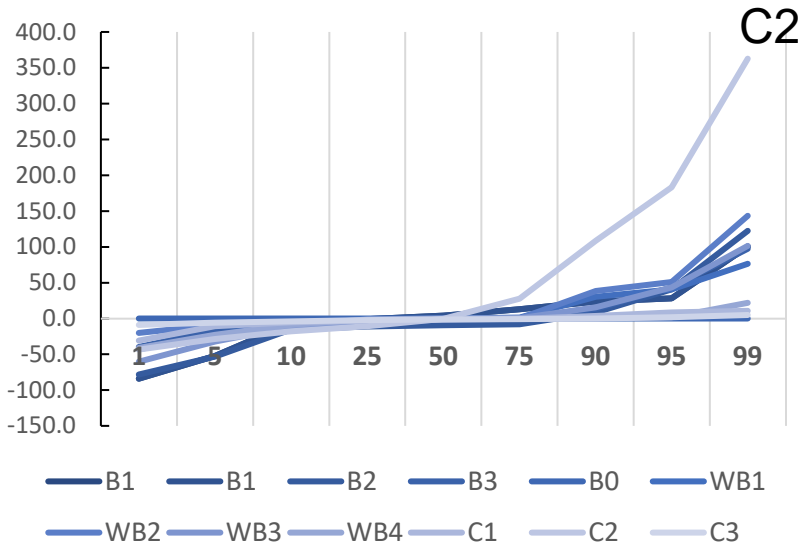
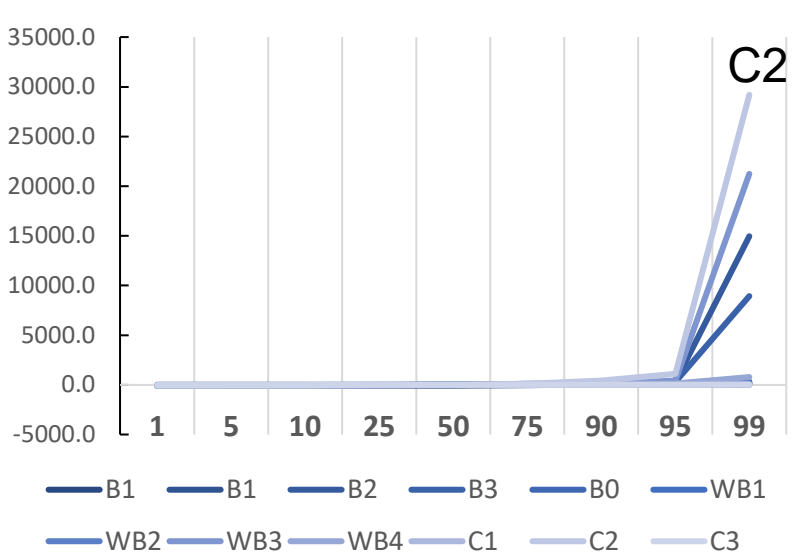
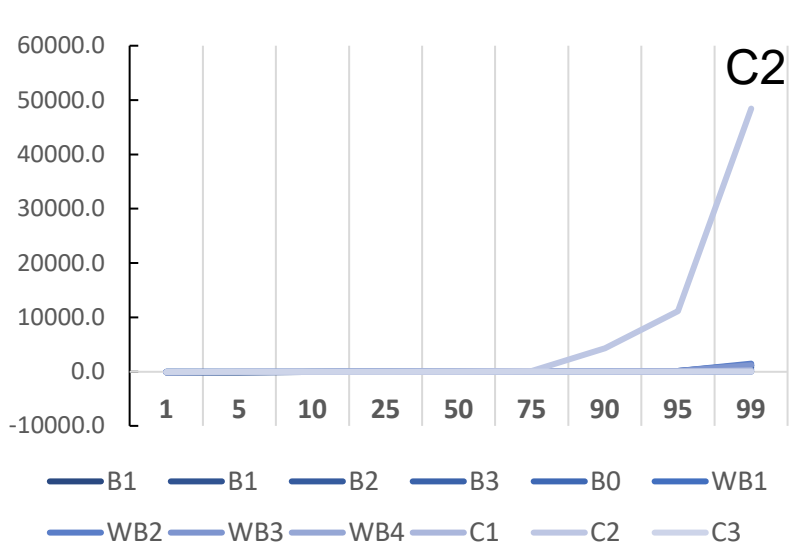


δ Water yield [%]



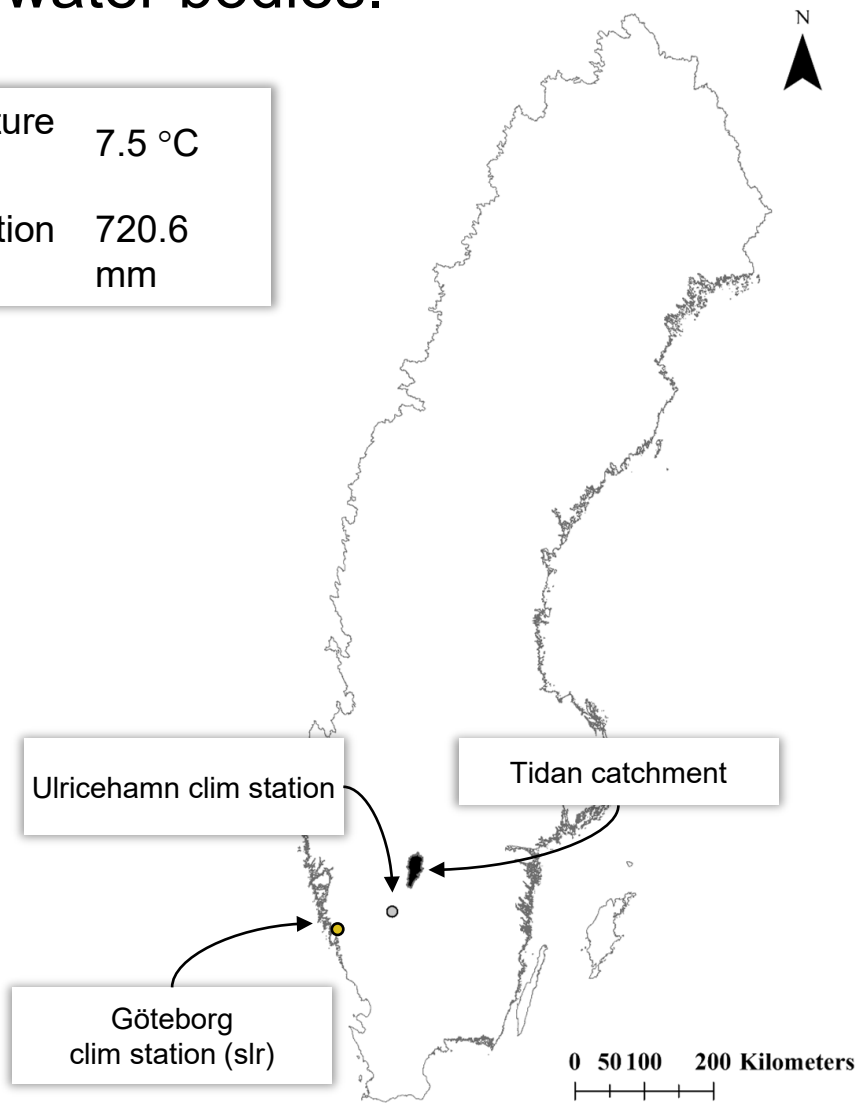
δ Average soil water [%]



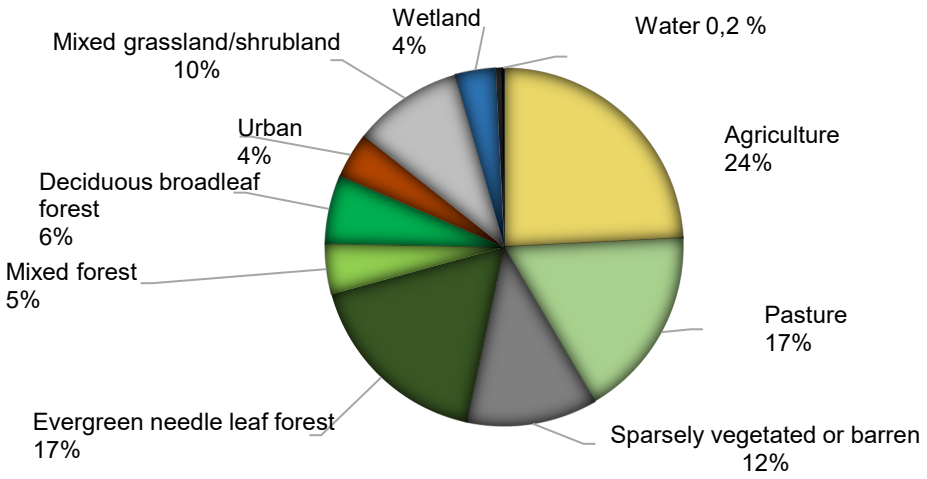
Percentiles

Tidan catchment - an example of a landscape highly modified in waterways and water bodies.

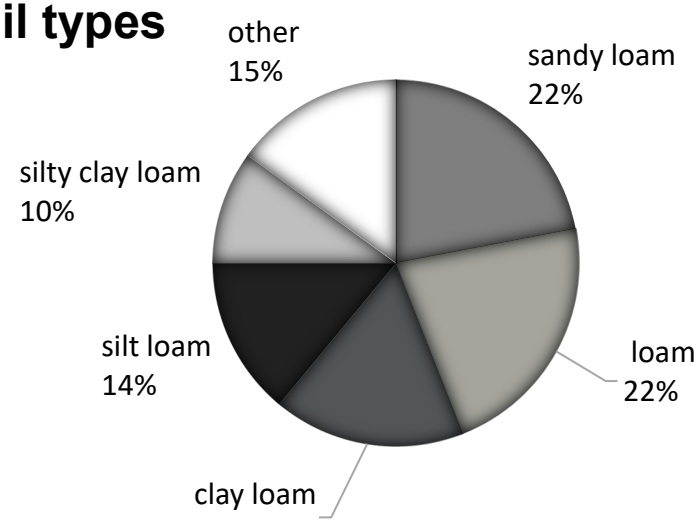
Annual temperature 1991-2020	7.5 °C
Annual precipitation 1991-2020	720.6 mm



Land use



Soil types



Model setup

Landuse

Ortophoto
Satelite data
National Land cover data
Historical maps

Soil data

MVM National soil database
Coup model forest data
Peer reviewed data sources
Soil depth map

Elevation

2m DEM

Climate

1 climate station obs data 1892-2022

Waterbodies & streams

National databases

Manual delineation historical maps

Resolution
30 m

HRUs
827

4 yr warm up

10 yr model periods/scenario

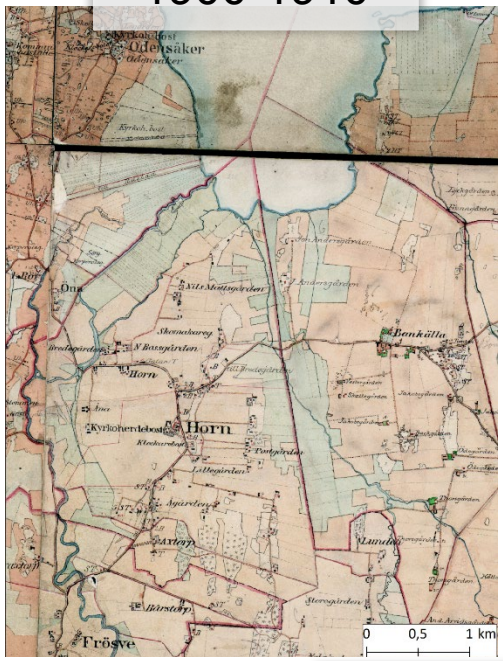
Calibration 2010-2016

KGE	0.54
Pearson coeff.	0.72
RMSE	1.07

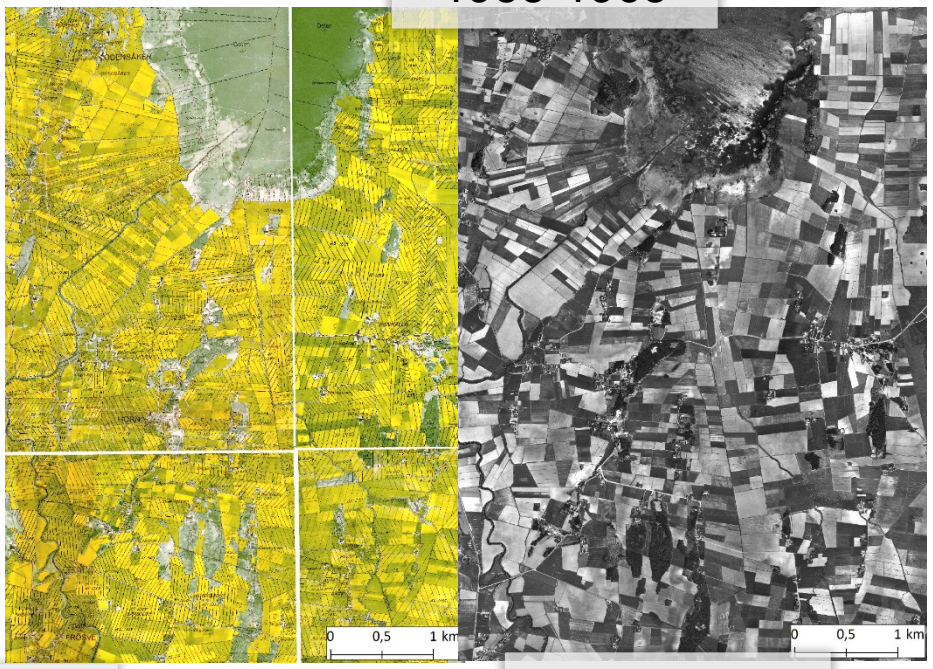
Validation 2017-2020

KGE	0.58
Pearson coeff.	0.77
RMSE	0.90

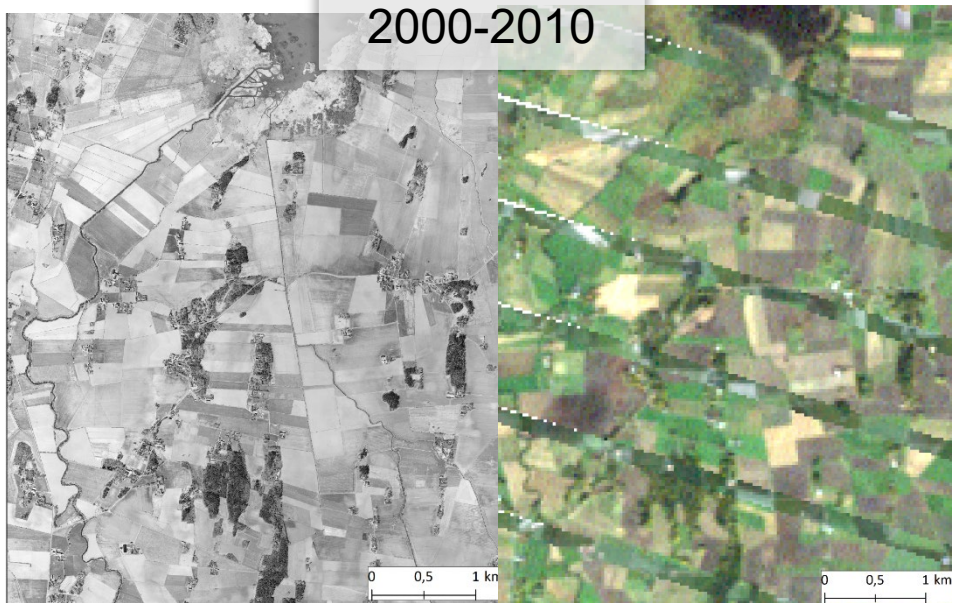
1900-1910



1955-1965



2000-2010



2010-2020

Content

- **Introduction**

Extreme weather linked to historic changes of water in agricultural landscapes

- **Method**

Using SWAT+ for estimating effect of historic waterbodies and streams on water balance under current climate and land use

- **Results**
- **Take home messages**