Efficiency of the buffer zones in nutrient load reduction under climate change conditions

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Budapest, July 5th 2024

Buffer zones - definition

„A strip of land which separates agricultural activity from a waterway”

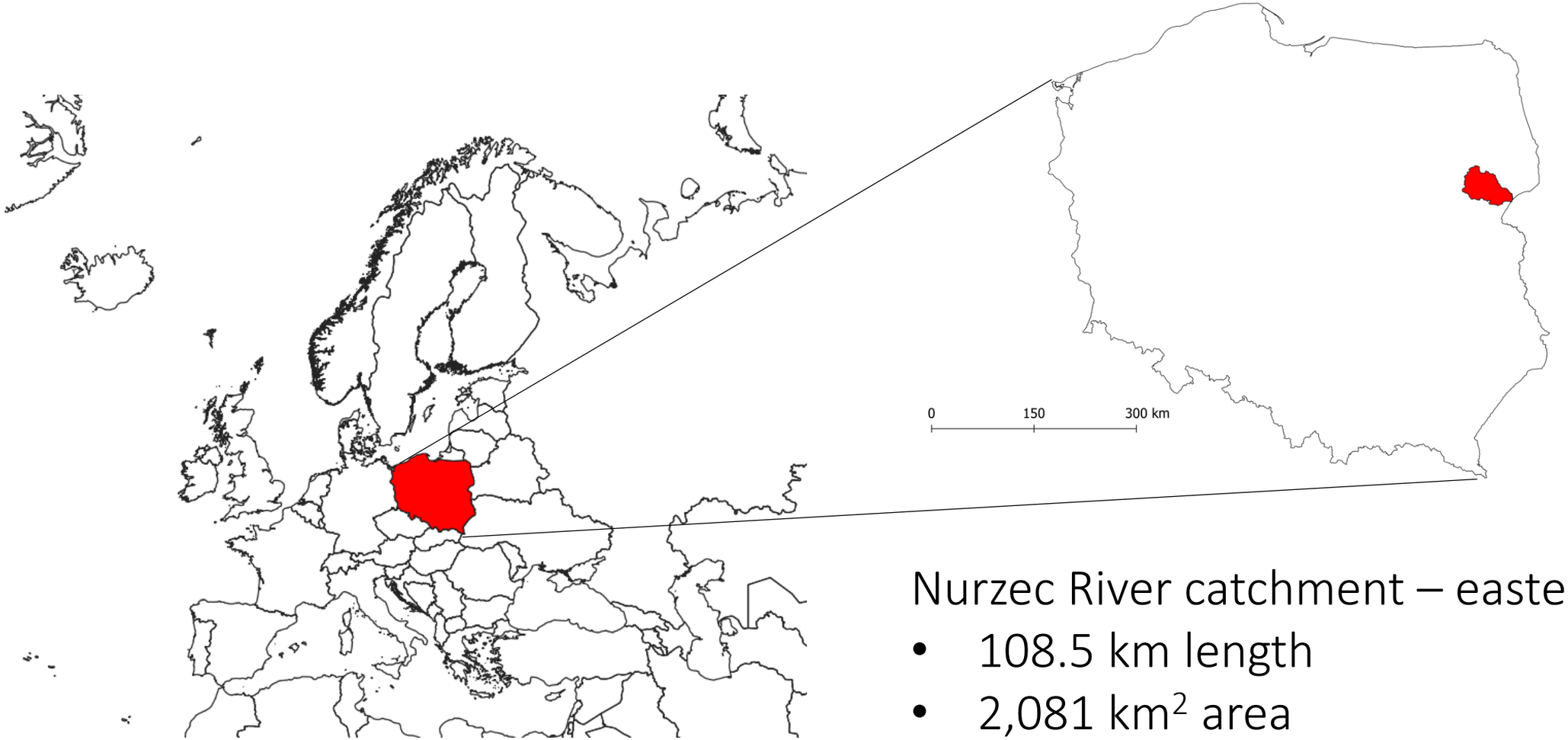
McKergow et al., 2022

Buffer zones remove contaminants through a combination of physical and biological processes

McKergow et al., 2022

photo from: McKergow, L., Matheson, F., Goeller, B., Woodward, B. (2022) Riparian buffer design guide, Water quality design and performance estimates. Design and performance estimates. NIWA, Hamilton, New Zealand.

Analysed area – Nurzec River



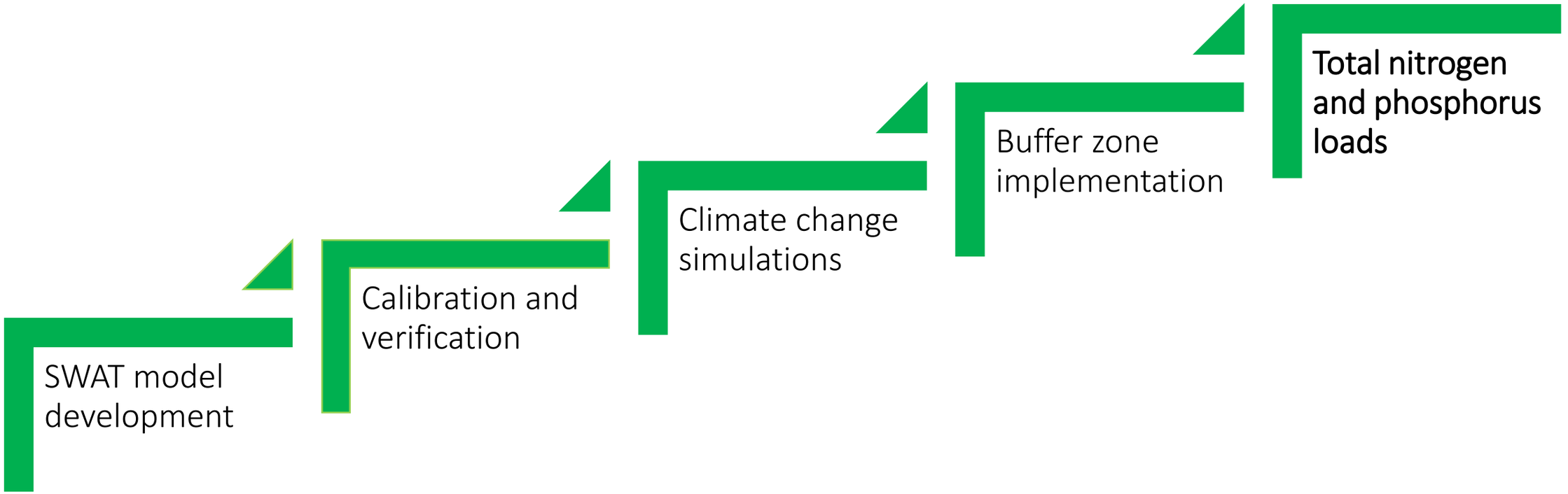
Nurzec River catchment – eastern Poland

- 108.5 km length
- 2,081 km^2 area
- 56,000 population

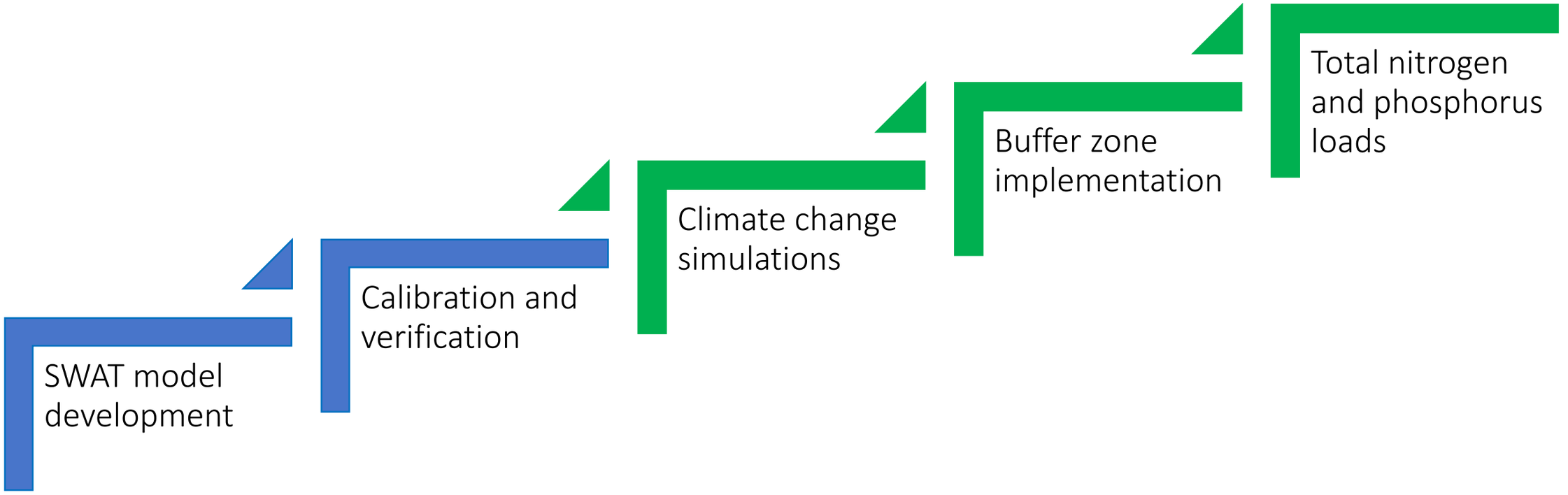
photo by Olga Sadowska, 2022

Workflow

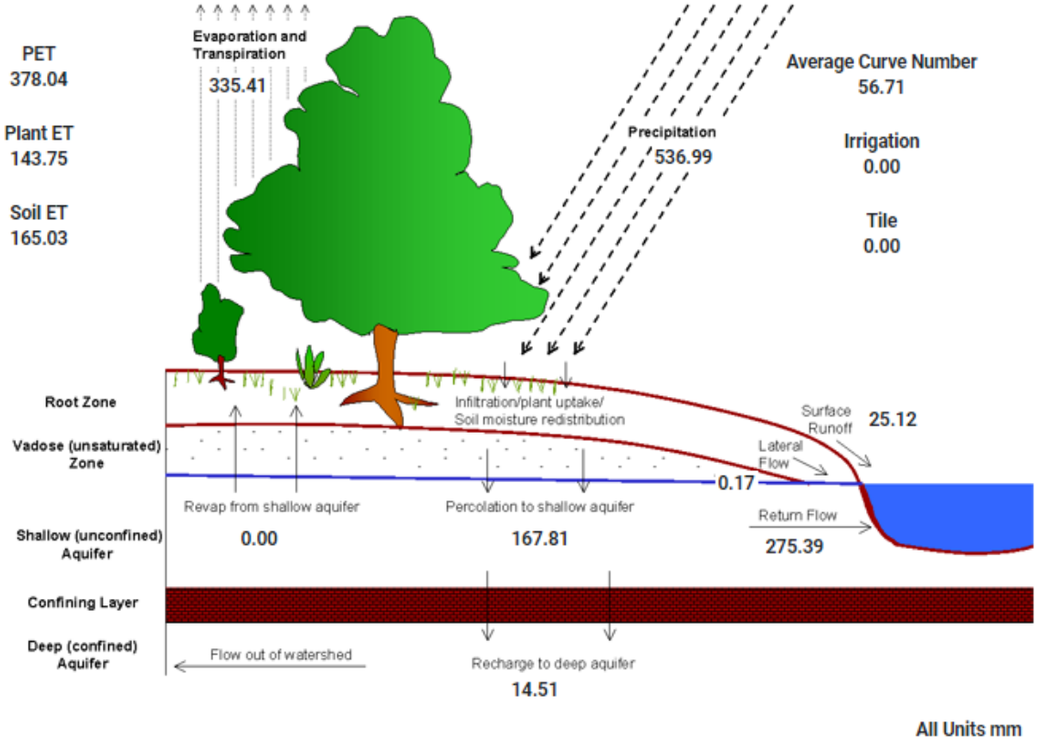
Aim: Evaluation the potential effect of buffer zone implementation in the Nurzec River catchment (eastern Poland) under current and future climate conditions



SWAT Model

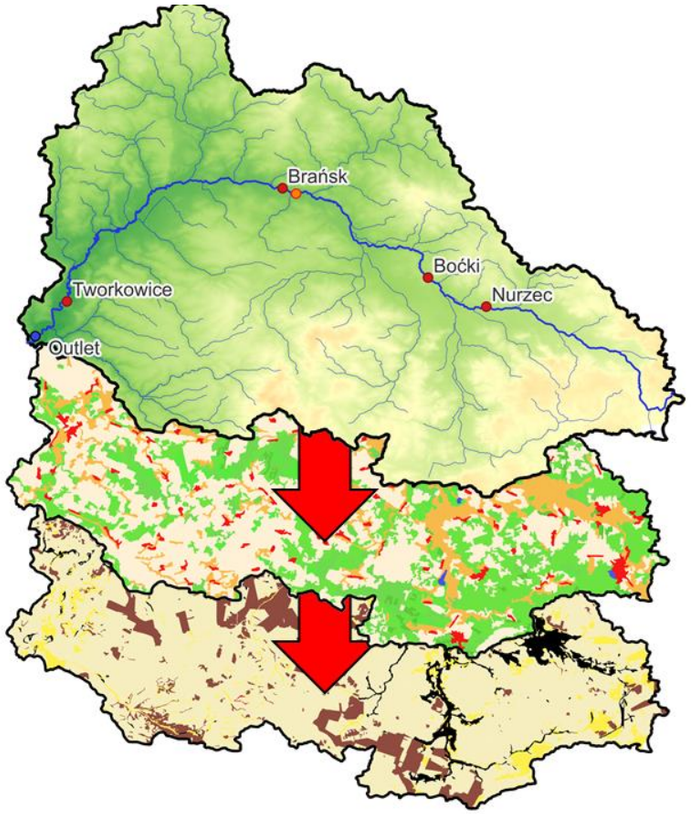

SWAT model development
Calibration and verification
Climate change simulations
Buffer zone implementation
Total nitrogen and phosphorus loads

SWAT Model



- Digital Elevation Model
- Soil map
- Land use map
- Weather data:
  - Precipitation
  - Air temperature
  - Solar radiation
  - Wind speed
  - Relative humidity

Nurzec River Model



Weather data:
1991-2020

Flow data:
1991-2020

Quality data:
2005-2020

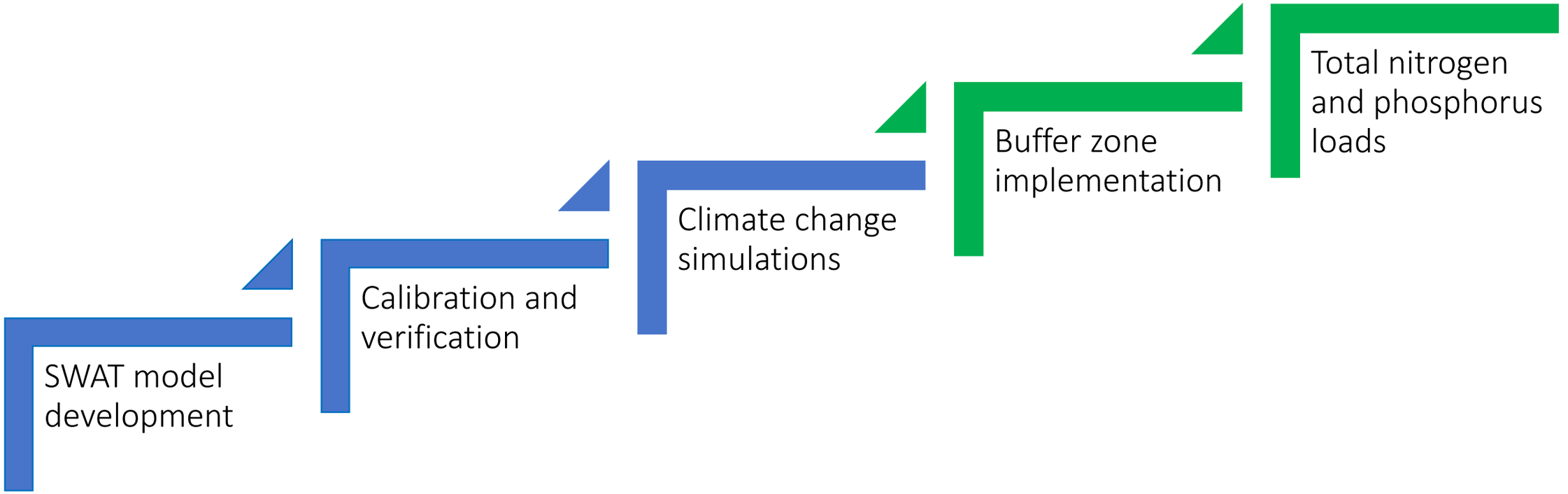
Point sources:
1991-2020

Crop data:
2010–2016

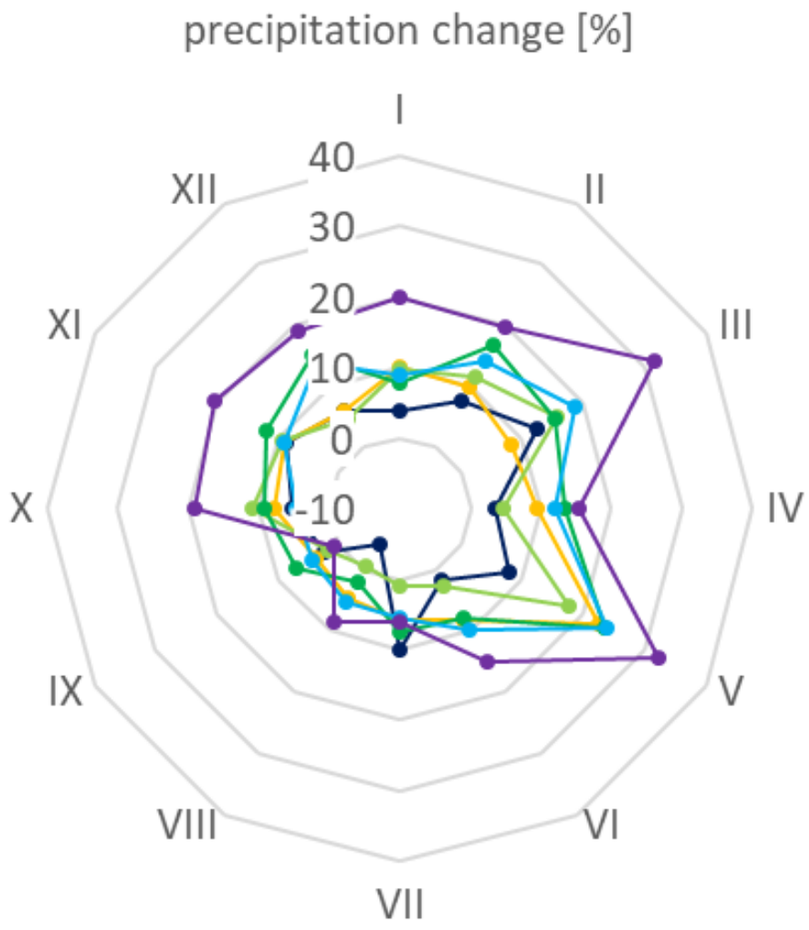
- Very flat area – problematic with building a model
- Peat soils – hard to simulate within the model

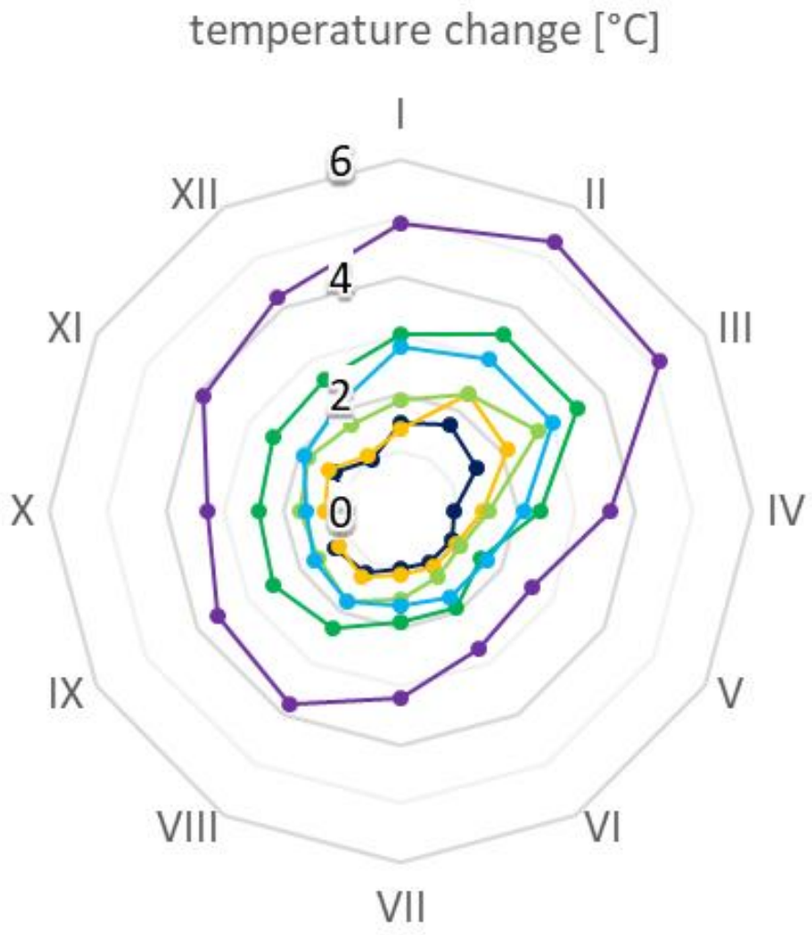
Parameter	Calculation profile	KGE	R^2	P_{BIAS}
	Calibration			
flow	Nurzec – Boćki	0.58	0.63	-27
	Nurzec – Brańsk	0.84	0.73	7
sediment	Nurzec – Tworkowice	0.49	0.73	-39
TN	Nurzec – Tworkowice	0.33	0.56	-49
TP	Nurzec – Tworkowice	0.86	0.79	1
	Validation			
TN	Nurzec – Nurzec	0.60	0.26	-66
TP	Nurzec – Nurzec	0.74	0.67	1

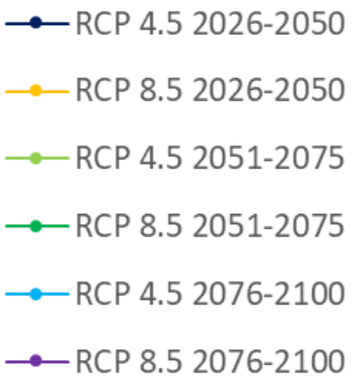
Climate change application



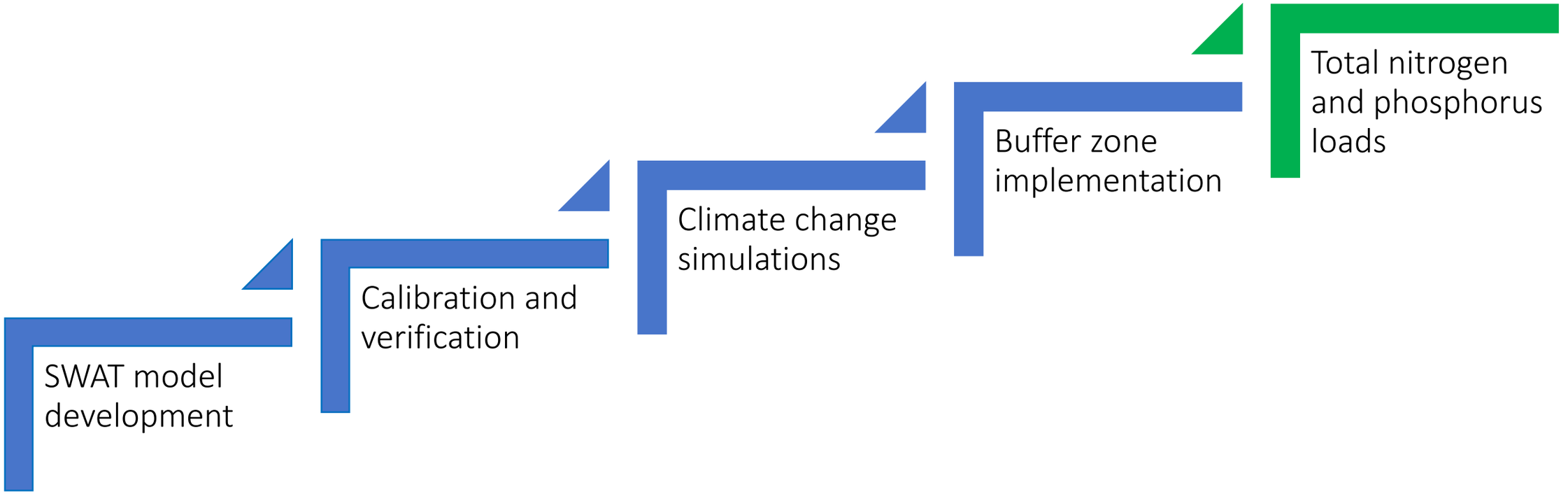
Climate change application





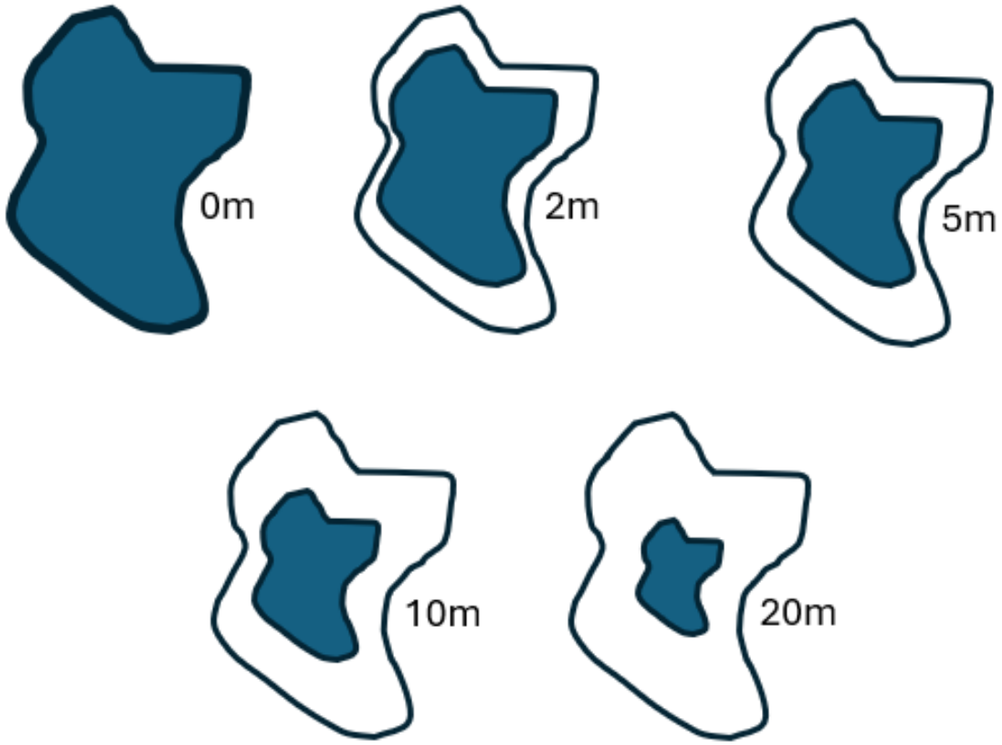


Buffer zone implementation

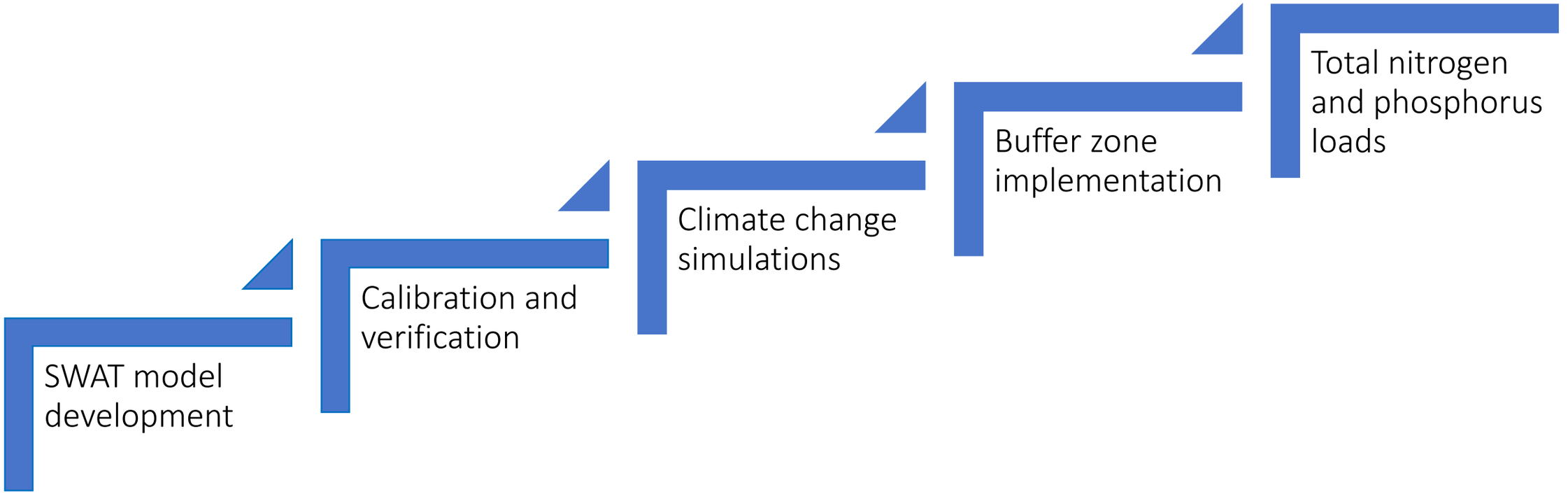


Buffer zone implementation

- Buffer zones applied to agricultural HRU
- 4 buffer widths (2–20 m)
- Inbuilt FILTERW option in SWAT intrface



Results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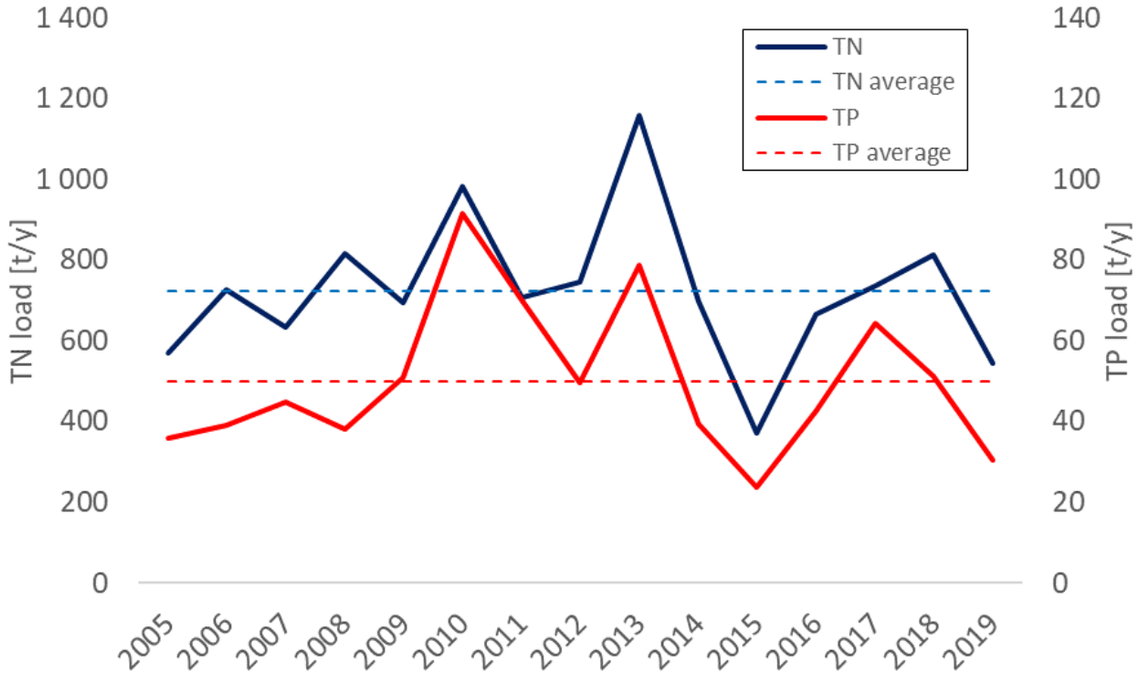
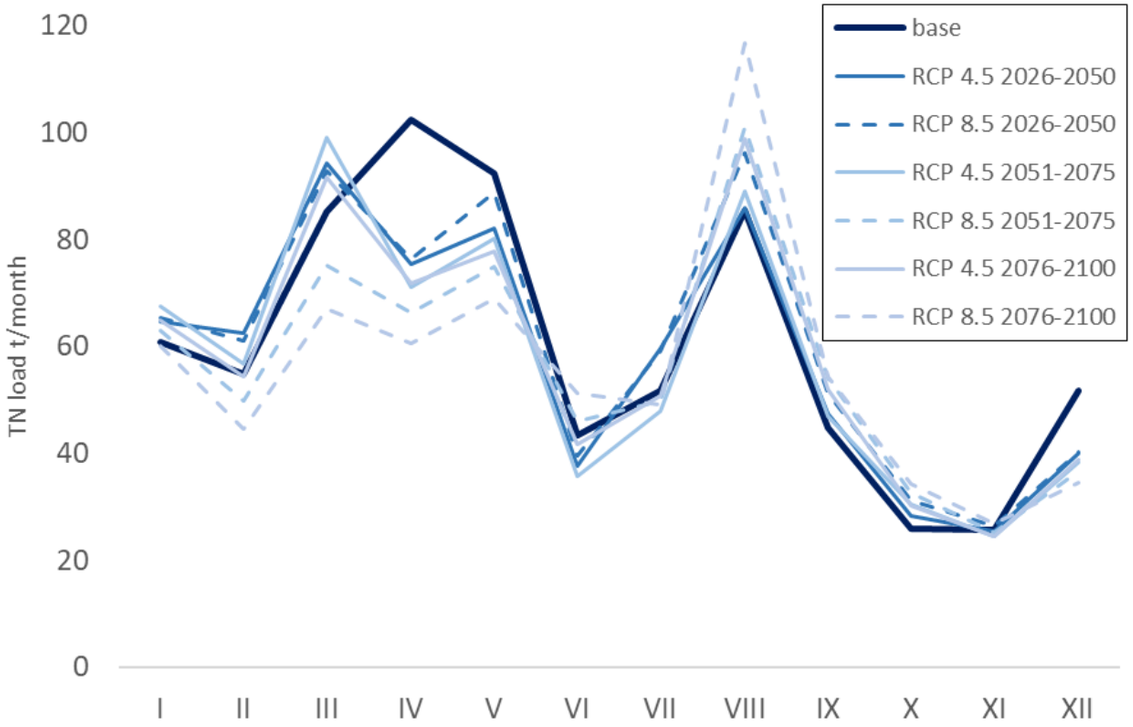
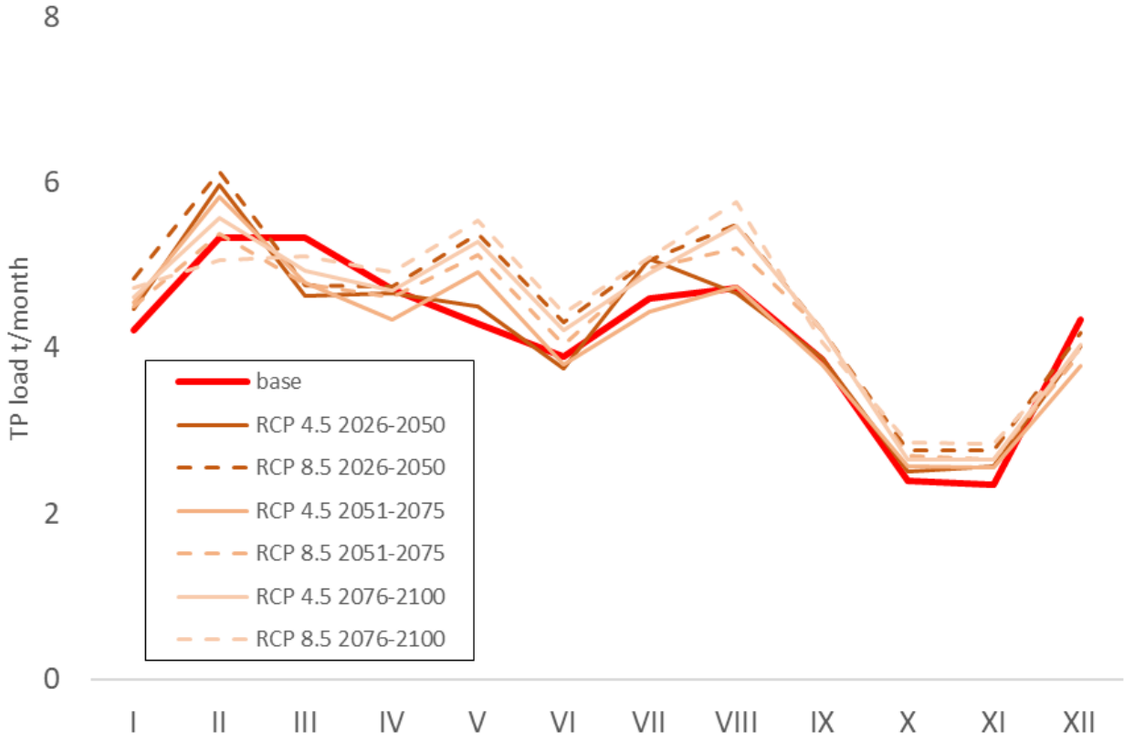
TN and TP output – baseline scenario



724 t/y of TN 50 t/y of TP

Climate change effects

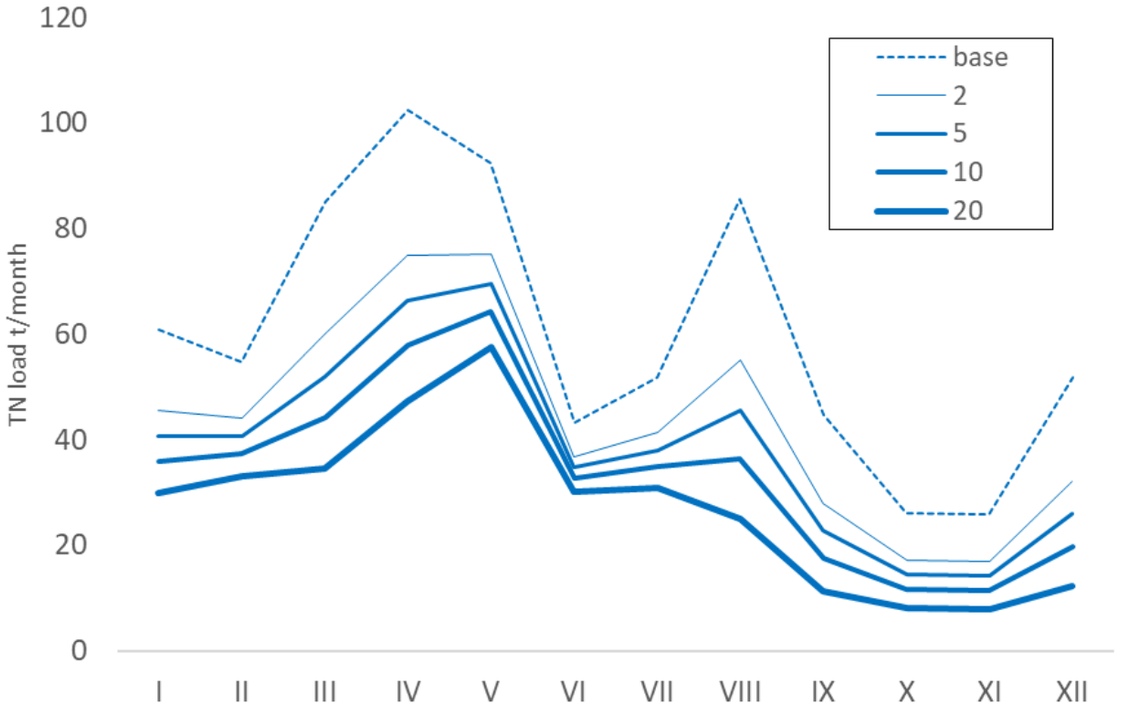


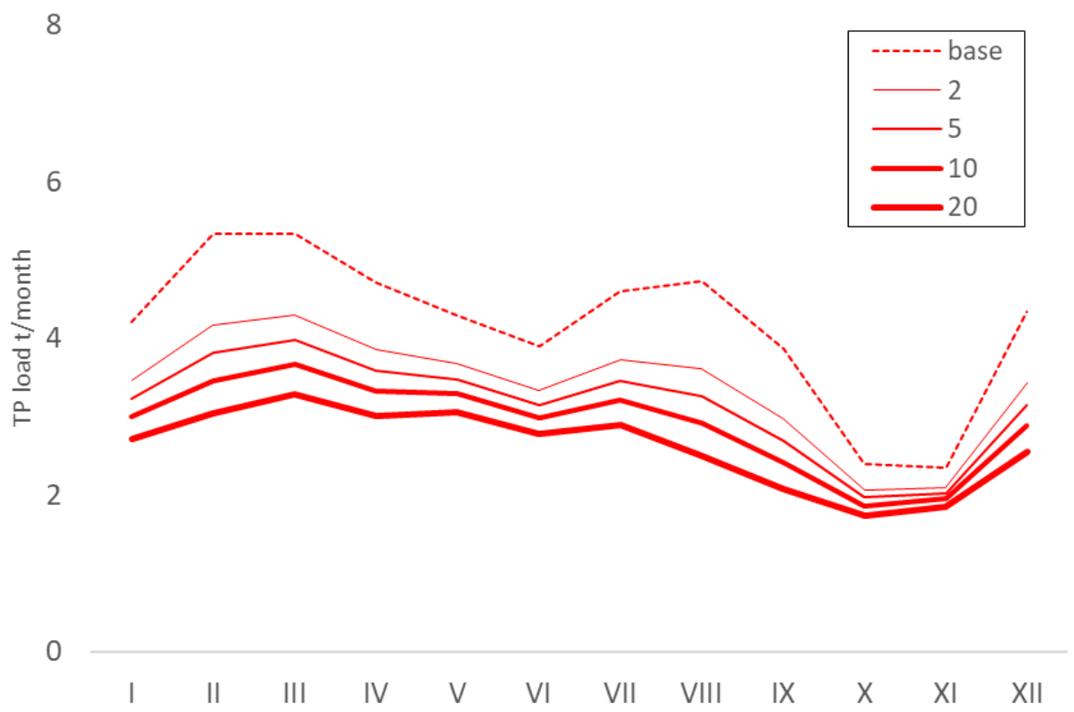


-40.9% – +36.6%

-13.1% – +29.1%

Buffer zone effect (no climate change)

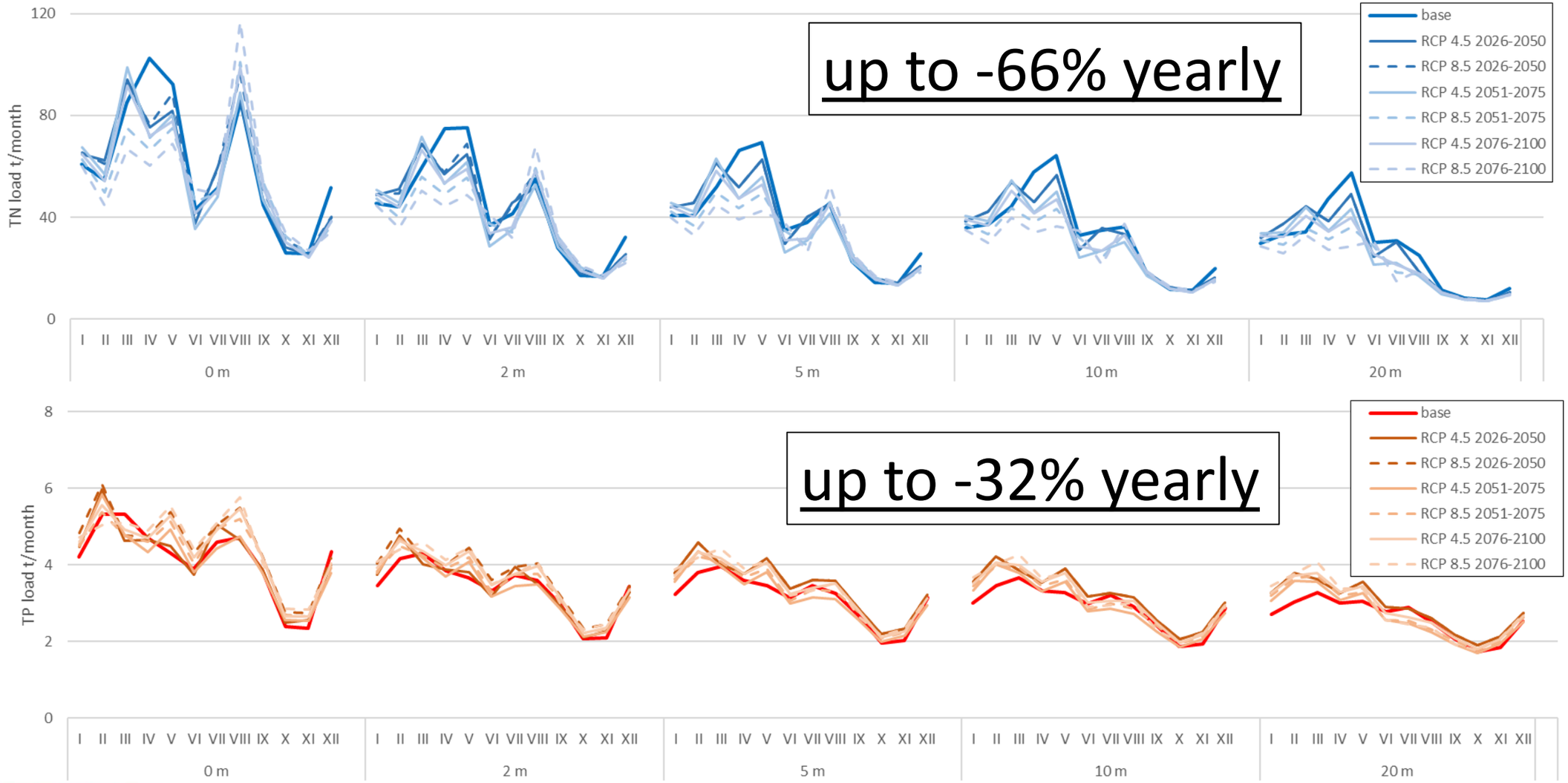




up to -55% yearly

up to -37% yearly

Buffer zones in climate change scenarios



Conclusions

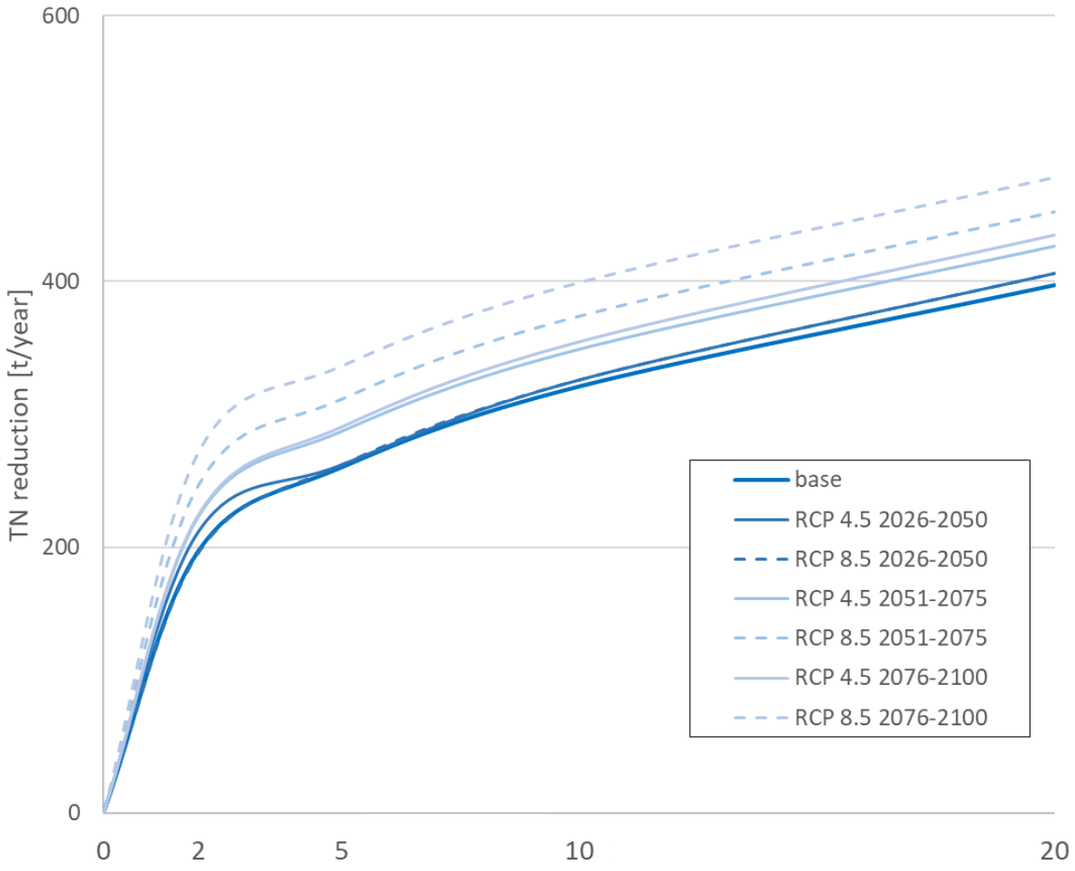
TN: 62 €/t/r
TP: 1 311 €/t/r

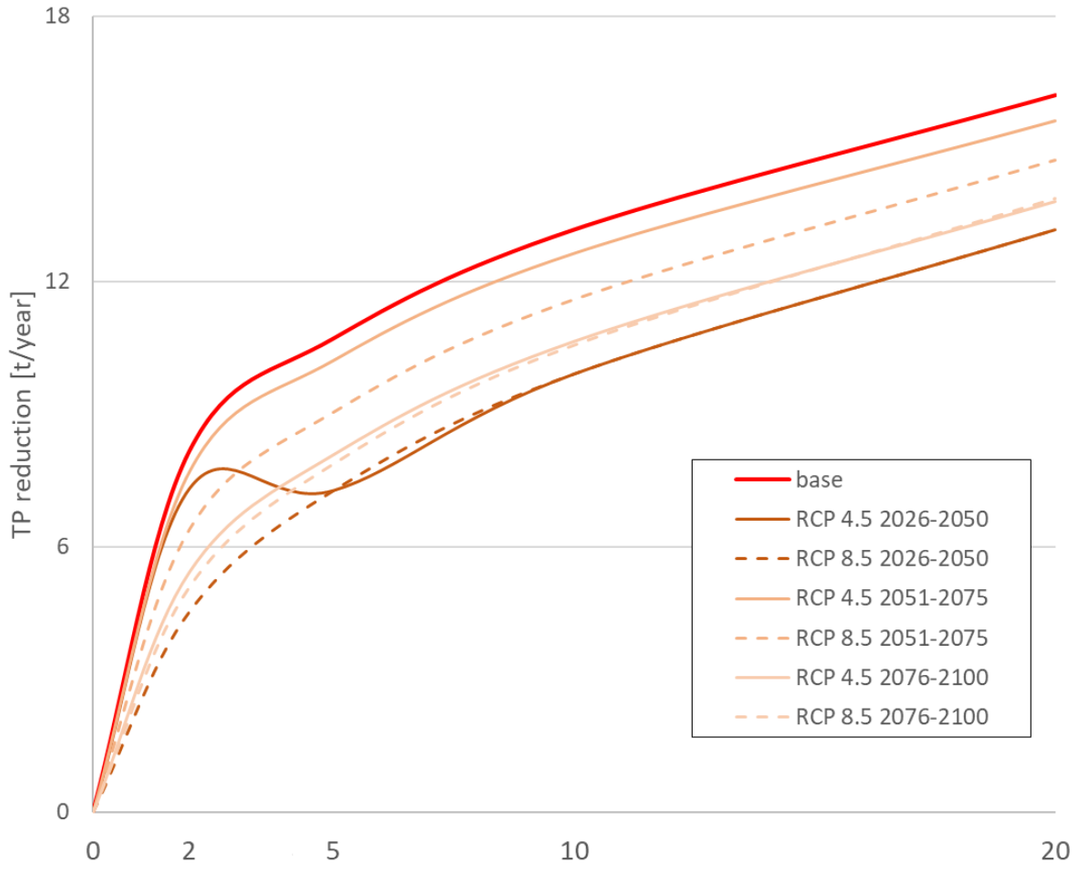
TN: 118 €/t/r
TP: 2 496 €/t/r

TN: 191 €/t/r
TP: 4 060 €/t/r

TN: 309 €/t/r
TP: 6 602 €/t/r

Effectiveness of buffer zones





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