BlueAdapt

National-scale nutrient loading under climate change and agricultural mitigation measure scenarios

5.10.2023 Final Seminar

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Syke

Introduction

- National scale WSFS-Vemala model
- SSP&CC Scenarios for nutrient loading
  - Loading to inland water bodies and coastal waters
  - Comparision to N and P limits for good ecological state
  - Input for coastal and ecological models
  - To support sustainable placement of new activities

VEMALA scenario modelling in BlueAdapt

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MOHC-HadGEM2-ES_SMHI RCP 2.6
MOHC-HadGEM2-ES_SMHI RCP 4.5
MOHC-HadGEM2-ES_SMHI RCP 8.5
MPI-M-MPI-ESM-LR_SMHI RCP 2.6
MPI-M-MPI-ESM-LR_SMHI RCP 4.5
MPI-M-MPI-ESM-LR_SMHI RCP 8.5

Base line
SSP1
SSP2
SSP3
SSP5

VEMALA hydrology

Agricultural optimization model

30 scenarios

Input: Water balance

Input: Fertilizer, Yield

Icecream field 1
Icecream field 2
Icecream field 3
Icecream field 4
Icecream field 5
Icecream field 6
Icecream field 7
Icecream field …
Icecream field 1XXX

Agric P, N

VEMALA catchment model

Agricultural load
Forested areas
Point load
Scattered settlements

P, N load

VEMALA river and lake model

P, N concentrations

HRMS and coastal models

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SCENARIO MEASURES:

- SSP5 Current measures
  - Agriculture will continue as it is at present and other sources of pollution will continue at current levels.
- SSP2b Agricultural measures
  - gypsum treatment, refined fertilization and a maximum amount of winter vegetation cover, collector crop, structural lime/fiber treatment and sludge placement
- SSP2 Planned river basin management measures
  - In agriculture the planned number of measures will be introduced and the load from other sources will be reduced by the estimated impact of the planned measures
- SSP1 Plant-based diet

CLIMATE SCENARIOS:

- RefClimate: reference climate from years 1986-2015, no climate change
- RCP2.6A: low climate change scenario (MOHC-HadGEM2-ES)
- RCP4.5A: average climate change scenario (MOHC-HadGEM2-ES)
- RCP8.5A: strong climate change scenario (MOHC-HadGEM2-ES)
- RCP2.6B: low climate change scenario (MPI-M-MPI-ESM-LR)
- RCP4.5B: average climate change scenario (MPI-M-MPI-ESM-LR)
- RCP8.5B: strong climate change scenario (MPI-M-MPI-ESM-LR)

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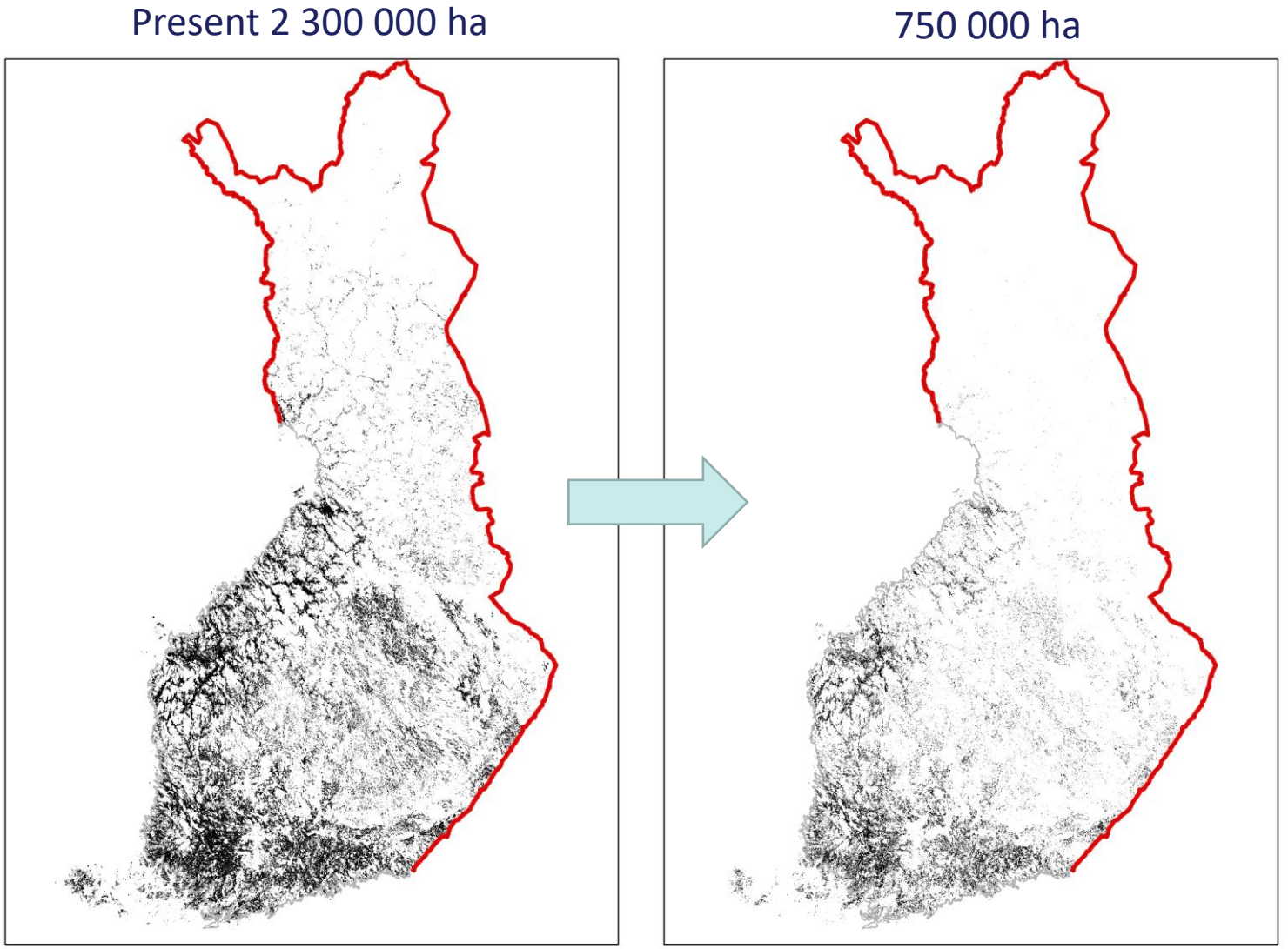
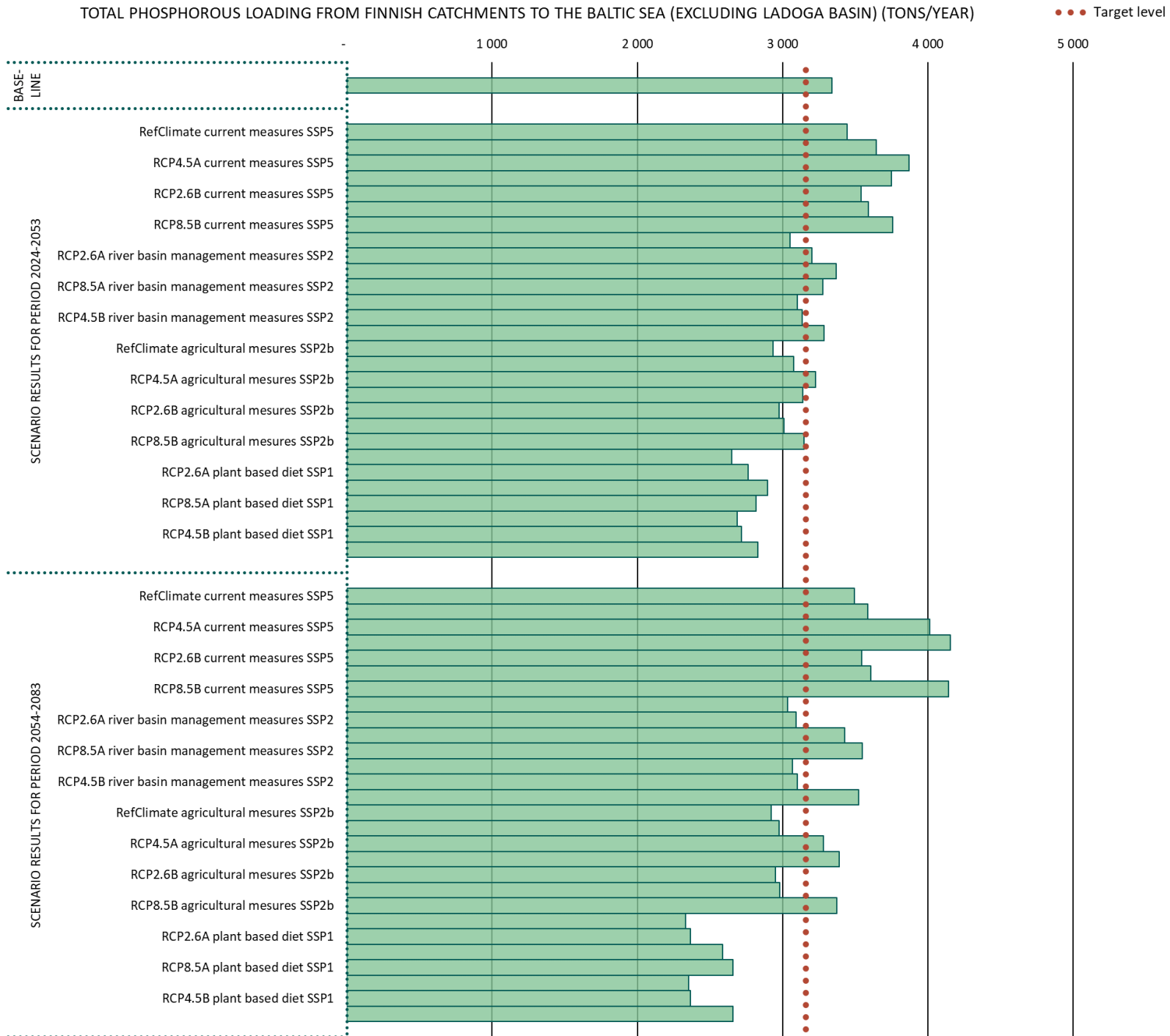
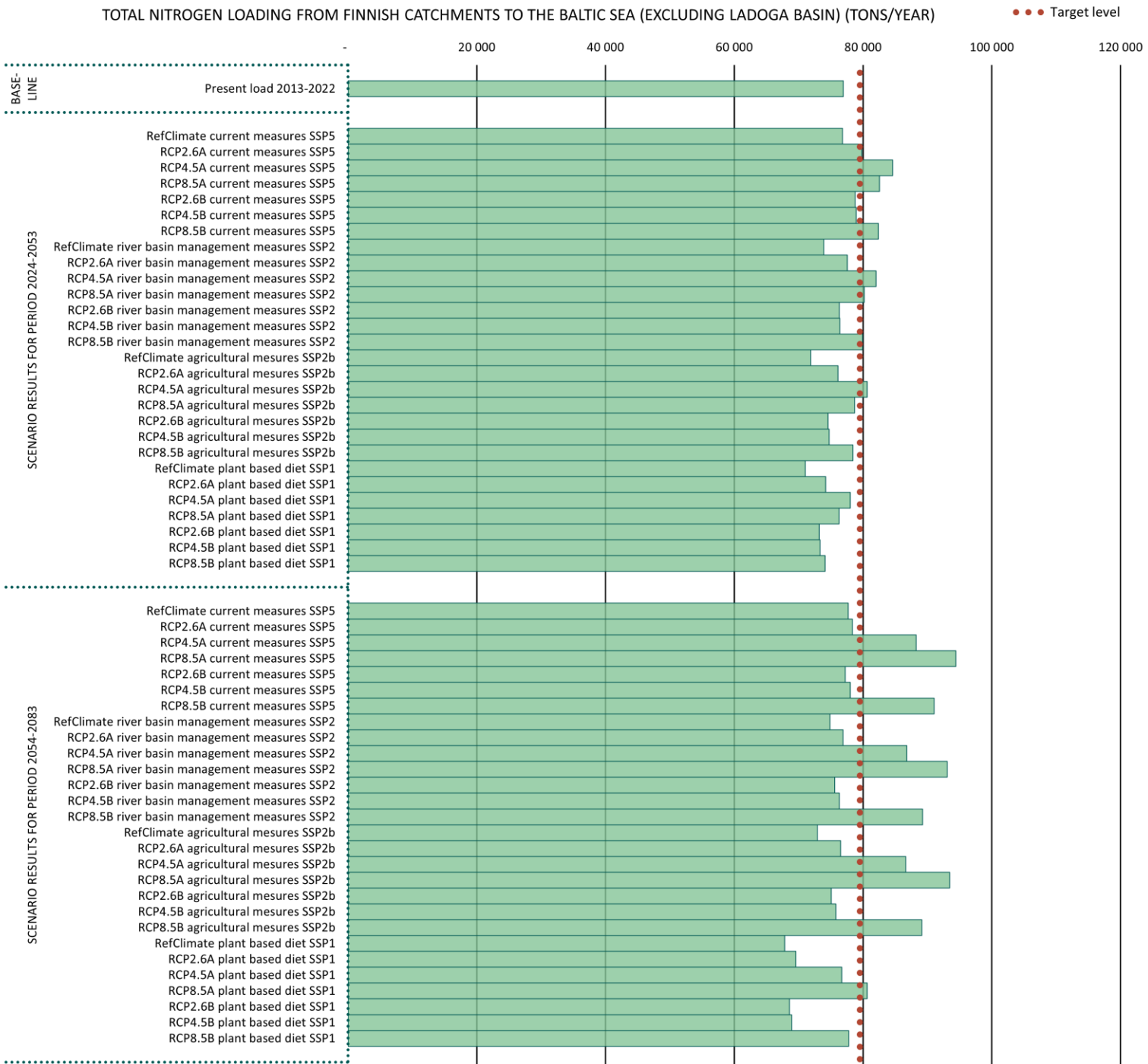
Plant based diet effect in nutrient loading

- 750 000 ha most fertile fields
- Mostly in South, South-Western and Western Finland




TOTAL PHOSPHOROUS LOADING FROM FINNISH CATCHMENTS TO THE BALTIC SEA (EXCLUDING LADOGA BASIN) (TONS/YEAR)
Target level
-
1 000
2 000
3 000
4 000
5 000
BASE-LINE
SCENARIO RESULTS FOR PERIOD 2024-2053
RefClimate current measures SSP5
RCP4.5A current measures SSP5
RCP2.6B current measures SSP5
RCP8.5B current measures SSP5
RCP2.6A river basin management measures SSP2
RCP8.5A river basin management measures SSP2
RCP4.5B river basin management measures SSP2
RefClimate agricultural mesures SSP2b
RCP4.5A agricultural mesures SSP2b
RCP2.6B agricultural mesures SSP2b
RCP8.5B agricultural mesures SSP2b
RCP2.6A plant based diet SSP1
RCP8.5A plant based diet SSP1
RCP4.5B plant based diet SSP1
SCENARIO RESULTS FOR PERIOD 2054-2083
RefClimate current measures SSP5
RCP4.5A current measures SSP5
RCP2.6B current measures SSP5
RCP8.5B current measures SSP5
RCP2.6A river basin management measures SSP2
RCP8.5A river basin management measures SSP2
RCP4.5B river basin management measures SSP2
RefClimate agricultural mesures SSP2b
RCP4.5A agricultural mesures SSP2b
RCP2.6B agricultural mesures SSP2b
RCP8.5B agricultural mesures SSP2b
RCP2.6A plant based diet SSP1
RCP8.5A plant based diet SSP1
RCP4.5B plant based diet SSP1


TOTAL NITROGEN LOADING FROM FINNISH CATCHMENTS TO THE BALTIC SEA (EXCLUDING LADOGA BASIN) (TONS/YEAR)
Target level
-
20 000
40 000
60 000
80 000
100 000
120 000
BASE-LINE
Present load 2013-2022
SCENARIO RESULTS FOR PERIOD 2024-2053
RefClimate current measures SSP5
RCP2.6A current measures SSP5
RCP4.5A current measures SSP5
RCP8.5A current measures SSP5
RCP2.6B current measures SSP5
RCP4.5B current measures SSP5
RCP8.5B current measures SSP5
RefClimate river basin management measures SSP2
RCP2.6A river basin management measures SSP2
RCP4.5A river basin management measures SSP2
RCP8.5A river basin management measures SSP2
RCP2.6B river basin management measures SSP2
RCP4.5B river basin management measures SSP2
RCP8.5B river basin management measures SSP2
RefClimate agricultural mesures SSP2b
RCP2.6A agricultural mesures SSP2b
RCP4.5A agricultural mesures SSP2b
RCP8.5A agricultural mesures SSP2b
RCP2.6B agricultural mesures SSP2b
RCP4.5B agricultural mesures SSP2b
RCP8.5B agricultural mesures SSP2b
RefClimate plant based diet SSP1
RCP2.6A plant based diet SSP1
RCP4.5A plant based diet SSP1
RCP8.5A plant based diet SSP1
RCP2.6B plant based diet SSP1
RCP4.5B plant based diet SSP1
RCP8.5B plant based diet SSP1
SCENARIO RESULTS FOR PERIOD 2054-2083
RefClimate current measures SSP5
RCP2.6A current measures SSP5
RCP4.5A current measures SSP5
RCP8.5A current measures SSP5
RCP2.6B current measures SSP5
RCP4.5B current measures SSP5
RCP8.5B current measures SSP5
RefClimate river basin management measures SSP2
RCP2.6A river basin management measures SSP2
RCP4.5A river basin management measures SSP2
RCP8.5A river basin management measures SSP2
RCP2.6B river basin management measures SSP2
RCP4.5B river basin management measures SSP2
RCP8.5B river basin management measures SSP2
RefClimate agricultural mesures SSP2b
RCP2.6A agricultural mesures SSP2b
RCP4.5A agricultural mesures SSP2b
RCP8.5A agricultural mesures SSP2b
RCP2.6B agricultural mesures SSP2b
RCP4.5B agricultural mesures SSP2b
RCP8.5B agricultural mesures SSP2b
RefClimate plant based diet SSP1
RCP2.6A plant based diet SSP1
RCP4.5A plant based diet SSP1
RCP8.5A plant based diet SSP1
RCP2.6B plant based diet SSP1
RCP4.5B plant based diet SSP1
RCP8.5B plant based diet SSP1

Needed reduction in loading from human sources (percent)

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Phosphorus	2013-2022	RefClimate current measures SSP5	RCP2.6A current measures SSP5	RCP4.5A current measures SSP5	RCP8.5A current measures SSP5	RCP2.6B current measures SSP5	RCP4.5B current measures SSP5	RCP8.5B current measures SSP5	RefClimate river basin management measures SSP2	RCP2.6A river basin management measures SSP2	RCP4.5A river basin management measures SSP2	RCP8.5A river basin management measures SSP2	RCP2.6B river basin management measures SSP2	RCP4.5B river basin management measures SSP2	RCP8.5B river basin management measures SSP2	RefClimate agricultural mesures SSP2b	RCP2.6A agricultural mesures SSP2b	RCP4.5A agricultural mesures SSP2b	RCP8.5A agricultural mesures SSP2b	RCP2.6B agricultural mesures SSP2b	RCP4.5B agricultural mesures SSP2b	RCP8.5B agricultural mesures SSP2b	RefClimate plant based diet SSP1	RCP2.6A plant based diet SSP1	RCP4.5A plant based diet SSP1	RCP8.5A plant based diet SSP1	RCP2.6B plant based diet SSP1	RCP4.5B plant based diet SSP1	RCP8.5B plant based diet SSP1
Suomenlahti	11	15	16	26	23	20	24	25	0	0	4	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Saaristomeri	2	14	24	33	29	20	23	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Selkämeri	0	9	21	28	24	16	18	24	0	2	8	5	0	0	5	0	0	2	0	0	0	0	0	0	0	0	0	0	0
Merenkurkku	7	11	25	25	23	10	13	21	7	21	21	19	5	9	17	0	11	11	9	0	0	7	0	0	0	0	0	0	0
Perämeri	12	10	14	19	16	10	8	17	5	9	15	11	5	3	12	0	4	9	5	0	0	6	0	0	0	0	0	0	0

Nitrogen	2013-2022	RefClimate current measures SSP5	RCP2.6A current measures SSP5	RCP4.5A current measures SSP5	RCP8.5A current measures SSP5	RCP2.6B current measures SSP5	RCP4.5B current measures SSP5	RCP8.5B current measures SSP5	RefClimate river basin management measures SSP2	RCP2.6A river basin management measures SSP2	RCP4.5A river basin management measures SSP2	RCP8.5A river basin management measures SSP2	RCP2.6B river basin management measures SSP2	RCP4.5B river basin management measures SSP2	RCP8.5B river basin management measures SSP2	RefClimate agricultural mesures SSP2b	RCP2.6A agricultural mesures SSP2b	RCP4.5A agricultural mesures SSP2b	RCP8.5A agricultural mesures SSP2b	RCP2.6B agricultural mesures SSP2b	RCP4.5B agricultural mesures SSP2b	RCP8.5B agricultural mesures SSP2b	RefClimate plant based diet SSP1	RCP2.6A plant based diet SSP1	RCP4.5A plant based diet SSP1	RCP8.5A plant based diet SSP1	RCP2.6B plant based diet SSP1	RCP4.5B plant based diet SSP1	RCP8.5B plant based diet SSP1
Suomenlahti	4	2	5	17	13	8	12	14	0	0	12	9	3	6	10	0	0	10	6	0	4	8	0	0	6	3	0	2	2
Saaristomeri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Selkämeri	1	3	10	18	16	7	8	14	0	4	14	11	1	2	9	0	0	10	6	0	0	4	0	0	7	4	0	0	0
Merenkurkku	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Perämeri	0	0	0	7	2	0	0	3	0	0	4	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0

Areal need to reduce loading from human sources

Target levels for sea basins and inland water bodies

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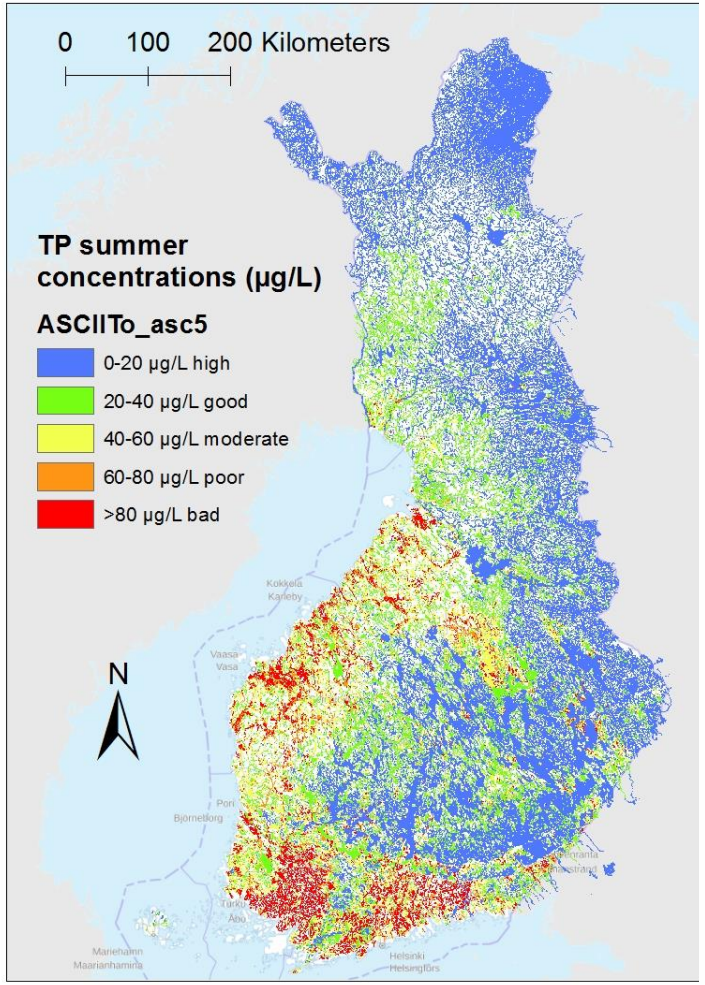
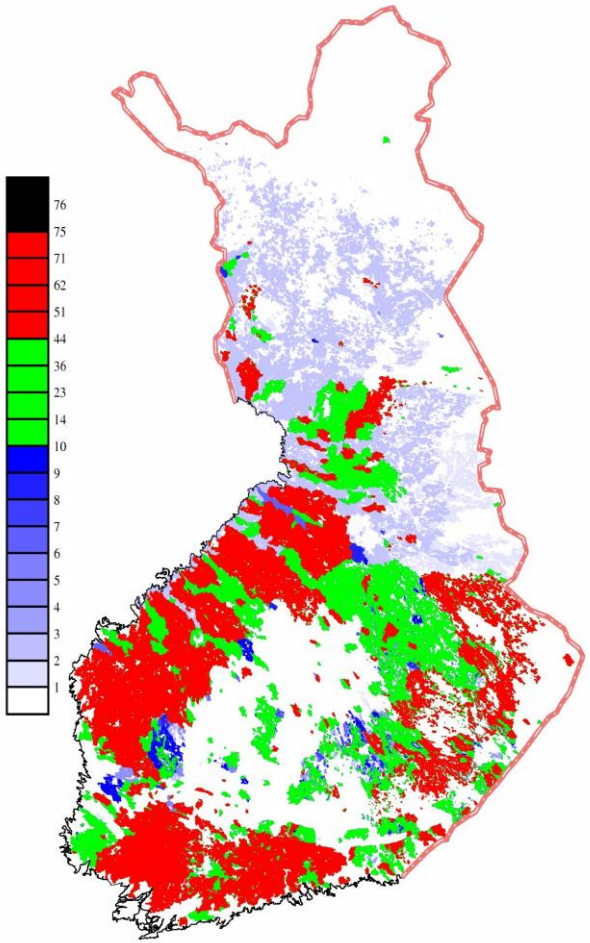
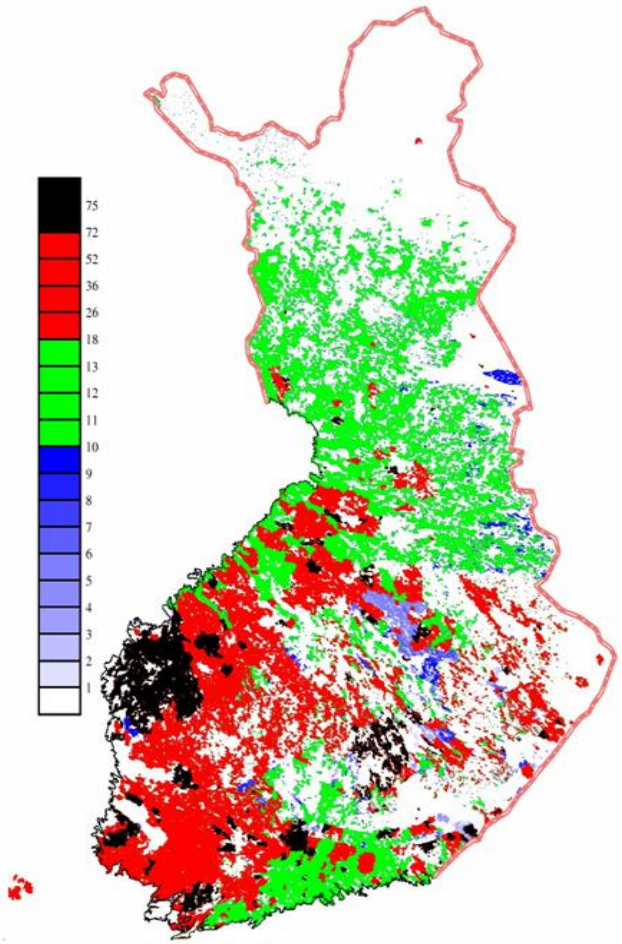




Fosfori kuormitusvähennystarve
prosenttia ihmisperäisestä kuormituksesta



Typpi kuormitusvähennystarve
prosenttia ihmisperäisestä kuormituksesta

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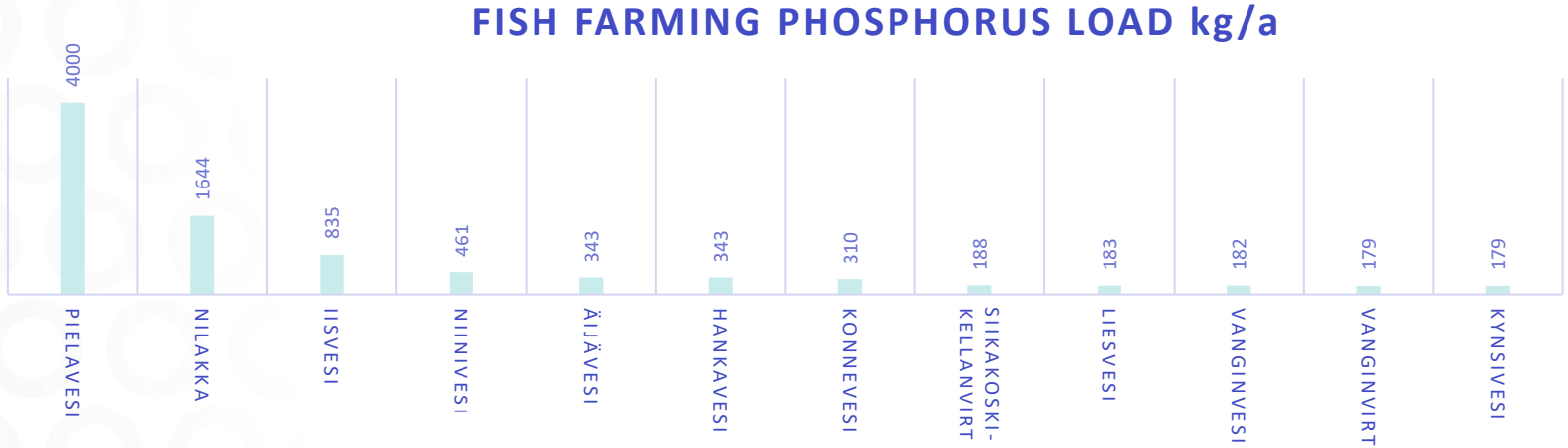
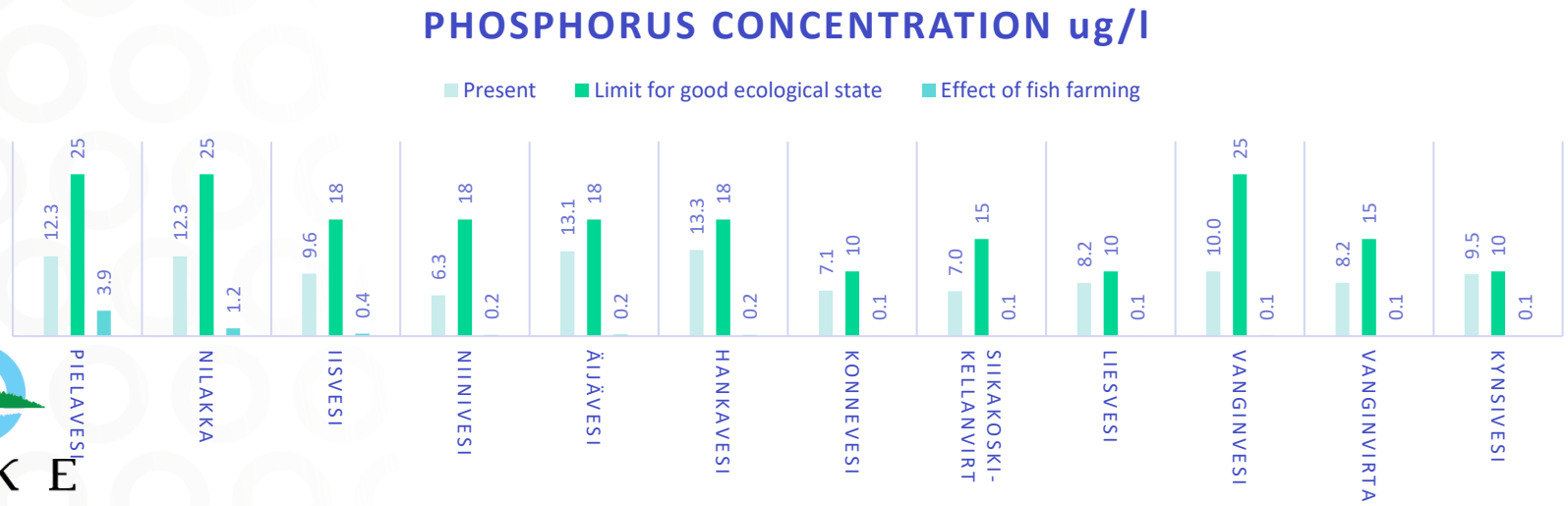
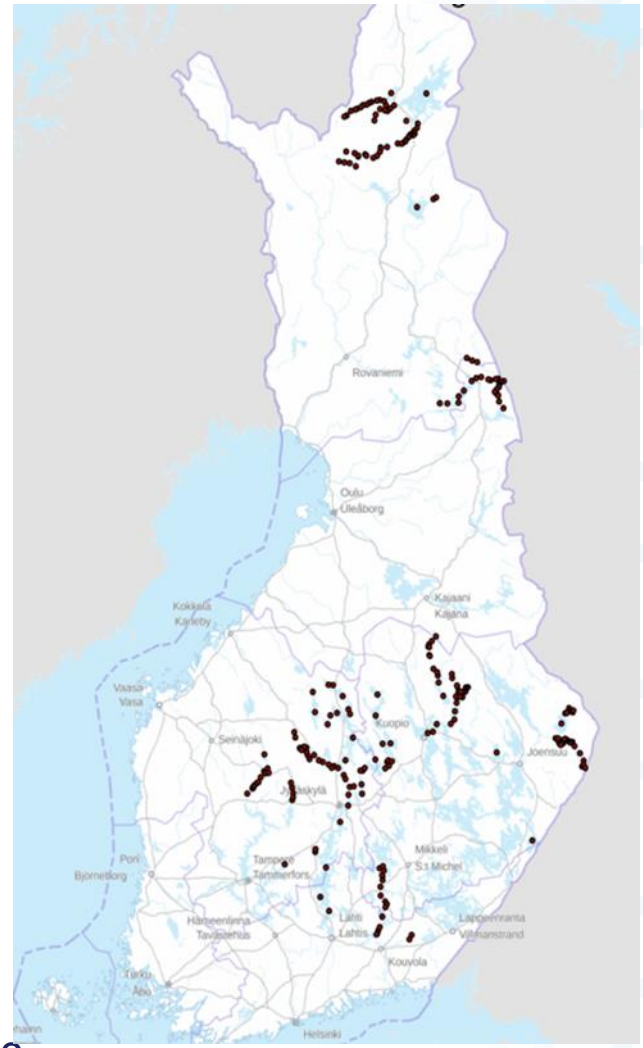
Estimating the effect of fish farming







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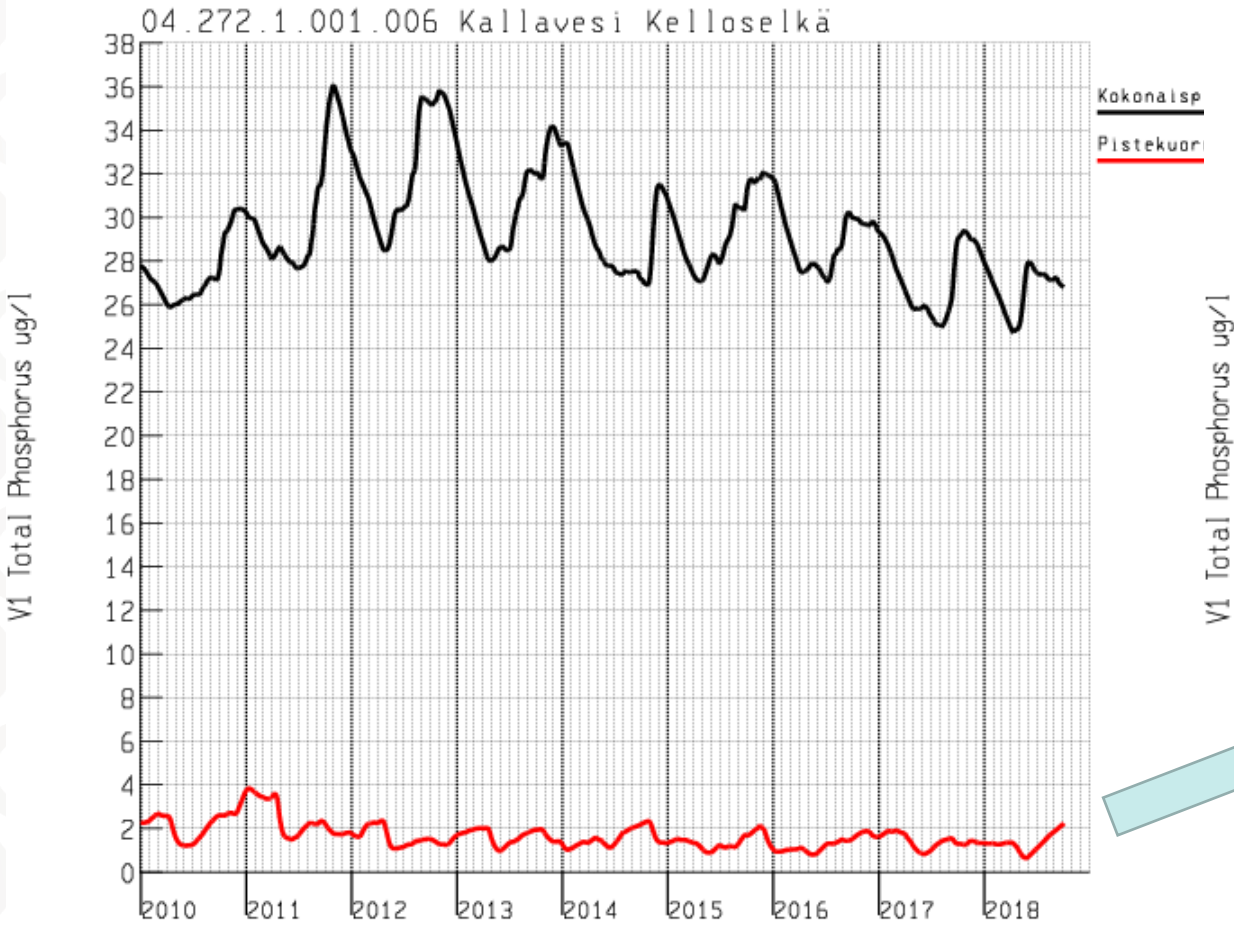
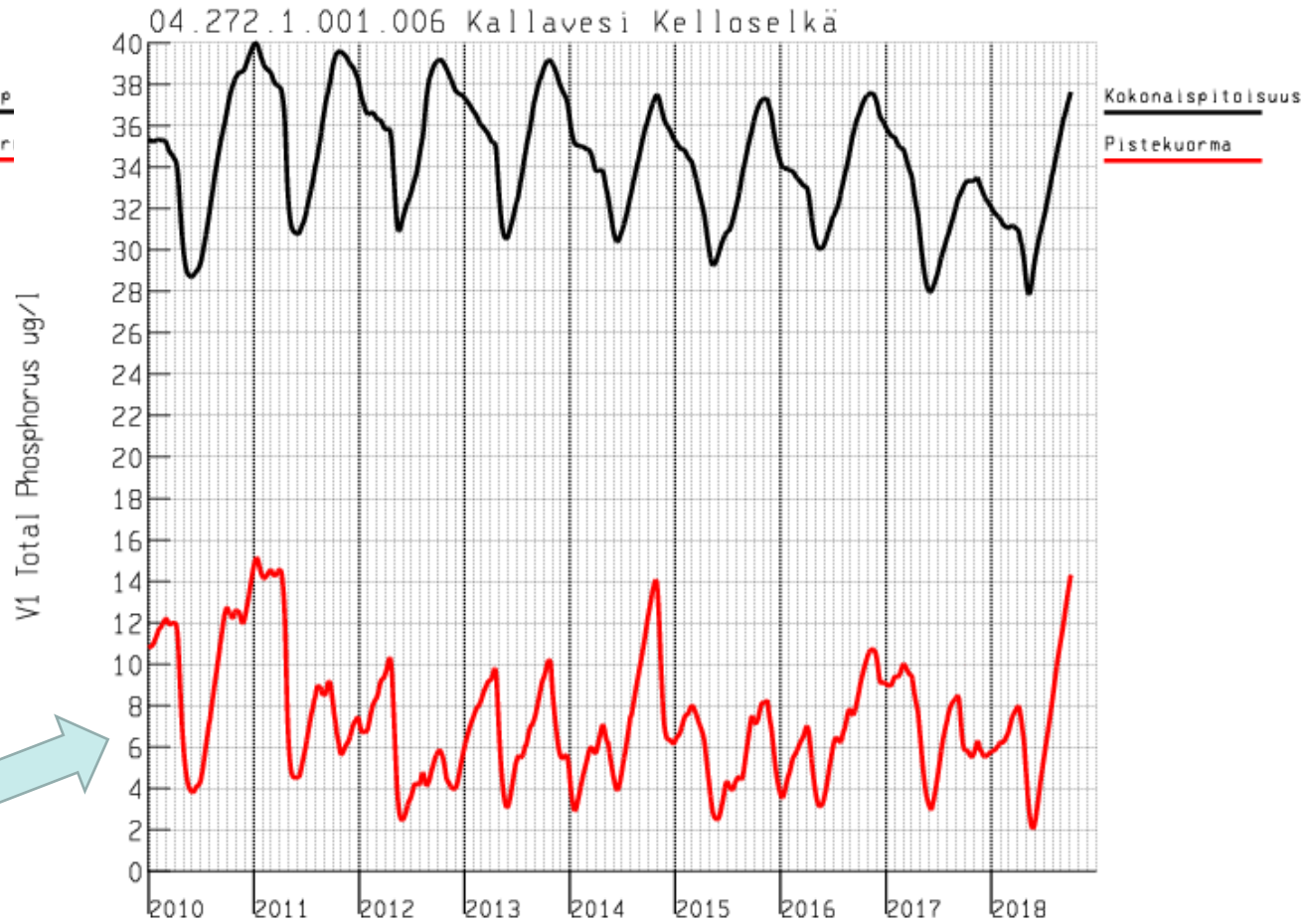
Plan for a bio product factory in Kuopio

WSFS-Vemala & LLR modelling





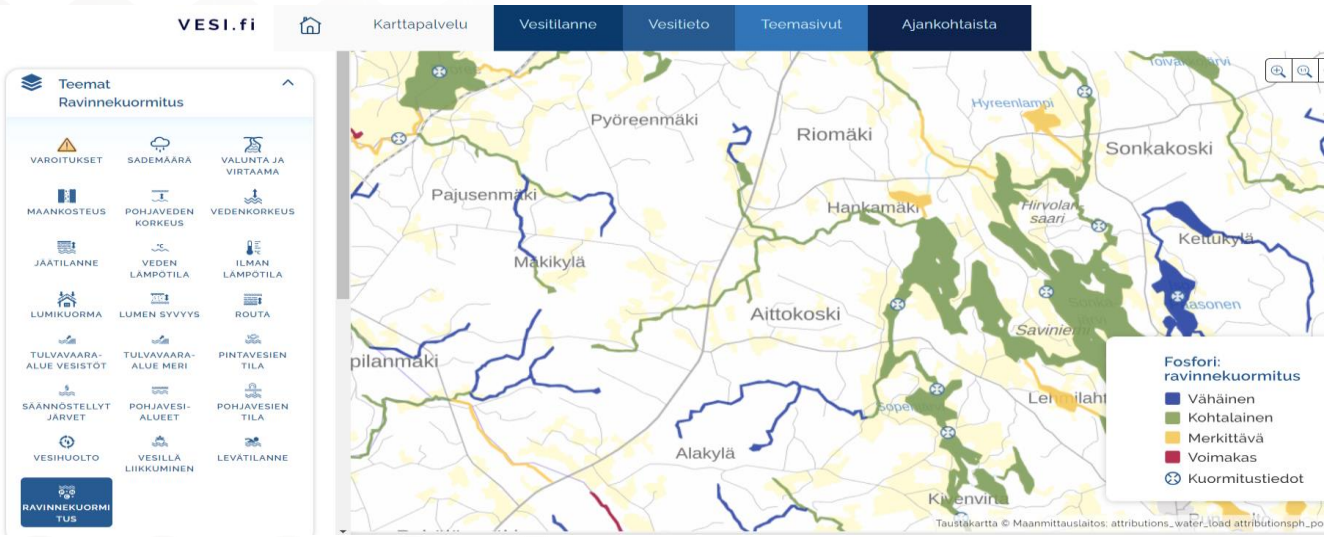
Dissemination

BlueAdapt

Science of The Total Environment
Volume 783, 20 August 2021, 146871

Agricultural nutrient loading under alternative climate, societal and manure recycling scenarios

Inese Huttunen [a], Kari Hyytiäinen [b], Markus Huttunen [a], Matti Sihvonen [b], Noora Veijalainen [a], Marie Korppoo [a], Anna-Stiina Heiskanen [a]



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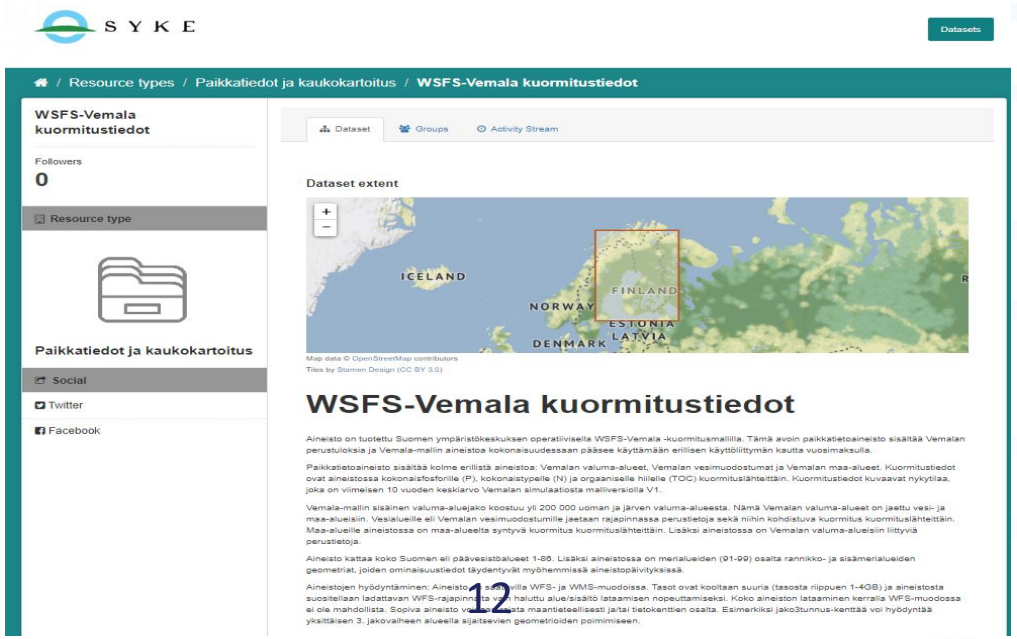
https://doi.org/10.23986/afsci.125385

National-scale nitrogen loading from the Finnish agricultural fields has decreased since the 1990s

Inese Huttunen[1], Markus Huttunen[1], Tapio Salo[2], Pasi Mattila[2], Liisa Maanavilja[2,3] and Tarja Silfver[4]

https://ckan.ymparisto.fi/en/dataset/wsfs-vemala-kuormitustiedot



Next steps

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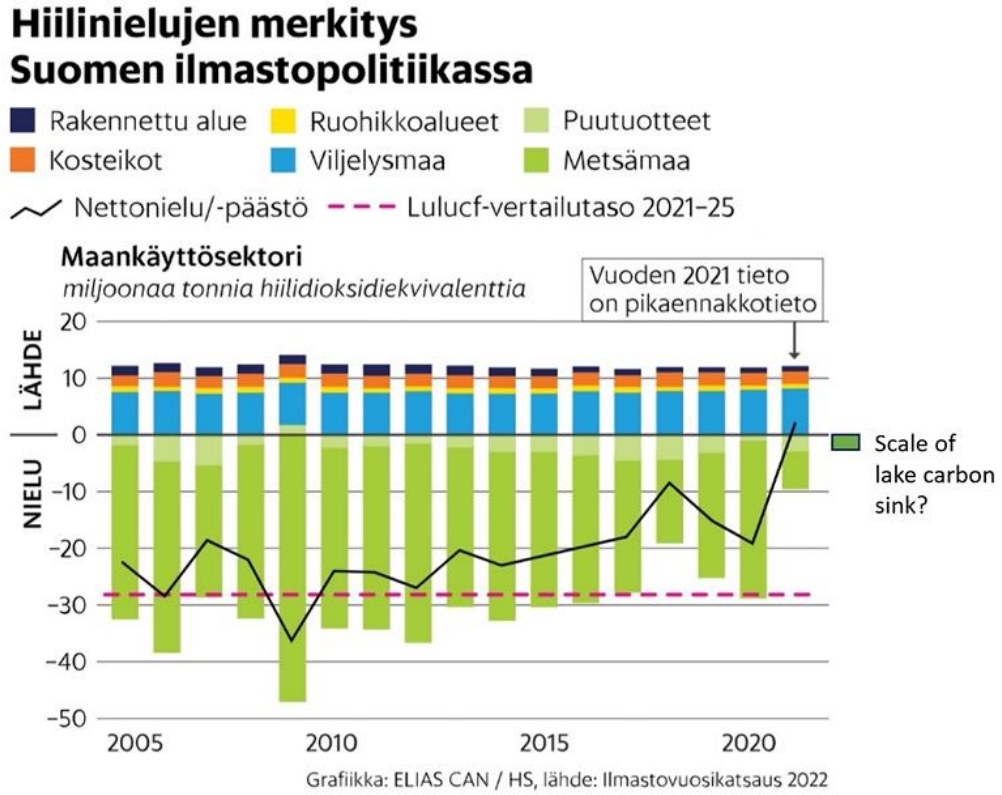
- Carbon
  - Loading from catchment, lake carbon sink and release to the atmosphere
  - Co-effect of SSP and CC scenarios
  - Effect of human actions on carbon sink in lakes?
  - BlueLakes project
- Latest AR6 climate input
  - Extremes
  - Dry periods



SYKE

Conclusions

- National scale WSFS-Vemala nutrient loading model
  - SSP & CC scenarios
  - Input for coastal and ecological models
- To support:
  - Understanding the current state of waters and sources of nutrient loading
  - Finding means to reach, in the changing climate, nutrinet loading level that is within the limits for good ecological state in the waters
  - Sustainable placement of new activities
- Effect of CC and human actions on carbon loading and carbon sink in lakes is to be included

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