Regional greenhouse gas (GHG) budget of Kokemäenjoki river basin, SW Finland

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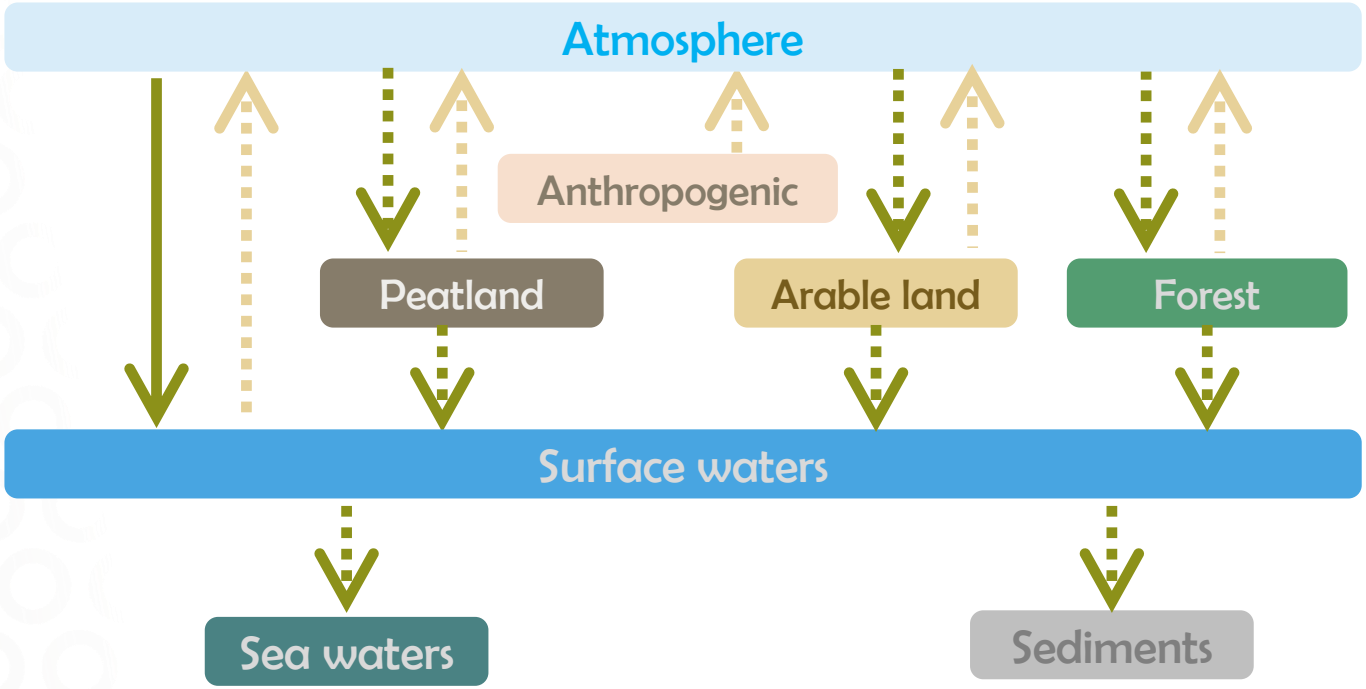
Background

- All land use sectors contribute to overall GHG balance
- Few studies include both aquatic and terrestrial fluxes
- Net emissions of a region determined by sectors' areas
- Knowledge on individual fluxes by sector helps evaluate mitigation strategies and adaptation options

Greenhouse gas fluxes



GHG emissions and sinks by land use in Kokemäenjoki river basin - estimates of current fluxes. **Totals for the region.**

Land use sector	Area (km^2)	Area (%)	Emissions $TgCO_2eq.\ yr^{-1}$	Emiss. *wrt total* (%)	Sinks $TgCO_2eq.\ yr^{-1}$	Sinks *wrt total* (%)	Net emissions $TgCO_2eq.\ yr^{-1}$
Forests	17 782	66 %	7.8	50 %	-10.5	99.8 %	-2.7
Arable land	3 920	14 %	0.6	4 %	0	0	0.6
Lakes, rivers	3 031	11 %	1.1	7 %	-0.02	0.1 %	1.1
Artifical surfaces	1331	5 %	6.0	38 %	0	0	6
Undrained peatland	524	2 %	0.1	1 %	0	0	0.1
Other areas	538	2 %	NA		NA		NA
Total	**27 125**	**100 %**	**15.6**	**100 %**	**-10.5**	**100 %**	**-5.1**

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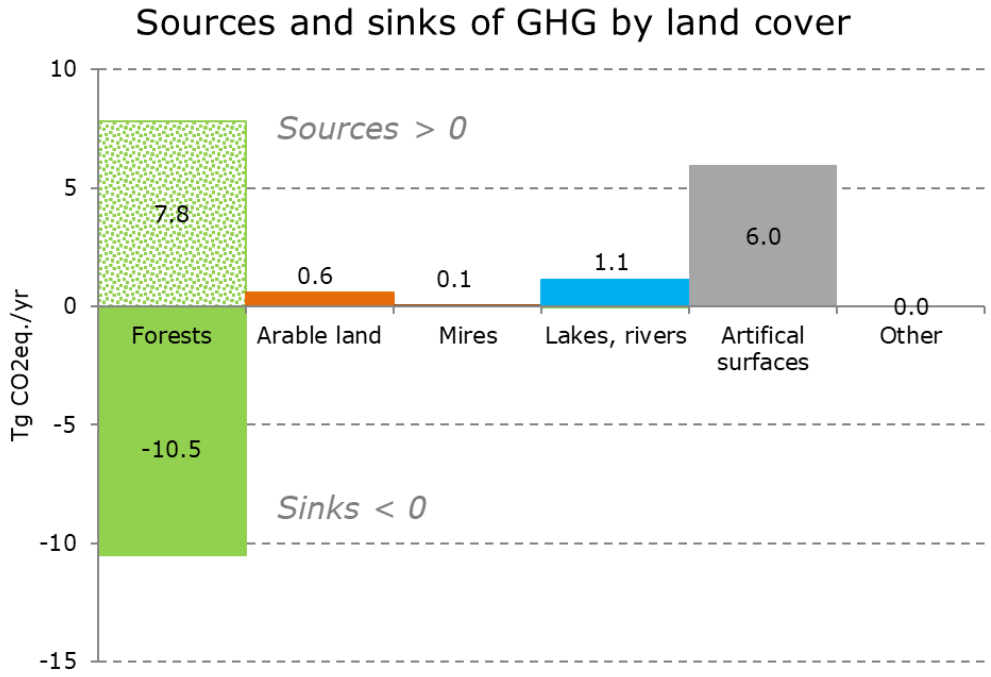
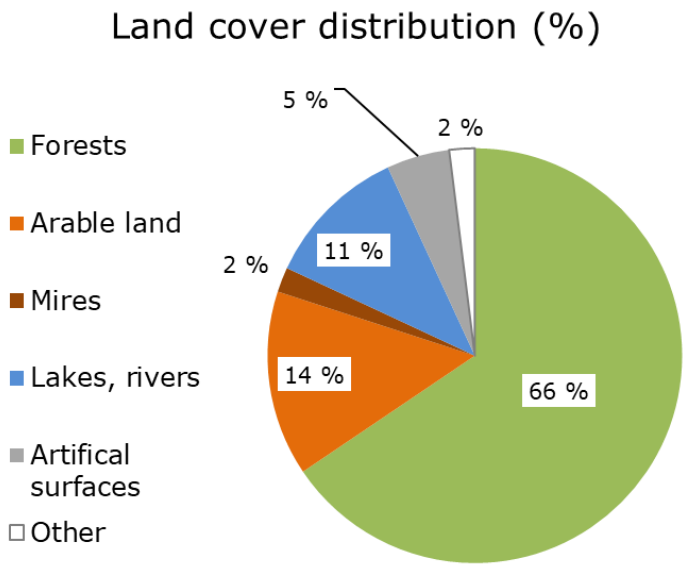
Net emissions of Kokemäenjoki river basin about 5 $TgCO_2eq./yr$





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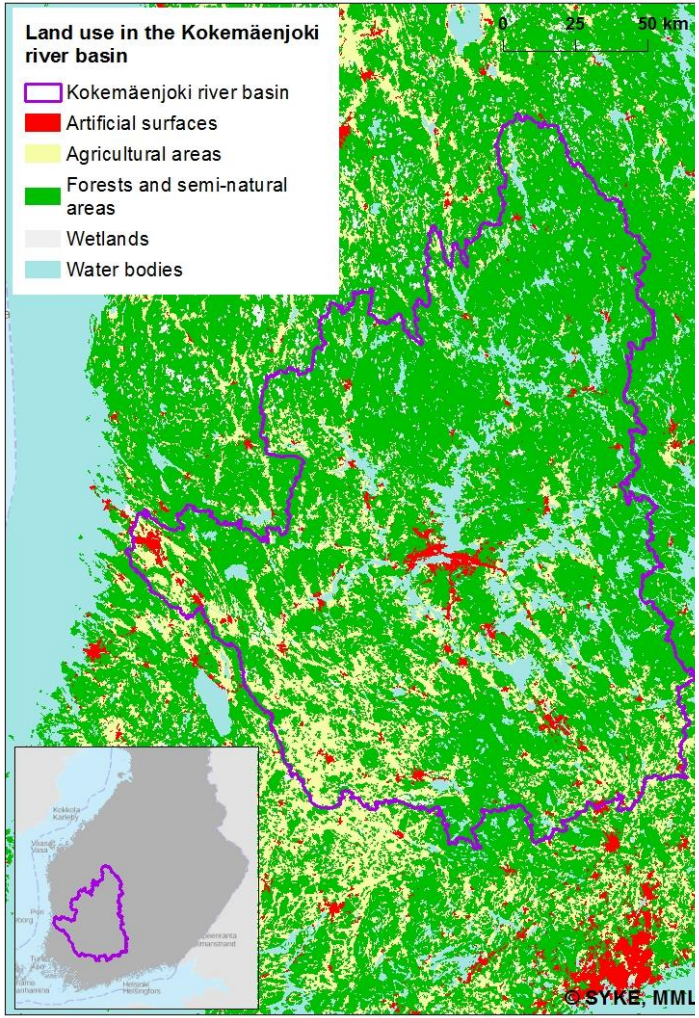
Land use in the river basin of Kokemäenjoki SW Finland

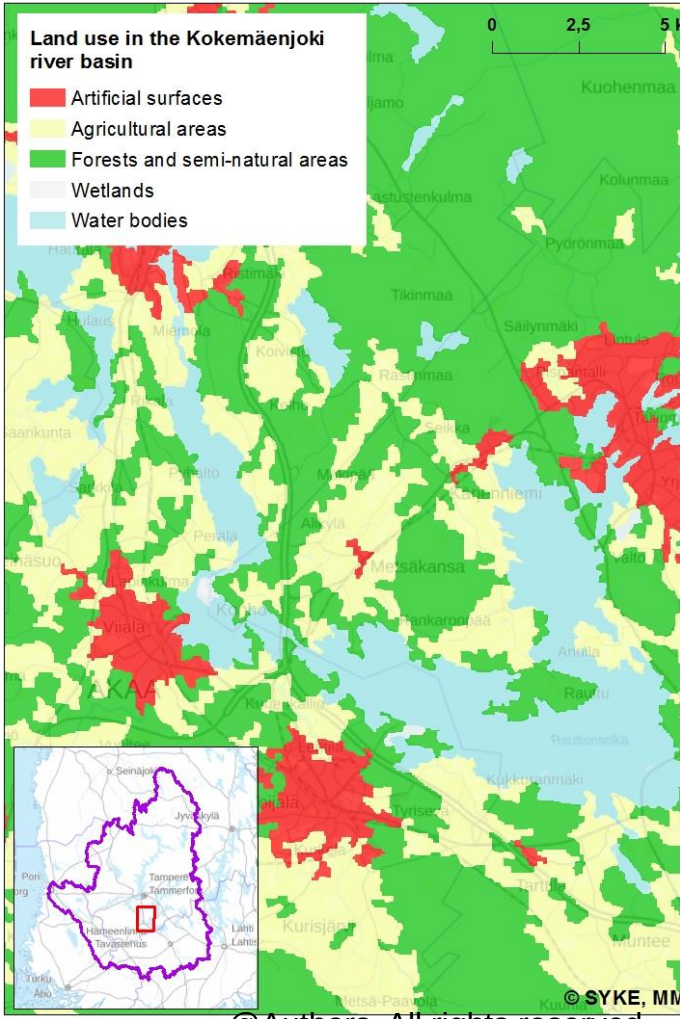
27 125 km^2
5th largest river basin
Surface water 11%

2 LTER sites:
Hyytiälä SMEAR II LTER – Finland

Lammi LTER – Finland

Corine landcover 2018 (EU 25ha)
SYKE, EEA, Copernicus





Estimated annual gas flux between atmosphere, land, and lake and river water surfaces

- Fluxes of carbon (C), methane (CH_4) and nitrous oxide (N_20) converted to carbon dioxide equivalents (CO_2 eq.) accounting for the global warming potential of each gas (28 for CH_4; 265 for N_20; 1 for CO_2).
- Estimated average gas balance in current climate, with current land use and current management.
- Overall estimate corresponds to area based emission calculation
- Mass balance not considered, meaning no explicit accounting of leaching of C or N from land to lakes, or of C and N stocks
- Annual leaching from the river basin to the sea 0.3 Tg CO_2eq. (Räike et al. 2016), about 2% of net emissions to the atmosphere(15 Tg CO_2eq. yr^{-1}).

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Estimation method depends on land use sector

- Dynamic model of tree growth and forest gas exchange
  - PREBAS with Yasso07: forest on mineral soil (CO_2)
  - *Minunno et al. 2016; Tuomi et al. 2009*
- Area based emission factors
  - Arable land, lakes and rivers, undrained mires, forest on peatland (CH_4, CO_2)
  - *Vanhala et al. 2016; National GHG accounting Statistics Finland 2019; Minkkinen & Ojanen 2013;*
- Regional model of anthropogenic emissions
  - FRES: emissions from combustion processes in industry, agriculture, traffic (excluding small scale wood combustion) CH_4, N_20, CO_2
  - Karvosenoja 2008; https://www.syke.fi/projects/fres

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Forest

PREBAS model

Minunno et al. 2016

LTER data used in model calibration

Site fertility
Tree species
Multisource NFI 16m

Current climate,
Standard management
2016 – 2018 simulations:

Harvested biomass
NEE

Net emissions =
NEE + harvested biomass

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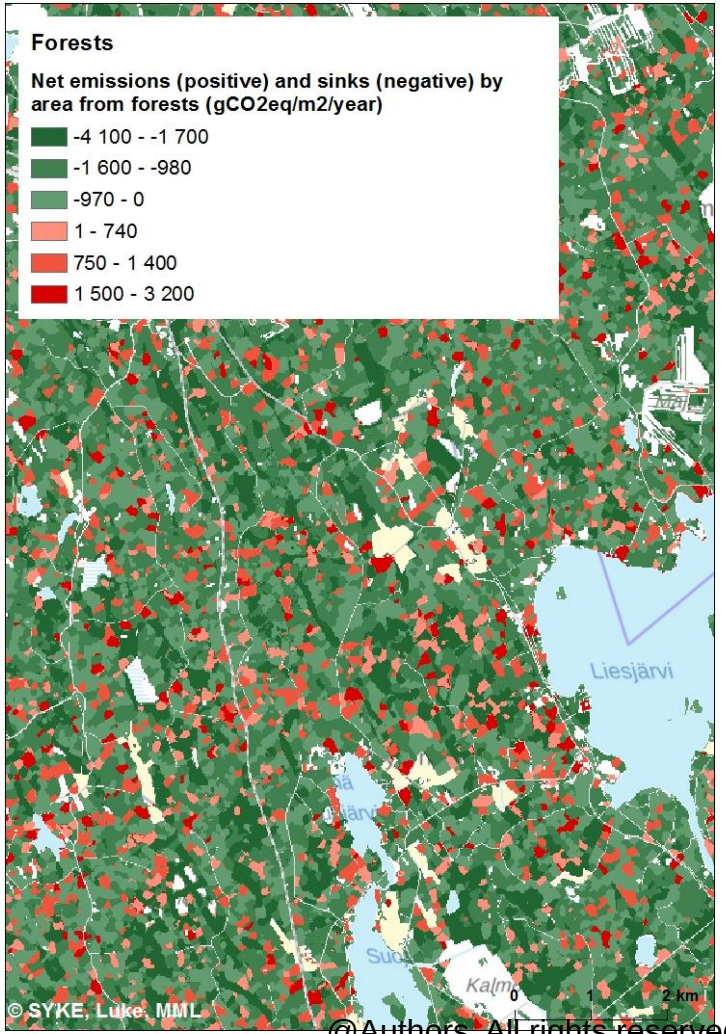
LUKE, NLS



Mires in natural state

- Classified into either minerotrophic or ombrotrophic

- Classification based on multisource national forest inventory data (MNFI) on site fertility class, site land class and site main class

- SYKE rasterdata on mire drainage status also used

- *Emission coefficients used:*
- *Minerotrophic: 224 $gCO_2eq\ m^{-2}\ yr^{-1}$*
- *Ombrotrophic: 136 $gCO_2eq\ m^{-2}\ yr^{-1}$*

Minkkinen and Ojanen 2013

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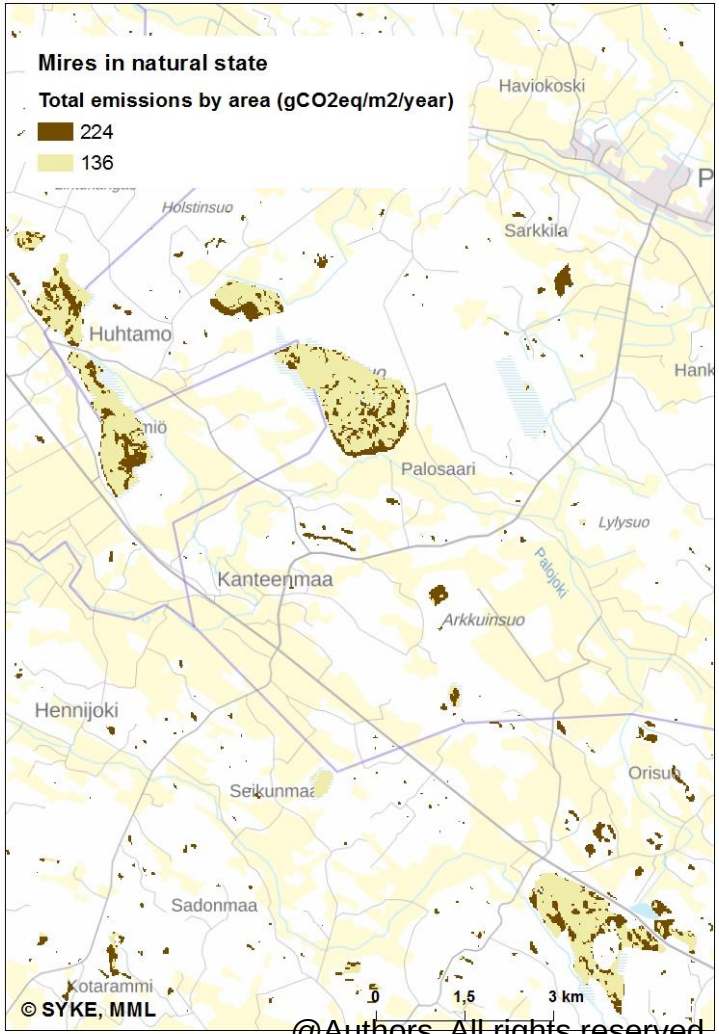


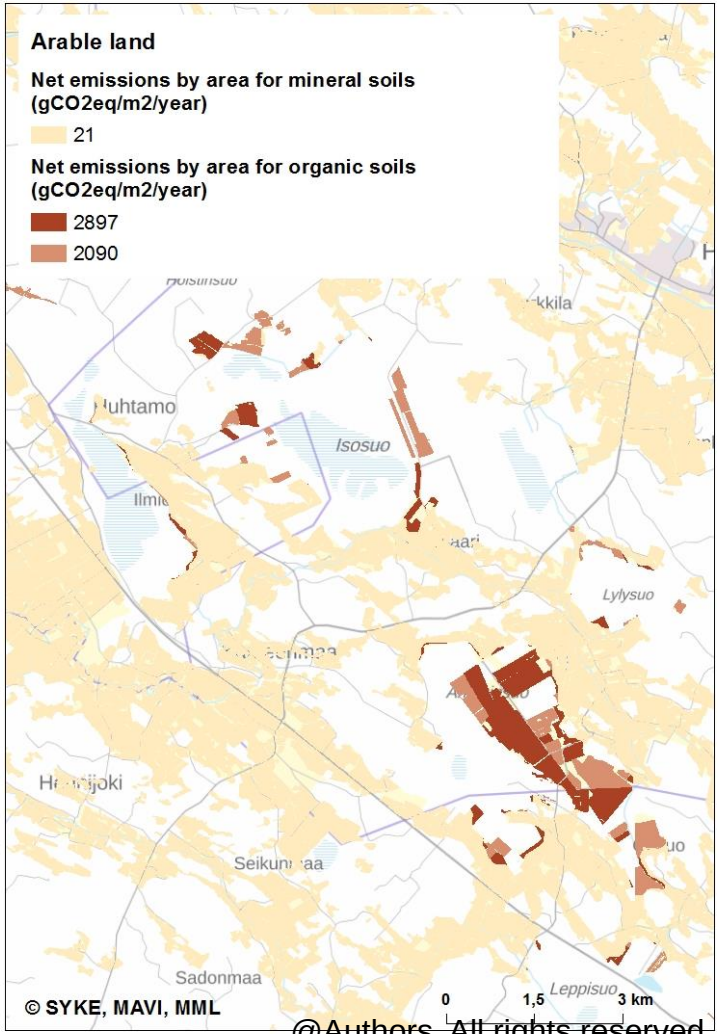
Arable land

- Soil map (Lilja et al. 2017)
- Field plot register

- For cropland on mineral soils, an area specific emission coefficient as the average for southern Finland for the years 2002 – 2017 (0.058 tC ha^{-1} yr^{-1}) based on values in Table 3_App_6j (Statistics Finland, 2019).

- For grassland and annual crops on organic soils, area specific emission coefficients of 5.7 and 7.9 tC ha^{-1} yr^{-1}, respectively, were used as estimates for Southern Finland (Statistics Finland, 2019).

SYKE, NLS, FFA, HU,LUKE



Artificial surfaces Anthropogenic Emissions

Finnish Regional Emission Scenario Model FRES

Karvosenoja 2008

https://www.syke.fi/projects/fres

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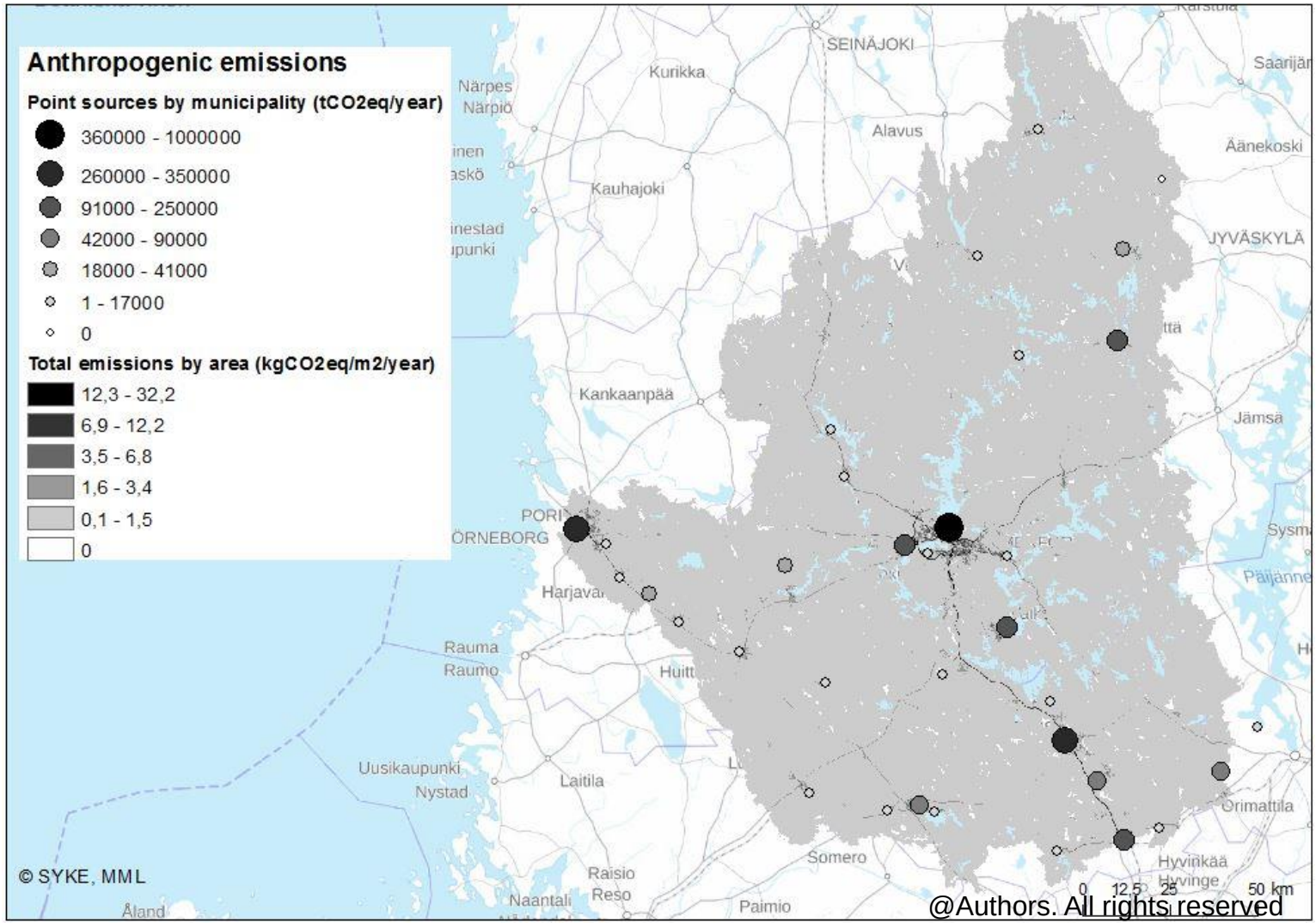

Lakes and rivers

5 lake size classes
CO_2 evasion
CO_2 accumulation
Kortelainen et al. 2006

CH_4 diffusion
CH_4 ebullition
Juutinen et al. 2009

Emergent macrophyte coverage;
CH_4 flux by species
Bergström et al. 2007
Juutinen et al. 2003

4 river size classes
CO_2 evasion
Humborg et al. 2010

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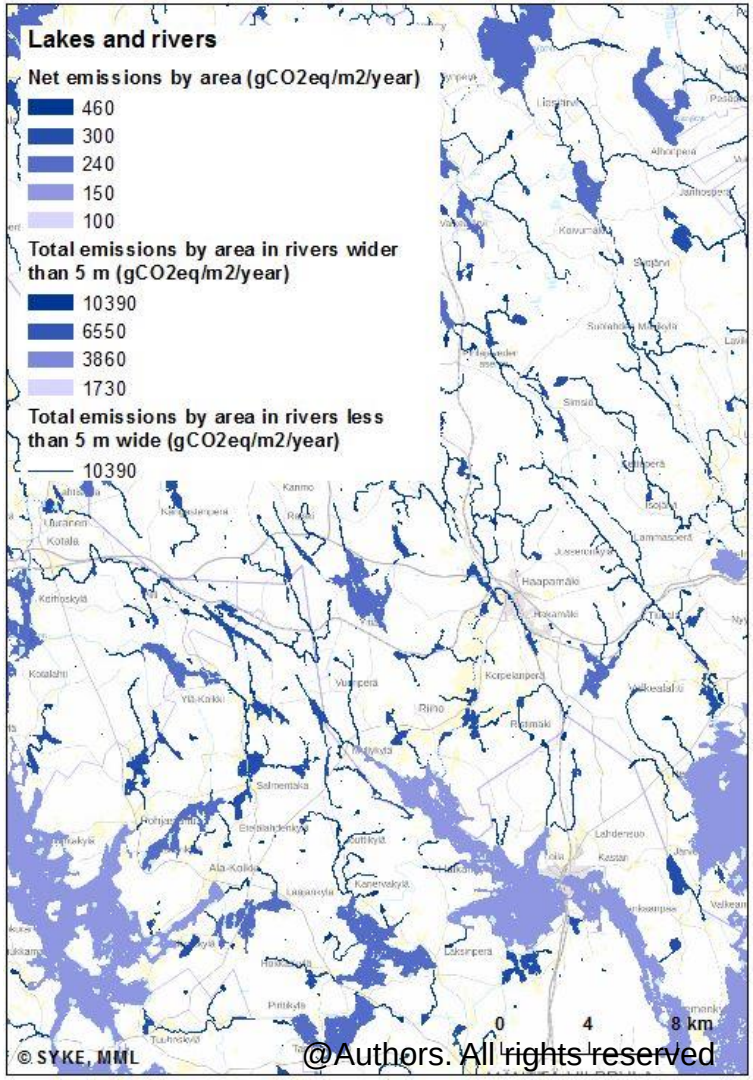

Regional greenhouse gas (GHG) budget of Kokemäenjoki river basin, SW Finland

- Considering the exchange with the atmosphere, the inland river basin's net emissions are 5 $TgCO_2eq/yr$
- Some leaching to the sea occurs 0.3 Tg $CO_2eq\ yr^{-1}$
- Forests occupy the largest area (66%), and contribute most to the total sinks (preliminary estimate 99%), and total sources (prel. est. 50%)
- Anthropogenic emissions (40% of total) represent only a small area (5%), making artificial surfaces the largest source by unit area

Future tasks

- Scenarios accounting for different management options
- Scenarios accounting for warming temperatures and changing precipitaiton patterns
- Study consequences of potential changes in land use
- Extending the area
- Publish summary as story map on the web
- Publish maps in map server

Collaboration and funding

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- eLTER H2020 GA 654359 https://www.lter-europe.net/elter
- IBC-Carbon SRC 2017/312559 http://www.ibccarbon.fi/fi-FI
- oGIIR http://ogiir.fi/
- Freshabit LIFE IP LIFE14/IPE/FI/023 http://www.metsa.fi/web/en/freshabit

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