Integrated assessment modelling of N: Experience in Finland

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Research Programme for Global Change

www.environment.fi/syke/gto

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SYKE

SYKE vs. CLRTAP

SYKE focal point for:

- TFIAM
- ICP Modelling and Mapping
- ICP Waters
- ICP Integrated Monitoring (also international Programme Centre)
- Emission inventories and reporting

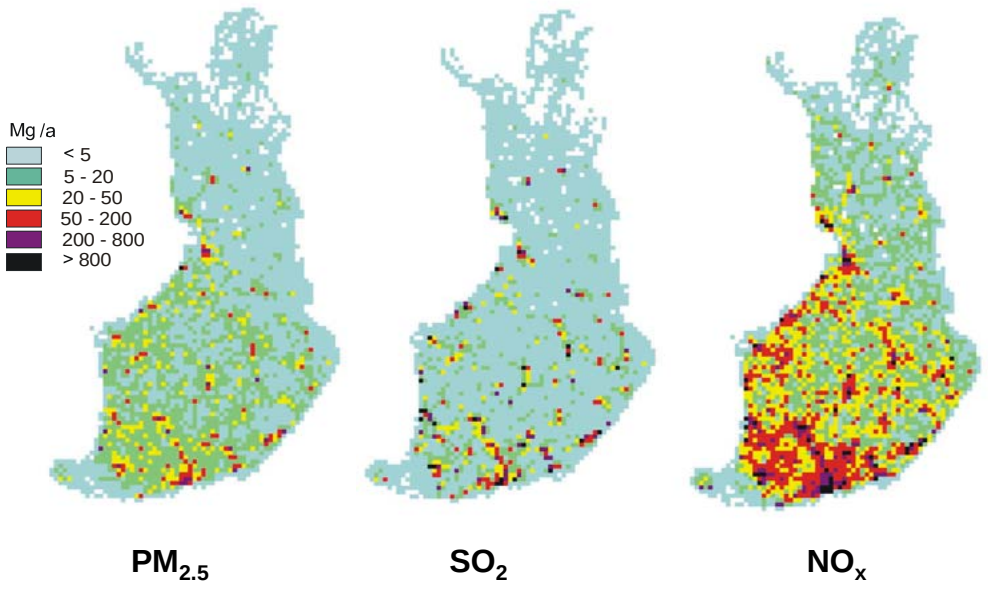
Main SYKE topics regarding N

- National Integrated Assessment model FRES
  - N, S, PM, emissions, scenarios and effects
  - Checking of RAINS data for Finland
- Calculation of critical loads for N
  - Mass balance and empirical CL
- EU/NitroEurope-project: SYKE contribution
  - YASSO modelling: C and N budgets for European forests
- N effects on ecosystems
  - INCA-N catchment modelling and scenario assessment (N-deposition, management, climate change)
  - N budgets and trends of catchments and lakes (WFD)
  - Biodiversity
  - Baltic Sea eutrophication
- LCA

Finnish Regional Emission Scenario (FRES) model

www.environment.fi/syke/pm-modeling

- Anthropogenic emissions 1990, 2000, 2010, 2020 (several activity scenarios)
- Comprehensive and congruent calculation for primary and secondary PM gases
  - •primary PM (TSP, PM10 - 2.5 - 1 - 0.1, chemical composition in size classes)
  - •SO_2, NO_x, NH_3, NMVOC
- Abatement technologies and costs
- Aggregation: 8 main sectors, over 100 sub sectors
- Large point sources (approx.250), area emissions ($1 \times 1km^2$)
- Several emission heights



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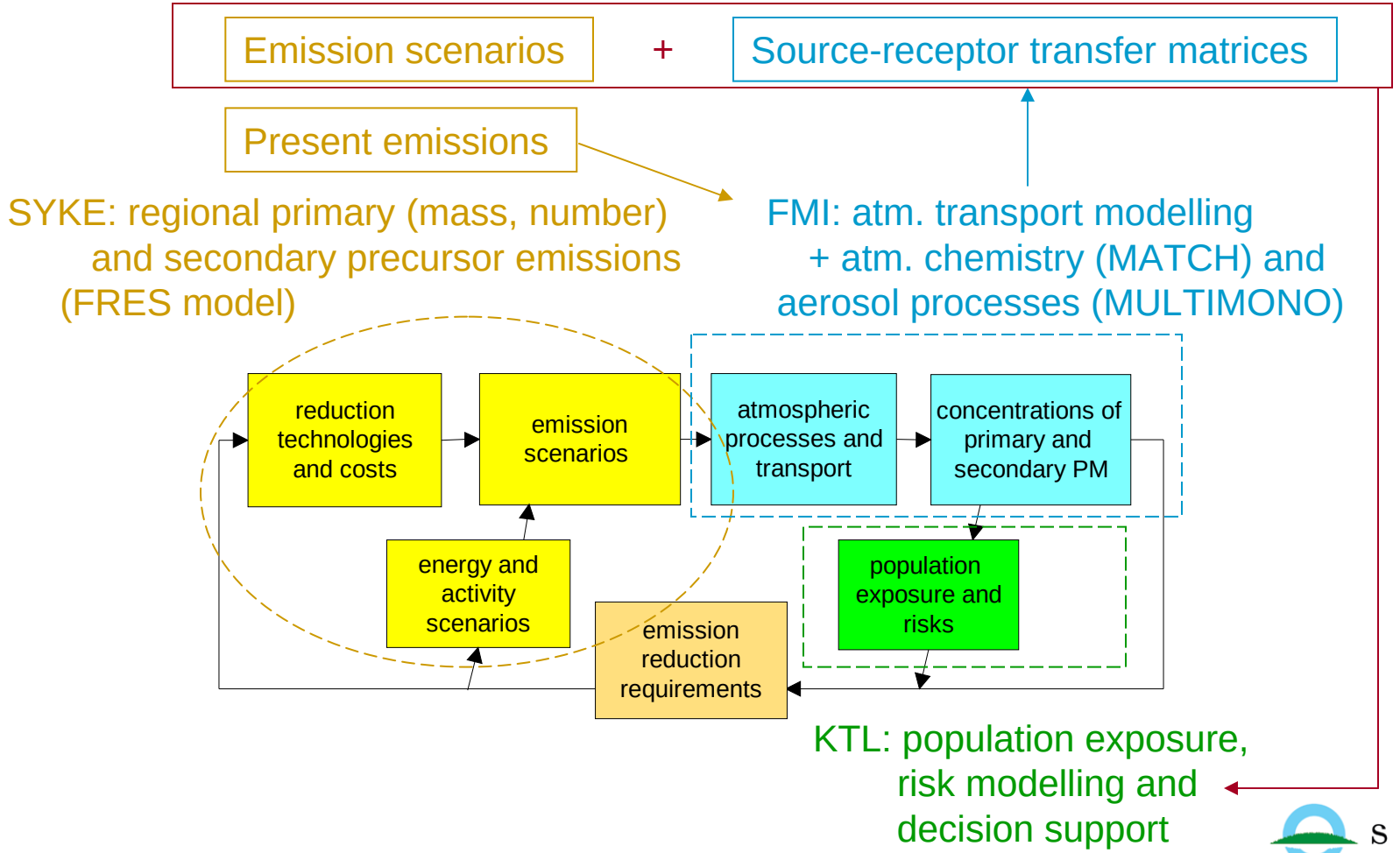
Integrated Assessment Modeling (IAM) in Finland

- KOPRA project (www.fmi.fi/research_air/air_47.html)

An integrated model for evaluating the emissions, atmospheric dispersion and risks caused by ambient air fine particulate matter, 2002-2005



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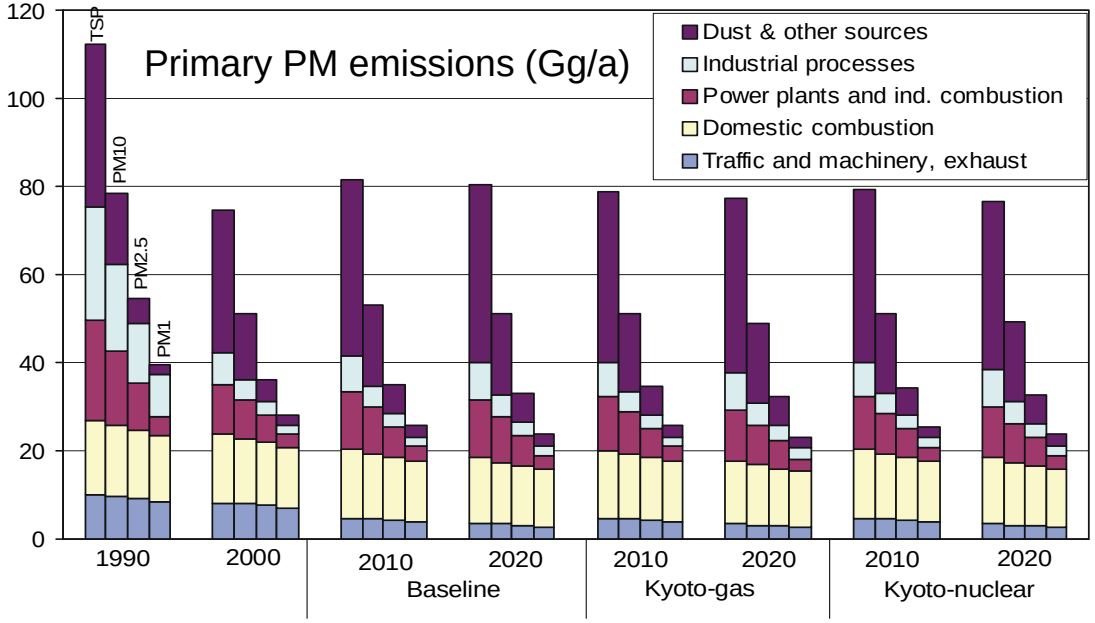
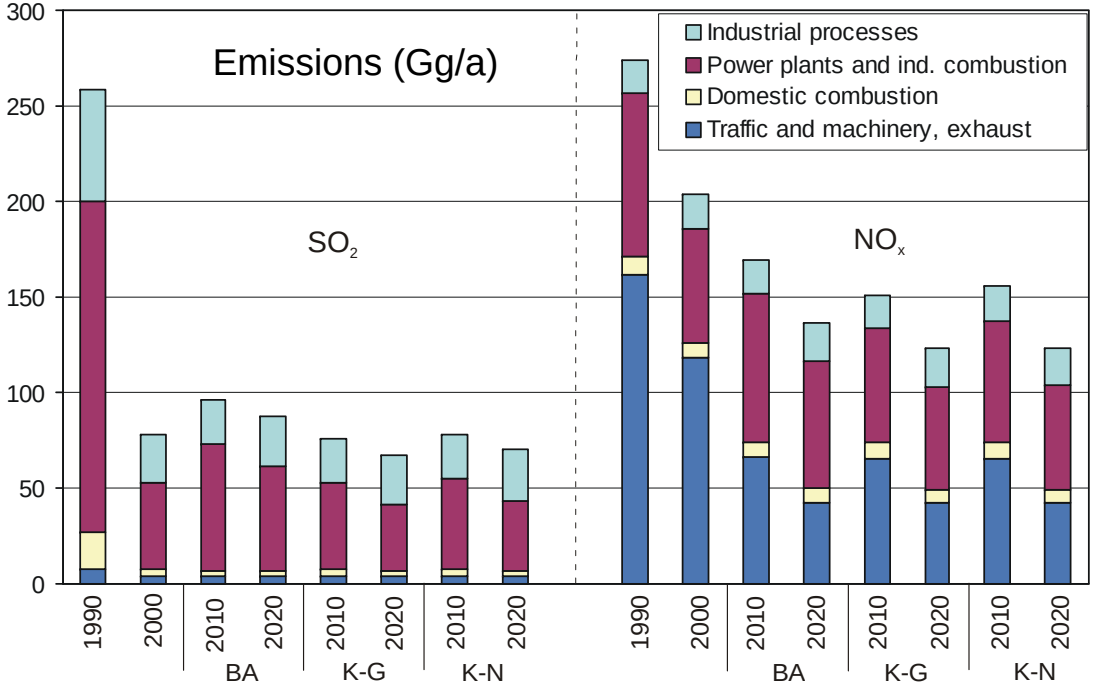
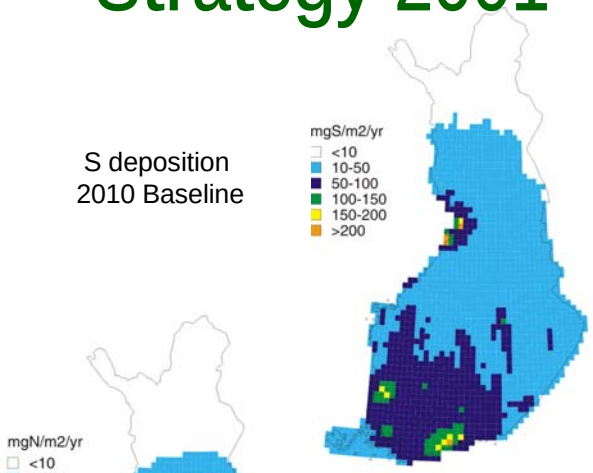
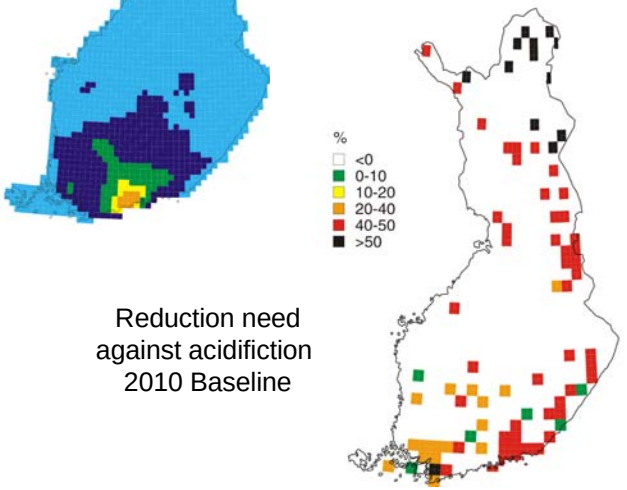
Environmental Impact Assessment of the Climate Strategy 2001









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Karvosenoja, Johansson, *Bor.Env.Res.* 8:125-133
Syri, Karvosenoja, Lehtilä, Laurila, Lindfors, Tuovinen, *Atm.Env.* 36:3059-3069

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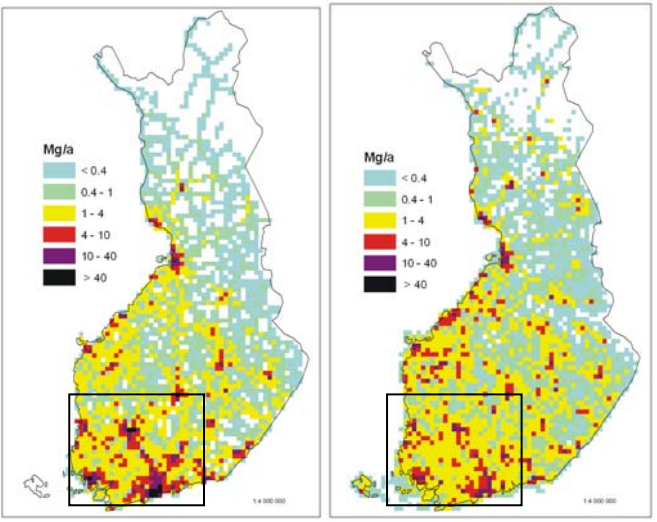
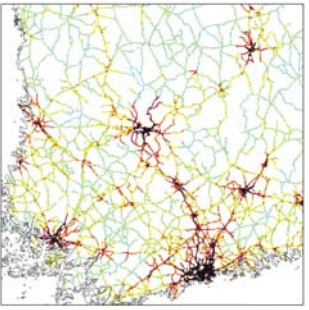
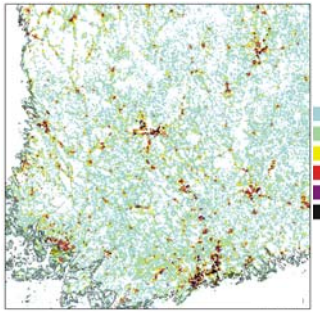
FRES modeling: emissions, transport, health

Emissions



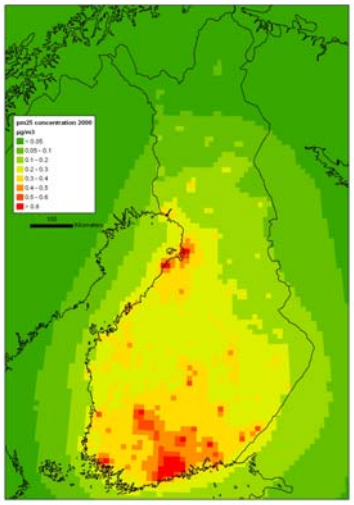




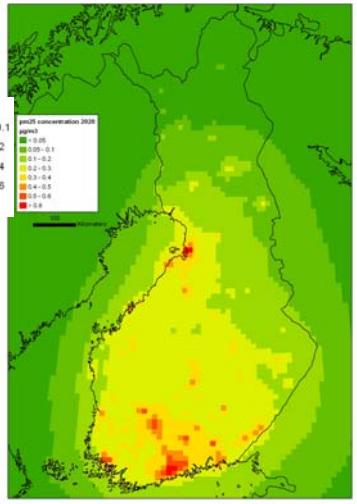
Road traffic

Domestic combustion

Concentrations

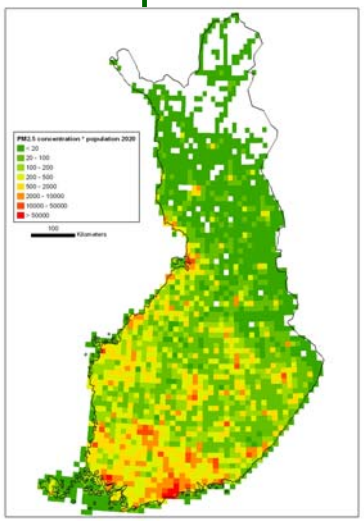


PM2.5 conc. in 2000



PM2.5 conc. in 2020

Population exposure



Health impacts

Emission	Exposed population		
Emission in Finland	**Finnish**	**Other Europe**	**Total**
Area sources (solid fuel)	12	7	19
Domestic combustion	52	39	91
Traffic	49	27	76
Agriculture+peat	14	9	23
Large power plants	13	11	24
Large industrial plants	10	8	18
Total	**150**	**102**	**252**
Source in Europe, total	195	..	
All emission sources	**345**	**..**	

Karvosenoja, Tainio, Kupiainen, Tuomisto, Kukkonen, Johansson, *Boreal Env Res.* in press
Rypdal, Rive, Åström, Karvosenoja, Kupiainen, Bak, Aunan, Kukkonen, *En.Policy.* in press

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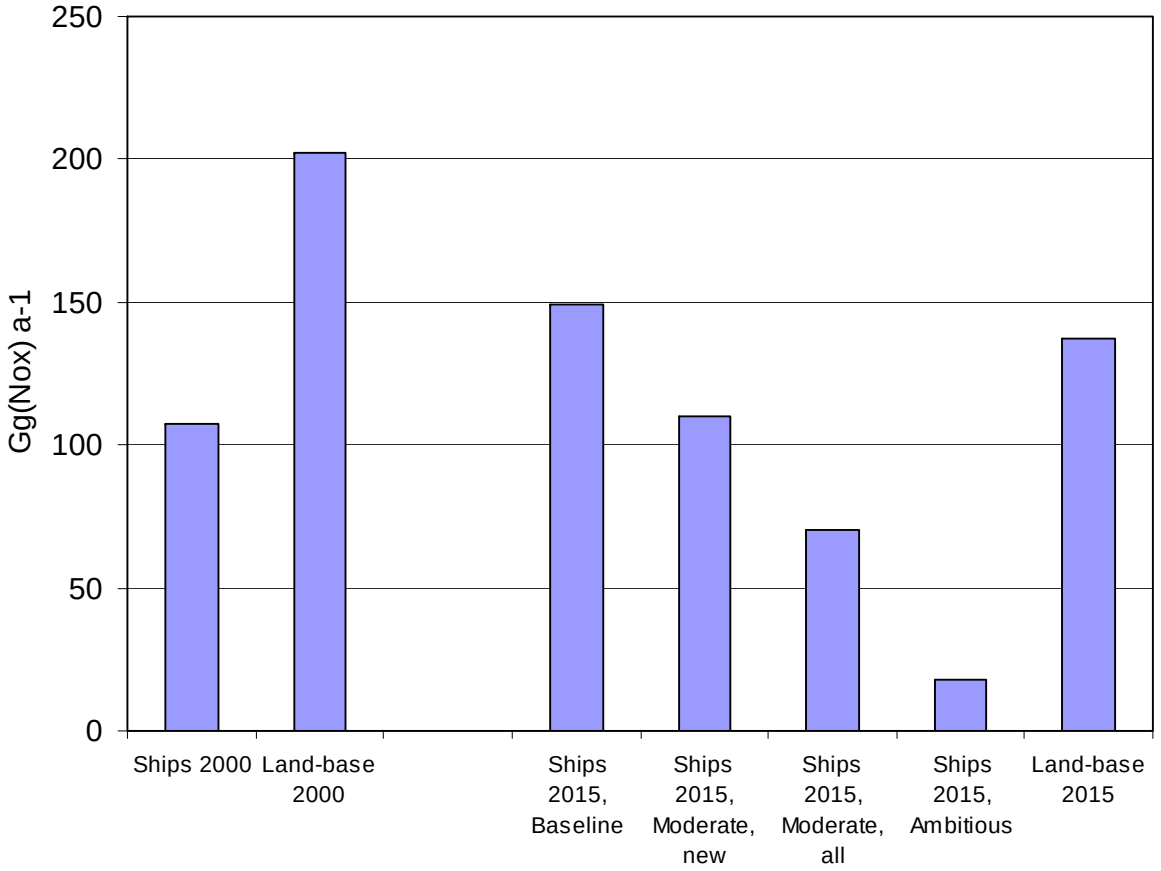
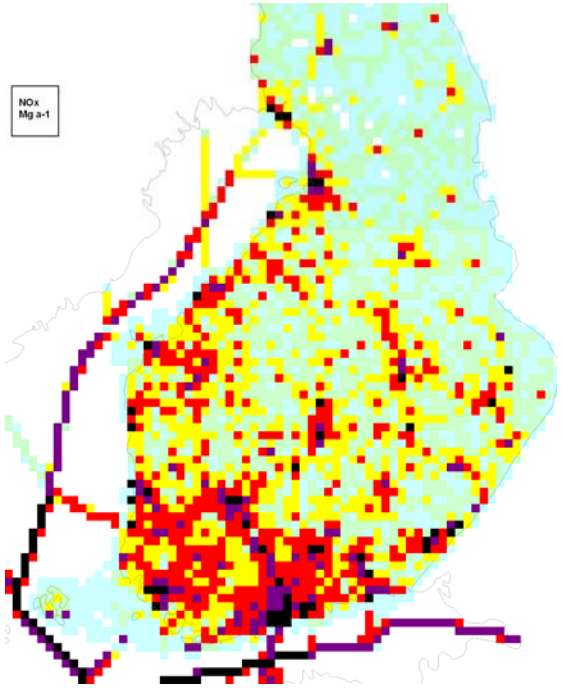
Ship emissions at Northern Baltic Sea



Ship and land-based NOx emissions 2000



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Wahlström, Karvosenoja, Porvari 2006

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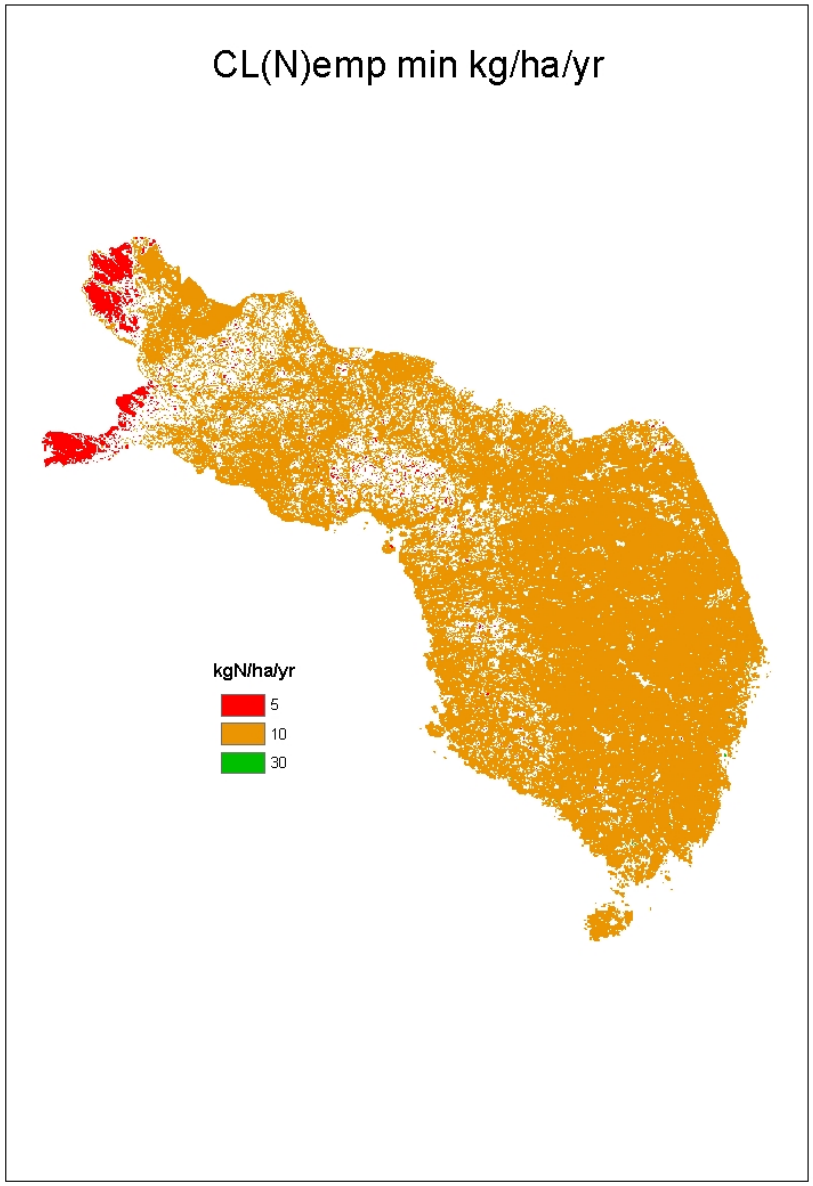
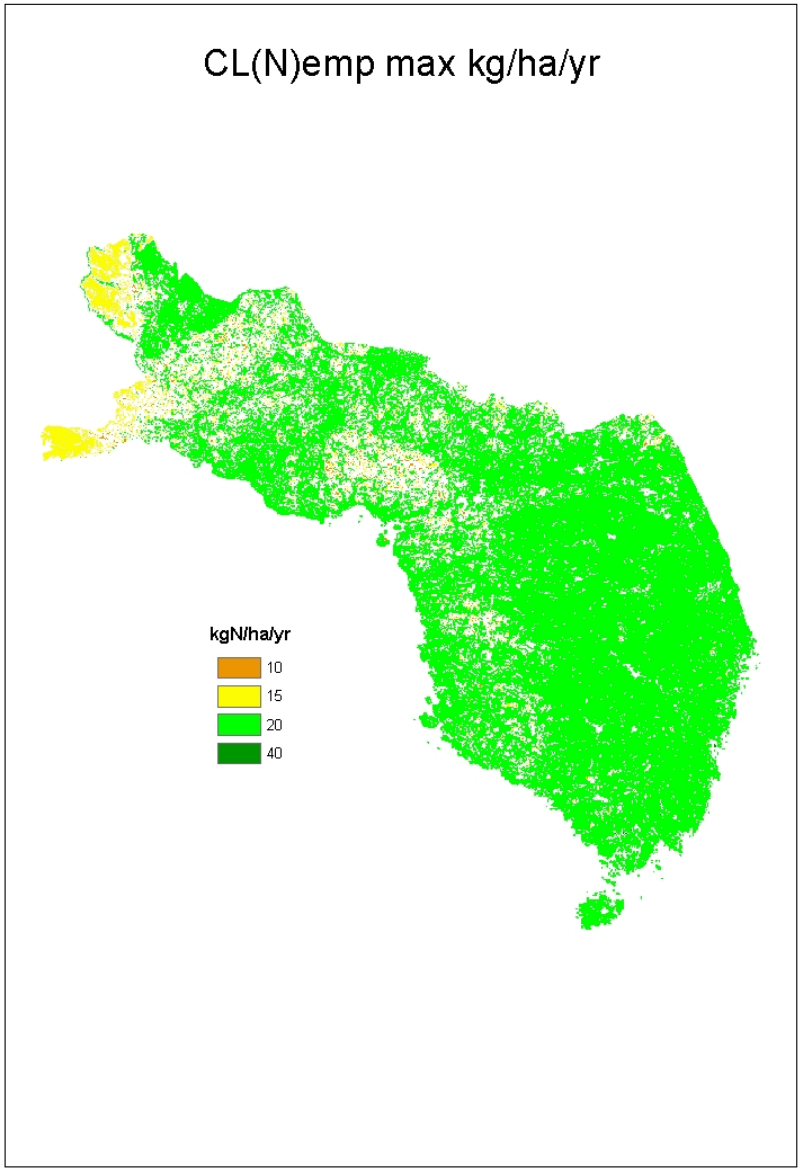


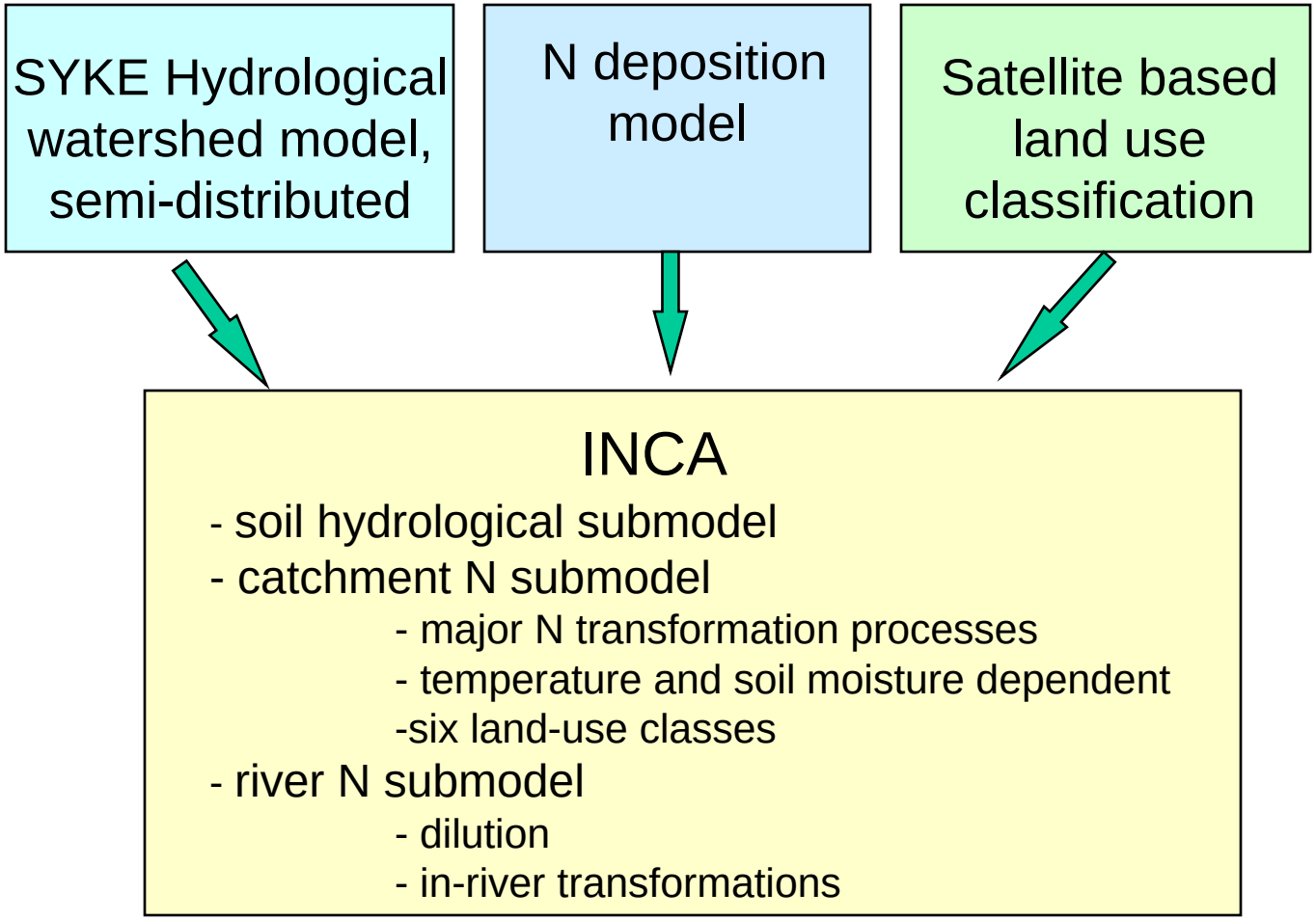


Empirical critical loads of nitrogen (kg N ha^{-1} yr^{--1}) per land use class a) Minimum and b) Maximum values given for each land use class by Bobbink et al. 2002

NitroEurope – SYKE contribution

- C and N budgets of European forests from 1990 (soil from 1950) to 2030
- Yasso model (Liski et al.) - the soil C module of the INTEGRATOR
- Collaboration with ALTERRA (Wim de Vries et al.)

Catchment modelling: INCA-N modelling framework



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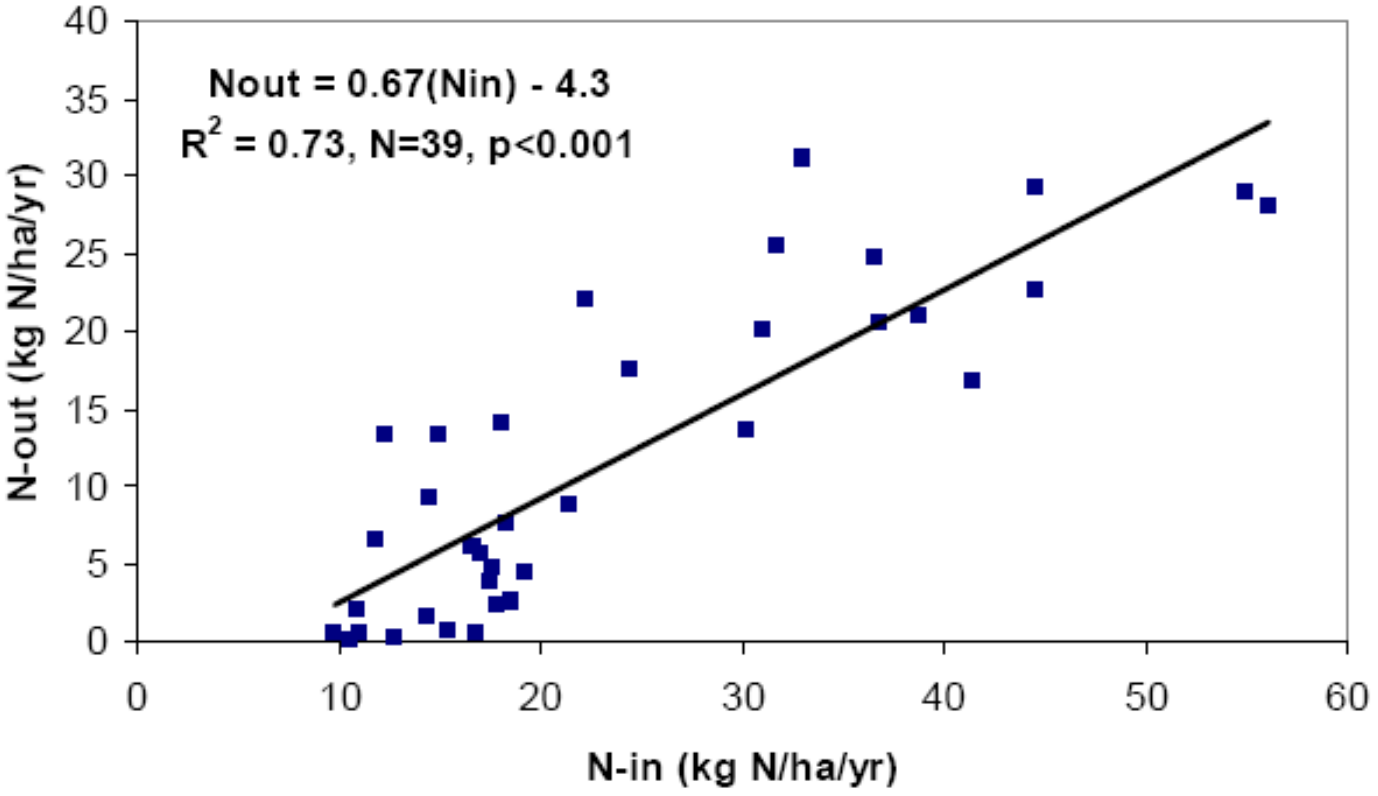
N-budgets and C-N interactions:

N leaching vs. N deposition in throughfall for sites with soil organic layer C/N < 23 for forested sites in Europe

(EU/CNTER-project)



(Gundersen *et al.* 2006)

Concluding remarks

- National IAM system available at SYKE
- Much additional N-work done in various sectors
- N-effects work not yet fully integrated
- Good possibilities to extend integrated N-modelling, but additional resources needed

Difficulties and suggestions for developing integrated N policies

Difficulties:

- Policies and interests sectorial
- Funding for extensions needed: possibilities uncertain

Suggestions:

- Include new sectors in assessment framework using available tools :
  - Surface and groundwaters, Baltic Sea, biodiversity
- Better integration of climate policies and GHG-budgets
- Enhance cooperation between national institutes/universities