Integrated catchment modelling as a tool for managing freshwaters

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Why model?

- To integrate processes and transport pathways within catchments in a systematic way

River Dee, NE Scotland

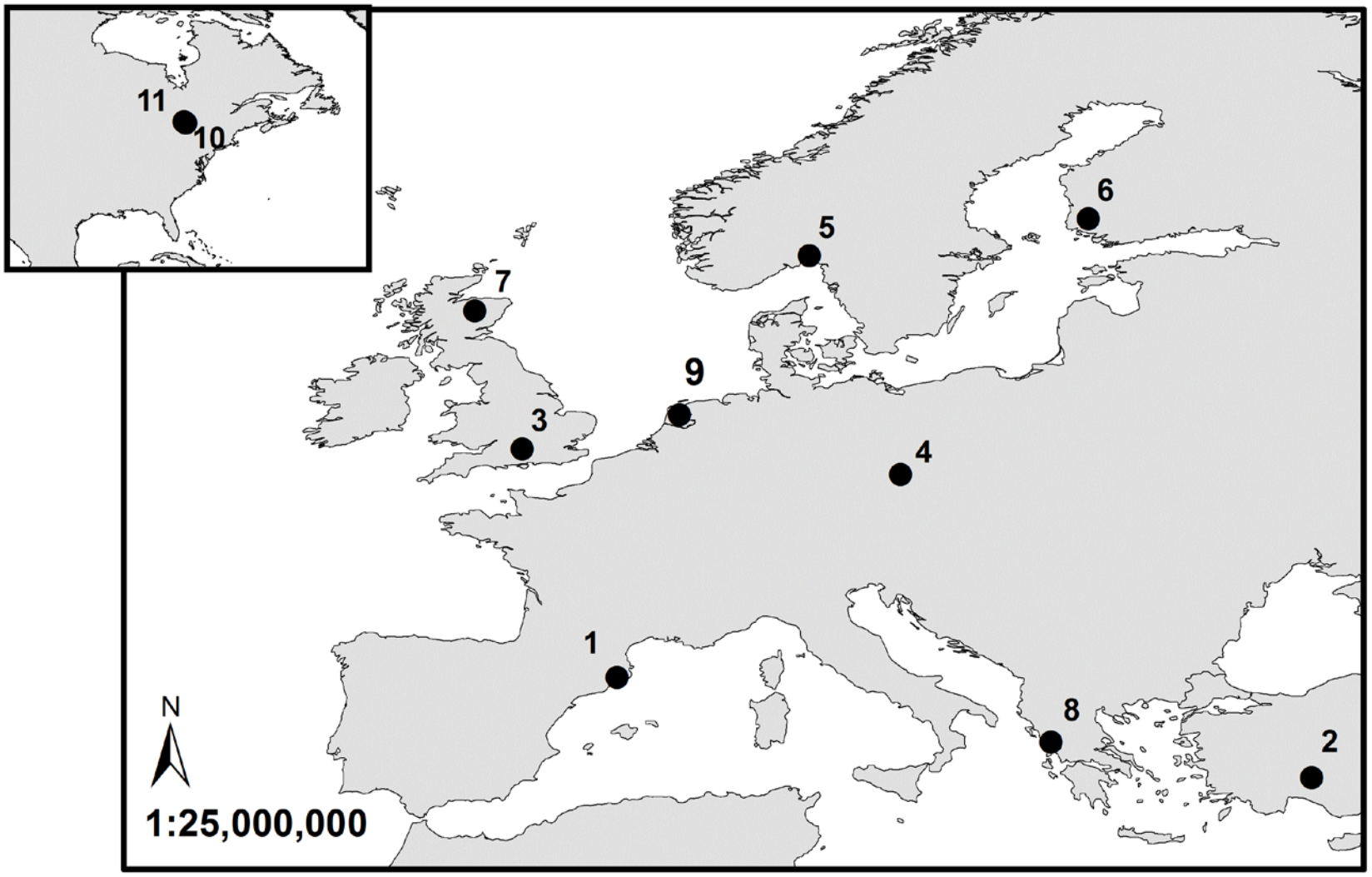
- To provide quantitative estimates (with uncertainty) of the likely impacts of global change on freshwater ecosystems

Aims

- To improve our understanding of how freshwater ecosystems will respond to environmental change over the next 50 years (2031-2060);

- To present this information in a form that can be used by catchment managers and fed into the design of cost-effective measures to reduce (nutrient) pollution.

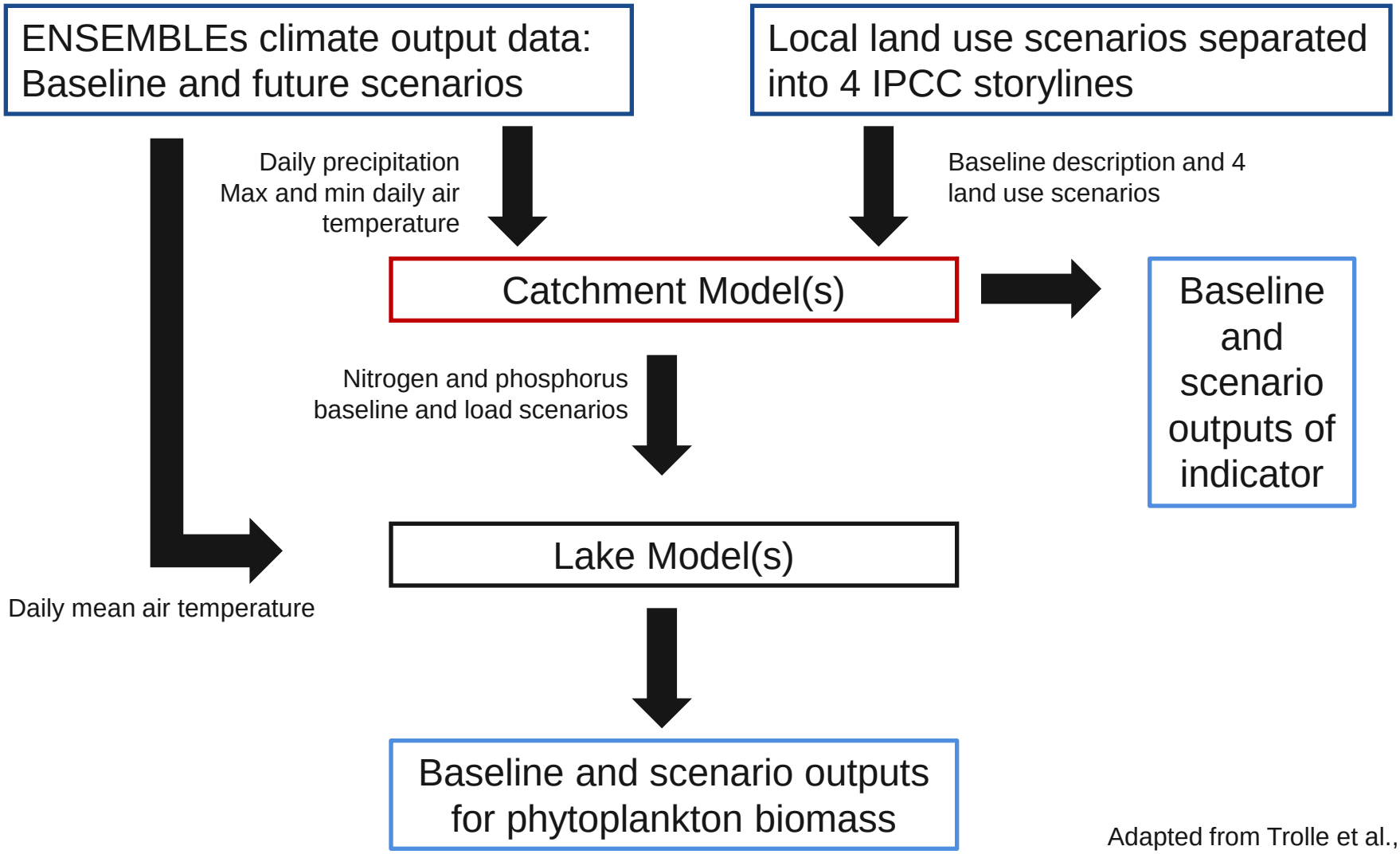
REFRESH Demonstration Site Locations



Site Name

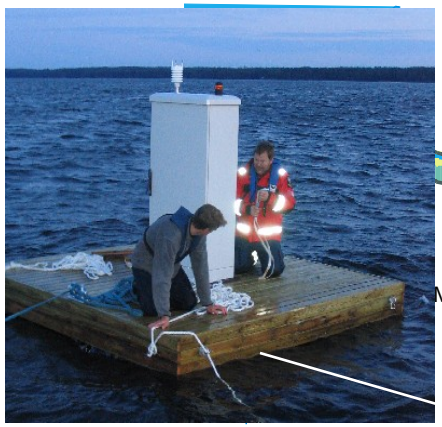
1 La Tordera
2 Lake Beyshir and catchment
3 Thames/Kennet
4 Vltava
5 Vansjø-Hobol
6 Lake Pyhäjärvi/River Yläneenjoki
7 River Dee
8 River Louros
9 IJsselmeer
10 Plastic
11 Harp

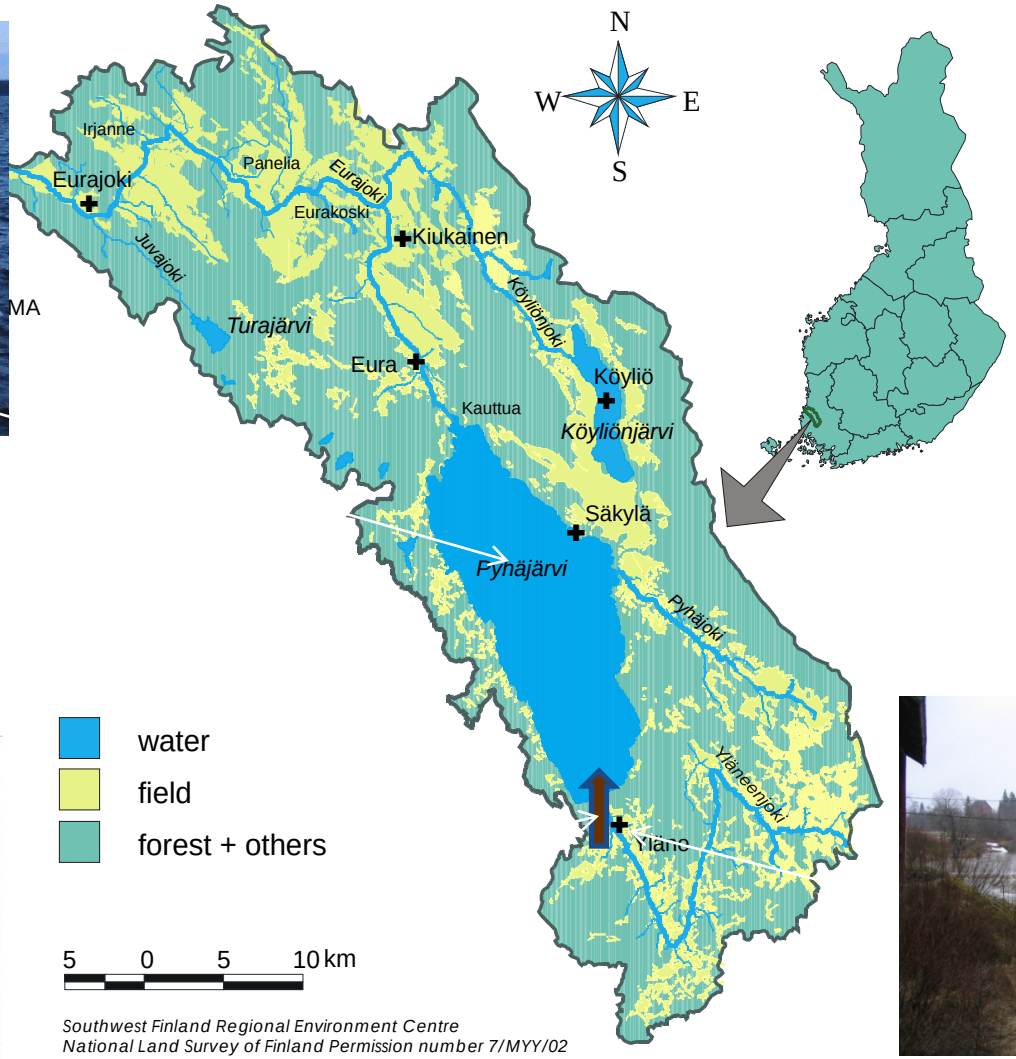
Modelling approach

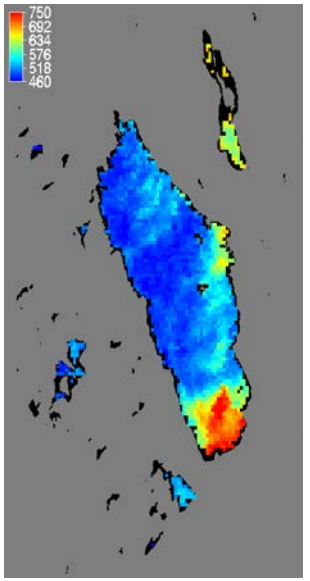


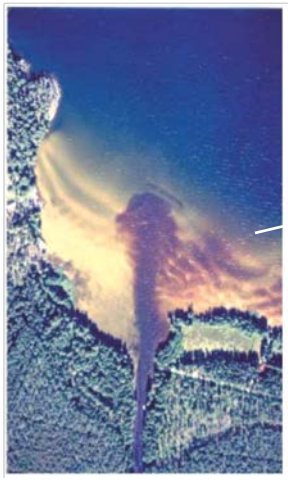
Adapted from Trolle et al., 2013. REFRESH Deliverable 5.2

Yläneenjoki River and Lake Pyhäjärvi







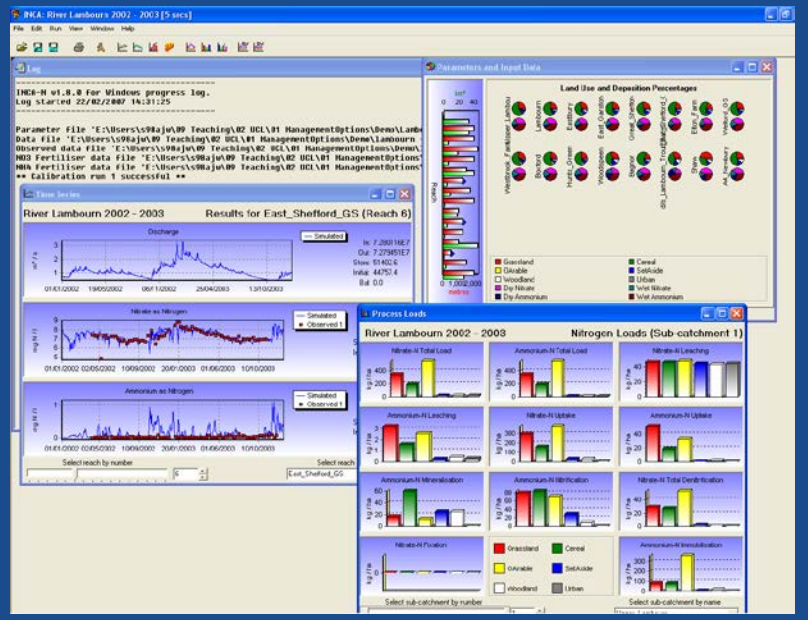


River Yläneenjoki

Catchment N, P, Sediment (and C) modelling

- Integrated Catchment model
- N and P dynamics in complex river systems
  - Terrestrial
  - In-stream
- Point and diffuse
- Process-based, mass balance
- Daily
- Simulates Flow, SS
- Simulates NO_3, NH_4, TP, TRP, PP

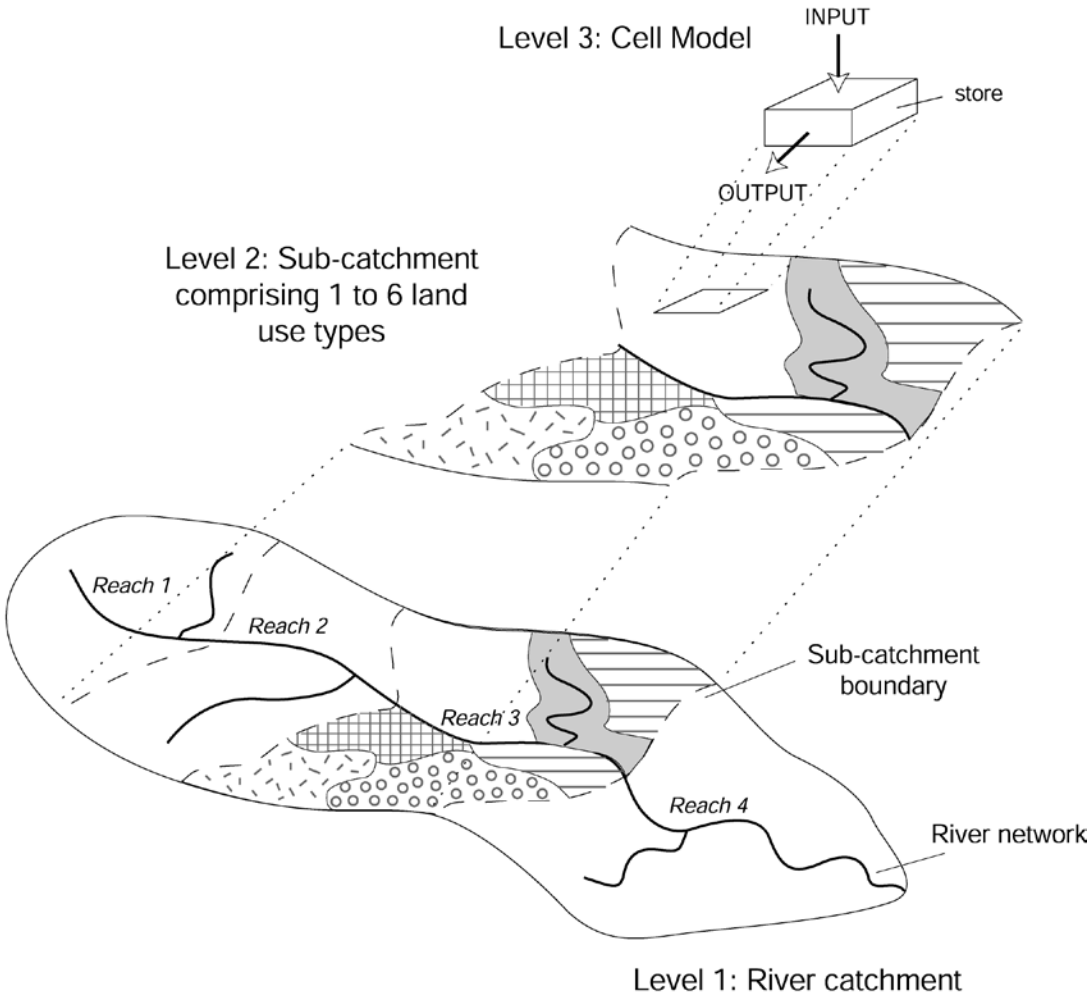
INCA screen shot

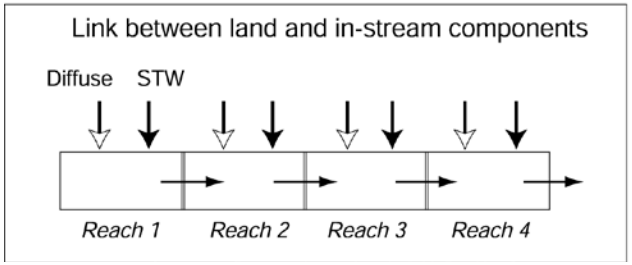


Wade AJ, Durand P et al. 2002.

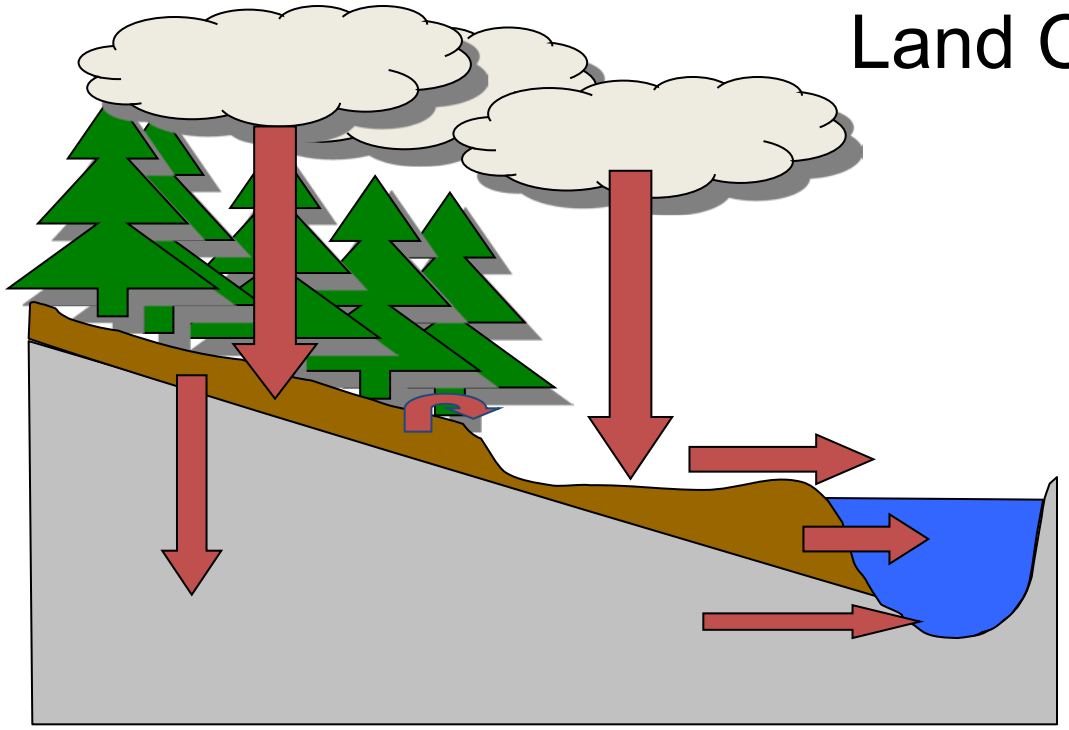
Whitehead et al. 1998

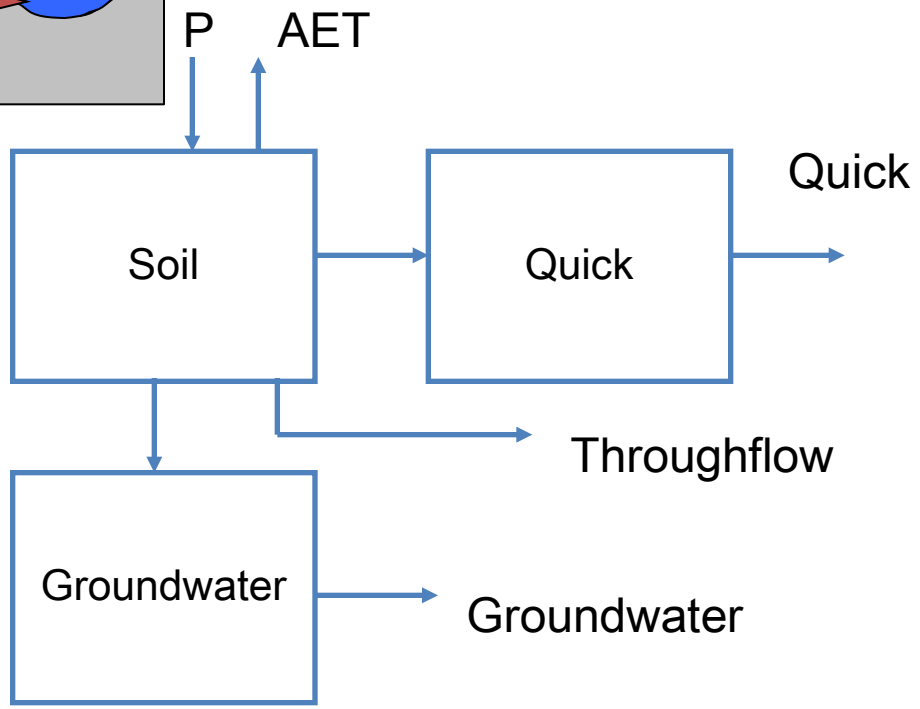
Integrated Catchment (INCA) model

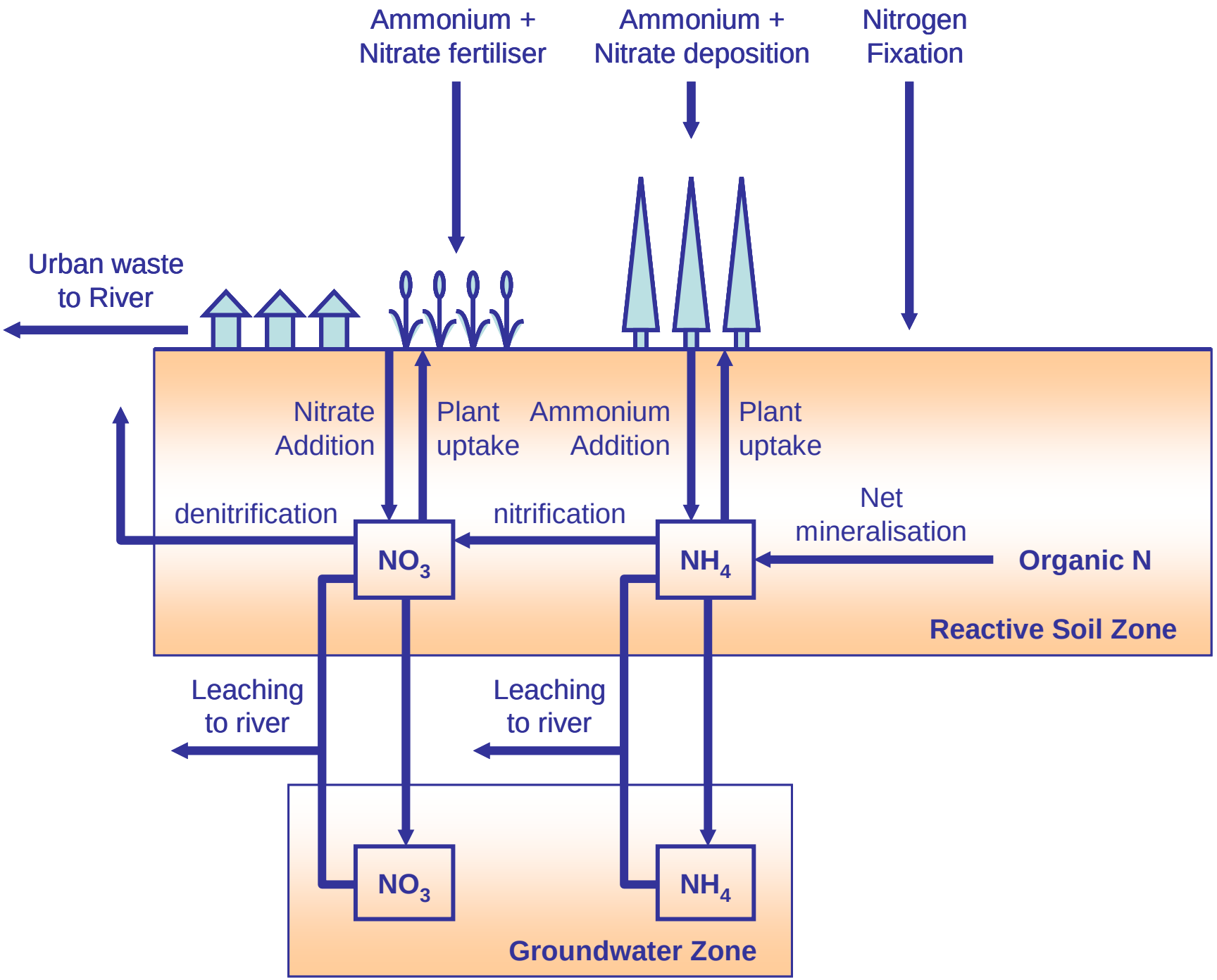




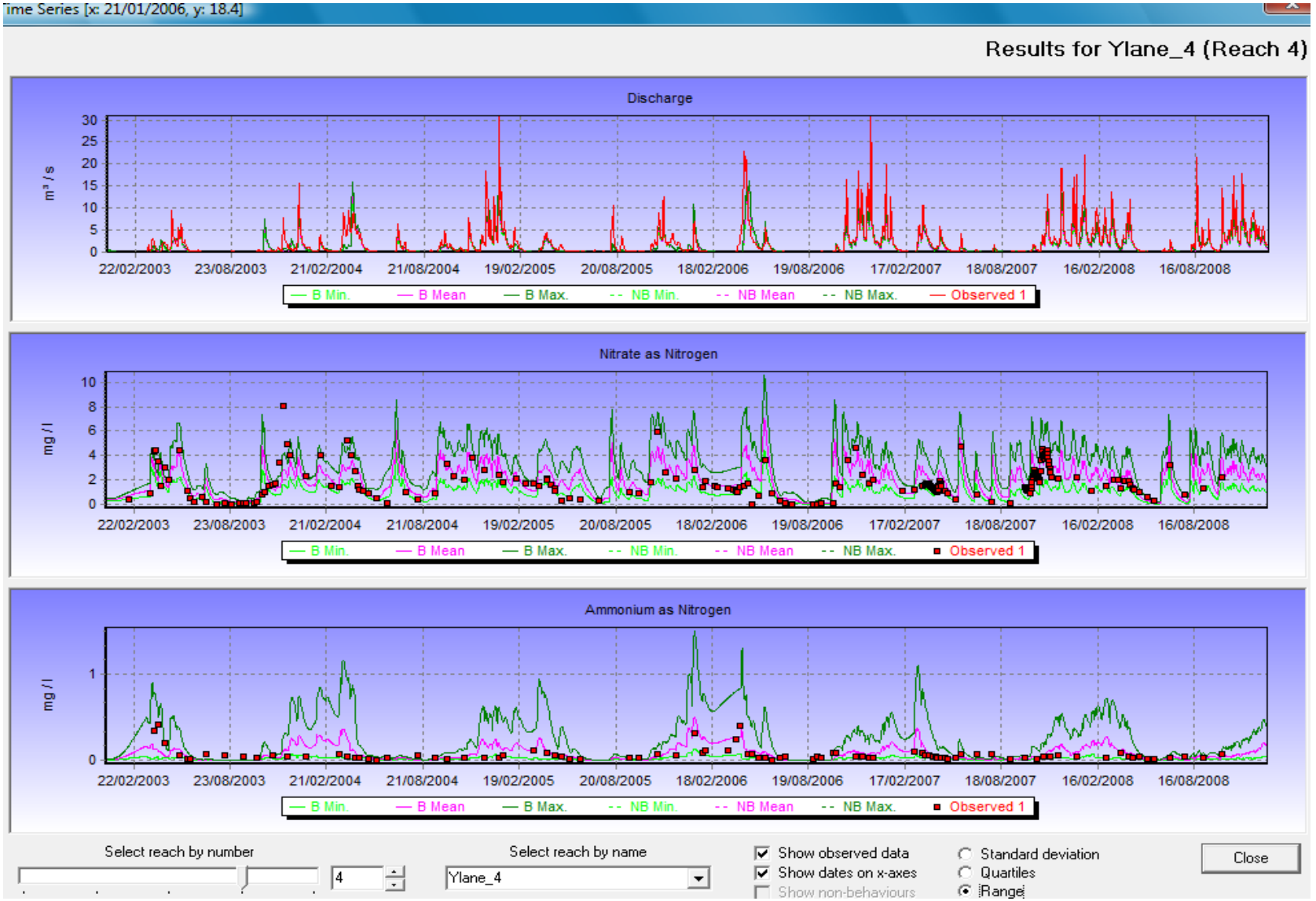
Land Cell: Hydrological Model





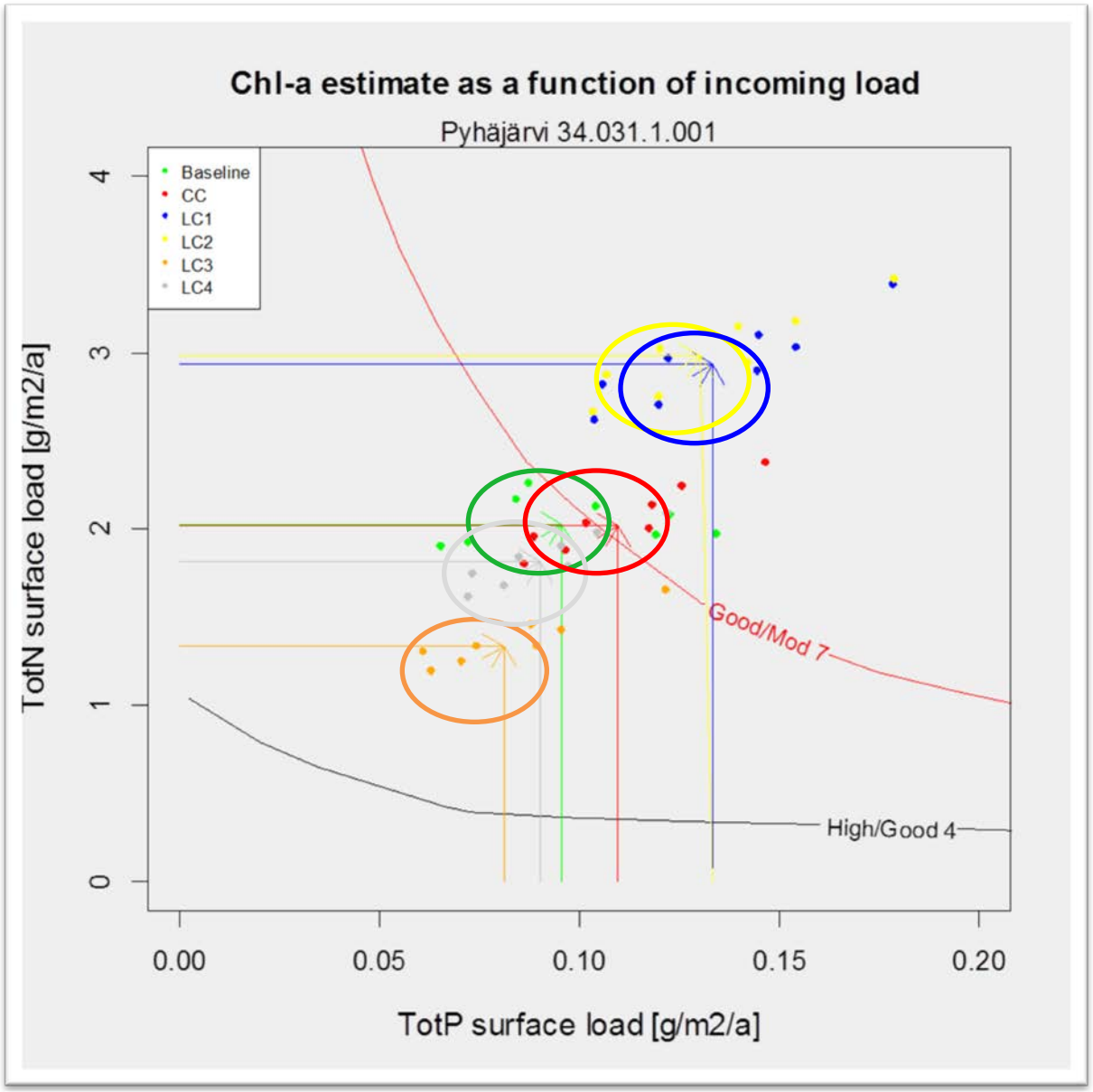

Ammonium +
Nitrate fertiliser
Ammonium +
Nitrate deposition
Nitrogen
Fixation
Urban waste
to River
Nitrate
Addition
Plant
uptake
Ammonium
Addition
Plant
uptake
denitrification
nitrification
Net
mineralisation
NO3
NH4
Organic N
Reactive Soil Zone
Leaching
to river
Leaching
to river
NO3
NH4
Groundwater Zone

INCA-N calibration and uncertainty: Yläneenjoki



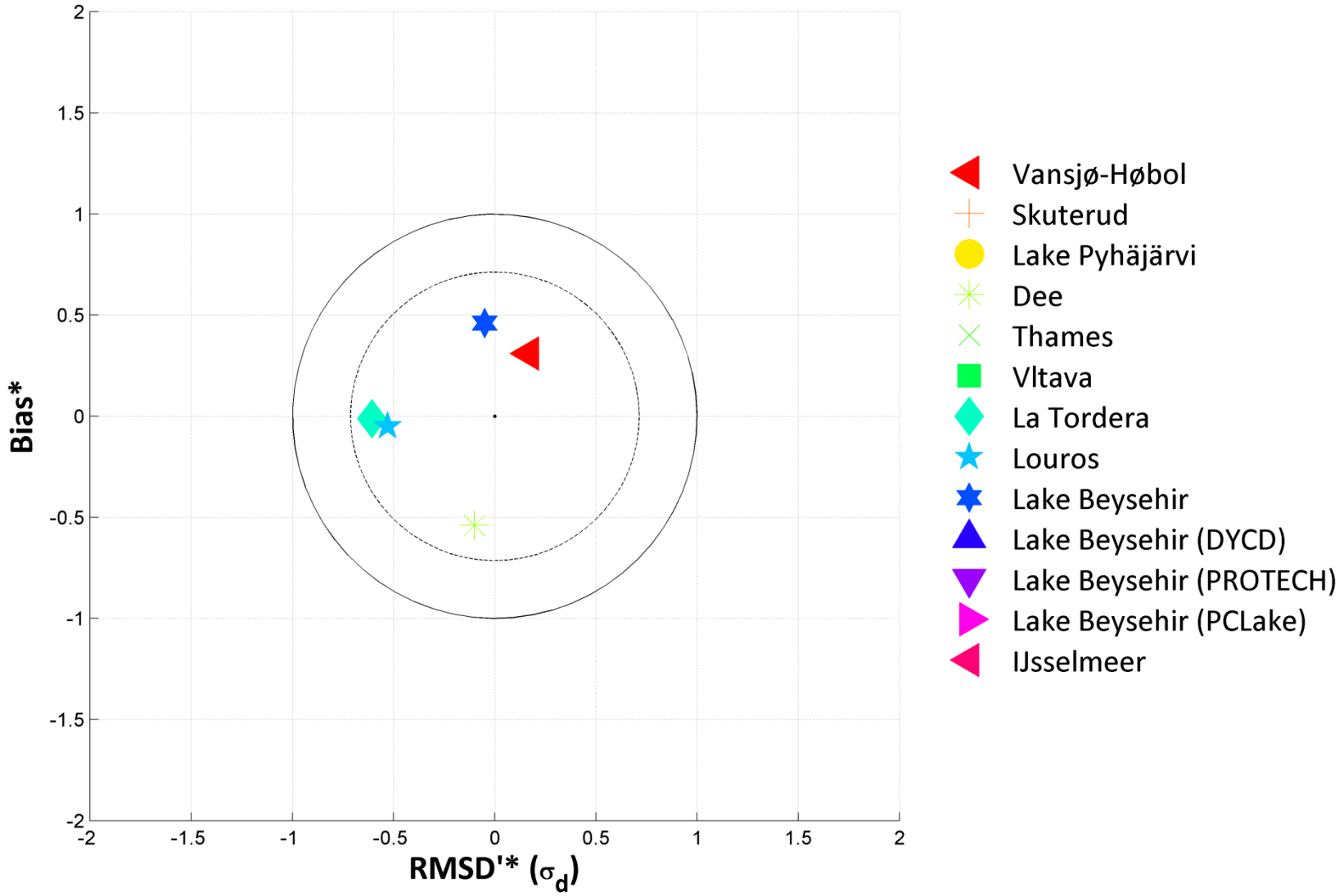
Etheridge et al. *2013. Hydrology Research*

Water biological response as a function of incoming INCA- P and N load

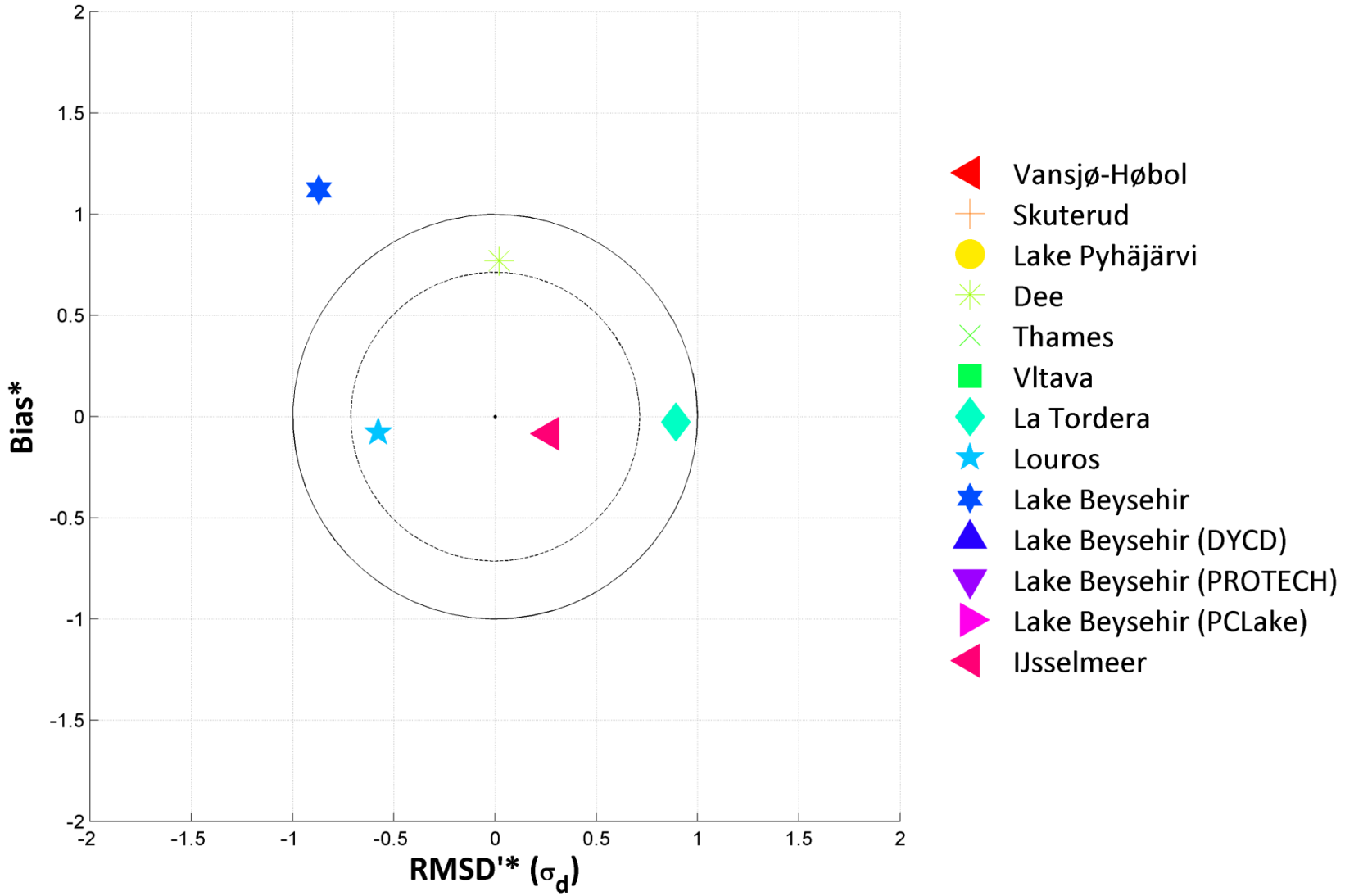


Lepistö et al., 2013. REFRESH Deliverable 5.5

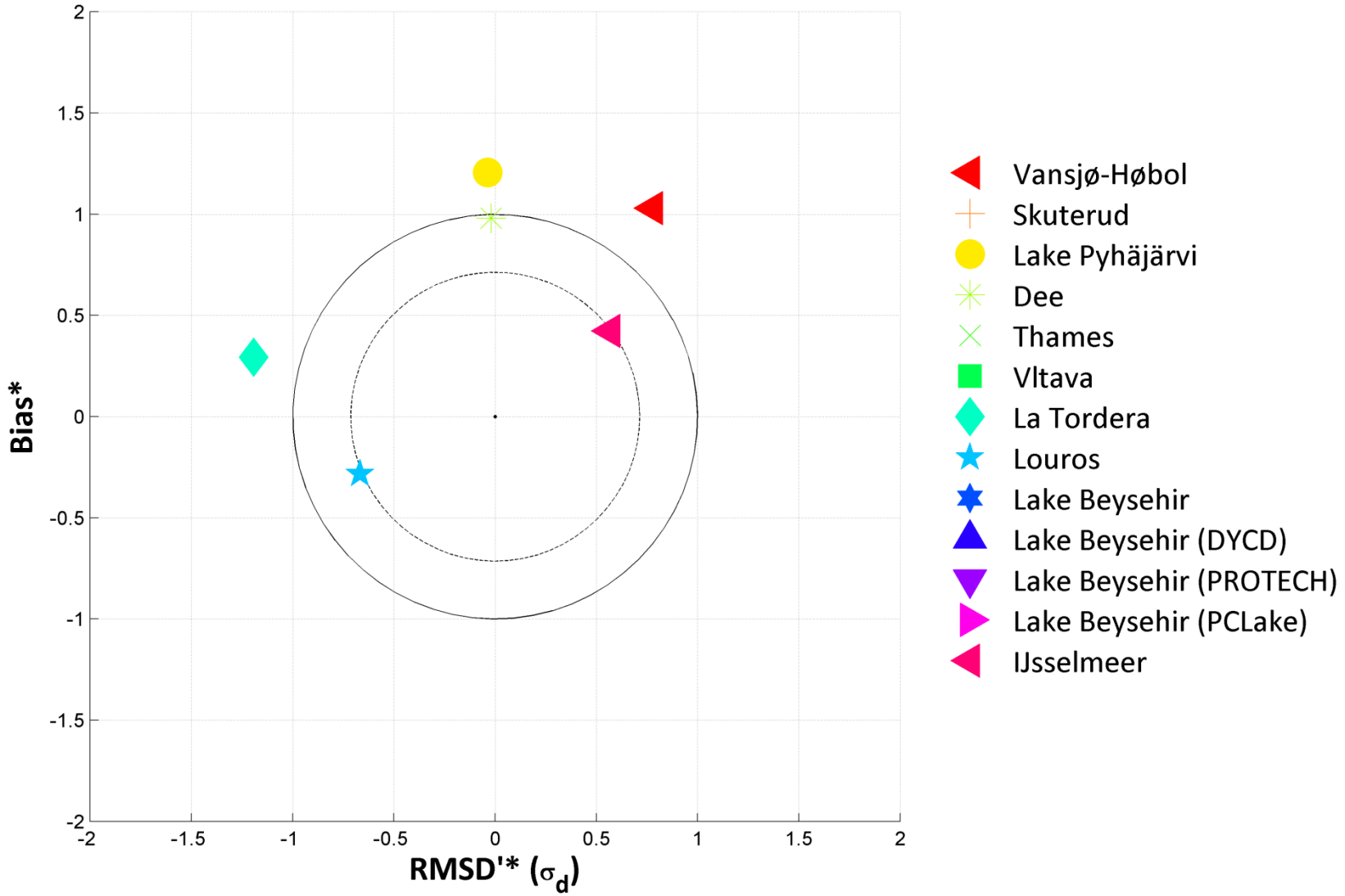
How certain are we about these results - flow?



How certain are we about these results - nitrogen?



How certain are we about these results - phosphorus?

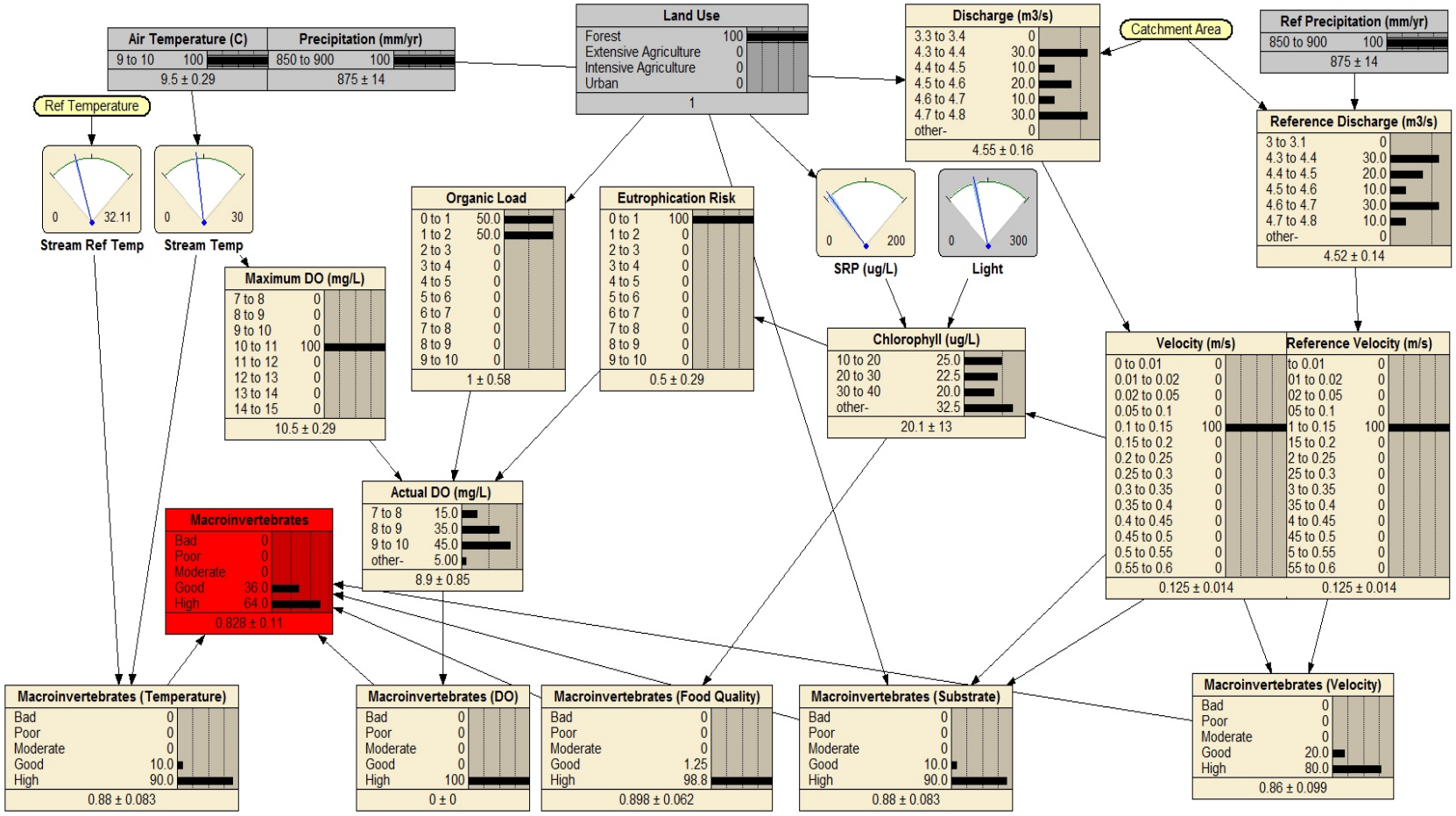


Preliminary conclusions

- Models, when used in a rigorous framework and following data analysis, can be informative for assessing the impacts of environmental change (and the effectiveness of measures)
  - Integrate climate, hydrology, biogeochemistry and ecological indicators
  - Dominant mode(s) of response
  - Key uncertainties
  - Flow > Water quality/Ecological indicator response > Ecosystem response

- Engagement with stakeholders
  - Measures and ecological indicators
  - Model pedigree and published parameter sets
  - Future partnership

REFRESH Models – Transfer of Information



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