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# AstrA

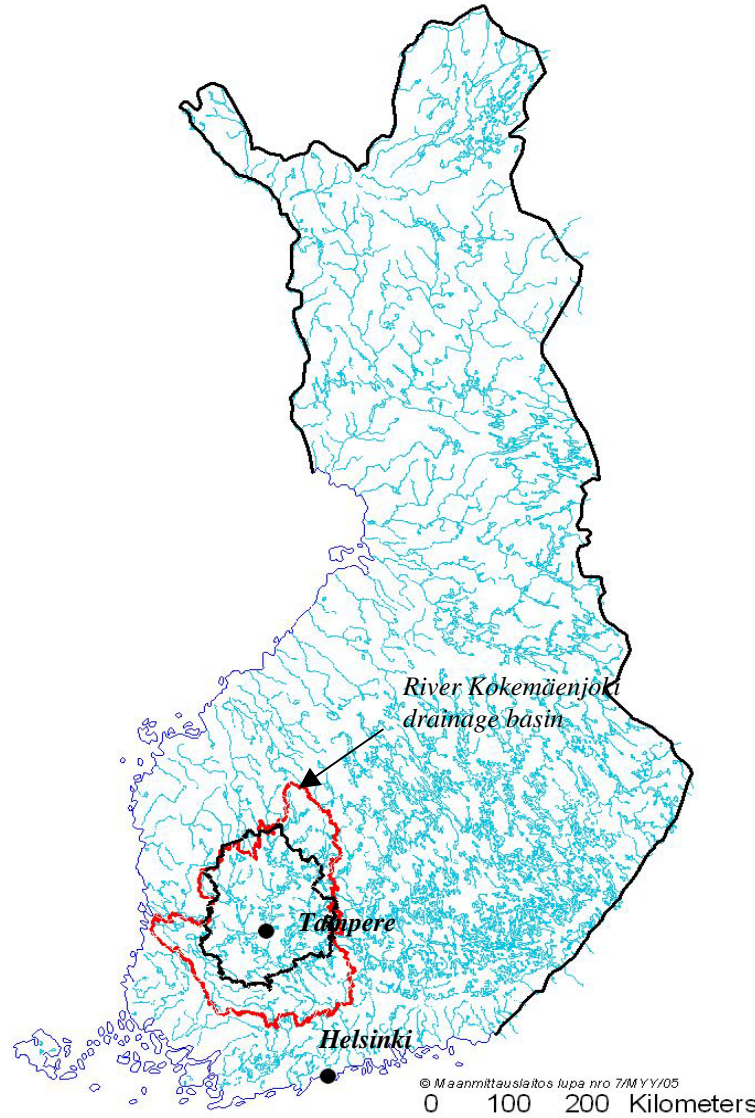
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# **The Case Study of Pirkanmaa Regional Environment Centre**

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**In the case study, the impacts of climate change on nutrient (P, N) flows into lakes and to the Baltic Sea from the drainage basin of River Kokemäenjoki are estimated.**

# The drainage basin of River Kokemäenjoki and Pirkanmaa Regional Environment Centre



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# THE BACKGROUND

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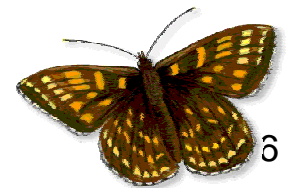


Eutrophication of the Baltic Sea and inland waters is a major environmental problem in Finland.

The reason for eutrophication is increased input of nutrients. Both phosphorus and nitrogen are important.

In lakes, phosphorus is a more important eutrophying factor, whereas in the Baltic Sea nitrogen is generally considered to be more important.

- ≡ Runoff model
- ≡ Nutrient transport model
- ≡ Water quality model
- ≡ Scenario runs



**Relatively simple conceptual model  
(based on HBV runoff model, Bergström 1976)**

**Drainage basin is divided to sub-basins**

**Forested and agricultural runoff**

**INPUT**

- temperature, precipitation and evaporation
- discharges and snow water equivalents (calibration)

**OUTPUT**

- discharges, soil moisture and soil frost



# Nutrient Transport Model, CATCHLOAD



$$L = Q_{\text{forest}} c_{\text{forest}} + Q_{\text{field}} c_{\text{field}}$$

L = transport (M T<sup>-1</sup>)

Q = discharge (L<sup>3</sup> T<sup>-1</sup>)

c = concentration (M L<sup>-3</sup>)

$$c_{\text{forest}} = c0_{\text{forest}} f(\text{lake percentage}) f(\text{area}) f(\text{runoff}) f(\text{soil frost}) f(\text{slope})$$

$$c_{\text{field}} = c0_{\text{field}} f(\text{lake percentage}) f(\text{area}) f(\text{runoff}) f(\text{soil frost}) f(\text{slope}) f(\text{plant cover type})$$



**The principle of the formulae is that the standard concentrations ( $c0_{Forest}$  and  $c0_{Field}$ ), referring to a certain standard catchment and hydrological situation for forest and field, are corrected using empirical functions. The functions are designed so that in the standard situation the values of the functions are equal to one. Some of the functions increase and some decrease concentrations.**



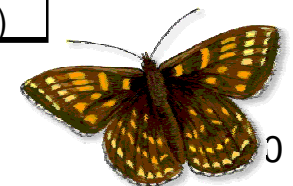
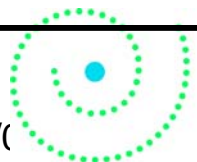
# Standard situations of the empirical functions and directions of the effects on changing circumstances



Standard situation	Change	Effect on loading
lake percentage low	more lakes	decreasing
small catchment area	area grows	decreasing
mean runoff	runoff grows	increasing
no soil frost	soil frost	decreasing
slope low	slope grows	increasing
plant cover type	no plants	increasing

## The forms of the empirical functions.

Name of the variable	Form	Variable	Constant	Notice
f (lake percentage)	$e^{(a \cdot p_l)}$	$p_l$	a	
f (catchment area)	$A^b$	A	b	A (km <sup>2</sup> )
f (runoff)	$(q / Mq)^c$	q, Mq	c	(q / Mq) > 1
f (soil frost)	d SF + 1	SF	d	SF = 0 (no soil frost) SF = 1 (soil frost)
f (slope percentage)	$(1 + SL)^f$	SL	f	
f (plant cover type)	g PT + 1	PT	g	PT = 0 (plants, soil frost) PT = 1 (no plants, no soil frost)



# Lake Mass Balance Model for tot-P

Vollenweider, 1969

$$I - Qc - S = 0$$

$I$  = input

$Q$  = discharge of the outlet of the lake

$c$  = average concentration in the lake

$S$  = retention (= net sedimentation).

$$c = \frac{I}{Q + \sigma V}$$

$$S = \sigma c V$$

$\sigma$  = first order sedimentation coefficient

$V$  = volume of the lake

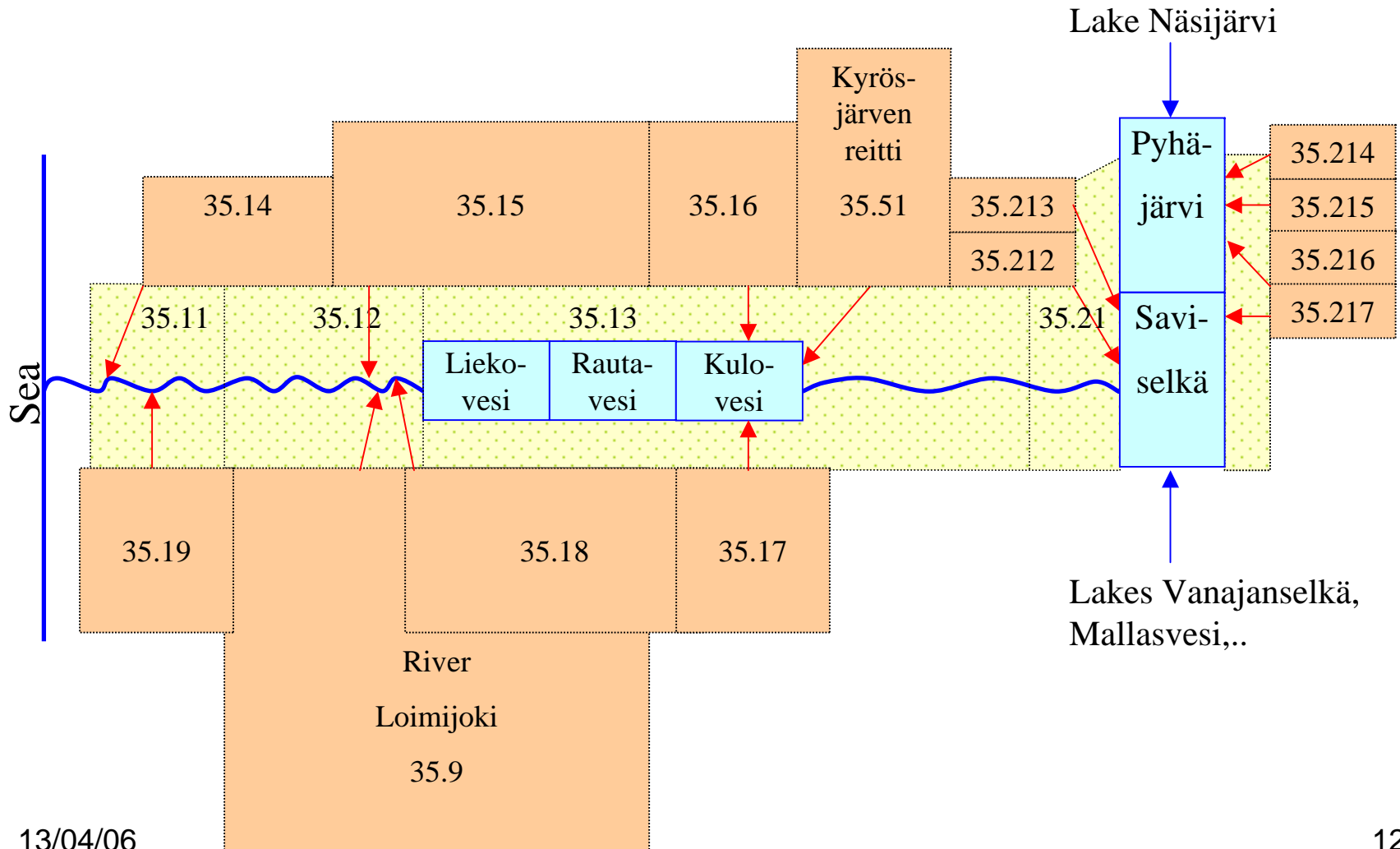
Canfield & Bachmann, 1981

$$\sigma = \sigma_1 \left( \frac{I}{V} \right)^b$$

$\sigma_1$  = coefficient, for natural lakes  $0.162 \text{ a}^{-1}$

$b$  = exponent, for natural lakes 0.458

# The system presentation of the lower part of the drainage basin of the river Kokemäenjoki



The impacts of different scenarios will be calculated using catchment and lake models:

- ≡ Climatic scenarios
- ≡ Socio-economical scenarios
- ≡ The scenarios will be discussed at the regional seminars organized by PREC

# Thank you!



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