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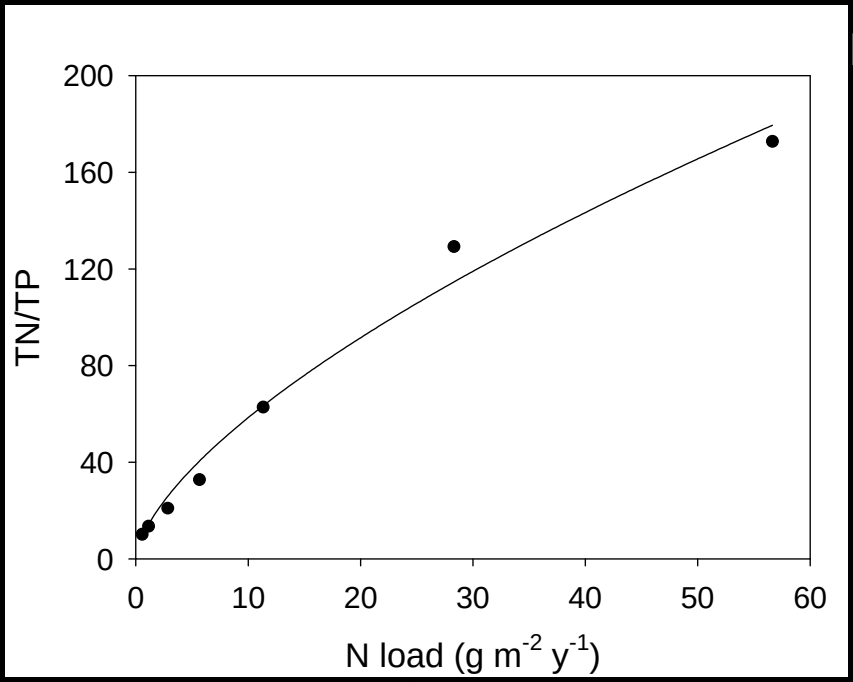
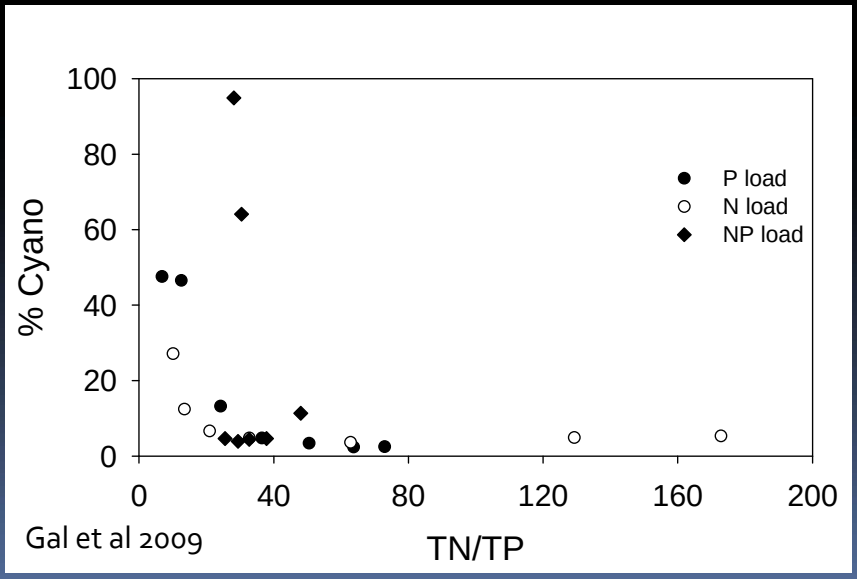
LEARNING FROM UNCERTAINTY IN LAKE ECOSYSTEM MODEL SCENARIOS

Models, uncertainty, and scenarios

- Ecosystem model as a basis for lake management
- Scenarios to determine sustainable management
- But… what is the impact of uncertainty?
- Use single-model ensemble modeling (multiple scenarios and realizations)





Data and models show:

1. relationship between Lake TN/TP and N and P loading
2. relationship between Cyanobacteria and lake TN/TP.

But how accurate are we?

What are we trying to predict?

Precise values?

Trends?

Relationships?

What is crucial for making management decisions?

Lake Kinneret

Altitude (m asl): -210

Surface area (km^2): 170

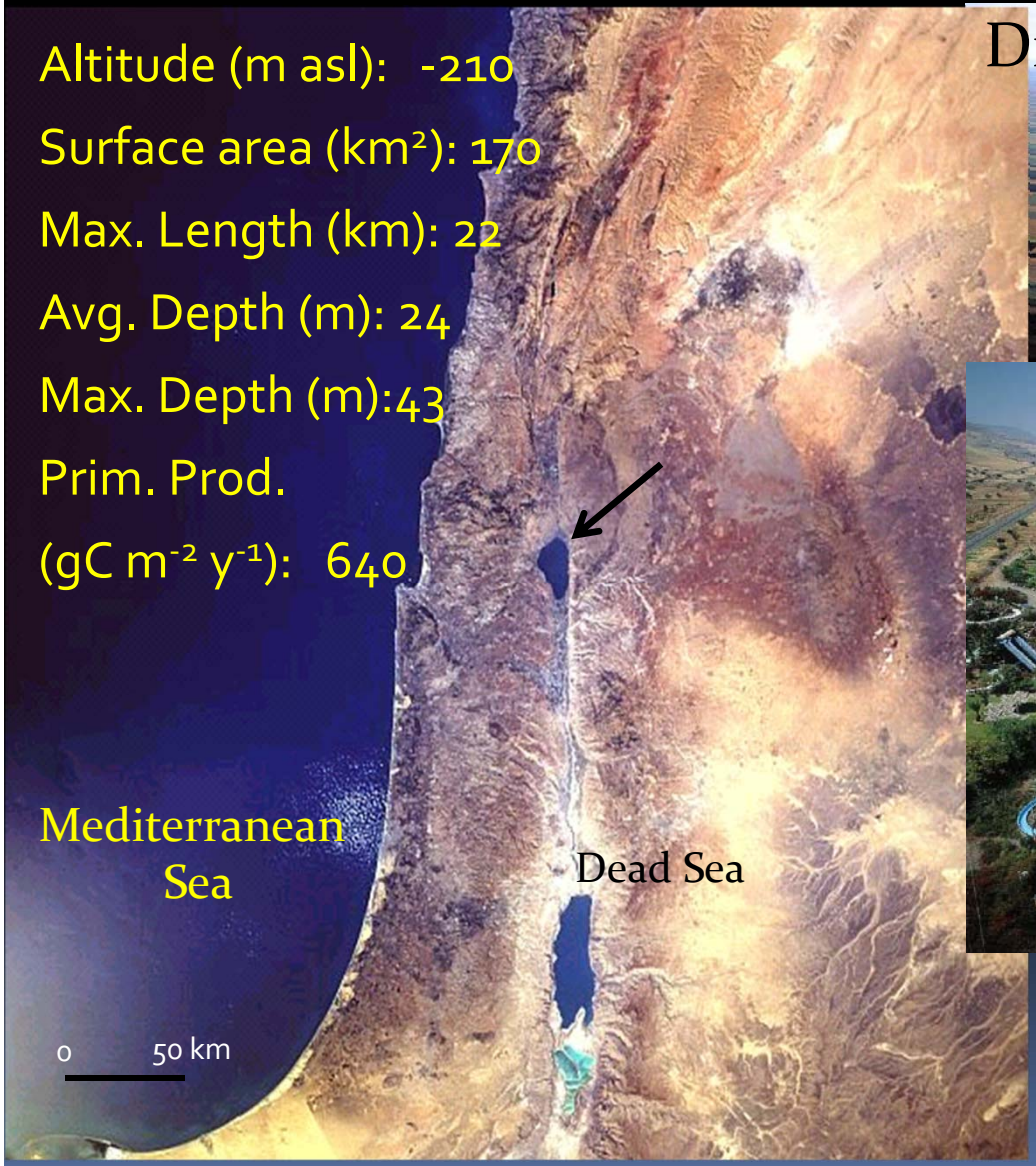
Max. Length (km): 22

Avg. Depth (m): 24

Max. Depth (m):43

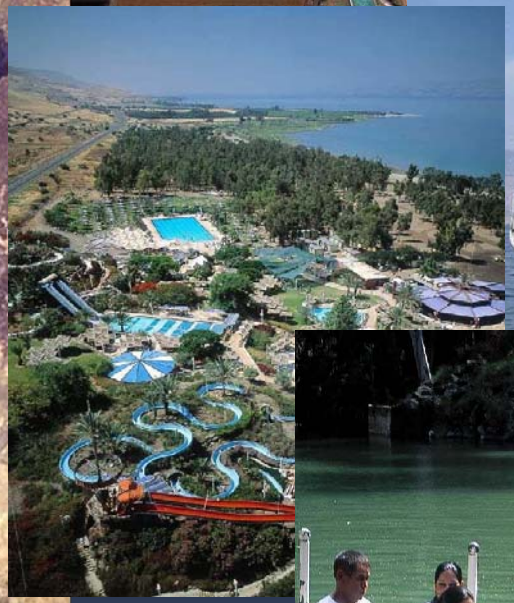
Prim. Prod.

($gC\ m^{-2}\ y^{-1}$): 640



Drinking water

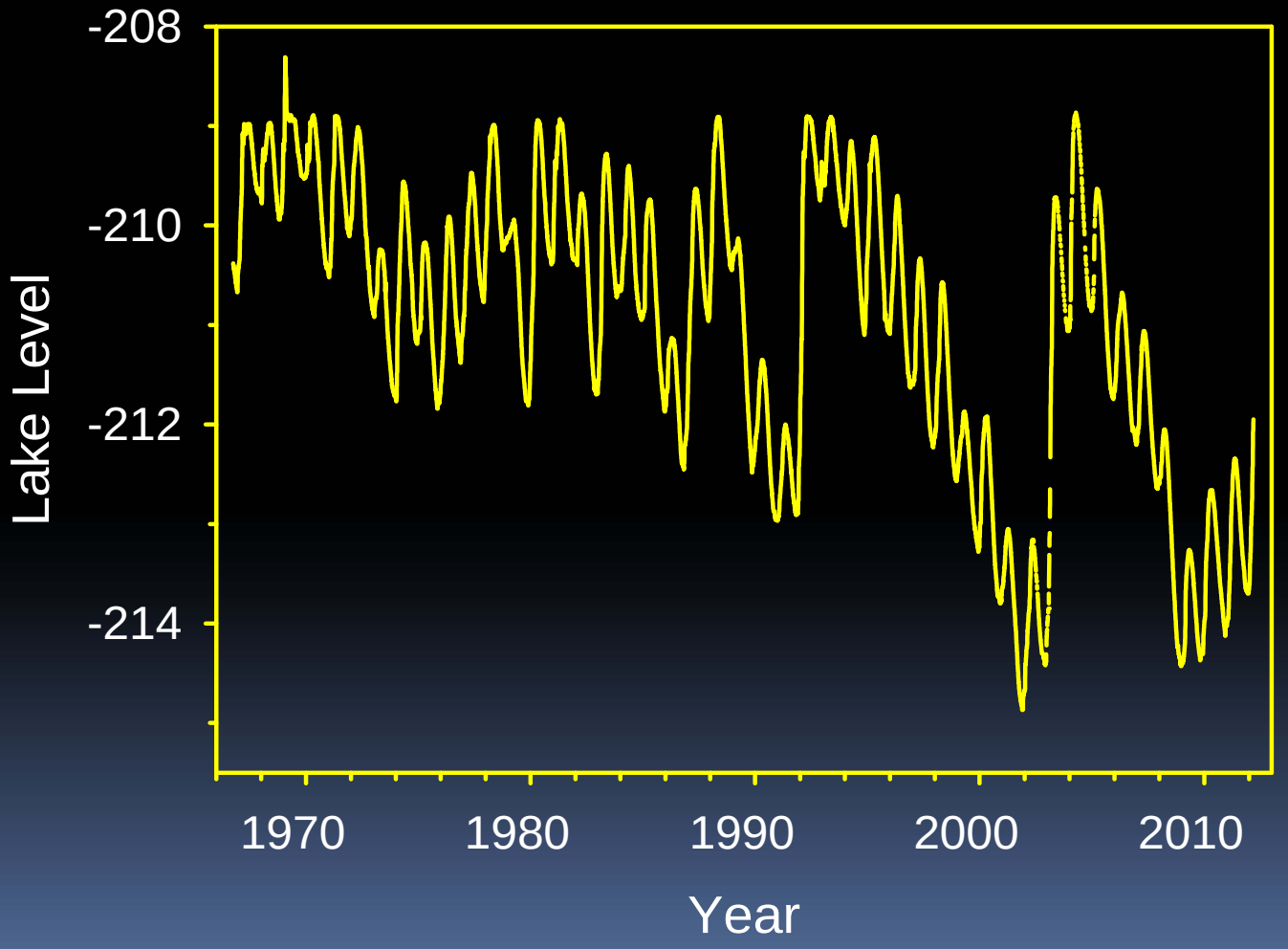
Fisheries



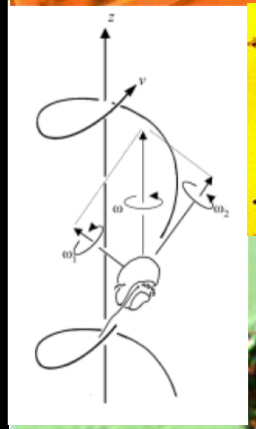
Recreation and tourism

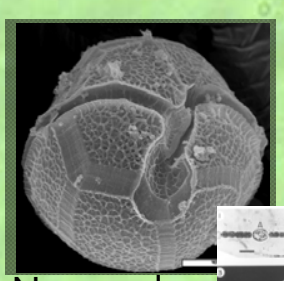
http://earthobservatory.nasa.gov

Drinking resource: Lake level



From Peridinium to…



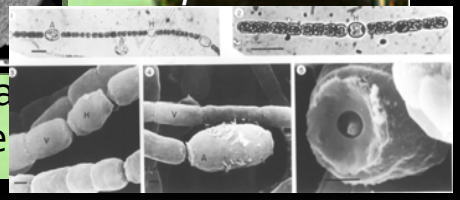


P. gatunense Nygaard – a dinoflagellate from Lake

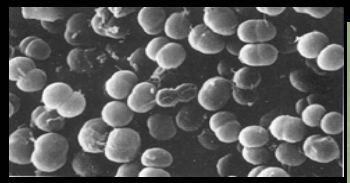
Photo: A. Alster

…Cyanobacteria

Aphanizomenon



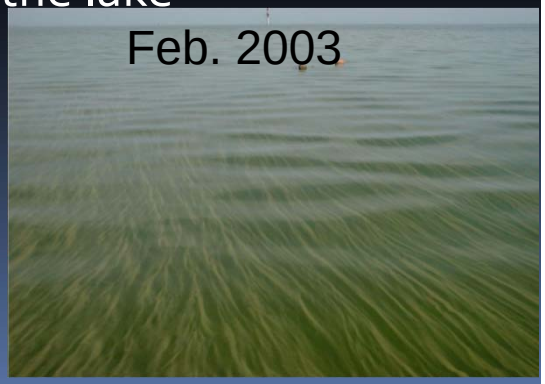
Microcystis



Microcystis blooms in the lake

Apr. 2009

Feb. 2003



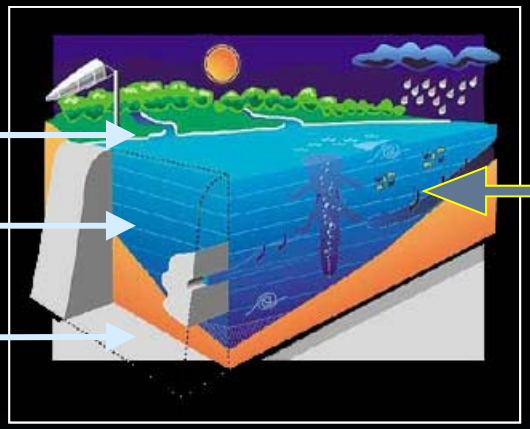
DYCD

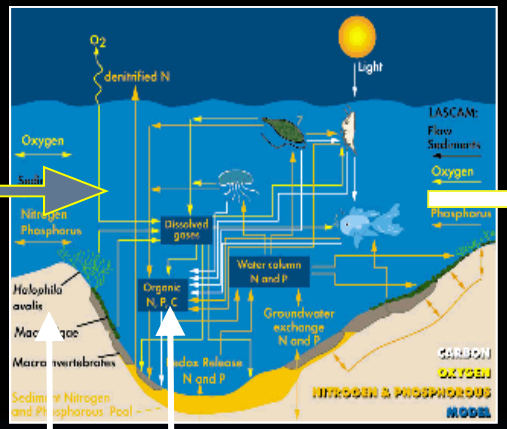
DYRESM 1D

CAEDYM Chem + Biol

Input data

- Meteorology
- In & outflows (vol, contents)
- Physical Initial conditions





Output

Lake mean value for each layer/ day/variable:
T°C, WL, N, P, DO, Food-web components

Biogeochemical initial conditions

Equation parameters

DYRESM = Dynamic Reservoir Model
CAEDYM = Computational Aquatic Ecosystem Dynamics Model.

} DYCD

PERMISSIBLE RANGES

Management Measures or External forcing	Permissible Range
N **&** P load & Water level	?<N **&** P load & WL<?

Improvement #3

Management Measures or External forcing	Permissible Range
Nitrogen **&** Phosphorus load	?<N **&** P load<?
Water level	?<WL<?

Improvement #2

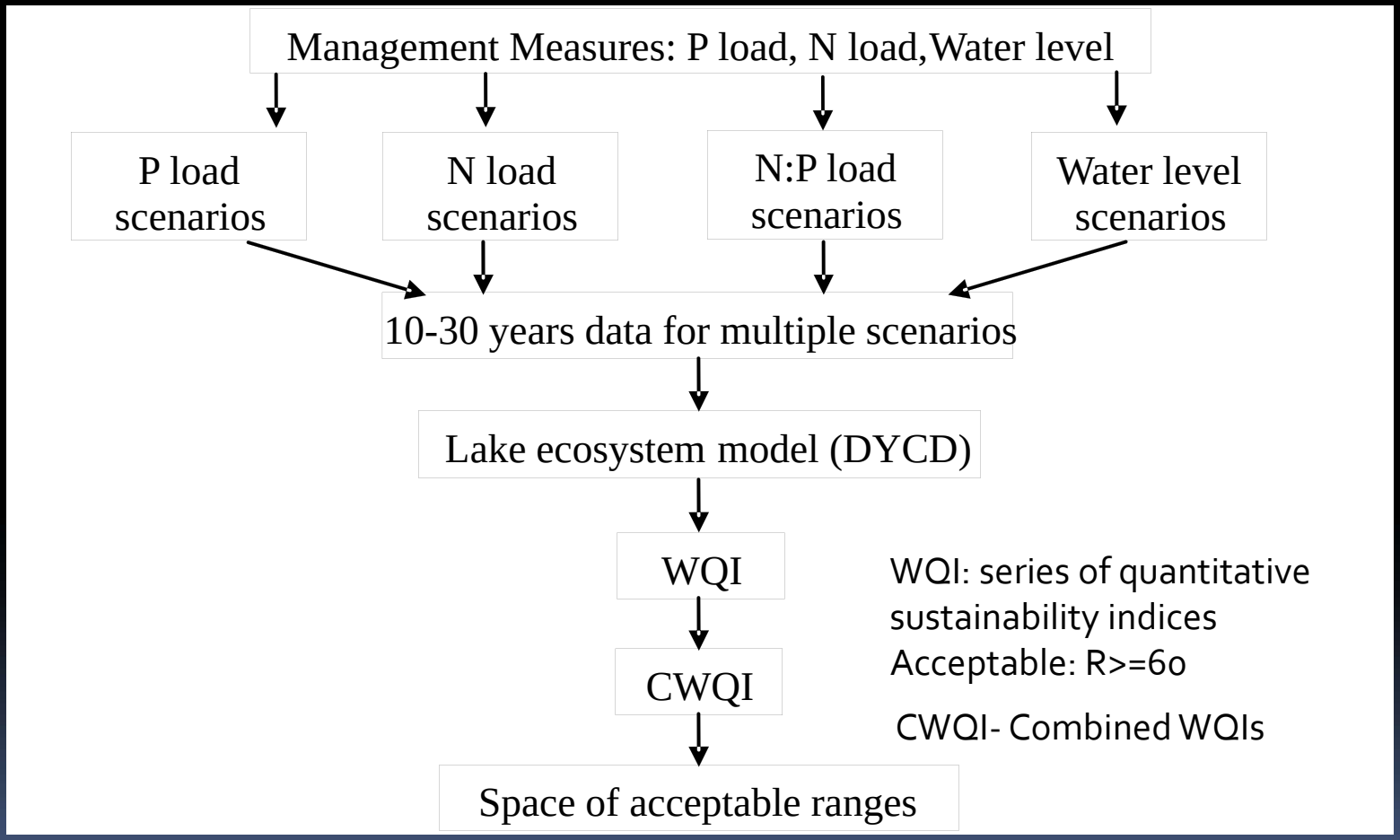
The traditional approach:

What will happen if…

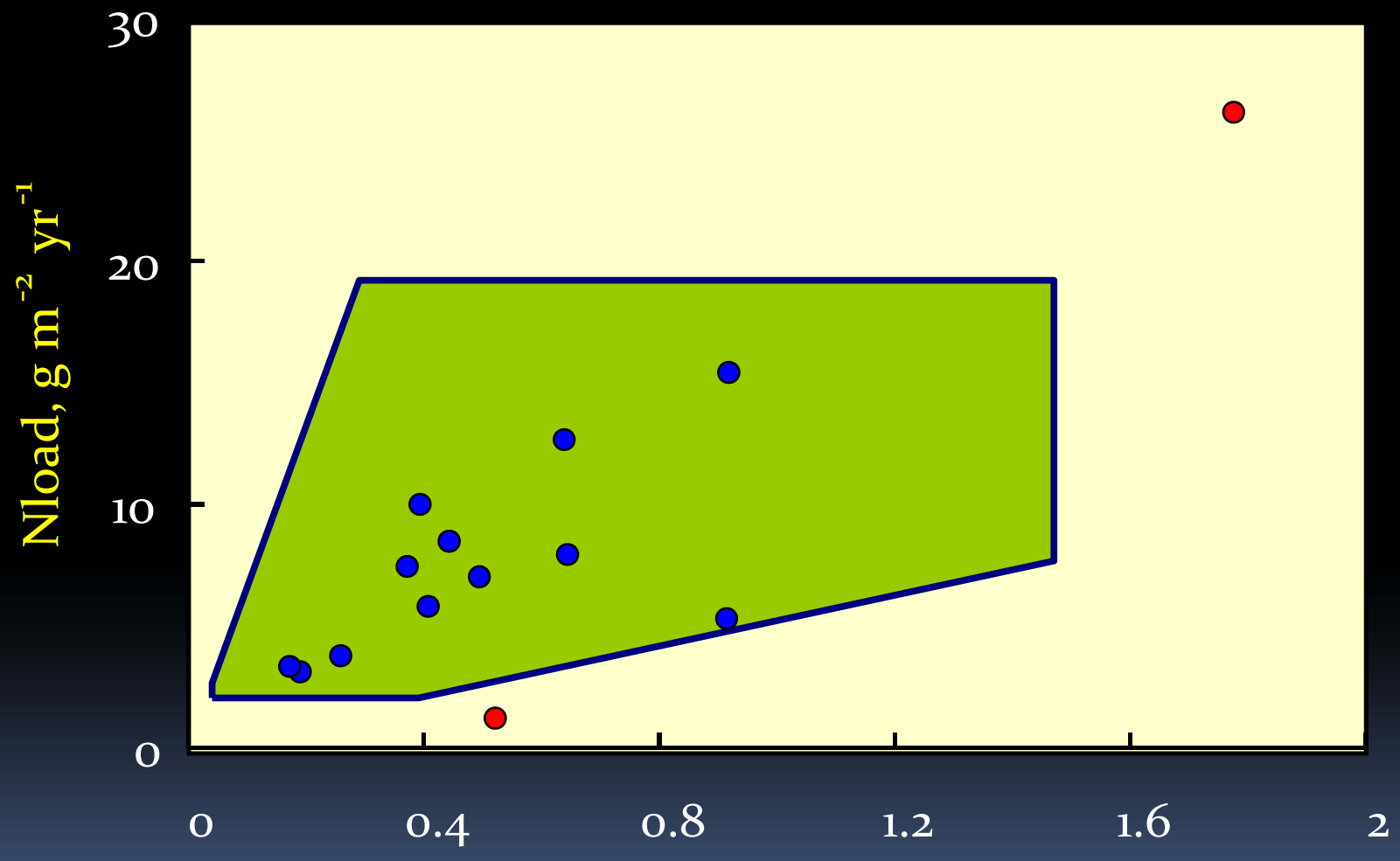
Improvement #1

Management Measures or External forcing	Permissible Range
Nitrogen load	?<Nload<?
Phosphorus load	?<Pload<?
Water level	?<WL<?

Modelling approach- merging of tools

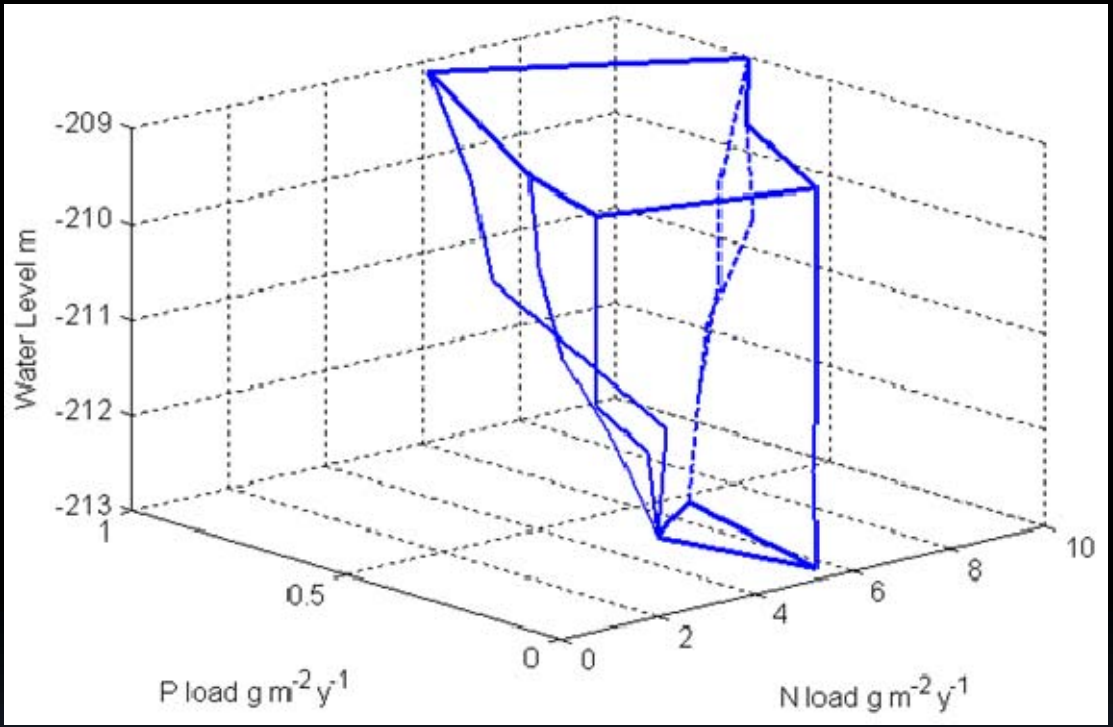


Sustainable Management Policy (WL=-210)

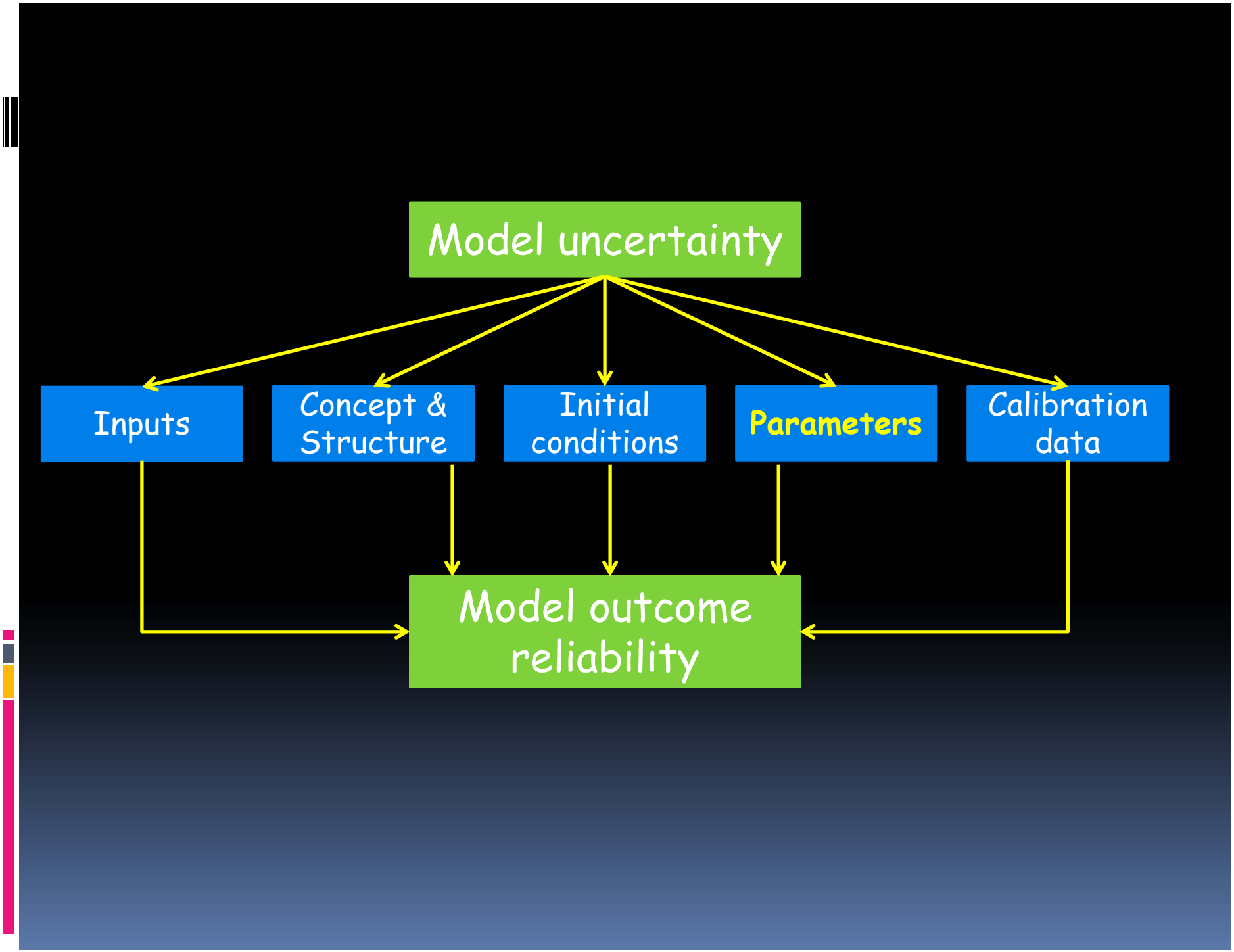


Parparov & Gal 2012

SUSTAINABLE MANAGEMENT POLICY



Gilboa et al. submitted


Model uncertainty
Inputs
Concept & Structure
Initial conditions
Parameters
Calibration data
Model outcome reliability

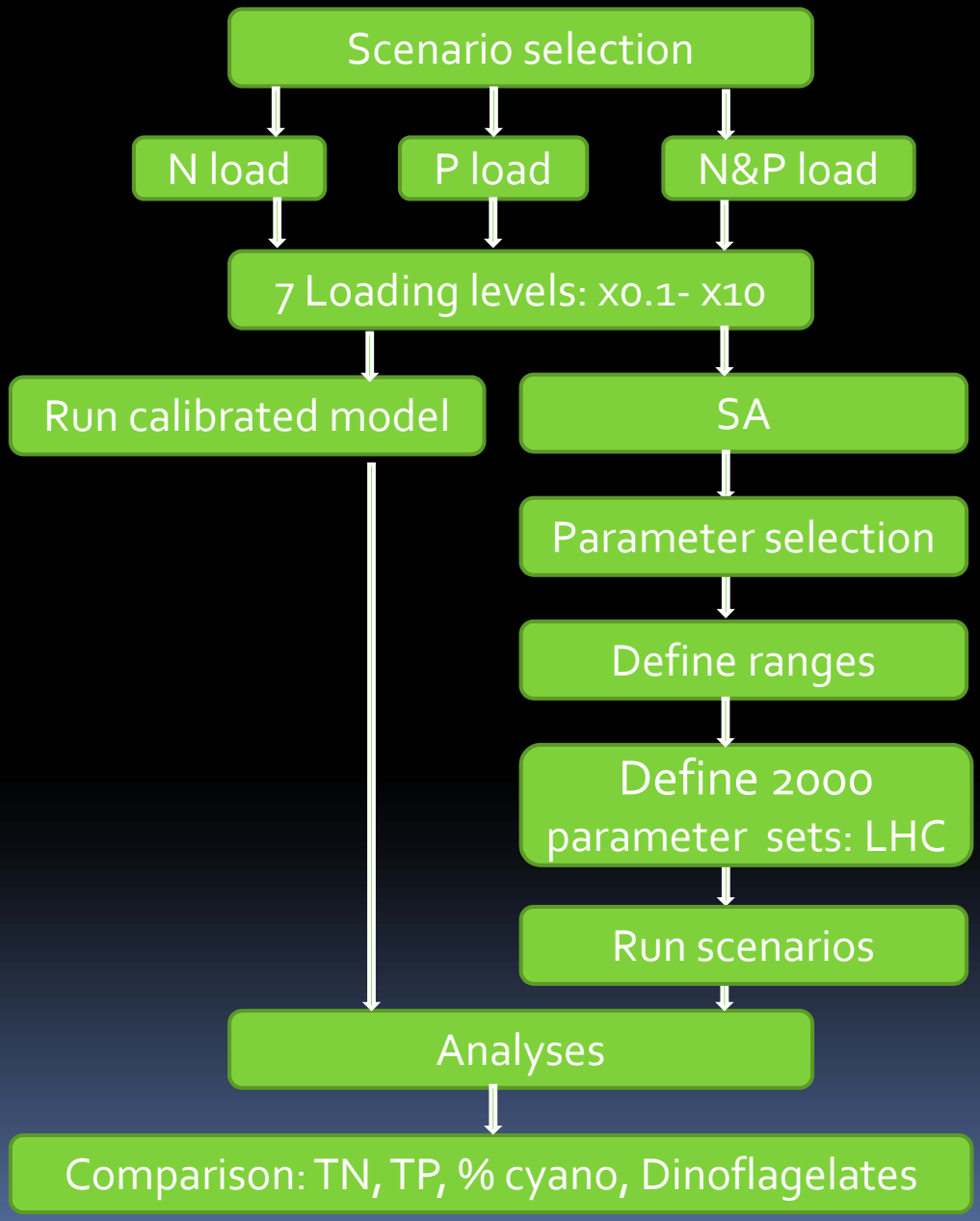
Possible approaches to confronting uncertainties

- Quantify various sources of uncertainty
- Quantify global uncertainty
- Multi-model ensemble approach (IPCC)

Alternatively…

a single-model ensemble approach: deals with parameter uncertainty

Methodology

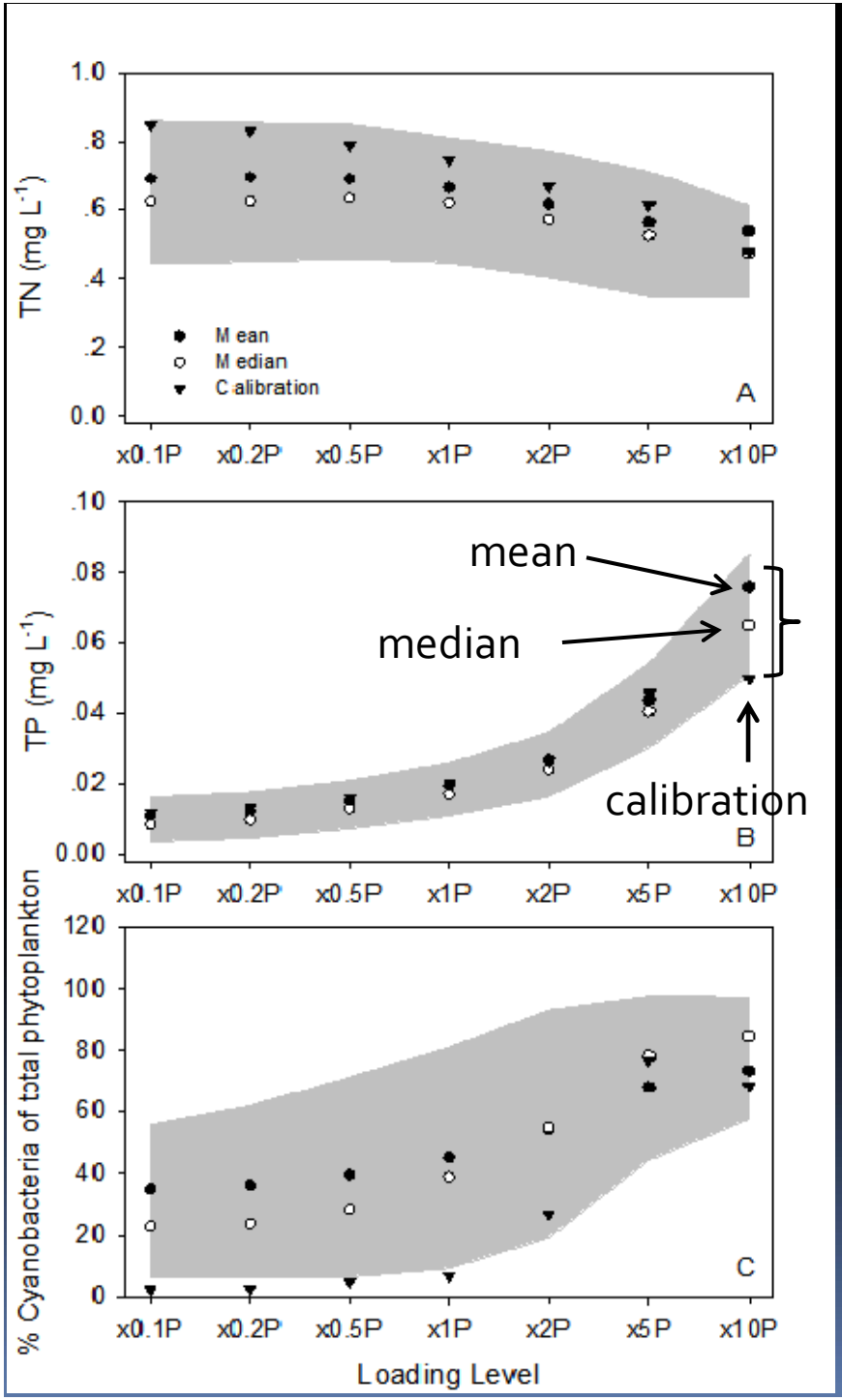


Makler-Pick et al 2011

7 x 3 x2000 simulations

Gal et al. submitted

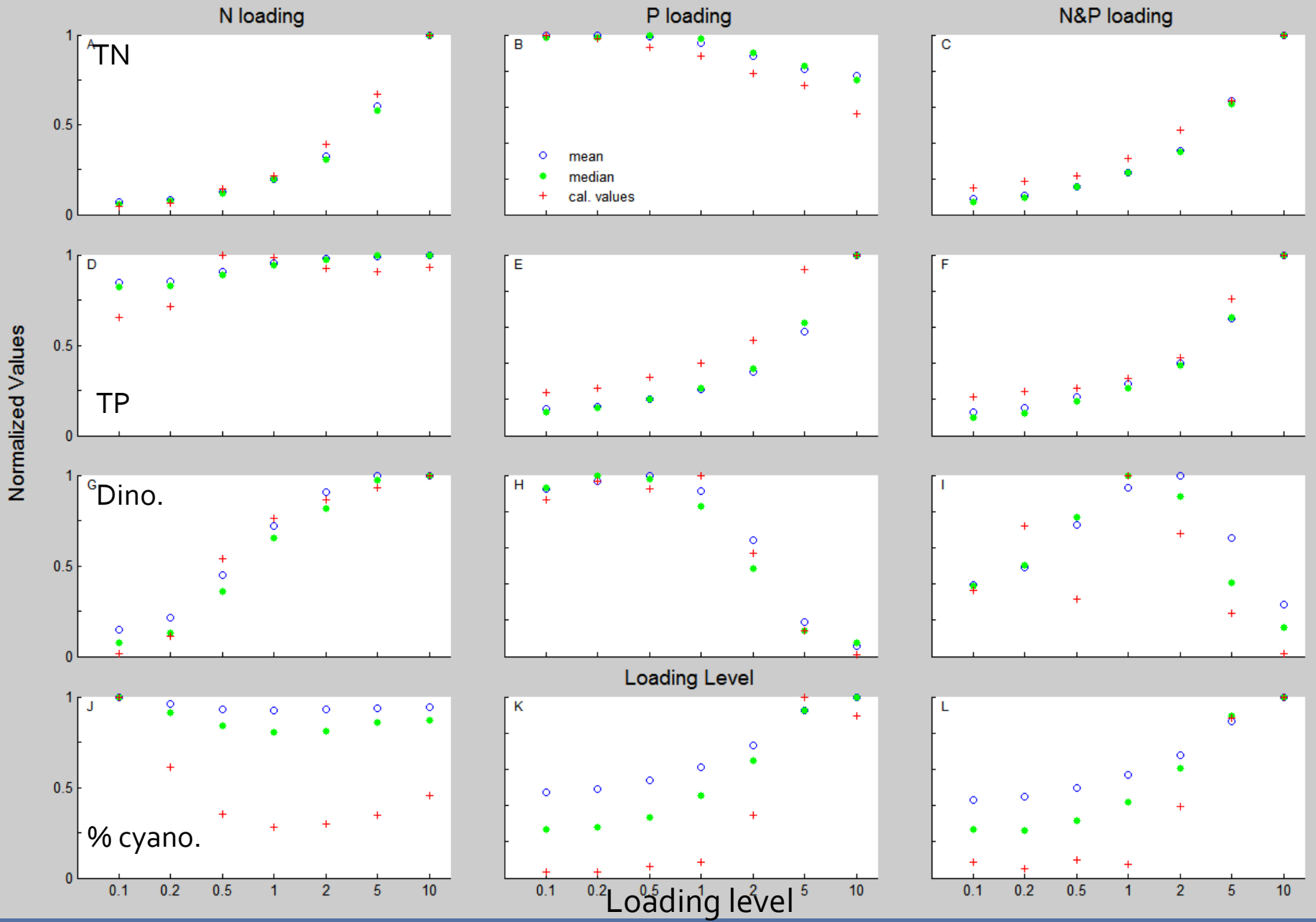
P loading scenarios



25-75 percentiles

Gal et al. submitted

Impact of N,P and N&P loading



Summary

- Ecosystem models are useful but suffer from uncertainties hindering their effectiveness as a management tool
- We use scenarios and multiple realizations to
  - Define relationships between loading levels and water quality and ecosystem variables
  - Define and recommend acceptable ranges of management measures
  - Evaluate impact of parameter uncertainty in context of management
- But, how to define scenarios?

Partners

- Arkadi Parparov
- Yael Gilboa
- Vardit Makler-Pick
- Noam Shahar