CROSS-BORDER CONSEQUENCES AND CONFLICTS OF INTEREST IN RIVER BASIN MANAGEMENT PLANNING

The case of the Tisza River (Ukraine, Romania, Hungary, Serbia)

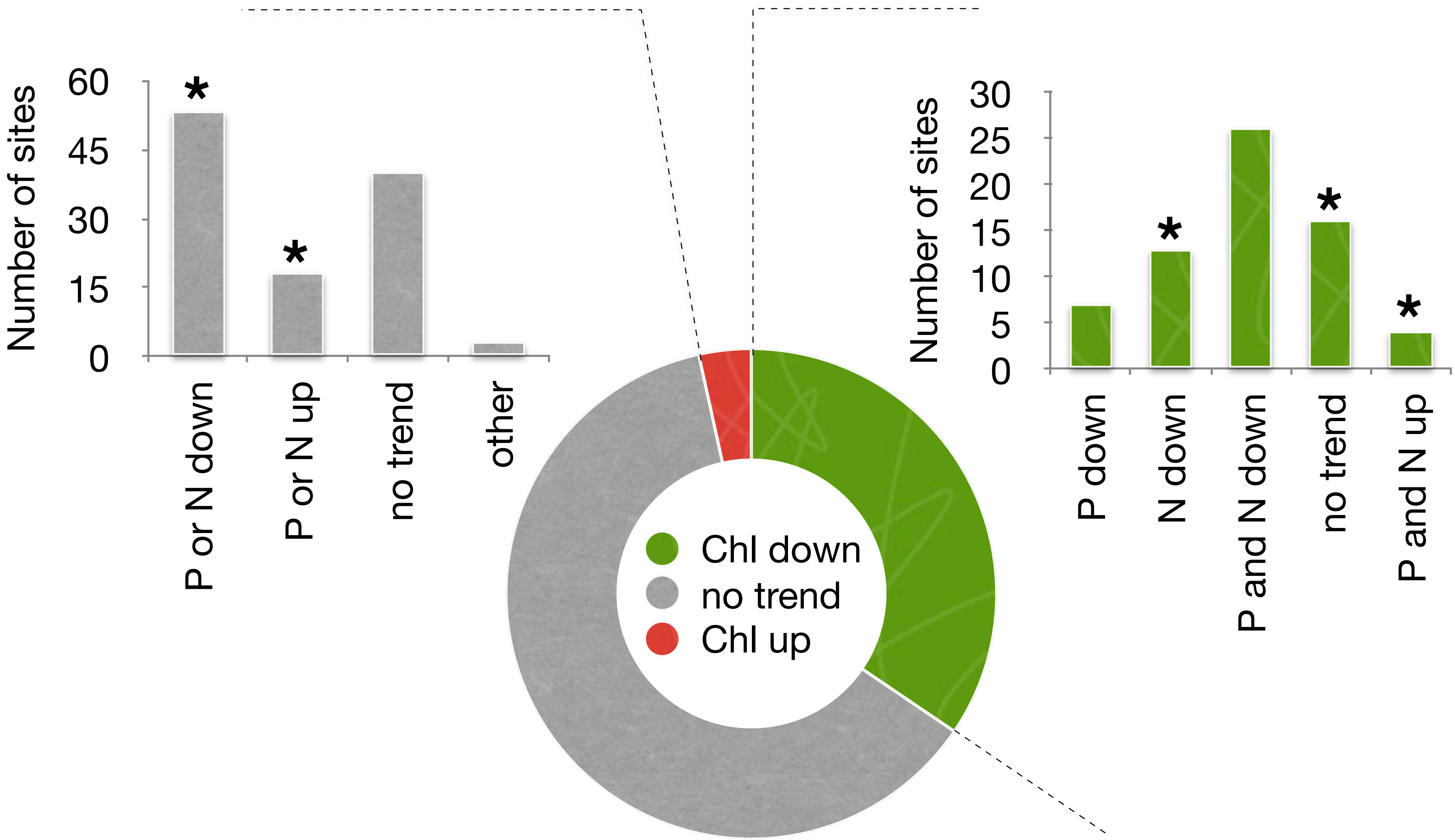
Mark Honti & Vera Istvánovics
MTA-BME Water Research Group, Hungarian Academy of Sciences

Stream eutrophication

- Eutrophication management relies on nutrient control
  - P control successful in lakes
  - Less obvious in streams
    - Interfering factors:
      - Hydromorphology (bedform)
      - Hydrodynamics (turbulence, WRT)
      - Stream network topology (reaches, reservoirs)

- Algal development may occur 100’s of kms downstream, management requires basin-scale approach
- WFD focuses on domestic water bodies

Stream eutrophication: fuzzy relation with nutrients

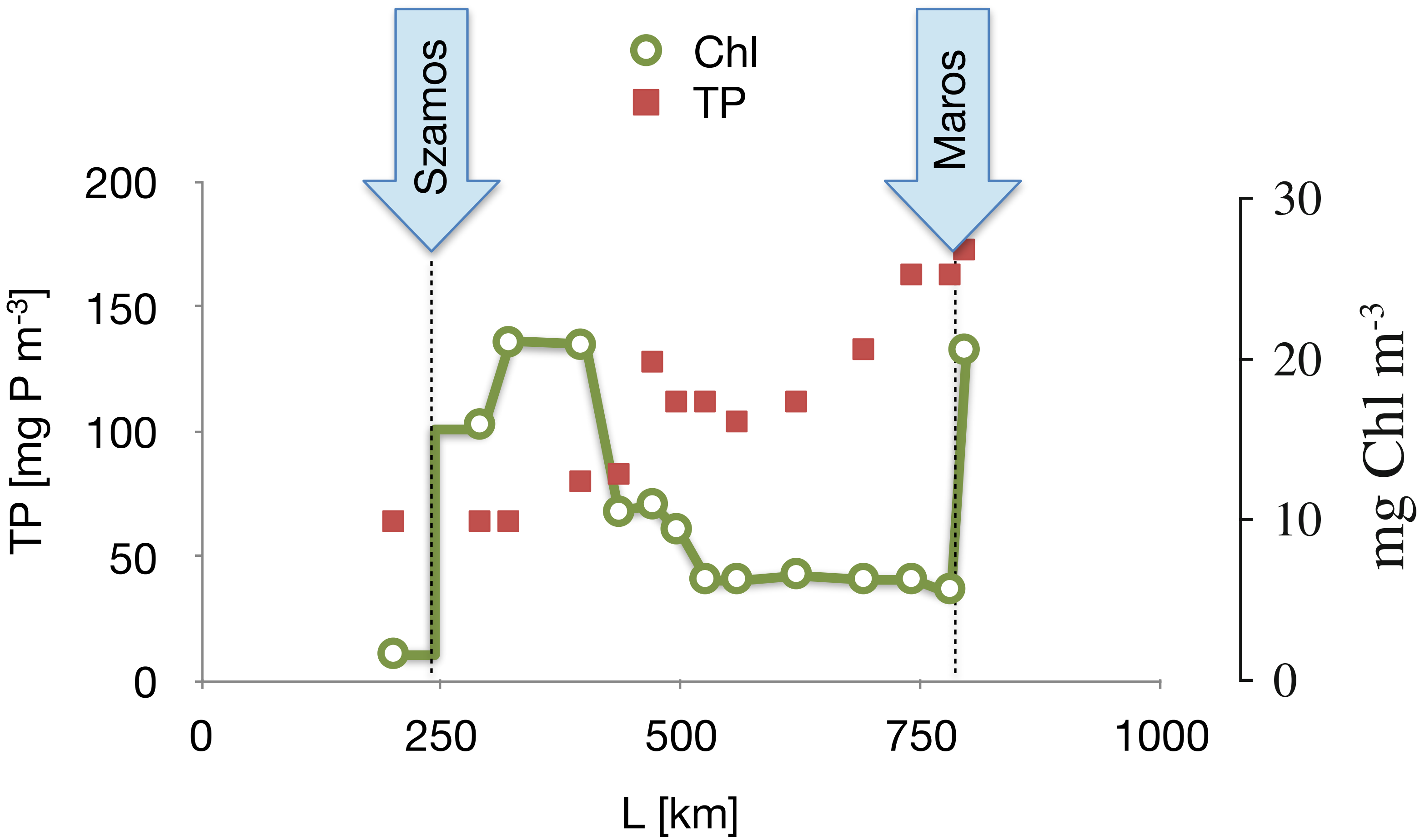


Istvánovics & Honti (2012) Efficiency of nutrient management controlling eutrophication of running waters in the Middle Danube Basin. doi: 10.1007/s10750-012-0999-y

Five countries share the Tisza catchment (UA,RO,SK,HU,SRB)

Eutrophication status in the Tisza River

- Tisza receives algae from 2 large tributaries[1]
- Tisza is too deep (up to 10 m) to support meroplanktonic algal growth[2]



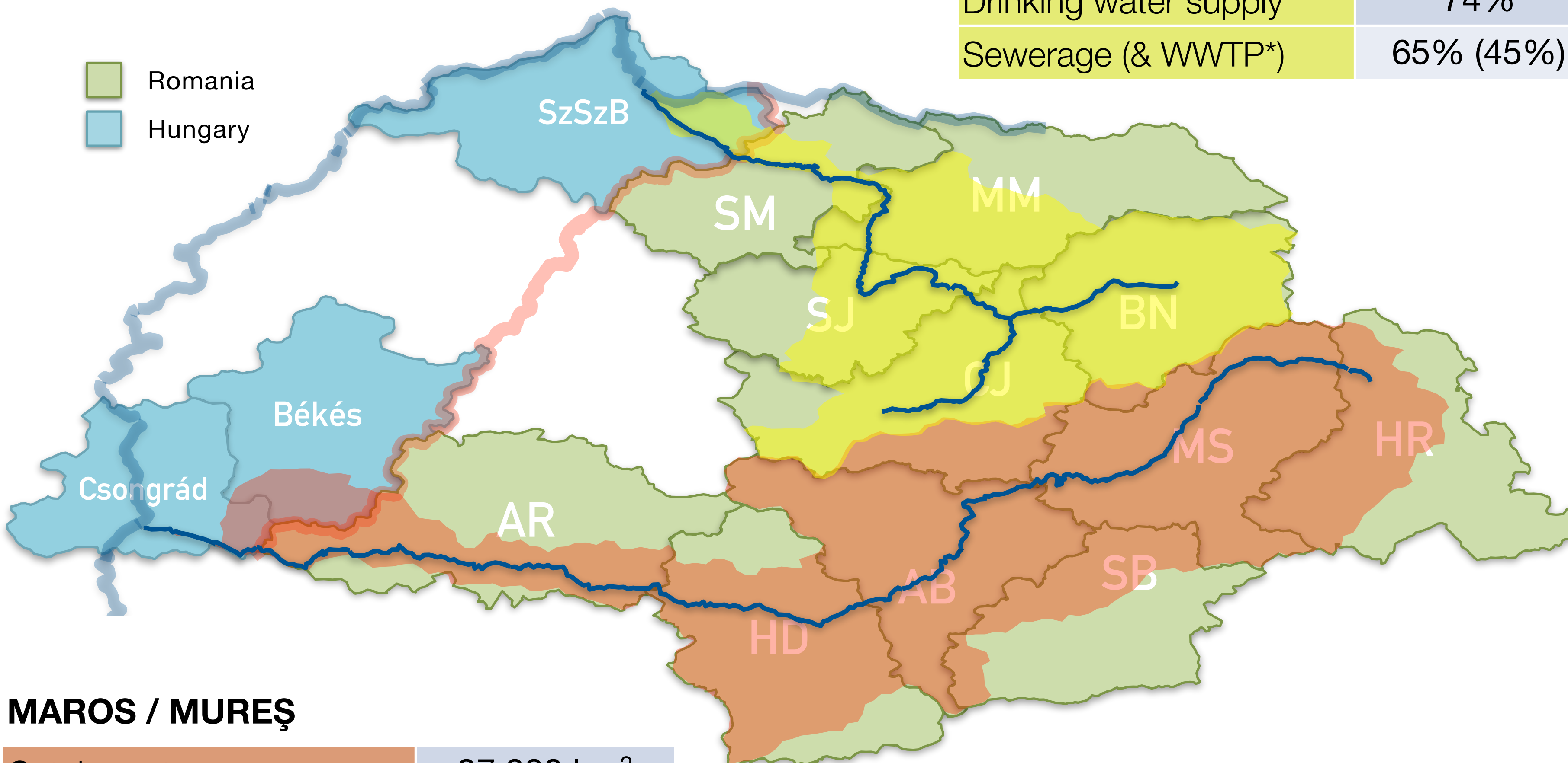
1: Istvánovics & Honti (2012) doi: 10.1007/s10750-012-0999-y

2: Honti et al. (2008) Assessing phytoplankton growth in River Tisza (Hungary). Verh. Internat. Verein. Limnol. 30 (1): 87-89.

Szamos & Maros

SZAMOS / SOMEŞ

Catchment area	18 000 km^2
Population	1 200 000
Drinking water supply	74%
Sewerage (& WWTP*)	65% (45%)



MAROS / MUREŞ

Catchment area	27 000 km^2
Population	2 300 000
Drinking water supply	63%
Sewerage (& WWTP*)	48% (30%)

*tertiary treatment

Conflicting development objectives along these international rivers

- Downstream: improve water quality, incl. trophic and toxicological status
- Upstream: improve drinking water and sanitation infrastructure

14 LIFE BELOW WATER

THE GLOBAL GOALS
For Sustainable Development

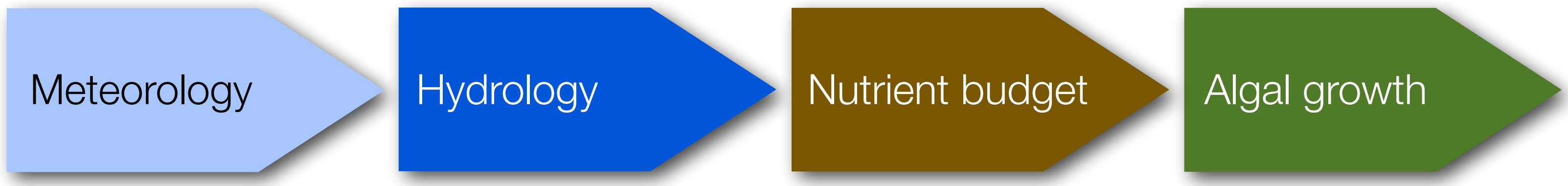
6 CLEAN WATER AND SANITATION

- Downstream has only indirect influence on incoming water quality

Approach

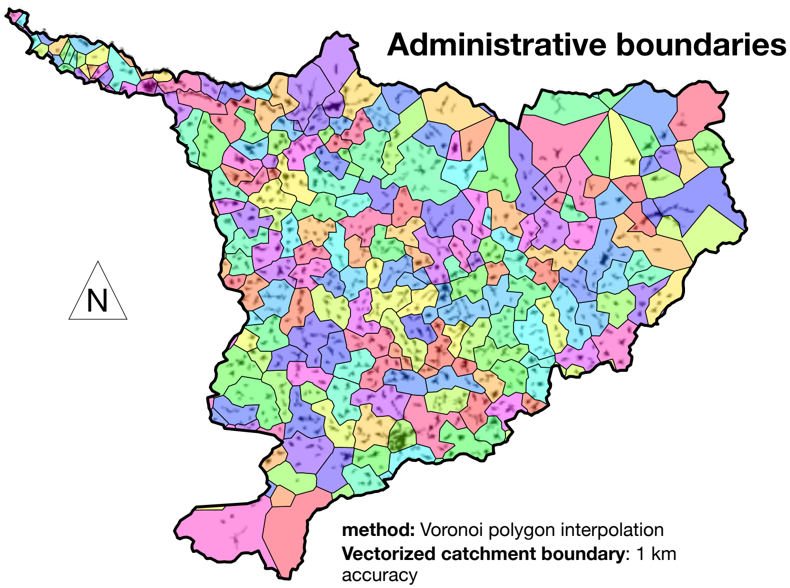
- **Objectives**
  - Model eutrophication in the Szamos and Maros
  - Assess improvement strategies
- **Methods**
  - Detailed modeling for the Szamos
    - Identify conflicts of interest
    - Propose compromise solution
  - Simplified modeling for the Maros (method testing)
    - Describe current status
    - Assess sensitivity / vulnerability

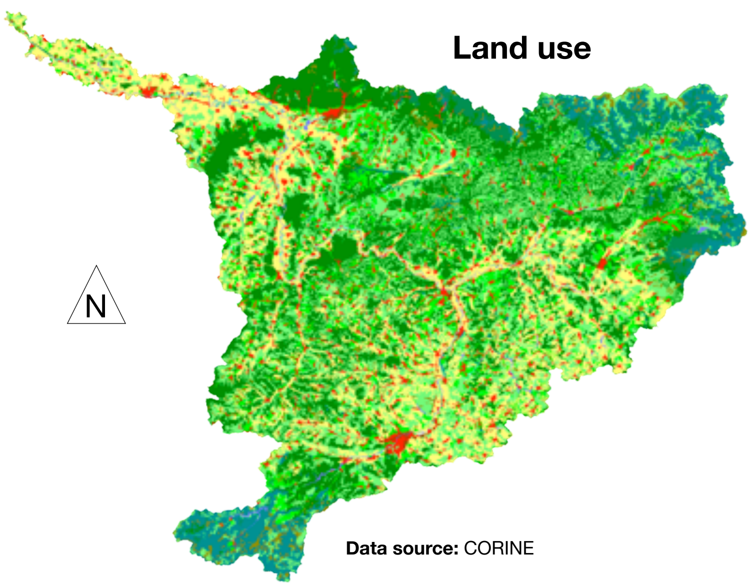
Szamos: Methods



- Nutrient budget on municipality-level
  - Point and diffuse sources
- Unified catchment and water quality model
  - Embedded in a GIS environment
  - Modelled discharge, nutrient fluxes and algal growth in the entire stream network
- Scenario analysis
  - Realistic and hypothetical states

Administrative & institutional differences



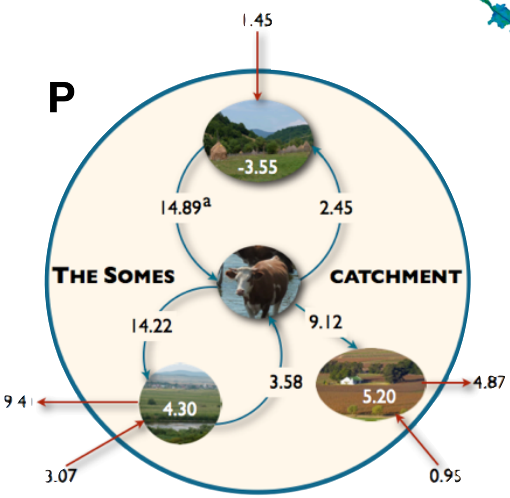


- Statistical data
  - Data collection on NUTS 5 level (RO: municipality, HU: settlement)
  - Different land use and crop categories
- Institutions
  - RO: The Environmental Agency (Agenţia pentru Protecţia Mediului) doesn't do routine water quality monitoring
  - RO: The Water Agency (Apele Române) focuses on water quantity data
  - HU: United Environmental, Water and Nature Protection Agency (until 2012), now under Ministry of Internal Affairs
- Water quality monitoring network
  - HU: high spatial resolution, monthly data
  - RO: minimum requirements from EU WFD, mostly NO_3

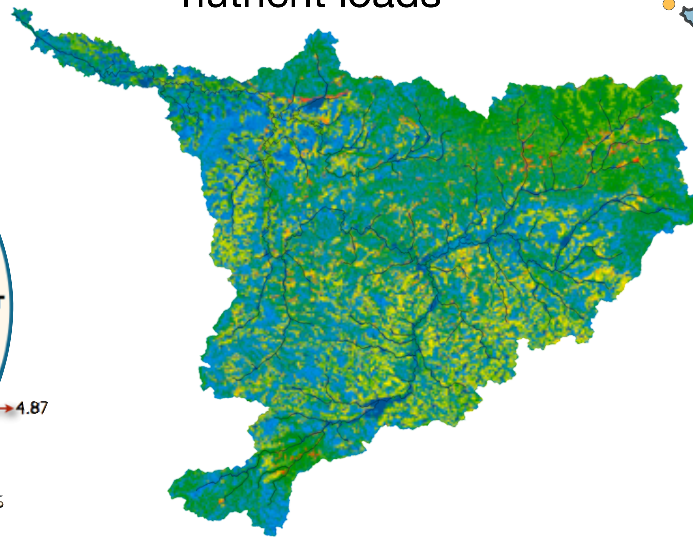
Low population density, extensive agriculture

Szamos: catchment modeling

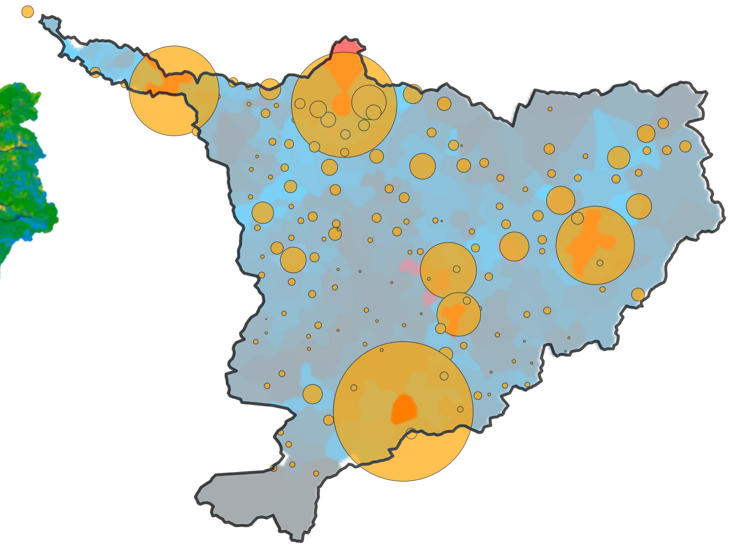
- Agricultural nutrient budget



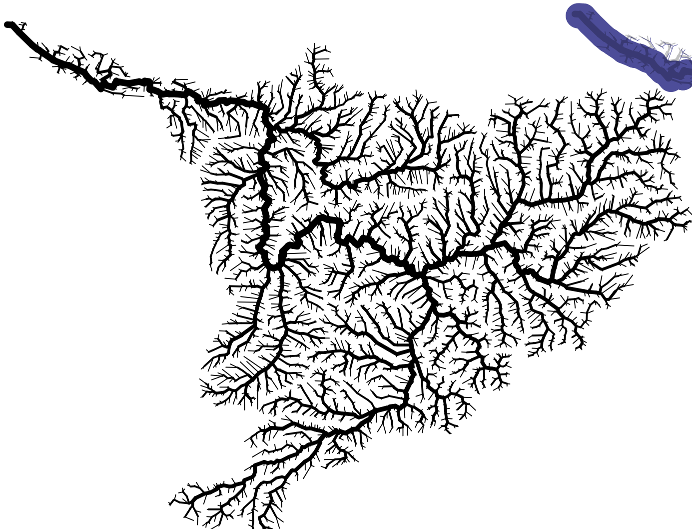
- Soil loss, diffuse nutrient loads



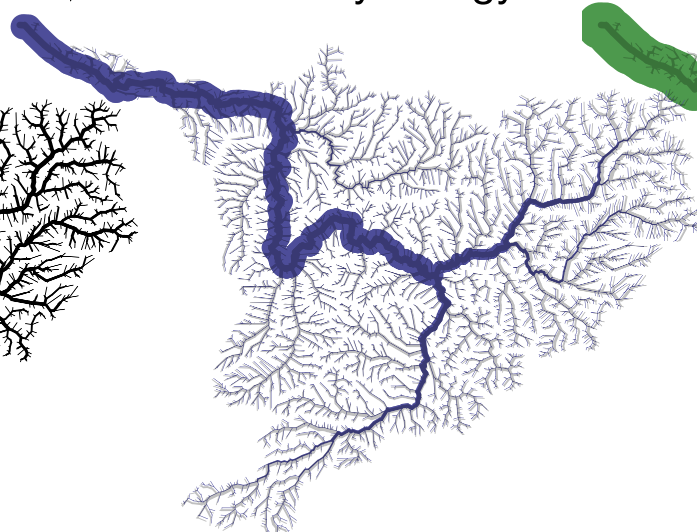
- Point sources



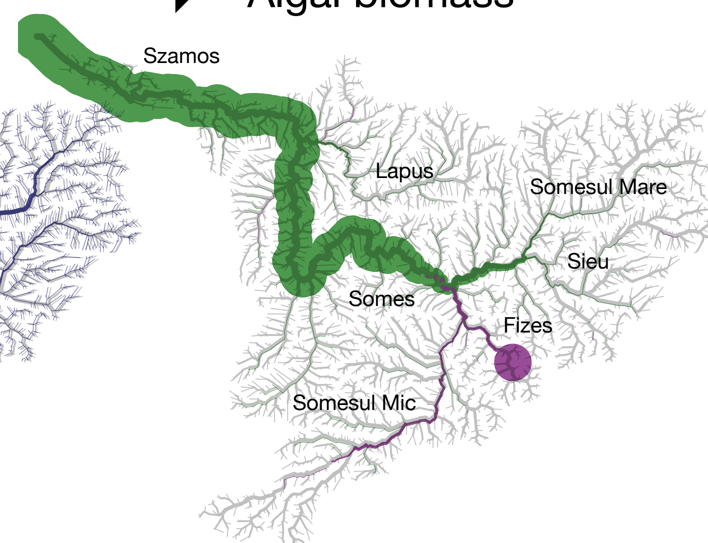
- Stream network



- Seasonal hydrology

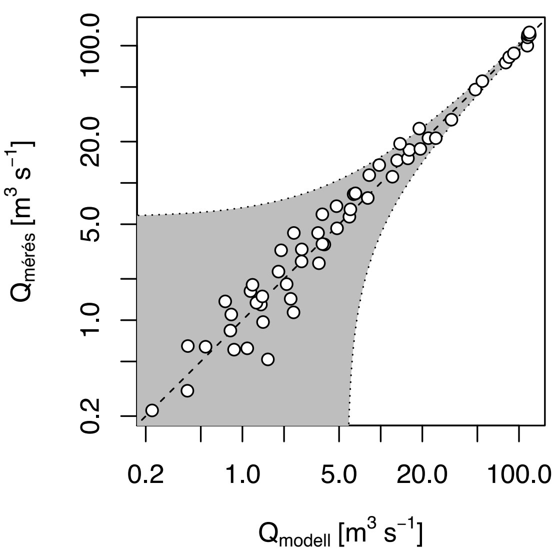


- Algal biomass

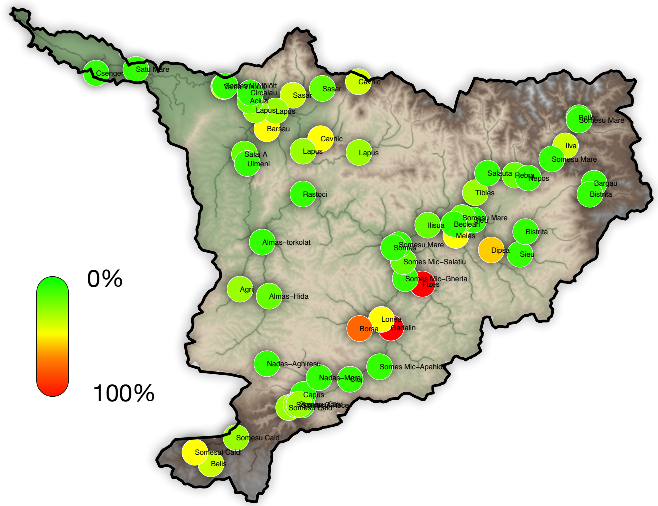


Szamos: catchment modeling

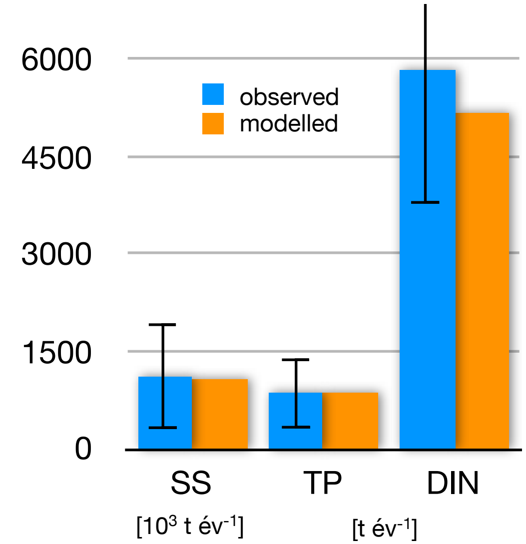
Modelled vs. observed Q



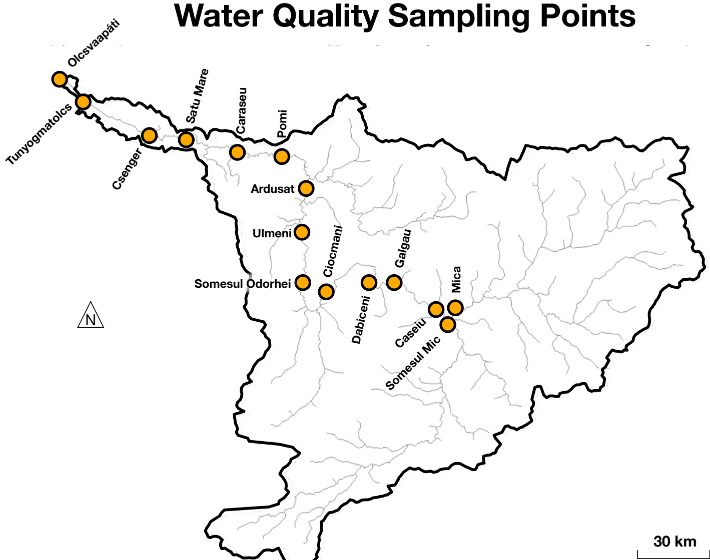
Q Error



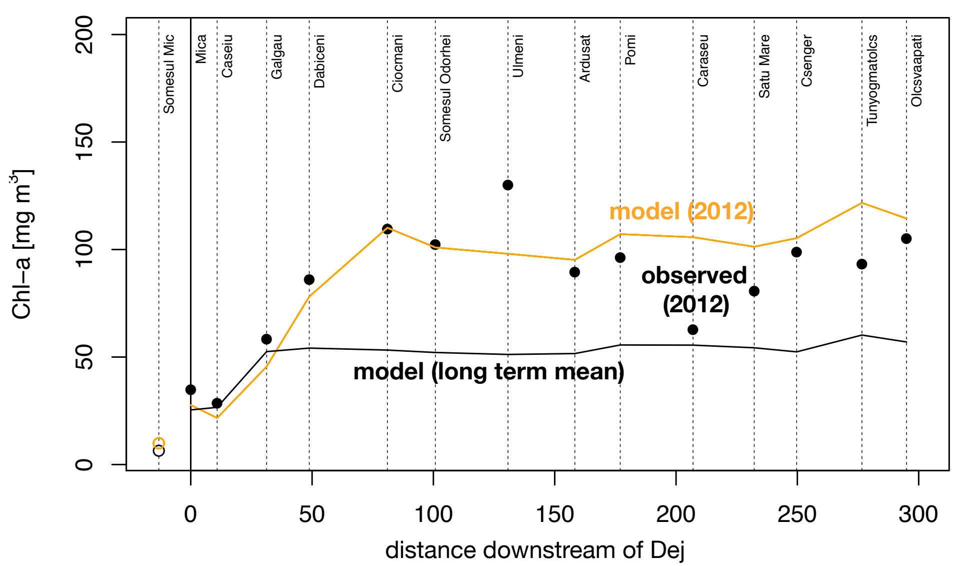
Annual load (Csenger)



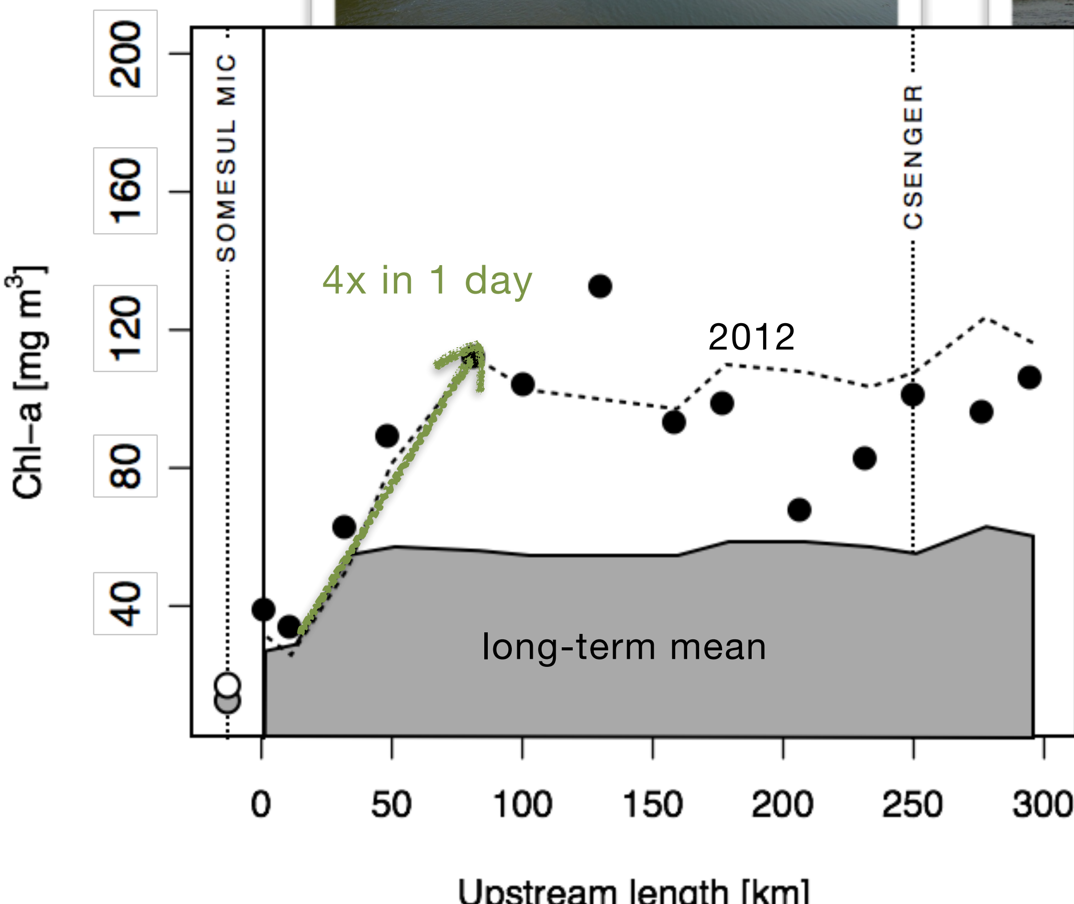
Water Quality Sampling Points



Observed & modelled algal biomass in Somes

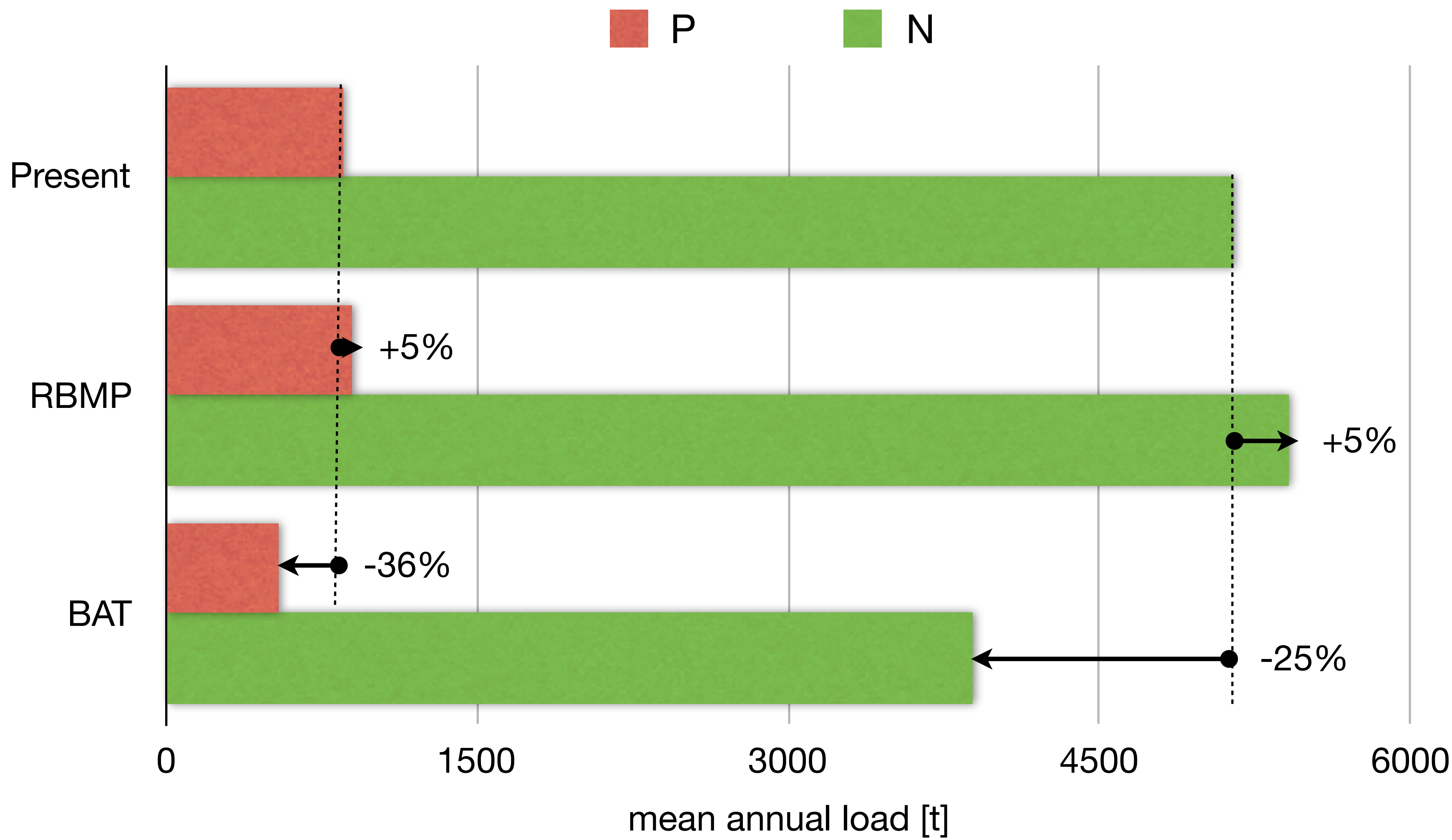


Szamos: hydromorphology & algal growth



- Generous P supply
- Shallow, braided channels increase apparent growth rate of algae
- Natural hydromorphology implies sensitivity to eutrophication

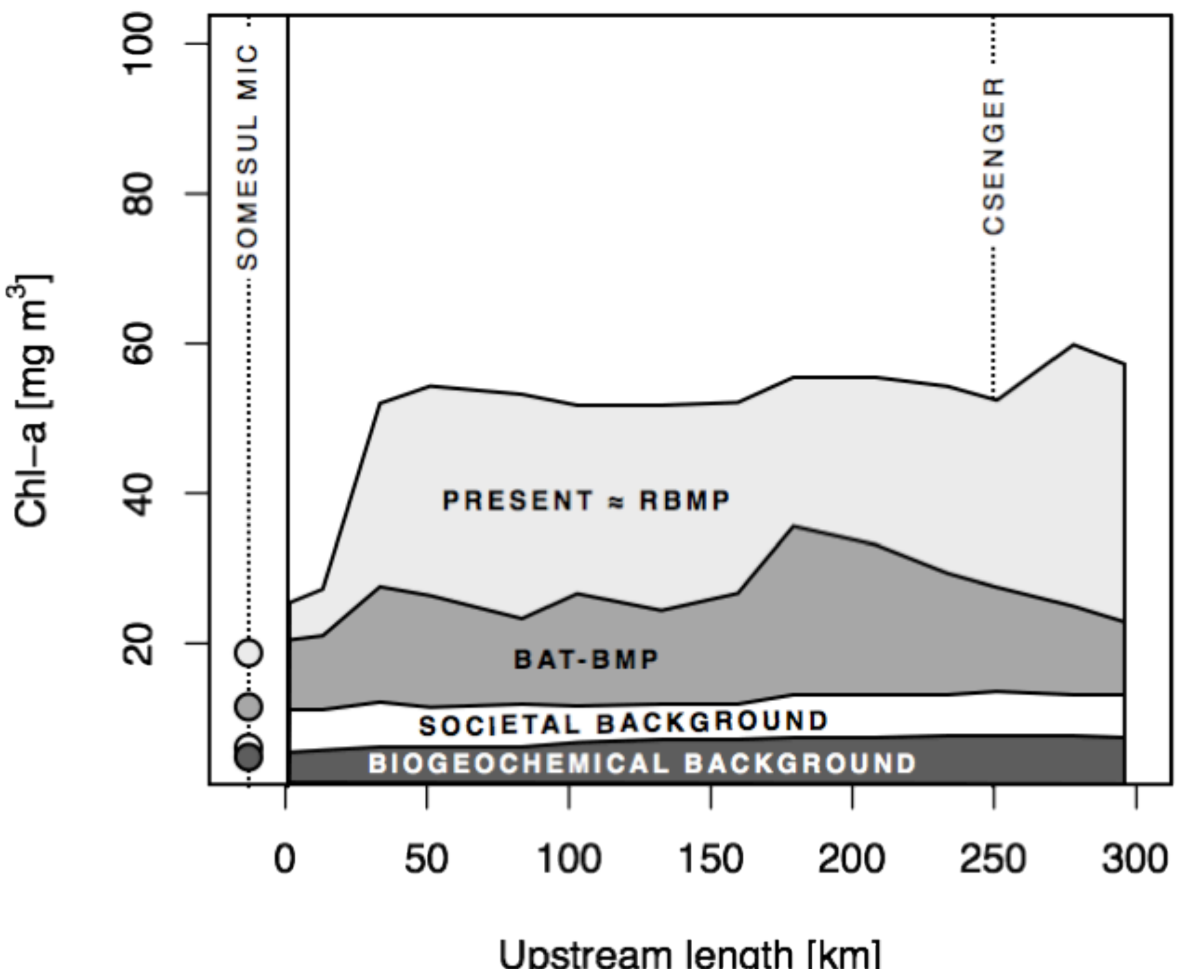
Szamos: nutrient loading scenarios



- RBMP: current river basin management plan (Apele Române: Planul de Management al Spatiului Hidrografic Someş-Tisa)
- BAT-BMP scenario: upgrade of 9 major WWTPs to enhance P removal + agricultural BMPs on erosion hot-spots

Szamos: eutrophication scenarios

- BAT-BMP scenario: upgrade of 9 major WWTPs to enhance P removal + agricultural BMPs on erosion hot-spots
- Societal background: present landuse + no point sources
- Biogeochemical background: no inhabitants, natural vegetation everywhere



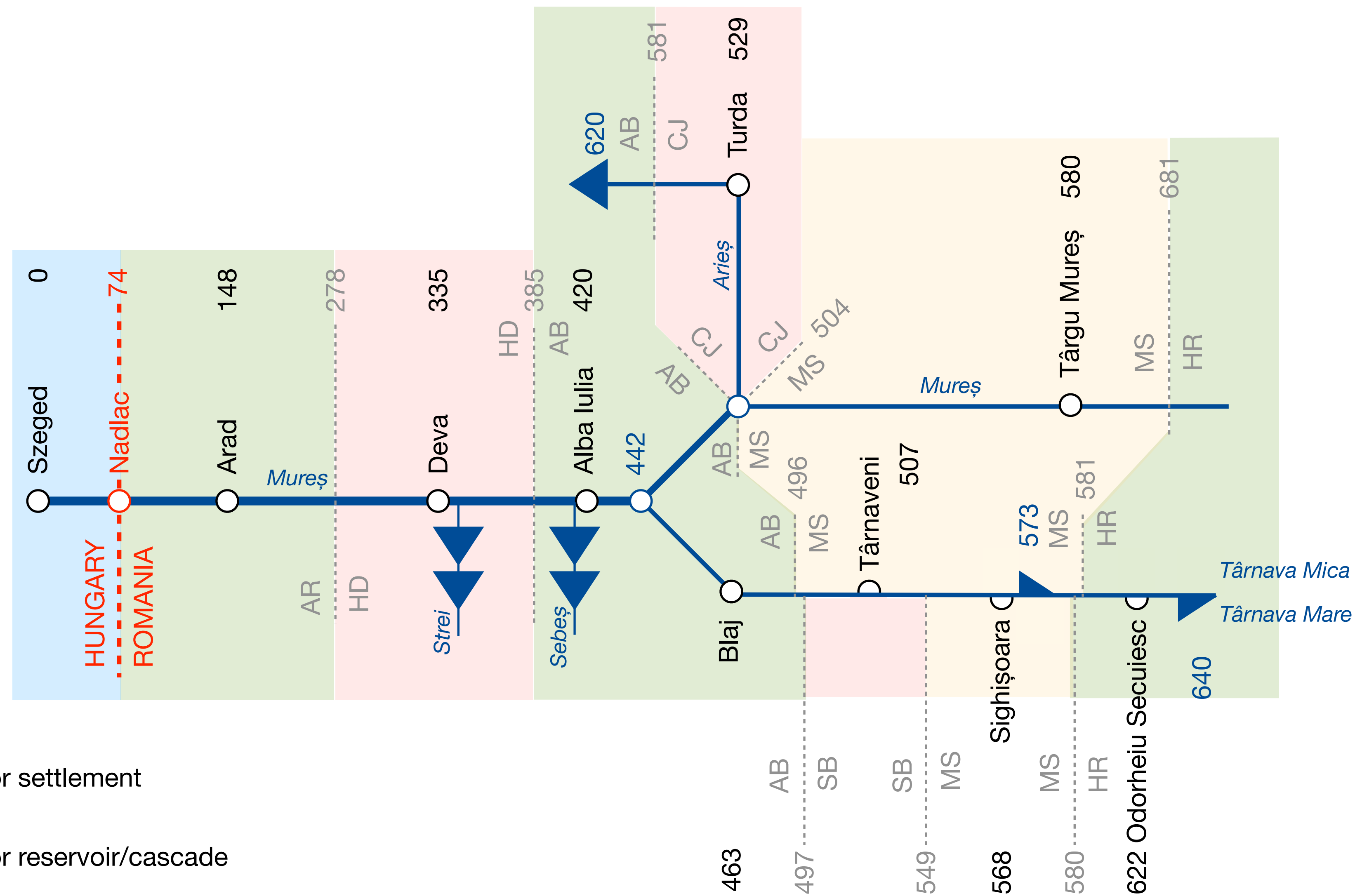
Lessons learnt from Szamos

- Management
    - Compromise solution exists, requires extra resources to improve status in Romania
- Science
    - Network topology is crucial
    - Rapid development of meroplanktonic algae in shallow, diverse streambeds
        - <u>Free growth length from closest obstacle</u> (e.g. large reservoir)
    - 66% of annual P load available for algal growth

Maros: Methods

- Discharge is estimated from catchment area
- Simplified nutrient emission is calculated at county (județ) level
  - Point and diffuse sources from population and WWTP data, agricultural statistics (inorganic fertilizers & manure, large animal farms)
  - Transfer efficiencies from Szamos
- Stream topological model
  - Simulation of present status
  - Assessment of vulnerability

Maros: Topological map

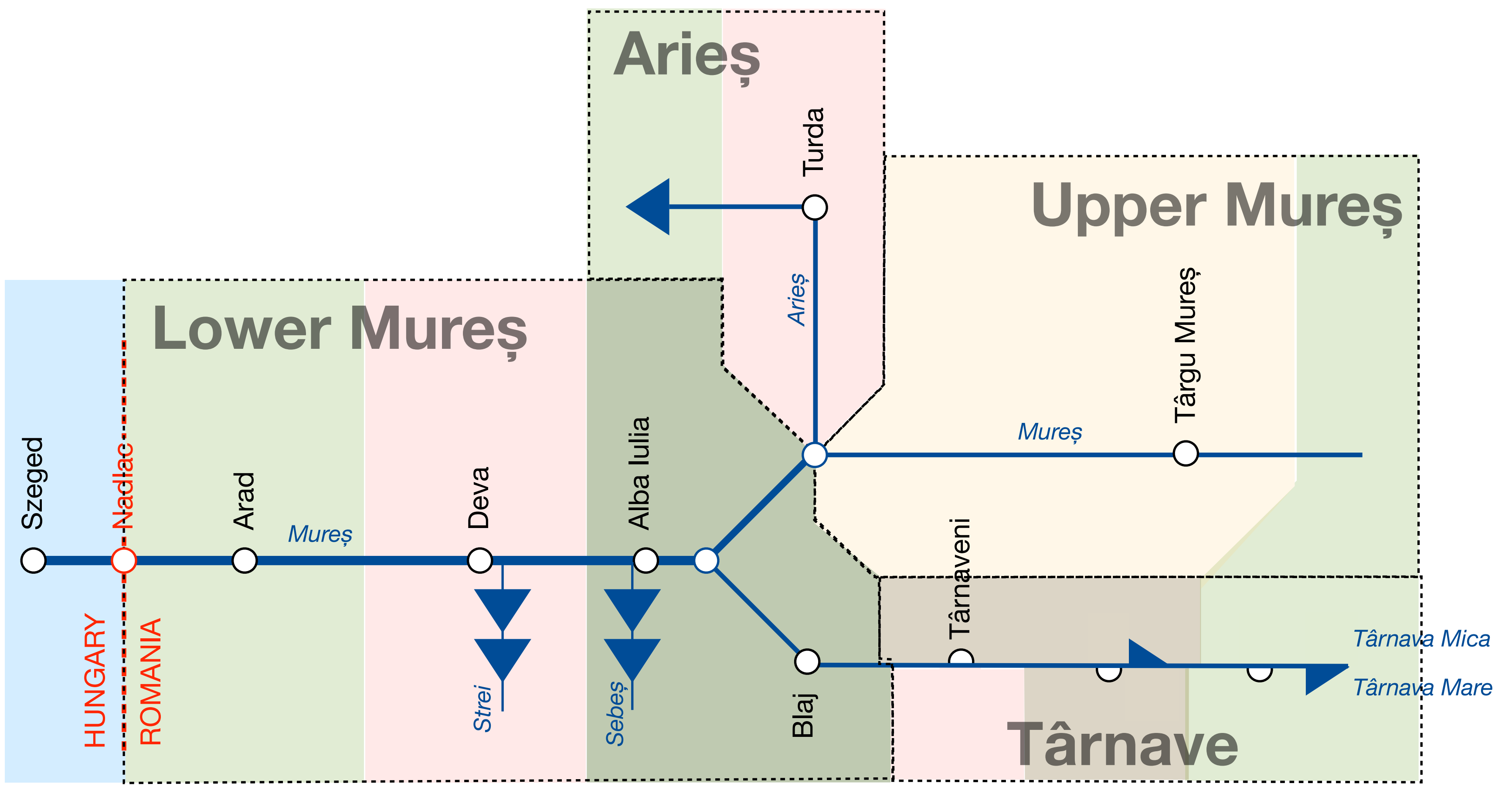


○ Major settlement

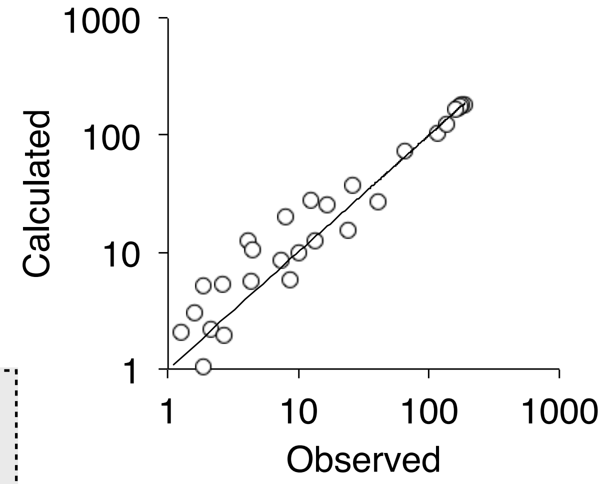
▶ Major reservoir/cascade

123 Distance from Tisza

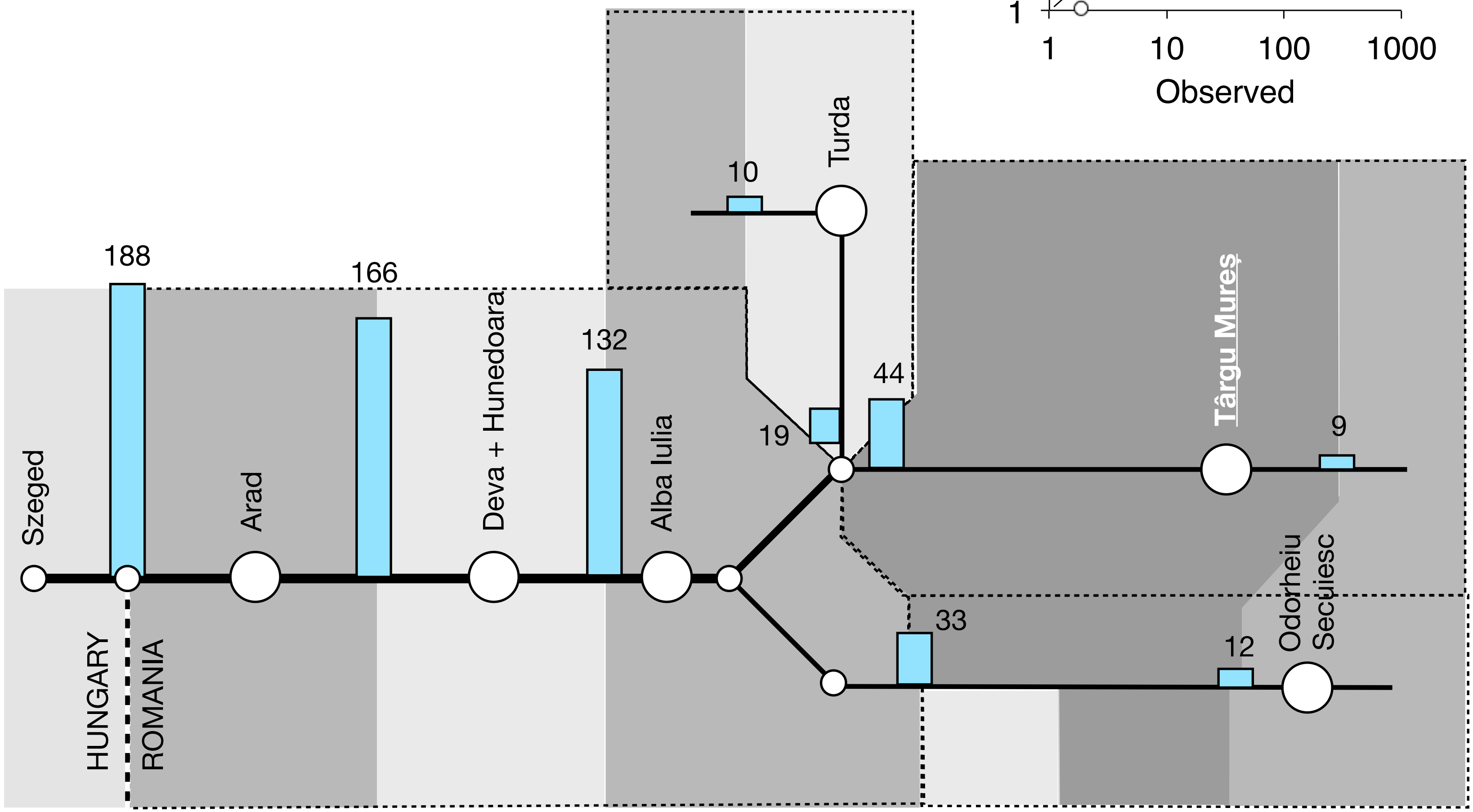
Maros: Subcatchments



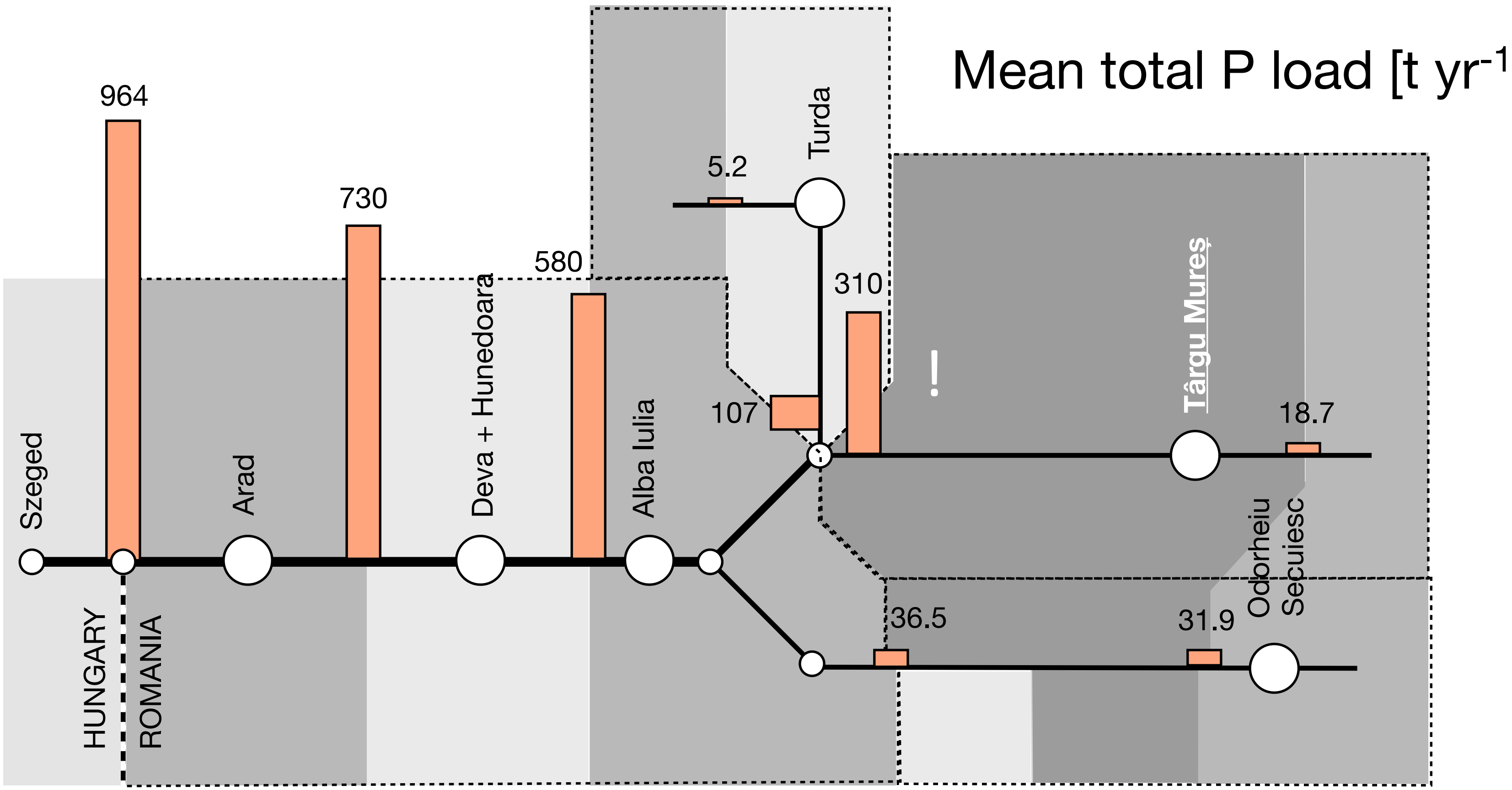
Maros: Results



Mean discharge [m^3 s^{-1}]



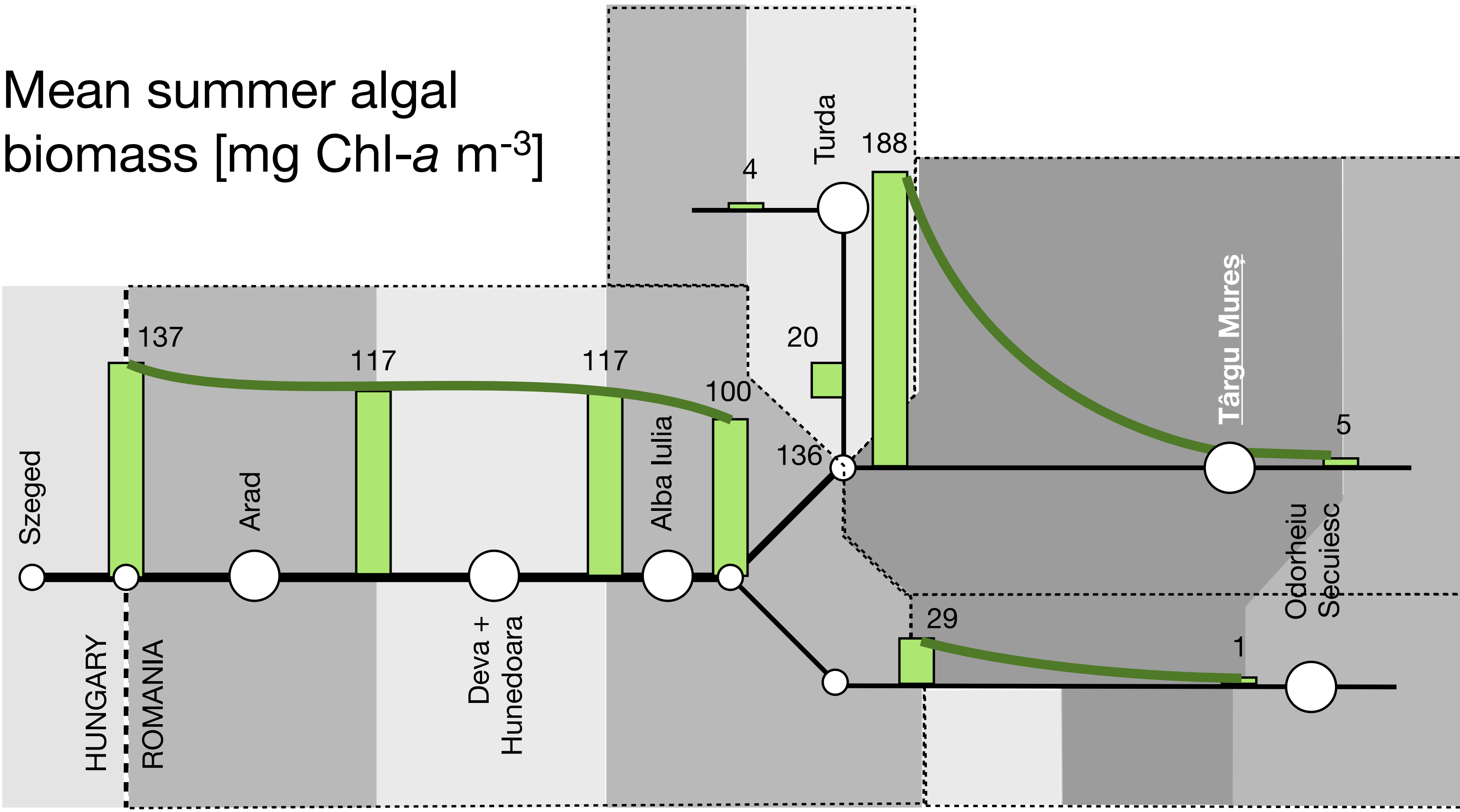
Maros: Results



- Observed TP load at the border: 900-1100 [t yr^{-1}] (~200-250 mg P m^{-3})
- City of Târgu Mureș adds ~200 t P/yr quite upstream

Maros: Results

Mean summer algal biomass [mg Chl-*a* m^{-3}]



- Observed mean concentration at the border: 128 [mg Chl-*a* m^{-3}]
- Algal growth explodes downstream of Târgu Mureș
- Algae exhaust P capacity in the last 500 km
- Sufficient diluting capacity for the large city loads in lower reaches

Maros: Vulnerability

- Full P exploitation of algae means that any additional P load will directly converted into Chl
- Reduction of P load is necessary to improve water quality along the river
- Infrastructural development without increasing WWTP efficiencies will increase P load
- Heavy morphological changes would not change outflowing biomass

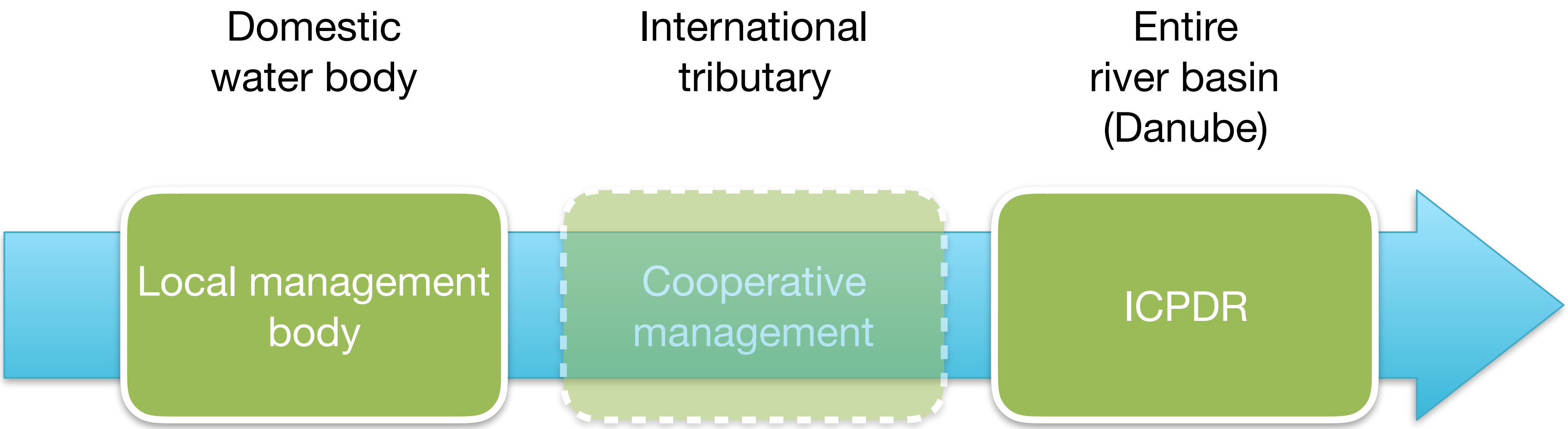
Issues with the RBMP practice

- Both Hungarian and Romanian RBMPs concentrate on local issues & solutions
- Most large river sections are classified as “heavily modified” because of flood defence infrastructure
- No real attempt is seen to improve ecological status
- Discrepancy of the “Water body” concept: a middle-sized creek counts as much as a section of a large river
- Virtual statistical improvement can be produced without touching the root of problems

Conclusions

- Controlling eutrophication in large tributaries would improve water quality 100s of kms downstream
- Harmonisation between domestic RBMPs is needed to
    - achieve improvement downstream
    - prevent worsening by pursuing alternative development objectives
- Meaningless to elaborate local RBMPs for downstream sections of large rivers
    - except improving state of local tributaries
- RBMP in SRB, HU should “target” upstream catchments, but how?

The missing link?



- International tributaries are sources of conflicts, which can't be resolved locally
- Typically not critical on the scale of the entire Danube Basin
- RBMP for such large tributaries should be done by international panels instead of glueing local RBMPs together

Summary

- Szamos & Maros are heavily eutrophicated
  - P load from point sources (infrastructural deficit)
  - Natural hydromorphology boosts algal growth
  - Droughts (climate change) increase algal growth
  - Management can reduce algal concentrations to about half
  - Infrastructural development without considering river properties will worsen status
- Water quality in Tisza is determined by tributaries



E N D