Assessment of nutrient retention in Hungarian rivers, based on long term water quality monitoring data

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Background: Nutrient retention in rivers is a key part of diffuse nutrient pollution emission estimation processes, as model performance can only be validated at monitoring points on rivers. In-stream retention can be modelled by complicated water quality models like QUAL, but in many cases only empirical relationships provide the means of estimating the retention e.g. in MONERIS model. This latter model have been used in Hungary as well, and the current work analyse the monitoring data of the national water quality monitoring network in order to check the model's performance on estimating in-stream nutrient retention. Data series length differ substantially at different monitoring stations, narrowing down the time gap in which retention calculation is possible. All monitoring stations that have at least monthly sampling have been included in the study, but only a fraction of them have more frequent measurements.

Methodology: This study follows a very simple methodology.

Step 1. Monitoring stations have been selected based on the following criteria:
- neighbour stations, no tributary rivers, small relative diffuse load
- neighbour stations with tributary between them, also monitored

Step 2. Monitoring station data statistics have been calculated
- Number of data per calendar year
- Average value for calendar year
- Average value for x year periods
- Standard deviation for calendar year

Step 3. Retention calculation for years, where the number of data is greater or equal than ***10*** both on upper and lower stations
- Load based retention calculation if data were sufficient

$$Ret_{load} = 1 - \frac{L_{ds}}{L_{us}}$$

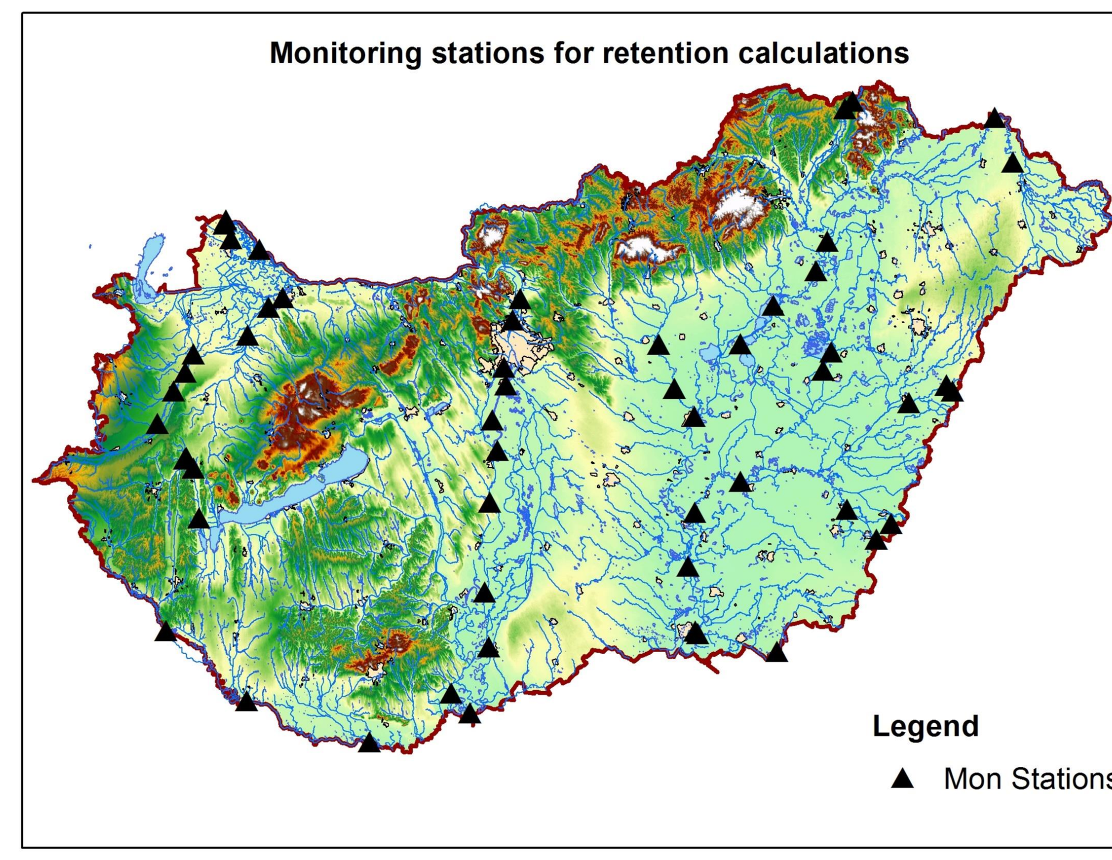
,where L_{ds} and L_{us} are upstream and downstream nutrient loads respectively

- Concentration based retention calculation if Q was not known

$$Ret_{conc} = 1 - \frac{C_{ds}}{C_{us}}$$

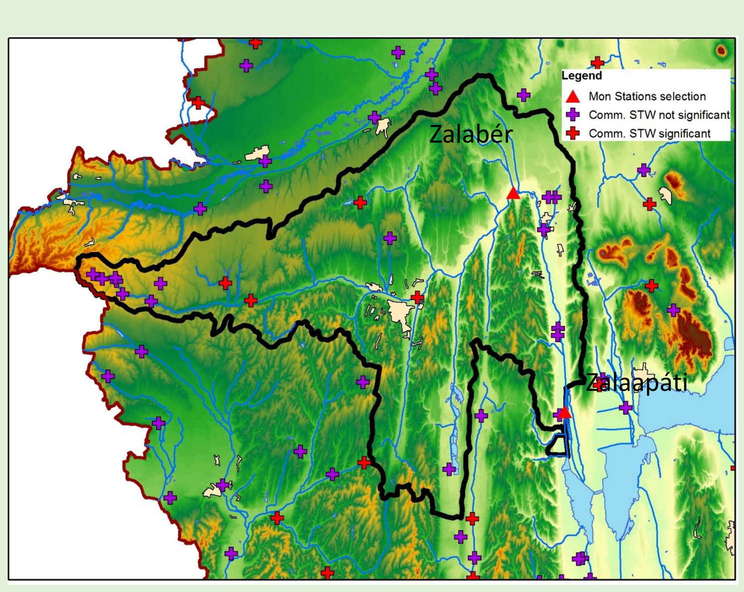
,where C_{ds} and C_{us} are upstream and downstream nutrient loads respectively

Step 4. Results were compared to Moneris equations used for retention estimation (Behrendt et al. 2000). Yearly average water temperature was approximated with 11 C° for Moneris retention estimation



Zala:

- Frequently monitored catchment (~1600 km²)
- small river
- Large q increase between stations
- Unknown tributary loads
- Only „soft" estimation is possible based on concentration values



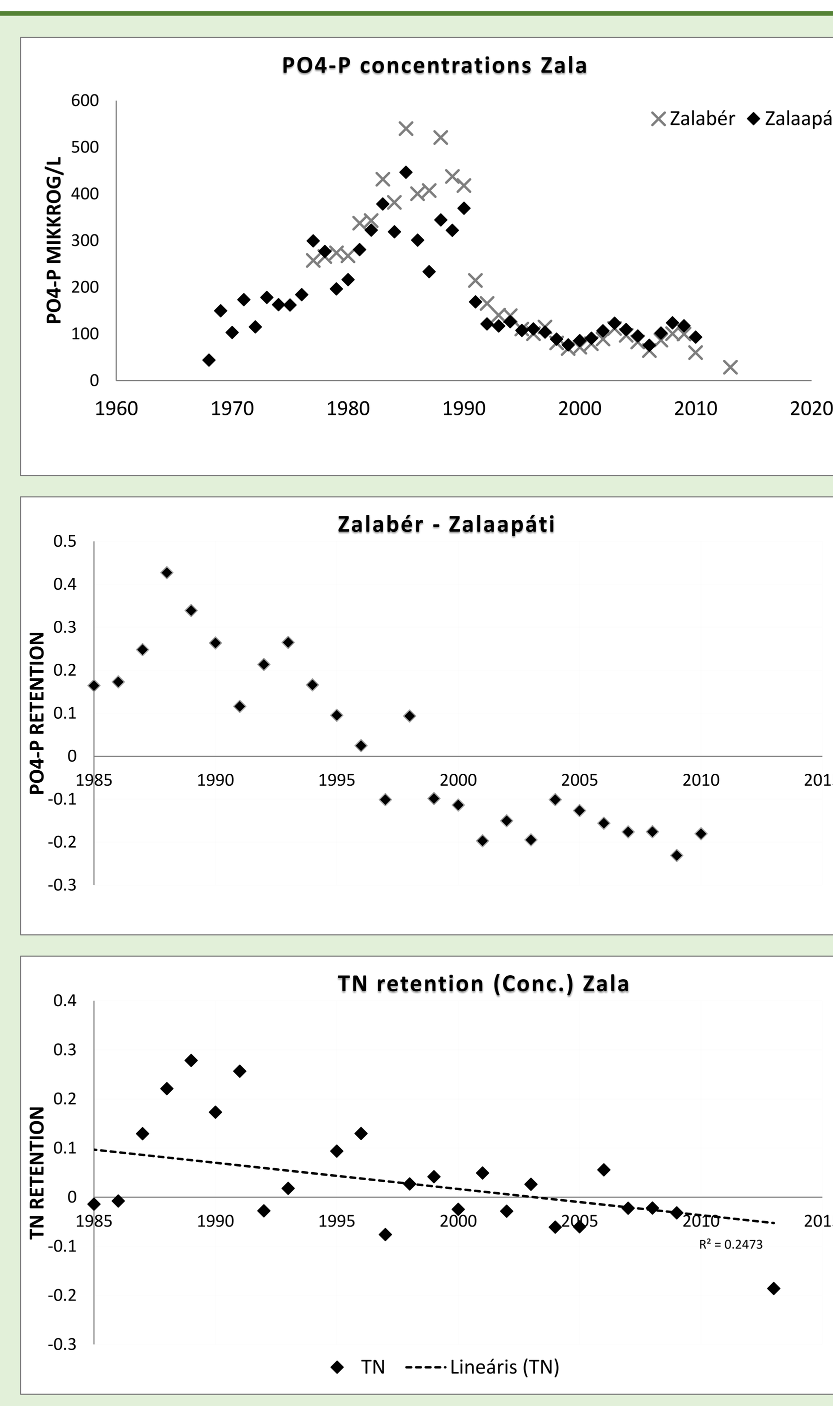


Fig R7,8,9: Temporal variations of in-stream conc. and ret. in Zala river

Remarks
- Significant river retention in the 80's
- + conc. gradient after 2000
- Likely cause: river bed inner loading after major reduction in upstream point loads

Results

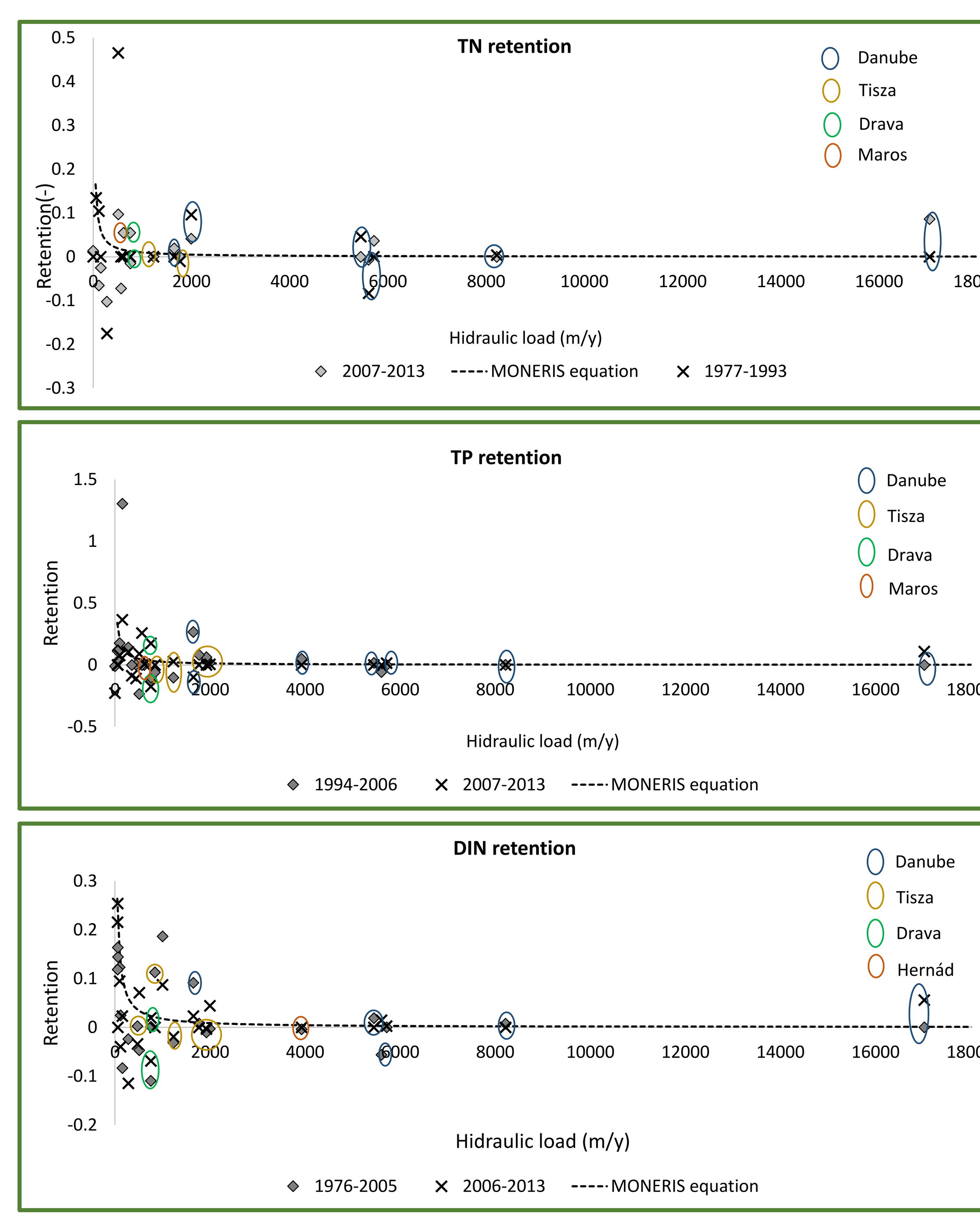


Fig R1,2,3: Retention values against Hydraulic load for TN, TP and DIN fractions

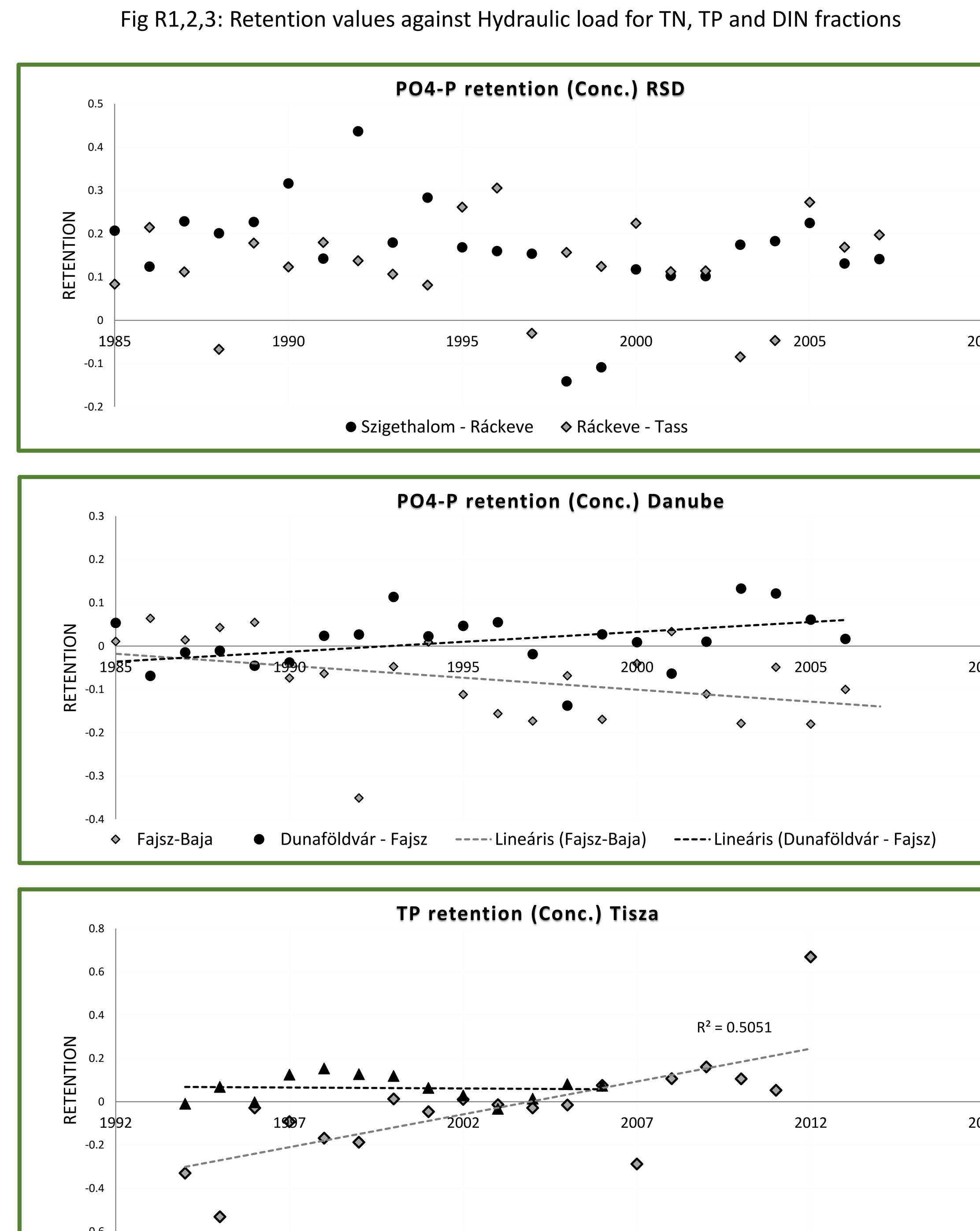


Fig R4,5,6: Retention values against time at different locations of different rivers

Conclusions

- None of the three nutrient parameters examined give back the empirical relationship, used in MONERIS model, accurately
- At higher hydraulic loads the retention values are close to zero, therefore fit well to the values calculated by the Moneris equation
- At lower hydraulic loads the average retention values between sampling points show larger variation, including negative retention in many cases
- Retention is changing along the Danube and Tisza, while there is also a temporal change in river nutrient retention in both rivers (Fig. R5, R6)

Possible causes of unclear results

- Both TP and TN measurements and Q measurement are inaccurate therefore retention calculations are not accurate either (PO4-P and DIN gives a chance for control)
- Monthly sampling used as minimum criteria is still not accurate
- Sampling at neighbour monitoring stations are sometimes delayed by many days, also causing inaccuracy in the retention values
- At smaller rivers, the increase of the flow is significant between monitoring points, but the loads from the incoming flows are generally unknown, i.e. the smaller the river the more uncertain is the calculation