Quantification and modeling of in-stream processes in forest impacted agricultural canals of the lower coastal plain

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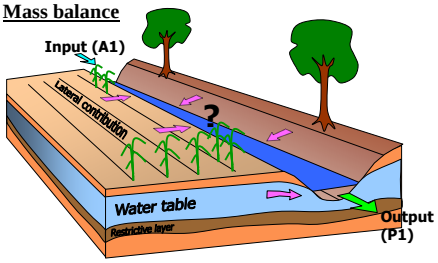
1. Objectives

- No accepted methods to describe and predict fate of nutrients in canals and streams
- Investigate the magnitude of the effects of in-stream processes in agricultural canals of the lower coastal plain
- Propose a modeling approach for quantifying nitrogen transformations in such canals

2. Methods

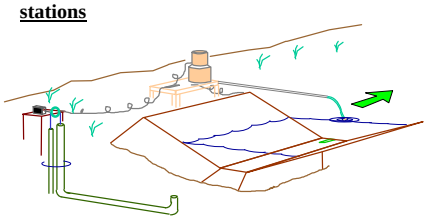
- Mass balance at the reach scale (1125 m long)
- Compare field results to transport modeling to derive an in-stream retention model for nitrogen

3. Mass balance



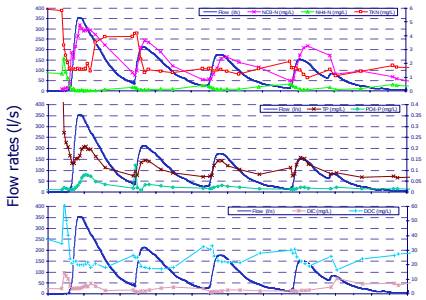
- Transformations = output – input – lateral contribution
- Lateral contributions monitored using nested GW wells for drainage flow calculations + weekly nutrient concentration in groundwater

4. Specially designed nutrient flux measurement stations



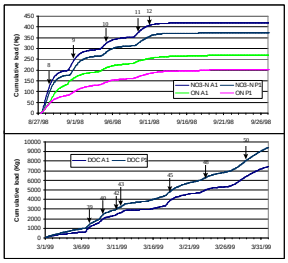
- Flow measured using Doppler flow meters in trapezoidal wooden section
- Nutrient concentrations obtained after analysis in the laboratory of samples collected at strategic times along the hydrographs
- 14-months of continuous data on flow and concentrations

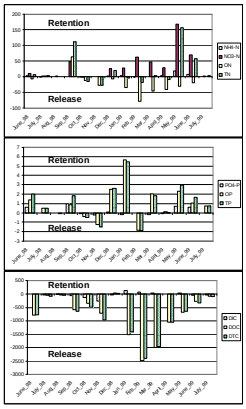
5. 14 months of continuous flow and concentration data



- "Concentration effect" during flow events for NO_3 (majority of the time), for TP and PO_4, TSS
- "Dilution effect"during flow events for NH_4, ON (majority of the time), DOC and Cl
- High DOC and NO_3 concentrations

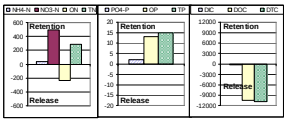
6. Measurable retention and release of nutrients in the reach



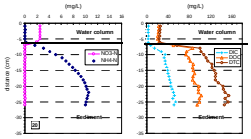


- After correction with lateral contributions
- Reach as a sink for:
  - TP and PO_4, (10.2% and 8.9% of input)
  - NO_3 and TN (5.5% and 3.1% of input)
- Reach as a source for:
  - ON and DOC (6.6% and 18.9% more than input)

7. Likely processes involved



- Macrophytes and algae uptake: no more than 20% of overall nitrate retention
- Most of nitrate disappearance attributed to benthic denitrification
- ON and DOC release attributed to export from benthic mineralisation

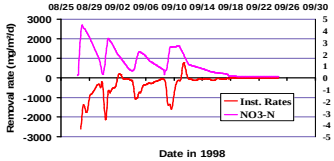


Interstitial sediment water concentrations

8. Using DUFLOW to calculate retention and release rates

- Use of modeling for predicting nutrient exports at the reach outlet without biogeochemical processes: transport modeling only
- Comparison between measured outfluxes and modeled ones:
  - Calculation of apparent rates of retention or release during identified periods of time
  - Release rates of ON, DOC and DTC over the winter flow period, with averages of 312 ±137, 11386 ±5707 and 11673 ±5801 mg/m²/d, respectively
  - During active flow periods NO_3 retention varied between ca. 200 and 800 mg NO_3-N/m²/d. Maximal values: 1162 (late March 1999) and 3838 mg/m²/d (June 1999)

9. Correlation between nitrate concentration and instantaneous retention rates



- Proposition of a simple model:

$$R = \rho \times [NO_3 - N]$$

- R retention rate (mg NO_3-N/m²/d), ρ mass transfer coefficient (m/d)
- Estimation with our data: ρ = 0.3 m/d

10. Conclusion

- Mass balance approach pertinent for measuring in-stream processes in canals of the lower coastal plain
- Magnitude of retention and release at the reach scale over a 14-month period within measurement uncertainties
- Studied reach acted like a wetland with retention of P, TSS, and NO_3 and release of ON and DOC

- NO_3 retention rates measured correspond to the upper reported values
- Data revealed at the reach scale an apparent "diffusion"-like process for NO_3 dissipation
- A simple nitrate retention model was proposed