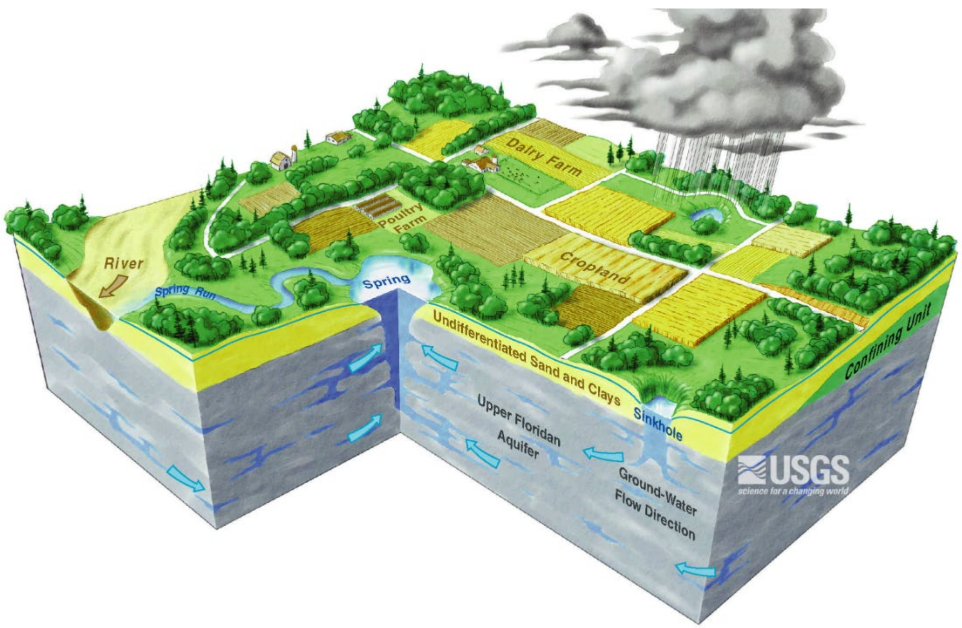
     

Disaggregating landscape-scale nitrate attenuation

James W. Jawitz   Amanda Desormeaux   Michael D. Annable

University of Florida



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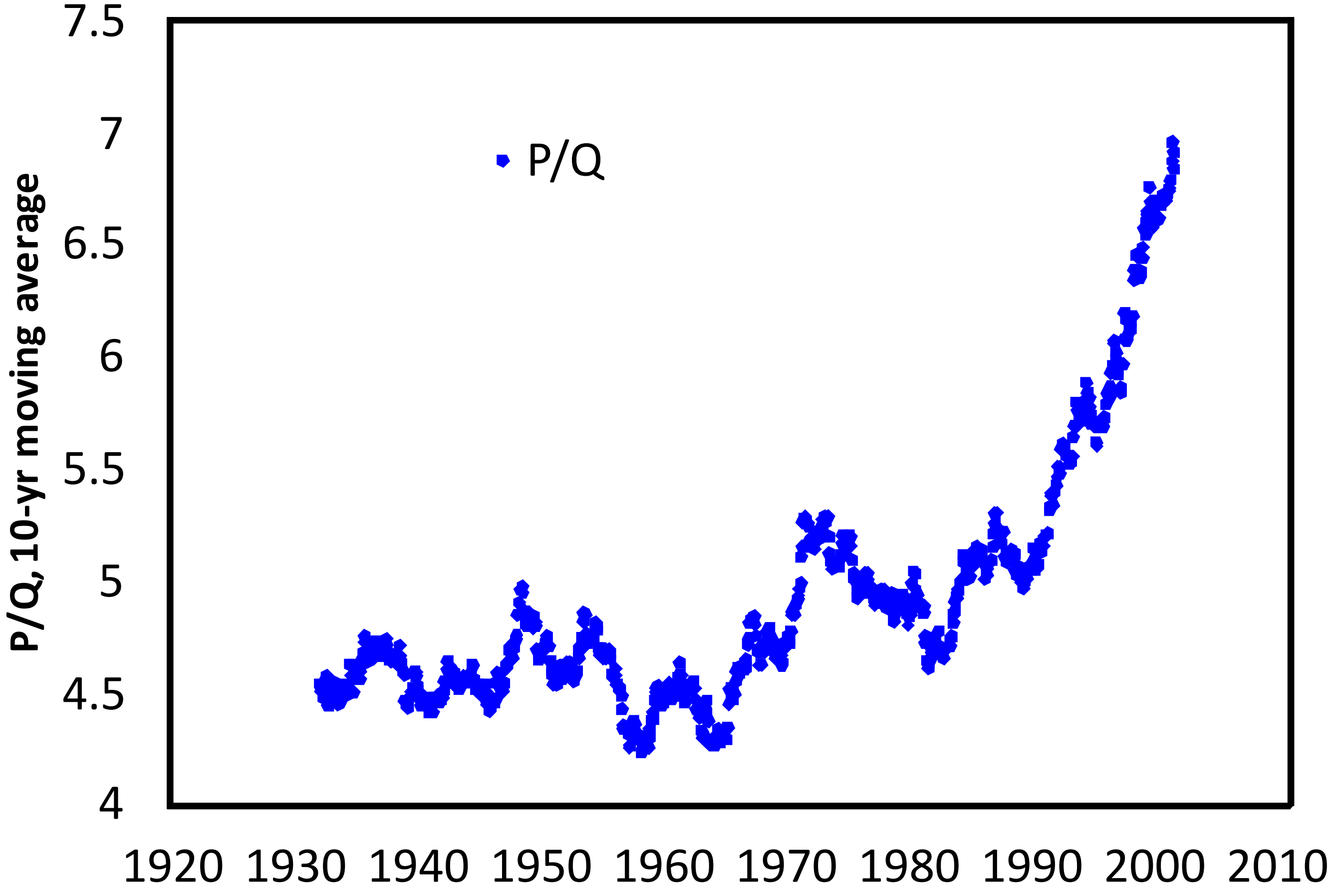
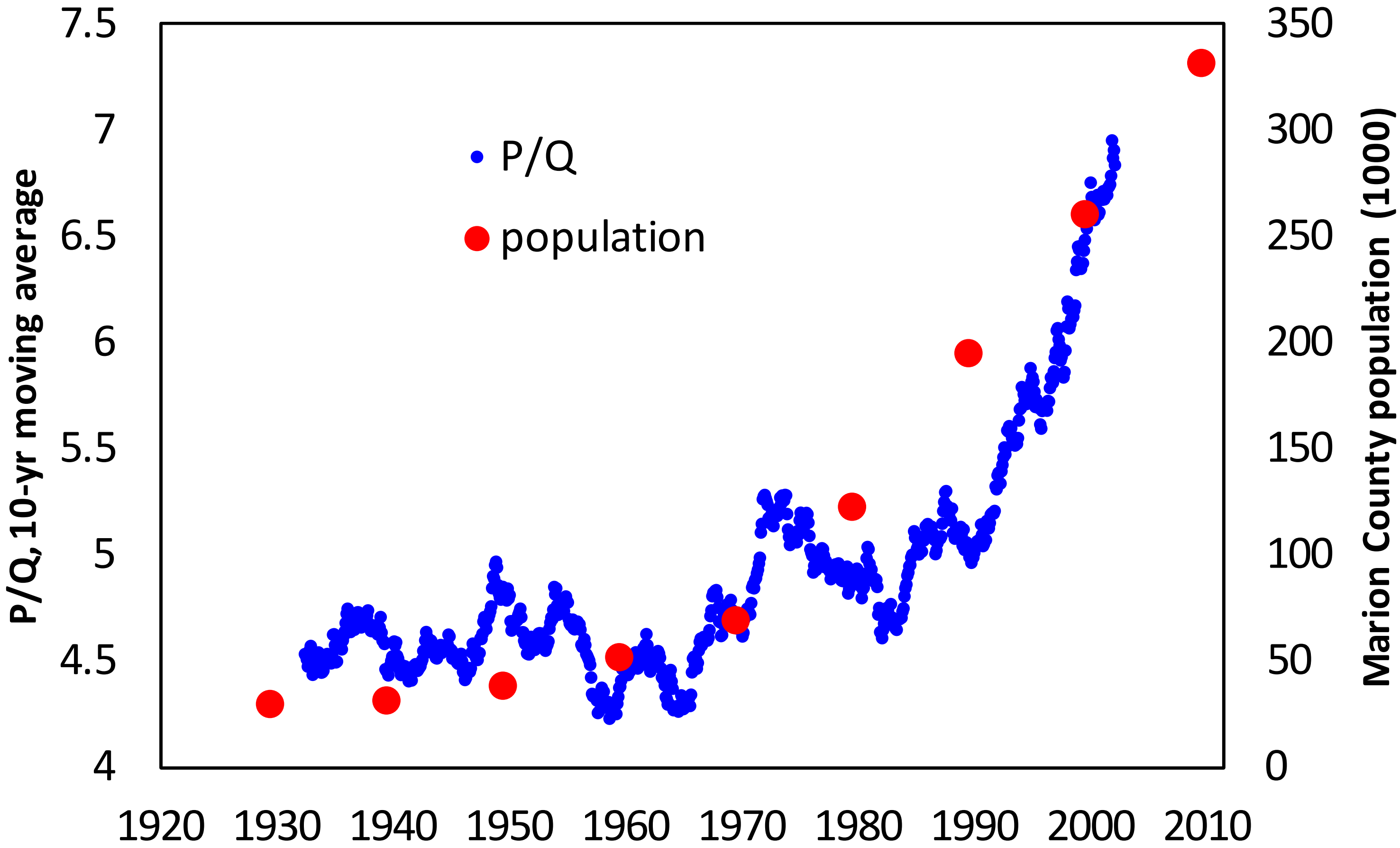
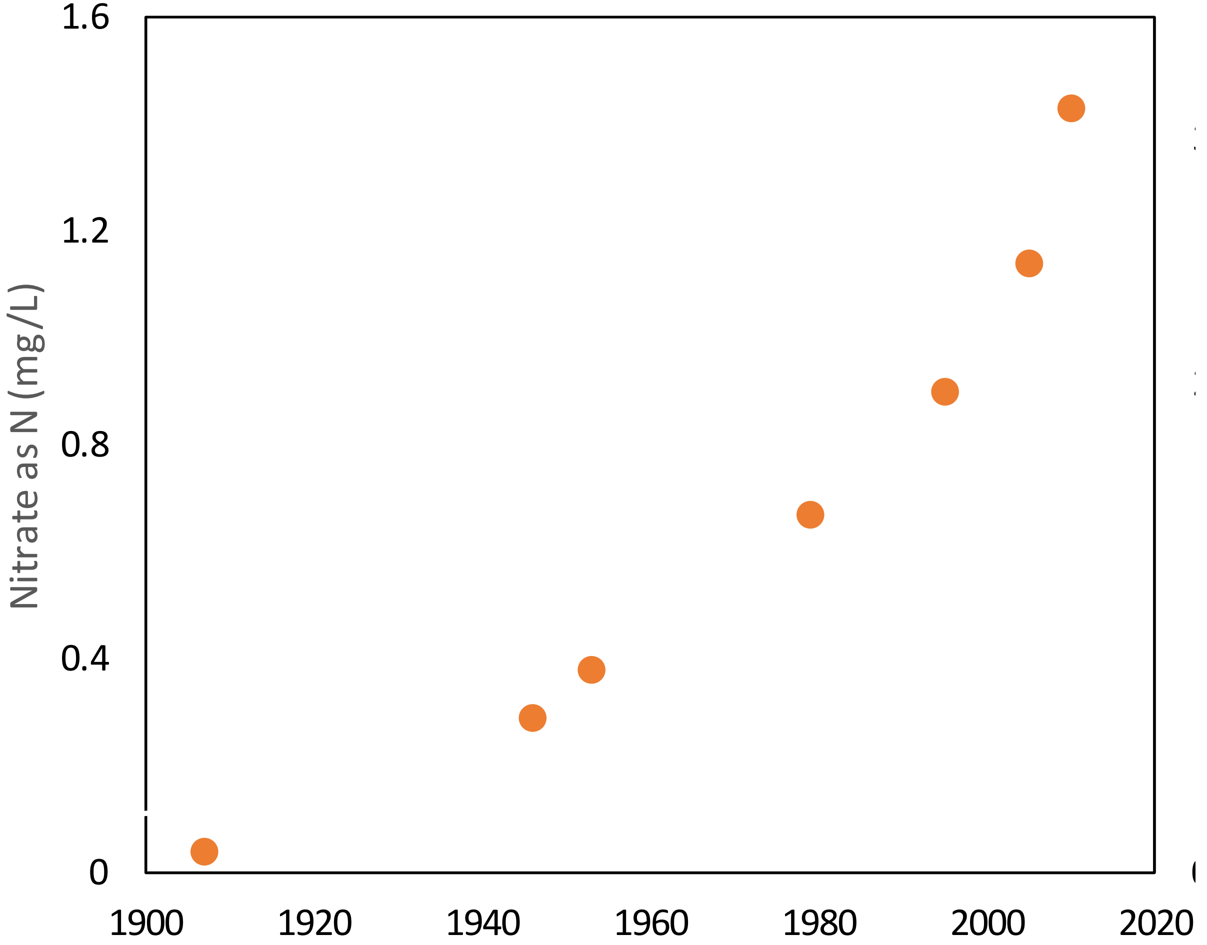
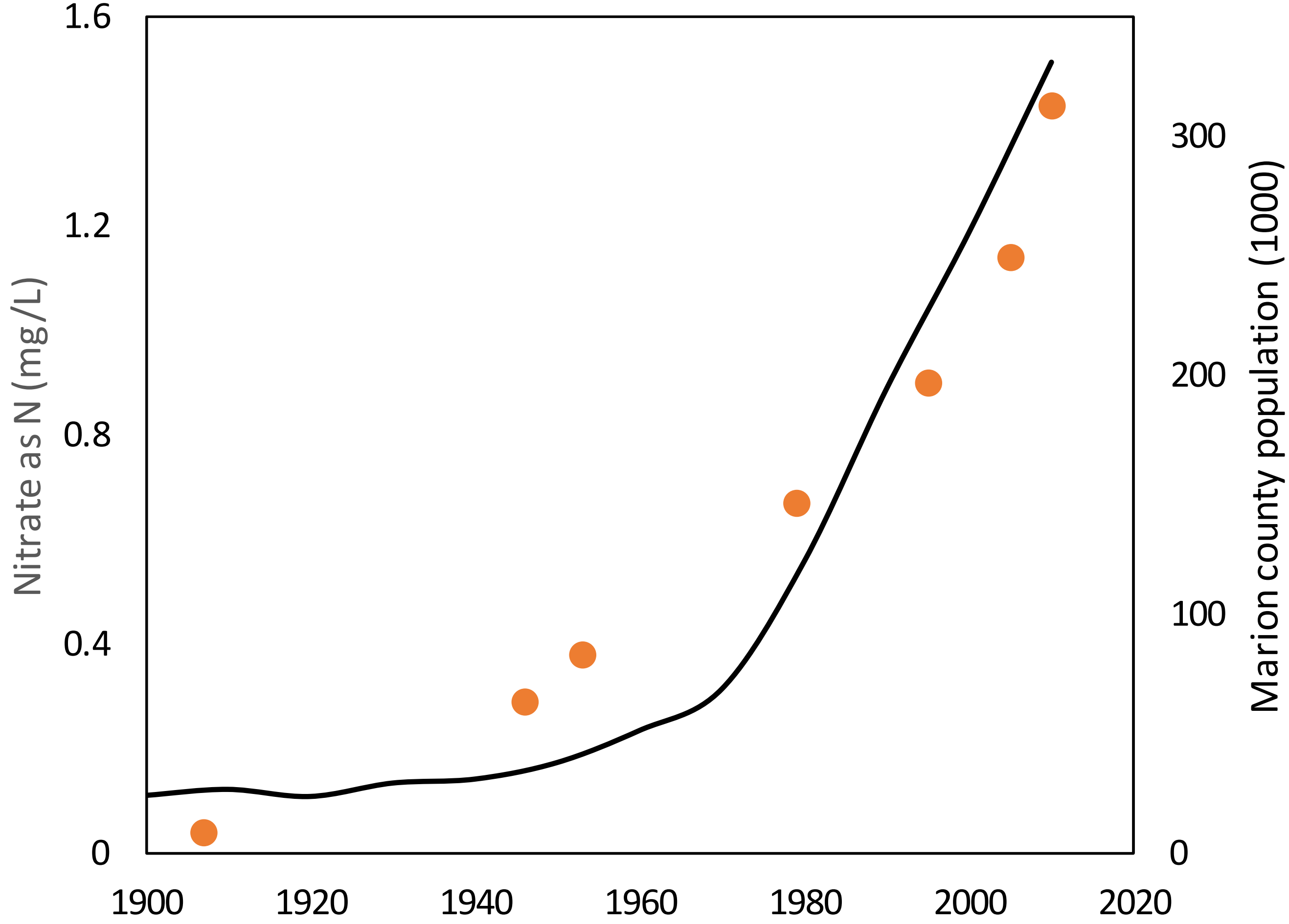

P/Q, 10-yr moving average
7.5
7
6.5
6
5.5
5
4.5
4
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
P/Q



P/Q, 10-yr moving average
Marion County population (1000)
P/Q
population
7.5
7
6.5
6
5.5
5
4.5
4
350
300
250
200
150
100
50
0
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010



Munch et al., 2007. *Fifty-year Retrospective Study of the Ecology of Silver Springs, Florida*, Special Publication SJ2007-SP4



Munch et al., 2007. *Fifty-year Retrospective Study of the Ecology of Silver Springs, Florida*, Special Publication SJ2007-SP4

Journal of Hydrology

journal homepage: www.elsevier.com/locate/jhydrol

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Research papers

Decadal scale recharge-discharge time lags from aquifer freshwater-saltwater interactions

Harald Klammler[a,b,*], James W. Jawitz[c], Michael D. Annable[a], J. Antonio Yaquian[c], Kirk Hatfield[a], Patrick Burger[c]

January 2020

water budget

Journal of Environmental Quality — TECHNICAL REPORTS

VADOSE ZONE PROCESSES AND CHEMICAL TRANSPORT

In Situ Measurement of Nitrate Flux and Attenuation Using a Soil Passive Flux Meter

Amanda Desormeaux, Michael D. Annable, Dean Dobberfuhl, and James W. Jawitz*

February 2019

nitrate budget

JGR Biogeosciences

RESEARCH ARTICLE

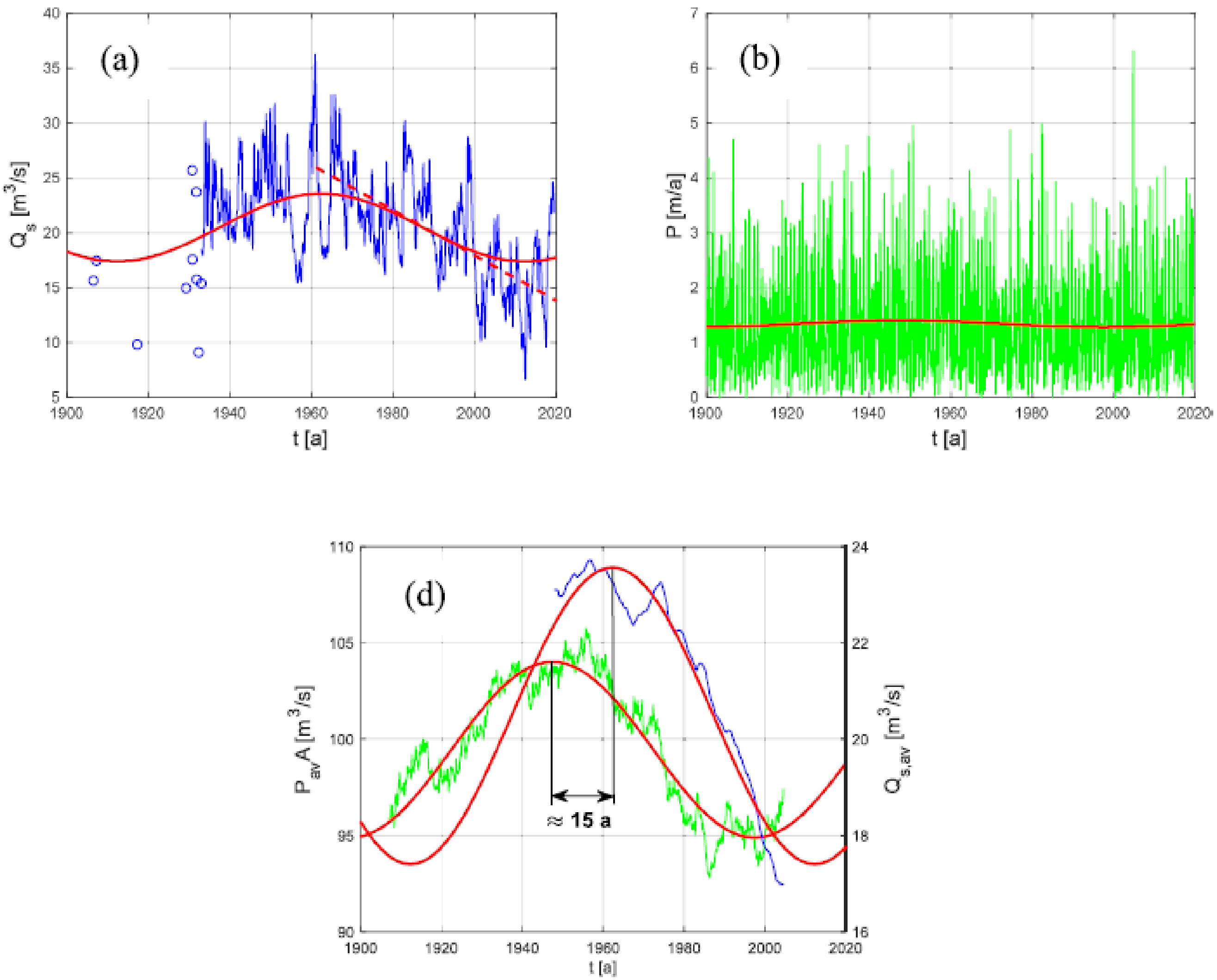
10.1029/2019JG005229

Special Section: Quantifying Nutrient Budgets

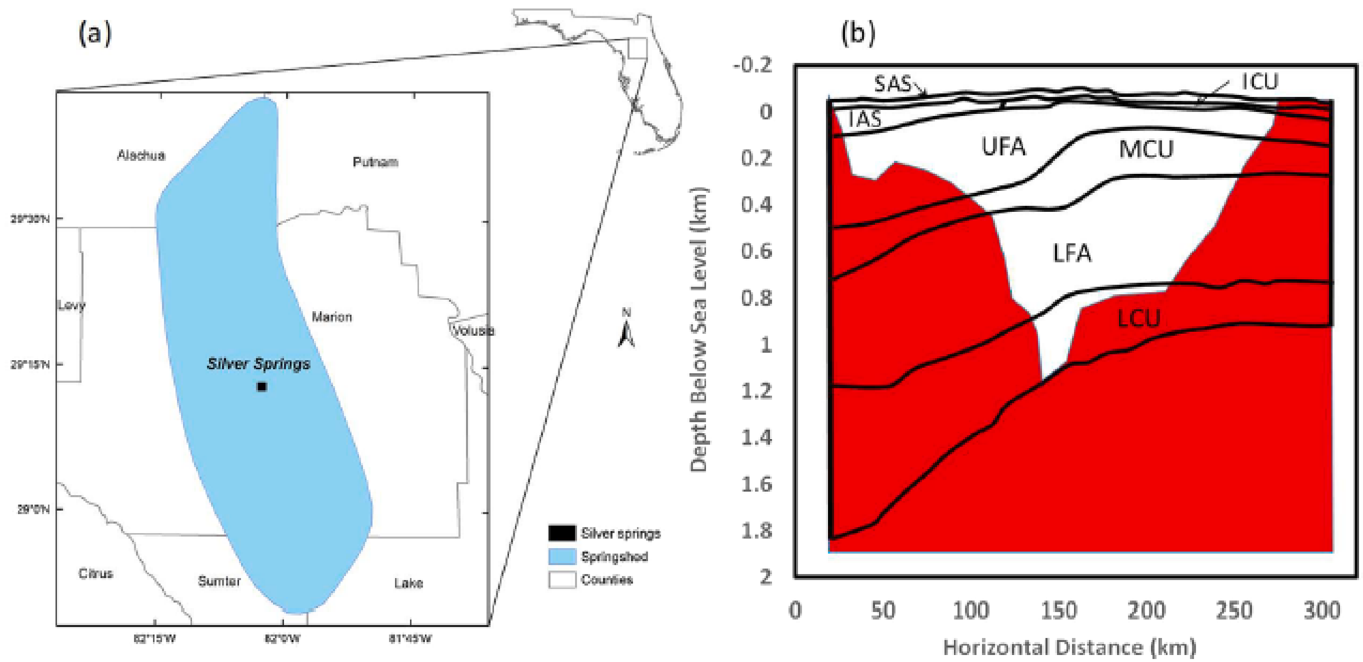
Disaggregating Landscape-Scale Nitrogen Attenuation Along Hydrological Flow Paths

J.W. Jawitz[1], A.M. Desormeaux[2], M.D. Annable[3], D. Borchardt[4], and D. Dobberfuhl[5]

February 2020

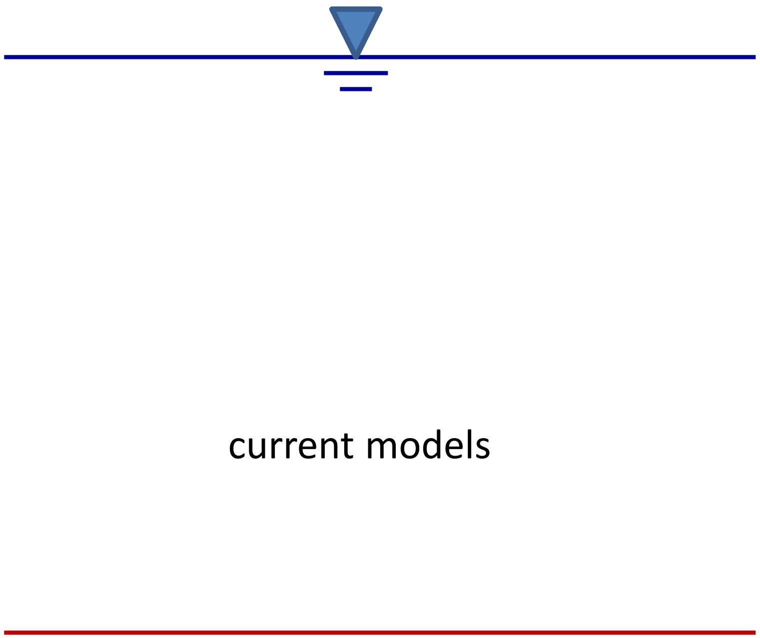


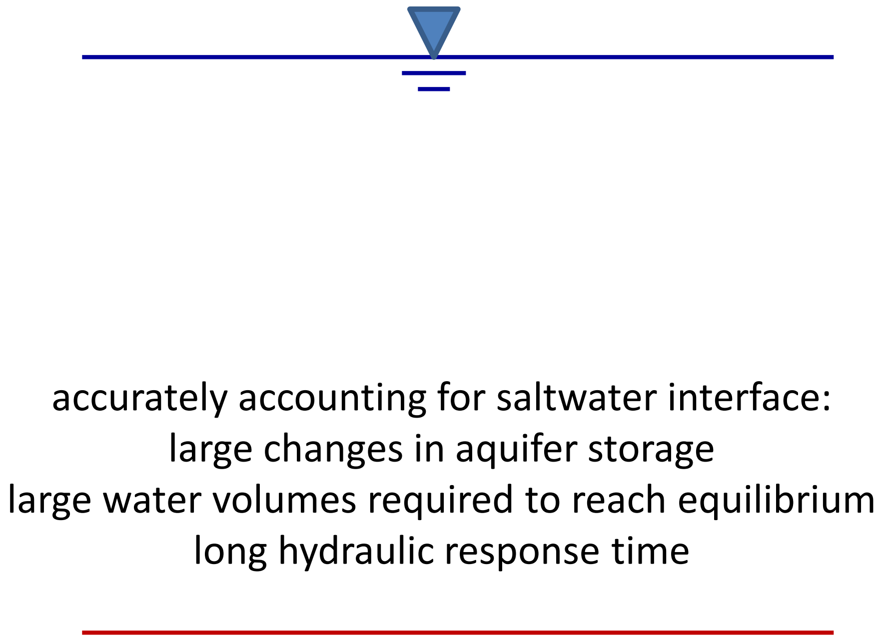
Klammler et al., 2020. Decadal scale recharge-discharge time lags from aquifer freshwater-saltwater interactions, *Journal of Hydrology*



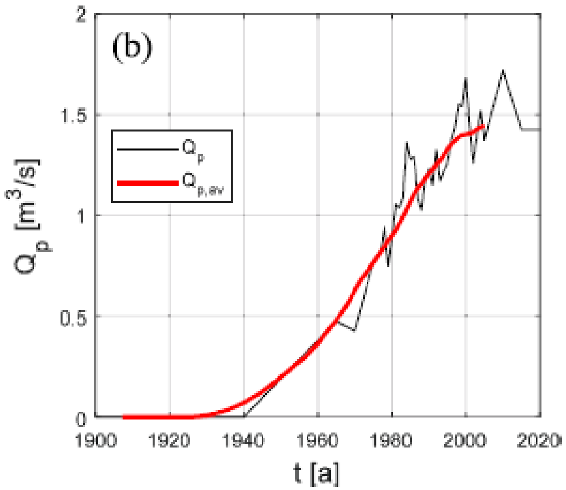
Klammler et al., 2020. Decadal scale recharge-discharge time lags from aquifer freshwater-saltwater interactions, *Journal of Hydrology*

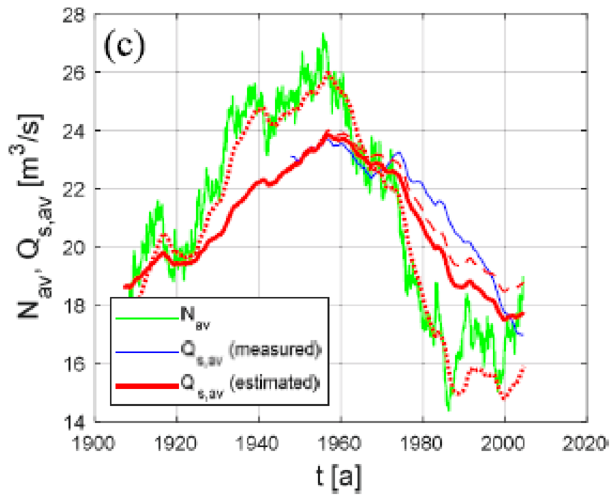
dynamic saltwater interface

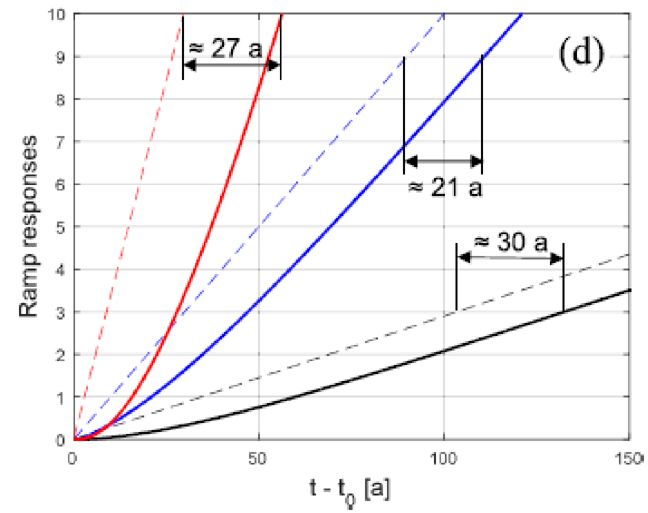




red = interface depth
blue = Q
black = storage







N = recharge (green)   Q = flow (blue)

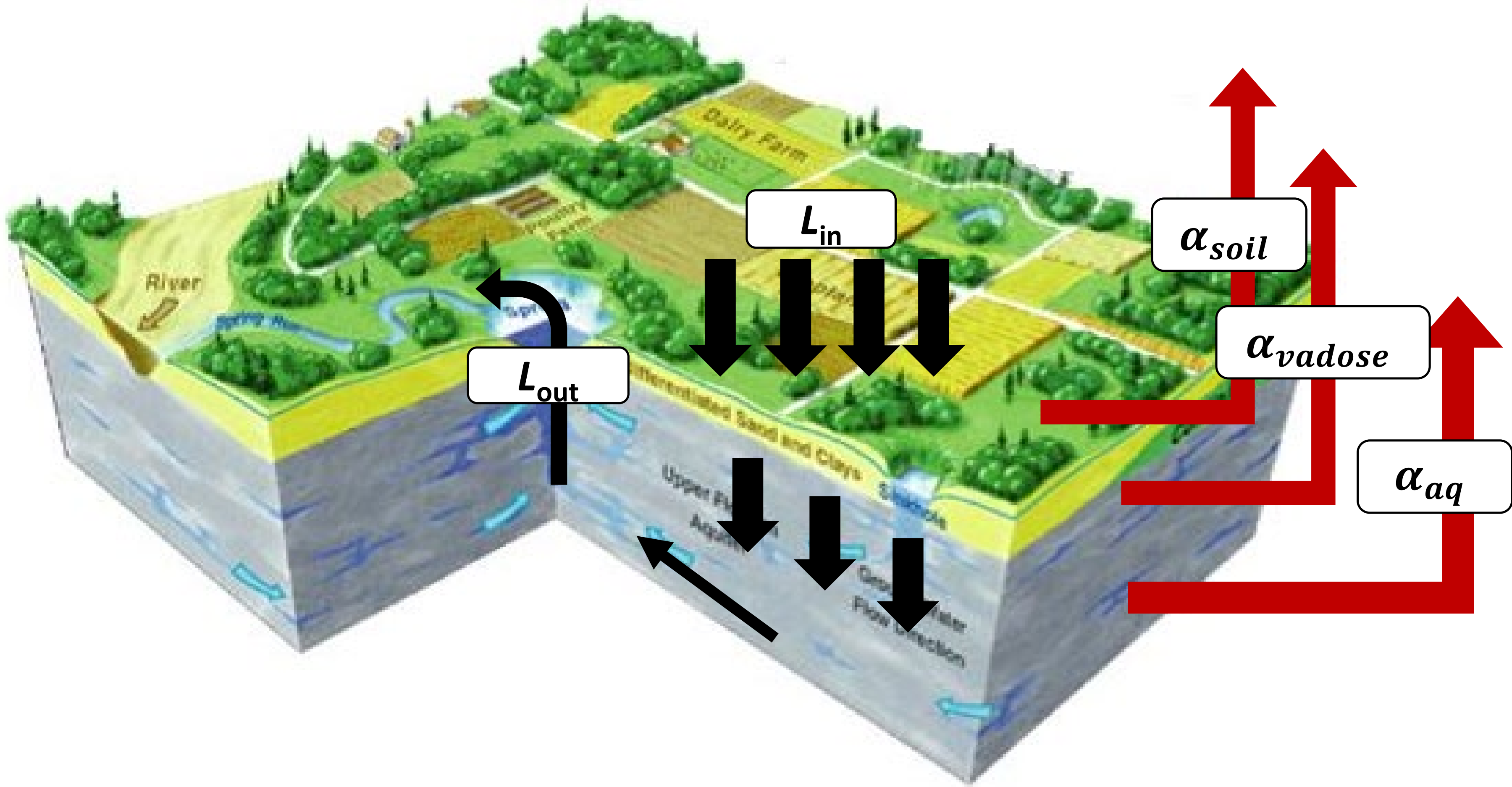
<u>models</u>
dotted red: [no saltwater, pumping]
dashed red: [saltwater, no pumping]
solid red: [saltwater, pumping]
closest match to observed flows

gradual change in recharge:
~ 20-30 yr lag times

Klammler et al., 2020. Decadal scale recharge-discharge time lags from aquifer freshwater-saltwater interactions, *Journal of Hydrology*

landscape-scale nitrate mass balance

disaggregating attenuation



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PLAN-B mass balance model framework

disaggregation of attenuation

measured N output	$L_{out}^{m} = \frac{C(t)Q(t)}{A_s}$	
estimated N input	$L_{in}^{p} = \sum_i [P_i L_i]_B$	P_i population/proportion L_i load per capita or per area
predicted N Output	$L_{OUT}^{p} = \sum_i [P_i L_i \underline{A_i N_i}]_B$	A_i anthropogenic attenuation N_i natural attenuation (delivery)
disaggregated attenuation	$N_i = \underline{N_{S,i} N_{V,i} N_A}$	$N = 1 - \alpha$ (natural attenuation delivery)

Jawitz et al., 2020. Disaggregating landscape-scale nitrogen attenuation along hydrological flow paths, *Journal of Geophysical Research-Biogeosciences*.

N budget in the springshed of Silver Springs, FL

A = 1300 km²

(a) and (c)

P_i population/proportion

L_i load per capita or per area

fertilized urban (red)

cropland (yellow)

pastures for horses and cattle (brown)

[largest horse population in the US!]

population density (reverse colors)

(d)

A_i anthropogenic attenuation

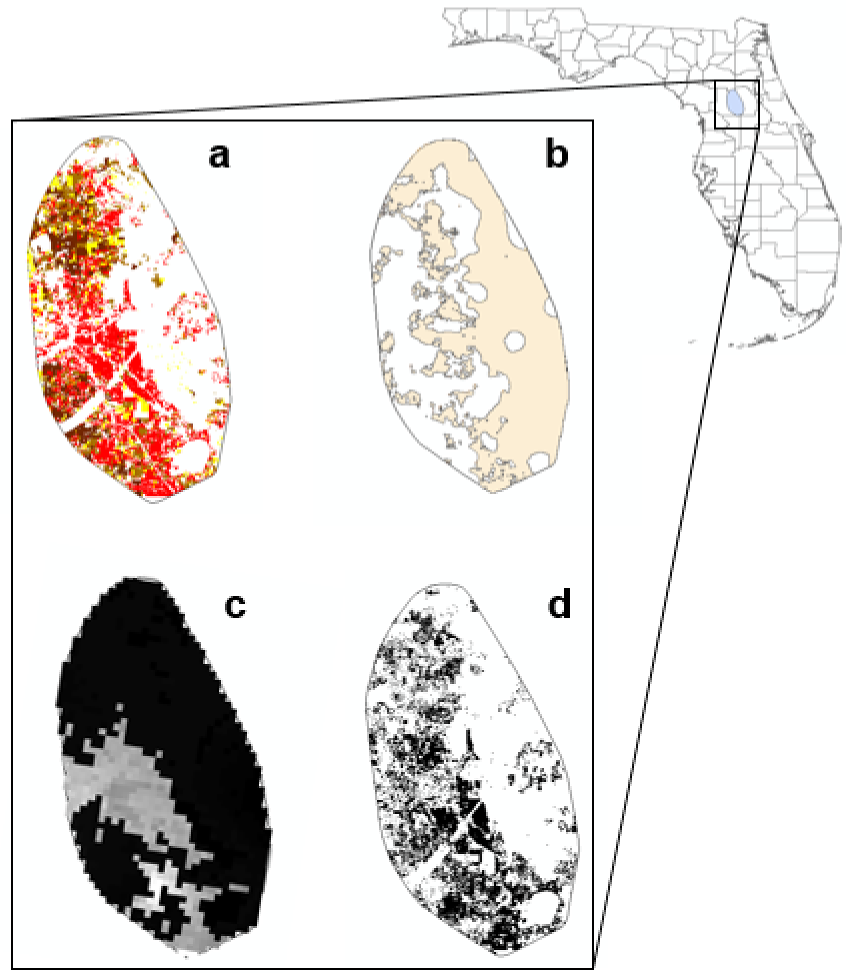
septic tanks (each point)

[68%!! more than 2x the state average]

(b)

$N_{i,v}$ natural attenuation (delivery)

confining unit



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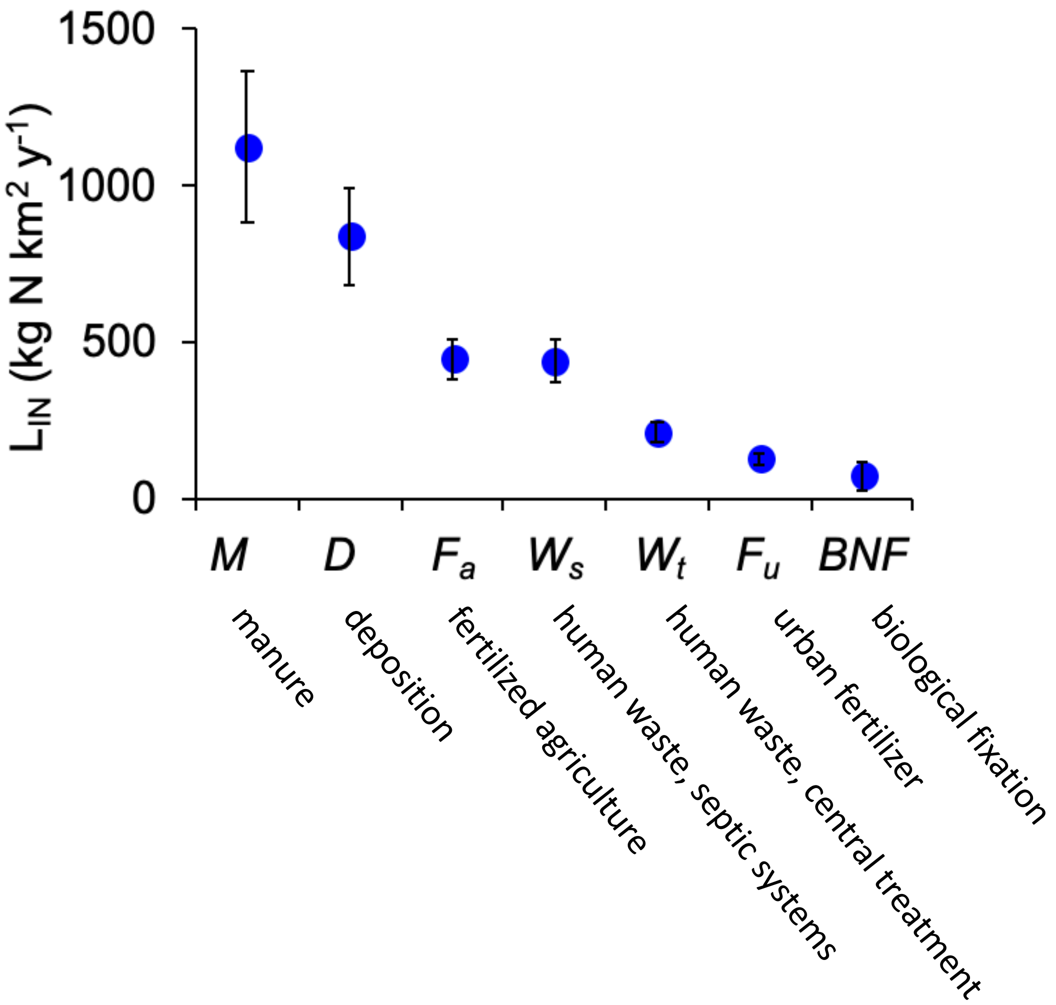
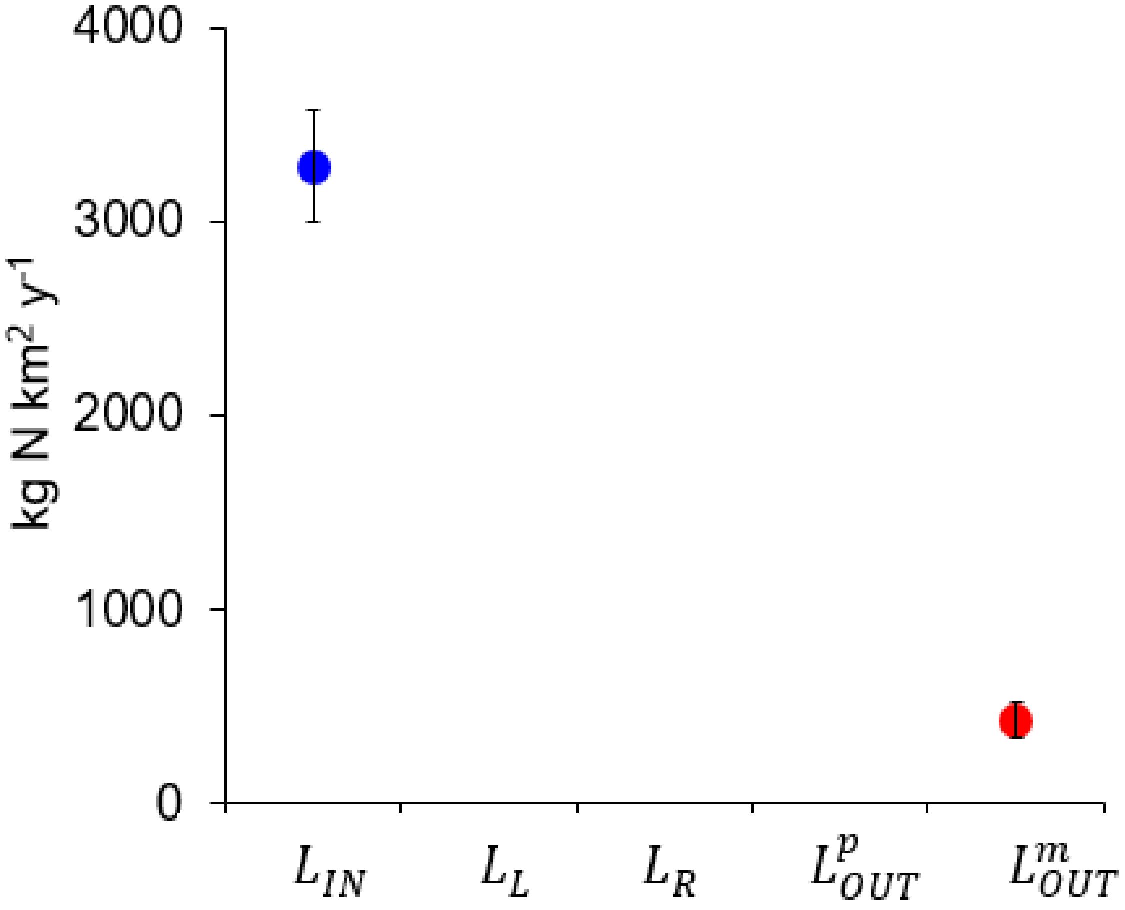
contribution of N sources to Silver Springs, FL

long-term average (1997-2017)



N budget in the springshed of Silver Springs, FL

long-term average (1997-2017)



N budget in the springshed of Silver Springs, FL

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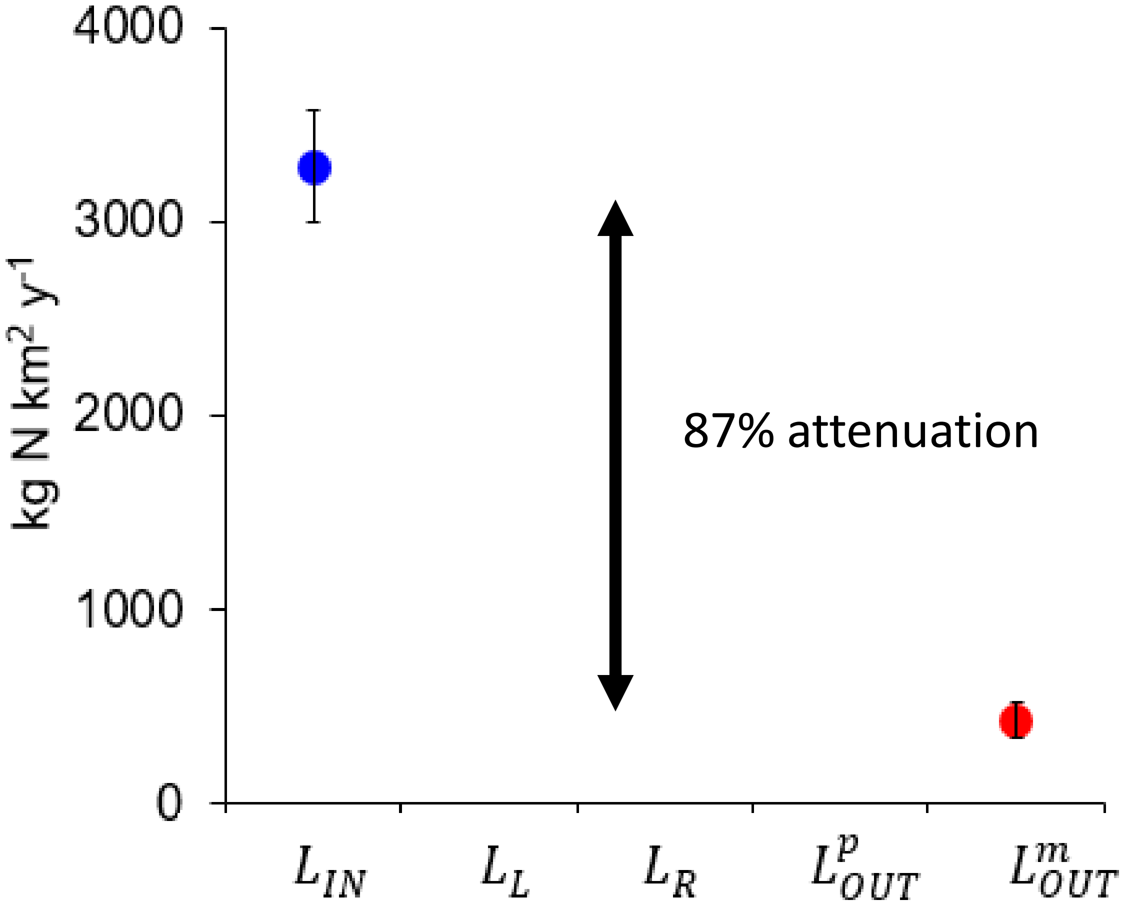
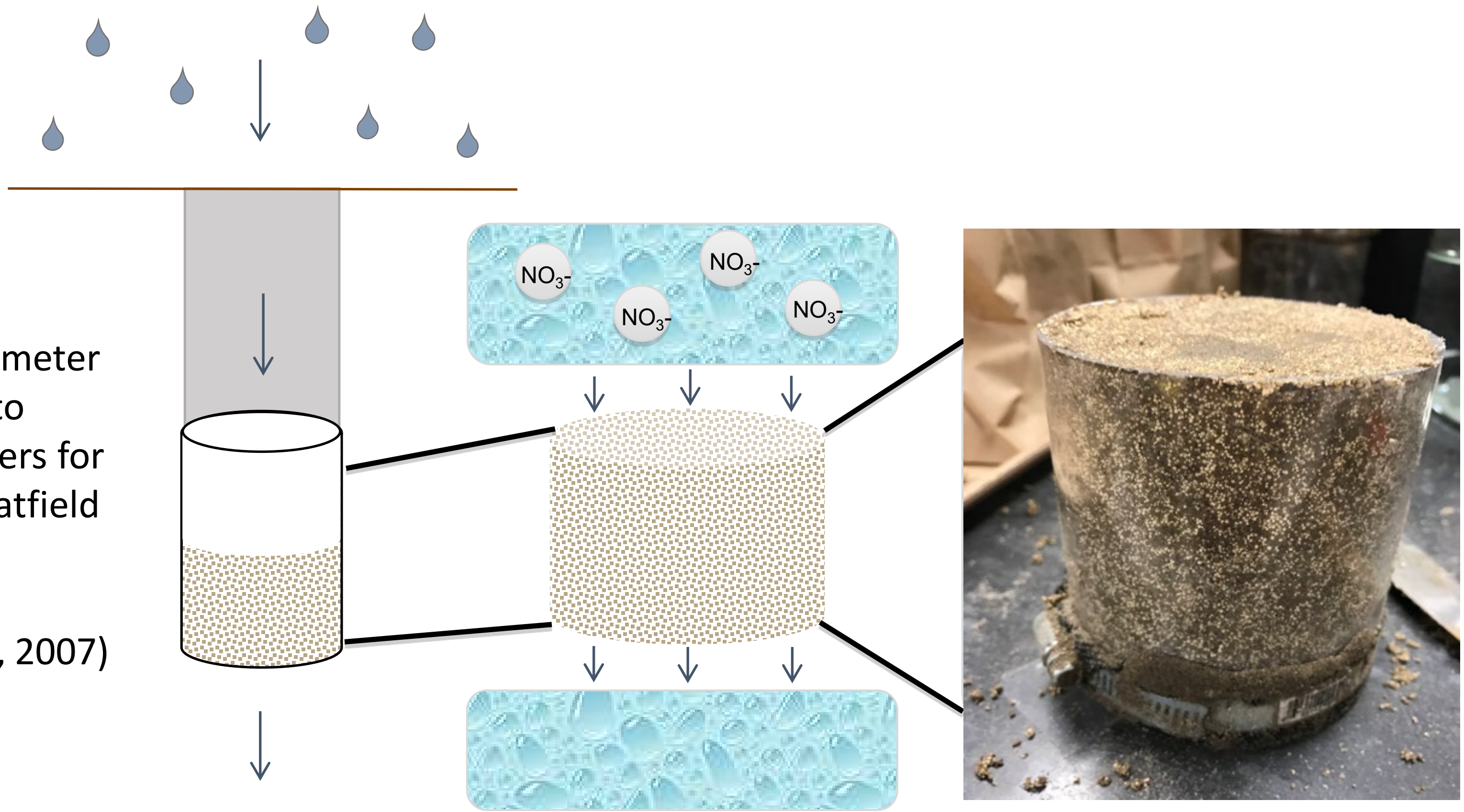


in situ measurement of soil attenuation

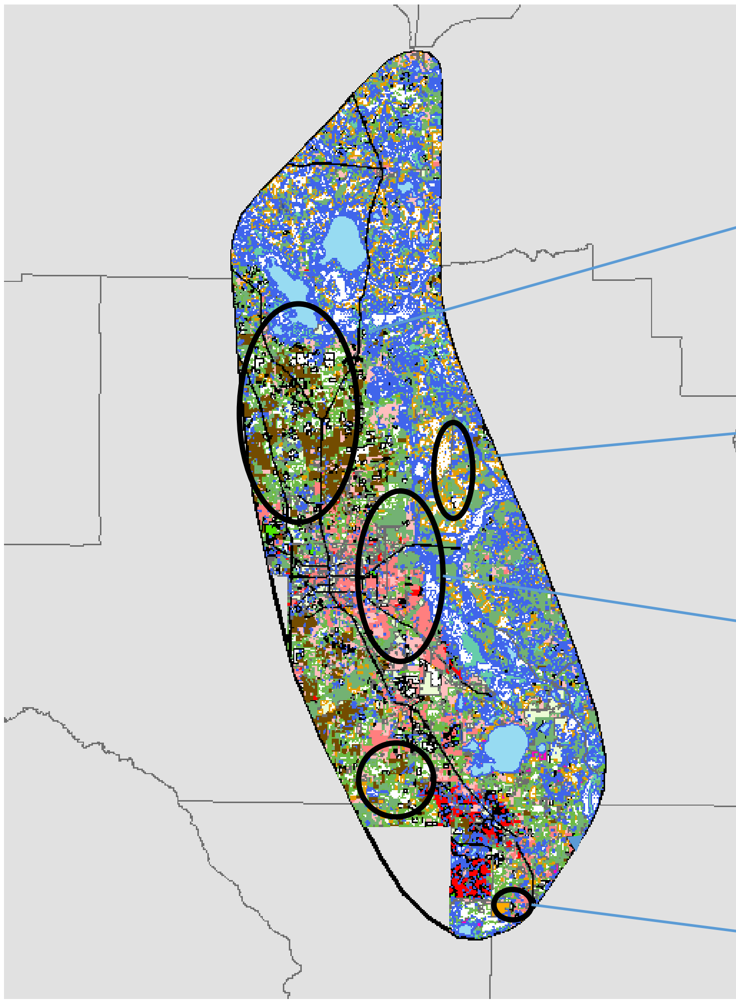
ion-exchange resin columns

Soil passive flux meter (SPFM), analog to passive flux meters for groundwater (Hatfield et al., 2004) and surface water (Klammler et al., 2007)

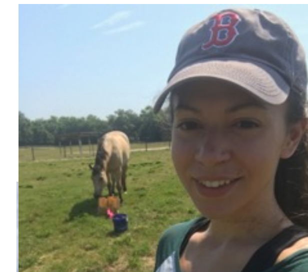


Desormeaux A, Annable MD, Dobberfuhl D, and Jawitz JW, 2019. In situ measurement of nitrate flux and attenuation using a soil passive flux meter, *Journal of Environmental Quality*, 48:709–716.

deployed in heterogeneous land uses



Horse pastures
n = 10

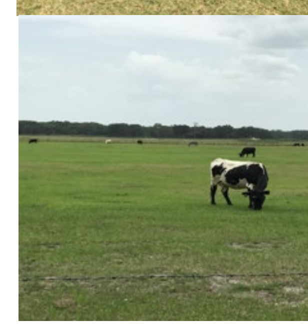


Field Crops
n = 5

Row Crops
n = 10

Urban
lawns and golf course
n = 15

Cattle pastures
n = 5

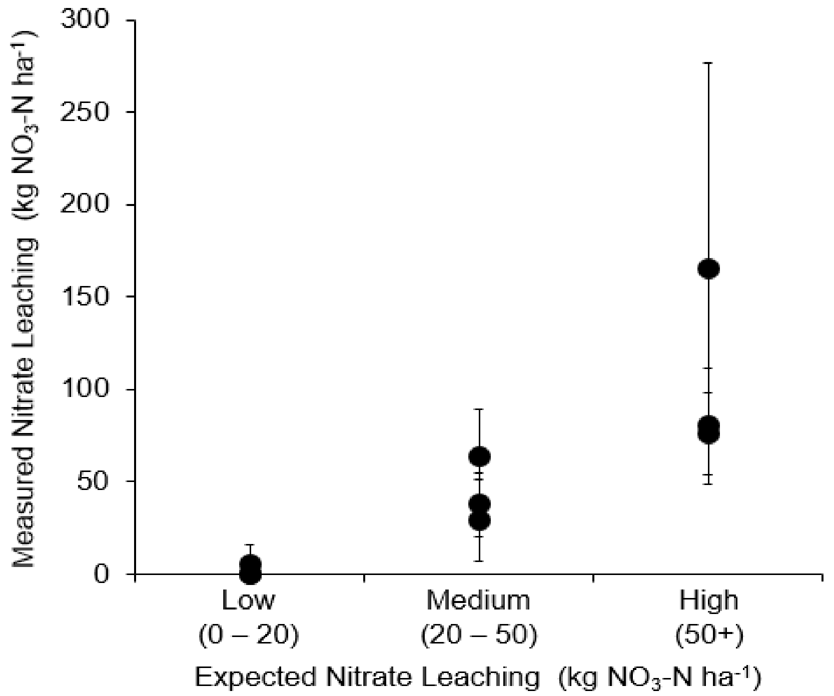


in situ measurement of soil attenuation

45 SPFMs deployed at 9 sites

	turf	crop	pasture
mean N attenuation	90%	59%	48%
flux CV (within land use)	117%	82%	37%

- differences within-land use are important based on land management practices



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contribution of N sources to Silver Springs, FL

long-term average (1997-2017)

manure **35% → 45%**

deposition **25% → 11%**

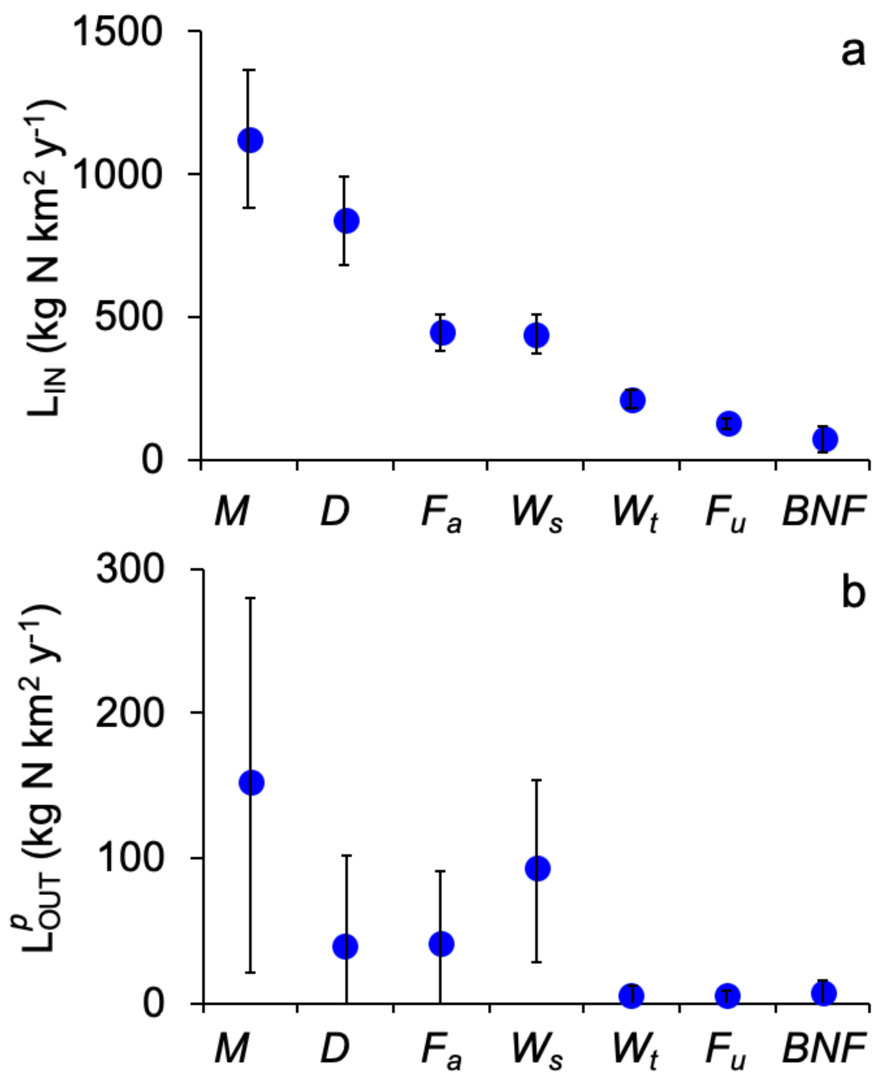
fertilized agriculture 14% → 13%

septic systems **14% → 27%**

central treatment 6% → 1%

urban fertilizer **4% → 1%**

biological fixation 2% → 2%



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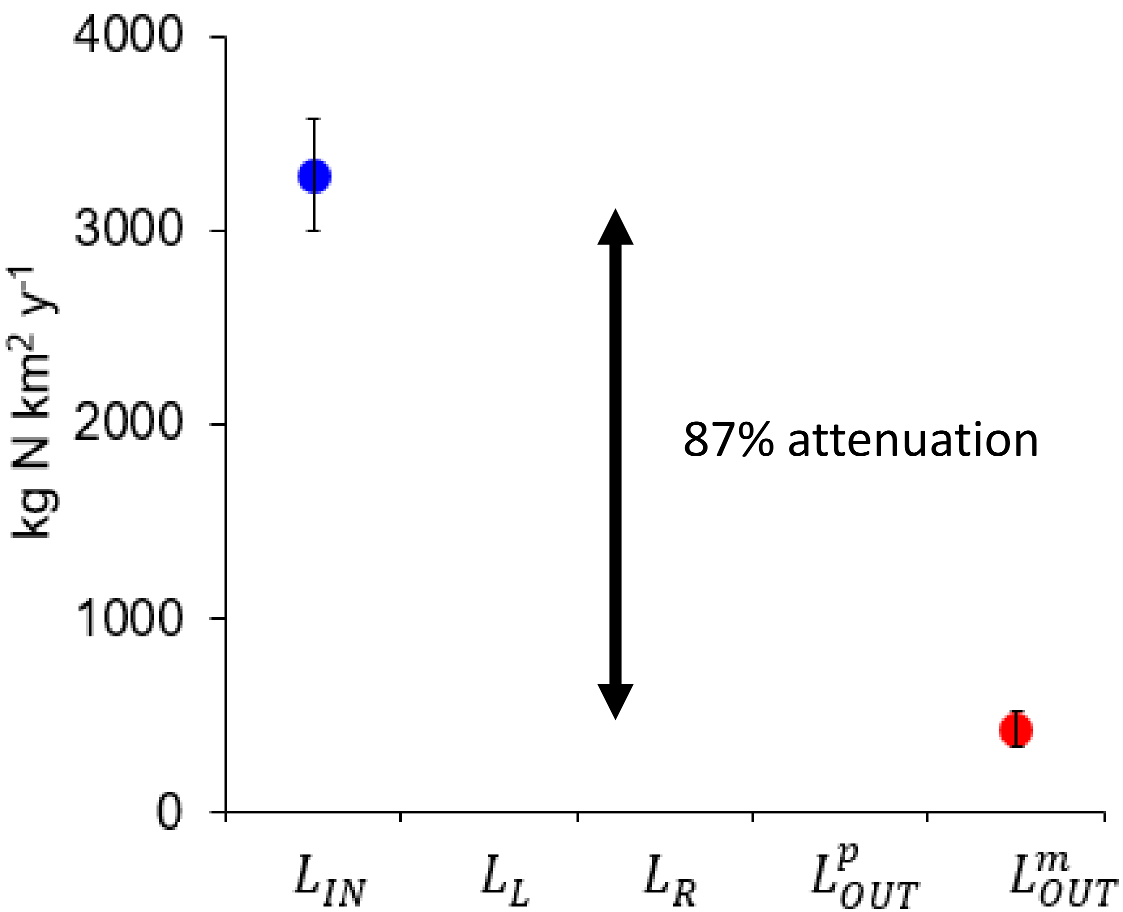
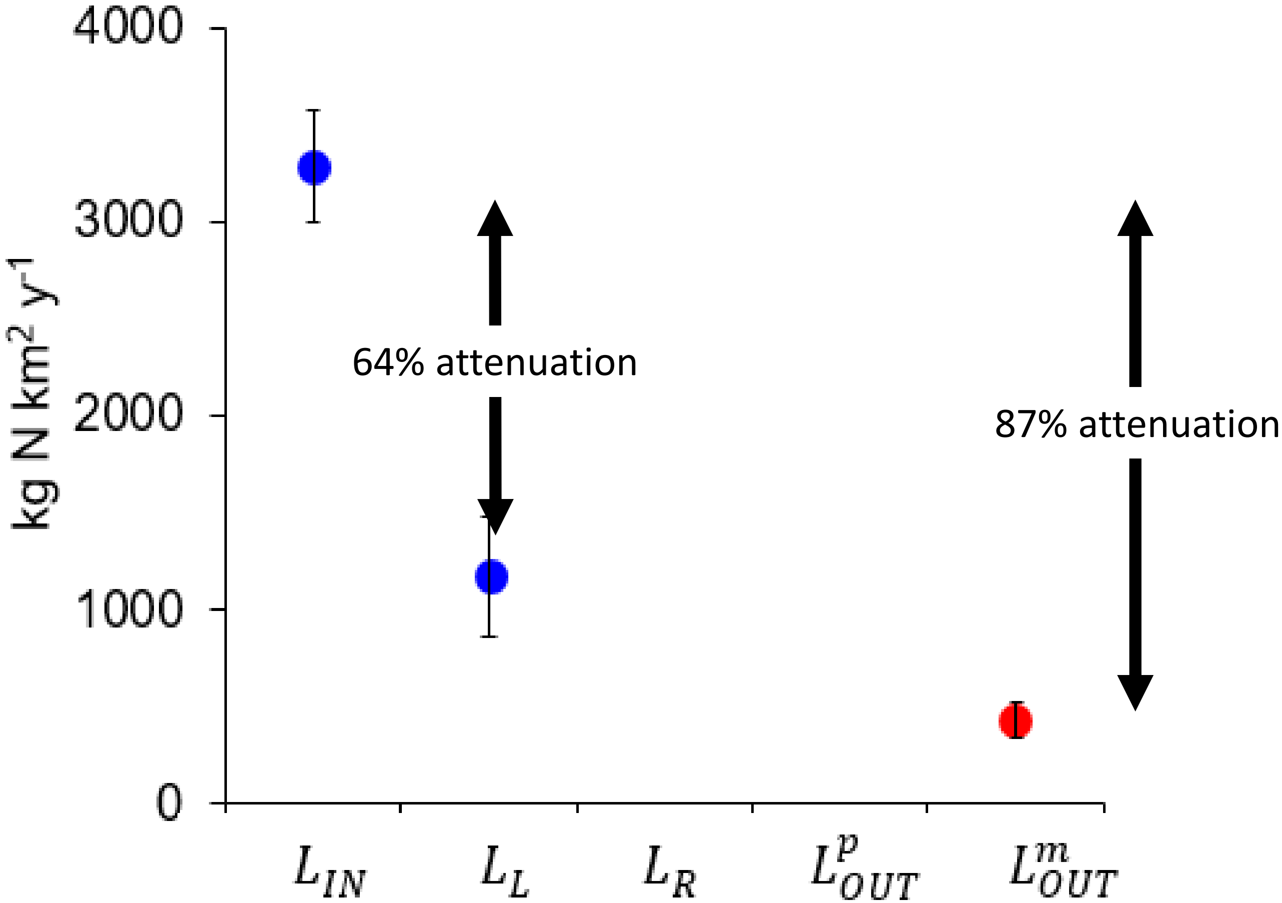
N budget in the springshed of Silver Springs, FL

long-term average (1997-2017)



disaggregation of N attenuation

soil, vadose zone, aquifer



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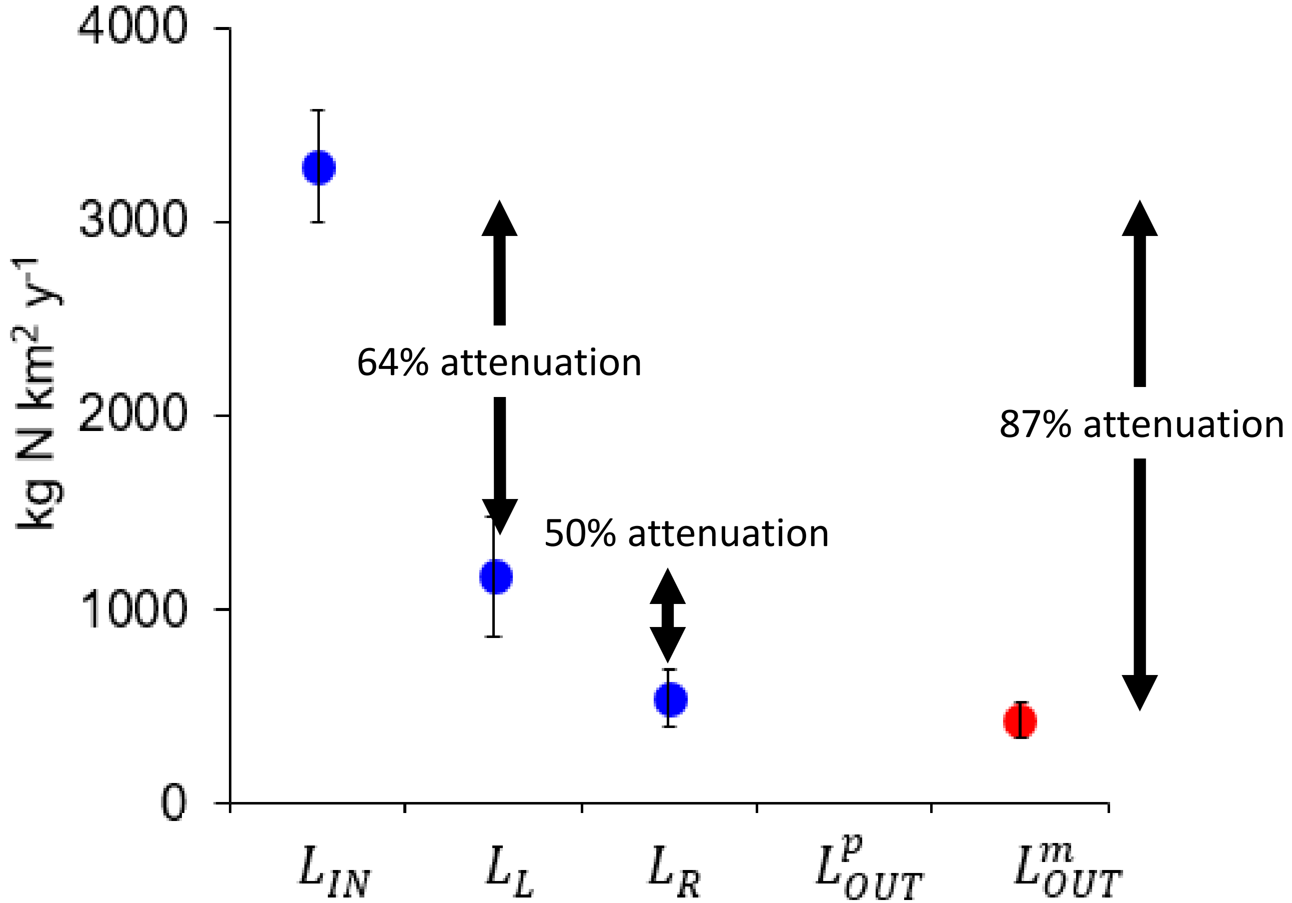
disaggregation of N attenuation

soil, vadose zone, aquifer



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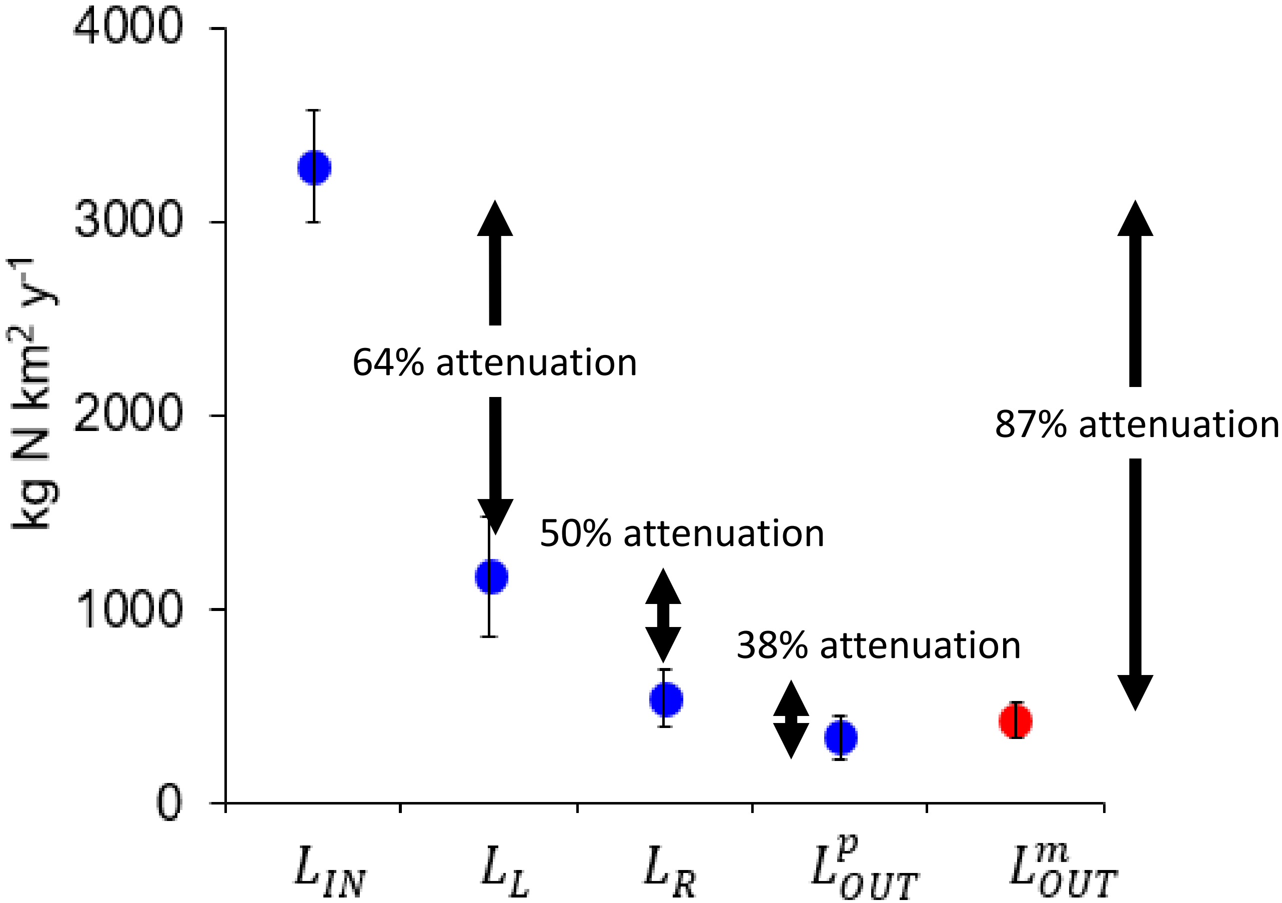
disaggregation of N attenuation

soil, vadose zone, aquifer



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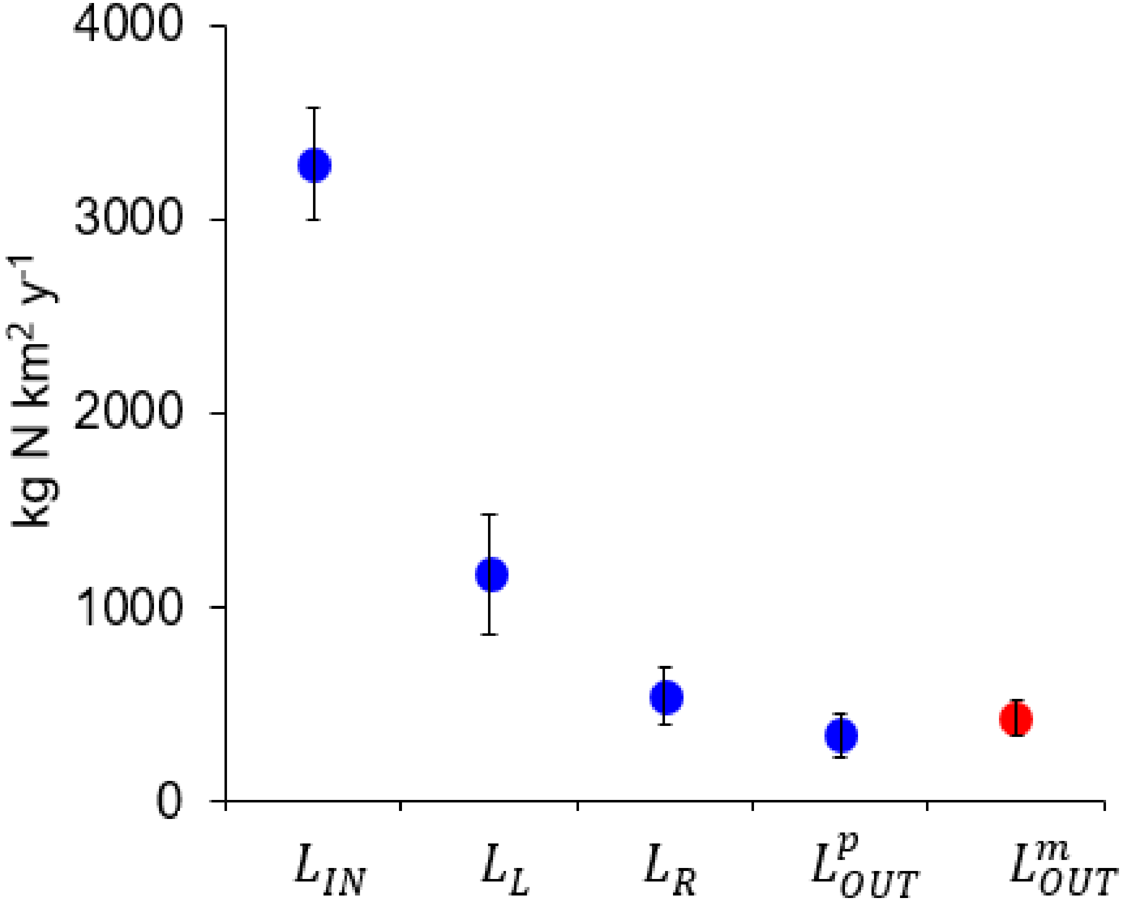
disaggregation of N attenuation

soil, vadose zone, aquifer



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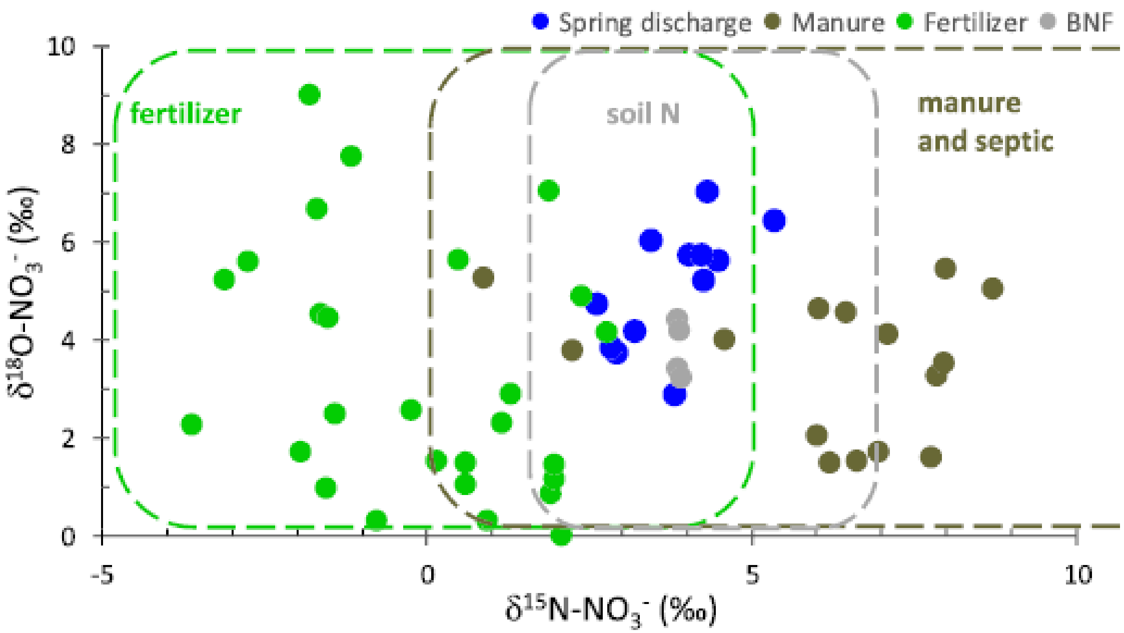


Figure 4. Nitrate $\delta^{18}O$ and $\delta^{15}N$ measured in Silver Springs discharge (blue) and in SPFMs deployed under fertilized fields (green), horse and cattle pastures (brown), and peanut crops (gray) in the springshed. Discharge values were adjusted for enrichment during aquifer denitrification. Typical ranges of $\delta^{15}N\text{-}NO_3^-$ and $\delta^{18}O\text{-}NO_3^-$ adapted from Kendall et al. (2007) for nitrate sources from inorganic fertilizer, soil N, and manure and septic are shown by dashed lines with color consistent with corresponding SPFM data.

Jawitz et al., 2020. Disaggregating landscape-scale nitrogen attenuation along hydrological flow paths, *Journal of Geophysical Research-Biogeosciences*.

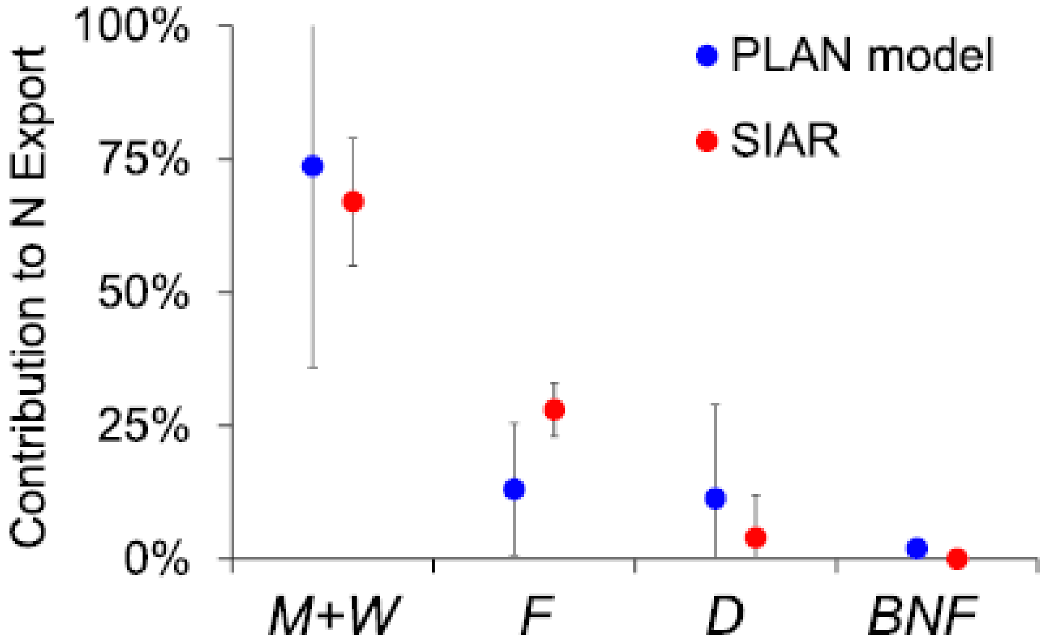
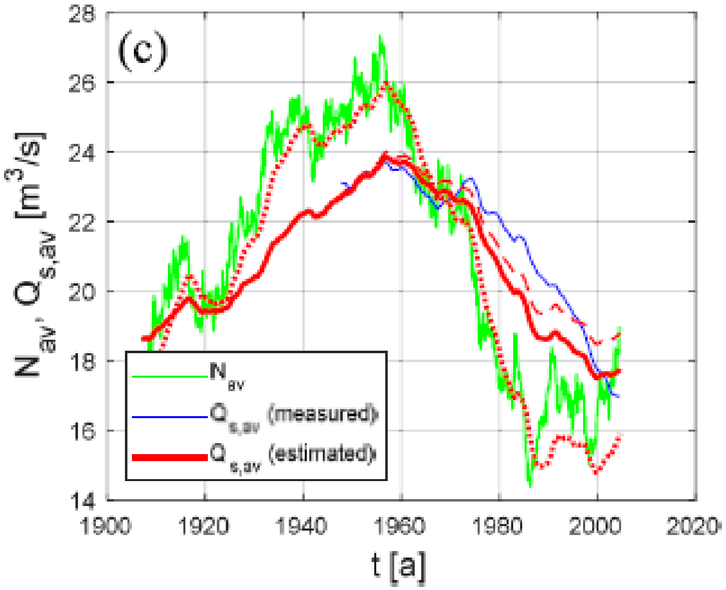


Figure 5. Comparison of source contribution to Silver Springs NO_3-N export estimated by catchment-scale *PLAN* model N budget and the SIAR mixing model. Sources are manure (*M*) and wastewater (*W*), fertilizer (*F*), atmospheric deposition (*D*), and biological nitrogen fixation (*BNF*).

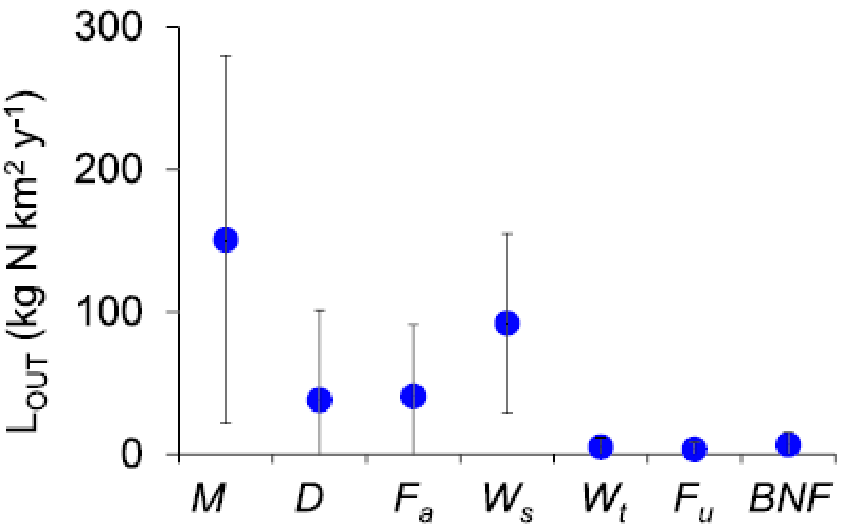
Jawitz et al., 2020. Disaggregating landscape-scale nitrogen attenuation along hydrological flow paths, *Journal of Geophysical Research-Biogeosciences*.

in conclusion

natural vs anthropogenic effects on flow



land use contribution to N export



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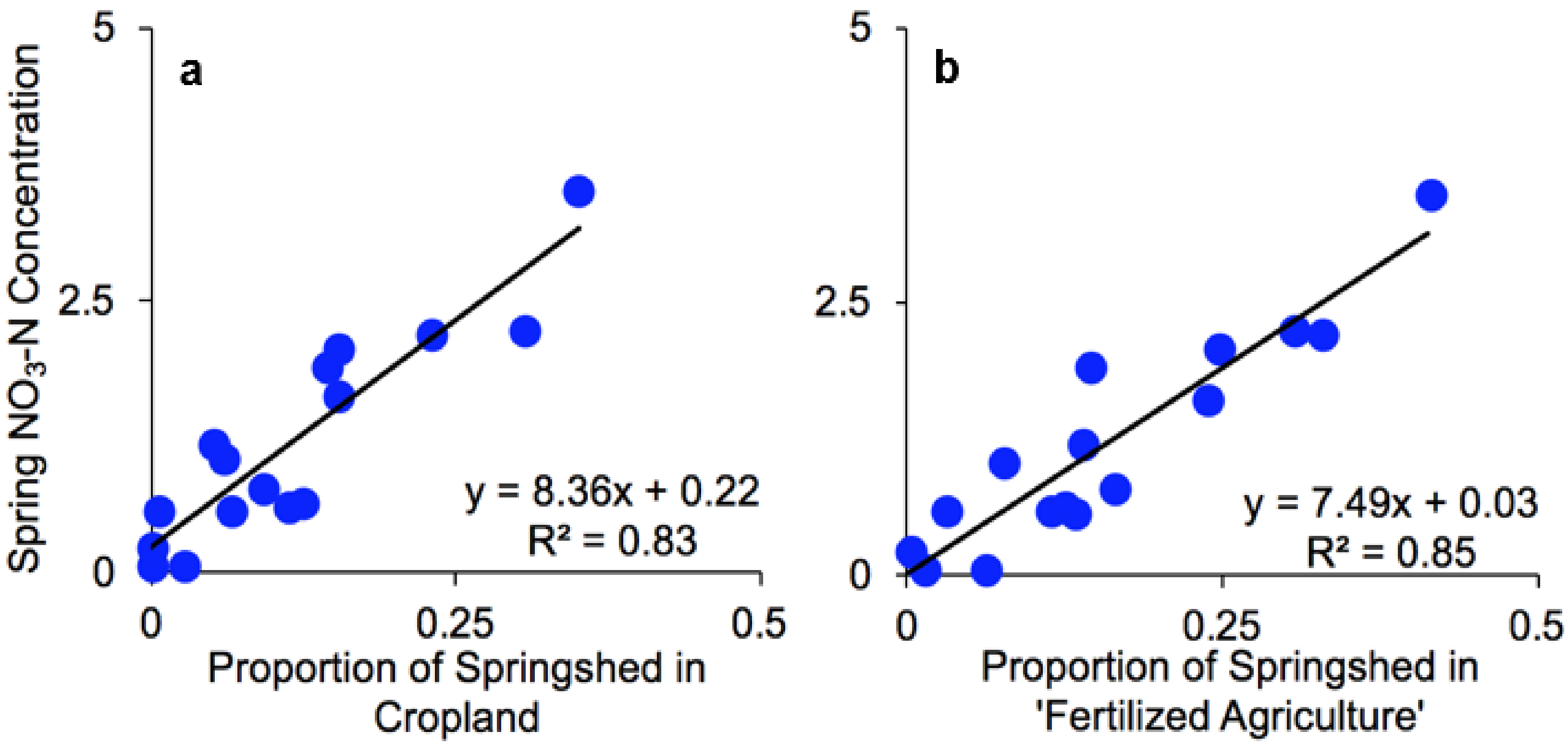
Drivers of N export

Significant positive correlation between proportion of springshed in cropland land uses and the average spring NO_3-N concentration



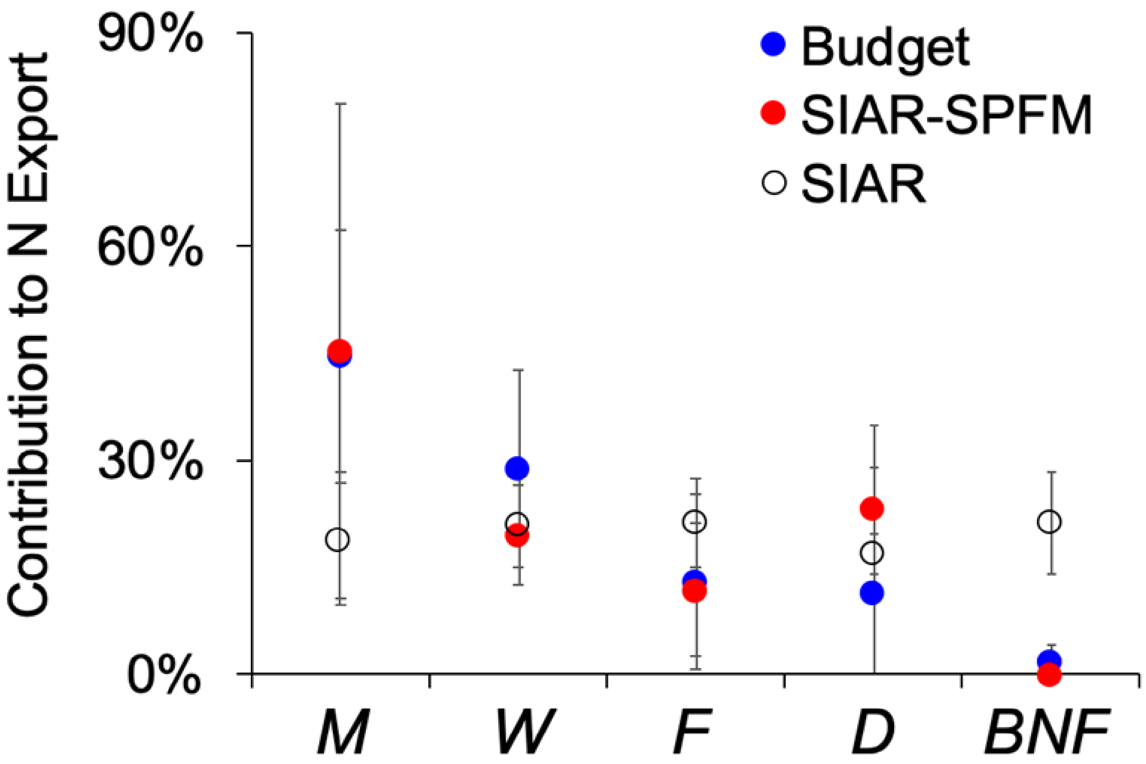
Source contributions in SIAR

- SIAR vs. budget

  (RMSE = 0.15)

- SIAR-SPFM vs. budget

  (RMSE = 0.07)



Comparison of source contribution to Silver Springs NO3-N export estimated by catchment-scale N budget, SIAR mixing model, and SIAR mixing model updated with SPFM-measured source signatures. Sources are manure (M), wastewater (W), fertilizer (F), atmospheric deposition (D), and biological nitrogen fixation (BNF).

Questions?