SWAT Conference
8-12 July - Strasbourg, France

Enhancing water quality assessment tools for a sustainable future: Part II, surface water–groundwater simulation by the coupled SWAT+gwflow

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Special thanks to:

Ryan Bailey, Estifanos Addisu Yimer

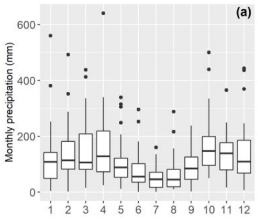
Sofía da Rocha, Eliana Delave, Armando Borrero, Julián Ramos, Andrés Saracho

Outline

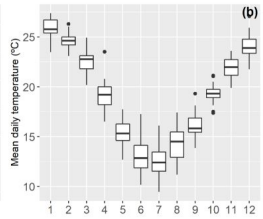
- Introduction
- Study area and dataset
- Model configuration
- Experiment design
- Preliminary results
- Summary

San Antonio basin
(213 km^2)

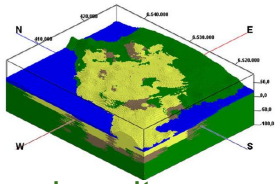
Precipitation



Temperature



sandstone

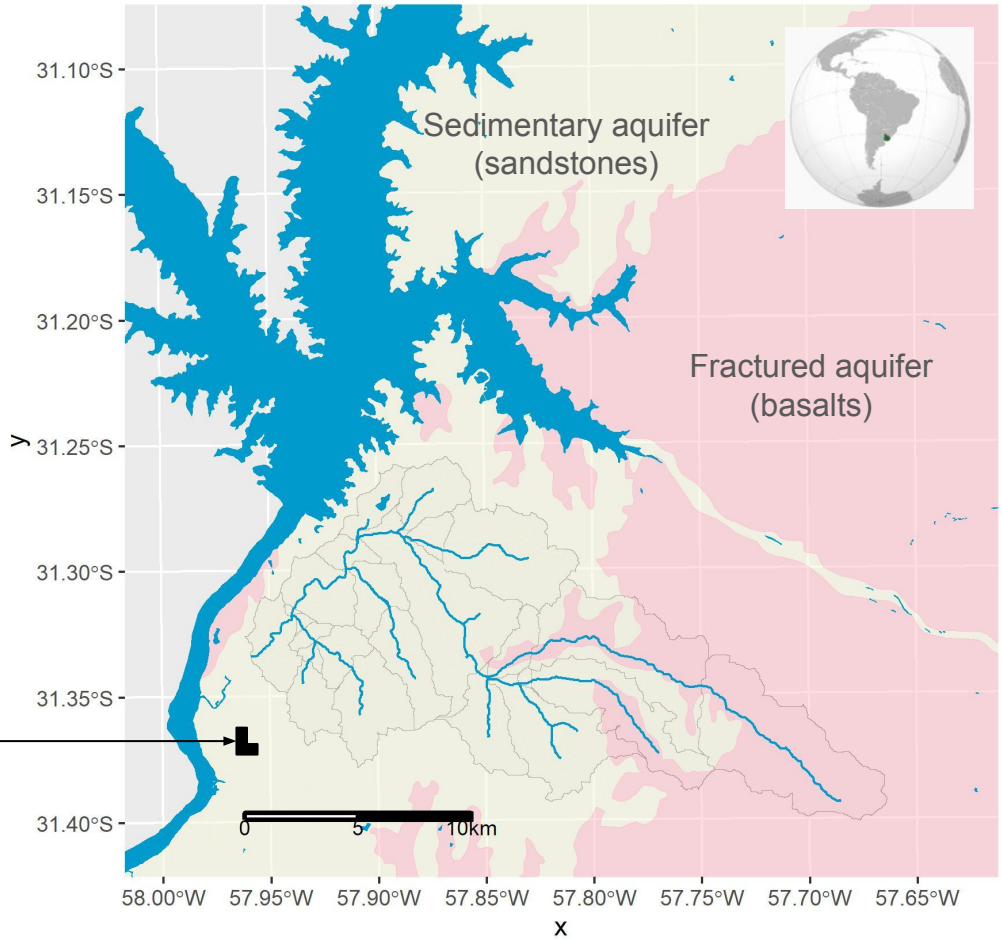


basalts

DEPARTAMENTO DEL AGUA

CENUR Litoral Norte

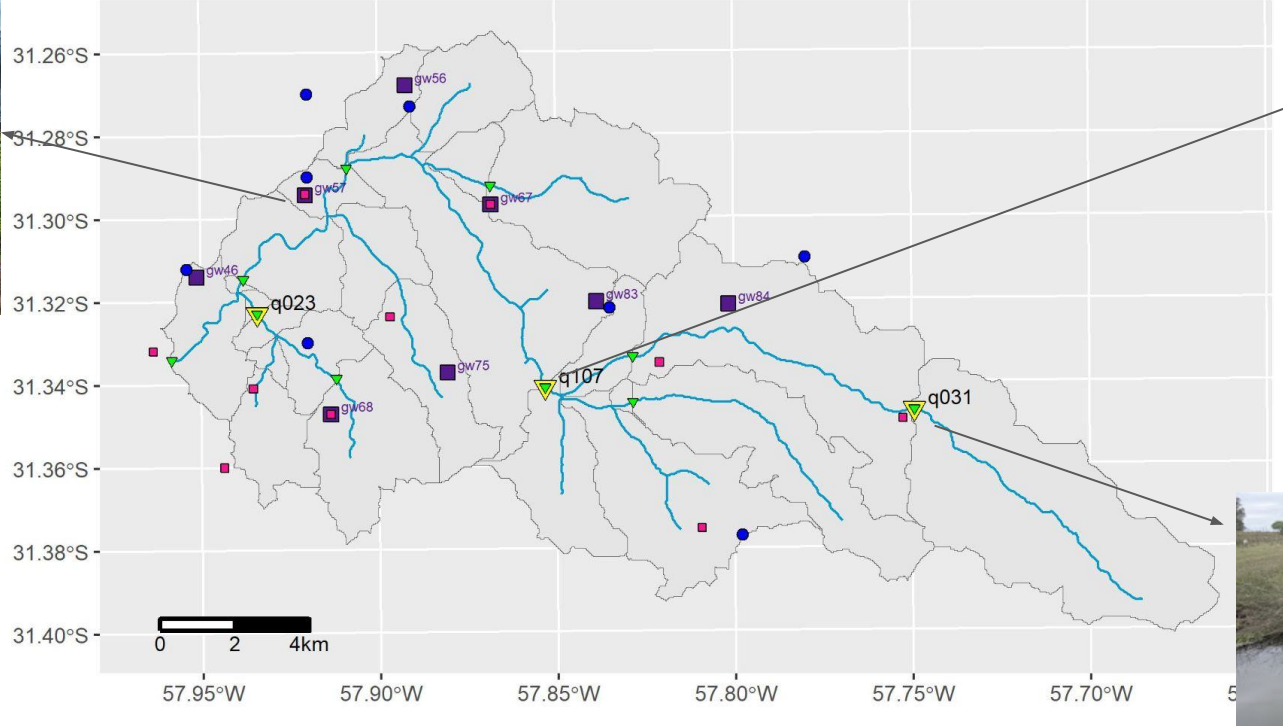
UNIVERSIDAD DE LA REPÚBLICA URUGUAY



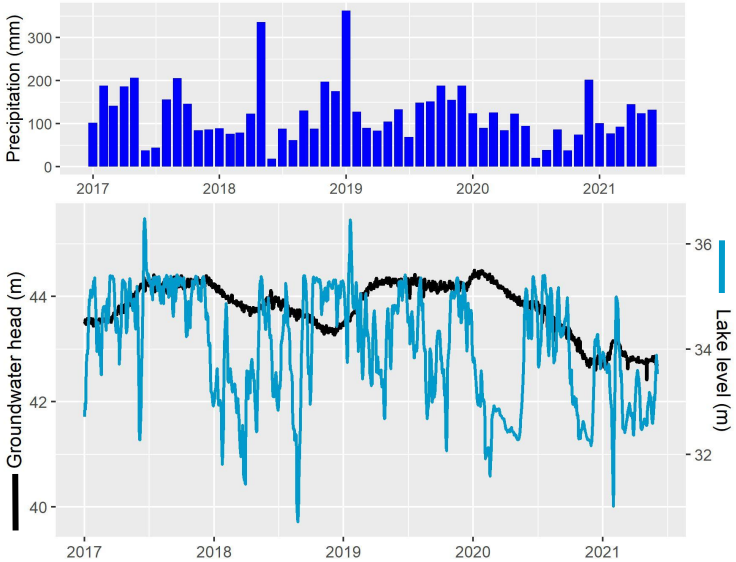
Objective

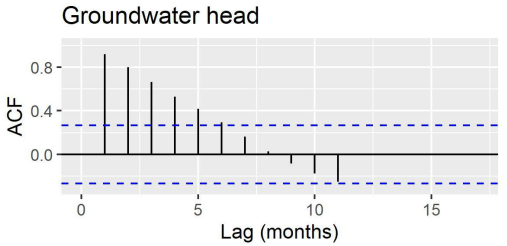
Explore the applicability of the SWAT+gwflow model to simulate hydrological processes, including groundwater dynamics, nutrient transfers, and runoff, in the San Antonio Basin, Uruguay.

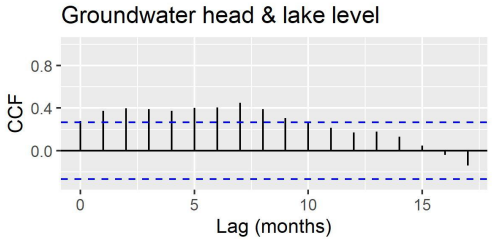
Instrumentation and sporadic observations

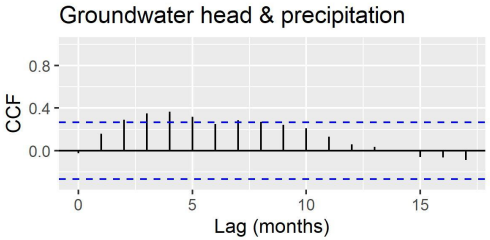


Groundwater head vs lake levels & precipitation

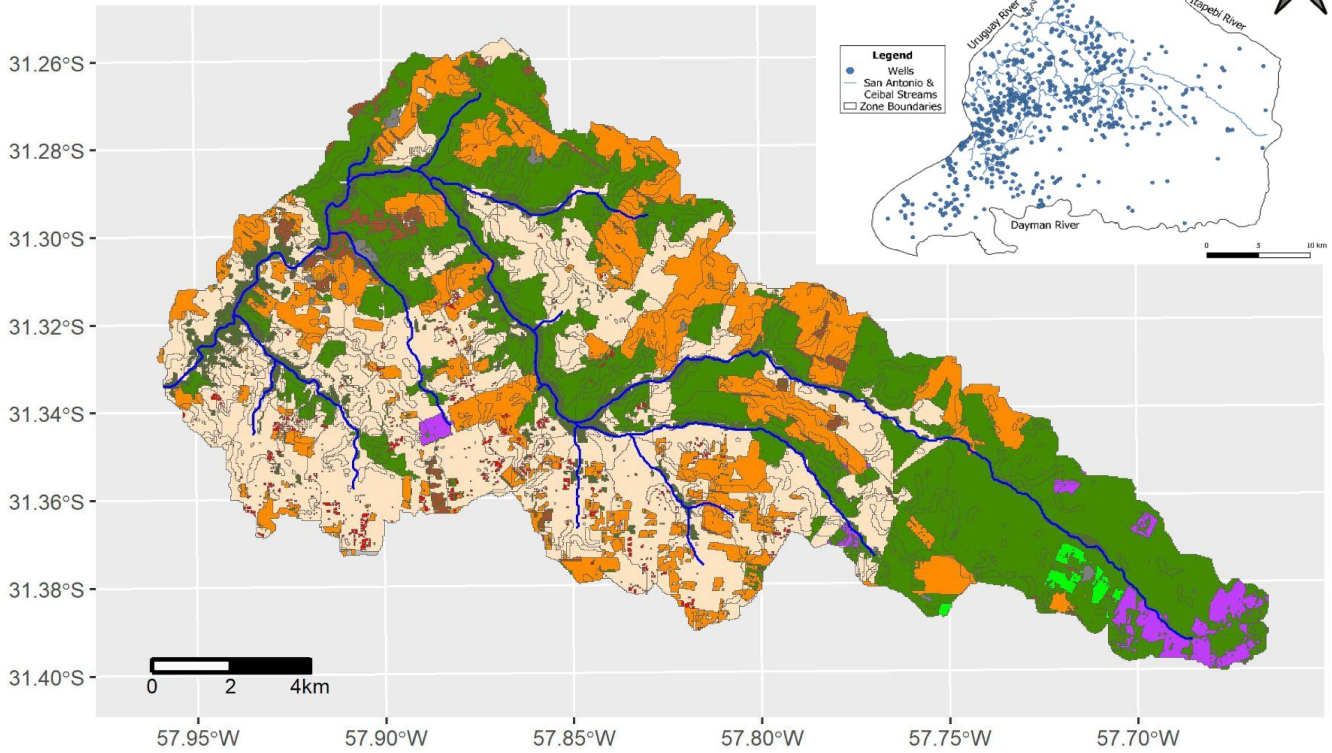




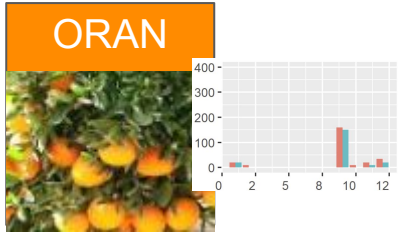


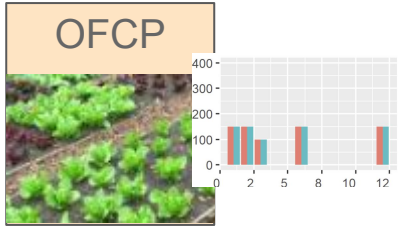


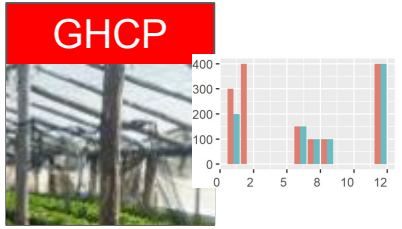
Land use and water use



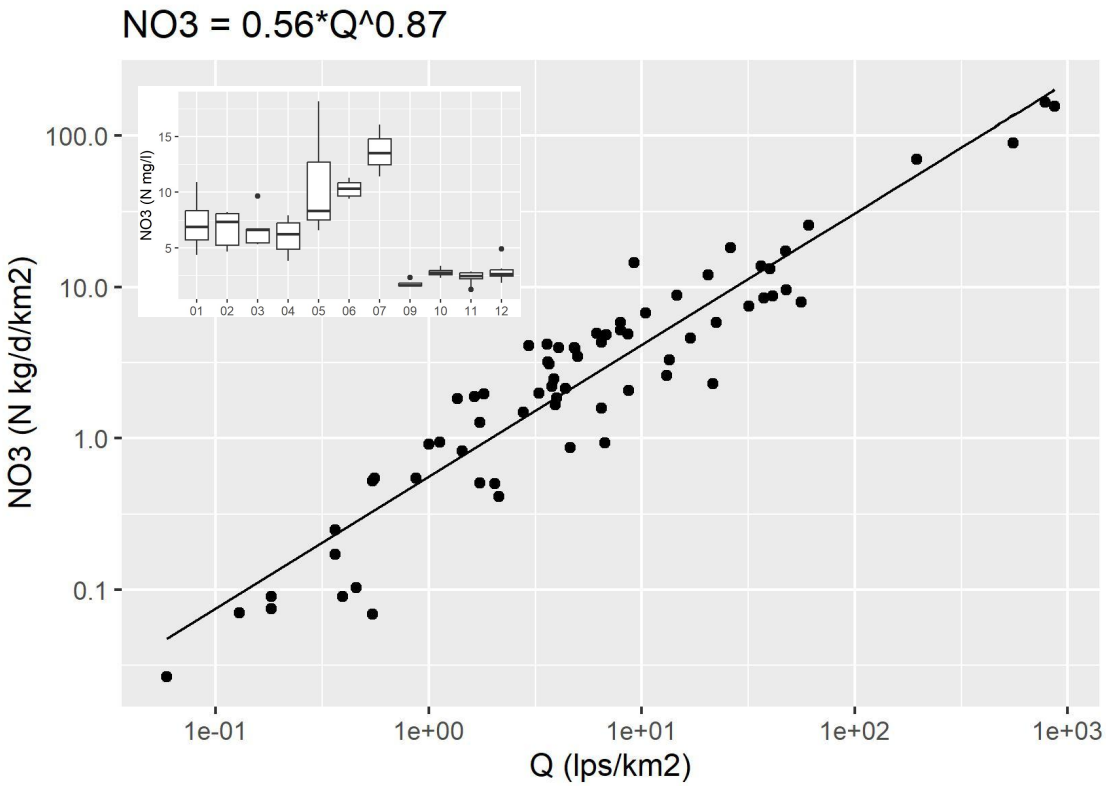
Landuse
- AGRL
- EUCA
- FRSE
- GHCP
- GRAS
- OFCP
- ORAN
- PAST
- URBN







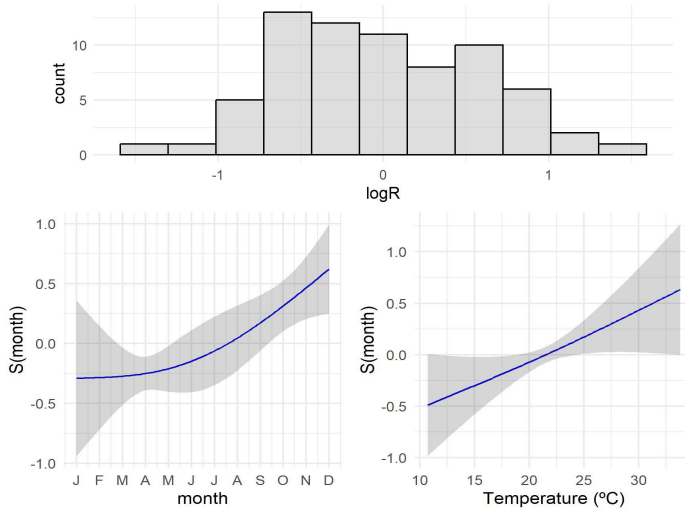
Nitrates rating curve



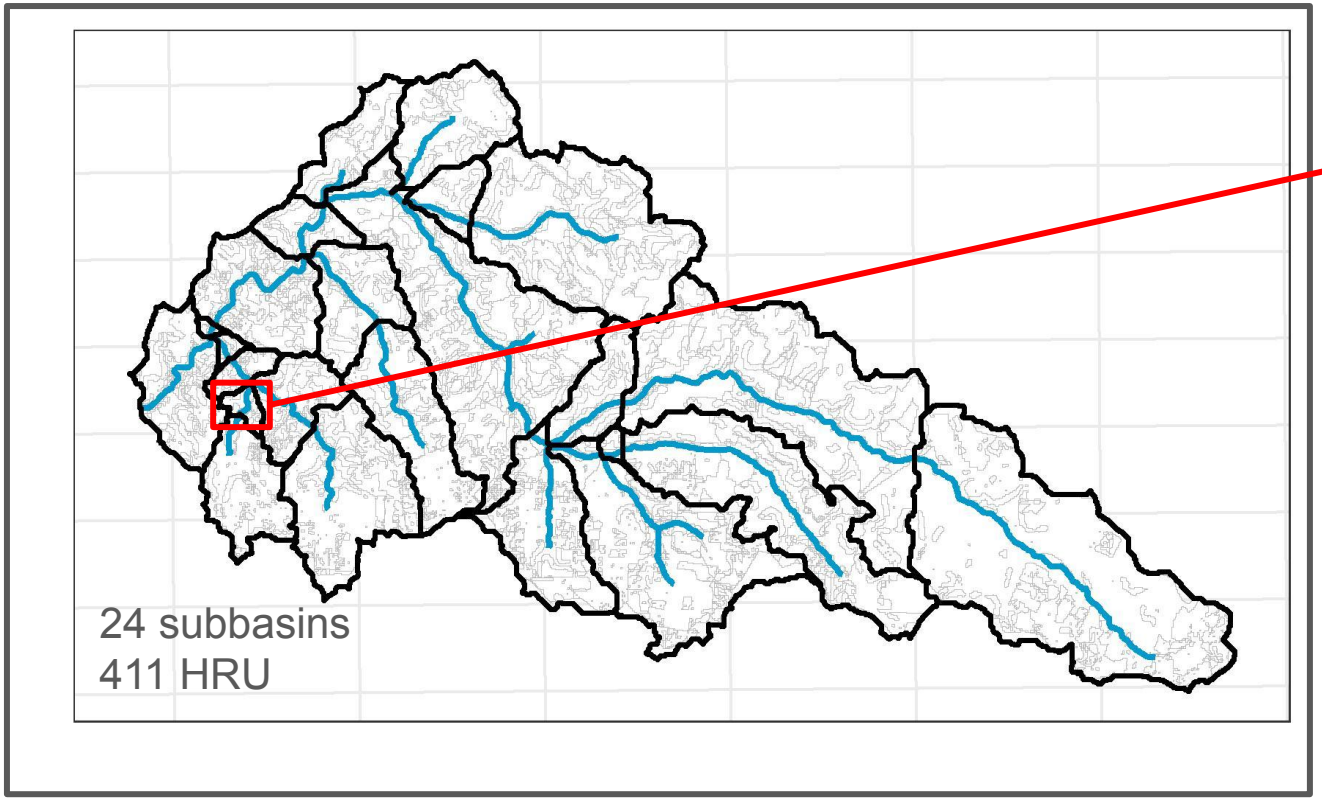
Model residuals (logR)

$$logR = log(NO3_{sim}) - log(NO3_{obs})$$

$$logR = s(month) + s(Temperature)$$

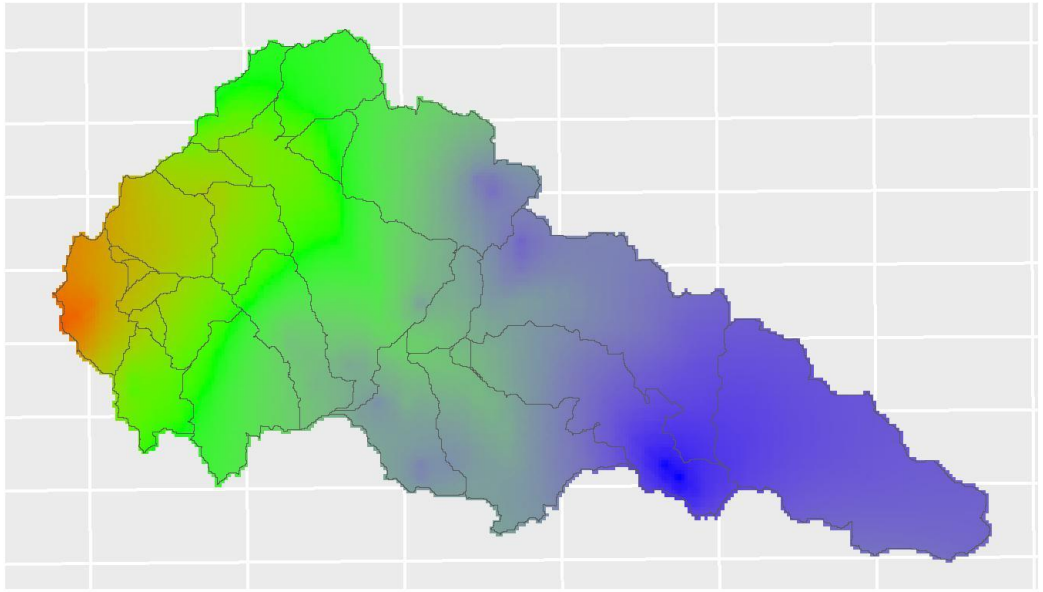


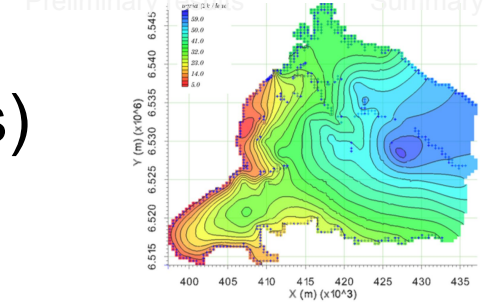
Model configuration (Subbasins, HRUs, gwflow grid)



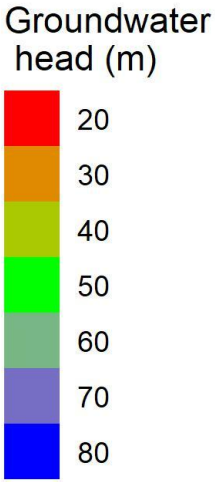
gwflow grid:
161 x 284 (100m)

Model configuration (gwflow initial conditions)



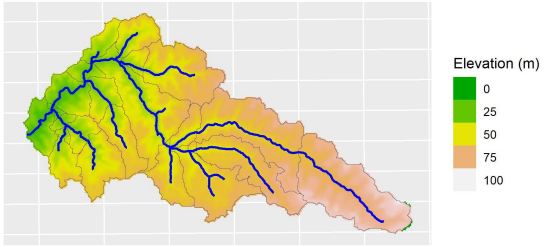


Stationary - MODFLOW
2 layers 250 x 250 m
(Borrero et al. 2024)

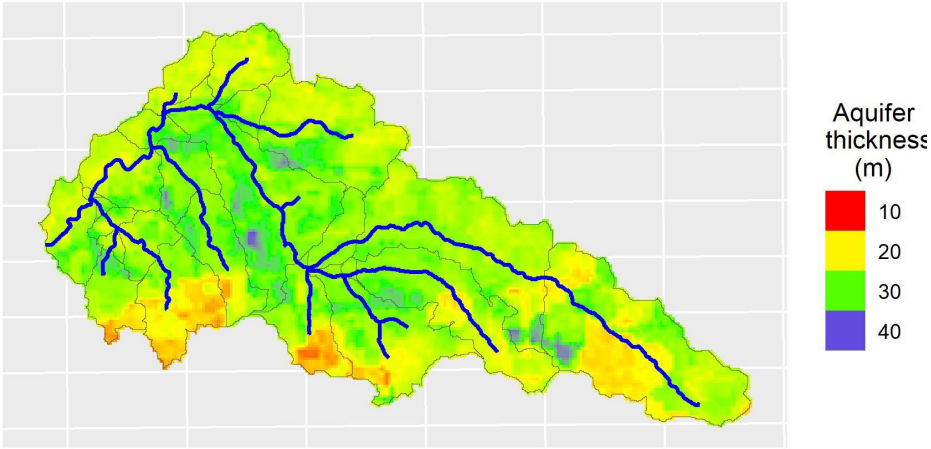


Model configuration

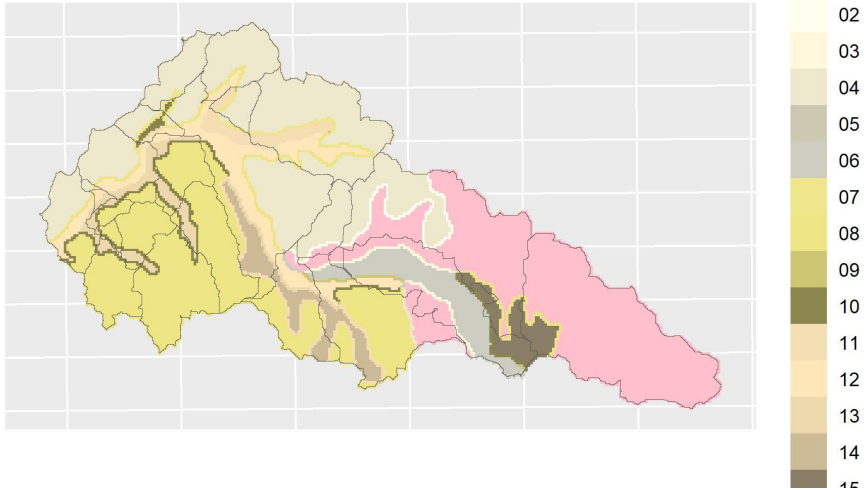
Elevation (RENARE)



Aquifer thickness (Shangguan et al. 2017)



Hydraulic conductivity and Specific yield (Huscroft et al. 2018)



Experiment design

1200 random sampling (uniform distributions)

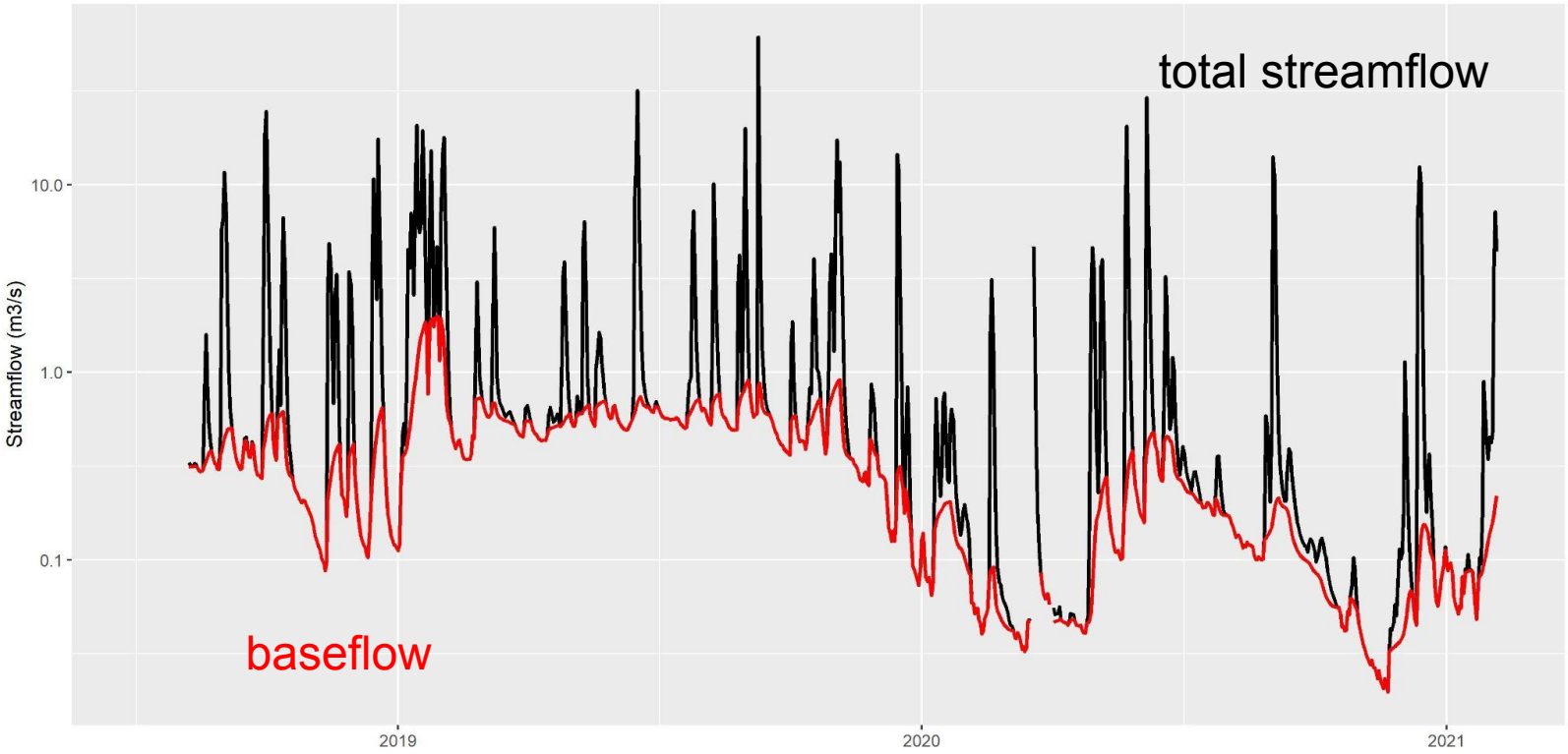
SWAT+standalone

Parameter	Component	range	change
alpha_bf	aqu	0-1	abs
cn2	cntable	0.85-1.15	rel
dep_bot	aqu	1-10	abs
dep_wt	aqu	0.1-0.9	abs*
epco	hydrology	0.6-1	abs
esco	hydrology	0.08-1.15	abs
flo_max	aqu	0-2	abs
flo_min	aqu	0-10	abs
gw_flo	aqu	0-2	abs
perc_crk	soil	0-1	abs
perco	hydrology	0-1	abs
rech_dp	aqu	0-1	abs
revap	aqu	0-1	abs
revap_min	aqu	0-10	abs
soil_dp1	soil	0.7-1.3	rel
soil_dp2	soil	0.7-1.3	rel
soil_k1	soil	0.7-1.3	rel
soil_k2	soil	0.7-1.3	rel
spec_yld	aqu	0.01-0.4	abs

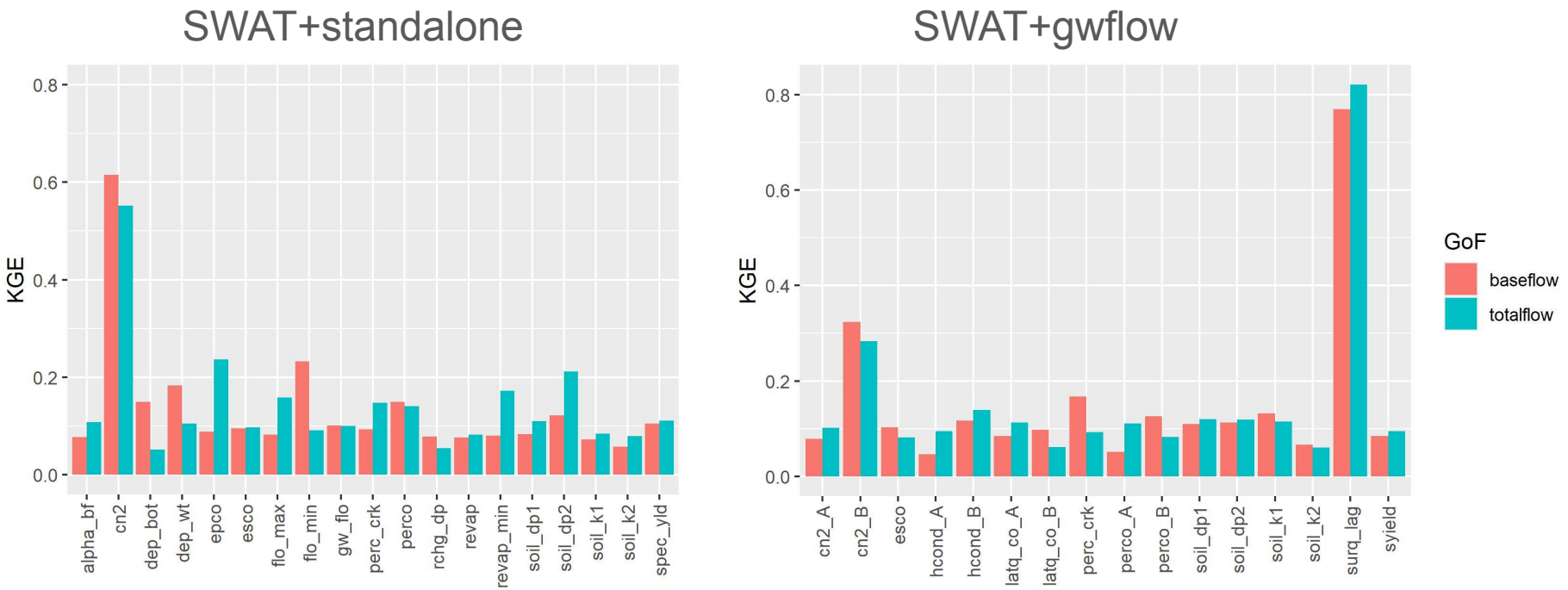
SWAT+gwflow

Parameter	Component	range	change
cn2_A	cntable	0.85-1.15	rel
cn2_B	cntable	0.85-1.15	rel
esco	hydrology	0.08-1.15	abs
hcond_A	gwflow.ini	0.5-25	abs
hcond_B	gwflow.ini	0.5-26	abs
latq_co_A	hydrology	0.01-1	abs
latq_co_B	hydrology	0.01-1	abs
perc_crk	soil	0-1	abs
perco_A	hydrology	0-1	abs
perco_B	hydrology	0-1	abs
soil_dp1	soil	0.7-1.3	rel
soil_dp2	soil	0.7-1.3	rel
soil_k1	soil	0.7-1.3	rel
soil_k2	soil	0.7-1.3	rel
surq_lag	parameters.bsn	1-24	abs
syield	gwflow.ini	0.1-0.35	abs

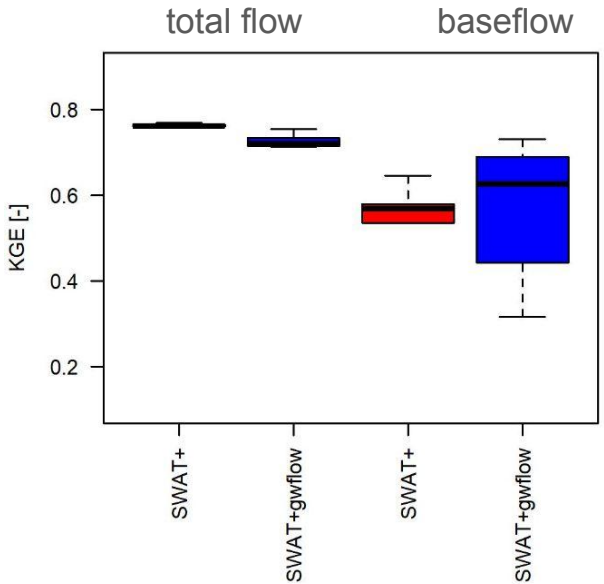
Baseflow separation (Lyne-Hollick)

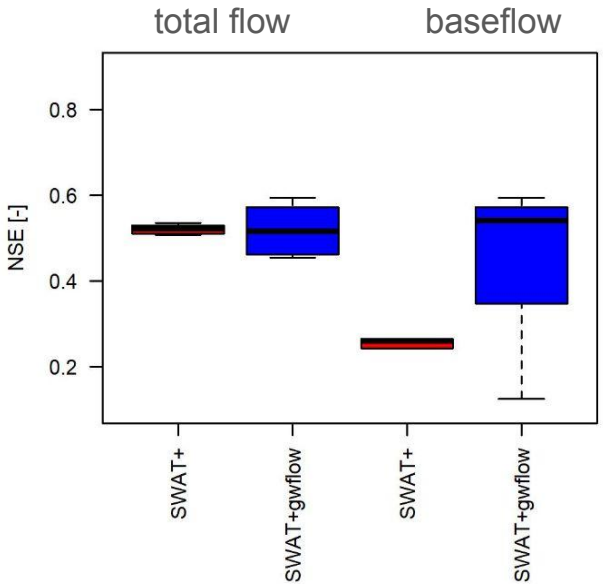


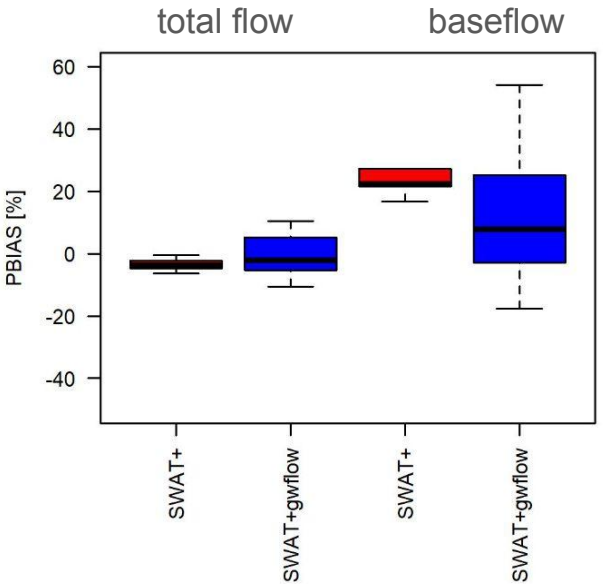
General Sensitivity Analysis | KGE(baseflow and totalflow)



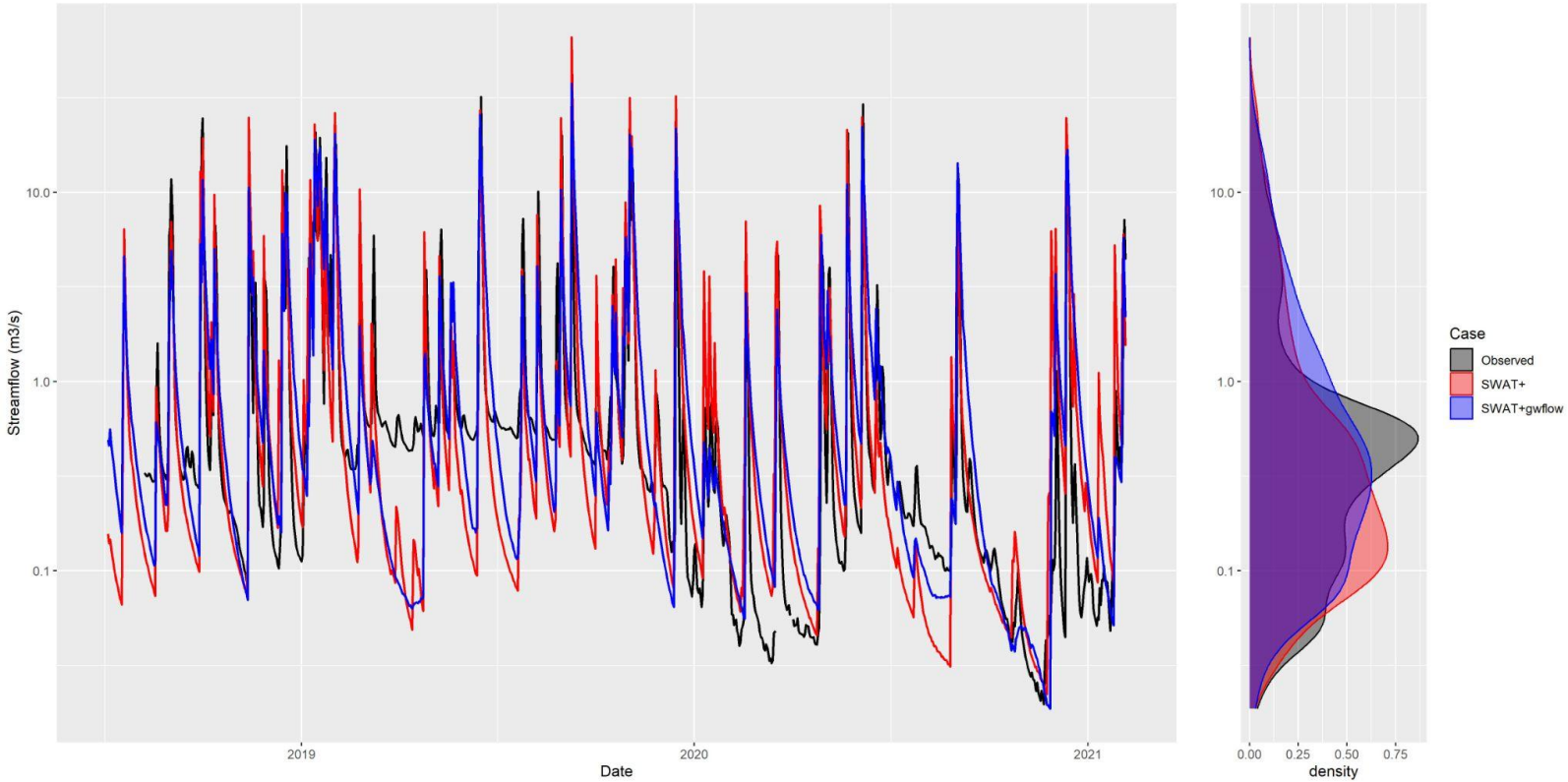
Model performance



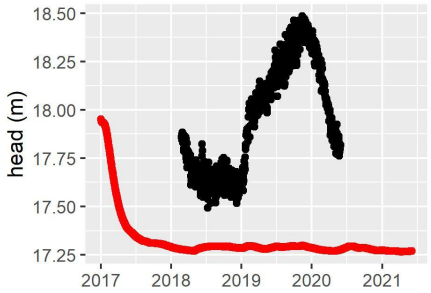


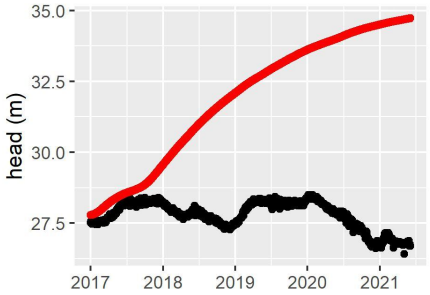


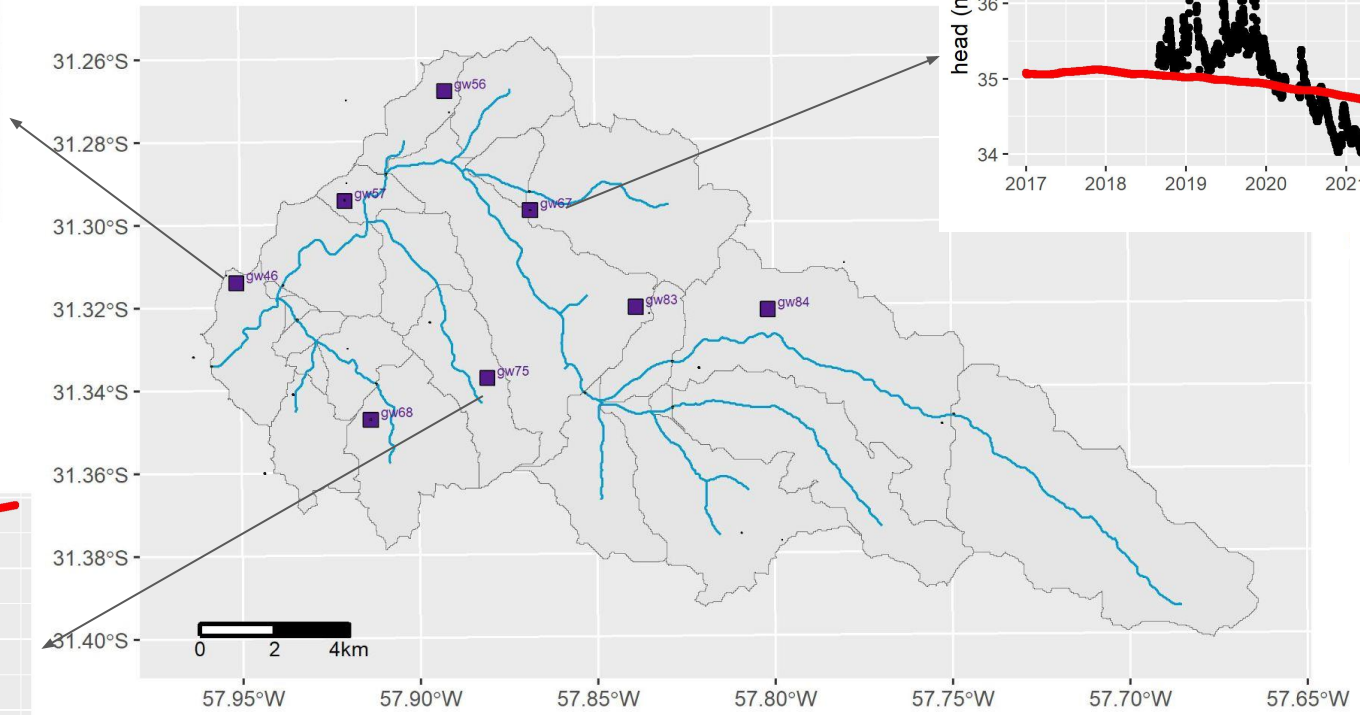
Streamflow simulations Q107



Groundwater observations and simulations

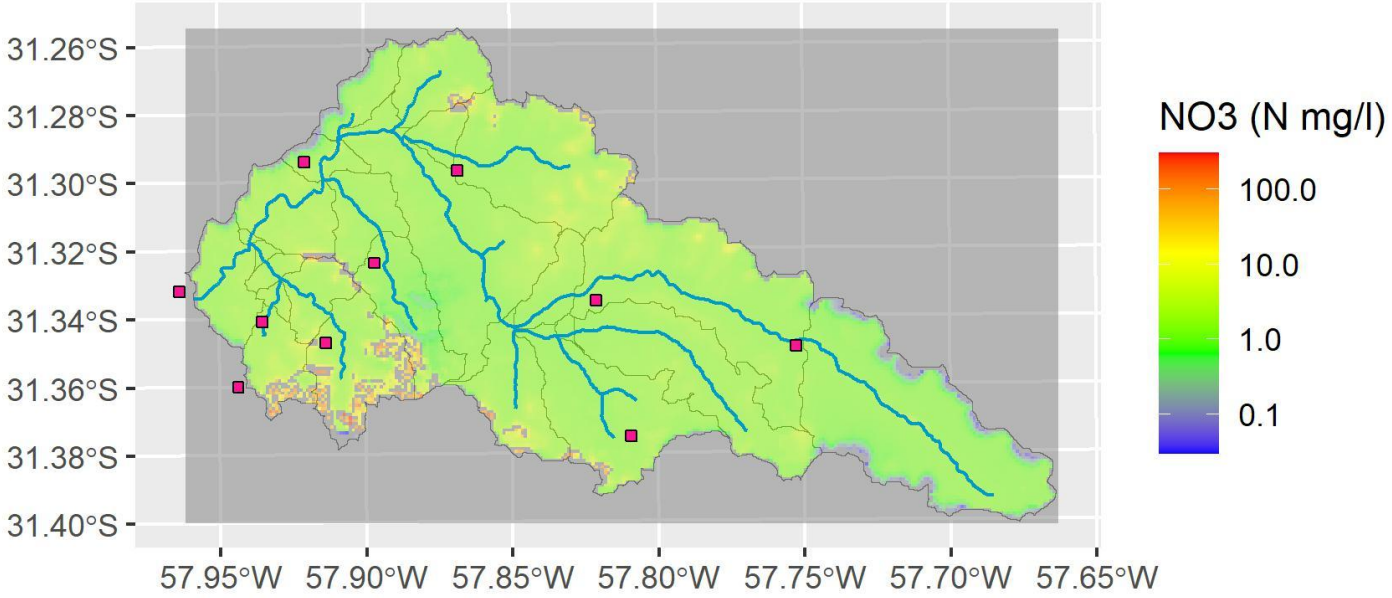






Nitrates concentrations (groundwater)

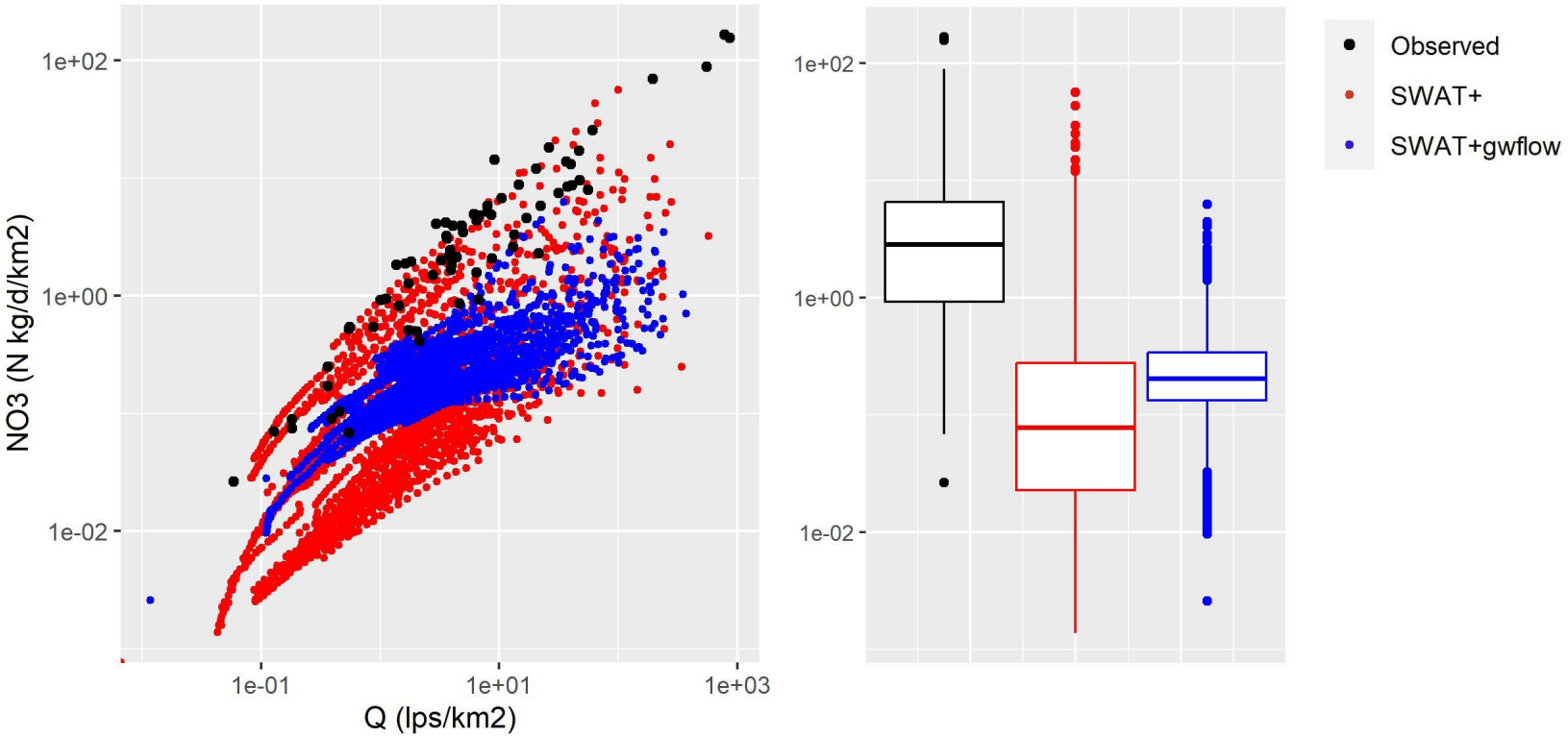
Annual average 2021



Observed values ranging

1-40 N mg/l

Nitrate loads (surface)



Summary

- Enhanced accuracy in predicting the baseflow component of streamflow.
- More precise estimation of nitrate rating curves.
- Results inform the optimal timing and location for sampling campaigns.

Next steps

- Include groundwater pumping for irrigation
- Incorporate total phosphorus (PT), total suspended solids (TSS).
- Integrate data derived from modflow.
- Calibration and scenario modelling.

Gracias - Thank you - Merci - Danke - Grazie - Obrigado - 谢谢 -- ありがとう - 감사합니다 - Спасибо - شكراً - धन्यवाद - תודה -

Teşekkürler - Ευχαριστώ - Dank u - Tack - Dziękuję - Köszönöm - Cảm ơn - Tak - Kiitos - Ačiū - Aitäh - Děkuji - Paldies -

Blagodaria - Hvala - Spasiba - Hvala vam - Takk - Grazzi - Takk fyrir - Paldies - Dėkoju - Dzięki - Mulţumesc - Благодаря -

Спасибі - Хвала - Ďakujem - Hvala - Tack så mycket - Ďakujem - Hvala lepa - Dhanyavaad - Mahalo

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