Water Balance Analysis of a Floodplain Coastal System: Congaree National Park, South Carolina

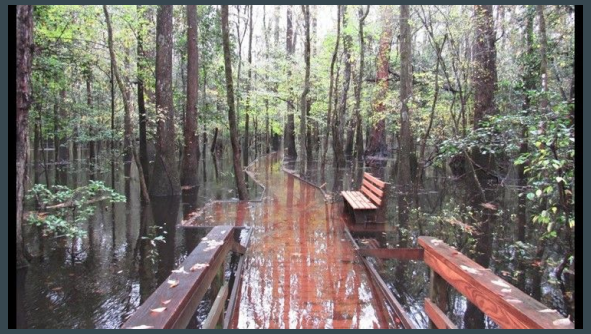
...

Emma Collins[1], Dr. Timothy Callahan[1], Dr. David Shelley[2]

1. *Geology and Environmental Geosciences, College of Charleston*
2. *Old Growth Bottomland Forest Research and Education Center, Congaree National Park*

Area of Study - Congaree National Park

(NPS)

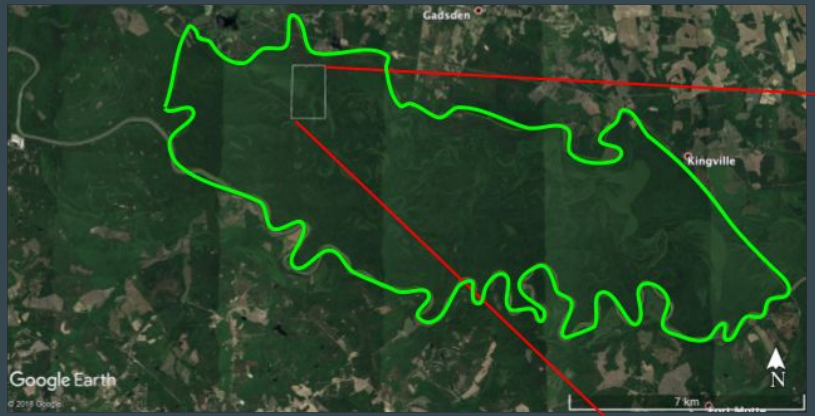


(WLTX.com)

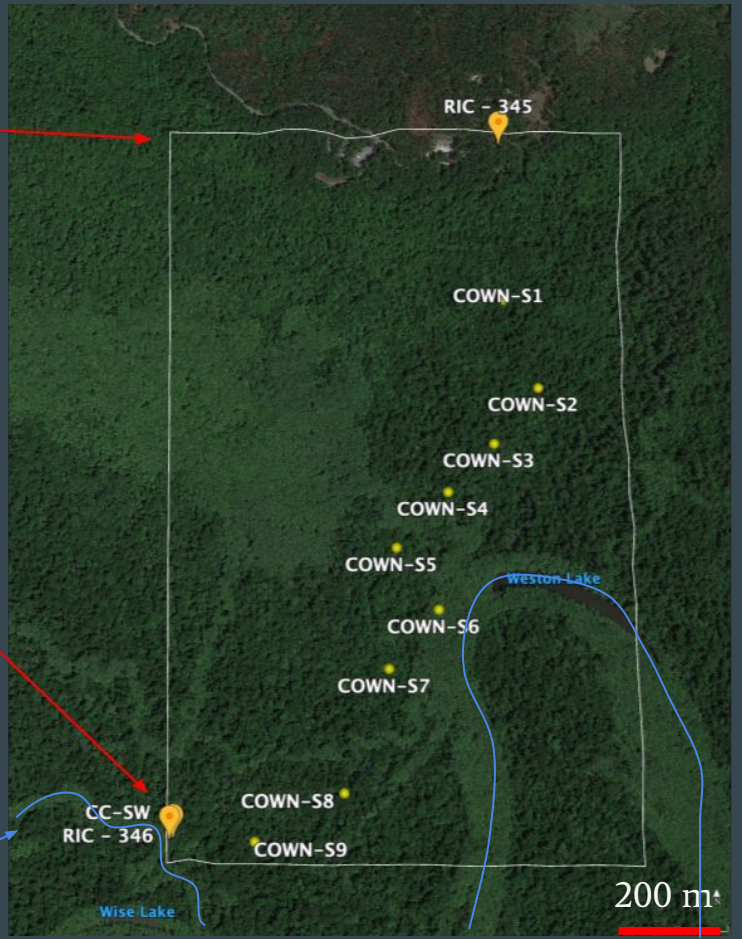
(NPS)

Objectives

- QA/QC COWN database
- Surface water/groundwater interaction analysis



Congaree National Park (left) and the Congaree Observation Well Network (COWN) within the park (right)



(Google Earth)

Approach

- Potential Evapotranspiration (PET) modeling with Priestley-Taylor
- Groundwater modeling with MODFLOW
- Water budget analysis

PET Estimation: Priestley-Taylor (1972)

$$PET = \alpha * \frac{\Delta}{\Delta+\gamma}(R_n - G)$$

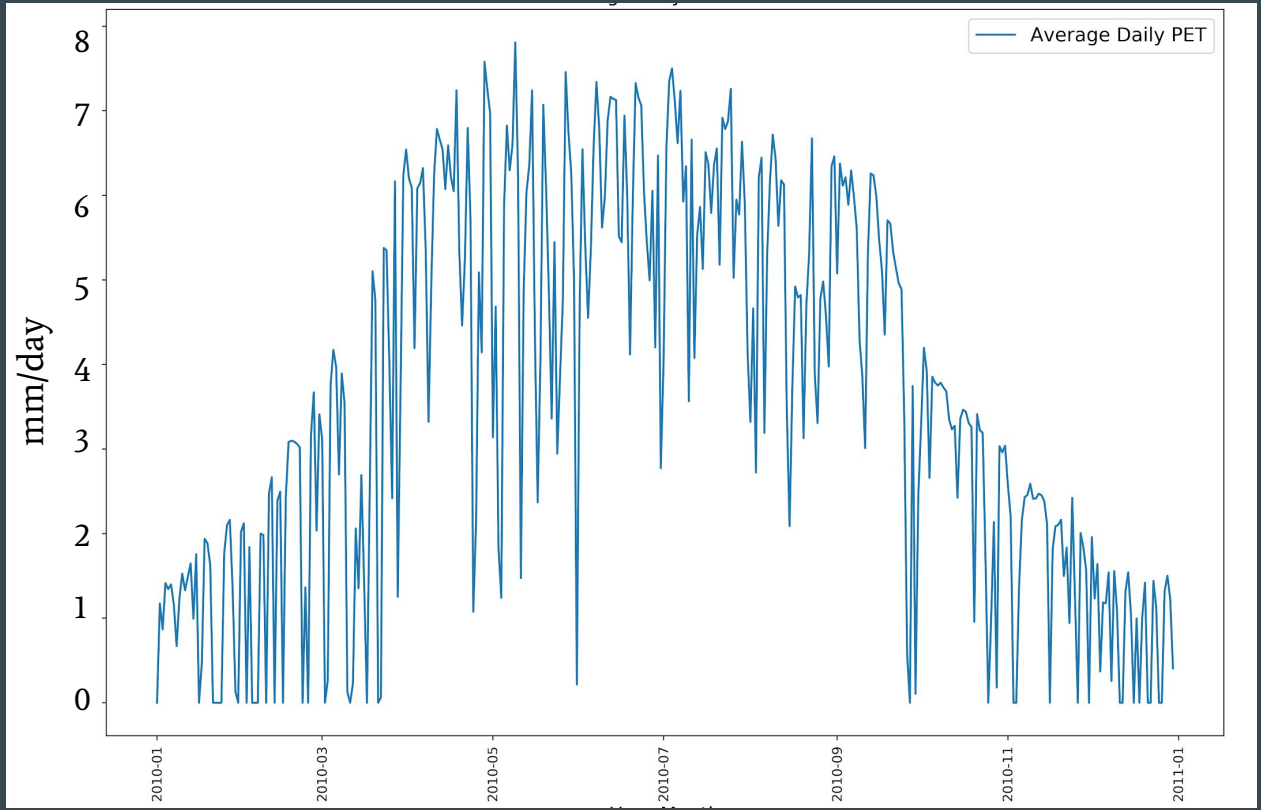
Where:

- Δ = slope of vapor pressure - temperature curve
- γ = psychrometric constant
- α = saturation deficit term (Drexler, et.al, 2004)
- R_n = net solar radiation
- G = soil heat flux

Python implementation for the Priestley-Taylor equations and associated factors (as described in Amayta, et.al., 2018, Drexler, et.al., 2004) can be found:

https://github.com/collinsemmalise/Priestly_Taylor_Python_Implementation

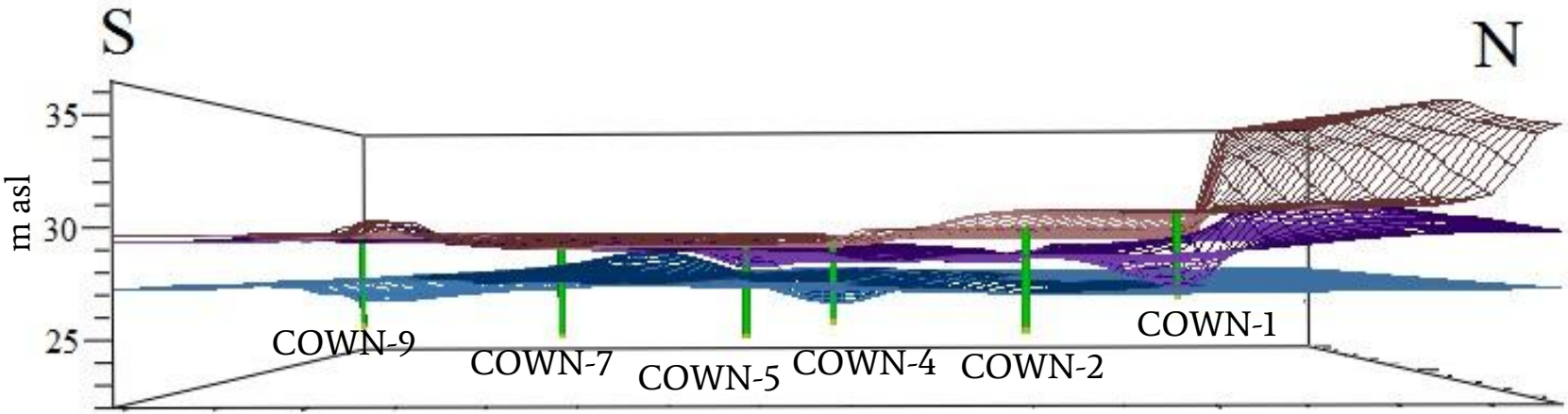
Daily Average PET for 2010

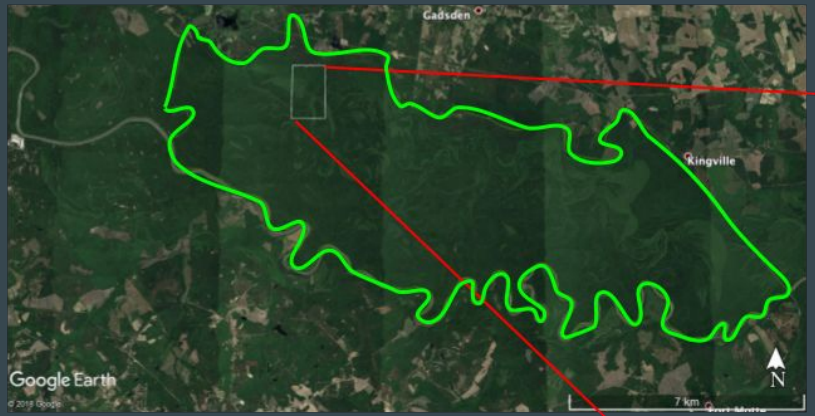


MODFLOW Groundwater Modeling

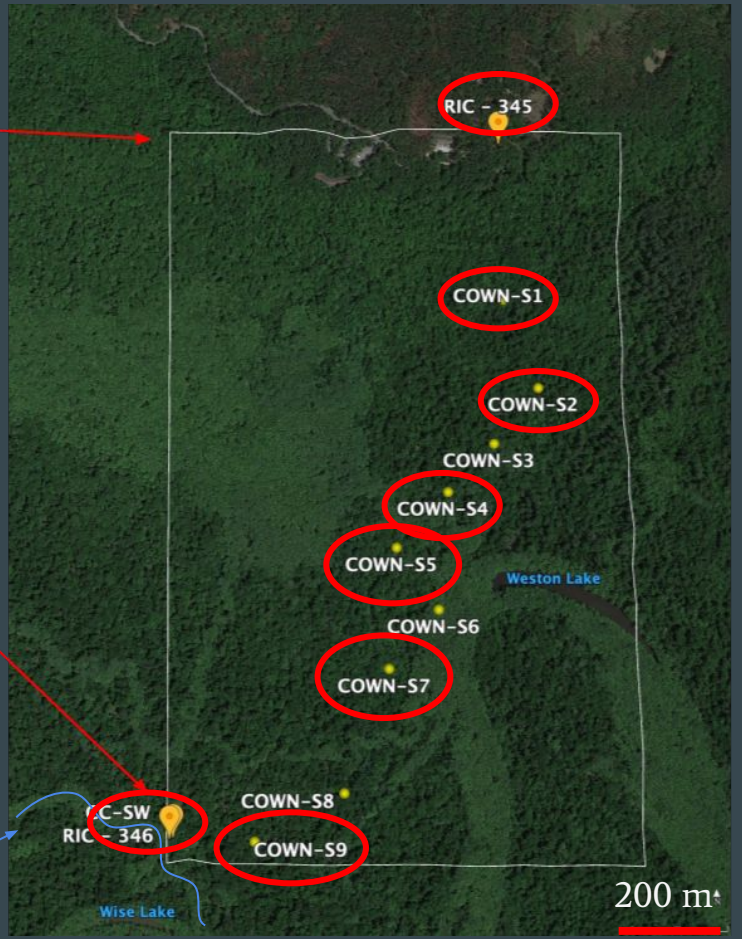
- Constructed idealized stratigraphic model of Congaree NP near COWN well transect
- Assumed homogeneous and isotropic layers ($K_x = K_y = K_z$ within layer)
- Estimated groundwater recharge using finite difference modeling software (MODFLOW) with parameter estimation package (PEST)

Stratigraphic Model of COWN Transect

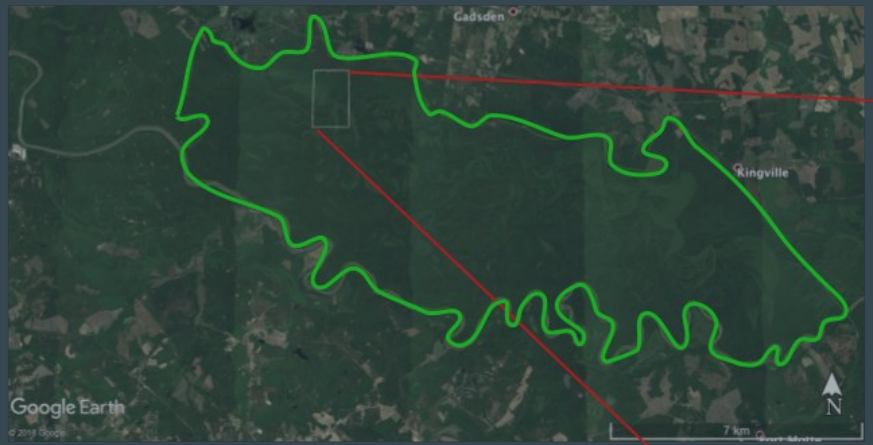




Congaree National Park (left) and the Congaree Observation Well Network (COWN) within the park (right)



(Google Earth)



Cedar Creek

N

Water Budget Analysis

- Assumed water balance governed by:

$$W = P - ET$$

- Recharge (W) estimated with MODFLOW from water table conditions
- Precipitation (P) observed from Congaree Weather Station
- Actual ET (ET) calculated by above

Results

	Estimated Recharge (mm/d)	Observed Precipitation (mm/d)	Estimated ET (mm/d)	Priestley-Taylor PET (mm/d)	Estimated ET:PET (%)
Annual Average	0.11	3.10	2.99	3.33	89.9
Growing Season Average	0.140	3.34	3.20	4.77	67.2
Dormant Season Average	1.00	2.48	1.48	1.71	86.4

Future Considerations

- Investigate seasonal relationships between water budget estimated ET and PET
- Constrain groundwater flow patterns throughout the park, especially regarding response to storm events (need more spatially diverse water table observations)
- Sensitivity analysis of MODFLOW recharge

References

- Amatya, D.M., Muwamba, A., Panda, S., Callahan, T., Harder, S., Pellet, A.(2018) Assessment of Spatial and Temporal Variation of Potential Evapotranspiration Estimated by Four Methods for South Carolina, USA. *Journal of South Carolina Water Resources*
- Drexler, J. Z., Snyder, R. L., Spano, D., & Paw U, K. T. (2004). A review of models and micrometeorological methods used to estimate wetland evapotranspiration. *Hydrological Processes,18* (11), 2071-2101.
- Guiguer, N., and Franz, T. (2002) *Visual MODFLOW*. Waterloo Hydrogeologic, Inc. Ontario, Canada.
- Priestley, C. H. B., & Taylor, R. J. (1972). On the assessment of surface heat flux and evaporation using large-scale parameters. *Monthly weather review*, *100*(2), 81-92.

Contact: Emma Collins, collinsel2@g.cofc.edu