Chapter 3: Isolated-Wetland Contribute Relatively Little to Stream Carbon but Foster External Lateral Export: Mapping the Carbon Cycle in “Wetlandscapes”.

* Landscape hydrology predicates that hydrologic and biogeochemical changes in one region of a watershed have the potential to cascade across the entire basin.
* Through the lens of landscape hydrology, the watershed is viewed as a singular, relatively closed system, encompassing micro-ecosystems that collectively contribute to the basin’s distinct biogeochemical and hydrologic fingerprint.
* However, the relevance of "landscape hydrology" is watershed specific, dependent on the basin's connectedness or how water flows and is stored between inland waters.
* This landscape "connectedness" is largely dependent on wetland area, namely geographically isolated wetlands (GIWs).
* GIWs disrupt the flow of watershed runoff. Instead of water flowing down elevation and exported to streams, water is instead stored within the catchment, fated to either efflux to the atmosphere, remain stored in the wetland basin, or exchange with the surficial aquifer.
* Through the wetland-aquifer exchange, GIWs modulate the surficial aquifer by sourcing groundwater (infiltration), receiving groundwater (exfiltration), and buffering flow extremes, thereby dictating downstream baseflow and facilitating transport between inland waters, even without overland connectivity.
* In low-relief catchments, the biogeochemical signature of each inland water is dependent on the upland hydrology, as well as the water table elevation.
* The chemical signature of low-relief stream water is the product of biogeochemical reactions occurring within the surficial aquifer and the "wetlandscape."
* In contrast, dry, unconfined watersheds with less exchange between inland waters feature aquatic environments that are more independent, with stream biogeochemical signatures more like terrestrial inputs.
* GIWs are significant reactors and sinks within the global carbon cycle.
* Considered global hot spots, GIWs act as capacitors for the landscape, storing water within the watershed and transforming nutrients within its basin.
* GIW anaerobic conditions, long residence times, and extended hydroperiods encourage the re-mineralization of carbon, resulting in GHG emissions, while dually exporting processed waters downstream through groundwater or overland flow ("spill-and-fill").
* However, according to current literature, GIWs contribution to stream carbon is minimal, only contributing 20% of total stream carbon with the rest, by default, assumed to be sourced by the riparian zone.
* Although these endeavors are advantageous for finite carbon budgeting, they undermine GIWs in global carbon cycling by (1) sampling from overland, intermittent flow paths while excluding subsurface export, (2) omitting estimates of riparian corridor sourced carbon, and (3) failing to interrogate how GIWs may influence watershed-level carbon export.
* As mentioned, GIWs modulate the surficial aquifer, providing a buffer against flow extremes, like drought.
* The wetlaThis hydrologic connection between inland waters, linked by the surficial aquifer,
* The indirect influence of GIWs, although modeled, have yet to be explored first-hand.
* The present global carbon budget has major discrepancies, especially when parsing inland water inputs and outputs. To resolve these discrepancies, more detailed observational studies across various landscapes are necessary. For the third chapter of my dissertation, I will estimate the carbon contributions from isolated, depressional wetlands to streams by longitudinally sampling for DIC, DOC, and POC from three BEF streams within basins of various wetland densities. Thus far in my PhD, I will have explored stream carbon temporal dynamics and RC fluxes in fluctuating hydrologic settings. By coupling my longitudinal sampling results with the findings from Chapters 1 and 2, I can isolate the influence of isolated wetlands. Assuming RC fluxes and stream productivity responses to fluctuating discharge are homogeneous throughout the reach, I can investigate how nearby wetlands influence stream carbon as water accumulates downstream. Studies have directly explored isolated wetland carbon contributions, and none have included observed RC fluxes along with stream metabolism models.
* (1) I hypothesize that each stream will gain carbon, increasing in DIC, DOC, and POC as water flows downstream. Although I expect depressional wetlands to contribute to the stream carbon, (2) I hypothesize the RC will remain the dominant carbon source. However, during flooded conditions, (3) I anticipate the wetland contribution will be greatest due to a shallower surficial aquifer and overland flow. Additionally, (4) I expect streams in watersheds with greater wetland density (wetland area/wetland quantity) to have higher total carbon (TC) concentrations and more homogeneous carbon quality across wetland, RC, and stream boundaries.
* Using the results from my entire dissertation, I aim to holistically map stream carbon sources and fluxes, allowing me to draw detailed inferences on low-relief, “wetlandscape” carbon budgets. By testing these hypotheses and developing a carbon budget, I aspire for this chapter to offer both an improved understanding of low-relief carbon cycling and practical applications. Specifically, my objective for Chapter 3 is to inform management decisions on how to optimize landscape hydrology for carbon storage.