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 isolated, depression wetlands.
* Depression wetlands 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, wetlands 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.
* Isolated wetlands are recognized as significant contributors to global carbon cycling and stream carbon.
* Considered global hotspots and carbon sinks, isolated wetlands act as "capacitors" for the landscape, storing water and transforming nutrients within their basins.
* The anaerobic conditions, long residence times, and extended hydroperiods of wetlands promote the re-mineralization of carbon and the emission of greenhouse gases (GHG), while also exporting processed nutrients downstream via subsurface flow or overland flow ("spill-and-fill").
* Due to their productivity and carbon storage potential, despite only covering 2-6% of Earth's surface, wetlands are assumed to be infinite carbon sources for streams, especially in low-relief landscapes.
* Despite there ecosystem function and high biogeochemical activity, observed estimate of carbon fluxed from isolated wetlands to streams are minimal
* Both modeled and observed estimate roughly ~20% of stream carbon is contributed by GIWs.
* This statistic is not helpful in depicting GIWs as carbon export facilitors even if they are not direct sources
* As mentioned wetlands dictates lateral export by modulating the surficial aquifer.
* Current research fails to include the “wetlandscape” within their discussion.
* Riparian wetlands are hypothesized to be a major source of stream carbon yet through lateral transport, is the catchments carbon funneled to them
* These publication can include stream respiration, although infrequently, but yet into riparian wetland, accrediting the excess carbon not sourced by GIWs to the river corridor. However, the observed estimates – not the remainder- have yet to be taken into account with GIW contributions
* They may not directly source carbon, but they are influential in supporting the transport network
* While wetland-stream carbon contributions in higher-order, tropical streams have been investigated, few studies have explored the influence of isolated wetlands on lower-order streams.
* Existing research interrogating headwater-wetland exchanges have primarily focused on perennial wetlands and do not include river corridor (RC) estimates.
* Furthermore, current river-wetland and headwater-wetland carbon flux estimates are contrasting, indicating that larger river-floodplain systems are not directly comparable to smaller, headwater streams.
* Wetlands of high-order rivers are recorded to contribute the majority of stream carbon (approximately 80%), whereas isolated wetlands associated with smaller, low-order streams only source about 20% of stream carbon. Assuming one scenario over the other can lead to significant inaccuracies in carbon inventories and inflate isolated wetland contributions.
* What I really want to say they have looked at isolated wetland contributions via water quality signatures but they have yet to do detailed budgeting, exploring isolated inputs in comparison to observed RC and metabolized stream carbon
* 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.