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ABSTRACT TITLE: Investigating the balance between uptake and export for inorganic carbon discharged to rainforest streams from regional groundwater, Costa Rica

ABSTRACT: Recent water and carbon data from the lowland rainforest at La Selva Biological Station in Costa Rica suggest that old regional groundwater elevated in dissolved inorganic carbon (DIC) flows beneath watershed topographic boundaries and discharges upward into streams and riparian wetlands, strongly influencing concentrations and fluxes of both DIC and dissolved organic carbon (DOC) and potentially augmenting CO_2 fluxes from streams and wetlands. This suggests accurate understanding of the carbon cycle and source/sink status of the ecosystem from field data requires accounting for carbon inputs from regional groundwater.

One objective is to determine the extent to which old DIC discharged to streams by regional groundwater is incorporated into the modern biological carbon cycle in the study streams. In other words, for this DIC, what is the balance between export from the site (via stream discharge, or degassing from streams) and uptake via in-stream photosynthesis? The latter could be seen as a short-term sequestration of old DIC from regional groundwater in the riparian corridor of the rainforest watersheds. We are evaluating this export-uptake balance by measuring particulate organic carbon (POC) concentrations and stable isotope values ($\delta^{13}C$), as well as atomic C:N ratios. *We hypothesized that if DIC from regional groundwater is being fixed via in-stream photosynthesis, then the POC of the streams will reflect that isotopically-distinct DIC source.*

Our focus includes two adjacent streams: the Arboleda that receives significant regional groundwater (40-50% of stream discharge), and the Taconazo that receives none. The POC concentrations were 0.16 to 1.59 mg C L^{-1} in the Arboleda and 0.50 to 3.27 mg C L^{-1} in the Taconazo; trends in concentration appear linked to stream flow in each system. The two streams had very different $\delta^{13}C$-DIC values due to the influence of regional groundwater in the Arboleda (-4.4‰ in the Arboleda, -22.4‰ in the Taconazo). Given the contrast in $\delta^{13}C$-DIC, and with most primary producers in the streams likely being C3 algae (carbon isotope fractionation of about -20‰ upon uptake), domination of stream POC by in-stream primary production would likely lead to very different $\delta^{13}C$-POC values for the streams: about -42‰ in the Taconazo and -24.4‰ in the Arboleda. But, this was not observed. The $\delta^{13}C$-POC distributions were very similar for both streams and fell within a range of -39 to -22‰. The median $\delta^{13}C$-POC for the Arboleda was -26.7‰ and the median C:N ratio was 16.7; corresponding values for the Taconazo were -27.1‰ and 15. For the POC in both streams, C:N ratio and $\delta^{13}C$ fell within the range typical of soil organic matter dominated by terrestrial C3 vegetation.

These results strongly suggest that old DIC from regional groundwater is not significantly incorporated into the modern biological carbon cycle in the Arboleda stream, likely due to light limitation on rates of photosynthesis in the streams beneath the rainforest canopy. The implication is that large DIC inputs to surface water from regional groundwater are exported from the rainforest with stream discharge or degassed as CO_2 (i.e., this DIC experiences minimal within-watershed sequestration, and thus is necessarily augmenting carbon fluxes across the air-water interface and out of the watershed with stream flow). Further work is underway using stable isotopes to determine if the DIC signal from regional groundwater is present in rainforest DOC. Based on the POC results, we hypothesize that such a contribution is low.