**Effects of high-carbon regional groundwater on carbon transfers in a lowland rainforest: groundwater to surface water to air**

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This project focuses on the discharge of high-carbon regional groundwater into streams and wetlands in a Costa Rican rainforest, and resultant impacts on ecosystem carbon pools and fluxes. In 2014 we measured $CO_2$ and $CH_4$ degassing fluxes from two rainforest streams at La Selva Biological Station: the Arboleda and Taconazo. In these two watersheds, only the lower Arboleda receives inputs of regional groundwater. Comparing the lower Arboleda to the upper and lower Taconazo and upper Arboleda, regional groundwater inputs: (1) increased streamwater $CO_2$ concentration by 4-6x in the dry season and 5-11x in the wet season (average increase 7x), and (2) increased $CO_2$ degassing flux by 7-15x in the dry season and 4-8x in the wet season (average increase 8.5x).

Regional groundwater input increased stream depth and lowered first-order gas exchange coefficient ($time^{-1}$) in the lower Arboleda, but the two effects offset each other and there was no major effect of regional groundwater on stream gas exchange velocity.

Regional groundwater had no effect on stream methane concentration or degassing flux. Regional groundwater at La Selva is generally oxic despite a long subsurface residence time of ~3000 yr in volcanic rock. Groundwater from regional aquifer systems of different geology may have more potential to influence stream methane, e.g., groundwater methane concentrations up to 13.3 mM (at least 100x larger than in regional groundwater at La Selva) have been found in sedimentary aquifers in Canada.

Normalized to full watershed land area, $CO_2$ degassing from the Arboleda stream was about 300 $gCm^{-2}yr^{-1}$, roughly the same as the mean NEE of $CO_2$. Such elevated stream $CO_2$ degassing could suggest an ecosystem has elevated respiration and is a net source (rather than sink) with respect to atmospheric $CO_2$; knowing that elevated $CO_2$ degassing is supported by large inputs of non-biogenic $CO_2$ from regional groundwater is important to not over-estimating ecosystem respiration and having a more accurate picture of the carbon source/sink status of the ecosystem.

Keeling plots were used to evaluate the signal of $CO_2$ from regional groundwater in air from stream degassing. In the Taconazo, where respiration is the only ecosystem source for $CO_2$, $\delta^{13}C$-$CO_2$ vs. 1/[ $CO_2$] gave a typical straight-line Keeling plot defined by atmospheric $CO_2$ and $CO_2$ from ecosystem respiration. However, data from the lower Arboleda plotted to the upper left of this line toward higher $\delta^{13}C$ values at higher $CO_2$ concentration, indicating the contribution of $CO_2$ from regional groundwater.