Comparative analysis of zero-order hillslope carbon and nitrogen heterogeneity using solid and liquid samples

Corinne Webb[2], Ed Hunt[1], Dr. Katerina Dontsova[1], Michael Volk[1]

[1] Biosphere 2, University of Arizona
[2] STAR, Humboldt State University

Objectives

Figure 1, the LEO hillslope

The Landscape Evolution Observatory (LEO) at Biosphere 2 near Tucson, AZ is a unique and singular experimental setup in which scientists are able to tackle large-scale earth science questions involving soil formation, nutrient cycling, and chemical weathering in a way that is unavailable in true Earth systems. Three identical zero-order 330 m^2 drainage basins are each filled with 330 m^3 of ground basaltic tephra with a loamy sand texture sourced from northern Arizona for its capacity for carbon sequestration. Mapping of carbon and nitrogen spatially allows scientists to track chemical changes occurring within the slopes.

Methods

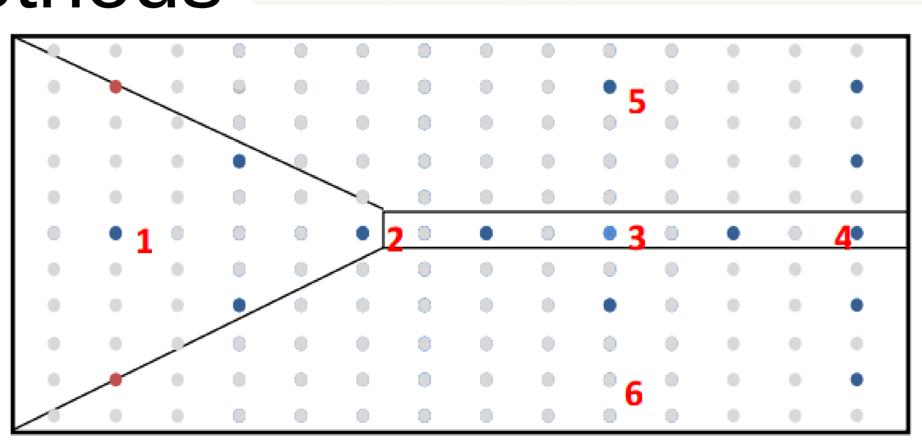

Figure 2, distribution of soil cores taken from LEO slopes

To obtain information on accumulation of carbon/nitrogen on LEO slopes as a result of biological and abiotic processes, six soil cores distributed across three locations (5, 3, and 6 shown above) in the LEO hillslopes were collected and six depths including 5, 20, 35, 50, and 85 cm were analyzed in a Shimadzu total carbon and nitrogen analyzer. Seepage samples from biweekly rains on LEO from the same time period were collected from a subset of the 1500 total available samplers and analyzed for pH, conductivity, carbon, nitrogen, cation, and anion concentrations.

Results

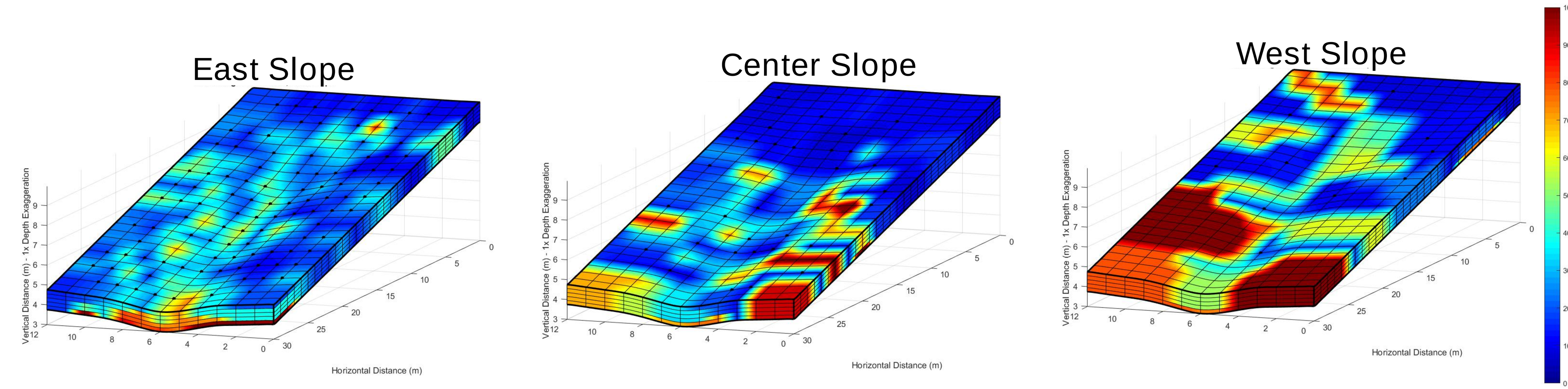

Figure 3, total inorganic carbon spatially located through the slopes; data comes from liquid rainfall samples collected from a subset of the 1500 total samplers.

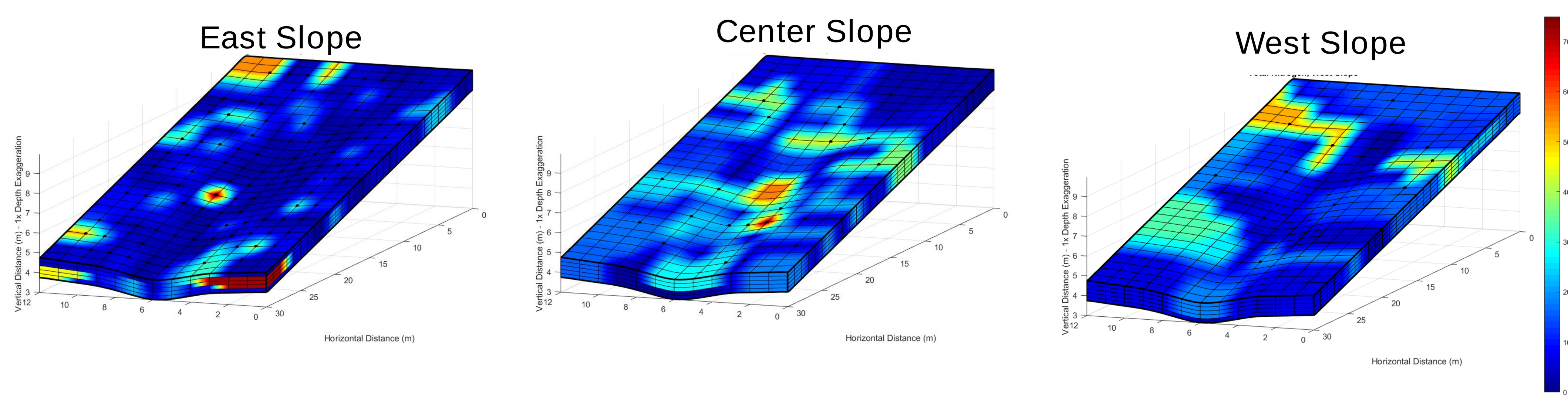

Figure 4, total nitrogen spatially located through the slopes.

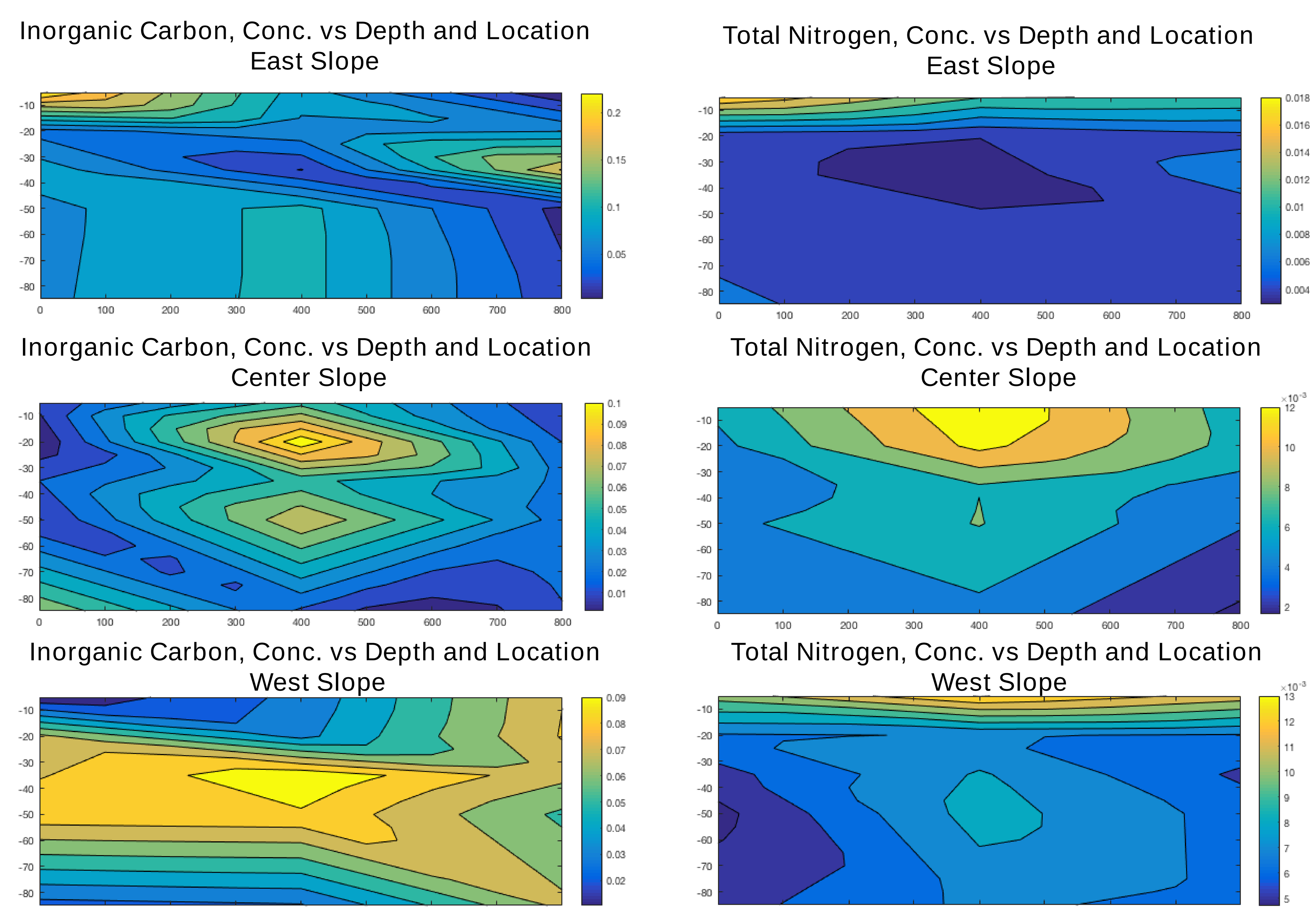

Figure 5, plot of concentrations in solid samples at locations five, three, and six (a cross section of the LEO hillslope). Location five corresponds to zero cm, location three corresponds to 400 cm, location 6 corresponds to 800 cm on the x-axis. Y-axis values are reversed.

Discussion

Inorganic carbon concentrations varied depending on slope location; in the east slope, it is concentrated along the flow path towards the center of the slope. However, in the west and center slopes, inorganic carbon seems to be concentrated along the outer areas of the slope and less so in the center. Inorganic carbon can come from inorganic processes such as weathering or biotic microbial activity. Nitrogen is accumulated on the soil surface in all three slopes, and in center slope significantly along the channel area. Total nitrogen concentrations in liquid samples did not have a distinct pattern. Significant accumulation of nitrogen and inorganic carbon after three years of simulated rainfall indicate incipient soil formation. Concentrations are expected to increase in solid phase and patterns would become more obvious over time as the soil weathers more. Future plans for LEO include the addition of plants to the slope to further study the effects of biotic and abiotic processes on soil carbon and nitrogen cycling.

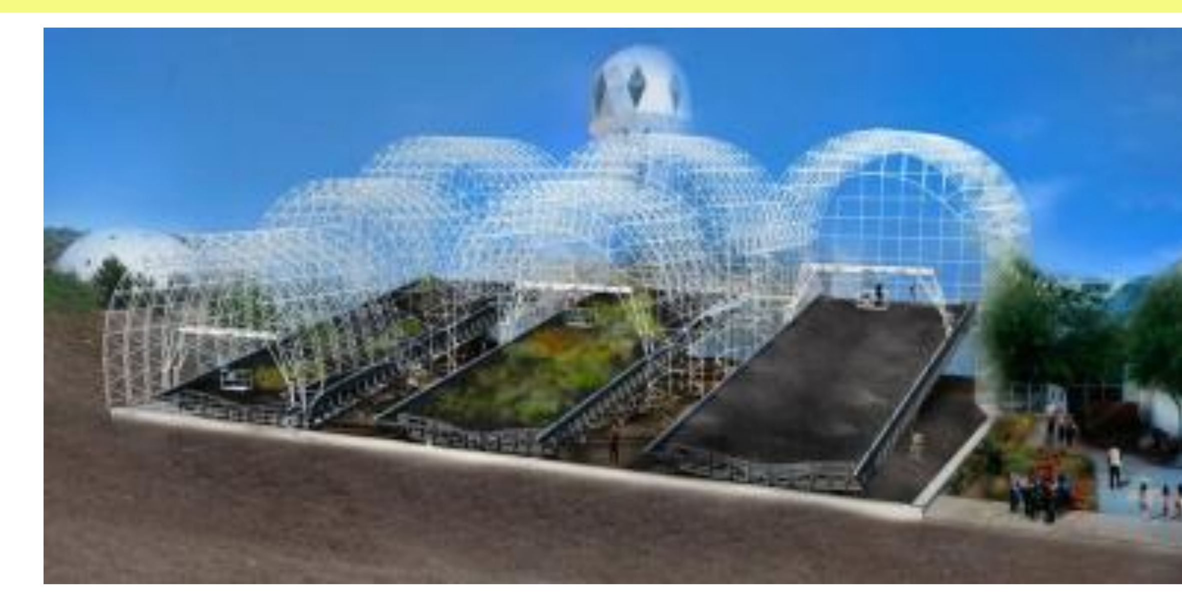

Figure 6, a projection model of LEO in the future with plants

Acknowledgements

Thank you to David Litwin (REU student) for helping me to create these figures, and to the rest of my roommates for their knowledge. This project could not have been completed without the help of Eunice Villasenor (REU student, Arizona State University). The 2017 STEM Teacher and Researcher Program and this project have been made possible through support from Chevron (www.chevron.com), the National Marine Sanctuary Foundation (www.marinesanctuary.org), the California State University Office of the Chancellor, and California Polytechnic State University, in partnership with Biosphere 2.

References

Pangle, Luke A et al. 2015. The Landscape Evolution Observatory: A large-scale controllable infrastructure to study coupled Earth-surface processes. *Geomorphology* 244: 190-203.
K. Dontsova, C. I. Steefel, S. Desilets, A. Thompson, J. Chorover. 2009. Solid phase evolution in the Biosphere 2 hillslope experiment as predicted by modeling of hydrologic and geochemical fluxes. *Hydrology and Earth System Sciences* 13: 2273-2286.