

[My Desktop](#)
[Prepare & Submit Proposals](#)
[Proposal Status](#)
[Proposal Functions](#)
[Awards & Reporting](#)
[Notifications & Requests](#)
[Project Reports](#)
[Submit Images/Videos](#)
[Award Functions](#)
[Manage Financials](#)
[Program Income Reporting](#)
[Grantee Cash Management Section Contacts](#)
[Administration](#)
[Lookup NSF ID](#)

Preview of Award 1331841 - Annual Project Report

[Cover](#) |
[Accomplishments](#) |
[Products](#) |
[Participants/Organizations](#) |
[Impacts](#) |
[Changes/Problems](#)

Cover

Federal Agency and Organization Element to Which Report is Submitted:	4900
Federal Grant or Other Identifying Number Assigned by Agency:	1331841
Project Title:	Luquillo CZO: The role of hot spots and hot moments in tropical landscape evolution and functioning of the critical zone
PD/PI Name:	William H McDowell, Principal Investigator Grizelle Gonzalez, Co-Principal Investigator Alain F Plante, Co-Principal Investigator Whendee Silver, Co-Principal Investigator
Recipient Organization:	University of New Hampshire
Project/Grant Period:	12/01/2013 - 11/30/2018
Reporting Period:	12/01/2015 - 11/30/2016
Submitting Official (if other than PD\PI):	William H McDowell Principal Investigator
Submission Date:	09/01/2016
Signature of Submitting Official (signature shall be submitted in accordance with agency specific instructions)	William H McDowell

Accomplishments

* What are the major goals of the project?

The overarching question guiding LCZO2 is: ***How do hot spots and hot moments in weathering, biogeochemical cycling, hydrologic processes, and atmospheric inputs drive landscape evolution and CZ function in a humid tropical forest?***

Our research is organized into four inter-related focal areas. [Focal Area 1](#) explores the importance of knickpoints and different landscape positions as hot spots for weathering, soil development, and biogeochemical cycling. [Focal Area 2](#) addresses the role of hot spots and hot moments in redox cycling that contributes to the dynamics of weathering, and to the retention and loss of C and nutrients in soils over a range of spatial and temporal scales. [Focal Area 3](#) determines the role of hot moments in

the transport of sediment, C, and nutrients in stream flow, and hot spots that determine the distribution of material across the landscape. Focal Area 4 scales up hot spots and hot moments in time and space using climate and hydrologic modeling, and identifies the role of key atmospheric inputs in clouds and rain. Taken together, the research proposed in LCZO2 will provide a well-integrated assessment of critical zone properties and processes that scale from microsites to catenas, watersheds, landscapes, and the region, and from minutes to hours, days, months, and years. The data collected and synthesized as part of LCZO2 will contribute to our understanding of the controls on weathering, soil development, C and nutrient storage and loss, soil and sediment transport, and ultimately landscape evolution and effects of climate change. Through collaborations with local and federal agencies and educational institutions, we will conduct workshops and outreach activities to inform policy makers and other stakeholders of our research findings and the significance of the Critical Zone in the Luquillo Mountains of Puerto Rico.

Our goal is to address each of the specific hypotheses listed below. Participants responsible for each focal area and hypothesis are also included.

Focal Area 1: Hot spots and hot moments in the deep critical zone (*Brantley Focal Area Lead*)

- H1.1: The higher chemical weathering flux and depletion of rock-derived elements from soils in quartz diorite (QD) above the knickpoint results from the penetration of high-O₂ waters into fractures that promote rapid weathering. Below the knickpoint, relatively low-O₂ waters effectively lower reaction rates. In contrast, in the volcanoclastic (VC) rocks, O₂ is consumed relatively high in the profile throughout the watersheds and deep dissolution of silicates outpaces deep Fe oxidation. As a result, VC-derived soils above and below the knickpoint show less variation than their QD-derived counterparts (*Brantley, Comas, Buss*)
- H1.2: Hot spots of rock-derived nutrient availability are best predicted from denudation rates and lithology. The transition from reaction limitation (below the knickpoint) to supply limitation (above the knickpoint) will result in much higher phosphorus and cation availability lower in the landscape (*Porder*)

Focal Area 2: Hot Spots and Hot Moments in Redox Dynamics and Associated Fe-C interactions (*Silver Focal Area Lead*)

- H2.1: Patterns in rainfall, drainage, and biological activity drive the distribution of redox environments in the critical zone (*Silver*)
- H2.2a: Rapid, high magnitude redox fluctuations create hot spots and hot moments of decomposition by stimulating Fe reduction and associated C decomposition (*Silver, Thompson, Plante*)
- H2.2b The storage and stabilization of soil organic matter in LCZO soils is controlled by hot spots of Fe-C interactions rather than the bulk mineral matrix. (*Plante, Thompson, Silver*)

Focal Area 3: Watershed scale hot spots and hot moments (*Jerolmack Focal Area Lead*)

- H3.1: Particulate carbon, fine sediment and bed material each have different characteristic transit times within a watershed. Particles with short residence times are generated at hot spots in the landscape, and particles with long residence times are eroded and transported from relatively stable parts of the landscape during hot moments. Because of differences in landscape stability, these characteristic time scales will differ with position above or below knickpoints (*Willenbring, Jerolmack, Shanley, González*)
- H3.2: Floods are hot moments that may be treated as 'impulses' that drive sediment transport. The availability of sediment is strongly variable in space due to hot spots associated with physical landscape discontinuities, mainly knickpoints. Sediment transport hysteresis curves allow estimation of time- and space-varying sediment availability. Feedbacks between transport and topography maintain hot spots. (*Jerolmack, Willenbring*)
- H3.3: Hot spots in stream chemistry are associated with recent landslides; hot moments are associated with high flow events that can dilute or enrich various solutes. Watershed lithology controls spatial and temporal variability of solute chemistry through its influence on landslides and subsurface flow paths (*McDowell, Shanley*)

Focal Area 4: Hydrologic and Atmospheric Hot Spots and Hot Moments (*McDowell Focal Area Lead*)

- H4.1: The distribution of hydrologic hot spots like sediment sources and landslides will vary with watershed soils, vegetation, and channel knickpoints; the occurrence of hot spots will vary as a function of storm intensity and frequency (hot moments) (*Bras, Wang, González*)
- H4.2: Orographic precipitation in the LM has decreased during historic times as a consequence of climatic warming. Orographic rains make a disproportionately large contribution to base flow (critical to municipal water supplies), and more so

in VC than QD. Cloud level has likewise changed, resulting in smaller cloud inputs of moisture and nutrients to the Luquillo Mountains with important biotic consequences (*Scholl, González, Gould, Shanley*)

- H4.3: Intercontinental transport of African dust alters incoming radiation and cloud formation, and provides nutrient inputs that are significant relative to those from rain events during periods without dust in the atmosphere (H4.2) (*Mayol-Bracero, Scholl, González*).

The major milestones anticipated during the course of LCZO2 are outlined in a supporting file (Accomplishments Supporting File 2).

The core research teams that comprise the LCZO2 and the tasks to meet the goals for each focal area are outlined in a supporting file (Accomplishments Supporting File 2).

*** What was accomplished under these goals (you must provide information for at least one of the 4 categories below)?**

Major Activities:

The LCZO team has made great progress toward achieving our major goals. We have produced over 56 scientific publications and given over 201 presentations at scientific and public meetings over the course of the project. Over the past year, the team published 16 papers, and made 101 presentations at national and international meetings and produced the new *lczodata.com* website. The LCZO is actively training students and young professionals in the field. Seven of the 16 papers published were authored or co-authored by at least one post-doctoral researcher or graduate student. Twelve of 17 additional papers that have been accepted, submitted, are under review, or are awaiting publication also were authored or co-authored by at least one post-doctoral researcher or graduate student. Of the total 101 presentations given during this reporting year, post-docs participated 51 times on 47 presentations (some presentations involved multiple post-docs), graduate students participated 61 times on 39 presentations and undergraduates participated 8 times on 6 presentations. Undergraduates also participated in LCZO research and published in 2 papers and presented at 9 national and international meetings. Graduate students have produced four dissertations thus far. Results from these products are highlighted in the Products Supporting File 4 PDF.

Integration of research among the 4 different focal areas and the coordination of efforts among all our partners and participants occurs through our executive committee and by hosting regular LCZO meetings. The executive committee consists of the PI and co-PIs, and has met regularly since it was formed in December 2013. The executive committee often meets prior to or after the LCZO webinars and communicates regularly via email. Each LCZO co-PI has had special responsibilities in the following areas, with reporting of progress and opportunities to the full Executive Committee:

- Site Management, local operations – González
- Data management, information transfer, engagement - Plante
- Cross-site CZO activities and new research initiatives - Silver

LCZO personnel attended general LCZO meetings via web-broadcast using GoToMeeting approximately every 8 weeks. These meetings were approximately 1.5 hours in length and were structured to present results from the 4 major focal areas and encourage integration across focal areas. The annual all-hands LCZO meeting in Puerto Rico was held from June 6-8, 2016. On the first day, overview presentations were given on the four focal groups, 14 “lightning” presentations on LCZO research were given by each project participant in attendance (including graduate students, post-docs, PIs and senior personnel), and a poster session was held at the El Portal Visitor’s Center (USDA Forest Service) at El Yunque National Forest where the public was invited to attend and posters were left on public display for 3 days. Groups of students from 3 local schools (2 high schools and 1 middle school) attended the LCZO poster Session at El Portal and each school presented a poster and interacted with LCZO scientists. On the second day, extensive discussion occurred about ways to foster the development of cross-cutting themes that integrate across focal areas. Working groups met multiple times throughout the day to discuss the following themes: Trees and the landscape – kinckpoints (Jane Willenbring lead), Short and long-term sediment/mineral/C export (Kathryn Clark lead),

Linking local redox to watershed function (Whendee Silver and Bill McDowell leads), Deep geobiology (Heather Buss lead). We spent a significant amount of time working on a conceptual model that connects the various processes in the critical zone on the second day as well. We also used the meeting to address cross-CZO initiatives that would further our project goals, and project administration. The entire advisory committee was present throughout the meeting. They presented their assessment of the LCZO and made valuable suggestions for ways in which the project might be improved. On the third day of the meeting, a group of project participants and advisory board members first visited the Rio Sabana Recreation Area where the group hiked to the Rio Icaos knickpoint and Jane Willenbring led a discussion of the knickpoint retreat. The group later hiked to the Rio Sabana knickpoint to assess retreat there. The agendas for the LCZO All-Scientist webinars and the LCZO annual all-hands meeting are attached in the Accomplishments Supporting File 3 PDF.

The accomplishments of the LCZO from August 3, 2015 through August 10, 2016 are further described within the framework of our milestones by hypothesis and our education and outreach milestones as outlined in the LCZO management plan. These major activities are contained within the Accomplishments Supporting File 2 PDF.

Efforts to promote cross-CZO science are described in the Additional Reporting Requirements contained within the Accomplishments Supporting File 1 PDF.

Specific Objectives: Specific objectives for each focal area and hypothesis are listed below.

Focal Area 1

H1.1

- Prepare a manuscript that explores the role of the knickpoint as related to fracture development and evolution (Comas et al, In Prep).
- Submit abstracts to the American Geophysical Union (AGU) Fall Meeting in San Francisco;
- Finish the search process for hiring a graduate research assistant at Florida Atlantic University at the Master's level to assist with geophysical data acquisition and processing.
- Submit a paper describing the architecture of the weathering environment in the three major lithologies in the Luquillo CZO. (S. Brantley and S. Hynek, in preparation for submission to GSA Bulletin fall 2016).
- Start a paper describing particle transport in the subsurface at the CZO (Postdoc Kim Hyojin).
- Submit paper comparing weathering mechanisms and rates in VC and QD saprolite (Buss et al., Subm.)
- Submit paper on Mg isotope dynamics in the VC (Graduate student at Bristol, Chapela Lara et al., Subm.)
- Submit paper on incipient weathering mechanisms and rates in VC bedrock (Graduate student at Bristol, Moore et al., In Prep).

H1.2

- Submit an NSF preproposal to the Ecosystems Panel to follow up on the knickpoint result (Porder, Willenbring, and Uriarte).
- Hire a new graduate student who will further the research on landscape scale N dynamics (Porder).

Focal Area 2

H2.1

- Use the sensor array and automated gas flux chambers to determine the spatial and temporal dynamics (hot spots and hot moments) of redox-sensitive biogeochemistry and the correspond controls.
- Use this information to inform models and laboratory experiments on C and N cycling in response to climate, mineralogy, and ecological dynamics.
- Our depth profile data will also inform models and laboratory assays with a specific focus on the depth of hot spots and the timing of hot moments.

H2.2a

- Use redox oscillation experiments to determine the influence of variation in the length of anoxic (and oxic) hot spots on CO₂ production and iron reduction rates (used as an electron acceptor for carbon oxidation).
- Use variation in the oxygen flux rate to create different rates of ferrous iron oxidation and then examine how that impacts Fe reduction rates and CO₂ production during subsequent anoxic periods.
- Include characterization of changes in the iron mineral composition in the above two objectives.

H2.2b

- Use selective dissolution experiments to extract and quantify Fe-derived soil minerals of varying crystallinity, and to quantify and characterize the organic carbon associated with those mineral phases. These Fe-minerals are hypothesized to be hot spots of soil C storage.

Focal Area 3

H3.1

- Determine whether extreme events in rainfall/discharge dominate coarse-sediment transport and river channel geometry (Phillips paper on extreme events).
- Determine particulate organic carbon and particulate nitrogen yields for the LCZO rivers for the last 30 years.
- Determine the sediment yields from the Icacos and Mameyes, two watersheds with similar climate but very different lithologies, for assessing erosion rates and the influence of rock type and draft manuscript (Clark et al in prep for TBD).

H3.2

- Delineate the phase space of occurrence of abrasion and fragmentation as a function of collision energy and material strength.
- Demonstrate that particle abrasion due to bed-load transport produces universal shape evolution in ALL environments – river, coastal and aeolian.
- Understand the transition from intermittent bed-load transport near the threshold of motion, to smooth and continuous transport far above threshold, as a consequence of interparticle collisions.
- Document hysteresis in suspended sediment concentrations through floods, and relate this to antecedent conditions. Prepare manuscript (K. Clark et al in prep) for WRRC special issue.

H3.3

- Evaluate the river biogeochemical cycles of particulates and solutes over rewetting events during an extreme drought.
- Establish changes in specific conductance, temperature, and dissolved oxygen in streams in response to hydrologic extremes
- Submit a proposal to NSF DEB to develop a coherent global network of stream sensors to place Luquillo CZO results in a broader context
- Synthesize the sometimes conflicting literature from the LCZO to develop a coherent hydrologic framework for each of the two lithologies (VC and QD). This may lead to follow-up experiments to resolve conceptual inconsistencies.

Focal Area 4

H4.1

- Simulate landscape evolution and prediction of hydrologic hot spots and hot moments at the Mameyes and Icacos watersheds within the LCZO.
- Develop a spatially-explicit model of soil organic carbon dynamics within an existing hydro-geomorphic model to link hot spots and hot moments in sediment sources with soil organic carbon dynamics.

H4.2

- Compare results from ceilometer and cloud cam. Expand climate change impacts in light of cloud base results.
- Analyze cloud base in relation to El Nino index. Observe clouds for longer amount of time.
- Analyze aerosols recorded by ceilometer and compare with radiosonde data from San Juan, look for urban influence on cloud base level and aerosol diurnal patterns.

H4.3

Improve our understanding of the

- impact of African dust on radiation
- role of dust particles in cloud properties such as liquid water content and drop sizes
- seasonal variations of dust concentrations at Pico Este TMCF, and
- the input of nutrients from dust compared to those from rainfall

Education and Outreach

- Improve the InTegrate curriculum using the feedback and prepare it for anonymous peer-review.
- Host teacher workshop
- Host LCZO-LTER data jam at annual Schoolyard Symposium

Significant Results:

Each focal area obtained results that address our overarching question: “How do hot spots and hot moments in weathering, biogeochemical cycling, hydrologic processes, and atmospheric inputs drive landscape evolution and CZ function in a humid tropical forest?”

Focal Area 1

H1.1

- Deep CZ bedrock chlorite dissolution is a key driver of baseflow Mg isotope signature in Bisley 1 stream (Chapela Lara et al., Subm.).
- Long-term weathering fluxes in the volcanoclastic (VC) regolith are larger than contemporary regolith fluxes (Buss et al., Subm.).
- VC regolith mineral weathering occurs in the deep CZ at rock-regolith interfaces (Buss et al., Subm.; Moore et al., In Prep).
- Incipient weathering reactions appear to be controlled by the oxidative dissolution of pyrite in the VC bedrock (Moore et al., In Prep).
- Long-term K and P fluxes are orders of magnitude slower in the quartz diorite (QD) regolith than in the VC, despite higher K and similar P abundances in the QD (Buss et al., Subm.).

H1.2

- A strong regional knickpoint exists on QD parent material, but not on VC parent material.
- 3 distinct soil domains exist across the landscape: QD above and below knickpoint, and VC.
- A distinct break in tree height is associated with the knickpoint on QD, but not across the same elevation on VC (knickpoint is absent).
- Geomorphology and soils, rather than elevation alone, have a detectable imprint on forest characteristics (Results Figure 1; Wolf et al. Submitted).

Focal Area 2

H2.1

- Soil organic matter decomposition was strictly limited by oxygen availability.
- Litter decomposition, surprisingly, was highest with static anoxic treatments and lower in fluctuating redox or static oxic treatments.
- We hypothesize that chemical complexity regulates how redox dynamics influence organic matter decomposition:
 - Oxygen availability limits the activities of aerobic heterotrophs and thus decomposition of more complex substrate in soil organic matter.
 - Other processes (e.g. anaerobic respiration and abiotic Fenton reactions) are able to liberate labile substrate in litter.
- Large-scale debris deposition increased C, N, and P pools, both at the surface and at depth (up to 90 cm).
- Effects of canopy disturbance also affected P pools at depth, highlighting the linkages between above- and below-ground processes.
- All biogeochemical properties measured had significant depth gradients, which revealed the differences between biologically-active surface soils and deep soil horizons that are dominated by minerals and have low resource availability for biological activity.
- Deep soils may be hot spots of biogeochemical activity due to their potential for accumulating C and nutrients at long time-scales, as revealed by the significant treatment effects at depth.
- Turnover of soil P fractions in laboratory incubations was governed by redox-induced Fe dynamics:
 - oxidation events reduced the extractability of inorganic P.
 - reduction events induced release of P to a lesser extent.

- Repeated redox oscillation gradually diminished the magnitude of soil Fe and P turnover.
- Almaraz (2016) presented the first empirical data to support a redox-driven tradeoff between N₂ and N₂O production (Results Figure 2).

H2.2a

- Rates of Fe reduction and associated CO₂ production are dependent on antecedent conditions in soils with variable redox.
- CO₂ production mirrors the results of Fe reduction following changes in the previous oxic exposure.
- CO₂ production is higher during an anoxic period that follows exposure to high O₂ concentrations.
- CO₂ production is correlated with rates of Fe reduction and formation of less crystalline ferric iron phases.

H2.2b

- Oxisols contained greater concentrations of extractable Fe than Inceptisols, and surface soils contained greater concentrations of extractable Fe than subsurface soils. Less than 25% of initial surface soil C was extracted, while the proportions were greater in subsamples.
- Relationships between extractable Fe and C vary substantially between soil types, depths and extractants. This was also observed in a second large sample set from the Calhoun CZO. At Calhoun, variability was found among land use histories. Overall, only a small fraction of soil C was extracted, and the correlations between extractable Fe phases and soil C were non-existent. These results do not support our hypothesis that Fe-SRO minerals dominate C stabilization over the bulk mineral matrix.

Focal Area 3

H3.1

- LCZO rivers have a much higher particulate organic carbon yield per unit of suspended sediment compared to global rivers.
- Tree canopy is higher below knickpoints in QD, where soil erosion rate and nutrient availability are higher. Low tree stature is also associated with low soil nutrients and high erosion above knickpoints (Wolf et al., in revision).
 - Holocene-epoch El Niño-hurricanes produce the fastest basin-wise erosion rates and floodplain sedimentation rates.
 - Soil rock fragments control the speed of landscape change (Brocard et al., 2016).
 - Storm sediment in rivers is a mixture of soil and landslide material but the soil signal is dominant. This contrasts modeling work by the Bras group.

H3.2

- Mechanics of bedrock weathering produce a universal shape for rock fragments, and bed-load transport selects for the “right” conditions for abrasion by chipping.
- Evolution of rock fragment shape due to bed-load abrasion is universal (same for rivers pebbles, coastal pebbles and eolian sand), and can be explained by chipping.
- Collisions of gravel with a stream bed produce pulses of bed-load transport, and the transition from intermittent and unpredictable transport near threshold to continuous

and more predictable transport above threshold can be explained from grain-scale collision dynamics.

- Coarse-grained rivers organize to be near the threshold of motion, and this causes sediment transport and channel form to be decoupled from climate [Phillips and Jerolmack, 2016].
- We observed unique clockwise hysteresis loops for turbidity (a proxy for suspended sediment, and particulate organic carbon) against discharge over 4 rewetting events.

H3.3

- During drought rewetting:
 - New water made a large contribution to streamflow.
 - River particulate and solute concentrations were consistent with the long-term record.

Focal Area 4

H4.1

- Tropical forests can be net atmospheric C sinks or sources depending upon forest management practices and other perturbations such as landslides.
- Spatial variation of tropical forest types controls the erosion-induced C exchange with the atmosphere at the watershed scale. Hillslope erosion significantly alters SOC production and oxidation rates in tabonuco and palm forests. The associated effects in colorado forests can be less severe.
- Frequent events of sediment transport lead to significant soil organic C erosion. Soil profiles at landslide sites are inferred to undergo rapid C replacement by atmospheric C sequestration.
- Spatial variability of soil moisture controls the spatial dynamics of nutrients.

H4.2

- The regional cloud system behaves anomalously at Luquillo, and this may create the observed lower clouds in the dry season, keeping the cloud forest healthy. This may also make the cloud forest more vulnerable to decreased rainfall in the wet seasons, since the clouds are not as low then as previously assumed.
- A mid-morning rise in cloud base was seen and looked similar to the pattern seen in urban San Juan. Urban expansion may have an effect on the cloud base level and thus the cloud forest.

H4.3

- Principal component analysis shows a positive correlation for ions from crustal origin and a negative correlation for ions from marine origin.
- For periods where the scattering and absorption coefficient decreased, ion concentration decreased by about half, the number concentration of droplets decreased, but the effective diameter increased.

Key outcomes or Other achievements:

Extreme Drought

Integrating Soils and Streams: A key challenge for any multi-faceted research program such as a Critical Zone Observatory is to integrate each of the individual elements into a coherent overview that bridges across the full critical zone. Here we highlight the biogeochemical and hydrologic response to an extreme drought currently occurring in Puerto Rico, as it provides insights into the overall functioning of this mountain landscape that would not be clear without such an integrated approach. Using the soil and stream sensor networks that were installed and are maintained by LCZO funding, we have been able to document an intriguing flip-flop in biogeochemical conditions in soils and streams. After several months of near-record low rainfall, soils dried out and became more oxygenated at all catena positions (Drought Fig. 1a and 1b). In contrast, the streams dried out (Drought Fig. 2a and 2b) and experienced declines in dissolved oxygen that appear to be due to in-stream or hyporheic metabolic processes. Evidence for this enhanced metabolic control on stream oxygen levels is provided by the strong diel periodicity in oxygen levels that is commonplace in streams with high ecosystem respiration (Drought Fig. 3a and 3b), but this variability is swamped at higher flow by turbulent exchange across the air-stream interface, as well as the shorter residence time of water in the groundwater flowpath, which reduces the impact of metabolic oxygen consumption on groundwater oxygen concentrations.

The drought increased soil carbon dioxide (CO₂) emissions from slopes by 60% and valleys by 163%. Methane (CH₄) fluxes declined by 90% in valleys after the drought but increased above pre-drought baseline by tenfold and hundredfold in ridges and slopes, respectively, post-drought, offsetting the initial decline in soil CH₄ emissions. Across ridge, slope and valley, concentrations of Fe(II) declined significantly during the drought as did inorganic P concentrations.

Stream sensors deployed in the Sonadora, Prieta and Icacos watersheds show that as soil moisture decreases and soil oxygen increases (Drought Fig. 1a and 1b), we see an increase in conductivity (Drought Fig. 4) and lower dissolved oxygen (Drought Fig. 3a and 3b) as streams are fed by deeper and deeper groundwater. We also see that streams get warmer as they dry out (Drought Fig. 5).

Developing a Conceptual Model

At the annual LCZO meeting a number of conceptual models were considered including Conceptual Figure 1 (Brocard et al., 2015), which depicts the formation of the island and Conceptual Figure 2 which depicts interactions between forest structure and topography. As we work to develop a more refined and integrative conceptual model, we will also consider the extent to which our model can be used to capture elements that are essential for developing numerical models such as those that link landform to water flow and biogeochemical fluxes.

Focal Area 1

Several papers have been submitted or are in preparation (see the significant results section).

Focal Area 2

In-depth characterization of soil profiles provides valuable information for predicting where and when hot spots and hot moments will occur. Moreover, the general patterns observed can be assumed to occur at other similar sites (i.e., same forest type and topographic position), adding a layer of information on the soil biogeochemical properties

of this forest. These data can inform future laboratory assays and modeling exercises that will contribute to our growing understanding of biogeochemical dynamics at this site.

Whendee Silver was named UC Berkeley's first Faculty Climate Action Champion.

Focal Area 3

Last year we believed that we had found a way to quantify pebble abrasion using brittle fracture theory. Progress in our experiments and theoretical understanding now leads us to a new conclusion: gradual abrasion results from chipping due to plastic deformation of the rock surface from an impact, while fragmentation results from brittle fracture. This is significant because current models for bedrock erosion assume that brittle fracture is the underlying mechanism. Our results show that plastic deformation and chipping are more likely to dominate erosion processes, which alters our view of landscape dynamics.

We have shown that all coarse-grained rivers – bedrock or alluvial – are organized to be near the threshold of motion, and that this blunts the impact of extreme rainfall events. As a result, rivers' shape and transport are insensitive to climatic variation. This is an important and controversial finding with implications for all studies examining the influence of climate on landscape erosion.

We have shown that our understanding of shape evolution due to bed-load abrasion that was developed in Luquillo can be used to estimate the transport distance of pebbles on Mars [Szabo et al., 2015 in Nature Communications]. This finding developed a new tool for quantitative reconstruction of sediment transport conditions from deposits, and was reported on widely in the media including the cover of the Los Angeles Times.

Our work shows that extreme events in terms of floods do NOT dominate channel form or landscape erosion, and have broad implications for how climate does (or does not) influence mountain erosion [Phillips and Jerolmack, 2016 in Science]. There was broad media coverage of this work.

We have discovered that the dominant mechanism for pebble abrasion and bedrock erosion is chipping due to plastic surface deformation, rather than brittle fracture. This may lead to a complete overhaul of the widely used theory of saltation abrasion for bedrock river incision.

We discovered that there is a soil thickness limit - above which the weathered soil material inhibits additional soil production. This is a significant result because it acts as a positive feedback on climate warming over long timescales. Increased silicate weathering from warming decreases future silicate weathering.

Jane Willenbring was awarded a NSF Career award (May 2016).

Focal Area 4

We have developed metrics for measuring seasonal cloud base altitude changes, which take into account cloud duration. We have calculated the tradewind inversion height as well as the lifting condensation altitude from regional radiosonde data, key levels for understanding cloud patterns regionally.

Our long-term stable isotope data set was able to provide information on the stream response to the drought, and helped to determine which water sources sustained baseflow during the drought.

We have been part of an international project that seeks to better understand impacts of African dust in the Caribbean region, with partners from Spain, Barbados and Miami. Dust concentrations will be determined and compared for the 4 sites.

Education and Outreach

The InTegrate team submitted a manuscript for publication in the Journal of Geoscience Education and submitted an abstract to the annual meeting of the American Geophysical Union. Twenty-two teachers attended the Data Jam workshop in November 2015. Six teachers conducted the Data Jam and 10 students participated in the Schoolyard Program Symposium in May 2016.

* What opportunities for training and professional development has the project provided?

The Luquillo CZO continues to aggressively build significant opportunities for training and mentoring. There were 15 undergraduate students, 20 graduate students and 8 post-doctoral researchers involved in the LCZO in year 3 (please refer to the participants section for more detailed information). Students and post-doctoral researchers receive one-to-one and group mentoring by LCZO PIs and other senior personnel. Please also refer to the section on the development of human resources

Focal Area 1

- S.L. Brantley began mentoring a LCZO postdoctoral associate, Hyojin Kim.
- Comas continues to include geophysical datasets collected at the Luquillo CZO in his undergraduate Solid Earth Geophysics class and his graduate Environmental Geophysics class.
- Buss began teaching a new undergraduate 2nd year unit in Soils and the Critical Zone at the University of Bristol, which incorporates cross-CZO concepts and data and explicitly uses specific CZO projects as case studies.
- Two Bristol PhD students are finishing summer 2016.
- A total of three FAU graduate students have been involved in the project so far to participate and assist with geophysical field campaigns. One Master's student has been just hired to assist with geophysical data acquisition and processing. Two PhD students participated in the 1-week summer field campaign to assist with data acquisition at the Luquillo CZO.
- PhD student Almaraz recently defended her dissertation and has accepted an NSF postdoc position in Ben Houlton's Earth Systems Ecology and Biogeochemistry laboratory at the University of California Davis.
- MS student Virginia Hoyt just entered UNH and will work on variability in concentration and flux of trace metals in LCZO streams.

Focal Area 2

- Our work on Fe redox cycling and Fe-C interactions has provided training to 2 postdoctoral scholars, 6 graduate students, 2 undergraduates.
- At Penn, the experimental work on FeC associations represents the PhD dissertation research of Elizabeth Coward, who has been trained in methods of soil analysis, including specific surface area and Mossbauer spectroscopy. Two undergraduate research assistants were trained and involved in the dissolution experiments.
- PhD student Jared Wilmoth completed his dissertation and secured a postdoc at Oak Ridge National Lab.
- At UGA, PhD student Barcellos was trained in trace gas analysis and Mössbauer measurements and field methods for characterizing iron and carbon dynamics. Undergraduate student Shannon Burns was trained in clean-room techniques and methods for soil chemical extraction. Undergraduate student Elizabeth Oesta was trained in field methods in Luquillo and characterization of iron reduction rates on field samples. High school student Isaac Powell was trained in image analysis for characterizing potential iron reduction capacity and also in soil particle size analysis. Postdoctoral scholar Chunmei Chen was trained in making Mössbauer measurements, trace gas measurements and conducting redox dynamic experiments.
- Postdoctoral scholar Ashley Campbell (from Collaborator Jennifer Pett-Ridge's lab) visited the Thompson lab to learn methods for conducting redox fluctuation experiments.

- At UC-Berkeley, the project has provided training in laboratory analytical skills for one graduate student (O. Gutiérrez del Arroyo), as well as the opportunity of applying the Century/DayCent model (developed by Bill Parton at CSU) to our site. This project contributes to work of a postdoctoral scholars Christine O'Connell and Yang Lin. One undergraduate research assistant (Kana Yamamoto) and one high school assistant (Rachel Mundaden) were trained and involved in laboratory incubation experiments conducted by Lin. This work also facilitates outreach effort of two graduate students (Gutiérrez del Arroyo and McNicol) and one postdoc (Lin) at Donlon Elementary School.

Focal Area 3

- PhD student Lee Dylan (Jerolmack's group) has participated in LCZO meetings and video conferences, and is coordinating research with students from diverse scientific backgrounds.
- PhD student Lee Dylan participates in science mentoring of elementary school children in West Philadelphia.
- New PhD student Kieran Dunne (Jerolmack's group) is building on our LCZO data to understand the transition in channel geometry and transport conditions across the gravel-sand transition.
- Undergraduate Sophie Bodek (Jerolmack's group) received a competitive research grant through Penn, and is leading the research effort on understanding the transition from abrasion to fragmentation.
- Postdoc Szabo completed a fellowship from the Hungarian national government to work at Penn (Jerolmack's group), and led research efforts to understand pebble shape evolution under abrasion, and to link Luquillo river rocks to Mars.
- PhD student Emma Harrison (Willenbring's group) is conducting collaborative and interdisciplinary research combining field and laboratory techniques.
- Post-doc K. Clark presented LCZO data at AGU 2015, hosted a meeting at AGU to discuss storm sampling results, ran a writing workshop in January 2016 and ran a break-out group at the annual meeting on short and long-term sediment, mineral and carbon fluxes in the LCZO.
- Under-represented minority Mayra Nunez (undergraduate student) assisted K. Clark with laboratory analysis of sediment for Clark et al. manuscripts that are in preparation for submission.
- Postdoc Brocard (Willenbring's group) is collaborating with LTER scientists to link the geologic history of Luquillo imprinted on the landscape to the ecosystem structure.
- PhD student Lauren Koenig is working on a manuscript describing trace gas fluxes from LCZO streams.
- All PhD students and postdocs are presenting their research at AGU, and smaller workshops and conferences.

Focal Area 4

- One-to-one and group mentoring of a graduate student (Yannis Dialynas) and a post-doc (Elisa Arnone).
- Post-doc Ashley Van Beusekom is analyzing the ceilometer data.
- Graduate student Elvis Torres-Delgado was part of the WMO GAWTEC 30th Training Session on Aerosol Physics, Global Atmosphere Watch Training & Education Centre, Environmental Research Station Schneesfernerhaus, Zugspitze, Germany, April 3-16, 2016. The trip was supported by the WMO.
- Graduate student Gilmarie Santos has been trained in the sampling and analyses related to the determination of the dust concentrations.

Education and Outreach

Dr. Adam Wymore and Dr. Ashlee Dere, two early career CZ scientists, continue to benefit from participation on InTegrate curriculum team. Both participated in university-level curriculum development and gained teaching experience. They also gained experience in writing a manuscript for a science education journal and Dr. Wymore will gain experience discussing CZ Science education in a public forum at the 2016 American Geophysical Union meeting.

Please refer to the Accomplishments Supporting File 2 for a more detailed description of training and professional development accomplishments that have occurred through development of the InTegrate curriculum (E&O 1), conducting Data Jam teacher workshops (E&O 3) and data jams at the CZO-LTER Schoolyard Program Symposium (E&O 2)

An AGU Chapman conference on "Extreme Climate Event Impacts on Aquatic Biogeochemical Cycles and Fluxes" has been organized by Shree Inamdar of U. Delaware, and LCZO scientists Jamie Shanley and William McDowell. The trio has been successful in obtaining additional funding in support of the conference, which will be held in San Juan, PR in January 2017. The conference will highlight CZO work and will include a field trip to the LCZO site. This Chapman Conference will focus on (a) water-driven exports of C, N, and P in particulate, dissolved, and gaseous forms from terrestrial to aquatic ecosystems; (b)

changes in biogeochemical cycles of C, N, and P in aquatic ecosystems following/during extreme climate events; and (c) changes in aquatic ecosystem functions and services as a result of extreme events.

*** How have the results been disseminated to communities of interest?**

Numerous presentations (101 in year 3) made by students, post-docs, PIs and senior personnel on research plans and results have been given at project meetings and at national and international conferences (e.g., AGU, ESA, ATBC, EGU, SFWS, GSA, Goldschmidt, TERN, Sino-US CZO Workshop). Students and postdocs are presenting results at major international conferences, including CZO special sessions at AGU and ESA including at AGU 2015: A Town Hall for the Network of CZOs, ESA 2016: Ecology in the Critical Zone, 2016 AGU Session: EP032: The Architecture and Workings of Earth's Critical Zone. Jerolmack and Willenbring have been invited to give talks at AGU. Project results have also been submitted for publication and published in the peer-review scientific literature (56 total). Research is being published in top technical and multi-disciplinary journals.

The LCZO also held webinar meetings approximately every 8 weeks where we discussed and explored our ongoing research findings. Webinar presentations have been published on YouTube for viewing by our members and the general public. For a detailed list of webinars, with links to videos of the presentations, see Accomplishments Supporting File 3 pdf. A number of collaborations have been established both with partner organizations and individual collaborators. Please see the "Participants & Other Collaborating Organizations" section for more details. The LCZO maintains a twitter feed with 174 followers and 217 tweets and retweets since early 2014. The twitter feed helps the CZO communicate information about upcoming presentations, posters and recent journal publications. The feed also helps us communicate with our members and the general public about news stories relevant to the CZO such as storms and other events impacting the region. Our feed can be found at <https://twitter.com/luqczo>. Lead PI McDowell has contributed to 6 different press releases reaching a broad range of audiences. Please see the products section for a detailed list of presentations, publications and other products. Data have also been archived on the LCZO website and are freely available. New interactive tools have been developed to facilitate scientists and the public exploration our available data: Mapping tool <http://lczodata.com/ODM2/ODM2CZOData/mapdata.html> ; Soils data tool: <http://lczodata.com/ODM2/ODM2CZOData/chartVariableAndFeature.html> ; Soils Scatter Plot: <http://lczodata.com/ODM2/ODM2CZOData/soilscatterplot.html> .

Scholl presented the latest results of the cloud immersion monitoring research (cloud cam study) to an audience of 150 researchers from six continents, at the International Conference on Fog, Fog collection and Dew held in Poland. It was well received and several researchers, from USA (UC Berkeley), Taiwan, China and Chile wanted further details on the method so they can apply it at their sites. This method represents a novel and affordable way to monitor spatial and temporal cloud immersion in the forest, with applications to ecohydrology and water availability. Two posters (Scholl et al. and Bassiouni et al) on the project were presented at the December 2015 AGU meeting.

Please refer to the Accomplishments Supporting File 2 for a more detailed description of how LCZO data and results have been disseminated to communities of interest through development of the InTegrate curriculum (E&O 1), conducting Data Jam teacher workshops (E&O 3) and data jams at the CZO-LTER Schoolyard Program Symposium (E&O 2).

*** What do you plan to do during the next reporting period to accomplish the goals?**

We will continue to facilitate research among the 4 different focal areas by holding regular executive committee meetings (every 6-8 weeks) and all-hands CZO meetings (every 6-8 weeks via GoToMeeting and once annually in Puerto Rico). We will continue with efforts outlined in our management plan for engaging in cross-CZO efforts and with the broad research community through working with partner organizations (USFS, USGS, and UPR) and other partners. We will also continue efforts outlined in our management plan to support education and outreach activities.

Tasks to meet the goals for each focal area and education and outreach milestones during the next reporting period are outlined below.

Focal Area 1

Comas and students will process geophysical datasets collected during the summer field campaign and prepare manuscripts for publication that show the potential of several geophysical methods, including electrical resistivity imaging (ERI), GPR, terrain conductivity, OhmMapper, induced polarization (IP), and shallow seismic to better understand and image how weathering develops and evolves in the Luquillo CZO. Comas et al will submit a second paper to explore the role of the knickpoint in the development and evolution of fractures in the Rio Icos watershed.

Post-Doc Kim Hyojin (Brantley group) is analyzing subsurface particle transport in the CZO, and will be preparing a paper that compares such transport to similar transport at Shale Hills.

Papers will be submitted based on M. Chapela Lara and O. Moore's PhD theses (Buss group) including a rare earth element analysis of redox dynamics in VC and QD regolith (Chapela Lara), a VC water residence time study (Chapela Lara), a synchrotron-based study of pyrite weathering in VC (Moore), and a reactive transport model of VC weathering rind development (Moore).

Porder, Willenbring, and Uriarte will revise and resubmit an NSF preproposal to the Ecosystems Panel in Jan 2017 to follow up on the knickpoint result.

Focal Area 2

Results from the mineral and organic phase characterizations will be analyzed, and manuscripts will be prepared for Coward's dissertation and submitted for publication. The effect of Fe-SRO minerals on the OM sorption capacity of soil, and the subsequent biogeochemical stability of the OM will be tested in a laboratory sorption-incubation experiment using Fe-coated and untreated soils. Field-collected soils will be characterized to determine in situ rates of iron reduction and carbon mineralization. We will perform an isotopic pool dilution experiment to investigate how redox hot spots and hot moments influence nitrogen cycling and nitrous oxide emissions. We will continue working with collaborators at Oak Ridge National Lab to integrate the sensor array dataset into the ACME model. We will report results from an ongoing experiment that examines responses of soil pH to redox oscillation and their effects on soil C loss. We will continue exploring the role of substrate chemical complexity in redox-driven soil C dynamics. We will also examine the interactive effects of redox conditions and landscape locations on soil C turnover through structural equation modeling. Furthermore, we plan to extrapolate our field- and laboratory-based findings to a watershed scale by leveraging other existing biogeochemical observations and terrain data (e.g. digital elevation models). We will publish our results on the depth profiles. The published data will be used to parameterize the DayCent model for our site, allowing us to explore impacts of future climate scenarios on biogeochemical cycling in wet tropical forests. Furthermore, laboratory assays will be developed to evaluate the interactions between climate (i.e., soil moisture, temperature) and coupled biogeochemical cycling of key elements, such as C, P, and Fe.

Maya Almaraz will submit a manuscript from her PhD dissertation.

Focal Area 3

- Complete and publish work showing that shape evolution under bed-load abrasion is universal, and use this finding to show how abrasion rate and perhaps even bedrock erosion rate can be estimated from the shape of pebbles.
- Complete experiments and all analysis to delineate the boundary between abrasion and fragmentation as a function of collision energy and material strength.
- Demonstrate unequivocally that plastic surface deformation and chipping is the dominant erosion mechanism.
- Complete analysis of river channel geometry across the gravel-sand transition, and directly test the hypothesis that there are bi-stable states of channel geometry.
- Publish two papers from Clark postdoc, yields paper and drought rewetting paper. Present drought rewetting paper at AGU 2016.
- Finalize the approach to correcting in-stream fluorescence sensor measurements for high turbidity and apply long-term record to calculate fluxes of DOC, POC, and TSS.
- Conduct two field seasons to work on soil production and function in the LCZO environment.
- Work to understand the discrepancy between the numerical modeling and geochemical data that predicts that sediment comes from different sources.
- Work with LTER to groundtruth the LiDAR and satellite data on tree canopy.

Focal Area 4

- Simulate the evolution of contrasting tropical landscapes and critical zone response to changing climate.
- Analyze hydrological controls of hydrological hot spots and hot moments on the C-N cycle

- Analyze aerosol data and compare cloud cam and ceilometer data. In light of these,
- Explore further implications of climate change and urbanization on the cloud forest.
- Coordinate a synthesis paper incorporating the various cloud monitoring data sets, remote sensing and hydrology aspects of potential effects of climate change on cloud water deposition and ecohydrology of the Luquillo forest (Scholl). The Mayol-Bracero research group as well as USFS and USGS groups will be included in this synthesis effort.
- The index of optical density analysis is complex and difficult and will be the next step, after we get the initial paper in prep published (Cloud cam project).
- USGS will analyze atmospheric Hg (wet deposition + litterfall) since 2014, when the station was moved to NADP site. This analysis will also include passive NH₃ measurements, making PR20 a NADP "supersite" (Shanley, Marty Risch, Gonzalez and McDowell).
- We will continue to improve our understanding on (a) the impact of African dust on radiation, (b) the role of dust in cloud formation and properties, (c) how clouds remove dust, and (d) dust nutrient inputs at Pico Este.
- The interstitial inlet construction will be completed
- Nutrient inputs (N, P, C) from African dust will be calculated using estimates of the atmospheric volume scavenged during rain events, derived from radar echo tops and measured airborne dust concentrations in collaboration with M. Scholl (USGS).
- Quantify the relative importance of dust nutrient input compared to that of rainfall.
- Install a radiation sensor that will measure total solar radiation and diffuse radiation.

Education and Outreach

- After anonymous peer-review, the InTegrate curriculum team will incorporate feedback into the online curriculum and prepare the curriculum to be released publically via the Science Education and Resource Center (SERC) at Carleton College.
- Incorporate peer-review feedback into the manuscript submitted to the Journal of Geoscience Education and prepare manuscript for final publication.
- Conduct Data Jam workshop that utilizes LCZO data fall 2016
- Host selected students and teachers at annual meeting poster session (June 2017)
- Give the following talk: Wymore AS et al. "Critical Zone Science as a Multidisciplinary Framework for Teaching Earth Science and Sustainability: at AGU 2016.
- Offer the following National Science Teachers Association Short Course "The Critical Zone: Where Rock Meets Life" in April 2017.

Supporting Files

Filename	Description	Uploaded By	Uploaded On
Accomplishments Supporting File 1.pdf	Additional reporting requirements and year 4 budgets and budget justifications. Budgets for UNH, UPenn, and FAU have been modified slightly since the original proposal submission and budgets for FIU and UCSD have been added since the original proposal submission.	William Mcdowell	09/01/2016
Accomplishments Supporting File 2.pdf	LCZO milestones, research teams and major activities.	William Mcdowell	09/01/2016
Accomplishments Supporting File 3.pdf	LCZO webinars (with links to YouTube videos), executive committee discussions, the annual meeting agenda, the advisory board report (following the annual meeting), and the annual meeting evaluation summary.	William Mcdowell	09/01/2016
Accomplishments Supporting File 4.pdf	Annual report figures.	William Mcdowell	09/01/2016

Products

Books

Book Chapters

Inventions

Journals or Juried Conference Papers

Almaraz, Maya, and Groffman, P, and Silver, Whendee, L and Hall, Steven, J and Ruan, Leilei, and Porder, Stephen, (2016). Differential controls on dinitrogen and nitrous oxide from a wet tropical forest. *TBD*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Arnone, Elisa, and Dialynas, Yannis, and Noto, L.V., and Bras, Rafeal, (2016). Accounting for Soils Parameter Uncertainty in a Physically-Based and Distributed Approach for Rainfall-Triggered Landslides.. *Hydrological Processes*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Aulenbach, B.T., and Burns, D.A., and Shanley, Jamie, and Yanai, R.D., and Bae, K., and Wild, A.D., (2016). Approaches to stream solute load estimation for solutes with varying dynamics from five diverse small watersheds. *Ecosphere*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Bastola, Satish, and Dialynas, Yannis, and Bras, Rafeal, and Arnone, Elisa, and Noto, L.V., (2016). Integration of a Physically based Distributed Hydrological Model with a Model of Carbon and Nitrogen Cycling. *TBD*. . Status = OTHER; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Bouskill, Nicholas, and Wood, Tana, and Baran, Richard, and Ye, Zaw, and Bowen, Benjamin P, and Lim, HsiaoChiem, (2016). Belowground Response to Drought in a Tropical Forest Soil. I. Changes in Microbial Functional Potential and Metabolism. *Frontiers in Microbiology*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Bouskill, Nicholas, and Wood, Tana, and Baran, Richard, and Ye, Zaw, and Bowen, Benjamin P, and Lim, HsiaoChiem, and Zhou, Jizhong, (2016). Belowground response to drought in a tropical forest soil II Change in microbial function impacts carbon composition. *Frontiers in Microbiology*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Brocard, Gilles, and Willenbring, Jane, and Miller, Thomas E., and Scatena, Fredrick, (2016). Relict landscape resistance to dissection by upstream migrating knickpoints. *Journal of Geophysical Research*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Buss, Heather, and Moore, Oliver, and Kurtz, Andrew, and Schulz, M.S., and White, A.F., (2016). Lithological influences on contemporary and long-term regolith weather at the Luquillo Critical Zone Observatory. Submitted to *Geochim. Cosmochim. Acta*. Accepted pending revision.. *Geochimica et Cosmochimica Acta*. . Status = ACCEPTED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Clark, Kathryn, and Shanley, Jamie, and Perdrial, Julia N., (2016). Tropical river suspended sediment and solute dynamics in storms during an extreme drought. *WRR special issue*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Comas, Xavier, and Hynek, Scott, and Buss, Heather, (2015). Architecture of the deep critical zone in the Rio Icacos watershed (Luquillo Critical Zone Observatory, Puerto Rico) inferred from drilling and ground penetrating radar (GPR). *Earth Surface Processes and Landforms*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Dalling, James W. , and Heineman, Katherine, and Gonzalez, Grizelle, (2015). Geographic, environmental and biotic sources of variation in the nutrient relations of tropical montane forests.. *Journal of Tropical Ecology*: DOI:10.1017/S0266467415000619. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Dialynas, Yannis, and Bras, Rafeal, and Marin-Spiotta, Erika, and Silver, Whendee, L and Arnone, Elisa, and Noto, L.V., (2016). Impact of Hydrologically Driven Hillslope Erosion and Landslide Occurrence on Soil Organic Carbon Dynamics in Tropical Watersheds.. *Water Resources Research*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

- Gonzalez, Grizelle, (2016). Building a Collaborative Network to Understand Regional Forest Dynamics and Advance Forestry Initiatives in the Caribbean. *Caribbean Naturalist*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes
- Gonzalez, Grizelle, (2016). Introduction: Caribbean Forest Dynamics and Regional Forestry Initiatives. *Caribbean Naturalist*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes
- Gutierrez del Arroyo, Omar, and Silver, Whendee, L (2016). Long-term effects of hurricanes on soil carbon and nutrient pools in a wet tropical forest. *In prep*. . Status = OTHER; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes
- Hall, Steven, J and Liptzin, D, and Buss, Heather, and DeAngelis, K, and Silver, Whendee, L (2016). Drivers and patterns of iron redox cycling from surface to bedrock in a deep tropical forest soil: a new conceptual model. *Biogeochemistry*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes
- Hall, Steven, J and Silver, Whendee, L and Timokhin, Vitaliy, and Hammel, Kenneth, (2016). Iron addition to soil specifically stabilized lignin. *Soil Biology and Biochemistry*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes
- Hynek, Scott, (2016). Stream solutes map lithology, regolith structure, and watershed function: Luquillo Mountains, Puerto Rico. *Geological Society of America Bulletin*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes
- Hynek, Scott, and Comas, Xavier, and Brantley, Susan, (2016). The effect of fractures on weathering of igneous and volcanoclastic sedimentary rocks in the Puerto Rican tropical rain forest. *Procedia Earth and Planetary Science (WRI-15)*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes
- Lara, Maria Chapela, and Buss, Heather, and Pogge von Strandmann, P.A.E., and Pogge von Strandmann, P.A.E., and Pogge von Strandmann, P.A.E., and Schuessler, J.A., (2016). The influence of critical zone processes on the Mg isotope budget in a tropical, highly weathered andesitic catchment. Submitted to *Geochim. Cosmochim. Acta*. Accepted pending revision. *Geochimica et Cosmochimica Acta*. . Status = ACCEPTED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes
- McClintock, Matthew, and Brocard, Gilles, and Willenbring, Jane, and Porder, Stephen, (2015). Spatial variability of African dust in a montane tropical landscape in Puerto Rico. *Chemical Geology*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes
- McGee, Steven, (2016). Drought in the Critical Zone: Engaging students in authentic inquiry through Data Jam. *The Earth Scientist*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes
- O'Connell, Christine S., (2016). Drought drives rapid shifts in soil biogeochemistry and greenhouse gas emissions in a wet tropical forest. *In prep*. . Status = OTHER; Acknowledgment of Federal Support = Yes ; Peer Reviewed = No
- Perdrial, Nicolas, and Thompson, Aaron, (2015). Soil geochemistry in the critical zone: influence on atmosphere, surface-and groundwater composition. *Principles and Dynamics of the Critical Zone. Developments in Earth Surface Processes*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes
- Scholl, Martha A, and Shanley, Jamie, (2015). Stable-isotope and solute-chemistry approaches to flow characterization in a forested tropical watershed, Luquillo Mountains, Puerto Rico. *Applied Geochemistry* 63:484-497. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes
- Shanley, Jamie, (2016). A TROPICAL PARADOX - MERCURY IS HIGH IN DEPOSITION, LOW IN THE FOOD WEB IN PUERTO RICO. *TBD*. . Status = OTHER; Acknowledgment of Federal Support = No ; Peer Reviewed = Yes
- Stallard, Robert, and Plante, Alain, and Gonzalez, Grizelle, (2016). Export and yield of river particulate organic carbon and particulate nitrogen from the Luquillo critical zone observatory in Puerto Rico. *TBD*. . Status = OTHER; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes
- Van Beusekom, Ashley, and Gonzalez, Grizelle, and Scholl, Martha A, (2016). Seasonal Cloud Base Patterns Highlight Small-Mountain Tropical Cloud Forest Vulnerability. *will be submitted to GRL soon*. . Status = OTHER; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

- Wolf,, and Brocard,Gilles, and Willenbring,Jane, and Porder,Stephen, and Uriarte,Maria, (2016). Abrupt change in forest height along a tropical elevation gradient detected using airborne lidar. *Remote Sensing*. . Status = SUBMITTED; Acknowledgment of Federal Support = Yes
- Wymore,Adam, and Coble,A.A., and Rodriguez-Cardona,B., (2016). Nitrate uptake across biomes and the influence of elemental stoichiometry: A new look at LINX II.. *Geophysical Research Letters*. *Accepted 2016*.. . Status = ACCEPTED; Acknowledgment of Federal Support = No
- Zalamea,M, and Gonzalez,Grizelle, (2016). Physical, chemical, and biological properties of soil under decaying wood in a tropical wet forest in Puerto Rico.. *Forests* 7(8), 168. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes
- Almaraz,Maya, and Porder,Stephen, (2016). Measuring ecosystem nitrogen status: a comparison of proxies. *Biogeosciences*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.5194/bg-2016-43
- Appling A., Leon M.C, McDowell W. (2015). Reducing bias and quantifying uncertainty in watershed flux estimates: The R package loadflex. *Ecosystems*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes
- Amone, E., Dialynas, Y. G., Noto, L. V., & Bras, R. L. (2015). Accounting for soils parameter uncertainty in a physically-based and distributed approach for rainfall-triggered landslides. *Hydrological Processes*. 30 . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1002/hyp.10609
- Brocard,Gilles, and Willenbring,Jane, and Miller,Thomas E., and Scatena,Fredrick, (2016). Relict landscape resistance to dissection by upstream migrating knickpoints. *Journal of Geophysical Research Earth Surface*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes
- Comas,Xavier, and Hynek,Scott, and Buss,Heather, (2016). Architecture of the deep critical zone in the Rio Icacos watershed (Luquillo Critical Zone Observatory, Puerto Rico) inferred from drilling and ground penetrating radar (GPR).. *Earth Surface Processes and Landforms*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes
- Dalling, J.W., Heineman, K., González, G., and Ostertag, R. (2015). Geographic, environmental and biotic sources of variation in the nutrient relations of tropical montane forests. *Journal of Tropical Ecology*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1017/S0266467415000619
- Figuroa-Nieves, D, McDowell, W. H., Potter. J.D. and Martinez, G. (2015). Limited uptake on nutrient input from sewage effluent in a tropical landscape. *Freshwater Science*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1086/684992
- J.B. Shanley, M. Engle, M.A. Scholl, D. Krabbenhoft, R. Brunette, M.E. Conroy (2015). High mercury wet deposition at a “clean air” site in Puerto Rico. *Environmental Science and Technology*.. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes
- Jaivime Evaristo, Jeffrey J. McDonnell, Martha A. Scholl, L. Adrian Bruijnzeel and Kwok P. Chun (2016). Insights into plant water uptake from xylem-water isotope measurements in two tropical catchments with contrasting moisture conditions. *HYDROLOGICAL PROCESSES*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1002/hyp.10841
- Joe Orlando, Xavier Comas, Scott Hynek, Heather L. Buss, and Sue L. Brantley (2015). Architecture of the deep critical zone in the Architecture of the deep critical zone in the Río Icacos watershed (Luquillo Critical Zone Observatory, Puerto Rico) inferred from drilling and ground penetrating radar (GPR). *Earth Surface Processes and Landforms*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1002/esp.3948
- McClintock, M.A., McDowell, W.H., Gonzalez, G., Schulz, M., and Pett-Ridge, J.C. (). African dust deposition in Puerto Rico; analysis of a 20-year rainfall chemistry record and comparison with models. *Journal of Geophysical Research- Atmospheres*. . Status = AWAITING_PUBLICATION; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes
- Phillips & Jerolmack (2016). Self-organized river channels are a critical filter on climate signals. *Science*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1126/science.aad3348

Riebe, C. S., Hahm, W. J., Brantley, S. L. (2015). Going deep to quantify limits on weathering in the Critical Zone. *Earth Surface Processes and Landforms, in review*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Scholl, M.A., Shanley, J.B., Murphy, S.F., Willenbring, J.K., Occhi, M., and González, G. (2015). Stable-isotope and solute-chemistry approaches to flow characterization in a forested tropical watershed, Luquillo Mountains, Puerto Rico.. *Applied Geochemistry*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1016/j.apgeochem.2015.03.008

Szabo, Domokos, Grotzinger, Jerolmack (2015). Reconstructing the transport history of pebbles on Mars. *Nature Communications*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1038/ncomms9366

Licenses

Other Conference Presentations / Papers

Harrison, E.J. (2015). *10Be in the landscape*. LCZO Meeting 2015. Luquillo, PR. Status = PUBLISHED; Acknowledgment of Federal Support = Yes

Brantley,Susan, (2015). *25th Anniversary Talk: Weathering and Surface Processes*. Goldschmidt Conference, Prague, CZ. Prague, CZ. Status = PUBLISHED; Acknowledgment of Federal Support = Yes

Brantley,Susan, (2015). *A Few Geological Uses of Neutron Scattering: How Does Porosity Change as Water Enters Rocks?*. Gaithersburg, MD invited talk at the Center for High Resolution Neutron Scattering (CHRNS) NSF Site visit review at the National Institute of Standards and Technology (NIST). Gaithersburg, MD. Status = OTHER; Acknowledgment of Federal Support = Yes

Morales-Garcia,Flavia, and Santos-Figueroa,G., and Custals,L.V., and Izaquirre,M., and Prospero,J.M., (2015). *A Local Index of Cloud Immersion in Tropical Forests Using Time-Lapse Photography*. AGU 2015. San Francisco, CA. Status = PUBLISHED; Acknowledgment of Federal Support = Yes

Arnone,Elisa, and Noto,L.V., and Dialynas,Yannis, and Bras,Rafeal, (2015). *A Physically-Based and Distributed Tool for Modeling the Hydrological and Mechanical Processes of Shallow Landslides*. AGU 2015. San Francisco, CA. Status = PUBLISHED; Acknowledgment of Federal Support = Yes

Shanley,Jamie, (2016). *A TROPICAL PARADOX - MERCURY IS HIGH IN DEPOSITION, LOW IN THE FOOD WEB IN PUERTO RICO*. PR LTER Annual Meeting June 2016. Luquillo, PR. Status = OTHER; Acknowledgment of Federal Support = No

Bassiouni,M, and Scholl,Martha A, (2015). *A local index of cloud immersion in tropical forests using time-lapse photography*. AGU 2015, A33H-0276. San Francisco, CA. Status = PUBLISHED; Acknowledgment of Federal Support = Yes

Morales-Garcia,Flavia, and Santos-Figueroa,G., and Custals,L.V., and Izaquirre,M., and Prospero,J.M., (2015). *African Dust Concentrations in the Caribbean Island of Puerto Rico. American Geophysical Union Fall Meeting. San Francisco, CA. December 2015.*. AGU 2015. San Francisco, CA. Status = PUBLISHED; Acknowledgment of Federal Support = Yes

Torres, E. and O. L. Mayol-Bracero (2014). *African Dust and Clouds at Pico Este Tropical Montane Cloud Forest: Cloud Chemistry and Microphysics, June 2, 2014, All-hands Meeting of the Luquillo Critical Zone Observatory, Luquillo, PR. (oral)*. All-hands Meeting of the Luquillo Critical Zone Observatory. Luquillo, PR. Status = PUBLISHED; Acknowledgment of Federal Support = Yes

Mayol O. (2014). *African Dust and Clouds at Pico del Este*. LCZO Cyber Seminar February 28, 2014. GoToMeeting. Status = OTHER; Acknowledgment of Federal Support = Yes

Elvis Torres Delgado (2015). *African dust inputs*. LCZO Meeting 2015. Luquillo, PR. Status = PUBLISHED; Acknowledgment of Federal Support = Yes

Silver W., Ruan L. (2015). *An Instrumented Hillslope*. LCZO Meeting 2015. Luquillo, PR. Status = PUBLISHED; Acknowledgment of Federal Support = Yes

Ruegg,Janine, and Sheehan,Kenneth, and Baker,C, and Daniels,M., and Dodds,Walter, and Farrell,K, and Flinn,M.B., and Gido,Keith, and Harms,T, and Jones,Jeremy, and Koenig,Lauren, and Kominoski,J.S., and McDowell,William, H and Bowden,W.B., and Rosemond,A., D. and Trentman,M.T., and Whiles,Matt, and Wollheim,Wilfred, M., and Parker,S., (2015). *Baseflow patterns of geomorphic heterogeneity in stream networks across biomes.*. Society for Freshwater Science Annual Meeting. Milwaukee, WI. May 17-21, 2015.. Milwaukee, WI. Status = PUBLISHED; Acknowledgement of Federal Support = No

Dodds,Walter, and Ruegg,Janine, (2015). *Biome Context and Lotic Ecosystem Rates. American Geophysical Union Fall Meeting. San Francisco, CA. December 2015.*. AGU 2015. San Francisco, CA. Status = PUBLISHED; Acknowledgement of Federal Support = No

Lee, D. (2015). *Bringing a Smart Rock to Luquillo.* LCZO Meeting 2015. Luquillo, PR. Status = OTHER; Acknowledgement of Federal Support = Yes

Lee D. (2014). *Bringing a Smart Rock to Luquillo - A Tool to Constrain the Onset of Motion and Gravel Bed Impact Energies.* LCZO Cyber Seminar October 3rd, 2014. GoToMeeting. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Sue Brantley (2014). *CZ-Topo: Using Measurements of Multiple Isotopes in One Setting to Understand Critical Zone Processes Occurring over Different Timescales (invited).* AGU Fall Meeting 2014. San Francisco. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Stone M.M., Plante A.F. (2014). *Changes in phosphatase kinetics with soil depth across a variable tropical landscape.* LCZO Meeting 2014. Luquillo, PR. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Coward,Elizabeth, and Plante,Alain, and Thompson,Aaron, and Silver,Whendee, L (2015). *Chemical characterization of iron-mediated soil organic matter stabilization in tropical subsoils.* AGU 2015. San Francisco, CA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Gonzalez, G. (2014). *Cielometer / data streams.* LCZO Meeting. Luquillo, PR. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Van Beusekom, A. (2015). *Cielometer and other cloud height measurements.* LCZO Meeting 2015. Luquillo, PR. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Shanley,Jamie, and Aulenbach,B.T., and Mast,A., and Clow,D., and Hood,K., (2015). *Comparing Stream DOC Fluxes from Sensor- and Sample-Based Approaches.* AGU 2015. San Francisco, CA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Brereton, R., A.Wymore, J. Potter, W.H. McDowell (2015). *Concentration-discharge relationships in a wet tropical landscape: Luquillo Mountains, Puerto Rico. Cross-CZO SAVI Workshop: Concentration-discharge relations in the critical zone: Implications for understanding critical zone structure, function and evolution.* CZO C-Q workshop. University of New Hampshire. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

McDowell,William, H (2016). *Critical Zone Science and the Luquillo Critical Zone Observatory.* Florida Coastal Everglades Long Term Ecological Research meeting. Miami, Florida. March 15, 2016.. Miami, Florida. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Thompson A. (2015). *Critical zone research at the University of Georgia.* Invited talk. University of Padua, Italy June 19, 2015. Padua, Italy.. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Buss H.L., Moore O., Chapela Lara M. Schulz M. and White A.F. (2014). *Critical zone weathering hotspots.*. Goldschmidt 2014. Sacramento. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Thompson,Aaron, (2015). *Delineating Climatic Regions Where Upland Soil Iron Reduction Is Potentially Important At The Ecosystem Scale.* AGU 2015. San Francisco, CA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Almaraz,Maya, and Groffman,P, and Silver,Whendee, L and Hall,Steven, J and Ruan,Leilei, and Porder,Stephen, (2016). *Differential controls on dinitrogen and nitrous oxide from a wet tropical forest.* LCZO 2016. Luquillo, PR. Status = OTHER; Acknowledgement of Federal Support = Yes

Bastola S., Dialynas Y. (2014). *Distribution of hot spot in sediment transport behavior in a humid tropical forest using tRIBS-VEGGIE*. LCZO Cyber Seminar February 28, 2014. GoToMeeting. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Satish Bastola (2015). *Distribution of hot spots in sediment transport and soil moisture in a humid tropical forest using tRIBS model*. LCZO Meeting 2015. Luquillo, PR. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Brantley, S. (2014). *Drilling Deep*. LCZO Cyber Seminar October 3rd, 2014. GoToMeeting. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Brantley, S. (2014). *Drilling to Explore the Transformation of Bedrock into Soil in the Deep Critical Zone*. technical seminar, Kansas State University, Manhattan, KS, October 16, 2014. Manhattan, KS. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Brantley,Susan, (2015). *Drilling to Explore the Transformation of Bedrock into Soil in the Deep Critical Zone*. 2015 Willie Woltz Visiting Scientist Lecture Series, North Carolina State University, Raleigh, NC. Raleigh, NC. Status = OTHER; Acknowledgement of Federal Support = Yes

Silver,Whendee, L (2016). *Drought in the Rainforest: Biogeochemical Responses and Feedbacks to Climate Change*. ESA 2016. Fort Lauderdale, FL. Status = OTHER; Acknowledgement of Federal Support = No

O'Connell,Christine S., and Silver,Whendee, L (2016). *Drought in the rainforest: biogeochemical responses and feedbacks to climate change*. LTER Annual Mtg. Luquillo, PR. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Brocard,Gilles, and Willenbring,Jane, and Miller,Thomas E., (2015). *Effect of rainforest development on the pace of knickpoint retreat during the growth a tropical mountain. Insights from the Luquillo CZO, Puerto Rico*. GSA 2015. Baltimore, MD. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Figueroa-Nieves,Debra, (2016). *Effects of sewage effluents on benthic algal communities in tropical streams..* Society for Freshwater Science Annual Meeting. Sacramento, CA. May 2016.. Sacramento, CA. Status = PUBLISHED; Acknowledgement of Federal Support = No

Brantley S. (2014). *Exploring the Transformation of Bedrock into Soil in the Deep Critical Zone*. Invited talk, UC-Riverside, Apr 8, 2014. UC-Riverside. Status = OTHER; Acknowledgement of Federal Support = Yes

Brantley S. (2014). *Exploring the Transformation of Bedrock into Soil in the Deep Critical Zone*. Invited technical lecture, 11th Annual Noel Potter Lectures, The Department of Earth Sciences, Dickinson College, Carlisle, PA, November 18, 2014. Carlisle, PA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Brantley,Susan, (2015). *Exploring the Transformation of Bedrock into Soil in the Deep Critical Zone*. Departmental Seminar (invited), Dartmouth College, Hanover, NH, April 3, 2015.. Hanover, NH. Status = OTHER; Acknowledgement of Federal Support = Yes

Brantley,Susan, (2015). *Exploring the Transformation of Bedrock into Soil in the Deep Critical Zone*. Departmental Seminar (invited), University of New Hampshire, Durham, NH, January 29, 2015.. Durham, NH. Status = OTHER; Acknowledgement of Federal Support = Yes

Brantley, S. (2014). *Exploring the transformation of bedrock into soil in the deep critical zone*. Invited seminar, Lamont Doherty Earth Observatory, Columbia University, Palisades, NY, September 15-16, 2014. Palisades, NY. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

McDowell,William, H (2016). *Export of carbon, nutrients, and weathering products from a highly urbanized tropical watershed..* Society for Freshwater Science Annual Meeting. Sacramento, CA. May 25, 2016.. Sacramento, CA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Shanley, J. (2015). *FDOM DOC and Turbidity*. LCZO Meeting 2015. Luquillo, PR. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Coward EK (2014). *Fe-C associations and soil organic matter stability*. All-hands Meeting of the Luquillo Critical Zone Observatory, Luquillo, PR. Luquillo, PR. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

- Coward EK & AF Plante (2014). *Fe-C associations and soil organic matter stability in tropical soils of two contrasting parent materials*. SOM6 workshop. Kiawah Island, SC. Status = PUBLISHED; Acknowledgement of Federal Support = Yes
- Coward E.K., Thompson A., Plante A.F. (2014). *Fe-C interactions and soil organic matter stability in two tropical soils of contrasting parent materials (B23I-07)*. AGU Fall Meeting 2014. San Francisco. Status = PUBLISHED; Acknowledgement of Federal Support = Yes
- O'Connell,Christine S., (2016). *Guest lecture on deforestation and climate impacts in tropical forests*. UC Santa Cruz. Santa Cruz, CA. Status = OTHER; Acknowledgement of Federal Support = No
- Bastola S., Dialynas Y. (2015). *Hot spots of sediment sources and links to Soil Organic Carbon Dynamics*. LCZO Cyber Seminar February 20, 2015. GoToMeeting. Status = PUBLISHED; Acknowledgement of Federal Support = Yes
- Brocard,Gilles, and Willenbring,Jane, (2015). *How Saharan Dust Slows River Knickpoints : Coupling Vegetation Canopy, Soils and the Foundation of the Critical Zone..* AGU 2015. San Francisco, CA. Status = OTHER; Acknowledgement of Federal Support = Yes
- Brocard,Gilles, and Willenbring,Jane, and Harrison,Emma, and Scatena,Fredrick, (2015). *How Saharan Dust Slows River Knickpoints: Coupling Vegetation Canopy, Soils and the Foundation of the Critical Zone*. AGU 2015. San Francisco, CA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes
- Gutierrez del Arroyo,Omar, and Silver,Whendee, L (2016). *How deep does disturbance go?*. LTER Annual Mtg. Luquillo, PR. Status = OTHER; Acknowledgement of Federal Support = No
- Gutierrez del Arroyo,Omar, and Silver,Whendee, L (2015). *How deep does disturbance go? The long-term effects of canopy disturbance on tropical forest soil biogeochemistry*. AGU 2015. San Francisco, CA. Status = PUBLISHED; Acknowledgement of Federal Support = No
- Brantley,Susan, (2015). *How porosity increases during incipient weathering of crystalline silicate rocks..* Pore-Scale Geochemical Processes Short Course, Prague, CZ. Prague, CZ. Status = OTHER; Acknowledgement of Federal Support = Yes
- Brereton R., McDowell, W.H. (2015). *Identifying Hot Spots and Hot Moments of Nitrogen Cycling in Riparian Groundwater and Streams*. LCZO Meeting 2015. Luquillo, PR. Status = PUBLISHED; Acknowledgement of Federal Support = Yes
- Torres-Delgado, E., C. J. Valle-Díaz, D. Baumgardener, W. H. McDowell, G. González, O. L. Mayol-Bracero (2015). *Impact of African dust on cloud and rain chemistry and cloud microphysics in Caribbean cloud forest*. 35rd Puerto Rico Interdisciplinarity Scientific Meeting 50th Junior Technical Meeting, Universidad de Puerto Rico, Río Piedras Campus, San Juan, Puerto Rico, 29 Mar 2015.. San Juan, Puerto Rico. Status = PUBLISHED; Acknowledgement of Federal Support = Yes
- Torres-Delgado, E., C. J. Valle-Díaz, D. Baumgardner, O. L. Mayol-Bracero (2016). *Indirect effect of African dust particles on cloud microphysical and chemical properties in a tropical montane cloud forest in the Caribbean*. 32nd Meeting of the American Meteorological Society – Hurricanes and Tropical Meteorology. San Juan, PR. Status = OTHER; Acknowledgement of Federal Support = Yes
- Dialynas,Yannis, and Bastola,Satish, and Bras,Rafeal, and Marin-Spiotta,Erika, and Silver,Whendee, L and Amone,Elisa, and Noto,L.V., (2015). *Influence of Soil Erosion and Landslide Occurrence on Soil Organic Carbon Storage and Loss in the Luquillo Critical Zone Observatory, Puerto Rico*. AGU 2015. San Francisco, CA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes
- McDowell,William, H (2015). *Integrating International LTER and CZO networks..* International LTER Coordinating Committee Meeting, Rome Italy. 24-30 September.. Rome Italy. Status = PUBLISHED; Acknowledgement of Federal Support = Yes
- McDowell,William, H (2015). *Integrating International LTER and CZO networks..* Sino-US CZO Workshop, Guiyang, China. Oct 5-11, 2015.. Guiyang, China. Status = PUBLISHED; Acknowledgement of Federal Support = Yes
- Bastola S., Dialynas Y. Amone, E. Wang, J., Bras, R.L. (2014). *Integration of Slope stability module into landscape evolution model (tRIBS erosion) to simulate sediment yield at watershed influenced by shallow landslides: A case study in the Luquillo Forest, Puerto Rico*. CZO All hands meeting 2014. Luquillo, PR. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Bastola, Satish, and Dialynas, Yannis, and Bras, Rafeal, and Amone, Elisa, and Noto, L.V., (2015). *Integration of a Physically based Distributed Hydrological Model with a Model of Carbon and Nitrogen Cycling: A Case Study at the Luquillo Critical Zone Observatory, Puerto Rico*. AGU 2015. San Francisco, CA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Hall S. (2015). *Interactions between biological and physical processes generate complex redox dynamics*. LCZO Meeting 2015. Luquillo, PR. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

McDowell, William, H (2015). *International Critical Zone Science: Opportunities to Build a Global Understanding of Land-Water Linkages*. AGU 2015. San Francisco, CA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

McDowell, William, H (2016). *International LTER and CZO networks: Opportunities to build a global understanding of land-water linkages*. Invited presentation at the High Level Round Table Global Observatory meeting hosted by Australian Terrestrial Ecology Research Network (TERN), Brisbane, Australia. 7 March 2016. Brisbane, Australia. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Brocard, Gilles, (2015). *Interplay of forest and topography during the growth a tropical mountain. Insights from the Luquillo CZO observatory, Puerto Rico*. Department seminar, Tulane University. New Orleans, LA. Status = OTHER; Acknowledgement of Federal Support = Yes

Brocard, G., Willenbring J. (2015). *Interplay of forest and topography during the growth of the Luquillo Mountains*. LCZO Cyber Seminar January 16, 2015. GoToMeeting. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Brocard, Gilles, and Willenbring, Jane, (2016). *Interplay of forest and topography in the Luquillo Critical Zone Observatory: the case of the Rio Blanco knickpoints*. Department seminar, university of Grenoble, France. university of Grenoble, France. Status = OTHER; Acknowledgement of Federal Support = Yes

Perdrial, Julia N., and McFarlane, K, and Heckman, K, and Reed, S, and Wood, Tana, (2015). *Into the Deep: Variability in Soil Microbial Communities and Carbon Turnover Along a Tropical Forest Soil Depth Profile*. AGU 2015. San Francisco, CA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Chen, C, and Sparks, D, and Thompson, Aaron, (2016). *Invited: The Impact of Redox Fluctuations on Coupled Fe and C Cycling*. Goldschmidt 2016. Yokohama, Japan. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Barcellos, Diego, and Silver, Whendee, L (2015). *Iron reduction and carbon dynamics during redox fluctuations in soil slurries from Luquillo CZO (Puerto Rico)*. AGU 2015. San Francisco, CA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Barcellos, Diego, and Wilmoth, Jared, and Thompson, Aaron, (2015). *Iron reduction rates and carbon mineralization in a soil from Puerto Rico*. Goldschmidt 2015. Prague, CZ. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Coward E.K. (2015). *Iron-mediated C stability in two tropical soils*. LCZO Cyber Seminar January 16, 2015. GoToMeeting. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Thompson, Aaron, (2016). *Keynote: The Role of Redox Variability in Structuring Iron Cycling in Soils*. Goldschmidt 2016. Yokohama, Japan. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Brocard, G. (2015). *Knick Points and Landscape evolution*. LCZO Meeting 2015. Luquillo, PR. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Kovalovich, A, and Harrison, Emma, (2015). *LIFE IMPACTS ON LANDSCAPE: WORMS DISPERSE PARTICLES AND AERATE TROPICAL SOILS*. GSA 2015. Baltimore, MD. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Willenbring, J. (2015). *Landscape Response to Uplift: Delayed or Immediate*. LCZO Meeting 2015. Luquillo, PR. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Almaraz, Maya, and Groffman, P, and Silver, Whendee, L and Hall, Steven, J and Ruan, Leilei, and Porder, Stephen, (2016). *Landscape scale variation in dinitrogen and nitrous oxide emissions from a moist tropical forest in Puerto Rico*. ESA 2016. Fort Lauderdale, FL. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Kovalovich,A, and Harrison,Emma, and Willenbring,Jane, (2015). *Life Impacts on Landscape: Worms Disperse Particles and Aerate Tropical Soils*. GSA 2015. Baltimore, MD. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Harrison,Emma, and Willenbring,Jane, and Brocard,Gilles, (2016). *Life's Impact on the Soil Production Function*. EGU, Vienna.. EGU 2016. Vienna, Austria. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Brantley,Susan, (2015). *Lithology and chemical weathering reaction fronts, and runoff paths through hillslopes*. Departmental Seminar (invited), Purdue University, West Lafayette, IN, Nov 19, 2015.. West Lafayette, IN. Status = OTHER; Acknowledgement of Federal Support = Yes

Brantley,Susan, (2015). *Lithology, chemical weathering reaction fronts, and runoff paths through hillslopes*. Gilbert Club Talk (invited), University of California at Berkeley, Berkeley, CA. California at Berkeley, Berkeley, CA. Status = OTHER; Acknowledgement of Federal Support = Yes

Brantley,Susan, (2016). *Lithology, chemical weathering reaction fronts, and runoff paths through hillslopes*. University of Wyoming, Laramie WY, April 2016.. Laramie WY. Status = OTHER; Acknowledgement of Federal Support = Yes

McDowell, W.H. (2015). *Long Term Nitrogen Dynamics in a Tropical Landscape*. Keynote address at Northeast Alliance for Graduate Education and the Professoriate - No longer a dream deferred! 8th NEA Science Day,. University of Puerto Rico, Mayagüez, Puerto Rico.. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

McDowell, W.H. (2015). *Long Term Nitrogen Dynamics in a Tropical Landscape*. Weekly Departmental Seminar. Department of Environmental Sciences, University of Puerto Rico. University of Puerto Rico – Rio Piedras, Puerto Ri. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

McDowell, W. H. (2014). *Long-term N dynamics in a tropical forest: Observations, inferences, and unanswered questions..* USGS National Headquarters Reston, VA. USGS National Headquarters Reston, VA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

McDowell,William, H (2016). *Long-term Nitrogen Dynamics in a Tropical Landscape..* Technical University of Dresden, Dresden, Germany. May 10, 2016.. Dresden, Germany. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

McDowell,William, H (2016). *Long-term nitrogen dynamics in a tropical landscape..* El Verde Field Station, University of Puerto Rico.. Luquillo, PR. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

McDowell, W.H. (2015). *Luquillo CZO: The role of hot spots and hot moments in tropical landscape evolution and functioning of the critical zone..* Plenary talk at the Luquillo Long-Term Ecological Research Program Annual Meeting. San Juan, PR. June 4, 2015. San Juan, PR. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

James Shanley, John Franco Saraceno,Mark Domblaser, Brent Aulenbach, et al. (2015). *Making Sense of Sensors: Stream Carbon Flux Determination at the Five USGS WEBB Watersheds*. AGU Fall Meeting 2014. San Francisco. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Buss H. (2015). *Mechanisms of profile development in the critical zone*. LCZO Cyber Seminar February 20, 2015. GoToMeeting. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Omar Gutiérrez del Arroyo (2015). *Modified Hedley Fractionation with NaHCO₃ and NaOH extractions*. LCZO Meeting 2015. Luquillo, PR. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Willenbring,Jane, (2015). *Natural or Anthropogenic: (Mis?)interpreting Floodplain Grain-size Structure, Flood Recurrence and Sedimentation Rates..* GSA 2015. Baltimore, MD. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Almaraz,Maya, and Porder,Stephen, and Groffman,P, (2015). *Nitrogen fertilizer increases nitrous oxide, but not dinitrogen, emissions from moist tropical forest soils in Puerto Rico*. AGU 2015. San Francisco, CA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Leon,Miguel, Carlos (2016). *ODM2 Admin: New Administrative Interface for ODM2 data mode for CZO Data Managers..* gotomeeting. gotomeeting. Status = OTHER; Acknowledgement of Federal Support = Yes

Leon,Miguel, Carlos (2016). *ODM2 Admin: New Administrative Interface for ODM2 data mode for the BigCZToolbox*. BiGCZ. gotomeeting. Status = OTHER; Acknowledgement of Federal Support = Yes

- Leon, Miguel, Carlos (2016). *ODM2 Admin: New Administrative Interface for ODM2 data mode for the CZO Community*. gotomeeting. gotomeeting. Status = OTHER; Acknowledgement of Federal Support = Yes
- Miguel Leon (2016). *ODM2-Admin Data Management*. 2nd Annual Cross-CZO EarthCube Microbial Ecology Workshop and NEON Microbial Ecology Working Group Meeting. Montreal, Quebec, Canada. Status = OTHER; Acknowledgement of Federal Support = Yes
- McDowell, W.H. (2015). *Opening remarks on "Career building and Critical Zone Science". Early Career Critical Zone Workshop: Critical Zone Resiliency*. Early Career Critical Zone Workshop: Critical Zone Resiliency. University of New Hampshire, Durham, NH. Status = PUBLISHED; Acknowledgement of Federal Support = Yes
- McDowell, W.H. (2015). *Opportunities for interaction and integration*. Annual LTER Science Council Meeting. Harvard Forest, Petersham, MA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes
- Mayol-Bracero, O. L (2015). *Overview of Aerosol and Cloud Measurements in the neighbor-island of Puerto Rico, with focus on African Dust*. 50th Anniversary of Climate Research in Barbados. Barbados. Status = OTHER; Acknowledgement of Federal Support = Yes
- Stone, M.M. (2014). *Patterns in carbon chemistry and stability with depth across contrasting soil and forest types*. LCZO Cyber Seminar October 3rd, 2014. GoToMeeting. Status = PUBLISHED; Acknowledgement of Federal Support = Yes
- Plante A. (2014). *Patterns of substrates, microbes and enzymes with soil depth in the LCZO*. Invited Seminar. Boise State University. Status = PUBLISHED; Acknowledgement of Federal Support = Yes
- Perdrial, Julia N., and Rizzo, J, and Harpold, A, (2016). *Perdrial et al. 2016. Investigating controls on stream water carbon dynamics in varied climates: Luquillo as endmember of a CZO climosequence ?*. LCZO allhands meeting. Luquillo, PR. Status = OTHER; Acknowledgement of Federal Support = No
- Willenbring, Jane, and Crosby, B, and Brocard, Gilles, (2015). *Persistent Landscape Transience Recorded by in situ-produced ¹⁰Be and Numerical Modeling*. GSA 2015. Baltimore, MD. Status = PUBLISHED; Acknowledgement of Federal Support = Yes
- McDowell, W.H. (2015). *Phosphate Fluxes across Luquillo Streams*. LCZO Meeting 2015. Luquillo, PR. Status = PUBLISHED; Acknowledgement of Federal Support = Yes
- Gonzalez, Grizelle, and Scholl, Martha A, and Shanley, Jamie, (2016). *Progress report on Hypothesis 4*. CZO Annual Meeting. Luquillo, PR. Status = OTHER; Acknowledgement of Federal Support = Yes
- Filley, T, and Guo, D, and Plante, Alain, (2015). *Promoting US-China Critical Zone Science Collaboration and Coordination Through Established Subnational Bilateral Science Partnerships: The US-China EcoPartnership for Economic and Environmental Sustainability*. AGU 2015. San Francisco, CA. Status = PUBLISHED; Acknowledgement of Federal Support = No
- Scholl, Bassiouni, Murphy, Gonzalez, Van Beusekom, Torres-Sanchez, Estrada-Ruiz (2015). *Quantifying Amount and Variability of Cloud Water Inputs Using Active-Strand Collector, Ceilometer, Dewpoint, and Photographic Measurements*. AGU Fall Meeting 2015. San Francisco. Status = PUBLISHED; Acknowledgement of Federal Support = Yes
- Scholl, Bassiouni, Murphy, Gonzalez, Van Beusekom, Torres-Sanchez, Estrada-Ruiz (2015). *Quantifying Amount and Variability of Cloud Water Inputs Using Active-Strand Collector, Ceilometer, Dewpoint, and Photographic Measurements*. AGU Fall Meeting 2015. San Francisco. Status = PUBLISHED; Acknowledgement of Federal Support = Yes
- Scholl, Martha A, and Bassiouni, M, (2015). *Quantifying Amount and Variability of Cloud Water Inputs Using Active-Strand Collector, Ceilometer, Dewpoint, and Photographic Measurements*. AGU, Session A33H-0278. <https://agu.confex.com/agu/fm15/meetingapp.cgi/Paper/67899>. San Francisco, CA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes
- Scholl, Martha A, and Fernanda, M., (2016). *Quantifying Cloud Water Hydrology in Tropical Mountain Forests Using Time-Lapse Photography*. Proceedings of the 7th International Conference on Fog, Fog Collection and Dew. 24-29 July, 2016, Wroclaw, Poland. Wroclaw, Poland. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Scholl,Martha A, and Bassiouni,M, and Gonzalez,Grizelle, (2015). *Quantifying amount and variability of cloud water inputs using active-strand collector, ceilometer, dewpoint, and photographic measurements*. AGU 2015, A33H-0278. San Francisco, CA. Status = OTHER; Acknowledgement of Federal Support = Yes

Scholl,Martha A, and Bassiouni,M, and Gonzalez,Grizelle, (2016). *Quantifying amount and variability of cloud water inputs using active-strand collector, ceilometer, dewpoint, and photographic measurements*. LCZO Annual Mtg, presented by Torres-Sanchez A. Luquillo, PR. Status = OTHER; Acknowledgement of Federal Support = Yes

Torres-Delgado, E., C. J. Valle-Díaz, D. Baumgardner, W. H. McDowell, O. L. Mayol-Bracero (2014). *Rain chemistry and cloud composition and microphysics in a tropical cloud forest under the influence of African dust*. 13th Quadrennial ICACGP Symposium 13th IGAC Science Conference on Atmospheric Chemistry, Natal, Brazil 23 Sep 2014.. Natal, Brazil. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Lin,Y, and Campbell,A.N., and Bhattacharyya,A, and Nico,Peter, and Silver,Whendee, L (2016). *Redox fluctuation differentially affected decomposition of litter and soil organic matter*. LCZO meeting 2016. Luquillo, PR. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Barcellos, D.; Wilmoth, J.; Thompson, A. (2014). *Redox fluctuations and Carbon stability in a tropical soil from Puerto Rico*. In: *Plant and Soil Graduate Symposium*. Plant and Soil Graduate Symposium (University of Georgia). Athens, GA, USA.. Athens, GA, USA.. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Lin,Y, and Campbell,A.N., and Bhattacharyya,A, and Nico,Peter, and Silver,Whendee, L (2016). *Redox-induced variations in phosphorus fractions in a humid tropical forest soil*. INTERFACE phosphorus workshop. INTERFACE phosphorus workshop. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Clark,Kathryn, (2016). *Research strategy and contribution*. University of Newcastle, UK. Newcastle, UK. Status = OTHER; Acknowledgement of Federal Support = Yes

Clark,Kathryn, and Plante,Alain, and Willenbring,Jane, and Jerolmack,Doug, and Gonzalez,Grizelle, and Stallard,Robert, (2015). *River Suspended Sediment and Particulate Organic Carbon Transport in Two Montane Catchments in the Luquillo Critical Zone Observatory of Puerto Rico over 25 years: 1989 to 2014*. AGU 2015. San Francisco, CA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Clark,Kathryn, and Plante,Alain, and Willenbring,Jane, and Jerolmack,Doug, and Gonzalez,Grizelle, and Stallard,Robert, (2015). *River Suspended Sediment and Particulate Organic Carbon Transport in Two Montane Catchments in the Luquillo Critical Zone Observatory of Puerto Rico over 25 years: 1989 to 2014*. AGU, Session EP31B-1003, Abstract #76225. <https://agu.confex.com/agu/fm15/meetingapp.cgi/Paper/76225>. San Francisco, CA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Clark,Kathryn, and Stallard,Robert, and Plante,Alain, (2016). *River particulate organic carbon, and nitrogen yields in the Luquillo Critical Zone Observatory*. All-CZO Annual Meeting. Luquillo, PR. Status = OTHER; Acknowledgement of Federal Support = Yes

Lara,Maria Chapela, and Buss,Heather, and Pogge von Strandmann, P.A.E., and Pogge von Strandmann, P.A.E., and Pogge von Strandmann, P.A.E., and Schuessler ,J.A., (2016). *Riverine Mg isotope ratios reflect deep critical zone weathering in a tropical andesitic catchment*. Goldschmidt 2016. Yokohama, Japan. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Wollheim,Wilfred, M., and Dodds,Walter, and Whiles,Matt, and Sheehan,Kenneth, and Stewart,Robert, and Ballantyne,F, and Baker,C, and Bowden,W.B., and Farrell,K, and Flinn,M.B., and Gido,Keith, and Harms,T, and Helton,Ashley , and Jones,Jeremy, and Koenig,Lauren, and McDowell,William, H (2016). *Scaling laws for aquatic metabolism vs. watershed size*. Society for Freshwater Science Annual Meeting. Sacramento, CA. May 22, 2016. Sacramento, CA. Status = PUBLISHED; Acknowledgement of Federal Support = No

Scholl M. (2014). *Scholl M. - Isotope hydrology research in the Luquillo CZO - overview and data resources*. LCZO Cyber Seminar October 3rd, 2014. GoToMeeting. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Van Beusekom,Ashley, and Gonzalez,Grizelle, and Scholl,Martha A, (2016). *Seasonal Cloud Base Patterns Highlight Small-Mountain Tropical Cloud Forest Vulnerability*. LTER Annual Meeting 2016. Luquillo, PR. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

- Harnes,P., and Dyda,R., and McDowell,William, H (2015). *Seasonal variation and processing of vascular plant organic matter in tropical montane catchments as reflected by riverine DOC compositions*. AGU 2016. San Francisco, CA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes
- Plante (2015). *Selective dissolution for soil Fe-C associations*. LCZO Meeting 2015. Luquillo, PR. Status = PUBLISHED; Acknowledgement of Federal Support = Yes
- Schwamer G. (2014). *Sensor Networks*. LCZO Meeting. Luquillo, PR. Status = PUBLISHED; Acknowledgement of Federal Support = Yes
- Barcellos,Diego, and Silver,Whendee, L (2016). *Soil Iron Reduction and Carbon Mineralization in Reconstructed Aggregates during Redox Fluctuations*.. Goldschmidt 2016. Yokohama, Japan. Status = PUBLISHED; Acknowledgement of Federal Support = Yes
- Plante,Alain, and Hockaday,W, (2015). *Soil Organic Matter Characterization by 13C-NMR and Thermal Analysis in Deep Tropical Soil Profiles from the Luquillo Critical Zone Observatory*. AGU 2015. San Francisco, CA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes
- Comas X. (2014). *Soil and Saporlite geophysics*. LCZO Meeting 2014. GoToMeeting. Status = PUBLISHED; Acknowledgement of Federal Support = Yes
- Thompson, A. (2014). *Soil carbon and Iron*. LCZO Meeting 2014. Luquillo, PR. Status = PUBLISHED; Acknowledgement of Federal Support = Yes
- Thompson A. (2015). *Soil carbon and Iron*.. LCZO Meeting 2015. Luquillo, PR. Status = PUBLISHED; Acknowledgement of Federal Support = Yes
- Gonzalez,Grizelle, and Fernanda,M., (2016). *Soil diversity and functioning in dry tropical forests: a review of case studies from Puerto Rico*. ESA 2016. Fort Lauderdale, FL. Status = PUBLISHED; Acknowledgement of Federal Support = No
- McDowell,William, H (2015). *Spatial and temporal variability in urban water quality on a tropical island*.. Second Conference on Water Resource Sustainability Issues on Tropical Islands. Honolulu, Hawaii.. Honolulu, Hawaii.. Status = PUBLISHED; Acknowledgement of Federal Support = Yes
- Ntarlagiannis,Dimitrios, and Comas,Xavier, and Wright,W, and Recinos,E, and Hynek,Scott, and Brantley,Susan, (2015). *Spatially continuous characterization of the bedrock - regolith interface at the Rio Icacos Watershed (Luquillo Critical Zone Observatory) Puerto Rico*.. AGU 2015. San Francisco, CA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes
- Dialynas, Y. (2015). *Spatially-explicit representation of hydrological, geomorphological, and biogeochemical processes*.. LCZO Meeting 2015. Luquillo, PR. Status = PUBLISHED; Acknowledgement of Federal Support = Yes
- O'Connell,Christine S., (2015). *Spoke at the weekly casual seminar for the LTER volunteers about our research in the National Forest (fall semester group)*. El Verde Research Station. Luquillo, PR. Status = PUBLISHED; Acknowledgement of Federal Support = Yes
- O'Connell,Christine S., (2016). *Spoke at the weekly casual seminar for the LTER volunteers about our research in the National Forest (spring semester group)*. El Verde Research Station. Luquillo, PR. Status = PUBLISHED; Acknowledgement of Federal Support = Yes
- Brereton,Rich, (2015). *Stream Ammonium Uptake Across Scales in Headwater Catchments of a Tropical Rainforest, Luquillo Mountains, Puerto Rico*.. AGU 2015. San Francisco, CA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes
- Clark, K. (2015). *Suspended Sediment*. LCZO Meeting 2015. Luquillo, PR. Status = PUBLISHED; Acknowledgement of Federal Support = Yes
- Song,C, and Argerich,A., and Baker,C, and Bowden,W.B., and Dodds,Walter, and Farrell,K, and Flinn,M.B., (2015). *Temperature sensitivity of stream gross primary production and respiration from the tropics to the arctic. American Geophysical Union Fall Meeting. San Francisco, CA. December 2015*.. AGU 2015. San Francisco, CA. Status = PUBLISHED; Acknowledgement of Federal Support = No

- Brantley, S. (2015). *The Deep Critical Zone*. LCZO Meeting 2015. Luquillo, PR. Status = PUBLISHED; Acknowledgement of Federal Support = Yes
- Ginn,B, and Meile,C , and Tang,Y, and Thompson,Aaron, (2016). *The Effect of High Amplitude Redox Cycles on Soil Fe Reduction Rates and Mineral Composition..* Goldschmidt 2016. Yokohama, Japan. Status = PUBLISHED; Acknowledgement of Federal Support = Yes
- Torres-Delgado,E., and Valle-Diaz,C.J., (2015). *The Role of African Dust Particles on Cloud Chemistry and Microphysics in a Tropical Montane Cloud Forest in the Caribbean. Association of Geophysical Union..* AGU, Session A23C-0329. <https://agu.confex.com/agu/fm15/meetingapp.cgi/Paper/82409>. San Francisco, CA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes
- Philips C. (2014). *The coarse sediment transport filter of mountain hydrology*. LCZO Cyber Seminar April 25th, 2014. GoToMeeting. Status = PUBLISHED; Acknowledgement of Federal Support = Yes
- Buss H.L., Brantley S.L., Comas X., Hynek S., Orlando J., Moore O.W. (2015). *The deep CZ of the Luquillo CZO..* NSF Deep CZ Work Salon 2015. . Status = PUBLISHED; Acknowledgement of Federal Support = Yes
- Willenbring,Jane, and Jerolmack,Doug, (2016). *The null hypothesis: steady rates of erosion, weathering and sediment accumulation during Late Cenozoic mountain uplift and glaciation.* AGU 2015. San Francisco, CA. Status = OTHER; Acknowledgement of Federal Support = Yes
- Willenbring,Jane, and Jerolmack,Doug, (2015). *The null hypothesis: steady rates of erosion, weathering and sediment accumulation during Late Cenozoic mountain uplift and glaciation..* AGU 2015. San Francisco, CA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes
- Silver,Whendee, L and Ruan,Leilei, and O'Connell,Christine S., and Gutierrez del Arroyo,Omar, (2015). *The sensitivity of soil O2 and redox biogeochemistry to landscape position and climate.* AGU 2015. San Francisco, CA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes
- Gonzalez,Grizelle, (2016). *There's something rottin' in the state of global climate change.* <https://www.youtube.com/watch?v=ptZXbk0B7JI>. www.youtube.com. Status = PUBLISHED; Acknowledgement of Federal Support = No
- Willenbring,Jane, and Brocard,Gilles, (2016). *Tool Belts: Latitudinal-Belt Predictions for the Persistence of Landscapes..* EGU 2016. Vienna, Austria. Status = PUBLISHED; Acknowledgement of Federal Support = Yes
- Pett-Ridge,Julie, C and King,E, and Marks,J, and Trierweiler,A, (2016). *Tracing Metal Processing in Soil with Molybdenum Isotopes.* Goldschmidt Meeting, Yokohama, Japan. Yokohama, Japan. Status = PUBLISHED; Acknowledgement of Federal Support = Yes
- O'Connell,Christine S., (2016). *Tropical forests in a changing world: Investigating global change impacts in Amazonia and Puerto Rico.* UCB Weekly Seminar (Dept. of ESPM). UC Berkeley. Status = PUBLISHED; Acknowledgement of Federal Support = Yes
- O'Connell,Christine S., and Silver,Whendee, L (2016). *Tropical forests in a changing world: Investigating global change impacts in Amazonia and Puerto Rico.* LBL Climate Brown Bag Lunch Seminar. UC Berkeley. Status = PUBLISHED; Acknowledgement of Federal Support = Yes
- Clark,Kathryn, and Shanley,Jamie, and Perdrial,Julia N., and Scholl,Martha A, (2016). *Tropical river suspended sediment and solute dynamics in storms during an extreme drought.* All-CZO Annual Meeting. Luquillo, PR. Status = OTHER; Acknowledgement of Federal Support = Yes
- Comas,Xavier, and Wright,W, and Hynek,Scott, (2015). *Understanding the architecture of the deep critical zone in the Rio Icacos watershed (Luquillo Critical Zone Observatory, Puerto Rico) using a combination of hydrogeophysical methods..* AGU 2015. San Francisco, CA. Status = OTHER; Acknowledgement of Federal Support = Yes
- Torres-Delgado, E., C. J. Valle-Diaz, D. Baumgardener, W. H. McDowell, G. González, O. L. Mayol-Bracero (2015). *Understanding the effect of African dust particles on cloud chemistry and microphysics in a tropical montane cloud forest in the Caribbean.* Latin American and Caribbean Aerosol Measurements School: From measurements technologies

to applications, La Paz, Bolivia, 24 June, 2015.. La Paz, Bolivia. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Hodges, C., Thompson, A. (2015). *Using Electromagnetic Induction to Determine Spatial and Temporal Patterns of Upland Fe Reduction at the Luquillo CZO*. LCZO Meeting 2015. Luquillo, PR. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Sue Brantley (2014). *Using a CZO Network to Explore the Architecture, Dynamics and Evolution of the Critical Zone, Invited talk*. CZO Network webinar, December 8, 2014. webinar. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Comas, X. (2015). *Using hydrogeophysical methods to understand the spatial distribution of the bedrock-regolith interface in the Rio Icacos watershed*. LCZO Cyber Seminar January 16, 2015. GoToMeeting. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Koenig, Lauren, and Ruegg, Janine, and Wollheim, Wilfred, M., (2016). *Variation in ammonium uptake rates throughout a tropical watershed: Implications for scaling ecosystem processes*.. Society for Freshwater Science Annual Meeting. Sacramento, CA. May 24, 2016.. Sacramento, CA. Status = PUBLISHED; Acknowledgement of Federal Support = No

Amone, E. (2014). *Watershed Hydrologic modeling*. LCZO Annual Meeting. Luquillo, PR. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Brantley, Susan, (2015). *Weathering and Surface Processes: Major Advances in the Past 25 Years*. National Science Foundation (invited), Arlington, VA, Dec 1, 2015. Arlington, VA. Status = OTHER; Acknowledgement of Federal Support = Yes

Silver, Whendee, L and O'Connell, Christine S., and Gutierrez del Arroyo, Omar, (2016). *What drives the distribution of phosphorus across the landscape?*. INTERFACE phosphorus workshop. INTERFACE phosphorus workshop. Status = OTHER; Acknowledgement of Federal Support = Yes

O'Connell, Christine S., and Silver, Whendee, L (2016). *What lies below: Looking beneath the soil surface*. LTER Annual Mtg. Luquillo, PR. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

McDowell, William, H (2015). *What makes a CZO a CZO?*. Sino-US CZO Workshop, Guiyang, China. Oct 5-11, 2015.. Guiyang, China. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Leon, M.C., Appling A.P., W.H. McDowell, Clark K. (2015). *educing bias and quantifying uncertainty in watershed flux estimates: The R package loadflex*. CZO C-Q workshop. University of New Hampshire. Status = OTHER; Acknowledgement of Federal Support = Yes

Other Products

Other Publications

Patents

Technologies or Techniques

Thesis/Dissertations

Almaraz, Maya. *Nitrogen Availability and Loss from Managed and Unmanaged Ecosystems*. (2016). Brown University. Acknowledgement of Federal Support = Yes

Stone M.M. *Soil microbial communities and soil organic matter: composition and ecological functions in the Luquillo Critical Zone*. (2014). University of Pennsylvania. Acknowledgement of Federal Support = Yes

Miller K.L., Jerolmack D.J.. *The Causes and Consequences of Particle Size Change in Fluvial Systems*. (2015). University of Pennsylvania. Acknowledgement of Federal Support = Yes

Phillips, C.B., Jerolmack, D.J.. *The Control of Grain-Scale Mechanincs on Channel Form Landscape Dynamics, and Climatic Perturbations in Gravel-Bedded Rivers*. (2015). University of Pennsylvania. Acknowledgement of Federal Support = Yes

Joseph Orlando. *The anatomy of weathering profiles on different lithologies in the tropical forest of northeastern Puerto Rico: from bedrock to clouds*. M.S. Thesis. (2014). The Pennsylvania State University. Acknowledgement of Federal Support = Yes

Websites

LCZO Knowledge Base

https://www.sas.upenn.edu/lczodata/research_papers

A Rich archive of 430+ papers from the Luquillo Experimental Forest back to the earliest days of it's formation.

LCZO Mapping data

<http://ec2-50-19-46-248.compute-1.amazonaws.com/mappingApp/index.html>

This site presents important GIS data from several studies stored as shape or raster files.

ODM2 Admin

<https://github.com/miguelcleon/ODM2-Admin>

ODM2 Admin is a Django based administrative application for Observation Data Model 2 (ODM2). ODM2 was created through National Science Foundation Grant EAR-1224638. Support for the development of this application comes from NSF Grant EAR-1331841 Luquillo CZO. This software is open source and available to the general public.

Quebrada Sonadora Streaming data

<http://lczodata.com/ODM2/ODM2CZOData/graphfa/samplingfeature%3D3/>

This site displays stream chemistry data from the Quebrada Sonadora site that are updated daily via telemetry.

lczodata

<http://lczodata.com>

This is the LCZO implementation of ODM2 Admin. ODM2 Admin is an administrative application for Observation Data Model 2 (ODM2). ODM2 was created through National Science Foundation Grant EAR-1224638.

lczodata map

<http://lczodata.com/ODM2/ODM2CZOData/mapdata.html>

This is a map view into the LCZO ODM2 database exposing viewers to many of the locations where data are or have been sampled. The map provide direct links for viewing and downloading data.

Supporting Files

Filename	Description	Uploaded By	Uploaded On
Products Supporting File 1.pdf	Cross-CZO Workshop Agendas â?? CZ services and Cross-CZO EarthCube Microbial Ecology Workshop.	William Mcdowell	09/01/2016
Products Supporting File 2.pdf	Focal area presentations from annual LCZO meeting.	William Mcdowell	09/01/2016
Products Supporting File 3.pdf	Presentations from Virtual Site Visit.	William Mcdowell	09/01/2016
Products Supporting File 4.pdf	Highlights and figures from recent products.	William Mcdowell	09/01/2016

Participants/Organizations

What individuals have worked on the project?

Name	Most Senior Project Role	Nearest Person Month Worked
McDowell, William	PD/PI	1
Gonzalez, Grizelle	Co PD/PI	1
Plante, Alain	Co PD/PI	1
Silver, Whendee	Co PD/PI	1
Bastola, Satish	Co-Investigator	6
Brantley, Susan	Co-Investigator	1
Bras, Rafael	Co-Investigator	1
Buss, Heather	Co-Investigator	2
Comas, Xavier	Co-Investigator	1
Crowl, Todd	Co-Investigator	0
Jerolmack, Doug	Co-Investigator	1
Mayol, Olga	Co-Investigator	2
Porder, Stephen	Co-Investigator	1
Thompson, Aaron	Co-Investigator	2
Willenbring, Jane	Co-Investigator	1
Fernandez, Denny	Faculty	1
Hall, Steven	Faculty	2
Marin-Spiotta, Erika	Faculty	1
McGee, Steven	Faculty	1
Perdrial, Julia	Faculty	1
Pett-Ridge, Julie	Faculty	1
Wang, Jingfeng	Faculty	1
Arnone, Elisa	Postdoctoral (scholar, fellow or other postdoctoral position)	0
Broard, Gilles	Postdoctoral (scholar, fellow or other postdoctoral position)	0

Ducard, Giles	Postdoctoral (scholar, fellow or other postdoctoral position)	0
Chen, Chunmei	Postdoctoral (scholar, fellow or other postdoctoral position)	2
Clark, Kathryn	Postdoctoral (scholar, fellow or other postdoctoral position)	12
Hynek, Scott	Postdoctoral (scholar, fellow or other postdoctoral position)	1
Hyojin, Kim	Postdoctoral (scholar, fellow or other postdoctoral position)	3
Lin, Yang	Postdoctoral (scholar, fellow or other postdoctoral position)	2
O'Connell, Christine	Postdoctoral (scholar, fellow or other postdoctoral position)	9
Ruan, Leilei	Postdoctoral (scholar, fellow or other postdoctoral position)	0
Szabo, Timea	Postdoctoral (scholar, fellow or other postdoctoral position)	0
Van Bueusekom, Ashley	Postdoctoral (scholar, fellow or other postdoctoral position)	12
Wymore, Adam	Postdoctoral (scholar, fellow or other postdoctoral position)	3
Baez Rodriguez, Noelia	Other Professional	1
Brown, Josh	Other Professional	6
Jimenez, Rafael	Other Professional	0
Leon, Miguel	Other Professional	12
Potter, Jody	Other Professional	1
Shattuck, Michelle	Other Professional	3
Bosiak, Matt	Technician	1
Diazgranados, Jorge	Technician	1
Lopez, Carla	Technician	3
Salazar Ortiz, Monica	Technician	4

Sallady, Ryan	Technician	12
Schwaner, Geoff	Technician	0
Snyder, Lisle	Technician	1
Swan, Katherine	Technician	1
Torres, Angel	Technician	1
Gould, William	Staff Scientist (doctoral level)	0
Martinuzzi, Sebastian	Staff Scientist (doctoral level)	1
Murphy, Sheila	Staff Scientist (doctoral level)	1
Scholl, Martha	Staff Scientist (doctoral level)	2
Shanley, Jamie	Staff Scientist (doctoral level)	1
Wood, Tana	Staff Scientist (doctoral level)	1
Almaraz, Maya	Graduate Student (research assistant)	12
Barcellos, Diego	Graduate Student (research assistant)	9
Brereton, Rich	Graduate Student (research assistant)	8
Chapela Lara, Maria	Graduate Student (research assistant)	12
Coward, Elizabeth	Graduate Student (research assistant)	12
Cyle, Taylor	Graduate Student (research assistant)	0
Dialynas, Yannis	Graduate Student (research assistant)	12
Gutiérrez del Arroyo, Omar	Graduate Student (research assistant)	12
Harrison, Emma	Graduate Student (research assistant)	12
Hodges, Caitlin	Graduate Student (research assistant)	1
King, Elizabeth	Graduate Student (research assistant)	3
Koenig, Lauren	Graduate Student (research assistant)	3
Lee, Dylan	Graduate Student (research assistant)	1
Litwin-Miller, Kim	Graduate Student (research assistant)	0
McClintock, Matthew	Graduate Student (research assistant)	0

Moore, Oliver	Graduate Student (research assistant)	9
Noor, Nadia	Graduate Student (research assistant)	3
Orlando, Joe	Graduate Student (research assistant)	0
Phillips, Colin	Graduate Student (research assistant)	0
Rodriguez, Josely	Graduate Student (research assistant)	0
Santos, Gilmarie	Graduate Student (research assistant)	1
Stone, Maddie	Graduate Student (research assistant)	0
Torres, Elvis	Graduate Student (research assistant)	8
Wilmoth, Jared	Graduate Student (research assistant)	6
Bodek, Sophie	Undergraduate Student	3
Casey, James	Undergraduate Student	1
Chang, Bowen	Undergraduate Student	6
Ciaburri, John	Undergraduate Student	1
Crespo, Ashley	Undergraduate Student	0
Gondak, Geneva	Undergraduate Student	1
Kovalovitch, Aria	Undergraduate Student	3
McGrath, Casey	Undergraduate Student	1
Mroz, Christina	Undergraduate Student	1
Nunez, Mayra	Undergraduate Student	1
Pereira, Michelle	Undergraduate Student	0
Phillips, Margaret	Undergraduate Student	1
Silver, Heather	Undergraduate Student	0
Stien, Rebekah	Undergraduate Student	0
Sullivan, Conor	Undergraduate Student	0
Tamayo, Cooper	Undergraduate Student	0

Ilyou, Mary	Undergraduate Student	3
Traxler, Emily	Undergraduate Student	0
Yamamoto, Kana	Undergraduate Student	3
Zhou, Mengzhou	Undergraduate Student	0
Morales, Flavia	Consultant	3
De Jesus Roman, Alertyadir	Research Experience for Undergraduates (REU) Participant	3
Perez Rivera, Katherine	Research Experience for Undergraduates (REU) Participant	3

Full details of individuals who have worked on the project:

William H McDowell

Email: bill.mcdowell@unh.edu

Most Senior Project Role: PD/PI

Nearest Person Month Worked: 1

Contribution to the Project: Executive Committee Member, responsible for intellectual project integration and stream sensor network

Funding Support: UNH

International Collaboration: No

International Travel: No

Grizelle Gonzalez

Email: ggonzalez@fs.fed.us

Most Senior Project Role: Co PD/PI

Nearest Person Month Worked: 1

Contribution to the Project: Monitoring of climate and hydrological data, ceilometer data interpretation

Funding Support: USDA FS

International Collaboration: No

International Travel: No

Alain F Plante

Email: aplante@sas.upenn.edu

Most Senior Project Role: Co PD/PI

Nearest Person Month Worked: 1

Contribution to the Project: Oversees research in soil carbon quality and dynamics. Supervises 1 PhD student, 2 undergraduate students, and co-supervises 1 post-doc. Has established cross-CZO working group in organic matter research.

Funding Support: UPenn LCZO

International Collaboration: No

International Travel: No

Whendee Silver**Email:** wsilver@berkeley.edu**Most Senior Project Role:** Co PD/PI**Nearest Person Month Worked:** 1**Contribution to the Project:** Soil Trace Gases, Iron Redox. Oversees post-docs and graduate students.**Funding Support:** UC-Berkeley**International Collaboration:** No**International Travel:** No

Satish Bastola**Email:** Satish.bastola@ce.gatech.edu**Most Senior Project Role:** Co-Investigator**Nearest Person Month Worked:** 6**Contribution to the Project:** Hydrologic modeling; landslide modeling.**Funding Support:** Georgia Tech**International Collaboration:** No**International Travel:** No

Susan L Brantley**Email:** brantley@eesi.psu.edu**Most Senior Project Role:** Co-Investigator**Nearest Person Month Worked:** 1**Contribution to the Project:** Investigates chemical and physical processes associated with the circulation of aqueous fluids in shallow hydrogeologic settings. Supervises a Post-Doc and Masters student.**Funding Support:** Penn State**International Collaboration:** No**International Travel:** No

Rafael Bras**Email:** ribras@gatech.edu**Most Senior Project Role:** Co-Investigator**Nearest Person Month Worked:** 1**Contribution to the Project:** Hydrologic modeling; landslide modeling.**Funding Support:** Georgia Tech**International Collaboration:** No**International Travel:** No

Heather Buss**Email:** h.buss@bristol.ac.uk**Most Senior Project Role:** Co-Investigator**Nearest Person Month Worked:** 2

Contribution to the Project: Consulted on borehole drilling, analysis of borehole samples, measurement and analysis of weathering profiles through deep CZ

Funding Support: University of Bristol, LCZO

International Collaboration: Yes, United Kingdom

International Travel: No

Xavier Comas

Email: xcomas@fau.edu

Most Senior Project Role: Co-Investigator

Nearest Person Month Worked: 1

Contribution to the Project: Work on GPR, deep critical zone science.

Funding Support: Florida Atlantic University

International Collaboration: No

International Travel: No

Todd Crowl

Email: crowl@fiu.edu

Most Senior Project Role: Co-Investigator

Nearest Person Month Worked: 0

Contribution to the Project: Local coordination and facilities management.

Funding Support: FIU

International Collaboration: No

International Travel: No

Doug Jerolmack

Email: sediment@sas.upenn.edu

Most Senior Project Role: Co-Investigator

Nearest Person Month Worked: 1

Contribution to the Project: Oversees research related to sediment transport and fluvial processes. Established 3 sediment transport monitoring stations, supervises one PhD student and co-supervises one PhD student.

Funding Support: UPenn

International Collaboration: No

International Travel: No

Olga Mayol

Email: omayol@ites.upr.edu

Most Senior Project Role: Co-Investigator

Nearest Person Month Worked: 2

Contribution to the Project: Impacts of African dust on cloud chemical composition and microphysics at Pico Este. Impacts of African dust on radiation. Determination of dust concentrations

Funding Support: UPR

International Collaboration: No
International Travel: No

Stephen Porder

Email: stephen_porder@brown.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Nitrogen and Phosphorus Cycling and limitation

Funding Support: Brown

International Collaboration: No
International Travel: No

Aaron Thompson

Email: AaronT@uga.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 2

Contribution to the Project: Oversees research in soil carbon quality and dynamics. Supervises 2 PhD students.

Funding Support: UGA

International Collaboration: No
International Travel: No

Jane Willenbring

Email: erosion@sas.upenn.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Conducting and coordinating all cosmogenic dating studies in the LCZO; Large scale geomorphology. .

Funding Support: UCSD

International Collaboration: No
International Travel: No

Denny Fernandez

Email: dsfernandez@gmail.com
Most Senior Project Role: Faculty
Nearest Person Month Worked: 1

Contribution to the Project: Impacts of African dust on radiation.

Funding Support: UPR-Humacao

International Collaboration: No
International Travel: No

Steven Hall

Email: stevenjh@iastate.edu

Most Senior Project Role: Faculty
Nearest Person Month Worked: 2

Contribution to the Project: Iron redox and soil carbon dynamics

Funding Support: Iowa State University

International Collaboration: No

International Travel: No

Erika Marin-Spiotta

Email: marinspiotta@wisc.edu

Most Senior Project Role: Faculty

Nearest Person Month Worked: 1

Contribution to the Project: Mechanisms of soil organic matter stabilization Hydrologic controls on carbon & nutrient transport

Funding Support: University of Wisconsin

International Collaboration: No

International Travel: No

Steven McGee

Email: mcgee@lponline.net

Most Senior Project Role: Faculty

Nearest Person Month Worked: 1

Contribution to the Project: Responsible for K-12 curricula development

Funding Support: Northwestern University and The Learning Partnership

International Collaboration: No

International Travel: No

Julia Perdrial

Email: julia.perdrial@uvm.edu

Most Senior Project Role: Faculty

Nearest Person Month Worked: 1

Contribution to the Project: DOM (sample and data) analysis of storm Erika samples

Funding Support: University of Vermont

International Collaboration: No

International Travel: No

Julie Pett-Ridge

Email: Julie.Pett-Ridge@oregonstate.edu

Most Senior Project Role: Faculty

Nearest Person Month Worked: 1

Contribution to the Project: Chemical weathering, soil formation, and biogeochemical cycling

Funding Support: Oregon State

International Collaboration: No
International Travel: No

Jingfeng Wang

Email: jingfeng.wang@ce.gatech.edu

Most Senior Project Role: Faculty

Nearest Person Month Worked: 1

Contribution to the Project: Hydrologic modeling; landslide modeling.

Funding Support: Georgia Tech

International Collaboration: No
International Travel: No

Elisa Arnone

Email: elisa.amone@gmail.com

Most Senior Project Role: Postdoctoral (scholar, fellow or other postdoctoral position)

Nearest Person Month Worked: 0

Contribution to the Project: Hydrologic modeling; landslide modeling.

Funding Support: Government of Italy

International Collaboration: Yes, Italy
International Travel: No

Gilles Brocard

Email: gbocard@sas.upenn.edu

Most Senior Project Role: Postdoctoral (scholar, fellow or other postdoctoral position)

Nearest Person Month Worked: 0

Contribution to the Project: Conducting cosmogenic dating studies in the LCZO and operating the UPenn cosmogenic lab.

Funding Support: grant

International Collaboration: No
International Travel: No

Chunmei Chen

Email: cmchen@uga.edu

Most Senior Project Role: Postdoctoral (scholar, fellow or other postdoctoral position)

Nearest Person Month Worked: 2

Contribution to the Project: Iron Redox

Funding Support: UGA

International Collaboration: No
International Travel: No

Kathryn Clark

Email: kathryn.clark@ouce.ox.ac.uk

Most Senior Project Role: Postdoctoral (scholar, fellow or other postdoctoral position)

Nearest Person Month Worked: 12

Contribution to the Project: Synthesis postdoc working on dynamics and properties of fine sediment transport in LCZO streams.

Funding Support: UPenn LCZO

International Collaboration: No

International Travel: No

Scott Hynek

Email: scott.hynek@gmail.com

Most Senior Project Role: Postdoctoral (scholar, fellow or other postdoctoral position)

Nearest Person Month Worked: 1

Contribution to the Project: Post-doc working on geochronology, geochemical tracers, and isotope geochemistry to understand processes and pathways in modern environments.

Funding Support: Penn State

International Collaboration: No

International Travel: No

Kim Hyojin

Email: hxk31@psu.edu

Most Senior Project Role: Postdoctoral (scholar, fellow or other postdoctoral position)

Nearest Person Month Worked: 3

Contribution to the Project: Post-doc working on geochronology, geochemical tracers, and isotope geochemistry to understand processes and pathways in modern environments.

Funding Support: Penn State

International Collaboration: No

International Travel: No

Yang Lin

Email: yanglin@berkeley.edu

Most Senior Project Role: Postdoctoral (scholar, fellow or other postdoctoral position)

Nearest Person Month Worked: 2

Contribution to the Project: Iron Redox

Funding Support: UC-Berkeley

International Collaboration: No

International Travel: No

Christine Sierra O'Connell

Email: coconn@berkeley.edu

Most Senior Project Role: Postdoctoral (scholar, fellow or other postdoctoral position)

Nearest Person Month Worked: 9

Contribution to the Project: Redox and greenhouse gas controls

Funding Support: UC-Berkeley

International Collaboration: No

International Travel: No

Leilei Ruan

Email: ruanleil@msu.edu

Most Senior Project Role: Postdoctoral (scholar, fellow or other postdoctoral position)

Nearest Person Month Worked: 0

Contribution to the Project: Iron Redox

Funding Support: UC-Berkeley

International Collaboration: No

International Travel: No

Timea Szabo

Email: tszabo.hu@gmail.com

Most Senior Project Role: Postdoctoral (scholar, fellow or other postdoctoral position)

Nearest Person Month Worked: 0

Contribution to the Project: Field and theoretical investigations of pebble abrasion

Funding Support: Hungarian Gov.

International Collaboration: Yes, Hungary

International Travel: No

Ashley Van Bueusekom

Email: ashley.vanbueusekom@gmail.com

Most Senior Project Role: Postdoctoral (scholar, fellow or other postdoctoral position)

Nearest Person Month Worked: 12

Contribution to the Project: responsible for work on cloud ceiling and its effects on forest ecosystems.

Funding Support: USDA FS

International Collaboration: Yes, United Kingdom

International Travel: No

Adam Wymore

Email: Adam.Wymore@unh.edu

Most Senior Project Role: Postdoctoral (scholar, fellow or other postdoctoral position)

Nearest Person Month Worked: 3

Contribution to the Project: Stream Solutes

Funding Support: None

International Collaboration: No

International Travel: No

Noelia Baez Rodriguez

Email: nbaez@ites.upr.edu

Most Senior Project Role: Other Professional
Nearest Person Month Worked: 1

Contribution to the Project: Data Jam organizer

Funding Support: Luquillo LTER

International Collaboration: No

International Travel: No

Josh Brown

Email: luquillo.czo@mail.com

Most Senior Project Role: Other Professional

Nearest Person Month Worked: 6

Contribution to the Project: Assists all LCZO personnel in field work and sample processing in Puerto Rico.

Funding Support: None

International Collaboration: No

International Travel: No

Rafael Jimenez

Email: ajz@sas.upenn.edu

Most Senior Project Role: Other Professional

Nearest Person Month Worked: 0

Contribution to the Project: Conducting research on decadal-scale changes in cloud base.

Funding Support: UPenn

International Collaboration: No

International Travel: No

Miguel Leon

Email: leonmi@sas.upenn.edu

Most Senior Project Role: Other Professional

Nearest Person Month Worked: 12

Contribution to the Project: data manager, responsible for expanding datasets online, working with other CZO managers to ensure comparability of datasets, communications, field work scheduling, and work on data products

Funding Support: None

International Collaboration: No

International Travel: No

Jody Potter

Email: jody.potter@unh.edu

Most Senior Project Role: Other Professional

Nearest Person Month Worked: 1

Contribution to the Project: lab manager, responsible for training UNH graduate students in laboratory analyses, and providing ongoing QA/QC of all analytical work for which UNH has responsibility

Funding Support: UNH

International Collaboration: No
International Travel: No

Michelle Shattuck

Email: michelle.shattuck@unh.edu
Most Senior Project Role: Other Professional
Nearest Person Month Worked: 3

Contribution to the Project: assists with grant and sub-contract management including reporting

Funding Support: UNH

International Collaboration: No
International Travel: No

Matt Bosiak

Email: mwz28@wildcats.unh.edu
Most Senior Project Role: Technician
Nearest Person Month Worked: 1

Contribution to the Project: Technician in the UNH Water Quality Analysis Laboratory where stream and groundwater samples are analyzed

Funding Support: UNH WQAL

International Collaboration: No
International Travel: No

Jorge Diazgranados

Email: jorge.diazgranados@upr.edu
Most Senior Project Role: Technician
Nearest Person Month Worked: 1

Contribution to the Project: Impacts of African dust on cloud chemical composition and microphysics at Pico Este. Impacts of African dust on radiation. Determination of dust concentrations

Funding Support: UPR-RP

International Collaboration: No
International Travel: No

Carla Lopez

Email: carla.lpez09@gmail.com
Most Senior Project Role: Technician
Nearest Person Month Worked: 3

Contribution to the Project: Technician responsible for conducting nutrient addition experiments in streams and assisting with other LCZO field and lab work, recently graduated from UPR

Funding Support: UNH

International Collaboration: No
International Travel: No

Monica Salazar Ortiz**Email:** monica.salazar@upr.edu**Most Senior Project Role:** Technician**Nearest Person Month Worked:** 4**Contribution to the Project:** Field Technician**Funding Support:** LCZO**International Collaboration:** No**International Travel:** No

Ryan Sallady**Email:** rsalladay@berkeley.edu**Most Senior Project Role:** Technician**Nearest Person Month Worked:** 12**Contribution to the Project:** Instrument installation**Funding Support:** UC-Berkeley**International Collaboration:** No**International Travel:** No

Geoff Schwaner**Email:** gwj4@wildcats.unh.edu**Most Senior Project Role:** Technician**Nearest Person Month Worked:** 0**Contribution to the Project:** Responsible for field sampling in Puerto Rico in support of all CZO projects**Funding Support:** None**International Collaboration:** No**International Travel:** No

Lisle Snyder**Email:** Lisle.Snyder@unh.edu**Most Senior Project Role:** Technician**Nearest Person Month Worked:** 1**Contribution to the Project:** Assists with aquatic sensor deployment and maintenance; assists with analyses at the UNH Water Quality Analysis Laboratory where stream and groundwater samples are analyzed**Funding Support:** UNH, NSF**International Collaboration:** No**International Travel:** No

Katherine Swan**Email:** Katherine.Swan@unh.edu**Most Senior Project Role:** Technician**Nearest Person Month Worked:** 1**Contribution to the Project:** Technician in the UNH Water Quality Analysis Laboratory where stream and groundwater samples are analyzed

Funding Support: UNH WQAL

International Collaboration: No

International Travel: No

Angel Torres

Email: ajtorres@usgs.gov

Most Senior Project Role: Technician

Nearest Person Month Worked: 1

Contribution to the Project: Field Technician, collects samples.

Funding Support: USGS

International Collaboration: No

International Travel: No

William Gould

Email: wgould@fs.fed.us

Most Senior Project Role: Staff Scientist (doctoral level)

Nearest Person Month Worked: 0

Contribution to the Project: Planning, data collection, analyses, presentation, and publication of results

Funding Support: USDA FS

International Collaboration: No

International Travel: No

Sebastian Martinuzzi

Email: seabamartinuzzi@gmail.com

Most Senior Project Role: Staff Scientist (doctoral level)

Nearest Person Month Worked: 1

Contribution to the Project: LiDAR analyses and interpretation

Funding Support: University of Wisconsin

International Collaboration: No

International Travel: No

Sheila Murphy

Email: sfmurphy@usgs.gov

Most Senior Project Role: Staff Scientist (doctoral level)

Nearest Person Month Worked: 1

Contribution to the Project: USGS Collaborator on rivers.

Funding Support: USGS

International Collaboration: No

International Travel: No

Martha Scholl

Email: mascholl@usgs.gov

Most Senior Project Role: Staff Scientist (doctoral level)

Nearest Person Month Worked: 2

Contribution to the Project: Isotope Hydrology

Funding Support: USGS

International Collaboration: No

International Travel: No

Jamie Shanley

Email: jshanley@usgs.gov

Most Senior Project Role: Staff Scientist (doctoral level)

Nearest Person Month Worked: 1

Contribution to the Project: Mercury and Carbon Biogeochemistry

Funding Support: USGS

International Collaboration: No

International Travel: No

Tana Wood

Email: wood.tana@gmail.com

Most Senior Project Role: Staff Scientist (doctoral level)

Nearest Person Month Worked: 1

Contribution to the Project: Warming experiment

Funding Support: USDA FS

International Collaboration: No

International Travel: No

Maya Almaraz

Email: maya_almaraz@brown.edu

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 12

Contribution to the Project: Nitrogen Cycling

Funding Support: Brown

International Collaboration: No

International Travel: No

Diego Barcellos

Email: diego.barcellos@yahoo.com.br

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 9

Contribution to the Project: Conducting research on iron redox processes in LCZO soils.

Funding Support: UGA

International Collaboration: No
International Travel: No

Rich Brereton

Email: rich.brereton@unh.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 8

Contribution to the Project: work describing how riparian flow paths affect stream chemistry

Funding Support: UNH

International Collaboration: No
International Travel: No

Maria Chapela Lara

Email: m.chapelalara@bristol.ac.uk
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 12

Contribution to the Project: Mg isotope analysis, analysis of decoupling of surface and deep nutrient cycles

Funding Support: CONACYT (Mexico) PhD Scholarship

International Collaboration: Yes, United Kingdom
International Travel: No

Elizabeth Coward

Email: ecoward@sas.upenn.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 12

Contribution to the Project: Conducting research on iron-organic matter interactions in LCZO soils.

Funding Support: UPenn Ben Franklin Grad Fellowship

International Collaboration: No
International Travel: No

Taylor Cyle

Email: unkown@notsure.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 0

Contribution to the Project: dissolved organic carbon measurements. Worked to optimize the methodology for the unique extract matrices.

Funding Support: UC- Berkeley

International Collaboration: No
International Travel: No

Yannis Dialynas

Email: ydialynas@gatech.edu

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 12

Contribution to the Project: Hydrologic modeling; landslide modeling.

Funding Support: Georgia Tech, 2006T95, 2006V31

International Collaboration: No

International Travel: No

Omar Gutiérrez del Arroyo

Email: omar.gutierrezdela@gmail.com

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 12

Contribution to the Project: Soil carbon and nutrient cycling controls (i.e., depth, climate)

Funding Support: UC-Berkeley

International Collaboration: No

International Travel: No

Emma Harrison

Email: haem@sas.upenn.edu

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 12

Contribution to the Project: Conducting cosmogenic dating studies in the LCZO and operating the cosmogenic lab.

Funding Support: UCSD

International Collaboration: No

International Travel: No

Caitlin Hodges

Email: chodges@uga.edu

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 1

Contribution to the Project: conducting field-level assessments of iron reduction potential.

Funding Support: University of Georgia

International Collaboration: No

International Travel: No

Elizabeth King

Email: eking@coas.oregonstate.edu

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 3

Contribution to the Project: Chemical weathering, soil formation, and biogeochemical cycling

Funding Support: Oregon State, SAVI

International Collaboration: No
International Travel: No

Lauren Koenig

Email: Lauren.Koenig@unh.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 3

Contribution to the Project: Stream Solutes

Funding Support: NSF Fellowship

International Collaboration: No
International Travel: No

Dylan Lee

Email: dylanlee@sas.upenn.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 1

Contribution to the Project: Developing smart rocks for bedload transport analysis

Funding Support: UPenn

International Collaboration: No
International Travel: No

Kim Litwin-Miller

Email: klitwin@sas.upenn.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 0

Contribution to the Project: Conducting research on sediment transport in the LCZO.

Funding Support: UPenn

International Collaboration: No
International Travel: No

Matthew McClintock

Email: mmclintock316@gmail.com
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 0

Contribution to the Project: Chemical weathering, soil formation, and biogeochemical cycling

Funding Support: Oregon State

International Collaboration: No
International Travel: No

Oliver Moore

Email: oliver.moore@bristol.ac.uk
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 9

Contribution to the Project: Analysis of deep CZ weathering: reactive transport modelling, traditional and synchrotron spectroscopies

Funding Support: NERC (UK) PhD Fellowship

International Collaboration: Yes, United Kingdom

International Travel: No

Nadia Noor

Email: nadia.noor25@uga.edu

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 3

Contribution to the Project: Conducting research on iron redox processes in LCZO soils.

Funding Support: UGA

International Collaboration: No

International Travel: No

Joe Orlando

Email: jjo167@psu.edu

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 0

Contribution to the Project: Research on deep CZO geochronology, tracers.

Funding Support: Penn State

International Collaboration: No

International Travel: No

Colin Phillips

Email: colinp@sas.upenn.edu

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 0

Contribution to the Project: Conducting research on sediment transport and exports of Luquillo streams.

Funding Support: UPenn

International Collaboration: No

International Travel: No

Josely Rodriguez

Email: josely_rodriguez313@hotmail.com

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 0

Contribution to the Project: African Dust Inputs

Funding Support: PRLSAMP fellowship

International Collaboration: No

International Travel: No

Gilmarie Santos**Email:** gilmarie17@hotmail.com**Most Senior Project Role:** Graduate Student (research assistant)**Nearest Person Month Worked:** 1**Contribution to the Project:** Sampling and determination of dust concentrations**Funding Support:** UPR**International Collaboration:** No**International Travel:** No**Maddie Stone****Email:** mmstone83@gmail.com**Most Senior Project Role:** Graduate Student (research assistant)**Nearest Person Month Worked:** 0**Contribution to the Project:** Conducting research on microbial ecology and organic matter characterization in LCZO soils.**Funding Support:** NSF-GRF**International Collaboration:** No**International Travel:** No**Elvis Torres****Email:** elvis.torres810@gmail.com**Most Senior Project Role:** Graduate Student (research assistant)**Nearest Person Month Worked:** 8**Contribution to the Project:** Impacts of African dust on cloud chemical composition and microphysics at Pico Este. Impacts of African dust on radiation. Determination of dust concentrations**Funding Support:** UPR**International Collaboration:** No**International Travel:** No**Jared Wilmoth****Email:** jared.wilmoth@gmail.com**Most Senior Project Role:** Graduate Student (research assistant)**Nearest Person Month Worked:** 6**Contribution to the Project:** Conducting research on iron redox processes in LCZO soils. PhD student Jared Wilmoth completed his dissertation and secured a postdoc at Oak Ridge National Lab.**Funding Support:** UGA**International Collaboration:** No**International Travel:** No**Sophie Bodek****Email:** sobodek@sas.upenn.edu**Most Senior Project Role:** Undergraduate Student**Nearest Person Month Worked:** 3

Contribution to the Project: Conducting research on sediment transport and exports of Luquillo streams.

Funding Support: UPenn-PURM Fellowship

International Collaboration: No

International Travel: No

James Casey

Email: jdf74@wildcats.unh.edu

Most Senior Project Role: Undergraduate Student

Nearest Person Month Worked: 1

Contribution to the Project: Assists with analyses at the UNH Water Quality Analysis Laboratory where stream and groundwater samples are analyzed

Funding Support: UNH WQAL

International Collaboration: No

International Travel: No

Bowen Chang

Email: bchang@sas.upenn.edu

Most Senior Project Role: Undergraduate Student

Nearest Person Month Worked: 6

Contribution to the Project: Assisting PhD student on nutrients and topography participated in fieldwork with Willenbring

Funding Support: PURM fellowship

International Collaboration: No

International Travel: No

John Ciaburri

Email: jvk29@wildcats.unh.edu

Most Senior Project Role: Undergraduate Student

Nearest Person Month Worked: 1

Contribution to the Project: Assists with analyses at the UNH Water Quality Analysis Laboratory where stream and groundwater samples are analyzed

Funding Support: UNH WQAL

International Collaboration: No

International Travel: No

Ashley Crespo

Email: acrespo@sas.upenn.edu

Most Senior Project Role: Undergraduate Student

Nearest Person Month Worked: 0

Contribution to the Project: Assisting with laboratory experiments on organic matter characterization in LCZO soils.

Funding Support: None

International Collaboration: No

International Travel: No

Geneva Gondak**Email:** ggondak@sas.upenn.edu**Most Senior Project Role:** Undergraduate Student**Nearest Person Month Worked:** 1**Contribution to the Project:** Undergrad research assistant for geomorph group**Funding Support:** UPenn LCZO**International Collaboration:** No**International Travel:** No

Aria Kovalovitch**Email:** ariakov@sas.penn.edu**Most Senior Project Role:** Undergraduate Student**Nearest Person Month Worked:** 3**Contribution to the Project:** Assisting PhD student usign experiments on wormholes and soils and participated in fieldwork with Willenbring**Funding Support:** PURM fellowship**International Collaboration:** No**International Travel:** No

Casey McGrath**Email:** crm12@wildcats.unh.edu**Most Senior Project Role:** Undergraduate Student**Nearest Person Month Worked:** 1**Contribution to the Project:** Assists with analyses at the UNH Water Quality Analysis Laboratory where stream and groundwater samples are analyzed**Funding Support:** UNH WQAL**International Collaboration:** No**International Travel:** No

Christina Mroz**Email:** notknown@unh.edu**Most Senior Project Role:** Undergraduate Student**Nearest Person Month Worked:** 1**Contribution to the Project:** Assists with analyses at the UNH Water Quality Analysis Laboratory where stream and groundwater samples are analyzed**Funding Support:** UNH WQAL**International Collaboration:** No**International Travel:** No

Mayra Nunez**Email:** mnunez@sas.upenn.edu

Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 1

Contribution to the Project: Assisting with laboratory experiments on organic matter characterization in LCZO soils.

Funding Support: UPenn LCZO

International Collaboration: No

International Travel: No

Michelle Pereira

Email: pereiram@sas.upenn.edu

Most Senior Project Role: Undergraduate Student

Nearest Person Month Worked: 0

Contribution to the Project: Assisting with laboratory experiments on fine sediment characterization in LCZO streams.

Funding Support: UPenn

International Collaboration: No

International Travel: No

Margaret Phillips

Email: mp1060@wildcats.unh.edu

Most Senior Project Role: Undergraduate Student

Nearest Person Month Worked: 1

Contribution to the Project: Assists with analyses at the UNH Water Quality Analysis Laboratory where stream and groundwater samples are analyzed

Funding Support: UNH WQAL

International Collaboration: No

International Travel: No

Heather Silver

Email: silverh@sas.upenn.edu

Most Senior Project Role: Undergraduate Student

Nearest Person Month Worked: 0

Contribution to the Project: Assisting with laboratory experiments on organic matter characterization in LCZO soils.

Funding Support: UPenn

International Collaboration: No

International Travel: No

Rebekah Stien

Email: unknown@notsure.com

Most Senior Project Role: Undergraduate Student

Nearest Person Month Worked: 0

Contribution to the Project: Nitrogen Cycling

Funding Support: Brown

International Collaboration: No
International Travel: No

Conor Sullivan

Email: unknown2@notsure.com
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 0

Contribution to the Project: Nitrogen and Phosphorus limitation

Funding Support: Brown

International Collaboration: No
International Travel: No

Cooper Tamayo

Email: unknown3@notsure.com3
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 0

Contribution to the Project: nutrient cycling

Funding Support: Brown

International Collaboration: No
International Travel: No

Mary Tilyou

Email: mtilyou@sas.upenn.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 3

Contribution to the Project: Assisting with laboratory experiments on organic matter characterization in LCZO soils.

Funding Support: UPenn Velay Fellowship

International Collaboration: No
International Travel: No

Emily Traxler

Email: etraxler@purdue.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 0

Contribution to the Project: Assisting with laboratory experiments on organic matter characterization in LCZO soils.

Funding Support: None

International Collaboration: No
International Travel: No

Kana Yamamoto

Email: kyamamoto95@berkeley.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 3

Contribution to the Project: Redox and litter decomposition

Funding Support: UC-Berkeley

International Collaboration: No

International Travel: No

Mengzhou Zhou

Email: mengzhou@sas.upenn.edu

Most Senior Project Role: Undergraduate Student

Nearest Person Month Worked: 0

Contribution to the Project: Assist in development of web based mapping system.

Funding Support: None

International Collaboration: No

International Travel: No

Flavia Morales

Email: fmorales.upr@gmail.com

Most Senior Project Role: Consultant

Nearest Person Month Worked: 3

Contribution to the Project: Determination of dust concentrations

Funding Support: UNH

International Collaboration: No

International Travel: No

Albertyadir De Jesus Roman

Email: albertyadir@yahoo.com

Most Senior Project Role: Research Experience for Undergraduates (REU) Participant

Nearest Person Month Worked: 3

Contribution to the Project: REU student from UPR conducting nutrient addition experiments in streams

Funding Support: UNH

International Collaboration: No

International Travel: No

Year of schooling completed: Junior

Home Institution: University of Puerto Rico

Government fiscal year(s) was this REU participant supported: 2016

Katherine Perez Rivera

Email: kathxpr.027@live.com

Most Senior Project Role: Research Experience for Undergraduates (REU) Participant

Nearest Person Month Worked: 3

Contribution to the Project: REU student from UPR conducting nutrient addition experiments in streams

Funding Support: UNH

International Collaboration: No
International Travel: No
Year of schooling completed: Junior
Home Institution: University of Puerto Rico
Government fiscal year(s) was this REU participant supported: 2016

What other organizations have been involved as partners?

Name	Type of Partner Organization	Location
Budapest University of Technology and Economics	Academic Institution	Budapest, Hungary
Columbia University	Academic Institution	New York, NY
Hebrew University of Jerusalem, Israel	Academic Institution	Jerusalem, Israel
Oregon State University	Academic Institution	Corvallis, OR
University of Miami	Academic Institution	Miami, Florida
University of Puerto Rico at Mayagüez	Academic Institution	Mayagüez, Puerto Rico
University of Puerto Rico – Humacao	Academic Institution	Humacao, Puerto Rico
University of Wollongong	Academic Institution	Wollongong, Australia
Università degli Studi di Palermo	Academic Institution	Palermo (PA), Italy

Full details of organizations that have been involved as partners:

Budapest University of Technology and Economics

Organization Type: Academic Institution
Organization Location: Budapest, Hungary

Partner's Contribution to the Project:

In-Kind Support
 Facilities
 Collaborative Research
 Personnel Exchanges

More Detail on Partner and Contribution: Collaborator Domokos serves as mentor and external advisor to LCZO PhD student Litwin, and Domokos' PhD student has performed research at LCZO.

Columbia University

Organization Type: Academic Institution
Organization Location: New York, NY

Partner's Contribution to the Project:

In-Kind Support
 Collaborative Research

More Detail on Partner and Contribution: Maria Uriarte from Columbia University has a postdoc who just started (May 2015) and is interested in working with the CZO LiDAR data. Their interests are primarily in quantifying vegetation structure (e.g., biomass, LAI) and examining underlying drivers (e.g., topography, elevation, etc). LiDAR-derived vegetation metrics will be used for models.

Hebrew University of Jerusalem, Israel

Organization Type: Academic Institution

Organization Location: Jerusalem, Israel

Partner's Contribution to the Project:

Facilities

More Detail on Partner and Contribution: Dr. Alon Angert, Hebrew University of Jerusalem, Israel, is an expert on phosphorus in dust and he and his group are collaborating with H4.3 to identify airborne sources of phosphorus using stable isotopes of dust aerosol samples.

Oregon State University

Organization Type: Academic Institution

Organization Location: Corvallis, OR

Partner's Contribution to the Project:

Collaborative Research

More Detail on Partner and Contribution:

University of Miami

Organization Type: Academic Institution

Organization Location: Miami, Florida

Partner's Contribution to the Project:

Facilities

Collaborative Research

More Detail on Partner and Contribution: Dr. Prospero's group from the University of Miami is collaborating with H4.3 for the determination of the dust concentrations.

University of Puerto Rico at Mayagüez

Organization Type: Academic Institution

Organization Location: Mayagüez, Puerto Rico

Partner's Contribution to the Project:

Collaborative Research

Other: Led part of the annual meeting field trip to introduce meeting participants to the caves.

More Detail on Partner and Contribution:

University of Puerto Rico – Humacao

Organization Type: Academic Institution

Organization Location: Humacao, Puerto Rico

Partner's Contribution to the Project:

Collaborative Research

More Detail on Partner and Contribution: Dr. Denny Fernandez, from the University of Puerto Rico – Humacao is collaborating with H4.3 on the impact of African dust on radiation at Pico del Este.

University of Wollongong

Organization Type: Academic Institution

Organization Location: Wollongong, Australia

Partner's Contribution to the Project:

Collaborative Research

More Detail on Partner and Contribution:**Università degli Studi di Palermo**

Organization Type: Academic Institution

Organization Location: Palermo (PA), Italy

Partner's Contribution to the Project:

Collaborative Research

Personnel Exchanges

More Detail on Partner and Contribution:**What other collaborators or contacts have been involved?****Focal Area 1**

- Raymond Fletcher (Penn State) - geophysical models.
- Dimitrios Ntarlagiannis (Rutgers University) - ERI and IP.
- Chris Duffy (SSHCZO) - VC residence time model.
- Julie Pett-Ridge (Oregon) on REEs.
- Anthony Dosseto (Wollongong, Australia) - U-series dating of weathering rinds.
- Kate Maher (Stanford) - reactive transport modelling.

Focal Area 2

- Dr. Jennifer Pett-Ridge at LLNL - redox fluctuation experiments.
- Dr. Tsutomu Ohno at University of Maine - soil Fe-C extracts
- Dr. Malak Tfaly at PNNL - soil Fe-C extracts
- Dr. Jay Regier at the Canadian Light Source in Saskatoon - extracted organic matter.
- Dr. Melanie Mayes from the Department of Energy - soil sensor array.
- Dr. Steven Hall from Iowa State University - Fe-C interaction.
- Dr. Karin Block – City College of New York - mineralogy and geochemistry of sediments.
- Dr. Jeffery Bird - Queens College CUNY - belowground C, N and S cycling.

Focal Area 3

- USGS Webb project - Stallard, Murphy
- Marty Risch (USGS) - atmospheric Hg
- Julia Perdrial and Nicolas Perdrial from the University of Vermont - suspended mineralogy.
- Kelly Kibler from Central Florida University - hydropower diversions

- Mark Noll and 2 graduate students from SUNY College at Brockport - stream PO4 and soil processes
- Brent Newman from DOE - pore water chemistry.
- Rich Norby from DOE- litterfall and pore water chemistry.
- Dr. Sarah Feakins from the University of Southern California - plant wax to link vegetation, soils and water. She is considering hosting an undergraduate field course in Puerto Rico.

Focal Area 4

Dr. Leonardo V. Noto, from Università degli Studi di Palermo

Education and Outreach

- Dr. Adam Wymore (UNH)
- Dr. Tim White (Pennsylvania State University)
- Dr. Ashlee Dere (University of Nebraska, Omaha)
- Dr. Adam Hoffman (University of Dubuque)
- Dr. James Washburne (University of Arizona)
- Dr. Martha Conklin (University of California, Merced)

Impacts

What is the impact on the development of the principal discipline(s) of the project?

Focal Area 1

- Geophysical methods show:
 - the importance of combining direct methods (such as drilling) with indirect methods (such as GPR) to understand the architecture of the CZ in tropical systems;
 - the interplay of the surficial stress regime, lithology and climate in dictating the architecture of weathering.
- Our work is providing a basis for understanding the importance of the deep CZ to surface processes and issues, including hydrologic and nutrient fluxes and soil fertility and security.
- Work in the CZO has informed the development of a weathering model in a paper under preparation by M. Lebedeva and S. Brantley.

Focal Area 2

The emphasis on Fe-C interactions and the role that short-range order, amorphous minerals play in stabilizing soil carbon at several CZO sites resulted in a discussion with a larger international group of scientists interested in these process. The outcome has been the convening of a two-year synthesis project funded by the USGS Powell Center for Analysis and Synthesis. The group is populated by scientists working on Luquillo (Plante), Calhoun (Thompson), Catalina-Jimez (Rasmussen) and Sierra (Berhe).

Focal Area 3

- Developed a new tool for determining abrasion rate from pebble shape, and deployed it on Earth and Mars.
- Demonstrated that not only is river channel geometry insensitive to climate, but that self-organization of the river creates a universal distribution of fluid forces for all coarse-grained rivers.
- Produced large datasets of river channel geometry, hydrology, and pebble tracer transport that are being used by other researchers.
- Preliminary findings that particle abrasion is the result of plastic chipping rather than brittle fracture may change the dominant model for bedrock incision.

Focal Area 4

Characterization of hydrologic feedbacks to hot spots and hot moments in landslide occurrence and sediment transport, and feedbacks to soil organic carbon dynamics are the most important points of this work. Process based models, as developed and implemented in this project, are advantageous over empirical approaches as they represent underlying physical laws of soil dynamics and hydrologic processes in data scarce spatially complex built terrains. The analysis spans a range of scales, capturing the small scale complexity of sediment transport in assessing the watershed integrated response in terms of soil organic carbon fluxes.

The distributed hydro-geomorphic model used in this project resolves important physical processes in both space and time, at scales relevant to landslide occurrence and to the dynamics of soil organic carbon. With increasing availability of high resolution topography, geological and biogeochemical datasets, the models developed in this work are able to reproduce spatiotemporal distributions of sediment transport and of soil organic carbon content at different soil profiles. The coupled spatially-explicit formulations can be used in landslide studies and landslide warning systems, in addition to assessments of effects of road infrastructure to slope stability. The distributed model discussed above is also the integrator of carbon dynamics and nutrient cycling at watershed scale. The fate of eroded soil organic carbon and the rate of carbon deposition at the floodplains of Mameyes and Icacos rivers are simulated.

Focal Area 4 scales up hot spots and hot moments in time and space using climate and hydrologic modeling, and identifies the role of key atmospheric inputs in clouds and rain.

What is the impact on other disciplines?

- We have shown that climatic variability has little influence on channel form or erosion, an important finding for linking climate to landscape change.
- Continued work on shape evolution of pebbles links Earth and planetary science, using new concepts from applied mathematics.
- The work delineating chipping and fragmentation shows how concepts from materials science and solid mechanics can be employed to understand geomorphological problems.
- Progress on collision-induced entrainment across the intermittent to continuous sediment transport regime uses ideas and tools from granular physics to make progress in sediment transport.

What is the impact on the development of human resources?

There were 15 undergraduate students, 20 graduate students and 8 post-doctoral researchers involved in the LCZO in year 3 (please refer to the participants section for more detailed information). Students and post-doctoral researchers receive one-to-one and group mentoring by LCZO PIs and other senior personnel. See also the opportunities for training and professional development in the accomplishments section.

Because the project includes collaborators at the national and international levels, it provides opportunities for graduate and undergraduate students to interact with collaborators/researchers from different institutions, background training, and field of expertise. These interactions create foundations for better scientific critical analyses and communication that are the basis for research, education, and networking for all people involved.

Focal Area 1

- At FAU, about 20-25 undergraduate students learn about CZO processes through unique geophysical datasets that combine several techniques. Similarly, about 10-15 FAU graduate students per year learn geophysical processing techniques using datasets collected at the Luquillo CZO. Furthermore, one graduate student at FAU will be initiating his Master's thesis based in CZO science.
- At Bristol, there will be about 20 undergraduates per year that now know about the CZO networks, the concept of CZ science, and issues, questions and processes involved in the CZ.
- Maria Chapela Lara has completed her PhD at Bristol and now identifies as a CZ Scientist in her home country of Mexico.

Focal Area 2

Several graduate and undergraduate students, as well as a post-doctoral researcher participate in focal area 2 research and contribute to publications. Refer to the opportunities for training and professional development section for more information.

Focal Area 3

Jerolmack has advised 2 PhD students, 2 postdocs and 1 undergrad on work related to LCZO in the past year. Willenbring has advised 2 postdocs, 1 PhD student and 1 undergraduate. They have engaged in interdisciplinary research and have developed an extended network of Earth scientists that simply would not have been possible without LCZO support. These young researchers have also presented research in small, productive workshops and large international conferences, some of which have led to postdoc opportunities.

Post-doc Adam Wymore at University of New Hampshire (UNH) is taking a leading role in inter-site activities and is developing a collaborative research program with the Slavkov Forest CZO, Czech Republic. Post-doctoral researcher Adam Wymore attended the CZO Workshop “Biogeochemistry across the CZ Network”, September 28/29 at UC Riverside. The focus was on biogeochemically related review papers and/or proposals. He also attended the CZ Workshop in Guiyang, China from October 5-11. About 20 US scientists traveled to Guiyang, China to attend a week-long workshop focused on international Cross-CZO proposals and projects.

UNH graduate student Koenig is developing field, lab, and modeling approaches to understanding stream nitrogen dynamics and gas evasion. UNH graduate student Richard Brereton is developing field and laboratory techniques to quantify riparian zone influence on solute delivery to streams. Under-represented minority Katie Swan received her Bachelor of Science degree in 2015 and works as a technician at the University of New Hampshire. Ms. Swan and technician Lisle Snyder receive guidance and training from laboratory manager Jody Potter. Josh Brown received his Bachelor of Science degree in 2006 and served as a field technician on this project. Both Dr. McDowell and Jody Potter have provided guidance and training to Josh. Carla Lopez recently received her Bachelor of Science Degree from the University of Puerto Rico – Río Piedras and served as a technician on this project. Ms. Lopez was responsible for conducting nutrient addition experiments in streams and assisting with other LCZO field and lab work. Undergraduates Albert De Jesus (University of Puerto Rico – Río Piedras) and Katherine Perez Rivera (University of Puerto Rico – Río Piedras) served as REUs during the summer of 2016 and were trained on nutrient analysis of water samples at the University of New Hampshire Water Quality Analysis Laboratory (UNH WQAL). These two REUs were responsible for independently conducting nutrient addition experiments in streams and analyzing the samples collected. Five undergraduates assisted with analysis of LCZO stream and groundwater samples at the UNH WQAL (Casey McGrath, Christina Mroz, James Casey, John Ciaburri and Margaret Phillips).

Focal Area 4

- Project has contributed significantly to the development of modeling skills and expertise of personal involved (Elisa Amone, Satish Bastola, and Yannis Dialynas). It has familiarized the personnel involved in the project with new and improved datasets, modeling framework and their utility in studying critical zone processes.
- At the Annual Luquillo CZO meeting in Puerto Rico (June 2016), Ph.D. Student Yannis Dialynas interacted with Luquillo CZO scientists and presented his doctorate research work on the development of a spatially-explicit model of soil organic carbon dynamics. He received detailed feedback from scientists of different fields (e.g., hydrologists, geologists, biogeochemists, and ecosystems ecologists) on his work, which significantly helped improve the quality of his effort.
 - The project has supported a doctoral student, still working on thesis. A postdoctoral student, a research engineer and a visiting professor have also participated and learned new modeling approaches.
 - PhD student Maoya Bassiouni was the lead author on one 2015 AGU presentation (Bassiouni and Scholl) and co-authored another (Scholl et al).

Education and Outreach

Please refer to the Accomplishments Supporting File 2 for a more detailed description of the impact on the development of human resources through the development of the InTegrate curriculum (E&O 1), conducting Data Jam teacher workshops (E&O 3) and data jams at the CZO-LTER Schoolyard Program Symposium (E&O 2).

What is the impact on physical resources that form infrastructure?

- Soil sensor networks and stream sensor networks have been established through a collaboration with CZO, DOE, and the Stream PULSE Macrosystems Biology project.
- Collaboration with USGS-Sacramento sensor group has resulted in new guidelines for successful application of in-stream optical sensors in a harsh environment (high flow, high sediment load).
- Jerolmack's laboratory has developed two new experimental setups for the study of abrasion due to collision or fragmentation during bed load, supported by LCZO.

What is the impact on institutional resources that form infrastructure?

CZO activity has provided cross-training opportunities to strengthen skill sets among USGS and USFS staff engaged in supporting activities (stream gaging, landslide mapping, water quality sampling, etc.) on site.

The CZO instrument purchase at the University of Pennsylvania has enabled other CZOs to measure fallout radionuclide measurements. Among the CZO supported institutions, UPenn is the only institution with this capability.

Please refer to the Accomplishments Supporting File 2 for a more detailed description of the impact on institutional resources that form infrastructure that have occurred through development of the InTegrate curriculum (E&O 1), conducting Data Jam teacher workshops (E&O 3) and data jams at the CZO-LTER Schoolyard Program Symposium (E&O 2).

What is the impact on information resources that form infrastructure?

We have been developing a new data management platform named 'ODM2 Admin' based on CUAHSI ODM2, this is being developed with an open source software stack and is freely available on github at <https://github.com/miguelcleon/ODM2-Admin>. This software is now presented in a functional state and serves as the primary database for CZO produced time series and soil geochemistry data. Miguel Leon the Luquillo CZO Data Manager has demonstrated this software for a number of groups including the CZO Data Managers, the CZO National Office, BigCZ, CUAHSI, and at a recent Cross-CZO EarthCube Microbial Ecology Workshop (see Products Supporting File 1 for agenda). This cross-CZO effort has decided to implement their own copy of ODM2 Admin as their meta-data management tool for their sampling effort. This should lead to more consistent, more well described meta-data for this effort. Discussions between the LCZO and several other CZOs indicate the possibility that they may also implement ODM2-Admin for from of their data management needs, these discussions are ongoing.

ODM2 Admin includes a number of tools for mapping sampling locations (<http://lczodata.com/ODM2/ODM2CZOData/mapdata.html>), plotting time series based on those sampling locations and downloading and displaying data from networked sets of sensors (<http://lczodata.com/ODM2/ODM2CZOData/graphfa/samplingfeature%3D3/>). This is done via automated download. Graphing of soils data with various depth intervals is also handled (<http://lczodata.com/ODM2/ODM2CZOData/profilegraph/selectedrelatedfeature%3D673/popup%3Dtrue/>) and we have created a tool for generating scatter plots of soils geochemistry data (<http://lczodata.com/ODM2/ODM2CZOData/soilscatterplot.html>).

All data generated have been organized and deposited on the LCZO website, with associated meta-data to make it discoverable and searchable by researchers. Currently this organization is being supplemented by visualization tools from ODM2 Admin as described above. We are also inputting chemical data into CZChem.db. We are inputting soil samples into SESAR, System for Earth Sample Registration, generating IGSN numbers for soil samples and printing barcodes as well as QR codes for soil samples. IGSNs are associated with sampling features in ODM2 Admin and displayed in the system for easy cross reference. Labeling samples with QR codes so anyone can scan a label with a smart phone and bring up information about the sample over the web from SESAR. This has both made the samples discoverable over the web and made storage of samples easier to maintain.

What is the impact on technology transfer?

The new modeling framework from FA4.1 is now being utilized in other universities and is available, so far, free of cost.

What is the impact on society beyond science and technology?

Understanding sediment fluxes over time is a critical component of identifying and ultimately mitigating anthropogenic impacts on landscapes. In Puerto Rico, the impacts of fine sediment are particularly important for coral reef community health.

Landsliding is the source of extraordinary infrastructure damage, land degradation and loss of lives. Carbon capture and release is a key component of the climate equation. The tools developed here can be used for planning, prediction and prevention and to develop management practices to control landslides and increase carbon capture.

Aerosol data generated through this project will help inform the general public about the influence of African dust on Puerto Rico. This is very important since Puerto Rico in the summer months receives huge amounts of African dust that produce a significant impact on air quality (degradation of visibility and health problems particularly in elderly, children, and people with respiratory conditions).

Changes/Problems

Changes in approach and reason for change

There were two unanticipated collaborations that were stimulated by the LCZO:

- A PhenoCam was established (in year 2) at the El Verde site through LCZO collaboration. Recent images can be viewed at: <http://phenocam.sr.unh.edu/data/latest/elverde.jpg>
- Data Manager Miguel Leon will serve as an ODM2 collaborating consultant for Tana Wood's USFS/DOE warming experiment: "Tropical Responses to Altered Climate Experiment (TRACE)". TRACE is funded by U.S. Department of Energy, Office of Science, Office of Biological and Environmental Research, Terrestrial Ecosystem Sciences Program, Award Number DE-SC-0011806. As part of this collaboration, a new data management web application based on CUAHSI's ODM2 (EAR-1224638) data model continues to be under development with their input. This application continues to be in development by the LCZO and TRACE receives regular updates and consultations.

One notable unexpected challenge is the recent active transmission of the Zika Virus in Puerto Rico. As of August 31, 2016, there were 13,791 locally acquired cases of the Zika virus. Women who are pregnant or planning to become pregnant, as well as men who plan to father a child or who's partner is pregnant, are advised not to travel to Puerto Rico. This has prevented a few of the LCZO participants from traveling to Puerto Rico. However, due to successful cross-training, other LCZO participants have been able to facilitate on-site field research for those who cannot travel to Puerto Rico. LCZO participants who could not travel to Puerto Rico for the annual meeting participated via GoToMeeting instead.

Focal Area 1

N/A

Focal Area 2

Critical Zone Science Workshop on Iron and Carbon cycling has been postponed until year 4.

Focal Area 3

A LCZO mini-proposal by Kathryn Clark was funded to support a LCZO writing workshop "River geochemical evaluation of a 'Hot moment' during storm activity in the Luquillo Critical Zone Observatory" in January 2016. Travel costs were paid from the UNH budget.

LCZO mini-proposal by Willenbring et al. was funded to support the LCZO-LTER-USFS collaboration to use the Rio Blanco knickpoints to test the influence of nutrient limitation on canopy height and forest composition (\$9,800 from UNH budget; \$2,800 travel and \$7,000 for 10Be analysis).

Development of the impact sensing smart rocks (H3.2) has been suspended. We have encountered technical challenges that have made it unlikely that the current design would be capable of acquiring the necessary data to test our hypotheses. We have also learned of progress by a group in Scotland, and are currently in discussion with them to see if their technology can be transferred. However, unexpected progress in our understanding of abrasion shows us that we can estimate collision energy associated with bed load transport by using pebble shape alone. The smart rocks were intended to be used to assess in-stream collision energy at high resolution. While using pebble shape clearly does not provide that same resolution, it is a first-order estimate that is still useful and is adequate for satisfying our original research goals.

Focal Area 4

N/A

Education and Outreach

N/A

Actual or Anticipated problems or delays and actions or plans to resolve them

Nothing to report.

Changes that have a significant impact on expenditures

Nothing to report.

Significant changes in use or care of human subjects

Nothing to report.

Significant changes in use or care of vertebrate animals

Nothing to report.

Significant changes in use or care of biohazards

Nothing to report.