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## Preview of Award 1331906 - Annual Project Report

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### Cover

Federal Agency and Organization Element to Which Report is Submitted:	4900
Federal Grant or Other Identifying Number Assigned by Agency:	1331906
Project Title:	Critical Zone Observatory for Intensively Managed Landscapes (IML-CZO)
PD/PI Name:	Praveen Kumar, Principal Investigator Alison M Anders, Co-Principal Investigator Elmer Bettis III, Co-Principal Investigator Timothy Filley, Co-Principal Investigator Thanos Papanicolaou, Co-Principal Investigator
Recipient Organization:	University of Illinois at Urbana-Champaign
Project/Grant Period:	12/01/2013 - 09/30/2019
Reporting Period:	12/01/2017 - 11/30/2018
Submitting Official (if other than PD\PI):	Praveen Kumar Principal Investigator
Submission Date:	12/15/2018
Signature of Submitting Official (signature shall be submitted in accordance with agency specific instructions)	Praveen Kumar

### Accomplishments

#### \* What are the major goals of the project?

The central hypothesis of Critical Zone Observatory for Intensively Managed Landscapes (IML-CZO) is that, through human modification, the critical zone of IMLs has passed a tipping point (or threshold) and has gradually shifted from being a *transformer* of material flux with high nutrient, water, and sediment storage to being a *transporter* of material flux with low nutrient, water and sediment storage. We expect that the *understanding of IMLs as systems in disequilibrium whose components are co-evolving under strong human, geological, and climatic drivers and which act as non-linear filters for material transformation and transport* will provide new insights to guide practices and policies for sustaining CZ services in the

Anthropocene. The IML-CZO effort, distributed across two primary sites (Upper Sangamon River Basin (USRB) (~3700 sq. km.) in Illinois and Clear Creek Watershed [CCW] (~270 sq. km.) in Iowa and a partner site Minnesota River Basin [MRB] (~44,000 sq. km) [funded independently through a NSF WSC Grant] is divided into multiple themes to cover a broad range of issues. The present report is organized per these themes and primarily reports on the effort and outcomes from the primary sites (results for the Minnesota River Basin effort is available through the project completion report associated with the WSC project [NSF Grant # CBET 1209402]).

### **Theme A: Geologic Timescale Processes-Glacial Legacy to Future Climate Change**

Theme A's major goal is to better understand how the glacial and prehistoric legacy recorded in the landscape and deposits of IMLs influence present processes and the trajectory of CZ evolution. Toward this end, four primary research foci are encompassed by this theme: 1) formulation of criteria for and mapping of fundamental landscape units (To identify the landscape distribution of fundamental critical zone processes and groups of processes); 2) assessment of the record of anthropogenic landscape disturbance recorded in post settlement alluvial deposits (PSA) (To understand the processes and impacts of post-settlement sediment accumulation on floodplains in agricultural landscapes); and 3) documenting the physical, chemical, and hydrologic characteristics of the weathering profile. Characterize the physical and chemical properties of the soils in the upper 6-25 meters under standard agriculture and restored prairie land uses at CCW and a satellite site at Glacier Creek in Omaha Nebraska. Pore water and stream water samples are used to document ongoing chemical weathering reactions at these sites. Bulk geochemistry of weathering profiles is determined at sites in Clear creek watershed, Upper Sangamon, and satellite sites in eastern Nebraska and central Iowa.

### **Theme B: Short- and Long-Term Dynamics of Soil Organic Matter**

Theme B's major goal is to examine how intensive cultivation has altered soil organic matter fluxes, residence time, and storage using key state variables under the forcings of regional climate and local anthropogenic activity. The key questions in this theme are: What is the dynamic relation between active and stabilized forms of SOM in IMLs and how does that relationship vary in activity centers and activity intervals? What are their effects on biotic and abiotic activities as they relate to SOM storage?

### **Theme C: Coupled Surface Water – Groundwater Hydrology and Biogeochemistry**

The major goal of Theme C is to quantify how intensive management of landscapes affects residence times & aggregate fluxes of water, carbon, nutrient, and sediment at scales ranging from flowpaths to catchments? Four key research questions have been articulated to achieve this goal: (1) How does the coupled interaction of surface water and groundwater control fluxes of water and solutes within the critical zone and their residence times in different elements of the landscape (e.g., vadose zone, stream, aquifer)? (2) How do the signatures of key materials that are exported (e.g., SOM and DOC) relate to those stored in the landscape? (3) How anthropogenic impacts have altered these fluxes, stores, residence times? and (4) How do different materials move through the system, and what are the timescales relevant for their transformation processes?

Intensive land use via agriculture leads to a well-documented loss of organic carbon from the critical zone. Whether this is a net source of carbon to the atmosphere or a sink is controversial because of the lack of landscape-scale constraints. Arguments have been made by others that downstream trapping of eroded soils and their C may act as a sink that counterbalances the loss. Most studies on this topic have focused on the landscape itself and have not considered waterways and downstream sediment traps at the same time. The major goal of this project for the Blair lab is evaluate the sources, fates and fluxes of carbon from intensively managed landscapes and into adjacent traps in an effort to determine to what extent the IML-CZ acts as a net C-source or sink. A major focus has been placed on transport during storm events in Clear Creek as they transport the majority of eroded C. The damming of rivers has created hotspots for organic carbon sequestration and methane production on a global scale as the reservoirs intercept fluvial suspended and dissolved loads. To better understand how the C-biogeochemistry of a reservoir responds to watershed processes and evolves over time, Lake Decatur, located in the Sangamon watershed of the IML-CZO was studied in terms of its sedimentary record by the Blair lab.

### **Theme D: Water, Soil, Sediment and Landscape Connectivity: Short- and Long-Term Budgets**

Theme D's major goal is to determine fluxes of water and sediment at different spatial (hillslope, stream, watershed) and temporal (annual, seasonal, event-based) scales within intensively managed landscapes, to establish sediment budgets at the watershed scale, and to determine the role of human and natural factors in water and sediment fluxes. Key question: How

are the sources, fluxes, and sinks of sediment in IMLs distributed in space and time? How do geomorphic, biogeochemical, hydrologic, and human processes interact with sediment production, transfer, and storage rates?

### **Theme E: Integrated Modeling and Critical Zone Services**

The major goal of this theme is to lead the development of an integrated modeling system that (1) exploits high resolution data such as those obtained from LiDAR and hyperspectral technologies; (2) represents micro-topographic variability in landscapes, roughness, vegetation and biogeochemical attributes; and (3) characterizes critical zone services in IMLs.

### **Theme F: Cyberinfrastructure and Services: Creation of an interactive web-portal for storage, retrieval, visualization and analysis of data produced by IML-CZO (measurements and simulations).**

Details below.

### **Theme G: Education/Outreach & Dissemination Plan: building a stakeholder network for dissemination of IML-CZO research through targeted education and outreach activities.**

Details below

### **Theme H: External Research Partnerships: actively engage IML-CZO in similar large-scale national projects and broadening its international dimensions.**

Details below.

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

Major Activities:

**Theme A:** Completed 3 years of pore and well water chemical and water level observations at localities in Clear Creek Watershed and eastern nebraska under row crop and restored prairie. Completed five years of water level and nutrient content observations of shallow wells, tile lines and stream water in Clear Creek Watershed. Cores have been collected and analyzed. Water samples have been collected from April-November for two years. Numerical modeling of landscape evolution as a function of different surface water routing scenarios. Conceptual and numerical model development for the role of groundwater in post-glacial landscape evolution. Conceptual model development for critical zone evolution through glacial-interglacial cycles in the IML-CZO

**Theme B:** To achieve this goal, soil samples in the top 10-cm were collected from representative locations throughout the Clear Creek Watershed (CCW) and Upper Sangamon River Basin (USRB). The soil samples collected as part of the baseline campaign and ER experiments and were analyzed for total SOM using Visible Near Infrared Spectroscopy (VNIR). The spectra provided from the VNIR scans were used to construct a statistical model for rapid determination of SOC. SOC concentration was determined by using partial least square regression (PLSR) modelling to extract the SOC signatures from the spectrum properties of soil, which were obtained from the visible near infrared spectroscopy. These SOC values were compared to the carbon and nitrogen content determined using the elemental C/N analyzer.

**Theme C:** Major activity included sampling precipitation, surface runoff, tile drain effluent, groundwater, vadose zone water, and stream water during storm events in the Sangamon and Clear Creek basins. Stream water samples have been collected pre-, during- and post- storm event to evaluate how biogeochemical signatures vary in the Clear Creek and Upper Sangamon watersheds. Organic and inorganic C, sediment mineralogy and concentration, and dissolved metals (Sr, Ca) and Sr isotopes (87/86) have been monitored. Samples were collected in the field. Chemical analyses was done in the laboratory. Calibration of Agro-IBIS and THMB models across the Mississippi River Basin. These models simulate coupled water, energy, carbon, and nutrient dynamics at the landscape-scale. These are being developed for the CCW site and

more broadly the Iowa River Basin and Mississippi River Basin. The key advantage of this framework is to link small-scale process dynamics to resultant landscape-scale outcomes. Additionally, these models enable our team to directly assess human land management decisions (e.g., fertilizer application rates, timing) and land use as controls on critical zone services and outcomes. Application of machine learning techniques to predict in-stream nitrogen as a function of climate and stream discharge at scales ranging from 1st to 5th order basins (CCW to Iowa River Basin). Preliminary results will be presented at 2018 GSA meeting. We are applying neural networks and leveraging high temporal resolution funding. Challenging the concept of bank-full discharge in low gradient floodplains. Monitoring network deployed to measure the frequency and magnitude of floodplain channel activation. Modeling using HEC-RAS to focus on surface connectivity (manuscript in review) and preliminary COMSOL Multiphysics model at the feature scale.

A network of autosamplers have been in operation in Clear Creek for this project to collect suspended sediments during storm events. Particulate organic C (POC) and N (PN), their stable isotopes ( $^{13}\text{C}/^{12}\text{C}$ ,  $^{15}\text{N}/^{14}\text{N}$ ), as well as infrared spectrograms have been measured on the sediments for six storm events. These analyses are now complete and the data synthesis nearly so. Prior analyses in the Lake Decatur project included solid phase analyses (% organic C, C/N,  $^{13}\text{C}/^{12}\text{C}$ ,  $^{15}\text{N}/^{14}\text{N}$ ) of soils and sediments sampled from stream bank exposures, river suspensions, and the lake bottom. In this last year, new measurements include biomarker analyses (lipids, lignin, carbohydrates), low density plant debris, solid phase carbonate identification, quantification and isotopic analyses, and analysis of high resolution visual wavelength images of sediment cores.

**Theme D:** The major activities comprised the combined use of state-of-the-art rainfall simulators and instantaneous digital surface-profile laser scanner, as well as data processing with geostatistical analysis. The study enhanced the well-established WEPP upland erosion model by incorporating space/time-variant resistance effects for landscape attributes such as grains, isolated roughness elements, and vegetation. The enhanced model was validated with field experiments, some of which were performed in Zone 1 of the Clear Creek Watershed. These experiments measured runoff rates and overland flow velocities under simulated rainfall. The validated model was then used to perform numerical experiments to meet the study objectives. A range of storm events, hillslope gradients and landscape attributes representative of the U.S. Midwest were simulated and their effects on the runoff hydrograph and stream power examined.

Theme E: See attached document on Modeling

#### Specific Objectives:

#### **Theme B: Perform VNIR and other in-situ measurements for total SOM**

Measure total SOC using Visible Near Infra-Red Spectroscopy (VNIR) in CCW and USB surface soil samples.

#### **Theme C: Biogeochemical reaction and transport -mechanisms and scales**

The objective of the Clear Creek project was to deconvolve sediment and POC storm pulses as they move through the watershed in an effort to understand the anatomy of a storm response. This is important for improving our predictive capability concerning how landscapes may respond to more intense storms in the future. The objective of the Lake Decatur project was to decipher t

#### **Theme D: Quantify erosion rates, travel times, and lag coefficients for Clear Creek through rainfall simulator experiments**

The specific objectives of the study were (1) to examine changes in microroughness under rain splash impact for smooth bare soil surface conditions that represent worst case scenarios of land use in intensively managed landscapes; (2) to evaluate the implications of the space/time-invariant resistance assumption adopted in most overland flow models on flow routing; (3) to examine the degree of influence of landscape attributes in IMLs on runoff hydrograph characteristics, and; (4) to identify the critical storm magnitude and hillslope gradient at which the net resistance effects of a surface roughness type on runoff hydrograph characteristics become negligible.

### **Theme E: Modeling**

See attached document

### **Theme J: Maintain common measurement sites and data/ sample collection**

The design aspects of the IML-CZO for storm event and continuous measurements with the corresponding observations and available datasets includes measurements to quantify the compositions and fluxes of energy, water, solutes, and sediment that are common across all CZOs. Reference measurements from surface soil and deep core extractions, geophysical surveys, LiDAR, and hyperspectral data are also available. Finally event-based measurements unique to IML-CZO including water table fluctuations, enrichment ratios, and roughness, as well as bank erosion, hysteresis, sediment sources, and lake/ floodplain sedimentation have been collected. These measurements support testing of system shifts from transformer to transporter in IML-CZO due to the interplay between management and weather/ climate. Data collected since 2014 are online through a data repository and geodashboard interface, which can be used for process-based model simulations.

### **Significant Results:**

#### **Theme A:**

#### **Define and map fundamental landscape units**

Constructed two conceptual models of how landuse and landscape position affect surface recharge, groundwater/stream water interaction and how these processes affect the loss of nutrients from the landscape.

#### **Post-settlement alluvium analysis using stream bank surveys, coring, fly ash screening, and radionuclide dating**

Determined the age structure of postsettlement alluvium in Clear Creek and Upper Sangamon watersheds. Related the age structure of the postsettlement alluvium to landuse changes withing the agricultural period in Clear Creek watershed.

#### **Investigate physical/geochemical characteristics of the upper two weathering profiles**

Land use change within the last 50 years results in significant differences in the physical structure (porosity, bulk density) in agricultural versus restored prairie settings in Iowa and Nebraska. Porewater and stream water chemistry shows significant differences in weathering reactions in restored prairies vs. agricultural sites. Modern weathering profile is significantly less weathered than that associated with the last Interglacial.

#### **Model Quaternary landscape development of the IML-CZO**

Rates of channel network expansion implied by pre-settlement landscapes require water from closed depressions to be routed to external drainage networks via overland flow or groundwater flow across surface water divides. Critical zone structure reflects the glacial history and changing physical, chemical and biological processes acting as climate changes.

**Theme B:****Perform VNIR and other in-situ measurements for total SOM**

In both watersheds, lower SOC was found in the fields with steep slopes and high soil erosion, and higher SOC was in the fields with flatter slopes or depressions and low soil erosion. The spatial distribution of SOC within the hillslope plots depends on slope position and surface morphology by following a significant SOC order of depressions > lower slopes > upper slopes > ridges, which is attributed to the transfer of SOC from the erosional area to the depositional area, as well as the protection from decomposition of buried carbon in the depositional area. Belonging to intensively managed landscapes, land management and topography have interacted effects on SOC accumulation. The combined management regime of converting from corn-soybean rotation to continuous corn and reducing tillage intensity, especially for sloping landscape, will attenuate soil erosion and SOC. After aggregating the SOC data based on the watershed categories, we found that SOC in CCW showed normal distribution with lower mean values, which is attributed to the high landscape connectivity favored rapid C export and diffusion processes on the landscape. In contrast, upland-depression characterized landscape fragmentation induced large C reservoirs and low C transport (diffusion/ advection) results in the bimodal carbon distribution with high mean values in the landscape level of USRB.

**Theme C:****Biogeochemical reaction and transport -mechanisms and scales**

In-channel algal production supported by nutrient run-off, surface soils from row crop fields, banks and tile drains were identified as sources of POC in Clear Creek. Algal C was most obvious prior to storm events. A source hypothesized to be surface-derived was activated during peak precipitation in October after fall harvest when fields are bare. Tile drains, a previously unreported source of particulate C and N, may be important to budgets at base flow. Concentration and stable isotopic relationships with discharge reveal that the headwater region acts in a net erosional mode whereas the lower reach may be exchanging material between the channel and adjoining environments. Upland C-isotopic signatures are partially overwritten as a consequence. POC sequestered downstream in depositional environments is not the same material lost from upstream slopes. Even so, there may be little net change in POC quantity between source and sink. Biomarker analyses of Lake Decatur samples indicate a period of eutrophication post-1960's that corresponds with heavy industrial fertilizer use. A biomarker for cellulose discovered during this project provided indications of episodic events, possibly large floods. Low density plant debris quantities were surprisingly low and are likely an indication of extensive sediment reworking during its transport to the deposition sites. Much of the debris seemed to be charcoal. Solid phase carbonate was discovered in the lake bed and it was identified as calcite and to have a freshwater diagenetic origin. Some, if not most of it, appears to have formed in the lakebed. This may represent a previously unrecognized C-sink. Analyses of high-resolution photographic images of cores have indicated a high frequency signal (days?) superimposed over what may be a decadal signal. The origins are unknown.

**Theme D:****Quantify erosion rates, travel times, and lag coefficients for Clear Creek through rainfall**

Our findings suggest that there is a consistent increase in microroughness with rainfall for microroughness scales on the order of 2 mm, a consistent decrease in microroughness for scales greater than 5 mm, as reported in the literature, while a mixed behavior is observed for intermediate scales. The increase in microroughness and the described conditional behavior of the interaction between rainfall and

roughness are consistent for all the examined indices and are formally recognized and investigated for the first time in our study. We acknowledge that an incorporation of the dynamic nature of roughness in erosion models is necessary. The results highlighted weaknesses of the space/time-invariant flow resistance assumption and demonstrated that assumptions on landscape terrain characteristics exert a strong control both on the shape and magnitude of hydrographs, with deviations reaching 65% in the peak runoff when space/time-variant resistance effects are ignored in some cases. It was also found that the net effects of land use change from vegetation to a bare surface resulted in hydrograph peaks that were up to 133% larger. Changes in hillslope profile curvature instead resulted in peak runoff rate changes that were only up to 16%. Critical storm magnitudes and hillslope gradients were found beyond which the effects of the landscape attributes on the peak stream power were negligible.

Theme E:

See attached document

Key outcomes or Other achievements: During the last annual report we had provided a detailed narrative of several findings from our CZO effort. Below we list four key synthetic outcomes that cut across several individual findings.

1. The CZ of depositional environment consists of parent material that is not locally produced but transported from far distances through glacial-interglacial cycles which drive fundamental shifts in the composition and functioning of CZ processes. [Anders et al. 2018, doi: 10.3389/feart.2018.00024].
2. Anthropogenic energy inputs associated with intensive management have created imbalances between increased rates of biogeochemical processes related to agriculture production and background rates of natural processes. These imbalances have cascaded through the deep inter-dependencies between carbon, soil, water, nutrient and ecological processes, resulting in a critical transition of the critical zone from a transformer to transport dominated system. [ Kumar et al. 2018, doi: 10.1016/j.ancene.2018.04.002]
3. Changes in near surface transport and transformation processes have significantly accelerated the mobilization of sediment, carbon, and nutrients resulting in restructuring of landscape heterogeneity at depth, and change in distribution of their storage and storage capacity. Event scale dynamics, micro-topographic variability, and dynamic connectivity play a dominant role in overall dynamical response of the system. [Papanicolaou et al. 2015, doi: 10.1002/2015JG003078]
4. Information flow is a fundamental attribute of dynamical interaction between inter-dependent variables driven by causality and feedback. Quantification of information flow reveals complex patterns of dependencies and dynamical connectivity that shape ecosystem response under stress [Goodwell et al., 2018, doi: 10.1073/pnas.1800236115]

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

The attached Table provides details of graduate and undergraduate students engaged along with postdocs and visiting professionals. The following table provides a summery for the current year while the attached Table provides details over the past five years.

Participant Category	Number	Gender		Disciplinary Background
		Male	Female	
Total participants	79	34	45	Other (11), Civil and Environmental Engineering (8), Earth and Planetary Sciences (1), Biology (1), Geology (12), Geography (2), Earth and Environmental Science (6)

External participants	5	1	4	Other (5)
Undergrad students	20	8	12	Civil and Environmental Engineering (2), Earth and Planetary Sciences (1), Biology (1), Other (4), Geology (8), Geography (2), Earth and Environmental Science (2)
Postdoctoral	2	2	0	Other (1), Earth and Environmental Science (1)
Graduate students	47	21	26	Civil and Environmental Engineering (25), Geology (3), Earth and Environmental Science (5), other (16)
Main Personnel	5	2	3	Civil and Environmental Engineering (2), Geology (2), Other (1)

Some details are provided below:

### Theme A:

#### *Define and map fundamental landscape units*

Trained one MS student, four undergraduate students (one foreign, UK) and two technicians

#### *Post-settlement alluvium analysis using stream bank surveys, coring, fly ash screening, and radionuclide dating*

One MS thesis, trained three undergraduates and two technicians.

#### *Investigate physical/geochemical characteristics of the upper two weathering profiles*

Undergraduate students are involved with site maintenance, sample collection and analysis at both sites. High school teachers have participated in sampling and analysis during the summers and their high school students design and conduct their own research in the fall. One MS thesis, two technicians trained.

#### *Model Quaternary landscape development of the IML-CZO*

PhD student Jingtao Lai completed his first paper working on flow routing and post-glacial channel network growth. MS student Cecilia Cullen is working toward her degree modeling groundwater contributions to landscape evolution

### Theme B:

#### *Perform VNIR and other in-situ measurements for total SOM*

Under the guidance of IML-CZO Co-Director Thanos Papanicolaou, there were three Ph.D. students and a Masters student who were involved in the field collection, sample processing, data analysis, and modeling components of Theme B. These include Ben Abban, Christos Giannopoulos and Shengnan Zhou at UTK. These students are mentored through frequent discussions (both organized and impromptu individual/group meetings) with Prof. Papanicolaou and other IML-CZO investigators. The students are encouraged to participate in the scientific discussions of Theme B between the Papanicolaou team and the team of co-theme leader Tim Filley (Purdue), as well as the broader IML-CZO science seminars.

### Theme C:

#### *Telescoping hydrological monitoring*

The project has supported one post-doctoral researcher, two PhD students, and two masters students at Indiana University.

#### *Biogeochemical reaction and transport -mechanisms and scales*

Over the lifetime of this project, many students, including undergraduates, have participated. This last year, a new Ph.D. student and three undergraduates, assisted. In the process, they learned both fundamental and state-of-the art stream analysis methods. One of the undergraduates, John Hayes, has graduated and started a job as the laboratory manager in a



new biogeochemical facility at another university. He is responsible for setting up the facility for many of the same measurements.

#### **Theme D:**

*Quantify erosion rates, travel times, and lag coefficients for Clear Creek through rainfall simulator experiments*

Working with IML-CZO Co-Director Thanos Papanicolaou, there were two Ph.D. students who were involved in the field collection, sample processing, data analysis, and modeling components of Theme D. These include Ben Abban and Christos Giannopoulos at the University of Tennessee – Knoxville. These students are supported through frequent discussions with their advisors and other project investigators and through regular project meetings.

#### **Theme E:**

Modeling work is presently pursued by 7 PhD students in Prof. Kumar's group. Two students graduated last year and held postdoc positions for 6 months and 1 year respectively.

#### **Theme F:**

*Services, workflows for data distribution and sharing*

We work closely with Hydrology Undergraduate and Graduate students on their data. Students are given guidance on proper data management; including storage, backups, organization, formatting and effective strategies for long-term viability of the data they collect.

#### **Theme G:**

*Local CZO education-outreach activities*

Through the Iowa Flood Center, we have begun working on Professional Development opportunities for in-service teachers, getting resources and lesson plans created that are aligned with the new Iowa Science Standards (based off of the NGSS).

#### **Theme H:**

*Broadening research engagement*

An undergraduate received in-depth training and experience with making FTIR measurements, their interpretation and manipulation.

#### **Theme J:**

*Set-up common measurement sampling locations*

Training of Masters student on field data collection.

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

##### **Local CZO education-outreach activities**

- We created a 7 lesson unit, taught in 90-minute block scheduling to 9th grade students at Clear Creek Amana School District. Overall, we had DIRECT instruction with a class of 28 students. However, this teacher retaught the materials to an additional 4 sections of his students. Plus, he also collaborated with another teacher who had three more sections. Overall, his class would add an additional 104 students (not all classes were the same size) and his colleague added another 53 students.

- Moreover, A weather station has been installed through CZO project in Fowler Farm (40.151018, -88.333556) in March 2017 as a Junior Observatory for Middle and High School students. The goal was to create an opportunity for the students to use the station as a lab and bring in a number of interesting angles to their experience while also serving as a research instrument. This year, in Astronomy, all of the 8th grade students at Edison School in Urbana (~240) used the data logger information to track 5 levels of soil temperature, solar radiation, and air temperature relating this to the tilt of the earth and

time of year. Also, students were able to see how solar radiation fluctuates greatly through the day and changes total amounts during different seasons. About 40 students from Urbana High School were introduced to the weather station in tour groups.

- The Extension program in UIUC holds an annual webinar for Certified Crop Advisors (CCA) to receive credits in Soil and Water Management. In February 2017, IML-CZO hosted the annual webinar and two speakers from IML-CZO presented:

- How extreme weather controls nutrient exports from the agricultural Midwest to the Gulf, and what we can do about it by Dr. Adam Ward and Laura Keefer
- Where does eroded soil come from and where does it go? Implications for soil and stream management by Dr. Thanos Papanicolaou and Dr. Bruce Rhoads
- 120 CCA's state wide attended the webinar.

- IML-CZO also engaged with the Extension Program to convert these webinars to two online courses

(<https://web.extension.illinois.edu/cca/>)

- [https://web.extension.illinois.edu/cca/articulate/Eroded\\_art/story\\_html5.html](https://web.extension.illinois.edu/cca/articulate/Eroded_art/story_html5.html)
- [https://web.extension.illinois.edu/cca/articulate/extreme\\_weather\\_controls\\_art/story\\_html5.html](https://web.extension.illinois.edu/cca/articulate/extreme_weather_controls_art/story_html5.html)

**Further A number of journal articles have been published and several conference presentation made. A summary is provided below:**

<b>Products</b>	
Journals	43
Book Chapters	1
Books	0
Thesis / Dissertation	15 PhD, 19 MS completed (Cummulative) 19 PhD 2 MS in progress
Other Conference Presentations/Papers	45
Other Publications	0
Technologies and Techniques	0
Patents	0
Inventions	0
Licenses	0
Websites	1
Other Products	0
<b>Education &amp; Outreach Activities</b>	
Presentations (public, academic)	3
STEM education/ outreach class and field activities/K-12	280 + 120 Certified Crop Advisors
Social Media	MostlyTwitter

Partnerships	3
International outreach	2

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

Please see attached document.

**Supporting Files**

Filename	Description	Uploaded By	Uploaded On
ModelingSummary.pdf	Summary of Theme E: Modeling Activities and Results	Praveen Kumar	11/28/2018
IMLCZO ParticipantList.pdf	List of graduate and undergraduate students and postdocs who have directly or indirectly contributed to IMLCZO.	Praveen Kumar	11/28/2018
Iowa-STEM-Documents-Combined.pdf	Illustrative educational material used in K-12 STEM engagement effort.	Praveen Kumar	11/29/2018
Plans-Year6.pdf	Plans for Year 6 and Budget status	Praveen Kumar	11/29/2018

## Products

### Books

### Book Chapters

### Inventions

### Journals or Juried Conference Papers

1. James Myers, Margaret Hedstrom, Dharma Akmon, Sandy Payette, Beth A Plale, Inna Kouper, Scott McCaulay, Robert McDonald, Isuru Suriarachchi, Aravindh Varadharaju, Praveen Kumar, Mostafa Elag, Jong Lee, Rob Kooper, Luigi Marini (2015). Towards Sustainable Curation and Preservation: The SEAD Project's Data Services Approach. *Proceedings of the 2015 IEEE 11th International Conference on eScience*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1109/eScience.2015.56

Abban, B.K.B., A.N. Papanicolaou, C.P. Giannopoulos, D.C. Dermisis, K.M. Wacha, C.G. Wilson, and M. Elhakeem (2017). Quantifying the changes of soil surface microroughness due to rainfall-induced erosion on a smooth surface. *Nonlinear Processes in Geophysics*. 24 (3), . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.5194/npg-24-569-2017

Amey Pathak, Subimal Ghosh, J. Alejandro Martinez, Francina Dominguez and Praveen Kumar (2017). Role of Oceanic and Land Moisture Sources and Transport in the Seasonal and Inter-annual variability of Summer Monsoon in India. *Journal of Climate*. 30 (5), . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1175/JCLI-D-16-0156.1

Amey Pathak, Subimal Ghosh, Praveen Kumar, and Raghu Murtugudde (2017). Role of Oceanic and Terrestrial Atmospheric Moisture Sources in Intraseasonal Variability of Indian Summer Monsoon Rainfall. *Nature Scientific Reports* 7. 7 (1), . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1038/s41598-017-13115-7

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Giannopoulos, C.P., B.K.B. Abban, A. N. Papanicolaou, D.C. Dermisis, K.M. Wacha, C.G. Wilson, and M. Elhakeem (2017). *Quantifying the evolution of soil surface roughness as a function of rainfall intensity*. 26th Tennessee Water Resources Symposium. Burns, TN. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

DERE, Ashlee Laura Denton<sup>1</sup>, MILLER, Andrew<sup>2</sup>, PARCHER, Sara<sup>1</sup>, JACKSON, Christopher<sup>2</sup> and BETTIS III, E. Arthur<sup>3</sup> (2018). *SOIL AND STREAM SOLUTE FLUXES FROM AGRICULTURAL AND RESTORED PRAIRIE LAND USE*. North Central Geological Society of America Annual Meeting. Ames, IA. Status = PUBLISHED; Acknowledgement of Federal Support = No

Balson, T, Y Li, AS Ward, HEC Dennis, R Henschel, H Brunst, S Simms, S Slavin. (2017). *Scaling parallel modeling of agroecosystems with Lustre*. Lustre User Group Conference. . Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Ward, AS, SM Wondzell, NM Schmadel. (2018). *Seasonal and long-term trends in network expansion, contraction, and connectivity*. HJ Andrews Experimental Forest monthly all-hands meeting. . Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Blair, N.E., Papanicolaou, T., Wilson, C.G. Leithold, E.L., Keefer, L. (2017). *Sediment dynamics and C-sequestration in the Midwestern USA reservoir, Lake Decatur*. Goldschmidt Conference. Paris. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Wondzell, SM, AS Ward, NM Schmadel (2018). *Subsurface Flow Paths and Summer Low Flows: Simulating Network Dynamics & Flow Permanence*. US Forest Service Summer Low Flows in Western Oregon: Processes, Trends, Uncertainties, and Management Implications workshop. . Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Cain, M, AS Ward. (2018). *Testing the two water worlds hypothesis in a mountain stream basin*. Crossroads Geology Conference, Indiana University. . Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Ferin, KM, A VanLoocke, AS Ward. (2017). *The impact of climate variability and land management practices on water quality in Iowa at the watershed scale*. Iowa Water Conference. . Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Freudenberg, V.B., A.N. Papanicolaou, B.K.B. Abban, C.P. Giannopoulos, C.G. Wilson, MS. Ghanneeizad (2017). *The role of cover crops to soil and water quality under a variable climate*. 26th Tennessee Water Resources Symposium. Burns, TN. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Remucal, C, AS Ward. (2018). *The role of hyporheic exchange in the environmental fate of lampricides*. Great Lakes Fisheries Commission annual meeting. . Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Stumpf, A.J., Lin, Y-F. (2017). *Thermophysical Characterization of the Heterogeneous Subsurface*. 2017 Geological Society of America Annual Meeting. Seattle, WA. Status = PUBLISHED; Acknowledgement of Federal Support = No

Hayes, J.M., Blair, N.E. (2017). *Tracing Sources of Organic Matter in a Midwestern USA Reservoir using Online TMAH Thermochemolysis*. American Geophysical Union National Meeting. New Orleans. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Abban, B.K.B., A.N. Papanicolaou, C.G. Wilson, C.P. Giannopoulos, M. Sivapalan (2017). *Understanding the role of the co-play between land use and climate on sediment flux laws in intensively managed landscapes*. American Geophysical Union Fall Meeting. New Orleans, LA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Blair, N.E., Ward, A., Bettis, A., Papanicolaou, T., Wilson, C.G. (2018). *The anatomy of a storm pulse: An example from the Clear Creek, IA site of the Intensively Managed Landscape – Critical Zone Observatory (IML-CZO)*. American Geophysical Union Winter Meeting. Washington, D.C.. Status = SUBMITTED; Acknowledgement of Federal Support = Yes

## Other Products

## Other Publications

## Patents

## Technologies or Techniques

## Thesis/Dissertations

M. Barnett. *A soil quality comparison study of a restored tallgrass prairie and an agricultural cornfield in Iowa, USA*. (2018). University of Birmingham. Acknowledgement of Federal Support = Yes

Debsunder Dutta. *Data Driven Estimation Of Soil And Vegetation Attributes Using Airborne Remote Sensing*. (2016). University of Illinois. Acknowledgement of Federal Support = Yes

Dong Kook Woo. *Dynamics of Inorganic Soil-Nitrogen Age In Intensively Managed Landscape*. (2017). UIUC. Acknowledgement of Federal Support = Yes

K.R. Goff. *Geochemical Analysis of Waerhering Zones from Clear Creek Watershed; Implications for Modelling Quaternary landscape Evolution*. (2017). The University of Iowa. Acknowledgement of Federal Support = Yes

Phong V. V. Le. *Predicting Malaria Dynamics Under Climate Change*. (2016). University of Illinois. Acknowledgement of Federal Support = Yes

K.J. Parsons. *Spatial and Temporal patterns of Land-Use Induced Sedimentation in Clear Creek Basin, Iowa*. (2018). The University of Iowa. Acknowledgement of Federal Support = Yes

Allison Goodwell. *Temporal Information Partitioning Networks To Infer Ecohydrologic Behaviors*. (2017). UIUC. Acknowledgement of Federal Support = Yes

## Websites

## Participants/Organizations

### What individuals have worked on the project?

Name	Most Senior Project Role	Nearest Person Month Worked
Kumar, Praveen	PD/PI	1
Anders, Alison	Co PD/PI	3
Bettis III, Elmer	Co PD/PI	1
Filley, Timothy	Co PD/PI	1
Papanicolaou, Thanos	Co PD/PI	1
Belmont, Patrick	Co-Investigator	0
Burkholder, Barbara	Co-Investigator	0
Foufoula-Georgiou, Efi	Co-Investigator	0
Garcia, Marcelo	Co-Investigator	0
Jacobson, Andrew	Co-Investigator	0
Krajewski, Witold	Co-Investigator	0
Lin, Henry	Co-Investigator	1
Lin, Yu-feng	Co-Investigator	1
Packman, Aaron	Co-Investigator	0
Parker, Gary	Co-Investigator	0
Peschel, Joshua	Co-Investigator	0

Name	Most Senior Project Role	Nearest Person Month Worked
Phillips, Andrew	Co-Investigator	0
Weber, Larry	Co-Investigator	0
Blair, Neal	Faculty	1
Chaubey, Inderjeet	Faculty	0
Dere, Ashley	Faculty	4
Flynn, Leslie	Faculty	0
Kumar, Charu	Faculty	0
Leithold, Elana	Faculty	0
Michalski, Greg	Faculty	1
Neal, Ted	Faculty	2
Rhoads, Bruce	Faculty	1
Stumpf, Andrew	Faculty	1
Ward, Adam	Faculty	1
Wilson, Christopher	Faculty	12
Benzoni, Rachel	K-12 Teacher	1
Greco, Bri	K-12 Teacher	1
Stover, Lee Ann	K-12 Teacher	1
Berry, Timothy	Postdoctoral (scholar, fellow or other postdoctoral position)	1
Goodwell, Allison	Postdoctoral (scholar, fellow or other postdoctoral position)	0
Le, Phong	Postdoctoral (scholar, fellow or other postdoctoral position)	12
Quijano, Juan	Postdoctoral (scholar, fellow or other postdoctoral position)	0
Schmadel, Noah	Postdoctoral (scholar, fellow or other postdoctoral position)	0
Vinson, David	Postdoctoral (scholar, fellow or other postdoctoral position)	0
Woo, Dongkook	Postdoctoral (scholar, fellow or other postdoctoral position)	5

Name	Most Senior Project Role	Nearest Person Month Worked
Yode, London	Postdoctoral (scholar, fellow or other postdoctoral position)	2
Yoder, Landon	Postdoctoral (scholar, fellow or other postdoctoral position)	6
Keefer, Laura	Other Professional	1
Keefer, Donald	Other Professional	0
Larson, Timothy	Other Professional	1
Marini, Luigi	Other Professional	1
Pitcel, Michelle	Other Professional	4
Hodson, Tim	Technician	5
Sargent, Steven	Technician	1
Seek, Lara	Technician	1
Storsved, Brynne	Technician	0
Grimley, David	Staff Scientist (doctoral level)	0
Muste, Marian	Staff Scientist (doctoral level)	1
Wang, Hong	Staff Scientist (doctoral level)	0
Abban, Benjamin	Graduate Student (research assistant)	12
Amir, Abbas	Graduate Student (research assistant)	0
Balson, Tyler	Graduate Student (research assistant)	1
Boys, John	Graduate Student (research assistant)	12
Cain, Molly	Graduate Student (research assistant)	9
Chen, Peng	Graduate Student (research assistant)	6
Childress, Laurel	Graduate Student (research assistant)	0
Cullen, Cecilia	Graduate Student (research assistant)	6
Dutta, Debsunder	Graduate Student (research assistant)	0
Ettema, Will	Graduate Student (research assistant)	2

Name	Most Senior Project Role	Nearest Person Month Worked
Farber, Brianna	Graduate Student (research assistant)	0
Fournillier, Kenny	Graduate Student (research assistant)	6
Giannopoulos, Christos	Graduate Student (research assistant)	12
Goff, Kathleen	Graduate Student (research assistant)	12
Hameed, Haider	Graduate Student (research assistant)	0
Hernandez, Leila	Graduate Student (research assistant)	6
Hester, Ulyssa	Graduate Student (research assistant)	12
Hopkins, Isaac	Graduate Student (research assistant)	6
Hou, Tingyu	Graduate Student (research assistant)	12
Jiang, Peishi	Graduate Student (research assistant)	12
Jin, Xinxin	Graduate Student (research assistant)	12
Kim, Jieun	Graduate Student (research assistant)	4
Lai, Jingtao	Graduate Student (research assistant)	2
Lee, Esther	Graduate Student (research assistant)	12
Leonard, Michael	Graduate Student (research assistant)	1
Li, Ming	Graduate Student (research assistant)	12
Lindroth, Evan	Graduate Student (research assistant)	6
Luo, Yaqi	Graduate Student (research assistant)	0
Miller, Melissa	Graduate Student (research assistant)	6
Muhammad, Umar	Graduate Student (research assistant)	1
Parsons, Kelli	Graduate Student (research assistant)	10
Prior, Kara	Graduate Student (research assistant)	0
Richardson, Meredith	Graduate Student (research assistant)	12
Roots, Paul	Graduate Student (research assistant)	1

Name	Most Senior Project Role	Nearest Person Month Worked
Roque-Malo, Susana	Graduate Student (research assistant)	1
Stevenson, Leigh	Graduate Student (research assistant)	1
Tighe-Dolan, Sharon	Graduate Student (research assistant)	6
Tokuhisa, Rai	Graduate Student (research assistant)	0
Wacha, Kenneth	Graduate Student (research assistant)	6
Wagner, Derek	Graduate Student (research assistant)	0
Wang, Kunxuan	Graduate Student (research assistant)	12
Xu, Haowen	Graduate Student (research assistant)	0
Yan, Qina	Graduate Student (research assistant)	12
Yu, Mingjing	Graduate Student (research assistant)	6
Zhou, Shengnan	Graduate Student (research assistant)	12
Ainsley, Benjamin	Undergraduate Student	0
Barnett, Megan	Undergraduate Student	3
Capalli, Courtney	Undergraduate Student	2
Clay, Samora	Undergraduate Student	2
Coker-Gunnick, Sophia	Undergraduate Student	1
Daugherty, Michael	Undergraduate Student	3
Davis, Eric	Undergraduate Student	2
Gerdes, Katherine	Undergraduate Student	1
Hayes, John	Undergraduate Student	3
Hemje, Amy	Undergraduate Student	1
Jackson, Christopher	Undergraduate Student	1
Kazmierczak, Breanna	Undergraduate Student	0
Kirton, Erin	Undergraduate Student	0

Name	Most Senior Project Role	Nearest Person Month Worked
Klein, Dillon	Undergraduate Student	1
Knapp, Kasie	Undergraduate Student	1
LeGrand, Lacey	Undergraduate Student	1
Lopez, Jazmin	Undergraduate Student	2
Magnuson, Angela	Undergraduate Student	3
Moravek, Jessie	Undergraduate Student	5
Nath, Sam	Undergraduate Student	1
O'Malley, Michele	Undergraduate Student	1
Parcher, Sarah	Undergraduate Student	1
Quan, Wei	Undergraduate Student	7
Shen, Bomo	Undergraduate Student	0
Skillman, Clark	Undergraduate Student	1
So, Rachel	Undergraduate Student	3
Terrell, Brian	Undergraduate Student	1
Velazquez, Diana	Undergraduate Student	3
Webb, Travis	Undergraduate Student	1
Williams, Joshua	Undergraduate Student	0
Yu, Zhihan	Undergraduate Student	2
Zhou, Nina	Undergraduate Student	1
Zona, Dominic	Undergraduate Student	1
Gasparini, Nicole	Consultant	0
Fetty, Nicholas	Other	0
Schnoebelen, Douglas	Other	0
Zeng, Yue	Other	0

#### Full details of individuals who have worked on the project:



**Praveen Kumar****Email:** kumar1@uiuc.edu**Most Senior Project Role:** PD/PI**Nearest Person Month Worked:** 1**Contribution to the Project:** Project Director**Funding Support:** NSF IMLCZO**International Collaboration:** Yes, China**International Travel:** No

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**Alison M Anders****Email:** amanders@uiuc.edu**Most Senior Project Role:** Co PD/PI**Nearest Person Month Worked:** 3**Contribution to the Project:** Development and application of conceptual and numerical models, communication of results**Funding Support:** this project and NSF-EAR 16-56935 to Anders**International Collaboration:** No**International Travel:** No

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**Elmer Bettis III****Email:** art-bettis@uiowa.edu**Most Senior Project Role:** Co PD/PI**Nearest Person Month Worked:** 1**Contribution to the Project:** Co-PI**Funding Support:** NSF IMLCZO**International Collaboration:** No**International Travel:** No

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**Timothy Filley****Email:** filley@purdue.edu**Most Senior Project Role:** Co PD/PI**Nearest Person Month Worked:** 1**Contribution to the Project:** Co-PI**Funding Support:** NSF IMLCZO**International Collaboration:** Yes, Chile, China**International Travel:** No

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**Thanos Papanicolaou****Email:** tpapanic@utk.edu**Most Senior Project Role:** Co PD/PI**Nearest Person Month Worked:** 1**Contribution to the Project:** co-director researcher looking at SOC dynamics, soil erosion, enrichment ratios**Funding Support:** University of Tennessee

**International Collaboration:** No  
**International Travel:** No

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**Patrick Belmont**  
**Email:** patrick.belmont@usu.edu  
**Most Senior Project Role:** Co-Investigator  
**Nearest Person Month Worked:** 0

**Contribution to the Project:** geomorphology, sediment transport, fluvial systems

**Funding Support:** Utah State University

**International Collaboration:** No  
**International Travel:** No

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**Barbara Burkholder**  
**Email:** bkb0811@umn.edu  
**Most Senior Project Role:** Co-Investigator  
**Nearest Person Month Worked:** 0

**Contribution to the Project:** None; Barbara has disengaged from the project. Her E&O responsibilities have been transferred.

**Funding Support:** None

**International Collaboration:** No  
**International Travel:** No

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**Efi Foufoula-Georgiou**  
**Email:** efi@uci.edu  
**Most Senior Project Role:** Co-Investigator  
**Nearest Person Month Worked:** 0

**Contribution to the Project:** geomorphic transport, scaling in river basins; supports collaboration with WSC funded project in the Minnesota River Basin

**Funding Support:** None

**International Collaboration:** No  
**International Travel:** No

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**Marcelo H Garcia**  
**Email:** mhgarcia@illinois.edu  
**Most Senior Project Role:** Co-Investigator  
**Nearest Person Month Worked:** 0

**Contribution to the Project:** river mechanics and environmental hydraulics

**Funding Support:** University of Illinois

**International Collaboration:** No  
**International Travel:** No

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**Andrew D Jacobson**  
**Email:** adj@earth.northwestern.edu

**Most Senior Project Role:** Co-Investigator  
**Nearest Person Month Worked:** 0

**Contribution to the Project:** aqueous and isotopic geochemistry

**Funding Support:** Northwestern University

**International Collaboration:** No  
**International Travel:** No

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**Witold Krajewski**

**Email:** witold-krajewski@uiowa.edu  
**Most Senior Project Role:** Co-Investigator  
**Nearest Person Month Worked:** 0

**Contribution to the Project:** hydrometeorology, radar rainfall estimation

**Funding Support:** University of Iowa

**International Collaboration:** No  
**International Travel:** No

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**Henry Lin**

**Email:** henrylin@psu.edu  
**Most Senior Project Role:** Co-Investigator  
**Nearest Person Month Worked:** 1

**Contribution to the Project:** Co-Lead Theme E, Cross-site studies, hydrogeology, sub-surface flow

**Funding Support:** Pennsylvania State University

**International Collaboration:** Yes, China  
**International Travel:** No

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**Yu-feng Lin**

**Email:** yflin@illinois.edu  
**Most Senior Project Role:** Co-Investigator  
**Nearest Person Month Worked:** 1

**Contribution to the Project:** Directed study of surface-groundwater interactions in USRB

**Funding Support:** Prairie Research Institute (General Revenue Funds)

**International Collaboration:** No  
**International Travel:** No

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**Aaron Packman**

**Email:** a-packman@northwestern.edu  
**Most Senior Project Role:** Co-Investigator  
**Nearest Person Month Worked:** 0

**Contribution to the Project:** environmental transport processes, stream ecology, microbiology

**Funding Support:** Northwestern University

**International Collaboration:** No  
**International Travel:** No

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**Gary Parker**

**Email:** parkerg@illinois.edu

**Most Senior Project Role:** Co-Investigator

**Nearest Person Month Worked:** 0

**Contribution to the Project:** morphodynamics and fluvial processes

**Funding Support:** University of Illinois

**International Collaboration:** No

**International Travel:** No

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**Joshua Peschel**

**Email:** peschel@illinois.edu

**Most Senior Project Role:** Co-Investigator

**Nearest Person Month Worked:** 0

**Contribution to the Project:** USRB Site & Facilities Co-coordinator, unmanned aerial system, robotics; As of yr 4 of the project, Josh Peschel is not engaged with the IMLCZO project as he has moved.

**Funding Support:** None

**International Collaboration:** No

**International Travel:** No

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**Andrew Phillips**

**Email:** phillips@isgs.illinois.edu

**Most Senior Project Role:** Co-Investigator

**Nearest Person Month Worked:** 0

**Contribution to the Project:** quaternary landscape evolution

**Funding Support:** Illinois State Geological Survey

**International Collaboration:** No

**International Travel:** No

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**Larry Weber**

**Email:** larry-weber@uiowa.edu

**Most Senior Project Role:** Co-Investigator

**Nearest Person Month Worked:** 0

**Contribution to the Project:** environmental hydraulics, tile drainage.

**Funding Support:** University of Iowa

**International Collaboration:** No

**International Travel:** No

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**Neal Blair**

**Email:** n-blair@northwestern.edu

**Most Senior Project Role:** Faculty  
**Nearest Person Month Worked:** 1

**Contribution to the Project:** Oversaw processing of ISCO collected samples for chemical analyses. Oversaw organic C analyses of samples. Synthesized data and prepared manuscript.

**Funding Support:** IML-CZO project, Northwestern University

**International Collaboration:** Yes, China  
**International Travel:** No

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**Inderjeet Chaubey**  
**Email:** ichaubey@purdue.edu  
**Most Senior Project Role:** Faculty  
**Nearest Person Month Worked:** 0

**Contribution to the Project:** Helped with Theme B ecohydrology and solute transport research activities.

**Funding Support:** IML-CZO

**International Collaboration:** No  
**International Travel:** No

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**Ashley Dere**  
**Email:** adeere@unoomaha.edu  
**Most Senior Project Role:** Faculty  
**Nearest Person Month Worked:** 4

**Contribution to the Project:** Oversight of weathering core collection and weathering experiment. Interpretation of data, presentations, manuscript production.

**Funding Support:** This project

**International Collaboration:** No  
**International Travel:** No

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**Leslie Flynn**  
**Email:** leslie-flynn@uiowa.edu  
**Most Senior Project Role:** Faculty  
**Nearest Person Month Worked:** 0

**Contribution to the Project:** No longer engaged with IMLCZO

**Funding Support:** None

**International Collaboration:** No  
**International Travel:** No

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**Charu Kumar**  
**Email:** cgkumar@illinois.edu  
**Most Senior Project Role:** Faculty  
**Nearest Person Month Worked:** 0

**Contribution to the Project:** metagenomics

**Funding Support:** University of Illinois

**International Collaboration:** No  
**International Travel:** No

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**Elana Leithold**  
**Email:** leithold@ncsu.edu  
**Most Senior Project Role:** Faculty  
**Nearest Person Month Worked:** 0

**Contribution to the Project:** Assisted with the sedimentology of the Lake Decatur project and manuscript preparation.

**Funding Support:** None

**International Collaboration:** No  
**International Travel:** No

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**Greg Michalski**  
**Email:** gmichalski@purdue.edu  
**Most Senior Project Role:** Faculty  
**Nearest Person Month Worked:** 1

**Contribution to the Project:** geochemistry

**Funding Support:** Purdue University; IMLCZO provides support for analysis but none for salary

**International Collaboration:** No  
**International Travel:** No

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**Ted Neal**  
**Email:** ted-neal@uiowa.edu  
**Most Senior Project Role:** Faculty  
**Nearest Person Month Worked:** 2

**Contribution to the Project:** Directed K-12 teacher workshops and engagement

**Funding Support:** This project Center For Regional and Global Environmental Research (u. of Iowa)

**International Collaboration:** No  
**International Travel:** No

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**Bruce Rhoads**  
**Email:** brhoads@illinois.edu  
**Most Senior Project Role:** Faculty  
**Nearest Person Month Worked:** 1

**Contribution to the Project:** Helped to supervise work on measurement and analysis of suspended sediment concentration data from the Upper Sangamon River basin as well as sediment tracing data on sediment sourcing

**Funding Support:** NSF - CZO project

**International Collaboration:** No  
**International Travel:** No

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**Andrew Stumpf**  
**Email:** astumpf@illinois.edu

**Most Senior Project Role:** Faculty  
**Nearest Person Month Worked:** 1

**Contribution to the Project:** Provided expertise on Quaternary geology in USRB

**Funding Support:** Prairie Research Institute, General Revenue Funds

**International Collaboration:** No  
**International Travel:** No

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**Adam Ward**

**Email:** adamward@indiana.edu  
**Most Senior Project Role:** Faculty  
**Nearest Person Month Worked:** 1

**Contribution to the Project:** senior personnel for Theme C

**Funding Support:** NSF

**International Collaboration:** No  
**International Travel:** No

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**Christopher Wilson**

**Email:** cwilso97@utk.edu  
**Most Senior Project Role:** Faculty  
**Nearest Person Month Worked:** 12

**Contribution to the Project:** Researcher SOC dynamics data management

**Funding Support:** IML-CZO other state and federal funding

**International Collaboration:** No  
**International Travel:** No

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**Rachel Benzoni**

**Email:** rachel@uiowa.edu  
**Most Senior Project Role:** K-12 Teacher  
**Nearest Person Month Worked:** 1

**Contribution to the Project:** data collection, analysis, curriculum development

**Funding Support:** No

**International Collaboration:** No  
**International Travel:** No

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**Bri Greco**

**Email:** bri@uno.edu  
**Most Senior Project Role:** K-12 Teacher  
**Nearest Person Month Worked:** 1

**Contribution to the Project:** data collection, analysis, curriculum development

**Funding Support:** No

**International Collaboration:** No  
**International Travel:** No

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**Lee Ann Stover**  
**Email:** leeann@uno.edu  
**Most Senior Project Role:** K-12 Teacher  
**Nearest Person Month Worked:** 1

**Contribution to the Project:** data collection, analysis, curriculum development

**Funding Support:** NO

**International Collaboration:** No  
**International Travel:** No

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**Timothy Berry**  
**Email:** berry10@purdue.edu  
**Most Senior Project Role:** Postdoctoral (scholar, fellow or other postdoctoral position)  
**Nearest Person Month Worked:** 1

**Contribution to the Project:** 13C content of lignin phenols in IML

**Funding Support:** EPA/NSf (IML-CZO)

**International Collaboration:** No  
**International Travel:** No

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**Allison Eva Goodwell**  
**Email:** goodwel2@illinois.edu  
**Most Senior Project Role:** Postdoctoral (scholar, fellow or other postdoctoral position)  
**Nearest Person Month Worked:** 0

**Contribution to the Project:** Development of information theory approach to understanding process network dynamics.

**Funding Support:** IML-CZO

**International Collaboration:** Yes, China  
**International Travel:** No

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**Phong Vu Viet Le**  
**Email:** phongle1@illinois.edu  
**Most Senior Project Role:** Postdoctoral (scholar, fellow or other postdoctoral position)  
**Nearest Person Month Worked:** 12

**Contribution to the Project:** Development of "Dhara" model for Critical Zone processes.

**Funding Support:** NSF (WSC REACH project)

**International Collaboration:** No  
**International Travel:** No

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**Juan C Quijano**  
**Email:** juan.quijano@gmail.com  
**Most Senior Project Role:** Postdoctoral (scholar, fellow or other postdoctoral position)  
**Nearest Person Month Worked:** 0



**Contribution to the Project:** ecohydrologic & nutrient dynamics modeling; As of yr 4 he is no longer with the project as he has moved back to South America (Equador).

**Funding Support:** University of Illinois

**International Collaboration:** No

**International Travel:** No

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**Noah Schmadel**

**Email:** noahschm@indiana.edu

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

**Nearest Person Month Worked:** 0

**Contribution to the Project:** spatial data analyses

**Funding Support:** Indiana University, NSF

**International Collaboration:** No

**International Travel:** No

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**David Vinson**

**Email:** dsvinson@uncc.edu

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

**Nearest Person Month Worked:** 0

**Contribution to the Project:** Assisted with manuscript

**Funding Support:** No

**International Collaboration:** No

**International Travel:** No

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**Dongkook Woo**

**Email:** dwoo5@illinois.edu

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

**Nearest Person Month Worked:** 5

**Contribution to the Project:** Development of a model to identify the age of nutrients in agricultural land.

**Funding Support:** IML-CZO

**International Collaboration:** Yes, China

**International Travel:** No

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**London Yode**

**Email:** yoderl@iu.edu

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

**Nearest Person Month Worked:** 2

**Contribution to the Project:** Assessment of watershed management authorities

**Funding Support:** NSF

**International Collaboration:** No

**International Travel:** No

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**Landon Yoder****Email:** yoderl@indiana.edu**Most Senior Project Role:** Postdoctoral (scholar, fellow or other postdoctoral position)**Nearest Person Month Worked:** 6**Contribution to the Project:** Postdoc**Funding Support:** NSF-other grants**International Collaboration:** No**International Travel:** No

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**Laura Keefer****Email:** lkeefer@illinois.edu**Most Senior Project Role:** Other Professional**Nearest Person Month Worked:** 1**Contribution to the Project:** Site coordinator: collaboration and facilitation of experiments at common stations or new locations.**Funding Support:** Some direct funding from IML-CZO grant and Prairie Research Institute-State of Illinois Salary**International Collaboration:** No**International Travel:** No

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**Donald Keefer****Email:** dkeefer@illinois.edu**Most Senior Project Role:** Other Professional**Nearest Person Month Worked:** 0**Contribution to the Project:** Advising on tile flow study**Funding Support:** None**International Collaboration:** No**International Travel:** No

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**Timothy Larson****Email:** thlarson@illinois.edu**Most Senior Project Role:** Other Professional**Nearest Person Month Worked:** 1**Contribution to the Project:** geophysics**Funding Support:** Illinois State Geological Survey & IMLCZO**International Collaboration:** No**International Travel:** No

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**Luigi Marini****Email:** lmarini@illinois.edu**Most Senior Project Role:** Other Professional**Nearest Person Month Worked:** 1**Contribution to the Project:** Data management

**Funding Support:** IML-CZO

**International Collaboration:** No

**International Travel:** No

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**Michelle Pitcel**

**Email:** mpitcel2@illinois.edu

**Most Senior Project Role:** Other Professional

**Nearest Person Month Worked:** 4

**Contribution to the Project:** Data management

**Funding Support:** IML-CZO

**International Collaboration:** No

**International Travel:** No

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**Tim Hodson**

**Email:** tohodson@gmail.com

**Most Senior Project Role:** Technician

**Nearest Person Month Worked:** 5

**Contribution to the Project:** Other

**Funding Support:** NSF (IML-CZO)

**International Collaboration:** No

**International Travel:** No

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**Steven Sargent**

**Email:** slsargen@illinois.edu

**Most Senior Project Role:** Technician

**Nearest Person Month Worked:** 1

**Contribution to the Project:** Maintains Sensors at Flux Tower; supervises data collection at Rantoul geothermal well; developed plan for DTS installation in Sangamon River

**Funding Support:** NSF IMLCZO

**International Collaboration:** No

**International Travel:** No

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**Lara Seek**

**Email:** laraseek@illinois.edu

**Most Senior Project Role:** Technician

**Nearest Person Month Worked:** 1

**Contribution to the Project:** Other

**Funding Support:** Illinois Department of Natural Resources/NSF-IMLCZO

**International Collaboration:** No

**International Travel:** No

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**Brynne Storsved**

**Email:** storsve2@illinois.edu  
**Most Senior Project Role:** Technician  
**Nearest Person Month Worked:** 0

**Contribution to the Project:** Other

**Funding Support:** NSF (IML-CZO)

**International Collaboration:** No  
**International Travel:** No

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**David Grimley**  
**Email:** dgrimley@illinois.edu  
**Most Senior Project Role:** Staff Scientist (doctoral level)  
**Nearest Person Month Worked:** 0

**Contribution to the Project:** Supervised collection of cores. Trained students in measurement of fly ash. Analysis and interpretation of PSA data. First author of manuscript.

**Funding Support:** ISGS

**International Collaboration:** No  
**International Travel:** No

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**Marian Muste**  
**Email:** marian-muste@uiowa.edu  
**Most Senior Project Role:** Staff Scientist (doctoral level)  
**Nearest Person Month Worked:** 1

**Contribution to the Project:** Design of the Annual Report Tool and overseeing workflow developments for the IML-CZO geo-portal

**Funding Support:** NSf-IMLCZO

**International Collaboration:** No  
**International Travel:** No

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**Hong Wang**  
**Email:** hongwang@illinois.edu  
**Most Senior Project Role:** Staff Scientist (doctoral level)  
**Nearest Person Month Worked:** 0

**Contribution to the Project:** Completed study soil organic carbon (SOC) cycling in the Upper Sangamon River Basin

**Funding Support:** Prairie Research Institute, General Revenue Funds

**International Collaboration:** No  
**International Travel:** No

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**Benjamin Abban**  
**Email:** babban@vols.utk.edu  
**Most Senior Project Role:** Graduate Student (research assistant)  
**Nearest Person Month Worked:** 12

**Contribution to the Project:** Roughness classification scheme and quantification

**Funding Support:** IML-CZO USGS USDA

**International Collaboration:** No

**International Travel:** No

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**Abbas Ali Amir**

**Email:** abbasali-amir@uiowa.edu

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 0

**Contribution to the Project:** Was involved in an exploration task for figuring out a web-based project management tool

**Funding Support:** NSF (IMLCZO) & University of Iowa/Other

**International Collaboration:** No

**International Travel:** No

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**Tyler Balson**

**Email:** tbalson@iu.edu

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 1

**Contribution to the Project:** Agro-IBIS modeling

**Funding Support:** NSF

**International Collaboration:** No

**International Travel:** No

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**John Boys**

**Email:** jboys@utk.edu

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 12

**Contribution to the Project:** How does management affect the various pools of SOM? What are the key mechanisms affecting changes in SOM storage potential in IMLs? What are the effects of tillage, pH, and N-fertilizer applications on aggregates, SOM decay and respiration rates?

**Funding Support:** University of Tennessee, Knoxville/NSF(IML-CZO)

**International Collaboration:** No

**International Travel:** No

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**Molly Cain**

**Email:** cainmr@iu.edu

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 9

**Contribution to the Project:** Field work in Clear Creek and Sangamon Basins, COMSOL Modeling

**Funding Support:** NSF

**International Collaboration:** No

**International Travel:** No

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**Peng Chen****Email:** Peng-chen@uiowa.edu**Most Senior Project Role:** Graduate Student (research assistant)**Nearest Person Month Worked:** 6**Contribution to the Project:** Research Assistant**Funding Support:** IML-CZO**International Collaboration:** No**International Travel:** No

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**Laurel Childress****Email:** lbchildr@u.northwestern.edu**Most Senior Project Role:** Graduate Student (research assistant)**Nearest Person Month Worked:** 0**Contribution to the Project:** Provided assistance with isotope analyses and supervision of undergraduates**Funding Support:** This project and NSF GeoPrisms project 1144483**International Collaboration:** No**International Travel:** No

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**Cecilia Cullen****Email:** ccullen3@illinois.edu**Most Senior Project Role:** Graduate Student (research assistant)**Nearest Person Month Worked:** 6**Contribution to the Project:** Development of numerical and conceptual models of groundwater contributions to post-glacial landscape evolution**Funding Support:** This project and NSF-EAR 16-56935**International Collaboration:** No**International Travel:** No

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**Debsunder Dutta****Email:** debsunderdutta@gmail.com**Most Senior Project Role:** Graduate Student (research assistant)**Nearest Person Month Worked:** 0**Contribution to the Project:** Development of a novel approach for use of hyperspectral, lidar and other remote sensing data for Critical Zone studies; He is no longer with the project as he is now a postdoc at JPL.**Funding Support:** NASA Fellowship**International Collaboration:** No**International Travel:** No

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**Will Ettema****Email:** william-ettema@uiowa.edu**Most Senior Project Role:** Graduate Student (research assistant)**Nearest Person Month Worked:** 2

**Contribution to the Project:** What role does intensive management of the landscape by humans plays in connectivity of water and sediment fluxes and corresponding budgets? Which controlling variables govern watershed response in terms of runoff and sediment fluxes? What are the feedback mechanisms between hydrological processes and the landscape, and how do these affect runoff and sediment distribution and fluxes on the landscape?

**Funding Support:** University of Iowa/NSF(IML-CZO)

**International Collaboration:** No

**International Travel:** No

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**Brianna Farber**

**Email:** bdfarber13@gmail.com

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 0

**Contribution to the Project:** E &O, Science/Farming

**Funding Support:** University of S. Carolina/NSF (IML-CZO)

**International Collaboration:** No

**International Travel:** No

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**Kenny Fournillier**

**Email:** kenny.fournillier@thermofisher.com

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 6

**Contribution to the Project:** Research Assistant

**Funding Support:** NSF grant

**International Collaboration:** No

**International Travel:** No

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**Christos Giannopoulos**

**Email:** cgiannop@vols.utk.edu

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 12

**Contribution to the Project:** travel times, enrichment ratios

**Funding Support:** IML-CZO

**International Collaboration:** No

**International Travel:** No

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**Kathleen Goff**

**Email:** kathleen-goff@uiowa.edu

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 12

**Contribution to the Project:** assisted with well installation data collection data analysis data collection data analysis literature research

**Funding Support:** NSF-IML-CZO NSF- EPSCoR

**International Collaboration:** No  
**International Travel:** No

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**Haider Hameed**

**Email:** haider-hameed@uiowa.edu

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 0

**Contribution to the Project:** Designer and developer of the Annual Report Tool for IML-CZO

**Funding Support:** IML\_CZO

**International Collaboration:** No

**International Travel:** No

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**Leila Hernandez**

**Email:** lch2@illinois.edu

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 6

**Contribution to the Project:** Characterization of landscape scale boundary layer fluxes in IML

**Funding Support:** NSF IMLCZO

**International Collaboration:** No

**International Travel:** No

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**Ulyssa Hester**

**Email:** uhester@purdue.edu

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 12

**Contribution to the Project:** Related to Theme B IML-CZO activities

**Funding Support:** Purdue Diversity Scholarship/NSF (IML-CZO)

**International Collaboration:** No

**International Travel:** No

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**Isaac Hopkins**

**Email:** iamihop11@gmail.com

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 6

**Contribution to the Project:** Research Assistant

**Funding Support:** NSF grant

**International Collaboration:** No

**International Travel:** No

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**Tingyu Hou**

**Email:** hou56@purdue.edu

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 12



**Contribution to the Project:** Focusing on statistics and biogeochemical sample analysis in Theme B IML-CZO

**Funding Support:** IML-CZO

**International Collaboration:** No

**International Travel:** No

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**Peishi Jiang**

**Email:** pjiang6@illinois.edu

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 12

**Contribution to the Project:** Use of IMLCZO data for semantic technology based model-data integration.

**Funding Support:** NSF (Geosemantics project)

**International Collaboration:** No

**International Travel:** No

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**Xinxin Jin**

**Email:** jinxinxin0218@163.com

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 12

**Contribution to the Project:** Related to Theme B IML-CZO activities

**Funding Support:** IML-CZO

**International Collaboration:** No

**International Travel:** No

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**Jieun Kim**

**Email:** jieunkim1618@gmail.com

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 4

**Contribution to the Project:** Generating biomarker data for Clear Creek, Sangamon and Lake Decatur

**Funding Support:** IML-CZO, Northwestern

**International Collaboration:** No

**International Travel:** No

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**Jingtao Lai**

**Email:** jlai11@illinois.edu

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 2

**Contribution to the Project:** Development and application of numerical models

**Funding Support:** Department of Geology

**International Collaboration:** No

**International Travel:** No

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**Esther Lee****Email:** elee98@illinois.edu**Most Senior Project Role:** Graduate Student (research assistant)**Nearest Person Month Worked:** 12**Contribution to the Project:** Development of MLCan model for application in a semi-arid region; supported collaboration with Catalina-Jamez CZO.**Funding Support:** NSF grant**International Collaboration:** No**International Travel:** No

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**Michael Leonard****Email:** mileonar@umail.iu.edu**Most Senior Project Role:** Graduate Student (research assistant)**Nearest Person Month Worked:** 1**Contribution to the Project:** Groundwater-surface water interaction**Funding Support:** Other**International Collaboration:** No**International Travel:** No

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**Ming Li****Email:** li-ming89@hotmail.com**Most Senior Project Role:** Graduate Student (research assistant)**Nearest Person Month Worked:** 12**Contribution to the Project:** Related to Theme B IML-CZO activities**Funding Support:** IML-CZO**International Collaboration:** No**International Travel:** No

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**Evan Lindroth****Email:** lindrot2@illinois.edu**Most Senior Project Role:** Graduate Student (research assistant)**Nearest Person Month Worked:** 6**Contribution to the Project:** IML-CZO**Funding Support:** Research assistant**International Collaboration:** No**International Travel:** No

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**Yaqi Luo****Email:** Yaqi.Luo@hotmail.com**Most Senior Project Role:** Graduate Student (research assistant)**Nearest Person Month Worked:** 0**Contribution to the Project:** Provided field support and assisted development of model for heat transport

**Funding Support:** Prairie Research Institute

**International Collaboration:** Yes, Chile

**International Travel:** No

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**Melissa Miller**

**Email:** mdm89@psu.edu

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 6

**Contribution to the Project:** Research assistant

**Funding Support:** IML-CZO

**International Collaboration:** No

**International Travel:** No

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**Umar Muhammad**

**Email:** umar83@illinois.edu

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 1

**Contribution to the Project:** Related to IML-CZO Theme D activities

**Funding Support:** IML-CZO

**International Collaboration:** No

**International Travel:** No

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**Kelli Parsons**

**Email:** kelli-parsons@uiowa.edu

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 10

**Contribution to the Project:** Undertook postsettlement mapping, isotopic dating and GIS analysis of data in Clear Creek Watershe

**Funding Support:** NSF

**International Collaboration:** No

**International Travel:** No

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**Kara Prior**

**Email:** kprior@umail.iu.edu

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 0

**Contribution to the Project:** field data collection and analysis

**Funding Support:** CZO, IU startup

**International Collaboration:** No

**International Travel:** No

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**Meredith Richardson**

**Email:** mlricha2@illinois.edu

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 12

**Contribution to the Project:** Development of Critical Zone Services for Intensively managed Landscapes

**Funding Support:** NSF (IMLCZO)

**International Collaboration:** Yes, China

**International Travel:** No

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**Paul Roots**

**Email:** pkroots@gmail.com

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 1

**Contribution to the Project:** stream sediment analysis

**Funding Support:** NSF (IML-CZO)

**International Collaboration:** No

**International Travel:** No

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**Susana Roque-Malo**

**Email:** sroque2@illinois.edu

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 1

**Contribution to the Project:** Coupled Modeling of Rhizosphere and Reactive Transport Processes

**Funding Support:** Fellowship

**International Collaboration:** No

**International Travel:** No

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**Leigh Stevenson**

**Email:** leesteeve@indiana.edu

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 1

**Contribution to the Project:** analysis of in-stream nutrient data

**Funding Support:** IU

**International Collaboration:** No

**International Travel:** No

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**Sharon Tighe-Dolan**

**Email:** satighedolan@unomaha.edu

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 6

**Contribution to the Project:** Research Assistant

**Funding Support:** None

**International Collaboration:** No  
**International Travel:** No

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**Rai Tokuhisa**

**Email:** rai-tokuhisa@uiowa.edu

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 0

**Contribution to the Project:** Urban Stream/biocells

**Funding Support:** University of Iowa/NSF (IML-CZO)

**International Collaboration:** No

**International Travel:** No

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**Kenneth Wacha**

**Email:** Ken.Wacha@ARS.USDA.GOV

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 6

**Contribution to the Project:** Worked on IML-CZO Theme D research on enrichment ratio, aggregate stability, as well as the field work and laboratory analysis component.

**Funding Support:** IML-CZO

**International Collaboration:** No

**International Travel:** No

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**Derek Wagner**

**Email:** dcwagner5@hotmail.com

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 0

**Contribution to the Project:** Development of model for flow through tiles; Installation and management of field facilities.

**Funding Support:** NSF (IMLCZO)

**International Collaboration:** No

**International Travel:** No

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**Kunxuan S. Wang**

**Email:** kswang3@illinois.edu

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 12

**Contribution to the Project:** Study of vegetation characteristics using waveform lidar data.

**Funding Support:** NSF (BrownDog project)

**International Collaboration:** No

**International Travel:** No

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**Haowen Xu**

**Email:** haowen-xu@uiowa.edu

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 0

**Contribution to the Project:** Workflows and tools for the IML-CZO Clear Creek

**Funding Support:** USACE's Institute for Water Resources

**International Collaboration:** No

**International Travel:** No

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**Qina Yan**

**Email:** qinayan2@illinois.edu

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 12

**Contribution to the Project:** Characterization of alluvial valleys in IMLCZO and modeling of landscape evolution to understand carbon transport due to human impact.

**Funding Support:** NSF (IMLCZO and Browndog)

**International Collaboration:** Yes, China

**International Travel:** No

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**Mingjing Yu**

**Email:** myu18@illinois.edu

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 6

**Contribution to the Project:** Aided with Geographic Information Science and research on long-term sediment dynamics related to Theme D.

**Funding Support:** IML-CZO

**International Collaboration:** No

**International Travel:** No

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**Shengnan Zhou**

**Email:** zshengna@vols.utk.edu

**Most Senior Project Role:** Graduate Student (research assistant)

**Nearest Person Month Worked:** 12

**Contribution to the Project:** SOC dynamics Visible Near Infrared Spectroscopy

**Funding Support:** Chinese gov

**International Collaboration:** No

**International Travel:** No

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**Benjamin Ainsley**

**Email:** BenjaminAinsworth2019@u.northwestern.edu

**Most Senior Project Role:** Undergraduate Student

**Nearest Person Month Worked:** 0

**Contribution to the Project:** stream sediment analysis

**Funding Support:** Northwestern

**International Collaboration:** No  
**International Travel:** No

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**Megan Barnett**

**Email:** megan-barnett@uiowa.edu

**Most Senior Project Role:** Undergraduate Student

**Nearest Person Month Worked:** 3

**Contribution to the Project:** Undertook study of soil physical properties in agricultural field and restored prairie in Clear Creek Watershed

**Funding Support:** No

**International Collaboration:** Yes, United Kingdom

**International Travel:** No

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**Courtney Capalli**

**Email:** courtney@uiowa.edu

**Most Senior Project Role:** Undergraduate Student

**Nearest Person Month Worked:** 2

**Contribution to the Project:** Data collection

**Funding Support:** none

**International Collaboration:** No

**International Travel:** No

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**Samora Clay**

**Email:** samora-clay@uiowa.edu

**Most Senior Project Role:** Undergraduate Student

**Nearest Person Month Worked:** 2

**Contribution to the Project:** Conduct field works associated with the experimental setup

**Funding Support:** CNH

**International Collaboration:** No

**International Travel:** No

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**Sophia Coker-Gunnick**

**Email:** sophia-cokergunnick@uiowa.edu

**Most Senior Project Role:** Undergraduate Student

**Nearest Person Month Worked:** 1

**Contribution to the Project:** undergrad research green storm water infrastructure

**Funding Support:** Other

**International Collaboration:** No

**International Travel:** No

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**Michael Cronin Daugherty**

**Email:** MichaelDaugherty2018@u.northwestern.edu

**Most Senior Project Role:** Undergraduate Student  
**Nearest Person Month Worked:** 3

**Contribution to the Project:** Biomarker analysis of Lake Decatur sediments

**Funding Support:** None for salary. This project provided support for the analyses.

**International Collaboration:** No  
**International Travel:** No

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**Eric Ryan Davis**

**Email:** EricDavis2021@u.northwestern.edu

**Most Senior Project Role:** Undergraduate Student  
**Nearest Person Month Worked:** 2

**Contribution to the Project:** Analyzed high resolution images of Lake Decatur cores

**Funding Support:** Northwestern

**International Collaboration:** No  
**International Travel:** No

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**Katherine Gerdes**

**Email:** u@not.edu

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

**Contribution to the Project:** data collection and analysis

**Funding Support:** None

**International Collaboration:** No  
**International Travel:** No

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**John M. Hayes**

**Email:** JohnHayes2018@u.northwestern.edu

**Most Senior Project Role:** Undergraduate Student  
**Nearest Person Month Worked:** 3

**Contribution to the Project:** Generated biomarker data for Sangamon and Lake Decatur

**Funding Support:** IML-CZO, Northwestern

**International Collaboration:** No  
**International Travel:** No

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**Amy Hemje**

**Email:** amy@uno.edu

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

**Contribution to the Project:** Data collection

**Funding Support:** None



**International Collaboration:** No  
**International Travel:** No

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**Christopher Jackson**  
**Email:** christopher@uno.edu  
**Most Senior Project Role:** Undergraduate Student  
**Nearest Person Month Worked:** 1

**Contribution to the Project:** Data collection

**Funding Support:** None

**International Collaboration:** No  
**International Travel:** No

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**Breanna Marie Kazmierczak**  
**Email:** BreannaKazmierczak2016@u.northwestern.edu  
**Most Senior Project Role:** Undergraduate Student  
**Nearest Person Month Worked:** 0

**Contribution to the Project:** Sample processing, data management, training

**Funding Support:** This project

**International Collaboration:** No  
**International Travel:** No

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**Erin Kirton**  
**Email:** erinkirton11@gmail.com  
**Most Senior Project Role:** Undergraduate Student  
**Nearest Person Month Worked:** 0

**Contribution to the Project:** Assisted with manuscript preparation

**Funding Support:** No

**International Collaboration:** No  
**International Travel:** No

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**Dillon Klein**  
**Email:** unavailable2@uno.edu  
**Most Senior Project Role:** Undergraduate Student  
**Nearest Person Month Worked:** 1

**Contribution to the Project:** data collection and analysis

**Funding Support:** This project

**International Collaboration:** No  
**International Travel:** No

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**Kasie Knapp**  
**Email:** unavaible3@uno.edu  
**Most Senior Project Role:** Undergraduate Student  
**Nearest Person Month Worked:** 1

**Contribution to the Project:** data collection and analysis

**Funding Support:** No

**International Collaboration:** No

**International Travel:** No

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**Lacey LeGrand**

**Email:** no@uno.edu

**Most Senior Project Role:** Undergraduate Student

**Nearest Person Month Worked:** 1

**Contribution to the Project:** data collection

**Funding Support:** None

**International Collaboration:** No

**International Travel:** No

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**Jazmin Lopez**

**Email:** jazmin-lopez@uiowa.edu

**Most Senior Project Role:** Undergraduate Student

**Nearest Person Month Worked:** 2

**Contribution to the Project:** assisted with well installation data collection data analysis

**Funding Support:** NSF-EPSCoR

**International Collaboration:** No

**International Travel:** No

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**Angela Magnuson**

**Email:** amagnus2@illinois.edu

**Most Senior Project Role:** Undergraduate Student

**Nearest Person Month Worked:** 3

**Contribution to the Project:** Expanded the work of Qina Yan on hydrogeomorphologic characterization of river valleys to include other CZOs.

**Funding Support:** NSF (IMLCZO)

**International Collaboration:** No

**International Travel:** No

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**Jessie Moravek**

**Email:** jessiemoravek@gmail.com

**Most Senior Project Role:** Undergraduate Student

**Nearest Person Month Worked:** 5

**Contribution to the Project:** stream sediment analysis

**Funding Support:** Other

**International Collaboration:** No

**International Travel:** No

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**Sam Nath****Email:** sam@uno.edu**Most Senior Project Role:** Undergraduate Student**Nearest Person Month Worked:** 1**Contribution to the Project:** Data collection**Funding Support:** None**International Collaboration:** No**International Travel:** No

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**Michele O'Malley****Email:** michele@uno.edu**Most Senior Project Role:** Undergraduate Student**Nearest Person Month Worked:** 1**Contribution to the Project:** Data collection**Funding Support:** None**International Collaboration:** No**International Travel:** No

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**Sarah Parcher****Email:** sparcher015@gmail.com**Most Senior Project Role:** Undergraduate Student**Nearest Person Month Worked:** 1**Contribution to the Project:** Collected and analyzed soil water and stream chemistry data.**Funding Support:** This project**International Collaboration:** No**International Travel:** No

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**Wei Quan****Email:** quanweisdu@gmail.com**Most Senior Project Role:** Undergraduate Student**Nearest Person Month Worked:** 7**Contribution to the Project:** Developed a GIS based approach for developing vegetation indices from Landsat data.**Funding Support:** CEE REU Support**International Collaboration:** No**International Travel:** No

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**Bomo Shen****Email:** shen-bomo@uiowa.edu**Most Senior Project Role:** Undergraduate Student**Nearest Person Month Worked:** 0**Contribution to the Project:** Cyberinfrastructure**Funding Support:** NSF/(IML-CZO)

**International Collaboration:** No  
**International Travel:** No

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**Clark Skillman**

**Email:** ClarkSkillman2018@u.northwestern.edu  
**Most Senior Project Role:** Undergraduate Student  
**Nearest Person Month Worked:** 1

**Contribution to the Project:** Sample preparation

**Funding Support:** None

**International Collaboration:** No  
**International Travel:** No

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**Rachel Tung So**

**Email:** RachelSo2020@u.northwestern.edu  
**Most Senior Project Role:** Undergraduate Student  
**Nearest Person Month Worked:** 3

**Contribution to the Project:** Generated carbonate data for Lake Decatur and the Sangamon

**Funding Support:** Northwestern, IML-CZO

**International Collaboration:** No  
**International Travel:** No

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**Brian Terrell**

**Email:** brian@uno.edu  
**Most Senior Project Role:** Undergraduate Student  
**Nearest Person Month Worked:** 1

**Contribution to the Project:** Data collection

**Funding Support:** None

**International Collaboration:** No  
**International Travel:** No

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**Diana Velazquez**

**Email:** DianaVelazquez2021@u.northwestern.edu  
**Most Senior Project Role:** Undergraduate Student  
**Nearest Person Month Worked:** 3

**Contribution to the Project:** Made FTIR measurements and analyzed data

**Funding Support:** Northwestern, IML-CZO

**International Collaboration:** No  
**International Travel:** No

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**Travis Webb**

**Email:** travis@uno.edu  
**Most Senior Project Role:** Undergraduate Student  
**Nearest Person Month Worked:** 1

**Contribution to the Project:** Data collection

**Funding Support:** None

**International Collaboration:** No

**International Travel:** No

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**Joshua John Williams**

**Email:** JoshuaWilliams2016@u.northwestern.edu

**Most Senior Project Role:** Undergraduate Student

**Nearest Person Month Worked:** 0

**Contribution to the Project:** Developed an age model for the Lake Decatur sediment cores

**Funding Support:** none

**International Collaboration:** No

**International Travel:** No

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**Zhihan Yu**

**Email:** ZhihanYu2014@u.northwestern.edu

**Most Senior Project Role:** Undergraduate Student

**Nearest Person Month Worked:** 2

**Contribution to the Project:** Biomarker analyses of stream organic C

**Funding Support:** None for salary. This project provided support for the analyses.

**International Collaboration:** No

**International Travel:** No

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**Nina Zhou**

**Email:** NinaZhou2019@u.northwestern.edu

**Most Senior Project Role:** Undergraduate Student

**Nearest Person Month Worked:** 1

**Contribution to the Project:** Generated data on plant debris in Lake Decatur

**Funding Support:** IML-CZO, Northwestern

**International Collaboration:** No

**International Travel:** No

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**Dominic John Zona**

**Email:** DominicZona2018@u.northwestern.edu

**Most Senior Project Role:** Undergraduate Student

**Nearest Person Month Worked:** 1

**Contribution to the Project:** Sample preparation and FTIR analyses

**Funding Support:** none

**International Collaboration:** No

**International Travel:** No

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**Nicole Gasparini****Email:** ngaspari@tulane.edu**Most Senior Project Role:** Consultant**Nearest Person Month Worked:** 0

**Contribution to the Project:** Dr. Gasparini has generously shared her expertise in helping us develop new LandLab components and providing guidance in testing/debugging LandLab models

**Funding Support:** none

**International Collaboration:** No

**International Travel:** No

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**Nicholas Fetty****Email:** nick-fetty@uiowa.edu**Most Senior Project Role:** Other**Nearest Person Month Worked:** 0

**Contribution to the Project:** conducted interviews, produced video, wrote summaries of research and outreach efforts

**Funding Support:** NSF IML-CZO

**International Collaboration:** No

**International Travel:** No

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**Douglas Schnoebelen****Email:** dschnoebelen@usgs.gov**Most Senior Project Role:** Other**Nearest Person Month Worked:** 0

**Contribution to the Project:** Assisted with manuscript preparation

**Funding Support:** None

**International Collaboration:** No

**International Travel:** No

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**Yue Zeng****Email:** yuezeng2017@u.northwestern.edu**Most Senior Project Role:** Other**Nearest Person Month Worked:** 0

**Contribution to the Project:** Analysis of high frequency events observed in Lake Decatur cores.

**Funding Support:** None for salary. This project provided support for the analyses

**International Collaboration:** No

**International Travel:** No

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**What other organizations have been involved as partners?**

Name	Type of Partner Organization	Location
City of Coralville,	State or Local Government	Iowa

Name	Type of Partner Organization	Location
Illinois State Water Survey, Prairie Research Institute	State or Local Government	Urbana, Illinois
Purdue University	Academic Institution	West Lafayette, Indiana
United States Geological Survey	State or Local Government	Urbana, Illinois
University of Iowa	Academic Institution	Iowa City, Iowa
University of Minnesota	Academic Institution	Minneapolis, MN
University of Tennessee, Knoxville	Academic Institution	Knoxville, Tennessee
University of Nebraska-Omaha	Academic Institution	Omaha Nebraska
Utah State University	Academic Institution	Logan, Utah
Illinois State geological Survey-Prairie research Institute	Academic Institution	Champaign, Illinois
Indiana University	Academic Institution	Bloomington, Indiana
Iowa-Cedar Watershed Interagency Coordination Team	State or Local Government	Iowa
LacCore	Academic Institution	University of Minnesota
North Carolina State University	Academic Institution	Raleigh, NC
Northwestern University	Academic Institution	Evanston, Illinois
Pennsylvania State University	Academic Institution	State College, Pennsylvania
Prairie Research Institute	State or Local Government	Urbana, Illinois

#### Full details of organizations that have been involved as partners:

##### City of Coralville,

**Organization Type:** State or Local Government

**Organization Location:** Iowa

##### **Partner's Contribution to the Project:**

Facilities

**More Detail on Partner and Contribution:** assisted with Watershed Improvement Research Board Tour in Clear Creek Watershed Financial support for buses

##### **Illinois State Water Survey, Prairie Research Institute**

**Organization Type:** State or Local Government

**Organization Location:** Urbana, Illinois

**Partner's Contribution to the Project:**

Facilities  
Collaborative Research  
Personnel Exchanges

**More Detail on Partner and Contribution:**

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**Illinois State geological Survey-Prairie research Institute**

**Organization Type:** Academic Institution  
**Organization Location:** Champaign, Illinois

**Partner's Contribution to the Project:**

Facilities  
Collaborative Research  
Personnel Exchanges

**More Detail on Partner and Contribution:**

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**Indiana University**

**Organization Type:** Academic Institution  
**Organization Location:** Bloomington, Indiana

**Partner's Contribution to the Project:**

Facilities  
Collaborative Research  
Personnel Exchanges

**More Detail on Partner and Contribution:**

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**Iowa-Cedat Watershed Interagency Coordination Team**

**Organization Type:** State or Local Government  
**Organization Location:** Iowa

**Partner's Contribution to the Project:**

In-Kind Support  
Facilities

**More Detail on Partner and Contribution:** Workflows for specific tasks in the Clear Creek IML-CZO were developed through a funded project for the Interagency Team by the Institute for Water Resources of USACE.

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**LacCore**

**Organization Type:** Academic Institution  
**Organization Location:** University of Minnesota

**Partner's Contribution to the Project:**

Facilities

**More Detail on Partner and Contribution:** The LacCore facility was used to analyze Lake Decatur cores for magnetic susceptibility, porosity and color.

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**North Carolina State University**



**Organization Type:** Academic Institution

**Organization Location:** Raleigh, NC

**Partner's Contribution to the Project:**

Collaborative Research

**More Detail on Partner and Contribution:** Prof. Leithold's group at NCSU assisted with the Lake Decatur sedimentology.

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### **Northwestern University**

**Organization Type:** Academic Institution

**Organization Location:** Evanston, Illinois

**Partner's Contribution to the Project:**

Facilities

Collaborative Research

Personnel Exchanges

**More Detail on Partner and Contribution:**

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### **Pennsylvania State University**

**Organization Type:** Academic Institution

**Organization Location:** State College, Pennsylvania

**Partner's Contribution to the Project:**

Facilities

Collaborative Research

Personnel Exchanges

**More Detail on Partner and Contribution:**

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### **Prairie Research Institute**

**Organization Type:** State or Local Government

**Organization Location:** Urbana, Illinois

**Partner's Contribution to the Project:**

In-Kind Support

Facilities

Collaborative Research

Personnel Exchanges

**More Detail on Partner and Contribution:** Illinois State Geological Survey and Illinois State Water Survey, which are part of PRI, are strong partners in the IMLCZO effort. Several personnel from PRI are directly or indirectly engaged in IMLCZO effort in field activities and scientific investigations.

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### **Purdue University**

**Organization Type:** Academic Institution

**Organization Location:** West Lafayette, Indiana

**Partner's Contribution to the Project:**

Facilities

Personnel Exchanges

**More Detail on Partner and Contribution:**

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**United States Geological Survey****Organization Type:** State or Local Government**Organization Location:** Urbana, Illinois**Partner's Contribution to the Project:**

Facilities

Collaborative Research

Personnel Exchanges

**More Detail on Partner and Contribution:**

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**University of Iowa****Organization Type:** Academic Institution**Organization Location:** Iowa City, Iowa**Partner's Contribution to the Project:**

Facilities

Collaborative Research

Personnel Exchanges

**More Detail on Partner and Contribution:**

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**University of Minnesota****Organization Type:** Academic Institution**Organization Location:** Minneapolis, MN**Partner's Contribution to the Project:**

Facilities

Collaborative Research

Personnel Exchanges

**More Detail on Partner and Contribution:**

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**University of Tennessee, Knoxville****Organization Type:** Academic Institution**Organization Location:** Knoxville, Tennessee**Partner's Contribution to the Project:**

Facilities

Collaborative Research

Personnel Exchanges

**More Detail on Partner and Contribution:**

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**University of Nebraska-Omaha****Organization Type:** Academic Institution**Organization Location:** Omaha Nebraska

**Partner's Contribution to the Project:**

Financial support

**More Detail on Partner and Contribution:**

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**Utah State University**

**Organization Type:** Academic Institution

**Organization Location:** Logan, Utah

**Partner's Contribution to the Project:**

Facilities

Collaborative Research

Personnel Exchanges

**More Detail on Partner and Contribution:**

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**What other collaborators or contacts have been involved?**

Illinois Water Resources Center (IWRC) provided support to Maryam Ghadiri who helped compile and synthesise this report. Their in kind contribution is gratefully acknowledged.

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

The IMLCZO project has resulted in a significant rethink of the managed landscapes in terms of the dependencies between carbon, water, nitrogen cycles and soil and ecosystem processes. We have established the multiple time scale dependencies between these components, how they have been altered by management, and their trajectories. This "unity" of understanding bridges across many traditional disciplines.

**What is the impact on other disciplines?**

The CZO program is interdisciplinary by nature. Two central components are the following: (1) to develop a unifying theoretical framework that integrates new understanding of coupled hydrological, geochemical, geomorphological, sedimentological and biological processes; and (2) to develop, couple and validate system-level models to predict how the critical zone responds to external forces such as anthropogenic, climatic, and/or tectonic processes. As described above, the IMLCZO project is developing a unified understanding to help solve some of the most perplexing challenges associated with managed landscapes.

**What is the impact on the development of human resources?**

We have attached a list of graduate (MS and PhD) and undergraduate students, and postdoc scholars, visiting scientists and K-12 teachers who have participated in the project, and contributed to its goal and benefited from the effort and outcome.

**What is the impact on physical resources that form infrastructure?**

A number of observational platforms have been deployed at the primary test fields in Clear Creek (Iowa) and Upper Sangamon River Basin (Illinois) to help perform the connectivity experiments. These include eddy covariance towers (with climate and soil moisture/temperature probes) to capture fluxes through soil-crop-atmosphere interface. A downslope transect of water table monitoring wells track not only water and dissolved constituents across the surface-subsurface interface, but also through the soil matrix, and tile monitoring facility. Advanced Radio-frequency ID, Rhodamine dye, Rare Earth Elements, and isotopic tracers can track the particulate movement across the surface and through a series of Alternative Tile Intakes along the hillslope from the surface to the subsurface. A monitoring camera has been installed at the outlet of this tile system to measure the fluxes through the subsurface drainage system, along with other water quality sensors and a collection weir. Finally an integrated stage-sediment-water quality monitoring system is installed just downstream of the field. This set up

allows us to track the water drop, sediment particle, carbon molecule from the top of the hillslope through the channel in one experiment. This deployment and associated datasets are likely to have a lasting impact on the science of intensively managed landscapes.

The infrastructure of IMLCZO has been described in detail in an upcoming publication [doi:doi:10.2136/vzj2018.04.0088]

### **What is the impact on institutional resources that form infrastructure?**

Nothing to report.

### **What is the impact on information resources that form infrastructure?**

#### **Webportal for the IMLCZO observatory**

A new landing page was developed and deployed at <http://data.imlcz.org/>. The page contains general How-To information about the IML-CZO data management, including information on how the data within the Geodashboard and Clowder are organized. It includes links to all data services including an experimental version of a Geodashboard for mobile devices. Developed of version 3 of the Geodashboard continues. A new search page based on this technology was deployed to the production site. Areas of new development include the Explore Page, the Detail Page, and a mobile versions of the application. The mobile version includes different mobile friendly view, including new graphs that show only the last two weeks of data. We have begun deploying and testing V3 to the development site. Our goal is to release and deploy Geodashboard V3 this Fall. We have also continued to make tweaks and improvements to V2, including bug fixes and cleanup of how sites are organized. The Clowder instance for management of raw files was updated several times. We are currently running v1.4.2 from v1.3.2. A full list of changes can be found at

<https://github.com/ncsa/clowder/blob/master/CHANGELOG.md>. We have recovered from multiple outages on the NCSA Nebula cluster and have been working closely with the administrators of the cluster to resolve issues. We have improved our recovery processes and added the ability to have down for maintenance pages for those occasions.

#### **Services, workflows for data distribution and sharing**

Data ingestion continues to occur across a variety of data sources, and parsers for new data sources are being developed. Over the past year, we have gone from 120 sites to 144, from 2 million datapoints to 3.5 million, and from 24K raw files to 50.6K. We have developed new parsing technology that instead of requiring new code to be written for every new data source and site, it allows developers to configure a generic parsers for the specific site and data formats by writing a simple text file in YAML. This works with most common formats provided by manufacturers of the logging instruments. This reusability will be key in quickly bringing online new data sources in the future, and supporting changes to legacy devices from the same manufacturer. This setup allows for easier code maintenance as the same code is used for all the configuration files. The following sites are being migrated to this technology: Flux Tower, Allerton Trust Farm, River Bend, Fowler Farm, and Mahomet. We fixed and redeployed the Mahomet parser. This script is utilized via a daily cron job, which again allows us to get new data uploaded to Clowder and parsed for visibility on the Geodashboard. Data is uploaded to the server on a daily basis, and then the script will add the data to Clowder and make the data available for usage on the Geodashboard. A new virtual machine dedicated to data ingestion was setup on the NCSA Nebula cluster. Campbell Scientific LoggerNet was reinstalled and set up as a new service on this virtual machine. LoggerNet is primarily utilized for data retrieval from Flux Tower and Allerton Trust Farm. Data is retrieved every hour with 15 minute data contained therein. This virtual machine allows for easier customization, and more consistent data retrieval for parsing. It includes mounts to other resources on the network including a Windows share from ISWS to ingest data for three sites. Currently, LoggerNet data from Flux Tower and Allerton Trust Farm are manually parsed weekly. Atmospheric and Soil Data from River Bend, Fowler Farm are manually parsed when data is available and requested. The Mahomet data is automatically checked on a daily basis for available data to parse. Lidar data (2.4TB) was ingested into the system using special purpose functionality within Clowder for large files.

### **What is the impact on technology transfer?**

Nothing to report.

### **What is the impact on society beyond science and technology?**

As stated elsewhere in this report also, IML-CZO also engaged with the University of Illinois Extension Program to develop two online courses that is available for Certificate for Crop Advisors (<https://web.extension.illinois.edu/ccaf/>).

- [https://web.extension.illinois.edu/ccaf/articulate/Eroded\\_art/story\\_html5.html](https://web.extension.illinois.edu/ccaf/articulate/Eroded_art/story_html5.html)

- [https://web.extension.illinois.edu/cca/articulate/extreme\\_weather\\_controls\\_art/story\\_html5.html](https://web.extension.illinois.edu/cca/articulate/extreme_weather_controls_art/story_html5.html)

These courses help train the trainers. In other words, IMLCZO reaches the stakeholders through sources that they trust.

Further, the publications from IMLCZO have had a number of media (news release, radio, etc.) as listed below. While it is difficult to assess impact, we have reached a broad audience.

- NSF News Release 18-064

In drought and heavy rains, ecosystems function like information communication networks

[https://www.nsf.gov/news/news\\_summ.jsp?cntn\\_id=296321](https://www.nsf.gov/news/news_summ.jsp?cntn_id=296321)

- Eos article: How Mesquite Trees Gain a Competitive Edge in Arid Arizona, <https://eos.org/research-spotlights/how-mesquite-trees-gain-a-competitive-edge-in-arid-arizona>

- Eos article:What Causes Ecological Shifts?, <https://eos.org/research-spotlights/what-causes-ecological-shifts>

- Eos article: Stories in the Soil, <https://eos.org/editors-vox/stories-in-the-soil>

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## Changes/Problems

### Changes in approach and reason for change

Nothing to report.

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

Nothing to report.

### Changes that have a significant impact on expenditures

We are still a bit behind in catching up with expenses due to the delays in the start of the project. These are unevenly distributed across partner institutions. Also, the funding rate is being managed to ensure support for student's degree completion, and personnel to provide adequate support for the project through delays of possible continuing support. A budget Table is included in the attached documents that describes the current expenses and that available for year 6.

### 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.