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Preview of Award 1331906 - Annual Project Report

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Cover

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|---|---|
| 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 - 11/30/2020 |
| Reporting Period: | 12/01/2018 - 11/30/2019 |
| Submitting Official (if other than PD/PI): | N/A |
| Submission Date: | N/A |
| Signature of Submitting Official (signature shall be submitted in accordance with agency specific instructions) | N/A |

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).

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

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

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

Major Activities:

During the past year, major activities have included: 1) Characterization of 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 (GC) in Omaha, Nebraska, 2) collection and analysis of pore water and stream water samples to document ongoing chemical weathering reactions at CCW and GC., 3) reconstruction of pre-settlement drainage networks using topography, soil characteristics, surficial geologic mapping, and pre-settlement survey data across the glaciated central lowlands (ND, SD, MN, IA, WI, IL, IN, MI, OH), 4) development and implementation of a numerical model of drainage network growth with groundwater contributions from across subtle surface water divides.

We are compiling a paper that uses the soil samples collected from representative locations throughout the Clear Creek Watershed (CCW) and Upper Sangamon River Basin (USRB) as part of the baseline campaign and ER experiments, as well as the total SOM analysis using Visible Near Infrared Spectroscopy (VNIR). This paper addresses (a) how topography and land management affect the accumulation and distribution of SOC along a hillslope; and (b) how geomorphology-based sediment connectivity affects the landscape averaged SOC and landscape distributed SOC. This work fits well with the central hypothesis of the IMLs-CZO team and the shift of IMLs from being a transformer to a transporter. The key finding was that the spatial distribution of SOC in the hillslope plots on the CCW and USRB are influenced by slope position and surface morphology, following the order of depressions > lower slopes > upper slopes > ridges. This 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.

Rainfall simulations with a constant rainfall intensity (60 mm hr⁻¹) was conducted in the high-gradient Clear Creek Watershed by introducing three soil aggregate classes (i.e., large aggregates, small aggregates, and fine) as source material that were tagged with different type of rare earth oxides (REOs) for sediment tracing. REE tracers were distributed over different aggregate size fractions and introduced at the plot. Runoff and sediment samples were collected at characteristic locations of the plots (i.e., source, rill, and weir). At the field scale, similar experiments under natural rainfall events were conducted in the low-gradient Upper Sangamon Watershed in the summer. Three source areas covered with REOs tagged aggregates were placed along a main flowpath. Soil samples were collected following logarithmic law inside the source areas as well as along the flowpath after every period of multiple rainfall events.

Specific Objectives:

During the past year, in addition to incremental developments, we have focussed on synthesizing key findings from our past research. These are reported together in the attached file: Accomplishments&Plan-Year7-Findings.pdf

Significant Results:

See attached file: Accomplishments&Plan-Year7-Findings.pdf

Key outcomes or Other achievements:

See attached file: Accomplishments&Plan-Year7-Findings.pdf

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

During the past year, we have been taking a comprehensive look at the outcomes from the project as a whole and these are included in the attached file: HRD-Report-Year7.pdf

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

As indicated in the attached pdf file, IMLCZO Research, since the beginning of the project in December 2013 has so far resulted in 83 publications (Web of Science) with annual distribution of 4 (2014), 11 (2015), 12 (2016), 21 (2017), 18 (2018), and 17 (2019). These are distributed over 42 different journals in 31 different fields involving over 275 unique authors with collaborations across 22 countries (as indicated by Web of Science) reflecting broad inter-disciplinary engagement and convergent research outcomes. These have been cited for a total of 794 times (2 in 2014, 27 in 2015, 54 in 2016, 141 in 2017, 249 in 2018, and 321 in 2019) with an H-index of 16. Additionally, several journal articles are in review or pending immediate publication, and many are under preparation. In addition several presentations have been made.

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

Consistent with the plan presented for the supplement funding request, these are detailed in the attached document: Accomplishments&Plan-Year7-Plan.pdf

Supporting Files

| Filename | Description | Uploaded By | Uploaded On |
|---|--|---------------|-------------|
| Accomplishments&Plan-Year7-Findings.pdf | Synthesis of key findings from past research | Praveen Kumar | 01/06/2020 |
| HRD-Report-Year7.pdf | IMLCZO personnel development summary | Praveen Kumar | 01/06/2020 |
| Accomplishments&Plan-Year7-Plan.pdf | Plan for Year 7 | Praveen Kumar | 01/08/2020 |
| Accomplishments&Plan-Year7-References.pdf | Numbered references associated with attached documents | Praveen Kumar | 01/08/2020 |

Products

Books

Book Chapters

Inventions

Journals or Juried Conference Papers

129. Kratt, C. B., Woo, D. K., Johnson, K. N., Haagsma, M., Kumar, P., Selker, J., and Tyler, S. (2020). Field trials to detect drainage pipe networks using thermal and RGB data from unmanned aircraft. *Agricultural Water Management*. 229 105895. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1016/j.agwat.2019.105895

131. Goodwell, G., P. Jiang, B. Ruddell, and P. Kumar (2020). Debates - Does Information Theory provide a new paradigm for Earth Science? Causality, interaction, and feedback. *Water Resources Research*. . Status = ACCEPTED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

142. Wlostowski, A., N. Molotch, S. Anderson, S. Brantley, J. Chorover, D. Dralle, P. Kumar, L. Li, K. Lohse, J. Mallard, J. McIntosh, S. Murphy, E. Parrish, M. Safeeq, M. Seyfried, Y. Shi and C. Harman (2019). Signatures of Hydrologic Function and Coevolution Across the Critical Zone Observatory Network. *Water Resources Research*. . Status = SUBMITTED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Athanasios N. Papanicolaou Benjamin K. B. Abban Dimitrios C. Dermisis Christos P. Giannopoulos Dennis C. Flanagan James R. Frankenberger Kenneth M. Wacha (2018). Flow Resistance Interactions on Hillslopes With Heterogeneous Attributes: Effects on Runoff Hydrograph Characteristics. *Water Resources Research*.. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1002/2017WR021109

Benjamin P. Wilkins, Dong Kook Woo, Praveen Kumar, Donald A. Keefer, Laura L. Keefer, Mark Fisher, Jianghanyang Li, Timothy Hodson, Lisa Welp, and Greg Michalski (2019). Quantification of Field-Scale Denitrification by Stable Isotope Analysis of Nitrate and Water from Tile Drain Discharge. *Water Resources Research*. . Status = SUBMITTED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI:

Blair, N.E., Bettis, E.A. III, Filley, T., Moravel, J., Papanicolaou, A.N.T., Ward, A., Wilson, C.G., Zhou, Kazmierczak, B. (2019). The evolution of storm pulses and their particulate organic C and N in an agriculturally-dominated stream network: Lessons from the Intensively Managed Landscape Critical Zone Observatory. *Biogeochemistry*. . Status = SUBMITTED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Christopher Wilson; Benjamin Abban; Laura Keefer; Kenneth Wacha; Dimitrios Dermisis; Christos Giannopoulos; Shengnan Zhou; Allison Goodwell; Dongkook Woo; Qina Yan; Maryam Ghadiri; Andrew Stumpf; Michelle Pitcel; Yu-feng Lin; Luigi Marini; Brynne Storsved; Kathleen Goff; Jason Vogelgesang; Ashlee Dere; Keith Schilling; Marian Muste; Neal Blair; Bruce Rhoads; Elmer Bettis; Henry Pai; Chris Kratt; Chris Sladek; Michael Wing; John Selker; Scott Tyler; Hangsheng (Henry) Lin; Praveen Kumar; Athanasios Papanicolaou (2018). The Intensively Managed Landscape Critical Zone Observatory: A Scientific Testbed For Understanding Critical Zone Processes In Agroecosystems. *Vadose Zone Journal*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.2136/vzj2018.04.0088

Control of tillage disturbance on the chemistry and proportion of raindrop-liberated particles from soil aggregates (2018). Tingyu Hou, Timothy D Berry, Sarmistha Singh, Madison N Hughes, Yanan Tong, AN Thanos Papanicolaou, Kenneth M Wacha, Christopher G Wilson, Indrajeet Chaubey, Timothy R Filley. *Geoderma*. 330 19. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1016/j.geoderma.2018.05.013

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Dere, A., Miller A., Hemje A., Parcher S., Capalli C., and Bettis A. III (2019). Solute fluxes through restored prairie and intensively managed critical zones in Nebraska and Iowa. *Frontiers in Earth Science*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.3389/feart.2019.00024

Dong Kook Woo, HominSong, PraveenKumar (2019). Mapping subsurface tile drainage systems with thermal images. *Agriculture Water Management*. 218 94. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1016/j.agwat.2019.01.031

Dutta, D., and Kumar, P (2018). A Framework for Global Characterization of Soil Properties Using Repeat Hyperspectral Satellite Data. *IEEE Trans. in Geoscience and Remote Sensing*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1109/TGRS.2018.2883311

Filippo Bressan, A. N. Papanicolaou, Benjamin Abban (2014). A model for knickpoint migration in first- and second-order streams. *Geophysical Research Letters*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1002/2014GL060823

Goodwell, A., P. Kumar (2019). A changing climatology of rainfall persistence across the U.S. using information-based measures. *JOurnal of Hydrometeorology*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1175/JHM-D-19-0013.1

Jiang, P. and P. Kuma (2019). Information transfer from causal history in complex system dynamics. *Physical Review E*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1103/PhysRevE.99.012306

Karen B. Gran, Christine Dolph, Anna Baker, Martin Bevis, Se Cho, Jonathan Czuba, Brent Dalzell, Mohammad Danesh-Yazdi, Amy Hansen, Sara Kelly, Zhengxin Lang, Jon Schwenk, Patrick Belmont, Jacques Finlay, Praveen Kumar, Sergey Rabotyagov, Gillian Roehrig, Peter Wilcock, Efi Foufoula-Georgiou (2019). The Power of Environmental Observatories for Advancing Multidisciplinary Research, Outreach, and Decision Support: The Case of the Minnesota River Basin. *Water Resources Research*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1029/2018WR024211

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Ken Wacha, Thanos Papanicolaou, Christos Giannopoulos, Ben Abban, Christopher Wilson, Shengnan Zhou, Jerry Hatfield, Tim Filley, and Tingyu Hou (2018). The Role of Hydraulic Connectivity and Management on Soil Aggregate Size and Stability in the Clear Creek Watershed, Iowa. *Geosciences*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.3390/geosciences8120470

Madhu Khanna, Benjamin M. Gramig, Evan H. DeLucia, Ximing Cai & Praveen Kumar (2019). Harnessing emerging technologies to reduce Gulf hypoxia. *Nature Sustainability*. 2 889. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1038/s41893-019-0381-4

Ming Li, Erika J. Foster, Phong V.V. Le, Qina Yan, Andrew Stumpf, Tingyu Hou, A. N. (Thanos) Papanicolaou, Ken Wacha, Christopher G. Wilson, Jingkuan Wang, Praveen Kumar, Timothy Filley (). A new dynamic wetness index (DWI) predicts soil moisture persistence and correlates with key indicators of surface soil geochemistry. *Geoderma*. . Status = SUBMITTED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Neal E. Blair, N.E., Elana L. Leithold, E.L., Thanos Papanicolaou, Christopher G. Wilson, Laura Keefer, L., Erin Kirtan, David Vinson, Douglas Schnoebelen, Bruce Rhoads, B., Ming Li Yu, Quentin Lewis (2018). The C-biogeochemistry of a Midwestern USA agricultural impoundment in context: Lake Decatur in the intensively managed landscape critical zone observatory. *Biogeochemistry*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1007/s10533-018-0439-9

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Phong V.V. Le, Praveen Kumar, Marilyn O. Ruiz, Charles Mbogo, and Ephantus J Muturi (2019). Predicting the direct and indirect impacts of climate change on malaria in coastal Kenya. *PLOS ONE*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1371/journal.pone.0211258

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Qina Yan and Praveen Kumar (2019). Sustainability of Soil Organic Carbon in Consolidated Gully Land in China's Loess Plateau. *Nature Scientific Report*. . Status = SUBMITTED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Susana Roque-Malo and Praveen Kumar (2019). Modeling the Role of Root Exudation in Critical Zone Nutrient Dynamics. *Water Resources Research*. . Status = SUBMITTED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Tingyu Hou, Yanan Tong, Benjamin Abban, Sarmistha Singh, A. N. Thanos Papanicolaou, Kenneth M. Wacha, Christopher G. Wilson, Indrajeet Chaubey, Timothy R. Filley (). Tillage-induced surface soil roughness controls the chemistry of different sized particles at early erosion stage. *Soil and Tillage Research*. . Status = SUBMITTED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Wang, K., and P. Kumar (2019). Characterizing relative degrees of clumping structure in vegetation canopy using waveform LiDAR. *Remote Sensing of Environment*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1016/j.rse.2019.111281

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Woo, D. K. and P. Kumar (2019). Impacts of Subsurface Tile Drainage on Age—Concentration Dynamics of Inorganic Nitrogen in Soil. *Water Resources Research*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: doi.org/10.1029/2018WR024139

Xinxin Jin, Aaron Gall, Muhammad Farhan Saeed, Shuangyi Li, Timothy Filley, Jingkuan Wang (2020). Plastic film mulching and nitrogen fertilization enhance the conversion of newly-added maize straw to water-soluble organic carbon. *Soil and Tillage Research*. 197 . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1016/j.still.2019.104527

Xinxin Jin, Tingting An, Aaron Gall, Shuangyi Li, Timothy Filley, Jingkuan Wang (2018). Enhanced conversion of newly-added maize straw to soil microbial biomass C under plastic film mulching and organic manure management. *Geoderma*. 313 154. Status = ACCEPTED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1016/j.geoderma.2017.10.036

Xueli Ding, Bin Zhang, Timothy R Filley, Chunjie Tian, Xudong Zhang, Hongbo He (2019). Changes of microbial residues after wetland cultivation and restoration. *Biology and Fertility of Soils*. 55 (4), 405. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1007/s00374-019-01341-2

Yan, Q, Phong V. V. Le, Dong K. Woo, Tingyu Hou, Timothy Filley, Praveen Kumar (2018). Three-Dimensional Modeling of the Coevolution of Landscape and Soil Organic Carbon. *Water Resour. Res.*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1029/2018WR023634

Yu, M. and Rhoads, B.L. (2018). Floodplains as a source of fine sediment in grazed landscapes: Tracing the source of suspended sediment in the headwaters of an intensively managed agricultural landscape. *Geomorphology*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1016/j.geomorph.2018.01.022

Zhengyang Cheng, Kyutae Lee, Dongsu Kim, Marian Muste, Pete Vidmar, Jim Hulme (2019). Experimental evidence on the performance of rating curves for continuous discharge estimation in complex flow situations. *Journal of Hydrology*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1016/j.jhydrol.2018.11.021

Licenses

Other Conference Presentations / Papers

Luigi Marini, Rob Kooper, Jong Lee, Indira Gutierrez-Polo, Max Burnette, Michelle M Pitcel, Marcus Slavenas, Yan Zhao, Paris Collingsworth, David LeBauer, Kenton McHenry and Praveen Kumar (2018). *Developing and Adapting Data Management Services Across Multiple Virtual Observatories*. AGU 2018 Fall Meeting. Washington, DC. 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 = PUBLISHED; Acknowledgement of Federal Support = Yes

Other Products

Other Publications

Patents

Technologies or Techniques

Thesis/Dissertations

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 Weathering Zones from Clear Creek Watershed; Implications for Modelling Quaternary landscape Evolution*. (2017). The University of Iowa. 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 | 1 |
| Bettis III, Elmer | Co PD/PI | 0 |
| Filley, Timothy | Co PD/PI | 1 |
| Papanicolaou, Thanos | Co PD/PI | 1 |
| Foufoula-Georgiou, Efi | Co-Investigator | 0 |
| Garcia, Marcelo | Co-Investigator | 0 |
| Krajewski, Witold | Co-Investigator | 0 |
| Lin, Henry | Co-Investigator | 1 |
| Lin, Yu-feng | Co-Investigator | 0 |
| Parker, Gary | Co-Investigator | 0 |
| Phillips, Andrew | Co-Investigator | 0 |
| Blair, Neal | Faculty | 1 |
| Chaubey, Inderjeet | Faculty | 0 |
| Dere, Ashley | Faculty | 0 |
| Goodwell, Allison | Faculty | 0 |
| Leithold, Elana | Faculty | 0 |
| Michalski, Greg | Faculty | 0 |
| Neal, Ted | Faculty | 0 |
| Rhoads, Bruce | Faculty | 1 |
| Stumpf, Andrew | Faculty | 1 |
| Ward, Adam | Faculty | 1 |
| Wilson, Christopher | Faculty | 2 |
| Berry, Timothy | Postdoctoral (scholar, fellow or other postdoctoral position) | 0 |
| Woo, Dongkook | Postdoctoral (scholar, fellow or other postdoctoral position) | 0 |
| Yoder, Landon | Postdoctoral (scholar, fellow or other postdoctoral position) | 0 |
| Keefer, Laura | Other Professional | 1 |

| Name | Most Senior Project Role | Nearest Person Month Worked |
|------------------------|---------------------------------------|-----------------------------|
| Larson, Timothy | Other Professional | 0 |
| Marini, Luigi | Other Professional | 2 |
| Pitcel, Michelle | Other Professional | 5 |
| Hodson, Tim | Technician | 2 |
| Sargent, Steven | Technician | 1 |
| Seek, Lara | Technician | 1 |
| Grimley, David | Staff Scientist (doctoral level) | 0 |
| Muste, Marian | Staff Scientist (doctoral level) | 1 |
| Abban, Benjamin | Graduate Student (research assistant) | 5 |
| Balson, Tyler | Graduate Student (research assistant) | 2 |
| Cain, Molly | Graduate Student (research assistant) | 3 |
| Childress, Laurel | Graduate Student (research assistant) | 3 |
| Cullen, Cecilia | Graduate Student (research assistant) | 1 |
| Fournillier, Kenny | Graduate Student (research assistant) | 0 |
| Giannopoulos, Christos | Graduate Student (research assistant) | 6 |
| Hernandez, Leila | Graduate Student (research assistant) | 6 |
| Hou, Tingyu | Graduate Student (research assistant) | 0 |
| Jiang, Peishi | Graduate Student (research assistant) | 6 |
| Kim, Jieun | Graduate Student (research assistant) | 3 |
| Lee, Esther | Graduate Student (research assistant) | 3 |
| Li, Ming | Graduate Student (research assistant) | 0 |
| Lindroth, Evan | Graduate Student (research assistant) | 0 |
| Miller, Melissa | Graduate Student (research assistant) | 0 |
| Richardson, Meredith | Graduate Student (research assistant) | 6 |
| Roots, Paul | Graduate Student (research assistant) | 1 |
| Roque-Malo, Susana | Graduate Student (research assistant) | 6 |
| Tighe-Dolan, Sharon | Graduate Student (research assistant) | 0 |
| Wacha, Kenneth | Graduate Student (research assistant) | 0 |
| Wang, Kunxuan | Graduate Student (research assistant) | 6 |
| Yan, Qina | Graduate Student (research assistant) | 4 |
| Zhou, Shengnan | Graduate Student (research assistant) | 6 |
| Gasparini, Nicole | Consultant | 0 |
| Fetty, Nicholas | Other | 1 |

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: Lead PI and Project Director

Funding Support: NSF

International Collaboration: Yes, China

International Travel: No

Alison M Anders

Email: amanders@uiuc.edu

Most Senior Project Role: Co PD/PI

Nearest Person Month Worked: 1

Contribution to the Project: Co-PI

Funding Support: NSF

International Collaboration: No

International Travel: No

Elmer Bettis III

Email: art-bettis@uiowa.edu

Most Senior Project Role: Co PD/PI

Nearest Person Month Worked: 0

Contribution to the Project: Retired and no longer contributing actively to the project

Funding Support: NA

International Collaboration: No

International Travel: No

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

International Collaboration: Yes, China

International Travel: No

Thanos Papanicolaou

Email: tpapanic@utk.edu

Most Senior Project Role: Co PD/PI

Nearest Person Month Worked: 1

Contribution to the Project: Co-PI and Co-Director of the project

Funding Support: NSF

International Collaboration: No

International Travel: No

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

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

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

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, hydropedology, sub-surface flow**Funding Support:** Pennsylvania State University**International Collaboration:** No**International Travel:** No

Yu-feng Lin**Email:** yflin@illinois.edu**Most Senior Project Role:** Co-Investigator**Nearest Person Month Worked:** 0**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

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

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

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

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

Ashley Dere

Email: adeere@unoomaha.edu

Most Senior Project Role: Faculty

Nearest Person Month Worked: 0

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

Allison Eva Goodwell

Email: allison.goodwell@ucdenver.edu

Most Senior Project Role: Faculty

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: No

International Travel: No

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

Greg Michalski

Email: gmichalski@purdue.edu

Most Senior Project Role: Faculty

Nearest Person Month Worked: 0

Contribution to the Project: geochemistry

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

International Collaboration: No

International Travel: No

Ted Neal

Email: ted-neal@uiowa.edu

Most Senior Project Role: Faculty

Nearest Person Month Worked: 0

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

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

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

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

Christopher Wilson
Email: cwilso97@utk.edu
Most Senior Project Role: Faculty
Nearest Person Month Worked: 2

Contribution to the Project: Researcher SOC dynamics data management

Funding Support: IML-CZO other state and federal funding

International Collaboration: No
International Travel: No

Timothy Berry
Email: berry10@purdue.edu
Most Senior Project Role: Postdoctoral (scholar, fellow or other postdoctoral position)
Nearest Person Month Worked: 0

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

Funding Support: EPA/NSF (IML-CZO)

International Collaboration: No
International Travel: No

Dongkook Woo
Email: dkwoo@lbl.gov
Most Senior Project Role: Postdoctoral (scholar, fellow or other postdoctoral position)
Nearest Person Month Worked: 0

Contribution to the Project: Dong Kook is now a postdoc at LBNL and is completing the manuscript for submission based on IMLCZO work.

Funding Support: IML-CZO

International Collaboration: No
International Travel: No

Landon Yoder
Email: yoderl@indiana.edu
Most Senior Project Role: Postdoctoral (scholar, fellow or other postdoctoral position)
Nearest Person Month Worked: 0

Contribution to the Project: Postdoc

Funding Support: NSF-other grants

International Collaboration: No
International Travel: No

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

Timothy Larson
Email: thlarson@illinois.edu
Most Senior Project Role: Other Professional
Nearest Person Month Worked: 0

Contribution to the Project: geophysics

Funding Support: Illinois State Geological Survey & IMLCZO

International Collaboration: No
International Travel: No

Luigi Marini
Email: lmarini@illinois.edu
Most Senior Project Role: Other Professional
Nearest Person Month Worked: 2

Contribution to the Project: Data management

Funding Support: IML-CZO

International Collaboration: No
International Travel: No

Michelle Pitcel
Email: mpitcel2@illinois.edu
Most Senior Project Role: Other Professional
Nearest Person Month Worked: 5

Contribution to the Project: Data management

Funding Support: IML-CZO

International Collaboration: No
International Travel: No

Tim Hodson
Email: tohodson@gmail.com
Most Senior Project Role: Technician
Nearest Person Month Worked: 2

Contribution to the Project: Other

Funding Support: NSF (IML-CZO)

International Collaboration: No
International Travel: No

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

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

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

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

Benjamin Abban

Email: babban@vols.utk.edu

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 5

Contribution to the Project: Roughness classification scheme and quantification

Funding Support: IML-CZO USGS USDA

International Collaboration: No

International Travel: No

Tyler Balson

Email: tbalson@iu.edu

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 2

Contribution to the Project: Agro-IBIS modeling

Funding Support: NSF

International Collaboration: No

International Travel: No

Molly Cain

Email: cainmr@iu.edu

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 3

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

Funding Support: NSF

International Collaboration: No

International Travel: No

Laurel Childress

Email: lbchildr@u.northwestern.edu

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 3

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

Cecilia Cullen

Email: ccullen3@illinois.edu

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 1

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

Kenny Fournillier

Email: kenny.fournillier@thermofisher.com

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 0

Contribution to the Project: Research Assistant

Funding Support: NSF grant

International Collaboration: No

International Travel: No

Christos Giannopoulos

Email: cgiannop@vols.utk.edu

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 6

Contribution to the Project: travel times, enrichment ratios

Funding Support: IML-CZO

International Collaboration: No

International Travel: No

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

Tingyu Hou

Email: hou56@purdue.edu

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 0

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

Peishi Jiang

Email: pjiang6@illinois.edu

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 6

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

Jieun Kim

Email: jieunkim1618@gmail.com

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 3

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

Esther Lee

Email: elee98@illinois.edu

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 3

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

Ming Li
Email: li-ming89@hotmail.com
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 0

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

Funding Support: IML-CZO

International Collaboration: No
International Travel: No

Evan Lindroth
Email: lindrot2@illinois.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 0

Contribution to the Project: IML-CZO

Funding Support: Research assistant

International Collaboration: No
International Travel: No

Melissa Miller
Email: mdm89@psu.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 0

Contribution to the Project: Research assistant

Funding Support: IML-CZO

International Collaboration: No
International Travel: No

Meredith Richardson
Email: mlricha2@illinois.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 6

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

Funding Support: NSF (IMLCZO)

International Collaboration: No
International Travel: No

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

Susana Roque-Malo
Email: sroque2@illinois.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 6

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

Funding Support: IMLCZO

International Collaboration: No
International Travel: No

Sharon Tighe-Dolan
Email: satighedolan@unomaha.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 0

Contribution to the Project: Research Assistant

Funding Support: None

International Collaboration: No

International Travel: No

Kenneth Wacha

Email: Ken.Wacha@ARS.USDA.GOV

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 0

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

Kunxuan S. Wang

Email: kswang3@illinois.edu

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 6

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

Funding Support: NSF (BrownDog project)

International Collaboration: No

International Travel: No

Qina Yan

Email: qinayan2@illinois.edu

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 4

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: No

International Travel: No

Shengnan Zhou

Email: zshengna@vols.utk.edu

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 6

Contribution to the Project: SOC dynamics Visible Near Infrared Spectroscopy

Funding Support: Chinese gov

International Collaboration: No

International Travel: No

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

Nicholas Fetty

Email: nick-fetty@uiowa.edu

Most Senior Project Role: Other

Nearest Person Month Worked: 1

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

What other organizations have been involved as partners?

| Name | Type of Partner Organization | Location |
|---|------------------------------|-----------------------------|
| City of Coralville, | State or Local Government | Iowa |
| 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-Cedat 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:

| |
|---|
| <p>City of Coralville,</p> <p>Organization Type: State or Local Government</p> <p>Organization Location: Iowa</p> <p>Partner's Contribution to the Project:</p> <p>Facilities</p> <p>More Detail on Partner and Contribution: assisted with Watershed Improvement Research Board Tour in Clear Creek Watershed Financial support for buses</p> |
| <p>Illinois State Water Survey, Prairie Research Institute</p> <p>Organization Type: State or Local Government</p> <p>Organization Location: Urbana, Illinois</p> <p>Partner's Contribution to the Project:</p> <p>Facilities</p> <p>Collaborative Research</p> <p>Personnel Exchanges</p> <p>More Detail on Partner and Contribution:</p> |
| <p>Illinois State geological Survey-Prairie research Institute</p> <p>Organization Type: Academic Institution</p> <p>Organization Location: Champaign,Illinois</p> <p>Partner's Contribution to the Project:</p> <p>Facilities</p> <p>Collaborative Research</p> <p>Personnel Exchanges</p> <p>More Detail on Partner and Contribution:</p> |
| <p>Indiana University</p> <p>Organization Type: Academic Institution</p> <p>Organization Location: Bloomington, Indiana</p> |

Partner's Contribution to the Project:

Facilities
Collaborative Research
Personnel Exchanges

More Detail on Partner and Contribution:

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.

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.

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.

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:

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:

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.

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:

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:

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:

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:

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:

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:

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:

What other collaborators or contacts have been involved?

Nothing to report

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

This is a highly interdisciplinary project. It is difficult to ascertain what principal discipline means.

What is the impact on other disciplines?

This is a highly interdisciplinary project. It is difficult to ascertain what other disciplines means.

What is the impact on the development of human resources?

As reported in the attachment, the project has contributed extensively in several aspect of the development and training of students and postdoc in the broad area of STEM fields. So far the summary of statistics is as follows:

Total Participants

13 Post-doc/Vist. Scholar

34 PhD

21 MS

56 Undergraduates

Women

7 (54%) Post-doc/Vist. Scholar

17 (50%) PhD

12 (57%) MS

25 (45%) Undergraduate

Under Represented Minorities

1 (8%) Post-doc/Vist. Scholar

5 (15%) PhD

2 (9%) MS

4 (7%) Undergraduates

For a more details see attachment.

What is the impact on physical resources that form infrastructure?

The IMLCZO field facilities are a community resource and have been used by several researchers from academia and state laboratories.

What is the impact on institutional resources that form infrastructure?

Nothing to report.

What is the impact on information resources that form infrastructure?

The streaming data is openly available in near real-time from <https://data.imlczzo.org/>. Laboratory analyses are available as soon as possible or directly through collaborative engagements with the scientists.

What is the impact on technology transfer?

See the atatched document on Human Resource Development

What is the impact on society beyond science and technology?

The outcomes from the project have been communicated broadly to stakeholders through direct engagement and indirectly through the Univ. of Illinois Extension program.

Changes/Problems**Changes in approach and reason for change**

No major changes have occured and the progress is consistent with the proposed effort.

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

Since the project had an offcycle start in year 1, there were delays with hiring of personnel during year 1. Some of those delays continue to cascade through these years in terms of expenditure. However, this project has generated a lot of synergy with many other projects, as a result there are no delays with our targeted goals.

Changes that have a significant impact on expenditures

As stated above, we anticipate requesting a no cost extension at the end of Year 7. The budget and expenditures through Year 6 are included in the attachment.

Professor Henry Lin, a Co-I from Pennstate Univ. passed away in August 2019. As a result his effort is assumed by Prof. Kumar's group. Prof. Art Bettis, Co-PI on the project, has retired from the University of Iowa and completed his obligations on the project.

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.