Preview of Award 1331906 - Annual Project Report

Cover

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Recipient Organization:	University of Illinois at Urbana-Champaign
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Signature of Submitting Official (signature shall be submitted in accordance with agency specific instructions)	Praveen Kumar

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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 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; 2) assessment of the record of anthropogenic landscape disturbance recorded in post settlement alluvial deposits (PSA); and 3) documenting the physical, chemical, and hydrologic characteristics of the weathering profile.

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?

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 disributed 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 in the attached Activities Report document.

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: Due to the length of the description, the Major Activities for Each Theme are described in the attached document.

Specific Objectives:

Theme A

Task: A.1 Define and map fundamental landscape units

1. **a. Specific Objectives:** Through this task we aim to investigate how the present configuration of the landscape and its underlying geology affect processes in the critical zone.

Task: A.2 Post-settlement alluvium analysis using stream bank surveys, coring, fly ash screening, and radionuclide dating

1. **a. Specific Objectives:** How has land use change impacted floodplain sedimentation across the IML-CZO? What is the history of sedimentation in our

study sites?

Task: A.3 Investigate physical/geochemical characteristics of the upper two weathering profiles

1. **a.** **Specific Objective:** To obtain cores and install monitoring wells for studying the weathering profile in CCW and the Minnesota River basin in order to investigate the degree of connectivity between the land surface and weathering profiles and to see how the position on the landscape affects connectivity between the land surface and the weathering profile.
2. **b.**

Task: A.4 Model Quaternary landscape development of the IML-CZO

Specific Objectives: To create a quantitative model for landscape evolution during the transition between glacial conditions to interglacial conditions and continuing into the Anthropocene. The science questions in this task are:

- By what processes and over what timescales do landscapes evolve from glacially-dominated to fluvial-dominated in low-relief, continental interiors?
- What was the pre-settlement tendency for channel evolution and characteristic rate and pattern of erosion and sedimentation in the IML-CZO study areas?
- What was the pre-settlement drainage density in the IML-CZO study areas?

Theme B

Task: B.1 Experimental farm footprints through mobile sensor platforms

Specific Objectives: To study the dynamic relation between active and stabilized forms of SOM in IMLs and how does that relationship vary in activity centers and activity intervals?

Task: B.2 Collect surface soil samples in Clear Creek

Specific Objectives: To study the following questions:

- What are the key mechanisms and control affecting changes and movement in SOM in IMLs?
- How does management affect the various pools of SOM?
- What are the effects of overland flow and tillage incorporation on litter inputs to soil active layer in IMLs?

Task: B.3 **Analyze surface soil samples in Clear Creek**

Specific Objective: In this task we aim to investigate the following issues:

- What are the effects of tillage, pH, and N-fertilizer applications on decay and respiration rates?
- What is the dynamic relation between active and stabilized forms of SOM in IMLs?

Task: B.4 Collect surface soil samples in Upper Sangamon

Specific Objectives: To address the same questions as identified for CCW above.

Task: B.5 **Perform VNIR and other in-situ measurements for total SOM**

Specific Objectives: The aim of this task is to quantify SOM at the watershed scale using VNIR analysis of field samples and correlating that with airborne hyperspectral measurements

Theme C

Task: C.1 Telescoping hydrological monitoring for biogeochemical signals that are measurable and differ amongst landscape elements, locations, and through storm-to-seasonal variability

Specific Objectives: 1. Continued hydrological and water quality monitoring with established infrastructure, and expanded infrastructure at hillslope and floodplain locations

2. Analysis of lateral hyporheic exchange through evolution of the surface drainage system

Task C2: Characterize decadal scale variability in stream OC export using sediment coring of lake Decatur

The sediments of Lake Decatur were sampled by coring in May 2104 and June 2105 in an effort to characterize sediment and and organic carbon export from the Sangamon watershed.

Task C3: Evaluate potential organic carbon sources to stream (in collaboration with Themes B and D)

Theme D

Task D1: Quantify erosion rates, travel times, and lag coefficients for Clear Creek through rainfall simulator experiments

Specific Objectives: In this task we want to address the following questions:

- What are the spatial and temporal lag effects between the processes and the distribution of the sources, sinks, and 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?
- Which controlling variables govern watershed response in terms of runoff and sediment fluxes; at what scales are these variables important; and what are the spatiotemporal scaling laws between these variables, runoff, and sediment?

Task D2: Characterize net sediment fluxes and sediment rating curves within stream channels of Clear Creek using storm-based evaluations

Specific Objectives:

- What role does intensive management of the landscape by humans plays in connectivity of water and sediment fluxes and corresponding budgets?
- What processes control the distribution of sources, sinks, and fluxes, and what are the spatial and temporal lag effects between the processes and the distribution of the sources, sinks, and fluxes?

- Which controlling variables govern watershed response in terms of runoff and sediment fluxes; at what scales are these variables important; and what are the spatiotemporal scaling laws between these variables, runoff, and sediment?

Task D3: Characterize net sediment fluxes and rating curves within stream channels of Upper Sangamon using storm-based evaluations

Specific Objectives: This task addresses questions related to the processes controlling the distribution of sources, sinks and fluxes, as well as the spatiotemporal lag effects on the landscape. Moreover, the task is also used to identify the variables governing the watershed response in regards to runoff and sediment fluxes, the scales at which the variables are important, as well as the spatiotemporal scaling laws.

Task D4: Develop short-term (i.e., single event) sediment budgets for the Clear Creek watershed using stable and radio-isotopes to partition sediment sources

Specific Objectives: This task addresses questions related to the processes controlling the distribution of sources, sinks and fluxes, as well as the spatiotemporal lag effects on the landscape by providing the relative partitioning of sediment fluxes from different source areas (i.e., terrestrial vs. in-stream).

Task D5: Develop short-term (i.e., single event) sediment budgets for the Upper Sangamon watershed using stable and radio-isotopes to partition sediment sources.

Theme E

Task E1: LiDAR Data Acquisition:

Specific Objective: The objective of this Task was to acquire LiDAR data for peak leaf-on period to capture vegetation attributes.

Task E2: LiDAR scale hydrologic and biogeochemical process modeling

Specific Objective: The specific objective of this task is to develop an integrated model at the LiDAR data resolution for both hydrologic and biogeochemical processes.

Task E3: Hydro-geomorphologic evolution of river valleys and impact of human development

Specific Objective: In This task we seek to understand the evolution of river valleys and floodplains and how they change under anthropogenic impact.

Task E4: Information theoretical approach to understanding eco-hydrological interdependencies

Specific Objective: The goal of this task is to develop methods and approaches to understand the critical zone dynamics as an evolving complex system using data and models.

Task E5: Critical Zone services

Specific Objective: Through this task we aim to develop, using data and models, an approach for assessing critical zone services using a life-cycle approach in intensively managed landscapes.

Significant Results:

The activities during the second year of the project have resulted in 15 published journal articles, 9 presently under submission and 3 under preparation for immediate submission. This period has also produced 12 invited presentations, and an additional 28 conference presentations.

We only note a few notable recognitions of the work here while other are found in the publications:

1. An article published in International Innovation featuring Praveen Kumar and the Critical ZOne Effort (http://www.internationalinnovation.com/the-critical-zone/)

2. Publication in Nature Communications by Ward et al. (http://www.nature.com/ncomms/2015/150508/ncomms8067/abs/ncomms8067.html) with associated highlights in many media outlets

[see https://www.google.com/search?q=Steroids+for+cattle+causing+sex+changes+in+fish&oq=Steroids+for+cattle+causing+sex+changes+in+fish&aqs=chrome..69i57j69i60j69i61.357j0j7&sourceid=chrome&es_sm=
8#q=Steroids+for+cattle+causing+sex+changes+in+fish&start=0]

Key outcomes or Other achievements:

The following new collaborations were established:

1. Collaboration with Dr. Gasparini funded by existing grant to foster use of LandLab in CZOs.
2. The USDA National Soil Survey Center in Lincoln NE has loaned the University of Tennessee the VNIR spectrometer for analyses
3. Diana Karwan, Dept. of Forest Resoursce, University of Minnesota. Joint study of sediment sourcing with isotopes
4. Sharon Billings, Dept. of Ecology & Evolutionary Biology, University of Kansas - Paired site study using an intact/ replicated ecosystems with deep, well-integrated root system (prairie or forest) and either an annually disturbed cropland or recently recovering system. Assess the biogeochemical consequences of disturbance severing and orphaning root systems. SOrCERO model (Billings et al. 2010) is a spreadsheet-based model to compute the extent to which any eroding soil profile serves as a net sink or source of CO_2. Model will provide IML-CZO with an independent check of our models to see the role of land management on carbon sequestration/ decomposition.
5. Marc Linderman, Associate Professor in the Dept. of Geographical and Sustainability Sciences at the University of Iowa. Dr. Linderman is in charge of the hyperspectral flights and analysis in Clear Creek. These flights are in conjunction with a NSF EPSCoR project.
6. Frank Loeffler, Dept. of Civil & Environmental Engineering, University of Tennessee Knoxville. Project Title: An integrated approach towards predictive understanding of N_2O flux in soil ecosystems. Study will elucidate the dynamics of relevant organisms, genes and transcripts over temporal and spatial scales to improve predictions of N_2O emissions from agricultural soils. Proposed analysis of stable isotope, qPCR, metagenomics, metatranscriptomics, amplicon sequencing, and mesocosms will complement ongoing efforts for predicting NEE from the skin of the earth. IML-CZO can share soil samples, model results, and investigator interactions.
7. Initial planning for a USGS Powell Center grant partnering with Shuguang Liu, Research Ecologist, Project Lead on Carbon Cycle and Global Change at the USGS for Earth Resources Observation and Science (EROS)
8. Liliana Lefticariu from the Univ. of Southern Illinois is planning on isotopic studies to understand the movement and residence times of meteoric water.
9. Jennifer Druhan, a recent Assistant Professor in Geology, joining Univ. of Illinois is collaborating on biogeochemistry of stable isotope processes in IML.

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

The tables below provide details of different activities associated with training and professional development.

Participant category	**Number**	**Gender**		**Disciplinary background**
		female	**male**	
Total participants	**164***	-	-	1 ABE, 1 BioEng, 6 CEE, 1 CEE/Geology, 1 CEE/IAHR, 3 CEE/IIHR, 2 EAS, 1 Eco Sys Sc & Mgmt, 1 Geography/GeoInfo, 1 Geology, 1 Geosciences, 1 Geosciences/IIHR, 1 IIHR, 1 EPS&CEE, 1 EPS, 5 PRI/ISGS, 1 PRI/ISWS, 1 SAFL/CEE, 1 SFL, 1 Watershed Science
Main personnel	33	5	28	1 ABE, 1 BioEng, 6 CEE, 1 CEE/Geology, 1 CEE/IAHR, 3 CEE/IIHR, 2 EAS, 1 Eco Sys Sc & Mgmt, 1 Geography/GeoInfo, 1 Geology, 1 Geosciences, 1 Geosciences/IIHR, 1 IIHR, 1 EPS&CEE, 1 EPS, 5 PRI/ISGS, 1 PRI/ISWS, 1 SAFL/CEE, 1 SFL, 1 Watershed Science

Postdoctoral	2	2	-	1, CEE; 1 Earth and Environmental Science
Graduate students	39	12	27	4 Geology, 2 Geography, 2 Engineering, 2 EAPS, 16 CEE, 2 Geoscience, 1 Earth & Planetary Sciences, 1 CS, 1 Earth and Environmental Science, 1 Geographic and Geographic Information Sciences, and others
Undergraduate students	13	7	6	1 Geoscience, 2 Geology, 2 Biology, 3 CEE, 1 CS, 3 Environmental, 1 Anthropology,
External participants1	74	-	-	(direct research, workshop delivery, cross-site exchanges, invited guests)

New courses related to IML-CZO project	1 (UI); 1 (Cross CZO Course on SOM for CUAHSI)	2
Presentations (public, academic)	all hands IML-CZO workshop (15 posters); public presentations (2 UI, 2 NU) IML-CZO seminar series (1); STEM teachers workshop (1 UI), webinars (1 UI, 1 NU, 2 PU)	25
STEM education/outreach class and field activities	Classes (1 UI, 1 UIUC,1 NU); STEM festivals (3 UI); Campus-wide (2 UI)	8
Social media	Youtube (1 PU, 1 UI, 1 UTK; 1 NU); Websites (2 UI), Twitter (1UI); Film production (1 UI)	8
Activities for K-12	in class (1 UI); after school (1 UI),	2
Partnerships	Local (1UI, 6 NU; 4 NU); National 1 UTK	12
International outreach	4 (watershed-focused and CZO partnerships);1 (UIUC Denmark)	5
Total number of participants benefitting from E&O activities	webinars (125 UI, 11 NU); courses (33); Collaborators (4 UI, 1 UIUC, 25 PU, 2 UI, 4 NU); Workshops (110 PU); STEM festival (UI) and Eng. Open House (UIUC) (1120); K-12 courses (30 UI); Teacher training (40 UI); Campus wide (38)	1543 (~ 25% female)

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

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

Task: G.1. Virtual engagement: website and social media: The IML-CZO national web site was enhanced and maintained in 2015 to highlight the education, research, news activities in 2015. Important publications included seven new journal publications and one book chapter that were featured on the website. Other activities included a joint AGE-ESA Event for collaborative networks, the cross CZO meeting in IL in May 2015, IML-CZO cyberseminar series, and IML-CZO meeting July 28-30th in Iowa. Nick Fetty journalism MS student in engaged on the project at no cost. He will be writing his thesis on the communication of science from researchers to a lay audience. Brianna Faber a PHD student in the social sciences is engaged on the project at no cost. Her research will examine attitudes of farmers to changing to various best management practices. The information is displayed on the IML-CZO website.

Task: G.2. Local CZO education-outreach activities: The K-12 education program for IML-CZO concepts were especially targeted for K-12 students and their parents at three all-day STEM festivals in eastern Iowa. This enabled an excellent coverage of IML-CZO research to a large and diverse K-12 audience. These included: (1) Cedar Rapids STEM Festival, Cedar Rapids, IA, 02/23/15 (270 attendees); (2) Drake University STEM, Des Moines, IA, 04/16/15 (350 attendees) and (3) Dubuque Family STEM Festival, Kehl Center, 04/18/15 (500 attendees). New developments in 2015 for IML-CZO education included a stream table, rainmaker, and various scale models combining discussion and "hand on" learning of IML-CZO research themes including soils, watersheds, agricultural drainage tiles, row crops, runoff, floods, wetlands, erosion,and nutrient/soil transport to streams to name just a few. In addition, two graduate students were employed in the teaching process of the K-12 students, gaining the MS students valuable experience on disseminating research to K-12 students. Students were given materials on science/engineering careers and cards for follow-up questions.

In addition, two other K-12 education events included an after school program developed for 5-6th graders on CZO concepts using the water cycle for the Burlington School in southeastern Iowa, 0/04/15, (30 students attended). Students in the program were predominantly from a rural background with 25% from low-income families. Science teachers at the middle school of Clear Creek Amana (CCA), IA were given materials and initial water quality information for monitoring Clear Creek (which cuts across school property). Amanda Simpson is lead science teacher at CCA for curriculum. The students in 2015-16 will then monitor and track basic water-quality as part of their science class. The IML-CZO is engaging IOWATER a volunteer water-quality monitoring program.

Science Teacher Training--Science teacher seminar for all high school science teachers in the Iowa City School District, with 40 teachers attending. Lecture and development of science teacher materials from IML-CZO in chemistry, math, earth sciences, physics, and engineering.

Integration of IML-CZO into University of Iowa STEM learning--Department of Education. April 2, 2015. Presentation to 25 participants from various STEM related departments on campus on IML-CZO activities for education and outreach.

WebX seminar--5 rural schools on IML-CZO and Mississippi River watershed, August 11, 2015, College of Education.

Graduate Engineering Student Chapters of IL and IA-- Workshop at LACMRERS on IML-CZ) , 25 graduate students (17 IL and 8 IA). 22 were Civil/Environmental Engineer and 1 was Electrical Engineering, and 2 were Mechanical Engineering.

Task G3: Graduate student led field tours and research expos

Graduate field trip for IL and IA students on IML-CZO was on August 19, 2015. The seminar and discussion was on IML-CZO research and topics in particular on the integrated approach through this study that can be applied in future work for the graduate students. There were 25 students, 17 IL and 8 IA. There were 8 females and 17 males. There were 15 minority students.

Graduate students from IL, IA, and Univ. of TN presented posters together on July 29, 2015 at the IML-CZO conference at LACMRERS, Univ. of IA

Task: G.4. External partnerships and programs (includes cross-site studies)

Art and Science Nexus-- Oftentimes science and art can operate in two different silos. As part of the education and outreach to reach a broader audience we have been working with Jeanine Breaker an intentional artist and lecturer with over 30 years experience from the Chicago area. Two years of Breaker's of art-science was at the British Geological Survey. This year Breaker has produced a short (~6 min) film using many images of the IML-CZO to tell story to better engage a lay audience. The film is not a documentary as such, but rather more to interest and engage a new audience in the IML-CZO. The film was presented at the CZO meeting and conference May 5, 2015 and will be posted on the web site.

Task G.5: Tracking Development of Critical Zone course and professional conferences

A four week summer intensive course at the University of Iowa in Water Quality and Quantity was taught May 18 to June 12, 2015 with large sections on the IML-CZO using field, lab, and lecture. There were 12 students: 3 graduate students in civil/environmental engineering, 2 undergraduates in chemical engineering, 1 undergraduate student in environmental science, and 6 undergraduates in civil/environmental engineering. Of the total students 7 were male and 5 were female. Three were minority students. In terms of recognition, we had Iowa Now and Big Ten network press coverage.

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

Cross-CZO Workshop on Proxies for Provenance and Process (PPP):

The Cross-CZO Workshop on Proxies for Provenance and Process was renamed to "Critical Zone Science, Sustainability, and Services in a Changing World". It is now part of the 2015 Joint US-China Annual Conferences of the U.S.-China EcoPartnership for Environmental Sustainability and the China-U.S. Joint Research Center for Ecosystem and Environmental Change. Filley is engaging the network of scientists in China who are part of the U.S.-China Ecopartnership to participate in the conference and help form linkages to the IML and CZO Network on like projects and sister-CZ sites. The conference satisfies our mission of cross CZO engagement and the formation of a bi-lateral CZ network with the emerging CZO in China.

This conference is run in conjunction with:

- 2015 workshop on Flux, Stabilization, and Reactivity of OM in the Critical Zone organized by the U.S. National Science Foundation Critical Zone (CZ) Observatory Network, Working Group on Organic Matter (OM) in the CZ.
- The Consortium for the Advancement of Hydrologic Science Instrumentation (CUAHSI) instrument training short course on The Role of Runoff and Erosion on Soil Carbon Stocks: From Soilscapes to Landscapes

The 2015 Joint Annual Conferences of the US-China EcoPartnership for Environmental Sustainability (USCEES) and the China-US Joint Research Center for Ecosystem and Environmental Change (JRCEEC) will focus on critical zone science, sustainability, and services. It will bring together and leverage the scientific communities from the USCEES, the JRCEEC, and members of the US Critical Zone Observatory Network (US-CZO) to address key aspects of CZ function and services and the threats to its sustainable use from a changing climate, increasing urbanization and population, and increasing resource extraction pressure.

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

At present there are no daviations from the original proposed work.

Supporting Files

Filename	Description	Uploaded By	Uploaded On

2015-AnnualReport-MajorActivities.pdf	The Major Activities for the different Themes of the project are described in this document.	Praveen Kumar	09/29/2015
2015-IMLCZO-SiteVisit-CombinedDocuments-Final.pdf	2015 Site Visit Documents and Steering Committee report	Praveen Kumar	11/08/2015
2015-AnnualReport-Outcomes.pdf	Major research outcomes from the project in year 2	Praveen Kumar	11/08/2015
2015-AnnualReport-Year3-BudgetRequest.pdf	Year 3 budget request and justification	Praveen Kumar	11/08/2015

Products

Books

Book Chapters

Papanicolaou, A.N., and B.K. Abban. (2015). Chapter 67: Channel Erosion and Sediment Transport. *Handbook of Applied Hydrology* McGraw-Hill.. . Status = PUBLISHED; Acknowledgement of Federal Support = Yes ; Peer Reviewed = Yes

Conference Papers and Presentations

Abban, B.K., A.N. Papanicolaou, K.M. Wacha, and C.G Wilson (2014). *A GIS-based framework for examining the effects of water-driven erosion on soil biogeochemical cycling*. American Geophysical Union Fall Meeting. San Francisco. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Gonzalez-Pinzon, R, AS Ward , C Hatch , AN Wlostowski , K Singha , MN Gooseff , R Haggerty , JW Harvey , OA Cirpka and JT Brock (2014). *A field comparison of techniques to quantify surface water- groundwater interactions*. American Geophysical Union Fall Meeting. . Status = OTHER; Acknowledgement of Federal Support = Yes

Burgin, AJ, TD Loecke, CA Davis, AS Ward, M St. Clair, D Riveros-Iregui, SA Thomas (2013). *Drought-induced enrichment of soil nitrogen leads to record high nitrate loading to agricultural river networks*. American Geophysical Union Fall Meeting. San Francisco. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Burgin, AJ, TD Loecke, CA Davis, AS Ward, M St. Clair, D Riveros-Iregui, SA Thomas (2013). *Drought-induced enrichment of soil nitrogen leads to record high nitrate loading to agricultural river networks*. American Geophysical Union Fall Meeting. . Status = OTHER; Acknowledgement of Federal Support = Yes

Allison E. Goodwell and Praveen Kumar (2014). *Ecosystem Network Shifts As Indicators of Climate Response*. American Geophysical Union Fall Meeting. San Francisco. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Allison Goodwell and Praveen Kumar (). *Ecosystem Network Shifts As Indicators of Climate Response*. AGU, Fall Meet. . Status = OTHER; Acknowledgement of Federal Support = Yes

Mostafa Elag, Praveen Kumar, Luigi Marini, Margaret Hedstrom, James D Myers and Beth A Plale (2014). *Emergent Data-Networks from Long-Tail Collections*. American Geophysical Union Fall Meeting. San Francisco. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Mostafa Elag, Praveen Kumar, Luigi Marini, Margaret Hedstrom, James D Myers and Beth A Plale (). *Emergent Data-Networks from Long-Tail Collections*. AGU, Fall Meet. . Status = OTHER; Acknowledgement of Federal Support = Yes

Wacha, K.M., A.N. Papanicolaou, B.K. Abban, C.G. Wilson, T.R. Filley, T. Hou, and J. Boys (). *Enrichment ratio and aggregate stability dynamics in intensely managed landscapes*. American Geophysical Union 2015 Fall Meeting. San Francisco. Status = OTHER; Acknowledgement of Federal Support = Yes

Phong V. Le and Praveen Kumar (2014). *Extreme Resolution Ecohydrologic Modeling for Understanding Micro-topographic Controls*. American Geophysical Union Fall Meeting. San Francisco. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Phong Le and Praveen Kumar (). *Extreme Resolution Ecohydrologic Modeling for Understanding Micro-topographic Controls*. AGU, Fall Meet. . Status = OTHER; Acknowledgement of Federal Support = Yes

Quinn W Lewis and Bruce L Rhoads (2014). *Field implementation of Particle Image Velocimetry (PIV) for studying flow dynamics at river confluences*. American Geophysical Union Fall Meeting. San Francisco. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Cullin, JA, AS Ward, DM Cwiertny, LB Barber, DW Kolpin, PM Bradley, SH Keefe, LE Hubbard (2014). *Field predictions of the fate and transport of a photolytic contaminant of emerging concern at Fourmile Creek in Ankeny, Iowa*. Fourth International Conference on Occurrence, Fate, Effects, & Analysis of Emerging Contaminants in the Environment. . Status = OTHER; Acknowledgement of Federal Support = Yes

Jessica A Zinger, Jim Best, Bruce L Rhoads and Timothy H Larson (2014). *Flow, Morphology and Sedimentology of an Evolving Chute Cutoff on the Wabash River, IL-IN*. American Geophysical Union Fall Meeting. San Francisco. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Elmer Arthur Bettis III, David A. Grimley, Alison M Anders, Bradford Bates and Emily Hannan (2014). *Fly Ash as a Time Marker for Anthropocene Alluvial Sedimentation*. American Geophysical Union Fall Meeting. San Francisco. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Praveen Kumar and Mostafa Elag (2014). *Geo-Semantic Framework for Integrating Long-Tail Data and Model Resources for Advancing Earth System Science*. American Geophysical Union Fall Meeting. San Francisco. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Debsunder Dutta and Praveen Kumar (2014). *High Resolution Imaging Spectroscopy for Characterizing Soil Properties over Large Areas*. American Geophysical Union Fall Meeting. San Francisco. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Reynolds, KN, TD Loecke, AJ Burgin, CA Davis, D Riveros-Iregui, SA Thomas, AS Ward, M St. Clair (2014). *High-frequency Water Quality Monitoring to Quantify Uncertainties of Sampling Strategies in Agricultural Watersheds*. The Future of Big Data: From Data to Knowledge. Nebraska Innovation Campus Conference Center. Status = OTHER; Acknowledgement of Federal Support = Yes

Hou, T., T.R. Filley, A.N. Papanicolaou, K.M. Wacha, B.K. Abban, C.G. Wilson, and J. Boys (2015). *Hillslope and erosional controls on soil organic geochemistry in intensely managed landscapes*. American Geophysical Union. San Francisco. Status = OTHER; Acknowledgement of Federal Support = Yes

Qina Yan and Praveen Kumar (2014). *Human Impact Intertwined with Glacial Legacy: Hydro-Geomorphologic Exploration using LiDAR data*. American Geophysical Union Fall Meeting. San Francisco. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Qina Yan and Praveen Kumar (). *Human Impact Intertwined with Glacial Legacy: Hydro-Geomorphologic Exploration using LiDAR data*. AGU, Fall Meet. . Status = OTHER; Acknowledgement of Federal Support = Yes

Gold, A, D Riveros-Iregui, CA Davis, AS Ward, AJ Burgin, TD Loecke, SA Thomas, MA St. Clair (2015). *Hydrologic and morphologic controls of nitrate concentrations in Iowa, USA*. Climate Change Symposium. University of North Carolina at Chapel Hill. Status = OTHER; Acknowledgement of Federal Support = Yes

Praveen Kumar and Dongkook Woo (2014). *Impact of Hydrologic Variability on Nutrient Age Distribution in Intensively Managed Landscapes*. American Geophysical Union Fall Meeting. San Francisco. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Praveen Kumar and Dong Kook Woo (). *Impact of Hydrologic Variability on Nutrient Age Distribution in Intensively Managed Landscapes*. AGU, Fall Meet. . Status = OTHER; Acknowledgement of Federal Support = Yes

Rachel Passig Oien, Alison M Anders and Ann Long (2014). *Improving the Laboratory Experience for Introductory Geology Students Using Active Learning and Evidence-Based Reform*. American Geophysical Union Fall Meeting. San Francisco. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Prior, K, AS Ward, CA Davis, AJ Burgin, TD Loecke, DA Riveros-Iregui, SA Thomas, MA St. Clair. (2014). *In-stream Nitrogen Processing and Dilution in an Agricultural Stream Network*. American Geophysical Union Fall Meeting. . Status = OTHER; Acknowledgement of Federal Support = Yes

Ward, A.S., K Prior, CA Davis, AJ Burgin, TD Loecke, DA Riveros-Iregui, DJ Schnoebelen, CL Just, SA Thomas, LJ Weber, MA St. Clair, SN Spak, KE Dalrymple (2015). *In-stream Nitrogen Processing and Dilution in an Agricultural Stream Network*. Society for Freshwater Science. . Status = OTHER; Acknowledgement of Federal Support = Yes

AS Ward, KE Dalrymple, SN Spak (2015). *In-stream nitrate responses integrate human and climate systems in an intensively managed landscape*. Water Sustainability and Climate Annual Meeting, National Science Foundation. . Status = OTHER; Acknowledgement of Federal Support = Yes

Ward, AS, CA Davis, A Burgin, T Loecke, D Riveros-Iregui, D Schnoebelen, C Just, S Thomas, L Weber, M St. Clair, S Spak, K Dalrymple, Y Li, K Prior (2014). *In-stream nitrate responses integrate human and climate systems in an intensively managed landscape*. American Geophysical Union Fall Meeting. . Status = OTHER; Acknowledgement of Federal Support = Yes

Bainbridge, S, AS Ward (2014). *Inter- and Intra-annual Nitrate Dynamics in Clear Creek During 2012 and 2013*. Summer Undergraduate Research Conference. . Status = OTHER; Acknowledgement of Federal Support = Yes

N. Blair, A. Ward, J. Moravek, Y. Zeng, D. Cooperberg, A. Bettis, K. Prior,, C. Davis (2015). *Landscape Response to a Storm Event in the Clear Creek, IA watershed*. Goldschmidt Conference. Prague. Status = OTHER; Acknowledgement of Federal Support = Yes

Bates, B., A. Anders, D. Grimley (2014). *Post-settlement alluviation in the Upper Sangamon River Basin, IL.*. The National Great Rivers Research and Education Center Student Poster. . Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Wacha, K.M., A.N. Papanicolaou, B.K. Abban, and C.G. Wilson (2014). *Potential carbon transport: linking soil aggregate stability and sediment enrichment for updating the soil active layer within intensely managed landscapes*. American Geophysical Union Fall Meeting. San Francisco. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Ward, AS, DM Cwiertny, EP Kolodziej (2014). *Product-to-parent reversion processes: Stream-hyporheic spiraling increases ecosystem exposure and environmental persistence*. American Geophysical Union Fall Meeting. . Status = OTHER; Acknowledgement of Federal Support = Yes

24. Ward, AS, JA Cullin, DM Cwiertny, LB Barber, DW Kolpin, PM Bradley, SH Keefe, LE Hubbard (). *Reach-scale predictions of the fate and transport of contaminants of emerging concern at Fourmile Creek in Ankeny, Iowa*. Fourth International Conference on Occurrence, Fate, Effects, & Analysis of Emerging Contaminants in the Environment. . Status = OTHER; Acknowledgement of Federal Support = Yes

Abban, B., A.N. Papanicolaou, C.G. Wilson, O. Abaci, K. Wacha, and D.E. Schnoebelen (2015). *Sediment Fingerprinting in Intensively Managed Landscapes: Application of an Enhanced Bayesian Un-mixing Framework that accounts for Spatiotemporal Heterogeneity to Study Intra-Seasonal Trends in Source Contributions*. Fall American Geophysical Union. . Status = OTHER; Acknowledgement of Federal Support = Yes

Darren Drewry, Praveen Kumar and Steve Long (2014). *Simultaneous Improvement in Water Use, Productivity and Albedo Through Crop Structural Modification*. AGU, Fall Meet. . Status = OTHER; Acknowledgement of Federal Support = Yes

Bruce L Rhoads, Quinn W Lewis and William Andresen (2014). *Stream Channel Change in an Intensively Managed Agricultural Landscape: Implications for Critical Zone Processes*. American Geophysical Union Fall Meeting. San Francisco. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Muhammad Umar, Bruce L Rhoads and Jonathan A Greenberg (2014). *Suspended Solids Mixing in Large River Confluences: A Remote Sensing Perspective*. American Geophysical Union Fall Meeting. San Francisco. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Blair, N.E (2014). *The Fate of Eroded Soil C Across the Landscape and Bathyscape*. Seminar at Indiana University – Purdue University Indianapolis. . Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Dongkook Woo, Juan Quijano, Praveen Kumar, Sayo Chaoka and Carl Bernacchi (). *Threshold Dynamics in Soil Carbon Storage for Bioenergy Crops*. AGU, Fall Meet. . Status = OTHER; Acknowledgement of Federal Support = Yes

Mingjing Yu, Bruce L Rhoads, Conor Neal and Alison M Anders (2014). *Tracing suspended sediment sources in the Upper Sangamon River Basin using fingerprinting techniques*. American Geophysical Union Fall Meeting. San Francisco. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Kory M Konsoer, Bruce L Rhoads, Jim Best, Christian E Frias, Jorge D Abad and Eddy J Langendoen (2014). *Using High-Resolution Field Measurements to Model Dune Kinematics in a Large Elongate Meander Bend*. American Geophysical Union Fall Meeting. San Francisco. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Dalrymple, KE, J Krajewski, AS Ward, SN Spak (2015). *We are what we drink: Examining public perceptions of water quality in the agricultural Midwest*. Water Sustainability and Climate Annual Meeting, National Science Foundation. . Status = OTHER; Acknowledgement of Federal Support = Yes

Inventions

Journals

Abban, B., A.N. Papanicolaou, M.K. Cowles, C.G. Wilson, O. Abaci, K. Wacha, and K.E. Schilling (2015). Sediment source dynamics in the headwater stream of an intensively cultivated agricultural watershed: A Bayesian fingerprinting study using stable isotopes. *Water Resources Research*. . Status = SUBMITTED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Allison Goodwell, and P. Kumar (2015). Information theoretic measures to infer feedback dynamics in coupled logistic networks. *Entropy*. . Status = SUBMITTED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Athanasios (Thanos) N. Papanicolaou and Mohamed Elhakeem and Christopher G. Wilson and C. Lee Burras and Larry T. West and Hangsheng (Henry) Lin and Ben Clark and Brad E. Oneal (2015). Spatial variability of saturated hydraulic conductivity at the hillslope scale: Understanding the role of land management and erosional effect . *Geoderma* . 243–244 58 - 68. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: http://dx.doi.org/10.1016/j.geoderma.2014.12.010

Bressan, F., A.N. Papanicolaou, and B. Abban (2014). A model for knickpoint migration in first and second order streams.. *Geophysical Research Letters*. 41 (14), 4987-4996. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Debsunder Dutta, Kunxuan Wang, Esther Le, Allison Goodwell, Derek Wagner (2015). Characterizing Vegetation Canopy Structure using Airborne Remote Sensing Data. *IEEE Trans*. . Status = OTHER; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Dermisis, D., A.N. Papanicolaou, B. Abban, and D. Flanagan (2015). Dynamic approach for predicting soil transport and delivery from fields and small catchments to headwater streams: field experiments and analysis. *Water Resources Research*. . Status = SUBMITTED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Dong K Woo and P. Kumar (2015). Impact of Hydrologic Variability on Mean Age Distribution of Soil-Nitrogen. *Water Resources Research*. . Status = SUBMITTED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Dong K. Woo and Juan C. Quijano and Praveen Kumar and Sayo Chaoka and Carl J. Bernacchi (2014). Threshold Dynamics in Soil Carbon Storage for Bioenergy Crops. *Environmental Science \& Technology*. 48 (20), 12090-12098. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1021/es5023762

Drewry, Darren T. and Kumar, Praveen and Long, Stephen P. (2014). Simultaneous improvement in productivity, water use, and albedo through crop structural modification. *Global Change Biology*. 20 (6), 1955--1967. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1111/gcb.12567

Dutta, D. and Goodwell, A.E. and Kumar, P. and Garvey, J.E. and Darmody, R.G. and Berretta, D.P. and Greenberg, J.A. (2015). On the Feasibility of Characterizing Soil Properties From AVIRIS Data. *Geoscience and Remote Sensing, IEEE Transactions on*. 53 (9), 5133-5147. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1109/TGRS.2015.2417547

Elag, M., J. Goodall, and P. Kumar (2015). Leveraging Semantics to Improve the Interoperability of Hydrologic Models. *Env. Modeling and Software*. . Status = SUBMITTED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Elhakeem, M., A.N. Papanicolaou, C. Wilson, and Y. Chang (2014). Prediction of saturated hydraulic conductivity dynamics in an Iowan agriculture watershed. *International Journal of Biological, Veterinary, Agricultural and Food Engineering*. 8 (3), 185-189.. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

González-Pinzón, R., AS Ward, CE Hatch, AN Wlostowski, K Singha, MN Gooseff, R Haggerty, JW Harvey, OA Cirpka, and J Brock (2015). A field comparison of techniques to quantify surface water groundwater interactions. *Freshwater Science*. 34 (1), 139-160. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Just, C, H Ausland, AS Ward, L Licht (2015). Enhanced Vadose Zone Nitrogen Removal by Poplar During Dormancy. *International Journal of Phytoremediation*. 17 (8), 729-736. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Kumar, Praveen (2015). Hydrocomplexity: Addressing water security and emergent environmental risks. *Water Resources Research*. 51 (7), 5827--5838. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1002/2015WR017342

Le, Phong V. V. and Kumar, Praveen (2014). Power law scaling of topographic depressions and their hydrologic connectivity. *Geophysical Research Letters*. 41 (5), 1553--1559. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1002/2013GL059114

Papanicolaou, A.N., K.M. Wacha, B.K. Abban, C.G. Wilson, J. Hatfield, C. Stanier, and T. Filley (2015). From Soilscapes to Landscapes: A landscape-oriented approach to simulate soil organic carbon dynamics in Intensely Managed Landscapes. *Journal of Geopysical Research Biogeosciences*. . Status = SUBMITTED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Papanicolaou, A.N., K.M. Wacha, C.G. Wilson, B.K. Abban (2014). From Soilscapes to Landscapes: A Landscape-oriented Approach to Simulate Soil Organic Carbon Dynamics in Intensely Managed Landscapes (IMLs). *Earth Surface Processes and Landforms*. . Status = PUBLISHED; Acknowledgment of Federal Support = No ; Peer Reviewed = Yes

Papanicolaou, A.N., M. Elhakeem, C.G. Wilson, C.L. Burras, L.T. West, H. Lin, B. Clark, and B.E. Oneal (2014). Spatial Variability of Saturated Hydraulic Conductivity at the Hillslope Scale: 1 understanding the role of Land Management and Erosional Effects. *Geoderma*. . Status = PUBLISHED; Acknowledgment of Federal Support = No ; Peer Reviewed = Yes

Papanicolaou, A.N., M. Elhakeem, D. Chang, C.G. Wilson, K. Schilling, D. Schnoebelen (2015). hydoscape to soilscape- A remote sensing approach to quantify flow paths and ponding regions in Iowa. *CATENA*. . Status = OTHER; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Parsons, K., E.A. Bettis, C.G. Wilson, A.N. Papanicolaou (2015). Spatial Patterns and Rates of Historic Sediment Accumulation in a Small Midwestern Catchment. *Geomorphology*. . Status = OTHER; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Phong V.V. Le and Praveen Kumar and Albert J. Valocchi and Hoang-Vu Dang (2015). GPU-based high-performance computing for integrated surface–sub-surface flow modeling . *Environmental Modelling & Software* . 73 1 - 13. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: http://dx.doi.org/10.1016/j.envsoft.2015.07.015

Quijano, Juan C. and Kumar, Praveen (2015). Numerical simulations of hydraulic redistribution across climates: The role of the root hydraulic conductivities. *Water Resources Research*. n/a--n/a. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1002/2014WR016509

Schilling, K.E., M.T. Streeter, K.J. Hutchinson, C.G. Wilson, B. Abban, K.M. Wacha, and A.N. Papanicolaou (2015). Evaluating the effects of land cover on streamflow variability in a small Iowa watershed: Toward development of sustainable and resilient landscapes. *American Journal of Environmental Science*. . Status = ACCEPTED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Thomas, J.T., A.N. Papanicolaou, C.G. Wilson, A.E. Bettis, and M. Elhakeem (2015). Mechanisms of knickpoint migration in a channelized western Iowa stream.. *Earth Surface Processes and Landfroms*. . Status = SUBMITTED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Ward, AS, DM Cwiertny, EP Kolodziej, CC Brehm. (2015). Coupled reversion and stream-hyporheic exchange processes increase environmental persistence of trenbolone metabolites. *Nature Communications*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1038/ncomms8067

Licenses

Other Products

Conference poster.

N.E. Blair, E.L. Leithold, C.E. Thompson, L.B. Childress, K. Fournillier (2014) The Fate of Soil OC in the Marine Environment: Examples from the Rapidly Eroding Landscapes of Two New Zealand North Island Rivers. Fall AGU Meeting, San Francisco, December 2014.

Conference presentation.

Praveen Kumar, Intensively Managed Landscapes (IML)-Critical Zone Observatory (CZO), Presented at 2014 Illinois Water Conference, 14-15 Oct, 2014.

Invited lectures and presentation.

Nanjing Agricultural University, Nanjing, China

Invited Lectures and Presentations.

Resolving Carbon's Rainbow from Uplands to the Deep Sea or What Happens to Eroded Soil C Argonne Laboratory, September 2015

Invited Lectures and Presentations.

Resolving Carbon's Rainbow from Uplands to the Deep Sea or What Happens to Eroded Soil C Indiana University, School of Public and Environmental Affairs, March 2015.

Invited Lectures and Presentations.

Resolving Carbon's Rainbow from Uplands to the Deep-sea. Univ. of Minnesota-Duluth Chemistry Department, Dec 2014.

Invited Lectures and Presentations.

Ward, AS. Coupled reversion and stream-hyporheic exchange processes increase environmental persistence of trenbolone metabolites. Prairie Research Institute, University of Illinois at Urbana-Champaign. 2015.

Invited Lectures and Presentations.

Ward, AS. Flood and drought-enhanced variations in streamwater nitrate flux in an agricultural watershed. Environmental Science Seminar Series, Iowa State University. 2014.

Invited Lectures and Presentations.

Institute of Applied Ecology, Chinese Academy of Sciences, Shenyang, China

Invited Lectures and Presentations.

Shenyang Agricultural University, Shenyang, China

Other Publications

Patents

Technologies or Techniques

Thesis/Dissertations

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	1
Filley, Timothy	Co PD/PI	1
Papanicolaou, Thanos	Co PD/PI	1
Belmont, Patrick	Co-Investigator	0
Blair, Neal	Co-Investigator	1
Burkholder, Barbara	Co-Investigator	0
Chaubey, Inderjeet	Co-Investigator	0
Foufoula-Georgiou, Efi	Co-Investigator	0
Garcia, Marcelo	Co-Investigator	0
Grimley, David	Co-Investigator	0

Jacobson, Andrew	Co-Investigator	0
Krajewski, Witold	Co-Investigator	0
Laura, Keefer	Co-Investigator	2
Lin, Henry	Co-Investigator	1
Marini, Luigi	Co-Investigator	2
Muste, Marian	Co-Investigator	1
Packman, Aaron	Co-Investigator	0
Parker, Gary	Co-Investigator	0
Peschel, Joshua	Co-Investigator	1
Phillips, Andrew	Co-Investigator	0
Rhoads, Bruce	Co-Investigator	1
Schnoebelen, Douglas	Co-Investigator	1
Ward, Adam	Co-Investigator	1
Weber, Larry	Co-Investigator	0
Wilson, Christopher	Co-Investigator	2
Kumar, Charu	Faculty	0
Michalski, Greg	Faculty	0
Elag, Mostafa	Postdoctoral (scholar, fellow or other postdoctoral position)	1
Hernandez, Oscar	Postdoctoral (scholar, fellow or other postdoctoral position)	2
Le, Phong	Postdoctoral (scholar, fellow or other postdoctoral position)	0
Lu, Nanxi	Postdoctoral (scholar, fellow or other postdoctoral position)	0
Quijano, Juan	Postdoctoral (scholar, fellow or other postdoctoral position)	1
Yu, Mingjing	Postdoctoral (scholar, fellow or other postdoctoral position)	6
Keefer, Donald	Other Professional	1
Larson, Timothy	Other Professional	1
Lin, Yu-feng	Other Professional	1

Angelo, Brock	Technician	6
Abban, Benjamin	Graduate Student (research assistant)	12
Amir, Abbas	Graduate Student (research assistant)	6
Arnott, Ryan	Graduate Student (research assistant)	3
Berry, Timothy	Graduate Student (research assistant)	1
Boys, John	Graduate Student (research assistant)	12
Burns, Adam	Graduate Student (research assistant)	0
Cain, Molly	Graduate Student (research assistant)	3
Childress, Laurel	Graduate Student (research assistant)	0
Culotti, Alessandro	Graduate Student (research assistant)	0
Dutta, Debsunder	Graduate Student (research assistant)	0
Ettema, Will	Graduate Student (research assistant)	3
Farber, Brianna	Graduate Student (research assistant)	1
Fetty, Nicholas	Graduate Student (research assistant)	2
Giannopoulos, Christos	Graduate Student (research assistant)	12
Goodwell, Allison	Graduate Student (research assistant)	0
Handa, Saki	Graduate Student (research assistant)	0
Hester, Ulyssa	Graduate Student (research assistant)	3
Jiang, Peishi	Graduate Student (research assistant)	0
Lai, Jingtao	Graduate Student (research assistant)	0
Leonard, Michael	Graduate Student (research assistant)	1
Lewis, Quinn	Graduate Student (research assistant)	1
Li, Zheng	Graduate Student (research assistant)	0
Maciel, Fernanda	Graduate Student (research assistant)	3
Muhammad, Umar	Graduate Student (research assistant)	3
Parsons, Kelli	Graduate Student (research assistant)	6

Prior, Kara	Graduate Student (research assistant)	6
Richardson, Meredith	Graduate Student (research assistant)	0
Roots, Paul	Graduate Student (research assistant)	6
Schmalle, Kayla	Graduate Student (research assistant)	2
Tokuhisa, Rai	Graduate Student (research assistant)	10
Wacha, Kenneth	Graduate Student (research assistant)	12
Wagner, Derek	Graduate Student (research assistant)	3
Wang, Kunxuan	Graduate Student (research assistant)	0
Woo, Dongkook	Graduate Student (research assistant)	6
Xu, Haowen	Graduate Student (research assistant)	0
Yan, Qina	Graduate Student (research assistant)	6
Ainsley, Benjamin	Undergraduate Student	0
Coker-Gunnick, Sophia	Undergraduate Student	0
Cooperberg, Danna	Undergraduate Student	0
DeBartolo, Gia	Undergraduate Student	0
Dunn, Jesse	Undergraduate Student	3
Gamblin, David	Undergraduate Student	1
Hughes, Madison	Undergraduate Student	0
Kirton, Erin	Undergraduate Student	0
Mettenberg, Daniel	Undergraduate Student	3
Moravek, Jessie	Undergraduate Student	1
Sevilla, Tiffany	Undergraduate Student	0
Shen, Bomo	Undergraduate Student	2
WInters, Jake	Undergraduate Student	0
Bauer, Erin	Other	1
Hodson, Tim	Other	1

Seek, Lara	Other	0
Storsved, Brynne	Other	1
Zeng, Yue	Other	12

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, Denmark
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 (IMLCZO)

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: 1

Contribution to the Project: Co-PI

Funding Support: NSF (IMLCZO)

International Collaboration: No
International Travel: No

Timothy Filley
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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

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

Funding Support: NSF (IMLCZO)

International Collaboration: No
International Travel: No

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

Neal Blair
Email: n-blair@northwestern.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Co-Lead Theme C, carbo-cycling processes, biogeochemistry of organic carbon

Funding Support: Northwestern University

International Collaboration: No
International Travel: No

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

Contribution to the Project: E&O

Funding Support: None

International Collaboration: No
International Travel: No

Inderjeet Chaubey
Email: ichaubey@purdue.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 0

Contribution to the Project: ecohydrology, watershed modeling, soil erosion

Funding Support: Purdue University

International Collaboration: No

International Travel: No

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

Contribution to the Project: geomorphic transport, scaling in river basins

Funding Support: University of Minnesota

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

David Grimley
Email: dgrimley@illinois.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 0

Contribution to the Project: glacial sedimentary processes

Funding Support: ILLINOIS STATE GEOLOGICAL SURVEY

International Collaboration: No
International Travel: No

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

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

Keefer Laura
Email: lkeefer@illinois.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 2

Contribution to the Project: Upper Sangamon River Basin Site & Facilities Co-coordinator, Fluvial Geomorphology, Hydraulics/Hydrology

Funding Support: NSF (IMLCZO) & University of Illinois, Illinois State Water Survey

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

Luigi Marini
Email: lmarini@illinois.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 2

Contribution to the Project: Co-Lead Cyber, large-scale data management system, cyber collaborator, CZOData Information Management Committee

Funding Support: NSF (IMLCZ) & University of Illinois/NCSA

International Collaboration: No
International Travel: No

Marian Muste
Email: marian-muste@uiowa.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Co-Lead Cyber, river mechanics, non-intrusive instrumentation, digital observatories, CZOData Information Management Committee

Funding Support: NSF (IMLCZ) & University of Iowa

International Collaboration: No
International Travel: No

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

Funding Support: Northwestern University

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

Joshua Peschel
Email: peschel@illinois.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: USRB Site & Facilities Co-coordinator, unmanned aerial system, robotics

Funding Support: University of Illinois/CEE

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

Bruce Rhoads
Email: brhoads@illinois.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Co-Lead Theme D, Floodplain and Stream Morphology, Fluvial Dynamics, Land use impacts

Funding Support: NSF (IMLCZO) & University of Illinois

International Collaboration: No
International Travel: No

Douglas Schnoebelen
Email: douglas-schnoebelen@uiowa.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: E&O Co-Coordinator, nutrient and sediment transport, CZO Network Web manager group

Funding Support: NSF (IMLCZO) & University of Iowa

International Collaboration: No
International Travel: No

Adam Ward
Email: adamward@indiana.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Co-Lead Theme C, solute movement, biogeochemical transport across steam-landscape-aquifer connectivity

Funding Support: NSF (IMLCZO) & Indiana University

International Collaboration: No
International Travel: No

Larry Weber
Email: larry-weber@uiowa.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 0

Contribution to the Project: environmetal hydraulics, tile drainage.

Funding Support: University of Iowa

International Collaboration: No
International Travel: No

Christopher Wilson
Email: christopher-wilson@uiowa.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 2

Contribution to the Project: CCW Site & Facilities Coordinator, geochronology, radionuclide tracers, bank erosion and finger printing

Funding Support: NSF (IMLCZO) & University of Iowa

International Collaboration: No
International Travel: No

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

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

International Collaboration: No
International Travel: No

Mostafa Elag
Email: elag@illinois.edu
Most Senior Project Role: Postdoctoral (scholar, fellow or other postdoctoral position)
Nearest Person Month Worked: 1

Contribution to the Project: Cyberinfrastructure

Funding Support: NSF (ACI)

International Collaboration: No
International Travel: No

Oscar Hernandez
Email: oscar-hernandezmurcia@uiowa.edu
Most Senior Project Role: Postdoctoral (scholar, fellow or other postdoctoral position)
Nearest Person Month Worked: 2

Contribution to the Project: E&O, modeling

Funding Support: INRC and LACMRERS funds/NSf (IML-CZO)

International Collaboration: No
International Travel: No

Phong Vu Viet Le
Email: phongle1@illinois.edu
Most Senior Project Role: Postdoctoral (scholar, fellow or other postdoctoral position)
Nearest Person Month Worked: 0

Contribution to the Project: Ecohydrologic processes, flow and moisture transport near surface at lidar data scale

Funding Support: University of Illinois

International Collaboration: No
International Travel: No

Nanxi Lu
Email: nanxi.lu@northwestern.edu
Most Senior Project Role: Postdoctoral (scholar, fellow or other postdoctoral position)
Nearest Person Month Worked: 0

Contribution to the Project: Biogeography of environmental microbiome at the IML-CZO

Funding Support: Other

International Collaboration: No
International Travel: No

Juan C Quijano
Email: quijano2@illinois.edu
Most Senior Project Role: Postdoctoral (scholar, fellow or other postdoctoral position)
Nearest Person Month Worked: 1

Contribution to the Project: ecohydrologic & nutrient dynamics modeling

Funding Support: University of Illinois

International Collaboration: No
International Travel: No

Mingjing Yu
Email: myu18@illinois.edu
Most Senior Project Role: Postdoctoral (scholar, fellow or other postdoctoral position)
Nearest Person Month Worked: 6

Contribution to the Project: Stimulating and predicting long-term sediment dynamics at watershed scale

Funding Support: China Scholarship Council/NSF (IML-CZO)

International Collaboration: No
International Travel: No

Donald Keefer
Email: dkeefer@illinois.edu
Most Senior Project Role: Other Professional
Nearest Person Month Worked: 1

Contribution to the Project: glacial deposit mapping, shallow groundwater flow

Funding Support: ILLINOIS STATE GEOLOGICAL SURVEY

International Collaboration: No
International Travel: No

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

International Collaboration: No
International Travel: No

Yu-feng Lin

Email: yflin@illinois.edu
Most Senior Project Role: Other Professional
Nearest Person Month Worked: 1

Contribution to the Project: geograhic information systems

Funding Support: Illinois State Geological Survey

International Collaboration: No
International Travel: No

Brock Angelo
Email: jba@illinois.edu
Most Senior Project Role: Technician
Nearest Person Month Worked: 6

Contribution to the Project: large-scale data management system, cyber collaborator

Funding Support: NSF (IMLCZO) & University of Illinois/NCSA

International Collaboration: No
International Travel: No

Benjamin Abban
Email: benjamin-abban@uiowa.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 12

Contribution to the Project: Which controlling variables govern watershed response in terms of runoff and sediment fluxes; at what scales are the variables important; and what are the spatiotemporal scaling laws between these variables, runoff and sediment?

Funding Support: NSF (IMLCZO) & University of Tennessee, Knoxville - University of Iowa

International Collaboration: No
International Travel: No

Abbas Ali Amir
Email: abbasali-amir@uiowa.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 6

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

Ryan Arnott
Email: arnott2@illinois.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 3

Contribution to the Project: Spatial and Temporal Variability in Floodplain Sedimentation during Individual Hydrologic Events on a Lowland, Meandering River: Allerton Park, Monticello, Illinois

Funding Support: University of Illinois at Urbana-Champaign/NSF(IML-CZO)

International Collaboration: No

International Travel: No

Timothy Berry
Email: berry10@purdue.edu
Most Senior Project Role: Graduate Student (research assistant)
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

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

Adam Burns
Email: burns7@illinois.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 0

Contribution to the Project: A Mobile High-Resolution Phenotyping Robot

Funding Support: Gates Foundation; Peschel

International Collaboration: No
International Travel: No

Molly Cain
Email: cainmr@umail.iu.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 3

Contribution to the Project: Connectivity of water and nutrient fluxes

Funding Support: NSF (IMLCZO) & Indiana University

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: 0

Contribution to the Project: stream sediment analysis

Funding Support: NSF

International Collaboration: No
International Travel: No

Alessandro Culotti
Email: aculotti@u.northwestern.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 0

Contribution to the Project: How does IML land use and water drainage influence the diversity and composition of microbial communities

Funding Support: Water Research Foundation

International Collaboration: No
International Travel: No

Debsunder Dutta
Email: ddutta3@illinois.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 0

Contribution to the Project: Prediction of landscape attributes using Hyperspectral Remote Sensing

Funding Support: NASA Fellowship

International Collaboration: No
International Travel: No

Will Ettema
Email: william-ettema@uiowa.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 3

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

Brianna Farber
Email: bdfarber13@gmail.com
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 1

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

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

International Collaboration: No
International Travel: No

Nicholas Fetty
Email: nick-fetty@uiowa.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 2

Contribution to the Project: E &O, Communications

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

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: 12

Contribution to the Project: Instream travel times, Sediment Transport

Funding Support: NSF (IML-CZO)

International Collaboration: No
International Travel: No

Allison Goodwell
Email: goodwel2@illinois.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 0

Contribution to the Project: How do ecosystems act as networks under variable environmental conditions, and how can network properties predict threshold conditions

Funding Support: University of Illinois at Urbana-Champaign

International Collaboration: No
International Travel: No

Saki Handa
Email: shanda3@illinois.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 0

Contribution to the Project: Human-Machine Interaction for Unmanned Surface Systems

Funding Support: Gates Foundation; Peschel

International Collaboration: No
International Travel: No

Ulyssa Hester
Email: uhester@purdue.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 3

Contribution to the Project: stabilization of plant C and N in microbial Biomass and mineral surfaces

Funding Support: Purdue Diversity Scholarship/NSF (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: 0

Contribution to the Project: Integration of long-tail data and models by semantic web

Funding Support: University of Illinois at Urbana-Champaign/other

International Collaboration: No
International Travel: No

Jingtao Lai
Email: jlai11@illinois.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 0

Contribution to the Project: Numerical modeling of landscape evolution from glacial to pre-settlement conditions

Funding Support: fellowship from Geology

International Collaboration: No
International Travel: No

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

Quinn Lewis
Email: qlewis2@illinois.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 1

Contribution to the Project: Geography and Geographic Information Science

Funding Support: VCR NGGREC Funds/NSF(IML-CZO)

International Collaboration: No
International Travel: No

Zheng Li
Email: zhengli6@illinois.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 0

Contribution to the Project: Nonisothermal Vapor Diffusivity in Soils

Funding Support: ORD; Peschel

International Collaboration: No
International Travel: No

Fernanda Maciel
Email: maciely2@illinois.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 3

Contribution to the Project: Spatially Distributed Bioaccumulation Risk Analysis: A GIS-Based Tool and a Case Study of Polychlorinated Biphenyls in the Great Lakes

Funding Support: Fulbright; Peschel; NGRREC/NSF(IML-CZO)

International Collaboration: No
International Travel: No

Umar Muhammad
Email: umar83@illinois.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 3

Contribution to the Project: Geomorphology

Funding Support: VCR NGRREC Funds/NSF(IML-CZO)

International Collaboration: No
International Travel: No

Kelli Parsons
Email: kelli-parsons@uiowa.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 6

Contribution to the Project: how has agricultural aland management affected sediment dynamics in a headwater basin

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

International Collaboration: No
International Travel: No

Kara Prior
Email: kara-prior@uiowa.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 6

Contribution to the Project: Nitrogen processing in agricultural stream networks

Funding Support: University of Iowa/NSF(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: 0

Contribution to the Project: Ecosystem Services related to CZO

Funding Support: NSF (ACI)

International Collaboration: No
International Travel: No

Paul Roots
Email: pkroots@gmail.com
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 6

Contribution to the Project: stream sediment analysis

Funding Support: NSF (IML-CZO)

International Collaboration: No
International Travel: No

Kayla Schmalle
Email: kayla-schmalle@uiowa.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 2

Contribution to the Project: How does the late glacial history of large valleys in glaciated regions affect their response to glacial/interglacial climate transitions

Funding Support: NSF (EPSCoR), NSF (IML-CZO)

International Collaboration: No
International Travel: No

Rai Tokuhisa
Email: rai-tokuhisa@uiowa.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 10

Contribution to the Project: Urban Stream/biocells

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

International Collaboration: No
International Travel: No

Kenneth Wacha
Email: kenneth-wacha@uiowa.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 12

Contribution to the Project: What are the key mechanisms affecting changes in SOM storage potential within IMLs?

Funding Support: Other/NSF(IML-CZO)

International Collaboration: No
International Travel: No

Derek Wagner
Email: wagner29@illinois.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 3

Contribution to the Project: Water quality, Placement of sensors at Allerton Park

Funding Support: NSF (ACI)

International Collaboration: No
International Travel: No

Kunxuan Wang
Email: kswang3@illinois.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 0

Contribution to the Project: Hydrology

Funding Support: NSF (ACI)

International Collaboration: No
International Travel: No

Dongkook Woo
Email: dwoo5@illinois.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 6

Contribution to the Project: Soil nitrogen age distribution, providing the comprehensive understanding of the fate of nitrogen inputs and the actual dynamics liking spatio-temperal pattern of distribution of nitrogen age to water flow processes.

Funding Support: NSF/IML-CZO

International Collaboration: No
International Travel: No

Haowen Xu
Email: haowen-xu@uiowa.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 0

Contribution to the Project: Cyberinfrastructure

Funding Support: University of Iowa

International Collaboration: No
International Travel: No

Qina Yan
Email: qinayan2@illinois.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 6

Contribution to the Project: How does glacial legacy and human legacy affect present day hydrologic dynamics

Funding Support: NSF (IML-CZO)

International Collaboration: No
International Travel: No

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

Sophia Coker-Gunnick
Email: sophia-cokergunnick@uiowa.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 0

Contribution to the Project: undergrad research green storm water infrastructure

Funding Support: Other

International Collaboration: No
International Travel: No

Danna Cooperberg
Email: DannaCooperberg2016@u.northwestern.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 0

Contribution to the Project: stream sediment analysis

Funding Support: Other

International Collaboration: No
International Travel: No

Gia DeBartolo
Email: giamarie-debartolo@uiowa.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 0

Contribution to the Project: undergrad research green storm water infrastructure

Funding Support: Other

International Collaboration: No
International Travel: No

Jesse Dunn
Email: jesse-dunn@uiowa.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 3

Contribution to the Project: undergrad research shallow groundwater

Funding Support: other

International Collaboration: No
International Travel: No

David Gamblin
Email: gamblind@purdue.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 1

Contribution to the Project: Other

Funding Support: Other

International Collaboration: No
International Travel: No

Madison Hughes
Email: hughes80@purdue.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 0

Contribution to the Project: Undergrad research: Isoscapes in CCW baseline

Funding Support: Other

International Collaboration: No
International Travel: No

Erin Kirton
Email: ErinKirton2015@u.northwestern.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 0

Contribution to the Project: stream sediment analysis

Funding Support: Northwestern URG

International Collaboration: No
International Travel: No

Daniel Mettenberg
Email: daniel-mettenberg@uiowa.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 3

Contribution to the Project: undergrad research soil sediment dynamics

Funding Support: U of Iowa

International Collaboration: No
International Travel: No

Jessie Moravek

Email: jessiemoravek@gmail.com
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 1

Contribution to the Project: stream sediment analysis

Funding Support: Other

International Collaboration: No
International Travel: No

Tiffany Sevilla
Email: tiffanysevilla2015@u.northwestern.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 0

Contribution to the Project: How does IML land use and water drainage influence the diversity and composition of microbial communities

Funding Support: Northwestern Murphy Fellowship

International Collaboration: No
International Travel: No

Bomo Shen
Email: shen-bomo@uiowa.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 2

Contribution to the Project: Cyberinfrastructure

Funding Support: NSF/(IML-CZO)

International Collaboration: No
International Travel: No

Jake WInters
Email: winters9@purdue.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 0

Contribution to the Project: Undergrad research: soil DOC

Funding Support: Other

International Collaboration: No
International Travel: No

Erin Bauer
Email: ebauer@illinois.edu
Most Senior Project Role: Other
Nearest Person Month Worked: 1

Contribution to the Project: Other

Funding Support: Illinois Department of Natural Resources

International Collaboration: No

International Travel: No

Tim Hodson
Email: tohodson@gmail.com
Most Senior Project Role: Other
Nearest Person Month Worked: 1

Contribution to the Project: Other

Funding Support: NSF (IML-CZO)

International Collaboration: No
International Travel: No

Lara Seek
Email: laraseek@illinois.edu
Most Senior Project Role: Other
Nearest Person Month Worked: 0

Contribution to the Project: Other

Funding Support: Illinois Department of Natural Resources

International Collaboration: No
International Travel: No

Brynne Storsved
Email: storsve2@illinois.edu
Most Senior Project Role: Other
Nearest Person Month Worked: 1

Contribution to the Project: Other

Funding Support: NSF (IML-CZO)

International Collaboration: No
International Travel: No

Yue Zeng
Email: yuezeng2017@u.northwestern.edu
Most Senior Project Role: Other
Nearest Person Month Worked: 12

Contribution to the Project: stream sediment analysis

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
Illinois State Water Survey, Prairie Research Institute	State or Local Government	Urbana, Illinois

Indiana University	Academic Institution	Bloomington, Indiana
Northwestern University	Academic Institution	Evanston, Ilinois
Pennsylvania State University	Academic Institution	State College, Pennsylvania
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, Tennesse
Utah State University	Academic Institution	Logan, Utah

Full details of organizations that have been involved as partners:

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:

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:

Northwestern University

Organization Type: Academic Institution
Organization Location: Evanston, Ilinois

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:

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, Tennesse

Partner's Contribution to the Project:
Facilities
Collaborative Research
Personnel Exchanges

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?
Nothing to report.

What is the impact on other disciplines?

The IMLCZO project is highly interdisciplinary involving people across several disciplines. Working together, the nature of work being done in each discipline is already being transformed.

What is the impact on the development of human resources?

Students are working on research topics with co-advising across departments and institutions.

What is the impact on physical resources that form infrastructure?

A number of observational system have been deployed using a strategic approach to support inter-disciplinary observational science. This deployment and associated datasets are likely to have a lasting impact on the science of intensively managed landscapes.

What is the impact on institutional resources that form infrastructure?
Nothing to report.

What is the impact on information resources that form infrastructure?
Nothing to report.

What is the impact on technology transfer?
Nothing to report.

What is the impact on society beyond science and technology?

Already covered in Education and Outreach.

Changes/Problems

Changes in approach and reason for change

Due to a career opportunity for our lead (Barbara Burkholder Heitkamp) on E&O at Univ. of Minnesota, she will be unable to help coordinate the E&O activities. We have moved the effort to Univ. of Iowa with Dr. Doug Schnoebelen taking the full charge of the effort with support from all partner institutions.

Actual or Anticipated problems or delays and actions or plans to resolve them
Nothing to report.

Changes that have a significant impact on expenditures
Nothing to report.

Significant changes in use or care of human subjects
Nothing to report.

Significant changes in use or care of vertebrate animals
Nothing to report.

Significant changes in use or care of biohazards
Nothing to report.

Major Activities For Each Theme

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

Task: A.1 Define and map fundamental landscape units

Major Activities: Functional landscape units (FLUs) are conceptualizations that depict how physical, chemical, hydrological and biological processes vary across the present landscape. They provide a landscape view of connectivity and highlight areas where important processes are concentrated in space and/or time. Mapping FLUs enhances both conceptual and numerical modeling of water, nutrient and sediment transport in a watershed. Year two involved collecting subsurface water level and stratigraphic data in Clear Creek Watershed and the Upper Sangamon Basin that significantly increased our understanding of connectivity among infiltrating precipitation and shallow groundwater. This better understanding of shallow subsurface water movement will allow us to better integrate available soil, topographic, geologic, and land use data sets to develop FLU map units and prepare a FLU map of Clear Creek Basin in year 3.

During year two the mapping of surficial geology of Clear Creek Watershed has begun and PSA drilling in Zone 1 of Clear Creek completed. Functional landscape units will form a conceptual framework for unifying observations and interpretations associated with themes A, B, C, and D.

Task: A.2 Post-settlement alluvium analysis using stream bank surveys, coring, fly ash screening, and radionuclide dating

Major Activities: Building on the prior year's work and in pursuance of the impact of land use change on flood plain sedimentation across the IML-CZO, we did field and lab work to collect cores or sampled profiles in 5 additional locations in the USRB and collected a profile from Clear Creek and then processed them accordingly. In addition to identifying magnetic fly ash, we measured grain size, clay mineralogy, chemical composition, magnetic susceptibility, and Cs137. Additionally, we worked to compare differences between CCW and USRB distribution of PSA and put in a context of landforms, landscape age, parent materials, etc. The data were then interpreted as representative of process over time in different environments.

The aim of this task connects to the weathering core interpretation, functional landscape units and landscape evolution model within Theme A. It also connects directly with Themes D and to some extent with Theme C. It relates closely to issues addressed at Calhoun CZO. More broadly, PSA is a local, regional, national and international topic. The methodology includes field sampling of stream banks/outcrops or sampling of shallow cores using soil auger/gridding probe. Sampling interval is set to 10 cm. Moreover, lab works in this task consist of sieving and separating magnetic fraction of fines, visual inspection and counting to give percentage fly ash. Also, another sampling method at ISGS Cs-137 and trace metals have been used in this task as well. A product from this task will be the development of fly ash methodology of PSA study using the data from each site. Use of fly ash for PSA in floodplains was the innovation carried out in this task.

Task: A.3 Investigate physical/geochemical characteristics of the upper two weathering profiles

Major Activities: The activity types in this task consist of Field work (activities at CCW and USB), microbial analyses (Northwestern), lab analysis (grain-size, pXRF, XRF, pH, clay mineralogy) and synthesis (well levels, precipitation).

We have established a weathering profile observatory in Clear creek Watershed (Maas Site). At this site we have obtained and described core, installed and instrumented three monitoring wells, installed two large gravity lysimeters, installed four soil moisture, temperature and electrical conductivity (EC) arrays, and have installed a meteorological station. The core has been described, portable XRF analyses have been made, and will be sampled in September for laboratory analyses. Data has been gathered from the instrumentation since October, 2014. Graduate and undergraduate students from the U of Iowa participated in the coring and instrument installation. A similar weathering profile observatory is scheduled for installation in October/November 2015.

During year 2 we began geochemical and magnetic analyses of weathering profile cores from USRB and CCW, and have monitored the flux of water through the soil and weathering profile at the observatories. Installation of suction lysimeters that will collect pore water from various zones in the weathering profile at all three observatories is scheduled for spring, 2016. The objective is to compare water passing through macroporosity with water in micropores to investigate the evolution of vadose and shallow ground water liquids and the chemical interaction of pore water with hosting deposits. This task has been accomplished with the help of USGS. Sampling methodology that has been employed through this task is core collecting with drill rig, and sampled using standard methods and procedures, pXRF analyses using Delta Innova-XM on geochem mode – 3beams-45 seconds/beam.

Task: A.4 Model Quaternary landscape development of the IML-CZO

Major Activities: Progress during the past year includes the development of a conceptual model for the glacial to interglacial transition, identification of crucial model components (flow routing, ponding, shallow groundwater flow, channel head cutting, vegetation interactions), assessment of existing quantitative models of critical processes, assessment of post-glacial and pre-settlement landscape characteristics, and GIS analysis of existing landscapes with differential amounts of time for fluvial network development. While the model to be developed will represent the study watersheds it will be much more broadly applicable to recently glaciated low-relief areas across central North America, northern Europe and portions of North/Central Asia. This activity is led by Dr. Anders and includes collaboration with Dr. Bettis. A formal collaboration with Dr. Gasparini has begun in August 2015 and this will include the LandLab model that is part of CSDMS. A graduate class has worked on aspects of this activity. Eight grad students worked on the model development this year in the GEOL 593 course led by Dr. Anders (Spring 2015). Two undergrads have helped with GIS analysis of Midwestern landscapes. Funding from National Great Rivers Research and Education Center contributed to model development and NGGREC sponsored an intern over the summer.

This activity connects with the post-settlement alluvium mapping through the identification of the pre-settlement drainage network, and allowing for the assessment of how much the drainage network changed during the period of PSA development. The activity also connects with weathering profile development as this development occurred during pre-settlement landscape evolution. Weathering profiles and soils provide information to constrain the pre-settlement model. Across CZO themes, this activity connects directly with Theme D by providing a picture of pre-settlement sediment routing and sedimentation rates. It also provides a context for theme C and fits under theme E as an effort to model this system. Across the CZO network, we connect to landscape-evolution based work in Boulder and Anthropogenic effects in Calhoun. This work is relevant to restoration and conservation efforts locally and across the upper Midwest. The landscape evolution pathway is also broadly relevant to northern Europe. We use GIS tools (ARCmap) to identify channel networks and compare statistics of landscape characteristics. The data sets include LIDAR DEMs, SSURGO soil maps, and GLO maps. Numerical model development includes specific new code developed by this project and existing models including LandLab. The task outcome contributes as a conceptual framework to IML-CZO modeling efforts. The new model will become part of a community model through LandLab. The work is interdisciplinary - combining soil science, landscape evolution, hydrology, paleoclimate, paleoecology and land use/land cover change. Products from this year include a map of USRB pre-settlement channel network and landscape character, a conceptual model of landscape evolution, and simulations of the impact of drainage ditching on landscape evolution. This is a novel landscape evolution model - it is a previously unstudied place/set of processes - both the pre and post settlement aspects.

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

Task: B.1 Experimental farm footprints through mobile sensor platforms

Major Activities: Filley lab is participating with the Papanicolaou Lab on the ER experiments in Clear Creek which uses mobile rainfall simulators with attached sensors for particle size determination and movement. Data collected with these tools is integrated into the laboratory analyses performed in the Filley Lab on particle organic and elemental chemistry. Relating geochemical characteristic of mobile sensed particles integrates concepts that look to relate connectivity between the slope-floodplain-stream gradient (Themes A-D). It allows for prediction of future event characteristics and explanation of current static baseline and pre/post settle alluvium. These concepts are the basis for a CUAHSI short course and workshop to be help at Purdue in October. We have at least 6 other CZO participants engaged in these Cross-CZO activities.

Samples from prospective sites were taken after several visits by Purdue CoPI Filley and collaborators from Purdue Profs. Greg Michalski and Marty Frisbee. It took approximately 1.5 years to sieve, process, and obtain the complete the geochemical analysis of the samples collected in the baseline measurement. The samples collected for the ER were delivered to the Filley lab for characterization of C,N elemental and stable isotope composition including soil samples for in-situ Soil Organic Carbon (SOC) determination, runoff rates, sediment fluxes, transported litter, and soil aggregates. The runoff/sediment samples and transported aggregates have been filtered and dried.

Sub-samples have been analyzed for texture using a sedigraph at the University of Iowa (IA), as well as organic matter content using an elemental Carbon /Nitrogen analyzer and a Visible Near InfraRed Spectrometer (VNIR). The aggregate stability were performed at University of Tennessee Knoxville (UTK) using calibrated rainfall simulators set at a fixed intensity following the methods by Moebius (2002), which accounts for disaggregation due to raindrop impact with rainfall simulators. The lignin content and organic geochemistry analyses were performed at Purdue University (PU) using a flash combustion elemental analyzer interfaced to a stable isotope ratio monitoring mass spectrometer at the Purdue Stable Isotope facility. The quantification of ERs that account for both the transported size fractions and soil aggregates will allow for more accurate estimates of soil and SOC redistribution along downslope flow pathways. Using accurate ER values will aid in model development, calibration and verification methods. The quantification of ERs that account for both the transported size fractions and soil aggregates will allow for more accurate estimates of soil and SOC redistribution along downslope flow pathways. Using accurate ER values will aid in model development, calibration and verification methods.

Task: B.2 Collect surface soil samples in Clear Creek

Major Activities: Based upon data collected in year two a request was made of collaborator Papanicolaou to obtain more baseline samples from transect B and for more flood plain surface soils. This was accomplished in June-July of 2015. Samples from this collection have yet to be ground or processed for geochemical properties. The samples collected for the hyperspectral imagery calibration in Clear Creek are in conjunction with the baseline surface soil samples which were collected in Clear Creek in 2014 and analyzed there. This task supports the overall CZO mission to measure and quantify significant processes of the critical zone and provide useable data for developing, coupling, and validating system-level models. This task also supports a common goal for the IML-CZO by measuring the properties and structure of the present-day critical zone and constructing a carbon budget in response to land management. The information can be used for upscaling soil biogeochemical properties to the watershed scale.

Surface soil samples from 0-5 cm were collected on May 1, 2015 in the Clear Creek, IA watershed from the same representative hillslopes used in the 2014 baseline sampling. Samples were collected along the main flowpath of the hillslope at 4 transects corresponding to the crest, shoulder, backslope, and toeslope. Four sampling locations were chosen along each transect for a total of 80 samples. Individual sampling scoops with a defined volume (5-cm x 5-cm x 5-cm) were used to collect the samples.Field tools included sampling scoops with a defined volume (5-cm x 5-cm x 5-cm) and a camera to capture the landscape condition. An aerial hyperspectral camera was also used.

A total of 80 soil samples were collected, along with the hyperspectral imagery. These samples were analyzed for moisture content and total Soil Organic Carbon (SOC). The soil samples are currently being analyzed at the University of Tennesse-Knoxville (UTK) for further analyses, including texture and aggregate stability. The hyperspectral imagery can be used for scaling up the baseline parameters, which are point measurements to the field and watershed scales.

***Task: B.3* Analyze surface soil samples in Clear Creek**

Major Activities: These continuing analyses were for the following bulk soil characteristics: soil texture, pH, aggregate stability, elemental C,N stable 13C, 15N abundance, lignin content, and organic geochemistry. The texture and pH measurements were conducted at the University of Iowa (IA), in conjunction with the University of Tennessee - Knoxville (UTK). The texture measurements were performed using a sedigraph, while the pH measurements were performed using a standard pH meter. The aggregate stability tests were performed at UTK using calibrated rainfall simulators set at a fixed intensity following the methods by Moebius (2002), which accounts for disaggregation due to raindrop impact with rainfall simulators. The elemental analyses, lignin content and organic geochemistry analyses were performed at Purdue University (PU) using a flash combustion elemental analyzer interfaced to a stable isotope ratio monitoring mass spectrometer at the Purdue Stable Isotope facility, as well as FTIR and by alkaline CuO extraction for extractable lignin and substituted fatty acid concentration.

This data are now being analyzed and correlated with factors such as texture, slope position, management regime, aspect, microtopography as controls on organic geochemical state and movement. Questions arising from these analyses necessitated that further baseline sampling occur during year 2 to address factors such as annual differences in ag management and distance to flood plain.

Task: B.4 Collect surface soil samples in Upper Sangamon

Major Activities: Surface soil samples (at 0-5 cm and 5-10 cm depth) are to be collected in the Upper Sangamon River Basin, IL watershed (USRB) from seven hillslopes representative of the various management practices, gradients, and soil types. The sampling is set for a 3-day field campaign during the last week in October 2015. At each site, we will sample along 4 transects corresponding to different catena positions (namely crest, shoulder, backslope, and toe). The downslope of the four transects will follow the main flowpath of the hillslope. Three sampling locations are selected along each transect. A total of 168 samples will be collected and will be analyzed for soil texture, bulk density, pH, lignin content, total C and N, aggregate stability, and organic geochemistry/ isotopic analysis. The soil samples are planned to be stored at the IML-CZO Sample Repository in Illinois. These samples will be used for identifying the physical ranges for key biogeochemical and hydrological modeling parameters.

***Task: B.5* Perform VNIR and other in-situ measurements for total SOM**

Major Activities: Analyses of the additional samples collected in May 2015 along the main flowpath of the representative baseline hillslopes in Clear Creek were performed using Visible Near Infrared (VNIR) spectroscopy through the University of Tennessee, Knoxville (UTK). The measurements were performed as part of the calibration for the aerial hyperspectral flights. These flights were in conjunction with Marc Linderman, Associate Professor in the Dept. of Geographical and Sustainability Sciences at the University of Iowa. The soil samples are being analyzed at the University of Tennessee, Knoxville (UTK) for further analyses, including texture and aggregate stability. The hyperspectral imagery can be used for scaling up the baseline parameters, which are point measurements to the field and watershed scales. This activity includes lab analyses.

The Visible Near InfraRed spectrometer was used to quantify SOC of soil samples collected to calibrate the imagery from an aerial hyperspectral camera. The soil samples were dried and powdered. The reflectance wavelengths of the soil samples was applied to a multiple regression equation established with the VNIR and nearly 600 other samples collected in the region to determine the total SOC.

The primary laboratory instrument was the VNIR spectrometer, while the aerial hyperspectral camera was used in the field. Hyperspectral maps will provide a snapshot of the total SOC throughout Clear Creek. They can also be used for soil moisture, bulk density, and residue cover. The additional SOC measurements provided by the VNIR can be compared with the other previous baseline samples and past measurements to track the changes in SOC over time in the representative fields due to management

Theme C: Coupled Surface Water-Groundwater Hydrology and Biogeochemistry

Task: C.1 Telescoping hydrological monitoring for biogeochemical signals that are measurable and differ amongst landscape elements, locations, and through storm-to-seasonal variability

Activity is primarily field-based monitoring and analysis of the data that are collected by our sensor network. The assessment of lateral hypothetic exchange in the surface drainage system is a modeling-based approach. Field experiments were conducted to characterize transport in surface streams in the IML-CZO. Telescoping hydrological monitoring supports all other themes in the CZO by quantifying fluxes of water through a host of landscape elements and across interfaces in the system (e.g., land-atmosphere, surface-subsurface, saturated-unsaturated). The data being collected are aligned with the Common Measurement Plan. Year 2 activity took place in both the CC and USRB field sites.
During Year 2, Theme C worked closely with the Iowa Flood Center and Iowa Nutrient Center to coordinate field installations and sensor maintenance, and sampling campaigns. Additionally, we worked with the Iowa Geological Survey and Prairie Research Institute on field deployment and ongoing sensor maintenance. Theme C partnered closely with Themes A, B, and D to plan and execute field campaigns.

Key goals identified in the Year 1 Annual Report are listed below with a brief summary of our actions related to these efforts.
1. Design and execution of a synoptic field campaign to quantify biogeochemical signatures across the landscape: conducted synoptic campaign in CCW in Year 2, and planned for USRB in Year 3.

2. Design and execution of an event-based sampling campaign to characterize transport and fate in the stream-floodplain-aquifer-vadose zone system, including sampling of artificial tile drainage:

collection of multiple sample sets from in-stream and tile discharge at 2-5 locations during storm event response and recession, plus sensing with deployed instrumentation.

3. Analysis of high temporal resolution data collected in-stream during Year 1 to explore hysteresis in dissolved chemistry and for comparison to sediment load (Theme B, D): isolation of storm events from the time series, analysis of sampling strategies and information content using IA-wide nutrient network.

4. Conduct targeted solute tracer studies in the stream network coupled with biogeochemical analysis of in-stream chemical changes: in-stream tracer studies initiated in Year 2, but flood hazard prevented extensive work in summer 2014 that was anticipated.

5. Targeted biogeochemical sampling campaigns during freeze-thaw and storm events: preliminary samples collected during 2015 thaw; planning 2016 campaign across multiple field sites.

6. Sample and characterize deep subsurface profiles (to 20-30 m) of microbial communities in Clear Creek, in conjunction with coring planned for September 2014: microbial samples collected as planned.

7. Perform initial assessment of the microbial biogeography of Clear Creek and Upper Sangamon watersheds based on synoptic sampling performed in 2014: samples collected in CC in Year 2, planned for USRB in Year 3

8. Characterize temporal dynamics in microbial ecosystem connectivity via storm water sampling: activity on hold until microbial biogeography results are analyzed

For Year 2, we further added goals of:

9. Simulation of transport vs. transformation in stream-hypothetic and vadose zone systems of interest for particular anthropogenic contaminants: conducted simulations of the transport and fate of steroidal hormones in stream-hypothetic systems and nitrate in vadose zones, both representing human disturbances to hydrological and biogeochemical function of the critical zone.

Stream samples were collected in the Clear Creek IA area synoptically at various locations and during a storm event. An array of laboratory (chemical) measurements was performed to establish which were feasible and provided useful information.

Stream water samples have been collected pre-, during- and post- storm event to evaluate how biogeochemical signatures vary in the Clear Creek and 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 done in the laboratory.

Task C2: Characterize decadal scale variability in stream OC export using sediment coring of lake Decatur

The sediments of Lake Decatur were sampled by coring in May 2104 and June 2105 in an effort to characterize sediment and and organic carbon export from the Sangamon watershed. Particulate organic C (POC) concentrations and isotopic (C, N) compositions were determined. Methane and dissolved inorganic C (DIC) concentrations and C-isotope compositions were determined for the sedimentary porewaters to track the fate of the exported C. A sedimentary record has been obtained back to circa 1922 when then Lake Decatur dam was emplaced. Aspects of this research will be specific to the Sangamon watershed but will also have generic implications.

Field work was required to collect sediments. Lab work was required for the geochemical measurements.

Task C3: Evaluate potential organic carbon sources to stream (in collaboration with Themes B and D)

Stream water samples were collected before-, during- and after storm events in October 2014 and June 2015 in the Clear Creek system using ISCO samplers. Water samples were filtered. Particulates were analyzed for %OC, %N, C/N, 13C/12C and 15N/14N ratios. Results were compared to soil samples and those obtained from ER experiments.

Critical zone C-cycle issues were discussed in a recently accepted manuscript concerning the global C-cycle and rivers.

Samples were collected in the field and analyzed in the laboratory. The analyses provided information for Themes B, C and D. They revealed that the sources of OC from the landscape to the stream changed during storm events. The accepted manuscripts address international connections.

This year's fieldwork was done in Clear Creek but has generic implications. The accepted manuscript was based on other watersheds and had a global perspective.

1.4. Theme D: Water, Soil, Sediment and Landscape Connectivity: Short- and Long-Term Budgets.

Task D1: Quantify erosion rates, travel times, and lag coefficients for Clear Creek through rainfall simulator experiments

a. **Major Activities:** During this reporting period, we looked at two datasets from the observations and measurements made during May & June of 2014 in Clear Creek Reaches 1-3 and 3-1. The first set of data included the radioisotopes of the collected suspended sediment. The activities of 7Be on the suspended sediment can be used to identify freshly eroded sediment from the landscape. The 7Be is delivered to the surface soils during a rain event. It attaches readily and is a conservative tracer over the time of the runoff event. The peak in 7Be activity can be tracked with the sediment moving downstream. The second set of data relied on the suspended sediment collected at Reaches

1-3, 2-1, 3-1, and 3-3 with ISCOs. In addition, the discharge and turbidity measurements were used. These three measurements are part of the common CZO measurements collected in Clear Creek. A relationship was developed between the suspended sediment concentration and the turbidity to produce a more complete temporal record that corresponded with the discharge measurements. To determine the travel times with the flow and sediment data, we correlated the rising and falling limbs of the hydrographs of 4 storms from 2014. For the 40 river km of Clear Creek, travel times calculated using both the radioisotopes and the flow-sediment measurements ranged from 18-20 hours, with roughly equal times between the upper and lower halves of the system.

We looked at the radioisotopes of the suspended sediment collected during May & June of 2014 from Clear Creek Reaches 1-3 and 3-1. The activities of 7Be on the suspended sediment were used to track freshly eroded sediment from the landscape. The peak in 7Be activity was tracked with the sediment moving downstream. The discharge, suspended sediment, and turbidity measurements collected at Reaches 1-3, 2-1, 3-1, and 3-3 during May & June of 2014 were also used to calculate travel times. The suspended sediment was collected with ISCOs, while the discharge was determined with pressure transducers and a stage-flow relationship. Turbidity was measured using the water quality sondes and the sedimeter. A relationship was developed between the suspended sediment concentration and the turbidity to produce a more complete temporal record that corresponded with the discharge measurements. To determine the travel times with the flow and sediment data, we correlated the rising and falling limbs of the hydrographs of 4 storms from 2014. A gamma spectroscopy system, ISCO (4), pressure transducers (4), seidmeter and turbidity meter was used as task tools.

The average travel times for the flow and sediment moving through Clear Creek are a result of this exercise. For the 40 river km of Clear Creek, travel times calculated using both the radioisotopes and the flow-sediment measurements ranged from 18-20 hours, with roughly equal times between the upper and lower halves of the system.

This task supports the overall CZO mission to measure and quantify significant processes of the critical zone and provide useable data for developing, coupling, and validating system-level models. This task also supports a common goal for the IML-CZO by measuring event-based dynamics and travel times. The central hypothesis of the IML-CZO is role of the system as either a transformer or transporter, which can be assessed using the travel times of water, sediment, carbon, and other nutrients.

The innovation in this task is the use of novel, natural tracers like 7Be to measure travel times, which has been only used sparingly in the literature. The samples for this task are currently being processed at the UTK gamma spectroscopy lab, which is part of the Hydraulic & Sedimentation Lab. These travel times are unique for Clear Creek but provide a good sense of how the system works. The data will be added to IML Clowder website.

Task D2: Characterize net sediment fluxes and sediment rating curves within stream channels of Clear Creek using storm-based evaluations

Major Activities: Two additional pressure transducers were deployed in June 2015 at Reach 2-1 in Clear Creek to measure flow hysteresis. The pressure transducers were first calibrated in a large settling column following factory specifications from GlobalWater. At each site, the transducers were placed in the stream 20 cm above the bed and surveyed with a total station from the nearby bridge. The transducers were 200 m apart. Three T-posts were placed in front of the transducers to prevent debris from hitting the sensors. The transducers were set to sample every 5 mins. Stage-flow rating curves were established for four events in June and July 2015 to determine patterns of flow hysteresis. In conjunction, ISCO samplers were established at the site as part of the common CZO measurements at the site. The ISCO collected water-sediment samples every four hours prior to an event, then every 1 hour during the event. The samples were filtered and dried for their sediment mass to quantify concentrations. The installation of the ISCOs was similar to the pressure transducer installation. The intakes were attached to T-posts facing downstream at a 1/3 of the baseflow depth. The hose from the intake to the sampler was run up to the top of the banks and secured by attaching to a chain using cable ties and fixed to the ground through earth anchors. The batteries on each ISCO are always kept charged. Hysteresis for the sediment concentration was also determined. Field Sampling; Monitoring were activity types in this work

Task D3: Characterize net sediment fluxes and ratin curves within stream channels of Upper Sangamon using storm-based evaluations

Major Activities: During this reporting period, we analyzed sediment fluxes and suspended sediment rating curves of Sangamon River at Saybrook. We collected aggregated suspended sediment samples using in situ suspended sediment tube sampler and three event-based suspended sediment samples using ISCO automatic pump samplers during this reporting period in June and July 2015. The ISCO collected water-sediment samples every 1 hour during the event. The samples were filtered and dried for their sediment mass to quantify concentrations. Stage-flow rating curves were established for seven events in June and July 2015 to determine patterns of flow hysteresis.

This task supports the IML-CZO common measurements plan by examining how different land use and climate scenarios affect the sources of sediment at the landscape scale. This addresses one of the central IML-CZO research questions, namely: How does heterogeneity induced by anthropogenic impacts affect residence times & aggregate fluxes of water, carbon, nutrient, and sediment? It directly uses measurements of suspended sediment concentration and discharge from the common measurement sampling. In terms of the Common Measurements of the CZO program, this tasks looks at event-based and continuous fluxes of water and sediment across critical zone/landscape interfaces.

Five pressure transducers were deployed in Upper Sangamon River Basin to measure flow hysteresis. At each site, the transducers were surveyed with a total station from the nearby bridge. The transducers were set to sample every 5 mins. Stage-flow rating curves were established for seven events in June and July 2015 to determine patterns of flow hysteresis. In conjunction, ISCO samplers and suspended sediment tube sampler were established at the site as part of the common CZO measurements at the site. The ISCO collected water-sediment samples every 1 hour during the event and suspended sediment tube sampler collected aggregated suspended sediment. Three flow events were monitored in June and July 2015. The samples were filtered and dried for their sediment mass to quantify concentrations. Hysteresis for the sediment concentration was also determined. These measurements will be supplemented with information provided by the nearby USGS gauging stations and rainfall stations. For the suspended sediment measurements, an ISCO suspended sediment samplers and suspended sediment tube sampler were deployed at Saybrook.

Water and suspended samples were collected during three storm events during June and July 2015 at Saybrook so far. The sediment samples are processed similar to the runoff samples from the experiments described for Task D.1 to establish the sediment concentrations with time. Data analysis is ongoing to quantify the hysteresis occurring on the flow/ sediment measurements.

Task D4: Develop short-term (i.e., single event) sediment budgets for the Clear Creek watershed using stable and radio-isotopes to partition sediment sources

Major Activities: During this reporting period, additional samples were collected in Clear Creek to perform another sediment sourcing study. Soil samples were collected in early June 2015 in the same agriculture fields as the baseline measurements in May and June 2014. These samples were collected using 2-in. diameter core tubes and extended 5 cm in depth. They were sub-sectioned at 0.5-cm depth intervals. One-meter cores were also collected at the adjacent stream banks. Concomitantly in the stream, 3 stream tubes (0.1m × 1m) were deployed in Reaches 1-1, 1-3 and 2-1 for aggregated suspended sediment samples. A large runoff event was sampled on June 7, 2015. The precipitation samples were collected in buckets for the rainfall event. Several (37) grab samples of water and suspended sediment were collected from bridges in Reaches 1-1, 1-3 and 2-1 during the event hydrograph. Additionally, ISCO samples were collected in Reaches 1-3 and 2-1. After the event, the precipitation buckets, stream tubes, and ISCO samples were collected transported back to the University of Tennessee Knoxville (UTK) gamma spectroscopy laboratory for lab processing and analysis. All these samples are currently being analyzed 7Be, 210Pb, and 137Cs using gamma spectroscopy.

Task D5: Develop short-term (i.e., single event) sediment budgets for the Upper Sangamon watershed using stable and radio-isotopes to partition sediment sources

Major Activities: During this reporting period, additional samples were collected in Upper Sangamon River Basin to perform another sediment sourcing study. To assess the provenance of suspended sediment and the relation between channel morphology and production of suspended sediment in Upper Sangamon River Basin, we collected suspended sediment in the stream and soil samples from potential source areas. We collected aggregated suspended sediment sample using in situ suspended sediment tube sampler (0.1m × 1m) and three event-based suspended sediment samples using ISCO automatic pump samplers at the outlet of Saybrook sub-basin during this reporting period. Sediment source samples were collected in April 2015 from five potential sources: farmland, forests, floodplains, river banks, and grasslands. A trowel was used to collect the upper 10 cm (3.9 in) from each sample site, except in the case of eroding outer banks where samples were collected just above the water level. Sediment samples are currently analyzed at the Illinois State Geologic Survey Stable Isotope Laboratories and Activation Laboratories in Ontario, Canada.

A quantitative geochemical fingerprinting technique, combining statistically verified multicomponent signatures and an un-mixing model, was employed to estimate the relative contributions of sediment from five potential sources to the suspended sediment loads. Organic matter content, trace elements, and radionuclides from soil samples were used as potential tracers. A relationship was developed between land use and production of suspended sediment. To differentiate the sediment the sediment derived from surface soil erosion from that of near-channel fluvial erosion, non-conservative tracers (10Be, 210Pb, and 137Cs) were used in sediment tracing analysis.

Source samples from the fields and stream banks and suspended sediment from the stream in Upper Sangamon River Basin were collected and prepared for trace elements, organic matter content and radioisotopes (7Be, 210Pb, and 137Cs) analysis. The samples for this task are currently analyzed at the Illinois State Geologic Survey Stable Isotope Laboratories and Activation Laboratories in Ontario, Canada. The outcome of this task will be the partitioning of the suspended sediment into its various sources.

This task supports the overall CZO mission to measure and quantify sediment transport processes of the critical zone and provide useable data for developing, coupling, and validating system-level models. This task also supports a common goal for the IML-CZO by measuring event-based dynamics and travel times, especially with the use of radioisotopes. The central hypothesis of the IML-CZO is role of the system as either a transformer or transporter, which can be assessed using the travel times of water, sediment, carbon, and other nutrients. The samples for this task are currently being processed at the Illinois State Geologic Survey Stable Isotope Laboratories and Activation Laboratories in Ontario, Canada.

1.5 Theme E: Integrated Modeling and Critical Zone Services

Major Goals: 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.

Task E1: LiDAR Data Acquisition:

Major Activities: The following data were acquired by NCALM on August 2-5 during which period the vegetation is very dense both in agricultural fields and the riparian corridor:

Upper Sangamon River Basin:

Area: 200 km^2 Infrared Waveform LiDAR + Hyperspectral + Bathymetry (Green) LiDAR

Clear Creek Watershed:

Area: 200 km^2 Infrared Waveform LiDAR + Bathymetry (Green) LiDAR

Infrared LiDAR data was received from NCALM on 22 December 2014; Hyperspectral & Green LiDAR data was received 20 March 2015

These data have been analyzed for USRB and we find that:

- The Infrared LiDAR shows a positive bias in landscapes that have dense canopies. Over soybean fields (LAI = ~7) the bias is ~0.7m, and over cornfields it is ~1.7m. The data shows a small error of ~0.07m over roads and bridges suggesting that the acquisition quality is excellent, but the signal penetration through the dense vegetation canopies is limited. We are exploring if the waveform information can be used to correct this to some extent, but this work is not yet completed due to lack of standard techniques for handling waveform data.
- A quick look at the Bathymetry lidar data shows that it has a maximum penetration depth of ~1m below water surface in the rivers. The penetration depth is a function of the turbidity of the water. Therefore, the bathymetry can be generally mapped for shallow headwater streams but not for deeper parts of the stream or where turbidity is high.
- We have atmospherically corrected the hyperspectral data and it has been used to study vegetation species classification and for the extraction of leaf area index.

In conjunction with the LiDAR flights, extensive ground truth data were collected which included surveys of vegetation structural characteristics (LAI, height, breast width, etc.), and chemical analysis were conducted on leaf and soil samples. We expect to correlate this with the LiDAR and Hyperspectral measurements.

Task E2: LiDAR scale hydrologic and biogeochemical process modeling

Major Activities: LiDAR based digital elevation data reveal micro-topographic features of the landscape. The features can have significant implications for hydrologic partitioning and nutrient dynamics.

- We have developed a model that couples surface – sub-surface water transport dynamics in 3-D at the LiDAR resolution (~1m).
- We are in the process of adding a nutrient dynamics component to this model to assess how micro-topographic features control biogeochemical processes in the landscape.
- We are adding a component to characterize tile flow to study their on ecohydrologic and nutrient dynamics at scales dominated by microtopographic variability, such as depression and roadside ditches. We expect that this integrated model will be completed in the third year of the IMLCZO award.
- Using a combination of point cloud LiDAR data and hyperspectral data, we have developed an approach to estimate the vertical leaf area density. This can enable us to capture the light regime in multi-layer canopy models.

Task E3: Hydro-geomorphologic evolution of river valleys and impact of human development

Major Activities: Using LiDAR data we have delineated floodplains and terraces in USRB and CCW. Further we have developed the concept of a ‘river valley hypsometric curve” to characterize the persistent features in river valleys (terraces and floodplains) and how they are related to flood frequency and human modification of landscape.

Task E4: Information theoretical approach to understanding eco-hydrological interdependencies

Major Activities: In this early phase we have focused on developing information theoretic measures to infer feedback dynamics in coupled logistic networks. Process network is a collection of interacting time series nodes, in which interactions can range from weak dependencies to complete synchronization. Between these extremes, nodes may respond to each other or external forcing at certain time scales and strengths. Since observed time series datasets are often limited in length, robust measures are needed to determine time dependencies, connection strengths, and synchronization within a process network. We compute variance, lagged mutual information, and transfer entropy measures within coupled chaotic logistic networks with a range of connectivity structures, time scales, and forcing mechanisms. Variance measures capture synchronization trends, but mutual information and transfer entropy provide further distinctions regarding drivers, redundancies, and time dependencies within the network. When randomness exists in the form of driving nodes or uniform random noise, we show that information measures differentiate between types of forcing and detect time dependencies over a range of connection strengths. We find that multiple measures are often warranted to accurately evaluate time dependencies and overall network behavior, particularly when nodes are subject to multiple drivers. In process networks constructed from observed data, these measures can be used to infer connectivity, drivers, and behavioral shifts. This method is presently being implemented to understand the dynamics of mussel population in Minnesota River Basin and also terrestrial ecosystem dynamics.

Task E5: Critical Zone services

Major Activities: To evaluate the trade-offs between positive and negative impacts, life cycle assessments is being used to create an inventory of all the energy inputs and outputs in a landscape management system. Total energy is computed by summing the mechanical energy used to construct tile drains, fertilizer, and other processes involved in intensely managed landscapes and the chemical energy gained by the production of biofuels from bioenergy crops. A multi-layer canopy model (MLCan) computes soil, water, and nutrient outputs for each crop type, which can be translated into Critical Zone services. These values are then viewed alongside the energy inputs into the system to show the relationship between agricultural practices and their corresponding ecosystem and environmental impacts.

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

Task: F.1 Webportal for the IMLCZO observatory.

In February 2015 we deployed version 1.0 of the IMLCZO web portal, which included a stable version of both the Clowder data management system as well as the geodashboard to visualize streaming data from the CZO [http://data.imlczo.org/geodashboard/]

Version 1.1 of the software stack was released in June 2015. This includes new data sources from HOBO sensors, Ameriflux data at the Bondville station, Sangamon River Forest Preserve data and ISWS locations Mahomet-105 and Saybrook-134. Different scripts were developed for the different data sources so that they could all independently ingested in near real time. This task was conducted by having close collaboration with NCSA, CZOData, and Hydroshare. In order to carry out the task Javascript, GeoJSON, and ODM2 were used.

The outcome of this task was sharing of datasets within and outside IML-CZO. The platform can also be used in classroom.

The following activities were also included as part of this Task:

Review options for IML-CZO information system adoption/development: We continue to review related efforts and adopt related standards and technologies as they become available.

Design and implementation of the IML-CZO information system: The ability for a user to register new sensors was added based on feedback from the community. This includes the ability to add metadata about a new sensor, support for different sensors types and the ability to associate a sensor with a dataset.

Delivery of the IML-CZO information system (including the associated training): An online tutorial was given in March 2015 to the CZO membership. A demo was presented at the IML-CZO site visit in May 2015. A presentation of all updates was delivered at the IML-CZO All Hands meeting in July.

Services, workflows for data distribution and sharing: We moved to a production virtual machine and development virtual machine setup to enhance the stability of the production systems. Services were setup behind an NGINX proxy to provide a clean namespace and avoid port blocking for services running on non common ports. The data.imlczo.org DNS was pointed to the production machine. The geodashboard is now available at http://data.imlczo.org/geodashboard/. The data management system is available at http://data.imlczo.org/clowder/.

Identification of the type of data to be handled and the associated metadata: The following data sources were identified and setup to be ingest into the data management system in near real time: HOBO sensors, Sangamon River Forest Preserve data and ISWS locations Mahomet-105 and Saybrook-134. The Ameriflux station at Bondville data stopped in 2008, so no ongoing data is available.

The following datasets were connected to the IML Clear Creek CZO Observatory: Precipitation (IFC), Stream gage sensors (IFC), USGS streamflow data, Water Quality sampled at selected sites in Clear Creeek.

Participation in the CZOData meeting was regular and ODM2 databases schema was installed on the IMLCZO Clear Creek server for testing.

1.7 Theme J: Site and Facilities Coordination.

Task J.1 Set-up common measurement sampling locations in CCW

The list of the sensors we have actively running in Clear Creek include the following:

- Pressure transducers (3) were installed in Clear Creek in Reaches 1-3 and 2-1, These will supplement the two USGS gauging stations located in Reaches 2-1 (Oxford, IA # 05454220) and 3-3 (Coralville, IA # 05454300).
- ISCOs (4) co-located with water quality sensors in Reach 1-3 (Church), 1-4 (Homestead), 2-1 (Oxford), and 3-3 (Coralville)
- ISCOs (2) in tiles at Site 1-2
- Real-time, continuous water quality sondes (Nitratax, Hydrolab, and YSI; 12) to measure nitrates, temperature, pH, specific conductance, DO, chlorophyll-a, ammonium, turbidity, fDOM, total algae, and chloride. These are co-located with the ISCOs.
- Eddy Towers (2) at sites 1-1 and 2-1 measuring CO2, H2O vapor, Eddy flux, Air temperature, Air pressure, Wind speed, Wind direction, Precipitation, Soil moisture, and Soil temperature.
- Groundwater wells w/ pressure transducers (17) at sites 1-1 and 2-1, Tiffin and Coraville
- Weathering array (1) at site 1-1

Task J.2 Set-up common measurement sampling locations in USRB

The list of the sensors we have actively running in **USRB** include the following:

Weathering Zone Studies: Sangamon River Forest Preserve has 3 Pressure Transducers (wells of depth 170 ft and 6ft, with 1 barometric), 12 soil moisture probes (located at 4 locations, depths -5cm, -20cm, -60cm), rain gauge, anemometer, 2 lysimeters (2 foot and 6 in depths), humidity, radiation, and leaf wetness

Hydro-geomorphological and Stream Nutrient Dynamics Studies:

- HOBOs (8) placed throughout the USRB at Wildcat Slough @ CR2800N, Sangamon River @Saybrook (2), Goose Creek @ CR600E, Goose Creek @ Bucks Pond (2), Camp Creek @1800N, and Big Ditch @ CR700E.
- ISCO Automatic Pump Samplers: (3) located at Saybrook, Mahomet and Monticello.
- STREAMGAGES: 2 sites are collecting 15 minute stream stage; 1 site water level actuator
    - Mahomet: Campbell Scientific - CR10X datalogger, CS475 Radar water level sensor; data download via via Raven XTV AirLink CDMA cell modem
    - Saybrook: Campbell Scientific - CR850 datalogger, pressure transducer water level sensor; data download via Raven XTV AirLink CDMA cell modem

- Monticello: ISCO model 1640 liquid level actuator which triggers ISCO pump sampler to initiate sampling on predetermined schedule.

Flux Tower: We have the following core equipment and 12-V power is available at the IML-CZO flux tower site:
a) 1 x CR1000 Data Logger with the NL115 Ethernet/Compact Flash Module (256MB card)
b) 1 x AM16/32 Chanel Relay Multiplexer
c) 1 x HUB-SDM8
d) 1 x Sierra Wireless Raven XT GPRS cellular modem
We record from the following sensors every 5-minutes, and transmit data to our server at NCSA at a frequency of once per hour (see attached schematic for current installation location of equipment):

At 25-m elevation:
a) 1 x Campbell Li-7500 gas analyzer (CO_2 and H_2O) – connected to HUB-SDM8 (HUB-SDM8 Power and SDM In cables are dropped down to ground level)
b) 1 x Campbell CSAT3 3D Sonic Anemometer – connected via digital port to HUB-SDM8
c) 1 x Campbell 83E RH & Temp (Cable dropped directly down to ground level)

At 10-m elevation: (All cables at 10-m are dropped down to ground level)
a) 1 x Decagon DS-2 Sonic Anemometer
b) 2 x Decagon SRS NDVI
c) 2 x Decagon SRS PRI
d) 1 x Apogee SI-1H1 Infrared Radiometer
e) 1 x Campbell LI190SB PAR

At ground level or subsurface:
a) 1 x Campbell TE525 Rain Gauge
b) 2 x Campbell HFP01SC Heat Flux Plates
c) 6 x Apogee 5TE Soil Moisture Probes
d) 1 x Campbell CS655 Reflectometer

Fiber-optic distributed temperature sensing (FO-DTS): Our partner ISGS (Illinois State Geological Survey) is equipped with:
1. SensorNet Oryx+ Distributed Temperature Sensing (DTS) system (kept in vehicle at the location)
2. Fujikura FS70 Fusion Splicer (kept in vehicle at the location)
3. Brugg BRUsens Temperature 4-fiber cable: 1100m for in situ measurement (kept in vehicle at the location)
4. MULTILINK AT-RK28T7X-004 2-fiber cable: 2500m for ditch bed deployment at flux tower site in 2015-2016
5. AFL DNS-0763 Flat Drop 2-fiber cable: 104m for 40m well in Rantoul site
6. AFL DNS-0763 Flat Drop 2-fiber cable: 171m for 100m borehole in Rantoul site
7. AFL DNS-0763 Flat Drop 2-fiber cable: 325m experimental configuration for future deployment
8. One 240 volt and 2,000 watt cartridge heater with 100m cable is under construction at the ISGS for future heat tracer tests such fracture detection and groundwater/surface water interaction.

Tile Drain Monitoring: Allerton Trust Farm Site will soon have a deployment of 1 ISCO, 2 pressure transducers (water depth, electrical conductivity, water temp), 1 rain gauge, 1 humidity/air temp/vapor pressure sensor, 1 wind gauge, 3 soil moisture probes at depths -5cm, and -20cm, and -60cm,

IMLCZO: Research Outcomes

Theme A:

A1. Historic and current floodplain sedimentation

Significant accumulations of post-settlement (post 1850) alluvium (PSA) have been identified in the USRB in the floodplains of the main stem of the Sangamon River and in numerous tributaries (Grimley et al., in prep). This PSA is not easily distinguished from pre-settlement floodplain deposits in the field and consequently was previously unrecognized. The similarity in color and grain size to pre-settlement floodplain material suggests limited depths of erosion on uplands and minimal contribution of sediment from gullying during the historic period. The thickness of PSA in the USRB increases with valley width and there is no evidence of significant incision of PSA (Grimley et al., in prep). In contrast, PSA in CC is visually distinct, thicker in narrow, headwater portions of the channel network than near the mouth, and significantly incised in lower reaches (Anders et al., in prep). Preliminary Cs-137 profiles indicate that a significant fraction (40-50%) of the PSA in both CC and the USRB post-dates 1960. There is no evidence for declining rates of sedimentation in recent decades, unlike the scenarios proposed for the nearby Driftless Area. Patterns and amounts of PSA in the USRB and CC generally similar to those found in other areas of the Midwest, indicating that the landscape response to intensive agriculture is broadly similar across areas with distinctly different Quaternary history (Anders et al., in preparation).

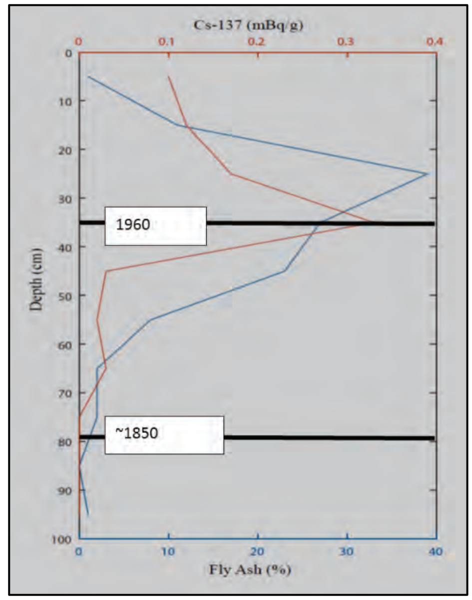

Figure A1. USRB core with fly ash data providing thickness of the PSA and Cs activity indicating 1960

Floodplain deposition measured during individual flood events on the Sangamon River shows a temporally consistent pattern that is highly variable in space (Arnott, 2015). Deposition is focused in low-elevation portions of the floodplain that are directly connected to the main channel by flood channels. We developed a conceptual model of this pattern that emphasizes the importance of flow routing over the floodplain as well as ponding of water during the receding limb (Arnott, 2015; Arnott et al., in prep). Event-scale deposition rates are of the same order of magnitude

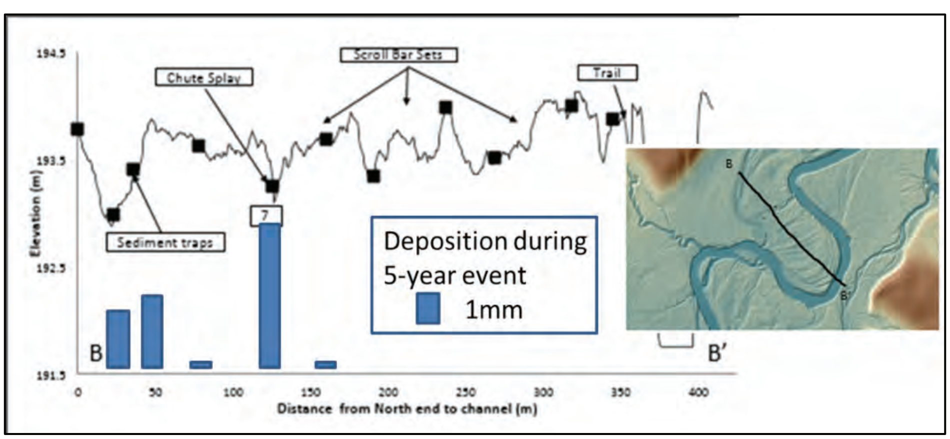

Figure A2. Floodplain deposition measured during a 5-year flood event at Allerton Park on the Sangamon River. (Arnott, 2015, MS Thesis).

as PSA accumulation rates measured in this area.

A2. Landscape Evolution

The landscapes of the IML-CZO all share a history of glaciation and all bear the signature of evolution from glacially-dominated landscapes toward fluvially-dominated landscapes. The USRB, in particular, was still recovering from glaciation at the initiation of intensive agriculture with significant fractions of the area lacking integrated fluvial drainage. These regions have been mapped using historic surveys, soils data, topography, and soil cores, allowing us to construct a map of the channel network prior to ditching and tile drainage. A numerical landscape evolution model in development suggests that the routing of water over unchannelized areas of the USRB has the potential to have significantly impacted channel network evolution. Specifically, modeled scenarios in which no water is passed across unchannelized uplands to head-cutting tributaries of the Sangamon predict destruction of constructional moraine topographic prior to significant growth of tributaries, in contrast to the observed topographic characteristics of the USRB. Significant overland flow and/or shallow groundwater sapping are likely necessary to generate the observed state of tributary growth relative to moraine erosion.

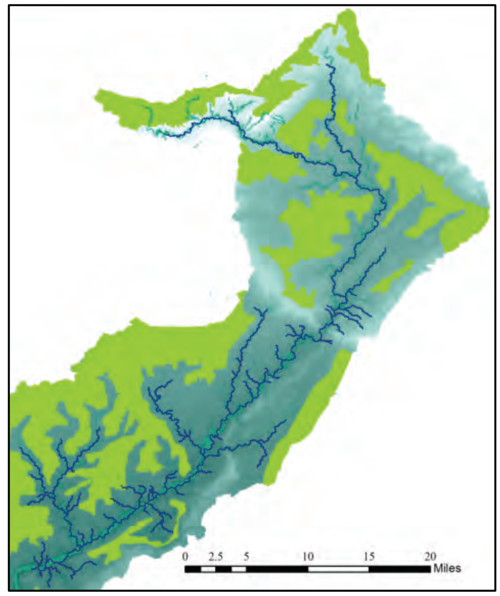

Figure A3. Light green areas of the USRB lacked incised channels prior to intensive agriculture.

A3. Geological Characterization

The critical zone's geologic materials in Illinois and Iowa house a 2 million year old legacy of deposition and erosion controlled primarily by the actions of glaciers, flowing water, and wind (Bettis et al. 2010; Stumpf and Atkinson, 2015). Sixty to 130 meters of glacial, fluvial, lacustrine, and eolian sediments overly an eroded surface cut in Paleozoic bedrock. Within this thick package of unlithified sediments resides multiple weathering profiles formed as the landscape evolved between glacial episodes. Weathering profiles in these deposits are recognized by pedologic features and structures, color and mottling patterns, fractures, and geochemical alterations such as leaching of primary carbonate minerals and/or accumulation of secondary minerals (Bettis, 2007).

The uppermost weathering profile in the area includes the postglacial or modern soil, a prairie soil (mollisol), or forest soil (alfisol). This weathering profile is most often formed in loess (Peoria Silt) or overconsolidated loamy glacial till, but along river valleys it may be formed in alluvium and glacial outwash. The Peoria Silt includes variably thick deposits of windblown material deposited by dust storms that were common during the last glacial period (Bettis et al., 2003). Regionally across the IML-CZO, the thickness of loess varies from 7 m in Clear Creek Basin (CCB) to about 0.75 m in the Upper Sangamon Basin (USRB). Loess typically thins downslope as a result of postglacial erosion, and the upper weathering profile is often developed through the thin loess and extends into underlying glacial till. In the

CCB, the Peoria Silt buries Pre-Illinois Episode till (>500 ka) while in the USRB the Peoria Silt buries Wisconsin Episode till (c.a. 21 ka).

Although the glacial legacy has imparted similar constraints on the landscape evolution in CCB and USRB, the overall geologic histories and provenance only partially overlap. Both field areas have multiple buried weathering profiles within the glacial sediments that record the character of ancient land surfaces. What differs is the regional depositional and erosion histories and source of the glacially transported material. The CCB has an irregular dissected bedrock surface that is covered by deposits, up to 70 m thick, containing Pre-Illinoian glacial and postglacial sediments (Bettis et al., 2010). The USRB overlies a broad preglacial bedrock valley that is completed filled in by Illinoian and pre-Illinoian glacial and interglacial sediments. The valley-fill is overlain by Illinoian and Wisconsinan glacial sediments that constitute a ridged to low-relief morainal topography that lies up to 130 m above the bedrock (Atkinson et al. 2014). The valley-fill contains the Mahomet glacial-drift aquifer that is a sole source of water in Illinois. Glaciers originating from ice sheets centered over northern Canada flowed southwest into CCB and west-southwest into USRB. The associated glacial deposits have distinctive physical, geochemical and mineralogical properties that are reflective of their source regions.

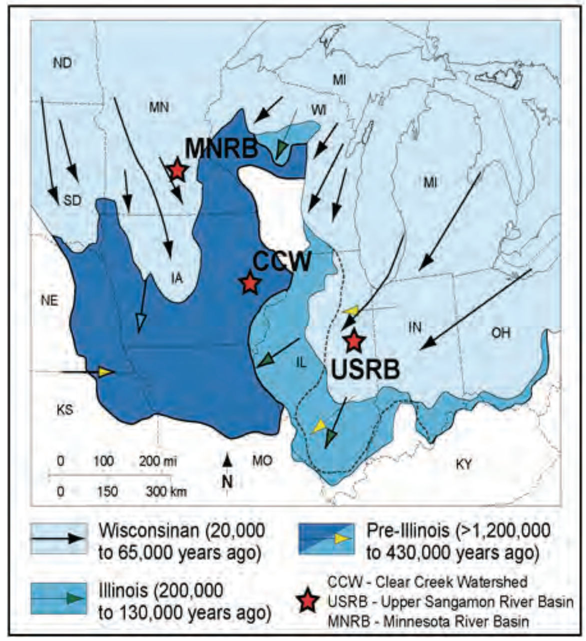

Figure A4: Provenance and timing of glacial advances impacting the IML-CZO

During 2014 and 2015, five boreholes were drilled to characterize the subsurface geologic materials for the IML-CZO. Four cores were collected in the USRB and 1 in CCW. Three of the four cores in the USRB were from the Sangamon River Forest Preserve in Champaign County to subsample for sedimentological, geochemical, and bio-geochemical analyses. Two of these cores were collected when the ground was frozen so that samples could be submitted directly for DNA sequencing and isotopic fingerprinting in support of Themes B, C, and D. The third core from the USRB, and the one in CCW provided baseline information on the character of weathering profiles in the upper 10 m. We found that oxidation from the modern surface extends to a depth of at least 4 m and in some places beyond 8 m.

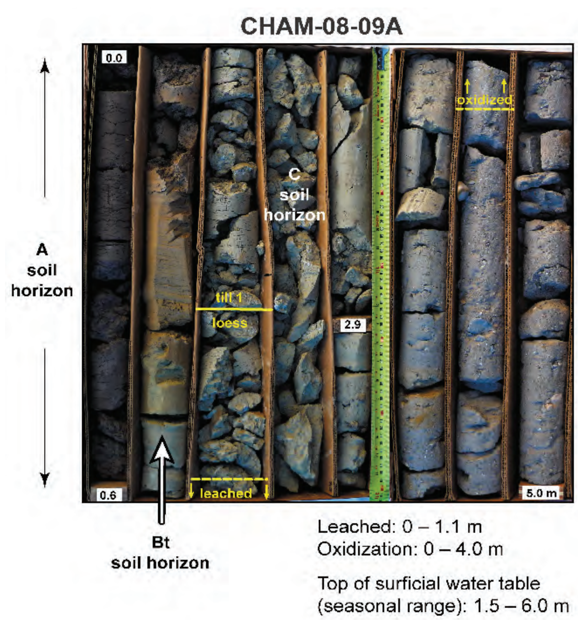

Figure A5: Third core from USRB; Sangamon River Forest Preserve.

Fracture networks in these materials provide preferential pathways for movement of water and colloids in these otherwise slowly permeable materials. The deepest borehole drilled was in the USRB, and this activity coincided with the CZO PI Site Visit held in May 2015. Over one hundred meters of continuous core was collected from land surface to the top bedrock using a mud-rotary rig. The sediments cored record the history of three glaciations that occurred over the past 12 million years. The borehole was logged open-hole using Mount Sorpris geophysical probes collecting measurements of natural gamma radiation, resistivity, magnetic susceptibility, and full waveform sonic. A distributed temperature sensing fiber optic cable was installed in the grouted hole to measure continuous ground temperatures.

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Theme B: Short- and Long-Term Dynamics of Soil Organic Matter: Findings and lessons learned in the IMLs

Soil Organic Matter (SOM) is a central parameter for assessing soil functions and health in Intensively Managed Landscapes (IMLs), as it relates to many other soil properties that govern resistance to different stresses and provide critical ecosystem services (Stott et al., 2013). This research explores how intensive cultivation and hydrologic modification have altered the physical forms of SOM, as well as its sources, fluxes, residence time, physical & chemical stabilization, and storage in both the surface & deep sediments. Our approach follows the response of key state variables (e.g., aggregate stability and enrichment ratios) and geochemical proxies (e.g., plant and microbial biomarkers, stable C and N isotope compositions) under the forcings of regional climate and anthropogenic land management. A primary goal of these efforts is to relate the geochemical character of SOM, soil, and sediment within a landscape perspective, to establish relationships between terrestrial hot spots and hot moments with the connectivity between land and stream within our CZO-unique landscape.

A primary innovation of this research is the linking of multi-proxy biogeochemical assessments of SOM source and degradation state to a newly developed coupled watershed erosion - organic matter cycling model (Papanicolaou et al., 2015) that addresses some of the major challenges in quantifying the impacts of erosion and deposition on the evolution and fate of SOC across the landscape. Most available biogeochemical models focus within a soil profile (e.g., Parton et al., 1987; Wilson et al., 2009) and cannot adequately resolve the known aggregate hierarchy controls on soil stability and reactivity (Olchin et al., 2008; Creamer et al., 2013), namely the contributions of the lighter size fractions of organic rich soils vs stabilized microaggregates. These limitations affect enrichment ratio estimates and can lead to unintended errors in SOC storage predictions (Papanicolaou et al., 2009). The coupled model incorporates a new enrichment ratio functionality that allows for simulating the transport of light and aggregate organic matter fractions along a topographic gradient by considering the effects of changing runoff coefficients, bare soil, tillage depth, fertilization, and soil roughness on SOC redistribution and storage.

Our assessments using the improved model supports the larger integrated goals of the IML that seek to assess the stability of rapidly mobilized and buried surface soil packages within post settlement alluvial layers throughout the upper Midwest watersheds.

Additionally, this research is examining the effects of management on the chemical nature and particle association of SOM in IMLs as it relates to plant and microbial sources, as well as the degrees and rates of degradation, exchange, and stabilization. The gains in organic carbon seen with the modeling above (Papanicolaou et al., 2015) would have less of an overall impact if the carbon is comprised of readily degradable sources (e.g. Boutton et al., 2009). On the basis of changes in total carbon (CT), a Carbon Pool Index (CPI) is calculated and, on the basis of changes in the proportion of labile C in the soil between a reference site and those subjected to agricultural practice or research treatments, a Lability Index (LI) is determined, too. These two indices are used to calculate a Carbon Management Index (CMI), with CMI = C Pool Index (CPI) x Lability Index (LI) x 100.

Finally, this research is examining the differences in aggregate stability and plant organic degradation across IMLs using biopolymer proxies such as lignin. Aggregates are labile OM incubators. For the restored prairie sampled in Clear Creek, both the aggregates were stronger and the lignin was less degraded when compared to the sampled row crop fields throughout the watershed (Figure 1). The aggregate stability decreased and the lignin degradation increased along a gradient of increasing tillage intensity, as evidence by increases in acid character of lignin (Figure 2). These trends are believed to be caused by the mechanical breakdown of the aggregates by tillage and erosion, which promote decomposition and they are further affected by the slope position and hillslope planar curvature (advective vs. diffusive regime) which may also have a control on decomposition rates.

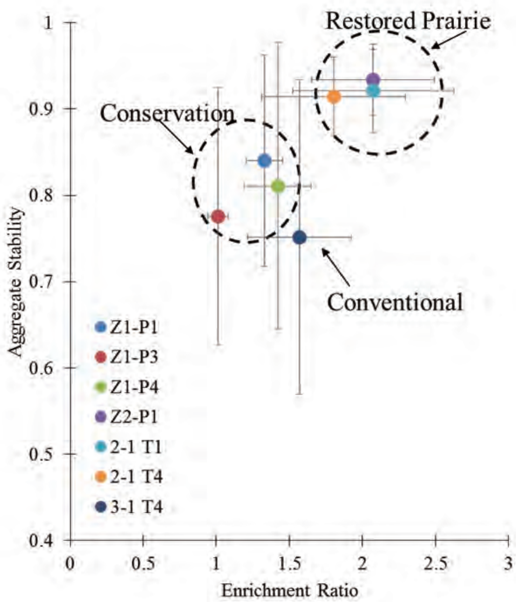

Figure B1. The aggregate stability as a function of the enrichment ratio increases along a gradient of increasing tillage intensity in the Clear Creek, IA watershed. Soils at the restored prairie and conservation tillage site had higher aggregate stability.

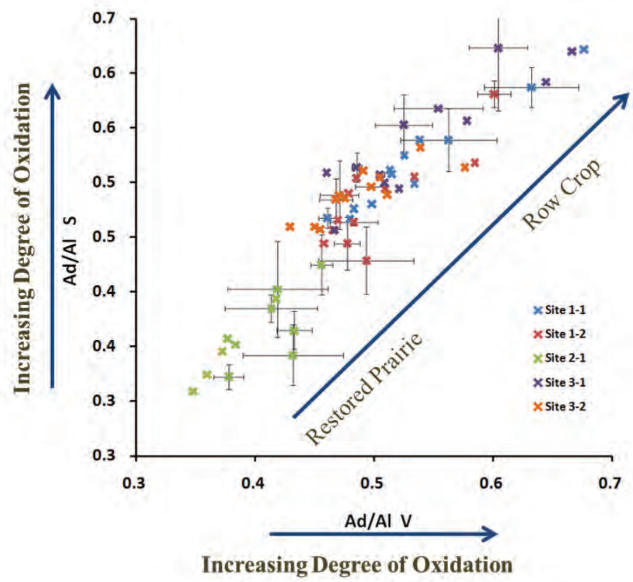

Figure B2. The degree of lignin oxidation increases along a gradient of increasing tillage intensity in the Clear Creek, IA watershed. The lignin in the soils at the restored prairie are less degraded than in the row crop sites.

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Theme C:

C1. Dissolved and Suspended Load Characterization During Storm Events

A major goal of the Intensively Managed Landscape CZO (IML-CZO) is to understand how the critical zone of the agricultural Midwest will respond to the pressures of increased land use and climate change. As an initial step towards that goal, the landscape response to storm events of the Clear Creek watershed has been studied to determine the sources of sediment to the creek and the threshold of activation of each. Water samples were collected prior to, during and after 3 storm events in 2014-2015 at multiple stations in the stream network. The suspended particulate load was isolated via filtration and characterized by transflectance micro-FTIR spectroscopy and C, N elemental and stable isotope analyses.

FTIR spectra indicate that there is a chronic source of sediment in the system, which has a carbonate component. C- and O- stable isotope measurements suggest that this material is derived from the dissolution of field applied lime followed by re-precipitation of carbonate after incorporation of respired CO2. There is also another component that has a mineral (Si-) OH absorbance. The low C/N ratios and the predominantly C3 d13C values suggest this source is a subsurface soil that predates the introduction of corn. Bank erosion is the likely mechanism of delivery. Surface soil erosion is activated on the ascending limb. δ13C values and C/N ratios reveal that the organic matter is derived in part from corn debris, which points to erosion of a surface source.

In-stream water chemistry were collected using a network of water quality sensors at high temporal resolution at the sampling locations. Analysis of in-stream nutrient timeseries in the CZO and region has been a focus for Ward, leading to one publication [Davis et al., 2014, JEQ] and two additional publications that are currently in preparation. Key findings focused on the role of antecedent moisture conditions in controlling in-stream N loads at nested sites within the Clear Creek CZO.

Captured sediments in the Lake Decatur impoundment provide a record of watershed processes in and near the IML-CZO. A clear transition to a more C3 plant source input is evident over the last decades. Further organic geochemical analyses are required to resolve changes in crop rotation (corn vs soybean), the use of riparian buffers, or lake eutrophication. Methane production occurs as a result of the rapid deposition of POC. Hotspots of production of this greenhouse gas correlate with POC burial rates. A novel proxy for integrated rates of methanogenesis, DIC δ13C, has been discovered and may allow evaluation of historical variations.

C2. Competing processes of transport and transformation

A key element of the IML-CZO is the competing processes of transformation within the CZ in comparison to transport out of the CZ. To-date, this has been explicitly considered in two primary studies. First, the Clear Creek site was a central location of interest in a synoptic survey of in-stream water quality conducted in the Iowa-Cedar Basin. These data were collected during flood, recession, and baseflow conditions at >140 sites within the basin, including several co-located with other CZO instrumentation. These data formed the basis of an MS Thesis [Prior, 2015] currently be prepared for publication. Key findings are that the basin behaves as a functionally zero-order system due to the prolonged, extreme N loading from agricultural activities on the landscape. Homogenization of the basin (spanning order 1-5) yielded nearly uniform N spiraling metrics throughout the stream network and under all flow conditions.

The interaction of transport and transformation were also studied in the context of the antropogenic loading of Trenbolone acetate metabolites in the environment [Ward et al., 2015].

Trenbolone is a synthetic androgen applied to cattle, which is then metabolized, excreted, and included in land-applied manure. This management activity on the landscape yields a load of the endocrine disruptor to the stream channel. Our study demonstrates the interaction between physical and chemical processes (i.e., transport and transformation processes), demonstrating that hyporheic exchange results in significantly greater exposure of aquatic ecosystems to this potentially harmful compound.

Theme D:

Water, Soil, Sediment and Landscape Connectivity - Short- and Long-Term Budgets

We have investigated where the IML-CZO watersheds fall on the spectrum between transformer and transporter watersheds by quantifying fluxes of water and sediment at different spatial (hillslope, stream, watershed) and temporal (annual, seasonal, event-based) scales, as well as establishing sediment budgets at the watershed scale. This process involved observation of key emergent patterns along the drainage network pertinent to sediment delivery and stream power. We have also identified key natural and human-induced features (tiles, ditches, gullies, floodplains, knickpoints) that promote transformation of upland sediment systems into accelerated transporters of material fluxes toward downstream parts of the drainage systems. A cross-comparison data analysis between Clear Creek and the Upper Sangamon (Figure 1) shows that Clear Creek has much less storage capacity (transporter) than the Sangamon (transformer/ transporter). Sangamon comprises of a sequence of storage channels such as pools with fallen tree logs working as barriers for flow and particulates during low to medium flow events.

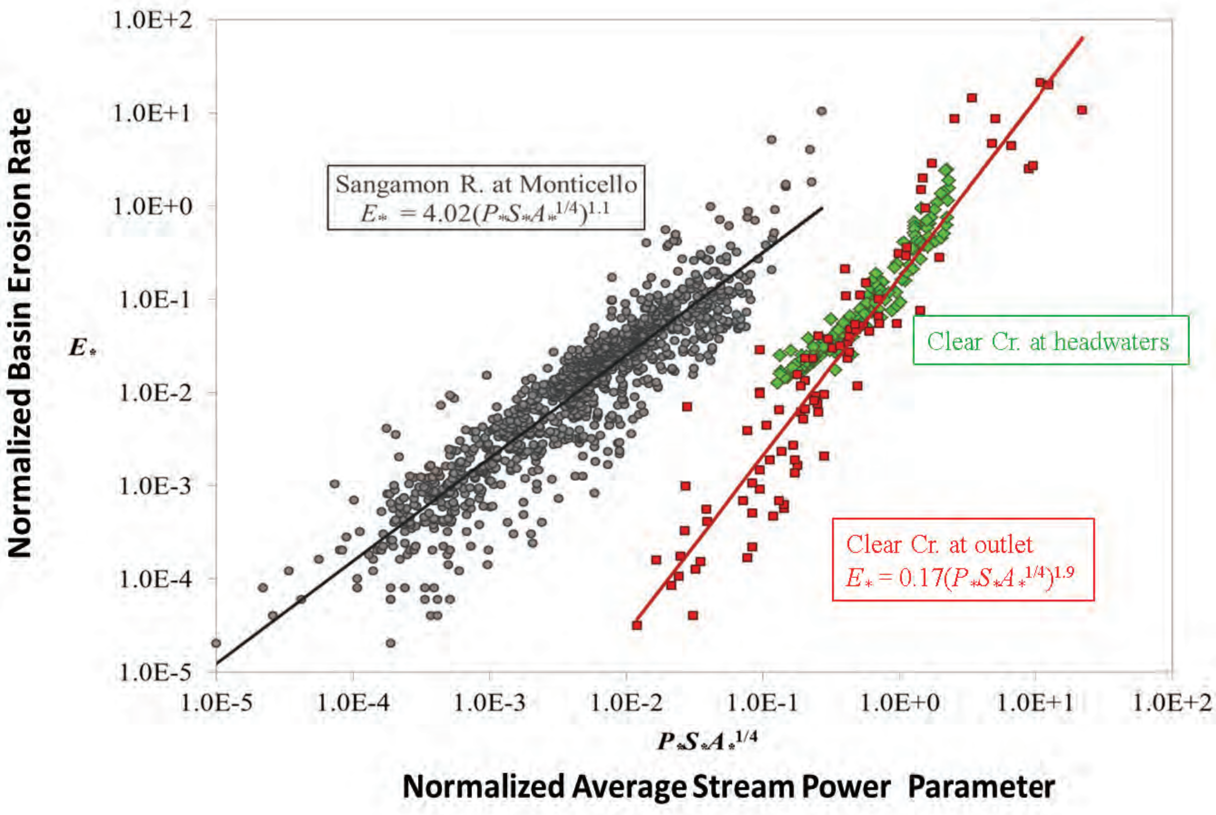

Figure D1: Normalized Basin Erosion Rate vs Normalized Average Stream Power for Clear Creek Watershed and Upper Sangamon River Basin

Our approach distinctly differs from other sediment budget approaches in that it focuses on event based dynamics and also incorporates the effects of drainage network on sediment delivery. Past approaches have solely focused on runoff driven sediment delivery without taking into consideration the travel and resting time of sediment in the system. Yet, the effects of the network in storing and transporting the material can be profound. Travel estimates using radionuclides coupled with the use of radio frequency IDs placed in coarser sediment particles reveal that there is a characteristic spatial unit scale where transport times and sediment provenance can significantly differ. Travel times in the headwaters of Clear Creek are shorter as the system is flashier (Figure 2). Approaching the mouth, the travel times increase and, as shown in Figure 1, sediment fluxes remain highly variable (the red dotted points) contrary to the headwater sediment fluxes (green symbols). This has implications on the choice of management practices as well as to their optimal placement within the drainage network. At different locations within the drainage network sediment provenance differs. This is well illustrated in Figure 3 and in the Upper Sangamon watershed (Rhoads et al., 2015). Near the headwaters of the watershed (Saybrook) the floodplain is the main source of sediments. At Wildcat Slough banks contribute the most.

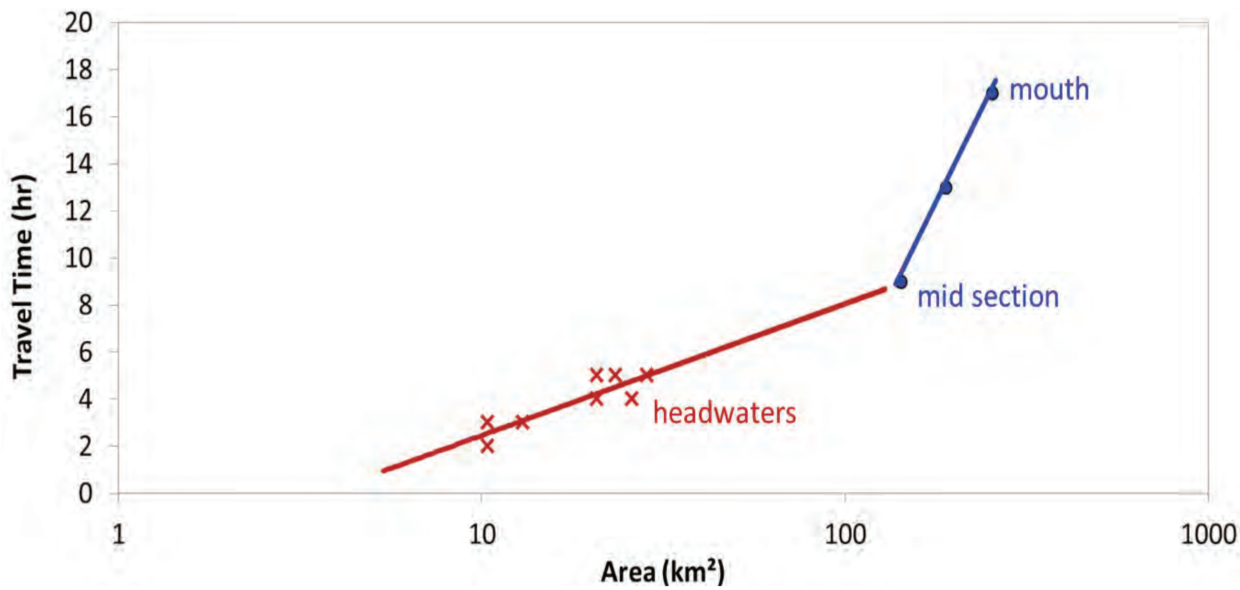

Figure D2: Travel Times in the Clear Creek Watershed

To differentiate eroded upland surface soils and channel-derived sediments in the suspended loads of each event we use a combination of probabilistic unmixing models with sediment fingerprinting tracers (Fox and Papanicolaou, 2008; Wilson et al., 2012). The Bayesian unmixing model has two key parameters, a and b, that respectively reflect the spatial origin attributes of sources and the time history (delivery and residence time/integration) of source soils/sediments delivered to and collected at the system outlet (Abban et al., 2015). The enhanced framework offers a probabilistic treatment of these two parameters, taking into account the variability in source contributions, their delivery times and storage within the watershed.

The radionuclide tracers, 7Be and 210Pbxs, as well as stable isotopes were used to differentiate eroded upland surface soils and channel-derived sediments in the suspended loads for different events and verify the findings of the Bayesian unmixing model.

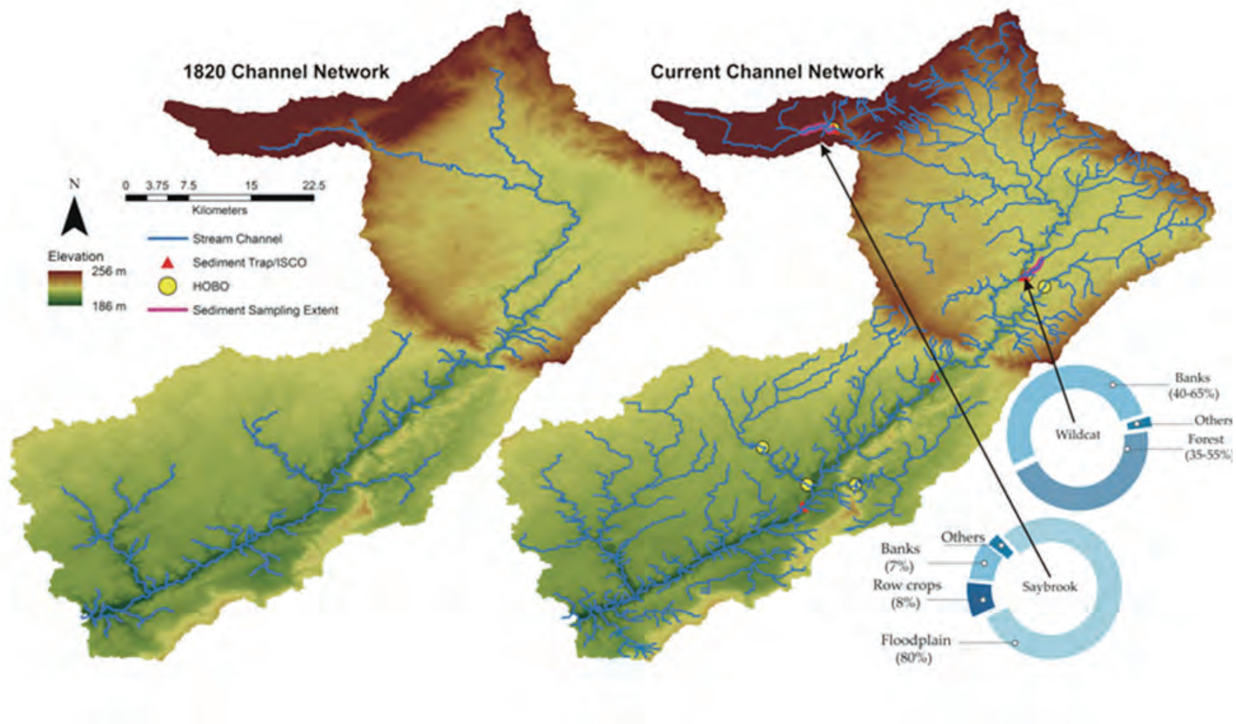

Figure D3: Map of Upper Sangamon River Basin Showing Sediment Provenance and Extent of Channel Network

References

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Theme E:

E1. Characterizing Vegetation Canopy Structure using Airborne Remote Sensing Data

The plant canopy structure plays an important role in photosynthesis and transpiration. It is instrumental in determining the vertical distribution of radiative states and scalar fluxes. The vertical foliage structure of a canopy is represented by leaf area density (LAD), which is defined as the one sided leaf area per unit volume. LiDAR point-cloud data allows us to characterize the LAD profile of the canopy, which is extremely useful for modeling 3-dimensional eco-hydrologic processes. However dense canopies with considerable overlap between trees leads to insufficient point density for accurate estimation of LAD. Here we show that a combination of high-resolution Hyperspectral and LiDAR data is better able to estimate the LAD of individual trees in dense canopies. A voxel-based inclined point quadrat method is used for determining the LAD together with high resolution hyperspectral data which enables us to identify each tree species in dense canopies. We introduce the concept of a tree-shaped voxel which is defined by the volume of rotation of the shape of the tree. The tree shape is obtained from empirical relationships using information of tree species, the geometry of overlap with adjacent trees and the tree heights. A comparison of the LAD obtained using tree-shaped voxels with that of commonly used cylindrical-shaped voxels indicates that species information leads to a better extraction of LAD profile. The tree shaped voxels reduce the LAD at the lower portions of the tree (fig. 1) which may be captured erroneously as an understory in the case of cylindrical voxels. The LAD obtained from tree shaped voxels sometimes may also be exaggerated at the top part of the canopy and requires further investigation in terms of denser and unequal voxels at tree tops. Further the results were validated with the derived leaf area index (LAI) values from the LAD data for cluster of trees. The results of field observed LAI, hyperspectral derived LAI and voxel based LAI were found to be consistent and similar. The novel tree shaped voxelization approach is expected to be beneficial in forest canopies with considerable overlap between trees and may be applicable for airborne LiDAR data with insufficient point density for accurate mapping of the canopy LAD.

Citation: Dutta, D., Wang, K., Lee, E., Kumar, P., Goodwell, A., Woo, D., and Wagner, D., Characterizing Vegetation Canopy Structure using Airborne Remote Sensing Data, *IEEE Trans on Geoscience and Remote Sensing* (To be Submitted), Oct-2015.

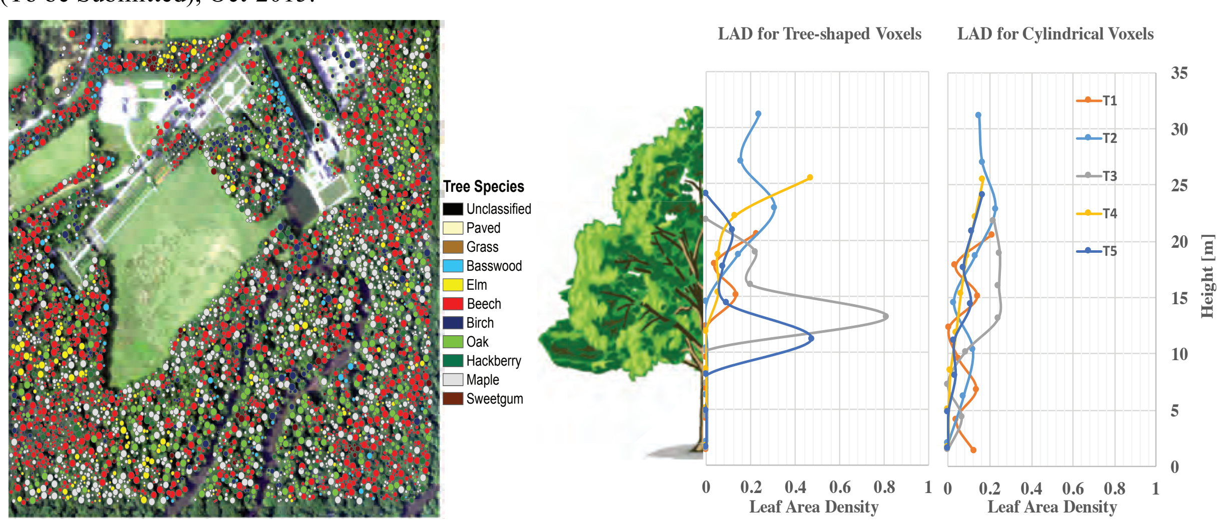

Figure E1: Tree species classification using CASI hyperspectral data over Allerton Park -1 field site (left) and comparison of LAD estimation using tree and cylindrical shaped voxels (right) from remote sensing and field measurements over the Upper Sangamon River Basin

E2. Extreme-scale integrated surface–sub-surface flow modeling in IMLs

The interaction between surface and sub-surface flow is an important component of the hydrologic cycle. Capturing these interactions in models is thus critical to predicting soil moisture states and the responses of ecohydrologic processes to global change across various scales. In intensively managed and agricultural landscapes, hydrologic fluxes exchanged between surface and sub-surface systems often arise from large-scale space and time integrated impact of small-scale practices and processes. However, the effect of these interactions on ecohydrologic dynamics, such as soil moisture content and surface runoff controlled by microtopographic variability, has been notoriously difficult to characterize over large areas. Part of the problem is that large-scale modeling of integrated flow at the emerging lidar-data resolution are numerically expensive due to the density of the computational grid and the iterative nature of the algorithms for solving nonlinearity. Here we develop a distributed physically-based integrated flow model that couples two-dimensional overland flow and three-dimensional variably saturated sub-surface flow on a GPU-based parallel computing architecture. The model has been used to simulate an intensively managed landscape in the Goose Creek watershed, Illinois, USA (Figure 1). We demonstrate that the method is much more computationally efficient and produces physically consistent solutions in comparison with traditional CPU models. We found that flow accumulation in microtopographic features, often ignored in modeling with lower resolution, carries substantial flows in agricultural landscapes. This results in significant changes in the ecohydrologic dynamics. Our study suggests the feasibility of GPU computing for extreme-resolution, fully distributed, physics-based hydrologic models over large areas, and can be served as a starting point to couple with other important processes. For example, extreme-scale modeling nutrient transformation and nutrient and carbon transport plays a critical role to understand, characterize and predict their impact on nutrient and carbon dynamics across the landscapes.

Citation: Phong V.V. Le, Praveen Kumar, Hoang-Vu Dang, Albert J. Valocchi (2015). GPU-based high-performance computing for integrated surface–sub-surface flow modeling. *Environmental Modeling & Software*, 73:1–13, doi:10.1016/j.envsoft.2015.07.015.

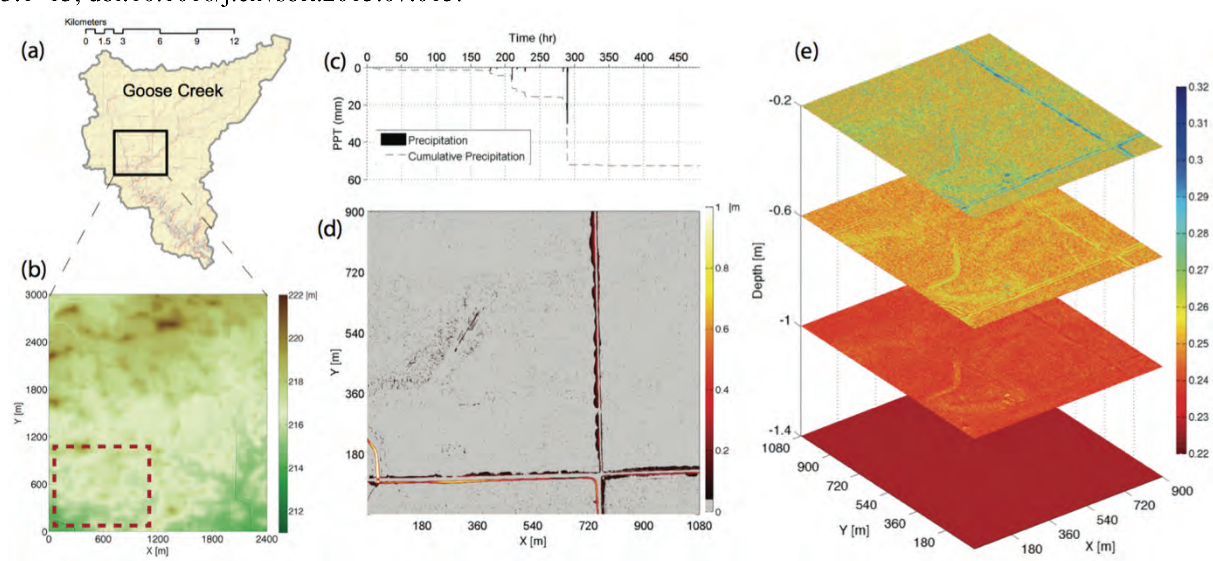

Figure E2: An example of integrated surface – sub-surface flow model simulation in Goose Creek watershed, Illinois, USA after a rainfall event. (a) Map of Goose Creek watershed; (b) Lidar topographic elevation of the study area; (c) Precipitation time series used for the simulation period; (d) Water depth simulated on the study area by the model at 320 h; (e) Corresponding soil moisture profile at layers over depth inside the red rectangle simulated by the model.

E3. River Valley comparison across Minnesota, Iowa and Illinois

River valley development is key to land surface process. Meanders, levees, bars, floodplains, terraces and other geomorphic features, as well as human activities, like agriculture and infrastructure construction, all lay inside river valley. Each feature has unique role in affecting the dynamics of channel meanders and sediment flux, landscape evolution, climate and riparian vegetation. The combination of all the processes of geomorphic features determines the development status of river valley as a whole, which is closely bounded to flooding events. However, the relationship between these features and flooding recurrence are unknown. Here we show that large flooding events may only cover a partial zone in river valley, which depends on the river valley maturity. We found that in a young river valley, like the Sangamon River in IL, even bankfull discharge can reach the two sides of valley wall. Whereas, in a mature river valley, like Minnesota River in MN and Clear Creek in IA, 100-yr flood recurrence can only intact with partial areas (floodplain zone) inside the river valley. Considering the similar geological age between Sangamon River and Minnesota River, our approach proves that climate, soil properties, vegetation type, and human activities work together to interact with river valley's topography development. We also discover a constant factor of 100-yr flood depth over bankfull depth, which is close to 1.5 in mature valley. Similarly, the ratio of water width of 100-yr flood over bankfull width is around 9 in mature valley. Moreover, we prove that the inconsistence of river valley maturity from upstream to downstream is mainly due to the moraines left by glacial legacy. We present a new way of identifying general geomorphological features of river valleys to better understand river valley topography. Our results would benefit both the field measurements and simulations on river valley related studies, including meanders, sediment flux, river and floodplain geometries developments.

Citation: Yan, Q., Iwasaki, T., Kumar, P., Parker, G., and Stumpf, A. Hydrogeological understanding of alluvial river valley topography. *Earth Surface Process and Landforms* (To be submitted).

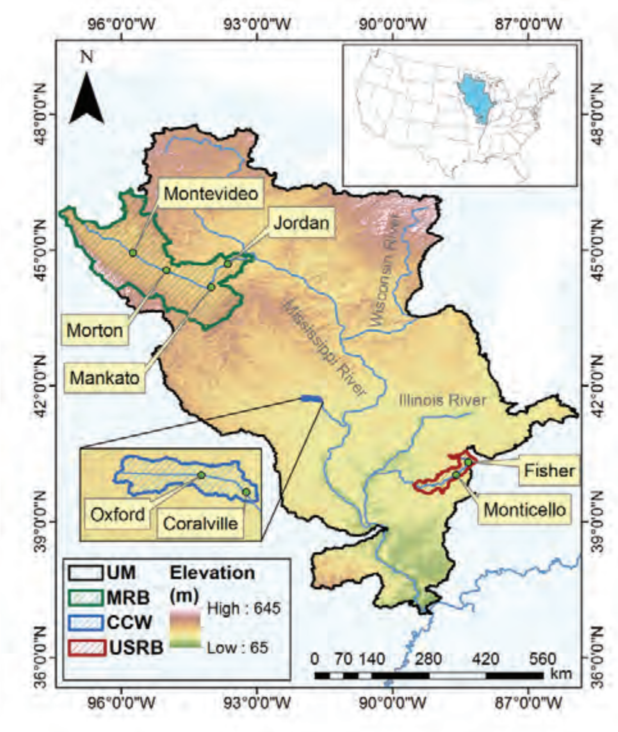

Figure E3a. Spatial map of Minnesota River Basin (MRB), Upper Sangamon River Basin (USRB), and Clear Creek Watershed (CCW). The cross-sectional geometry data of USRB is from 1.2 meter LiDAR DEM. Minnesota River Basin and Clear Creek Watershed are from 1.0 meter DEM. Labelled locations are USGS stream gage stations. (The LiDAR data for USRB is obtained from Illinois State Geological Survey (ISGS), the one for MRB is from Minnesota Geospatial Database, and the one for CCW is from National Topography Database.

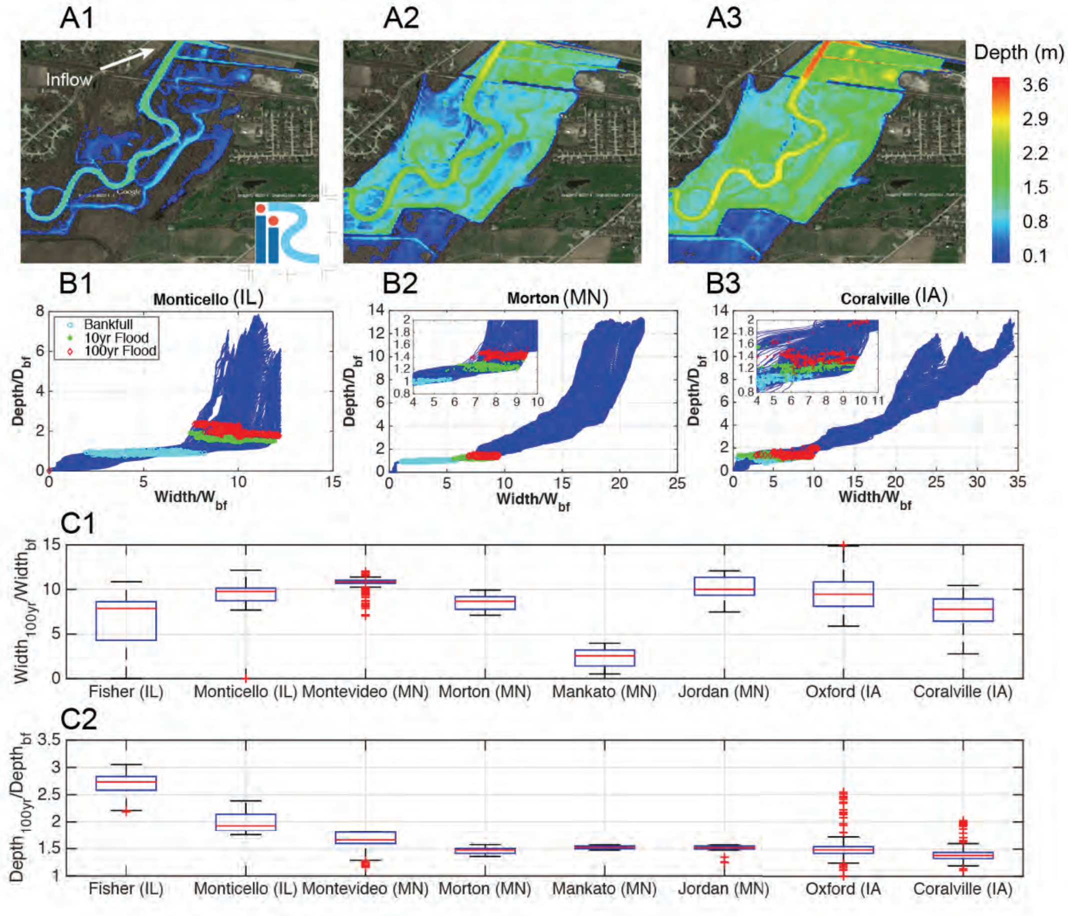

Figure E3b: (A) Flooding simulation in Monticello, IL. The discharge inputs from A1-A3 are bankfull, 10-yr recurrence, and 100-yr recurrence respectively. (B1-B3) The simulation results on the river valley hypsometric (RV) curve. RV curve translates river valley's cross-sectional geometry into the relation between valley depth (starting from the river bed) and the corresponding horizontal width from the cross section. Each single line represents one cross section along the valley reach. (C1) The water width under 100-yr flood over bankfull width among 8 sites that cross IL, MN, and IA. (C2) The water depth under 100-yr flood over bankfull depth among 8 sites.

E4. Impact of hydrologic variability on mean age distribution of soil-nitrogen

Our interests in reactive nitrogen and the nitrogen cycle have shifted from increasing the efficiency of nitrogen delivery to target crop species to decreasing environmental damage caused by intensive agricultural practices. Enhancing reactive nitrogen use for increasing food production to meet future demand inevitably contributes to an increase in the nitrogen load in the environment, often adversely impacting the ecosystem. Many novel strategies have been developed to provide better management practices and, yet, the problem remains unresolved. Specific prediction and analysis methods are thus required to gain a better understanding of the transformation and transport properties of soil-nitrogen. One of these properties is the estimation of age, which is an analysis of an elapsed time in a particular state within a control volume. Here we show that the mean nitrogen age concept can thus serves as a tool to further disentangle complex soil-nitrogen dynamics without requiring additional parameters. We find that the highest mean ammonia-ammonium age in the top soil layer is within a depth of 1 m. The primary factor driving the result is the positive charge of ammonium resulting in adherence to the soil, which in turn reduces the ammonium leaching through the vertical soil column. The high solubility and negatively charged ion of nitrate allow high rates of nitrate leaching through the vertical soil column with water fluxes, resulting in the high levels of age to the deeper soil layers. Our results demonstrate the mean ages of nitrogen transferred and transformed within the soil is a dynamic process which depends on concentration as well as dynamics of nitrogen species. We anticipate that the estimation of mean nitrogen age can provide a novel approach in resolving nitrogen-relevant problems, such as eutrophication downstream, since the signature of mean nitrogen age in deep soil layers can be used to identify preferential flow paths of nitrogen leaching. Furthermore, this study validates the potential to predict the ultimate fates of reactive nitrogen, and explain spatial differences in concentration and age.

Citation: Woo, D.K., and Kumar, P. Impact of hydrologic variability on mean age distribution of soil-nitrogen. In review in *Water Resources Research*, Oct. 2015.

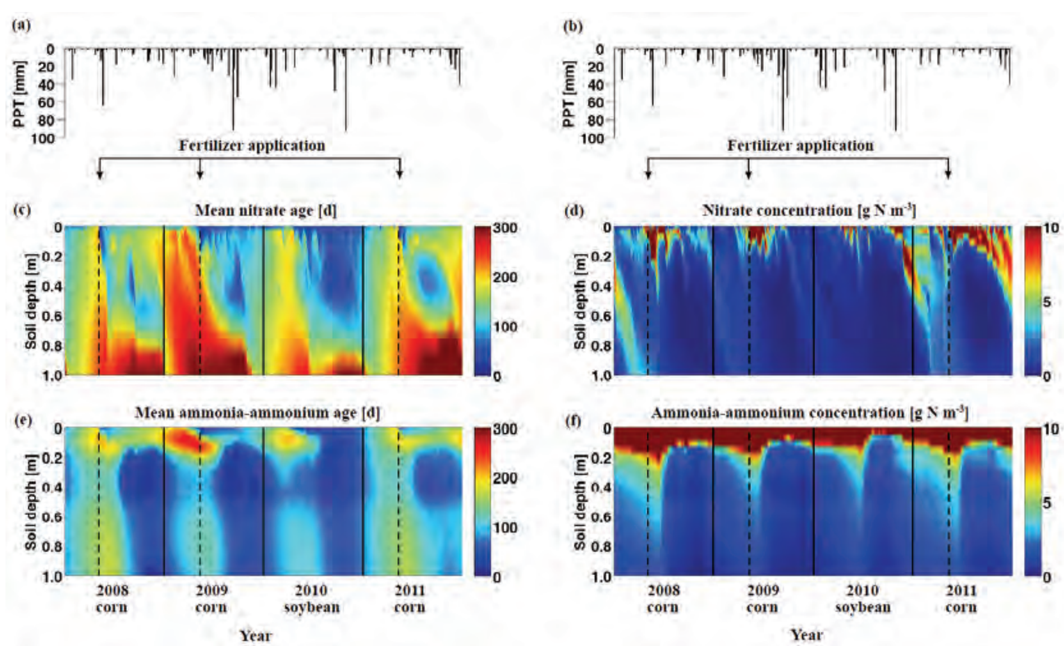

Figure E4: (a and b) Precipitation, (c) mean nitrate age, (d) nitrate concentration, (e) mean ammonia-ammonium age, and (f) ammonia-ammonium concentration to the depth of 1 m over a four year simulation with corn-corn-soybean rotation, which was forced by observed weather data. The sold lines and dashed lines represent the first day of each year and the day of fertilizer application, respectively. 28% urea ammonium nitrate fertilizer is applied at rates of 16.8, 20.2, and 18.0 g N m^{-2} in 2008, 2009, and 2011, respectively.

E5. Ecohydrologic networks to evaluate ecosystem responses

As humans modify the natural environment through land use or urbanization, we increase uncertainties regarding how ecosystems will respond to perturbations. An unexpected outcome can result from altered linkages and feedbacks between vegetation, soil, and atmospheric subsystems. A framework that views the system as a network of interacting components is needed for an integrated analysis of how perturbations lead varied responses. We develop such a framework in which ecohydrologic timeseries data represent nodes, and interdependencies are identified based on information theory measures. Links consist of lagged mutual information Iτ between "source" and "target" nodes at different timescales. Here we use 1-minute weather station data from the Sangamon Forest Preserve (SFP) site within the IML-CZO to construct process networks over 4-hour intervals between June 2014 - August 2015. Nodes are radiation (Rg), air temperature (Ta), wind speed (WS), wind direction (WD), precipitation (PPT), relative humidity (RH), and leaf wetness (LW). We see that periods with high rainfall (Figure 1A) show strong detected information links between all nodes at time scales ranging from a few minutes to an hour. These linkages decrease in strength as rainfall decreases, and further decrease as conditions become dry for several day periods (Figure 1D). Previously, process networks constructed over long timescales found that drought resulted in a breakdown of feedbacks over a season. This study shows that there is also a breakdown in feedbacks associated with individual wet and dry conditions. This work provides insight into ecosystem responses, and can be extended to modeling studies where simulated fluxes represent nodes or indices of ecosystem functionality.

Citation: Goodwell, A., and Kumar, P. Information theoretic measures to infer feedback dynamics in coupled logistic networks. In Review in *Entropy*, Oct. 2015

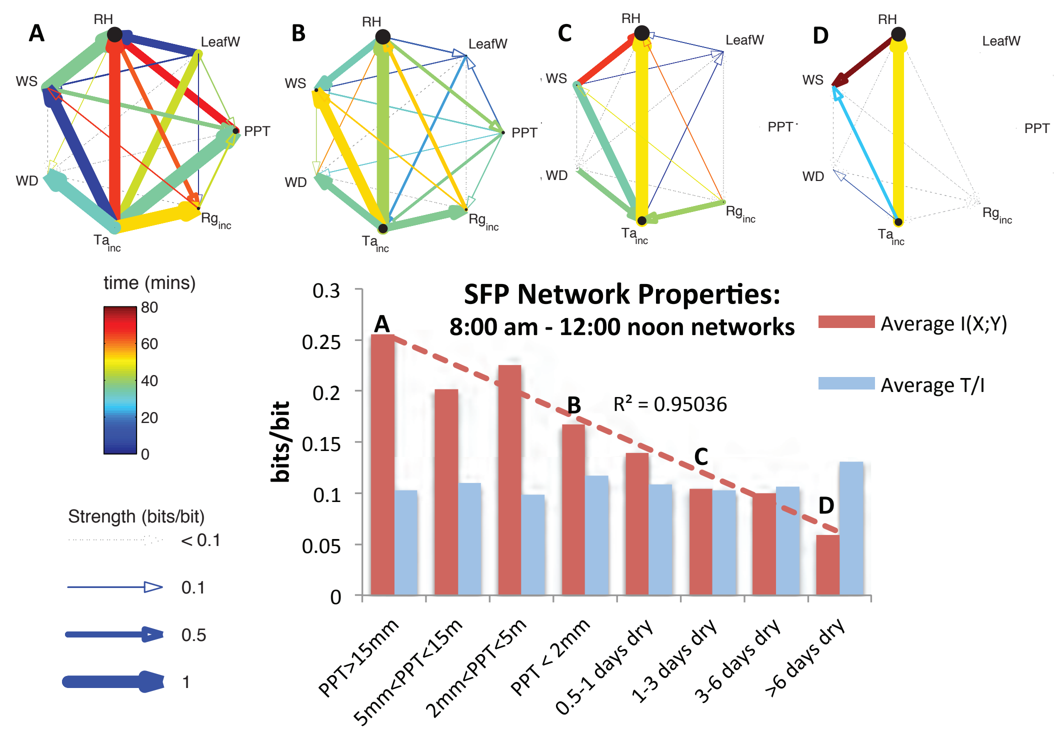

Figure E5: (A-D) Average information (I) links and their dominant timescales for varying weather conditions. (bottom) As time intervals go from very wet to very dry (A-D labels on bars), detected I links decrease in strength. T/I is a measure of link redundancy, and remains nearly constant over all conditions, indicating that links are similarly redundant with each other for all networks although they vary in strength.

Agenda for IMLCZO Site Visit
4-6 May, 2015

May 3 (Sun):

For those who arrive early, meet in the Hampton Inn Lobby at 7pm to go for informal dinner at Biaggi's in Champaign (2235 S Neil St, Champaign, IL 61820)

May 4 (Mon): [5602 Beckman Institute]

B'fast on your own at hotel or Perkins Restaurant

Meeting in Beckman Institute (Cross University Avenue from near Perkins and it is the first big building on the right. See attached map). Go to the 5th floor - the elevators are in the center of the building. The meeting room 5602 is right next to the elevator (north side).

8:00 – 8:20	Introductions and Welcome
8:20 – 8:50	Field trip background guidelines
9:00-11:30pm	Field trip ("Drill the Till" by ISGS) [9:00-9:30 Drive to drill site]
11:30-1:00	Sangamon Forest Preserve Site [11:15-11:45 drive to SFP site; 12:20-1:00 drive to Allerton]
1:00-2:15pm	Lunch (buffet) at Allerton Mansion
2:15- 4:45pm	Allerton Park & Monticello Superstation Site [4:15-4:45: Drive to ISGS]
4:45- 6:30pm	IMLCZO Virtual Tour (ISGS 3D Vis. Lab.)
6:30- 8:00pm	Dinner Memorial Stadium

May 5 (Tue): [5602 Beckman Institute]

B'fast on your own at hotel or Perkins Restaurant

8:00 - 12:15am	Headwaters Field trip (Saybrook, Goose Creek ER Expt.) Meet in the Beckman Parking Lot
12:15- 1:15pm	Lunch (buffet) and lunch talk [Jeanine Breaker]
1:15-1:40pm	Minnesota River Basin [Patrick Belmont]
1:40-2:00pm	TReNDS – Transport and Reduction of Nitrate in Danish Landscapes at various Scales [Anker Højberg, International Partner]
	[2:00 – 5:45 Independent : IMLCZO Team adhoc collaboration discussions, poster setup]
2:00 – 6:00pm	CZO PIs Business

2:00 – 2:30 CZ Going Critical (Dan)
[15 min presentation + 15 min discussion]
2:30-3:30 X-site science/common measurements (Jon, Bill, Tim)
[15 minute presentation, 45 minute discussion]
3:30-3:45 Break
3:45-4:45 Working group progress, plans, strategy(s)

- Suzanne, Sue "salon"
- Sue B tree workshop
- Concentration-discharge (Jon C)
- Critical Zone services (Bill McD)
- Microbial ecology ()
- Biogeochemistry ()
- CZ resiliency to disturbance ()
- Organic matter ()

4:45-5:45 CZOData project: "Moving Forward" (Anthony)
[15 minute presentation, 45 minute discussion with Q&A led by Lou]

6:00 - 8:30pm	Dinner and IMLCZO posters [Beckman Atrium]

May 6 (Wed): [5602 Beckman Institute]

	B'fast on your own at hotel or Perkins Restaurant
8:00 - 11:15am	CZO Steering Comm. Meeting [Beckman Room 1003] (without CZO PIs – Gordon to decide agenda)
8:00 - 8:30am	X-CZO Collaborative ideas involving IMLCZO [Thanos]
8:30am – 1:30pm	CZO PI Business 8:30-9:45 NSF: Program leadership, annual report structure and review policies 9:45-10:00 Break 10:00-10:45 Report from National Office and SAVI project (Lou & Tim) [25 min presentation + 20 min discussion] including website and international activities 10:45-11:15 LTER outreach (Dan, Bill McD, Tim) [15 minute presentation, 15 minute discussion] 11:15 - 11:45 Summary & Guidance from Steering comm. & NSF 11:45 - 12:30pm Boxed Lunch 12:30 - 1:30pm Discussion of miscellaneous topics to include: • international activities • AGU planning • criticalzone.org and czen.org • others………
1:30pm	High fives and depart for CMI airport

Drill the Till

The drilling taking place on May 4th, 2015 is being done in support of the geologic mapping program at the Illinois State Geological Survey (ISGS) in collaboration with the Intensively Managed Landscapes Critical Zone Observatory (IML-CZO) project. The collection of a 100-meter-long continuous sediment core to bedrock will help complete geologic mapping in the Rantoul Quadrangle (Figure 1) for the United States Geological Survey (USGS) STATEMAP program, a component of the National Cooperative Geologic Mapping Program. This information will provide a better understanding of the local and regional surfical and subsurface geology.

Background

The region of east–central Illinois has been glaciated by at least three major advances of the south-central margin of the Laurentide Ice Sheet over the last 1.2 million years or so (Figure 2). The latest and penultimate glaciations are referred to as the Wisconsin and Illinois Episodes. The glaciations and interglacials prior to this, and extending back to the onset of the Pleistocene in Illinois are collectively known as the pre-Illinois Episode. The southernmost extent of unconsolidated glacial deposits in North America is found in Illinois. These deposits provide regional and local aquifers, local sources of construction aggregate, are the soil parent material for extensive agricultural areas, and form a wide range of complex landforms that control the distribution of wetlands and other biosystems. Understanding the Pleistocene stratigraphy is particularly important for tracing the flow of surface and ground water for identifying hydraulic interconnections.

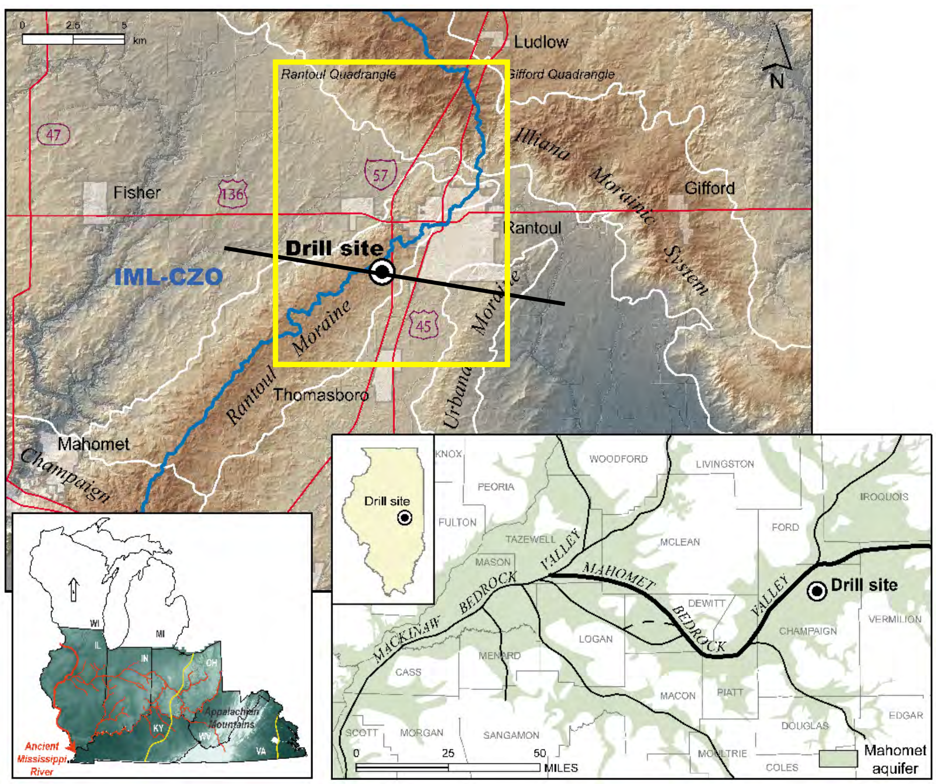

Figure 1 Location of drill site in east–central Illinois. The site is shown on a hillshaded image made from lidar topographic data. The site is located over the Mahomet Bedrock Valley which contains the Mahomet aquifer. The bedrock valleys in east–central Illinois were part of a mid-continent drainage system before the area was glaciated. Transect of geologic cross section in figure 3 is shown.

Drilling Project

The drill site is located just beyond the eastern headwaters of the Upper Sangamon River on a gently sloping surface of the Rantoul Moraine (Figure 1). The moraine was formed during a second ice advance during the Wisconsin Episode as glaciers flowed into the area from the north–northeast (Stumpf, 2014).

Subsequent erosion by flowing water and surface processes modified this glaciated landscape. The site also lies 70 meters above the Mahomet Bedrock Valley (Figure 1), part of a valley system formed during preglacial times, which was a major component of a mid-continent drainage system connecting the Appalachian Mountains to the Gulf of Mexico (Melhorn and Kempton 1991).

At this site, the Drummer silty clay loam soil is developed in a thin surficial deposit of loess (windblown silt) and the underlying dense, matrix-dominated loamy glacial diamicton (till). The A-horizon of soil is ~0.75 m thick, the leached portion of the Bt-horizon (upper weathering profile) is found down to 1.25 m, and weathering (oxidation, yellow to brown coloring) in the C-horizon to ~4.25 m. These soil horizons will be cored with a hollow-stem auger. Using the mud rotary drilling method, a core of glacial and interglacial deposits will be collected over the next 90 m to the bedrock. The deposits of the last glaciation (Wisconsin Episode) are found down to 27 m. Fracture networks in these materials may provide preferential pathways for movement of water and colloids in these otherwise slowly permeable materials (Stumpf et al., 2014).

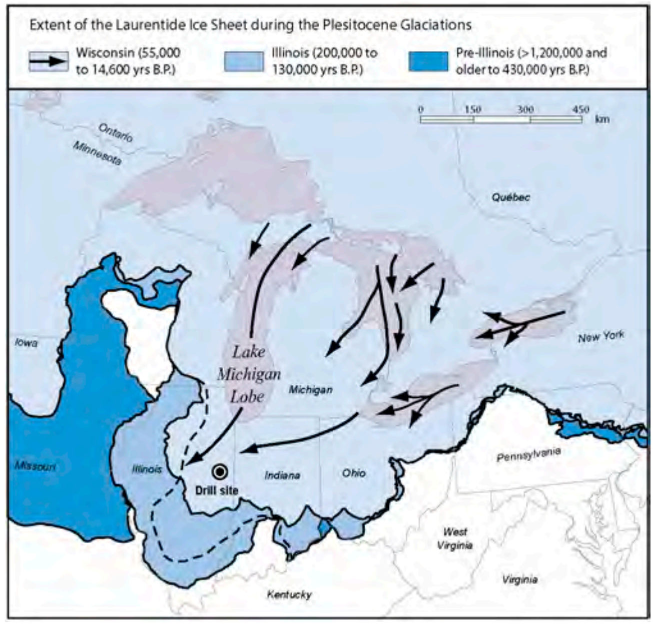

Figure 2 Extent of glaciers lobes along the south-central margin of the Laurentide Ice Sheet. The approximate flow lines of glacial lobes during the Wisconsin Episode glaciation are shown. Glacial lobes during the Illinois and pre-Illinois Episodes followed similar flow paths. The dashed line delineates the maximum extent of glaciers during the pre-Illinois Episode.

From 28–67 m below the land surface are deposits of the Illinois Episode glaciation. These deposits form a thick sequence that includes packages of sandy to silty textured material interpreted as ice marginal and proglacial sediments (till, sand, and silt), deposited when ice stagnated and melted in place. These deposits overlie a thin till unit and proglacial sand and gravel deposited during the Illinois Episode under and in front actively-flowing glaciers of the same ice sheet. In much of the region, the basal sand and gravel unit overlies glacial outwash (sand and gravel) deposited during the pre-Illinois Episode glaciation. Collectively these deposits are 20 m thick (Figure 3) and compose the Mahomet aquifer; an aquifer that supplies

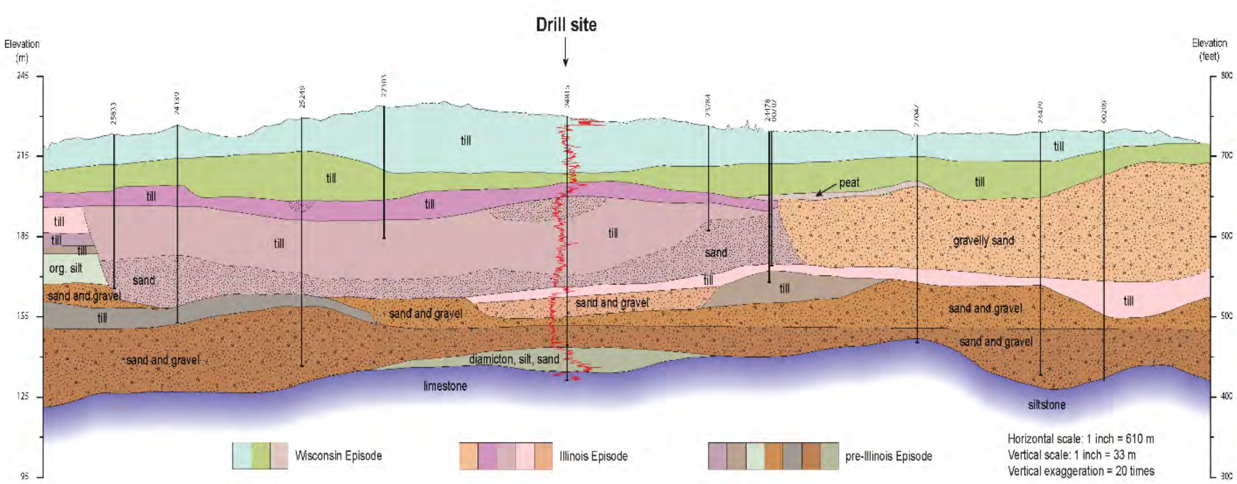

Figure 3 Geologic cross section across the drill site representing the unconsolidated Pleistocene deposits found above Pennsylvanian-age bedrock. The interconnections between aquifer units in the subsurface is important, especially for managing the important groundwater resources in the region.

groundwater to nearly 1 million people in the region. Note, at this site, till and interglacial deposits (organic-rich silt or lake sediment) from the pre-Illinois Episode have been eroded. But nearby, these tills and interglacial deposits are preserved and can be up to 15 m thick (Figure 3). Locally, the bedrock is overlain by discontinuous deposits of preglacial alluvium or regolith consisting of non-glacial diamicton, silt, and sand.

Conclusions

The integration of information from drill core and other subsurface borings like these, along with maps of the surficial geology, soils and glacial geomorphology, profiles from geophysical surveys, and physical and chemical testing of geologic materials provide a foundation for defining the initial Fundamental Soil Landscape Units. Defining the units are the basis for better understanding how the landscapes (modern and ancient) have evolved over time. Interactions between the geologic materials and associated soil landscape over time, and under different climatic conditions, vegetation and land use, drive the morphodynamic and biogeochemical processes. Using these types of data we are developing conceptual and dynamic models of landscape evolution and physical/chemical gradients in the IML-CZO that can identify heterogeneities and complexities in earth systems over time and space. For example, 3-D models of the local/regional geology and hydrology are being developed to identify areas where surface–groundwater interactions may be occurring and to detect changes in aquifer conditions that are impacted by different land uses and climate change.

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Fiber-Optic Distributed Temperature Sensing

Team : Y.F. Lin, W.S. Dey, S.L. Sargent & P. Kumar

Fiber-optic distributed temperature sensing (FO-DTS) is an emerging technology that has promise for characterizing estuary-aquifer and stream-aquifer interaction and for identifying transmissive fractures in bedrock boreholes. FO-DTS measurements involve sending laser light along a fiber-optic cable. Photons interact with the molecular structure of the fibers, and the incident light scatters. Analysis of Raman backscatter for variation in optical power allows us to estimate temperature.

There are two major questions that the FO-DTS team led by Dr. Yu-Feng Forrest Lin at the ISGS intends to unveil at the IML-CZO sites: (1) the dynamic spatial patterns of groundwater and surface water interaction in various temporal scale based on seasonal change, extreme weather events and landscape management activities, and (2) the relationship among the temperature profile in the whole critical zone's vertical coverage, the hydrological cycles and ecological progressions.

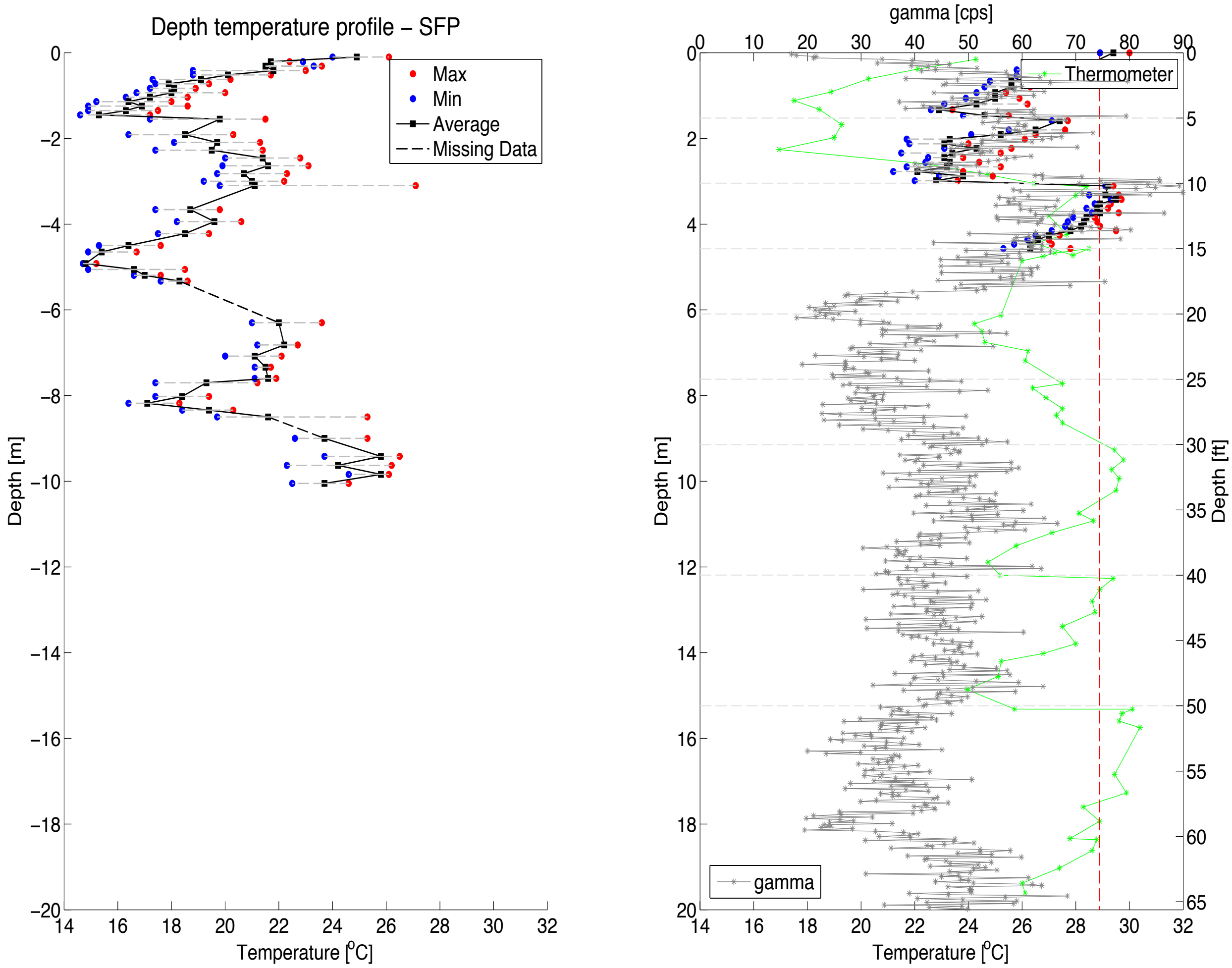
In order to answer the first question, a 2500m fiber-optic cable is scheduled to be deployed on the streambed of the Big Ditch near Goose Creek. Previous observations have identified some groundwater discharge from the streambed at this ditch. The groundwater and surface water usually carry different temperature signatures in this region. The cable will measure the temperature of streambed to identify potential patterns of groundwater and surface water interaction continuously in various seasons, as well as before and after the maintenance activities on this ditch.

In order to answer the second question, the initial step is the deployment of two sets of cables (150m and 110m) to two bore holes which are one open hole and one monitoring well with casing. This configuration is to understand the subsurface temperature distribution including unsaturated and saturated zones. The figure below shows preliminary results of the temperature vertical profile from cores obtained during Summer 2014. The following step is the deployment of one cable set vertically along the flux tower to measure high-resolution temperature distribution above surface to complete the vertical coverage of critical zone profile.

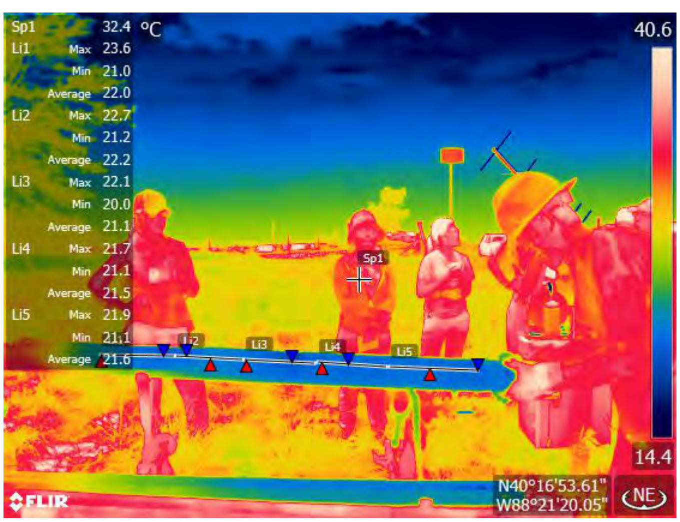
The FO-DTS team at the ISGS was established in 2013 and is equipped to measure:

- Temperature Resolution: 0.01^{o}C
- Operating Temperature: -40^{o}C ~ 65^{o}C
- Temporal Resolution: 15 sec
- Temporal Range: Limited by Storage
- Spatial Resolution: 1m for linear deployment and sub-cm for coil configuration
- Spatial Range: 5000m per channel for linear deployment
- Number of Channels: 4

With those extended measurements, the CZO team will be able to integrate this distributed temperature in dynamic spatiotemporal scales with other hydrological and biological observations for developing more collaborations on climate change and/or anthropogenic impact.



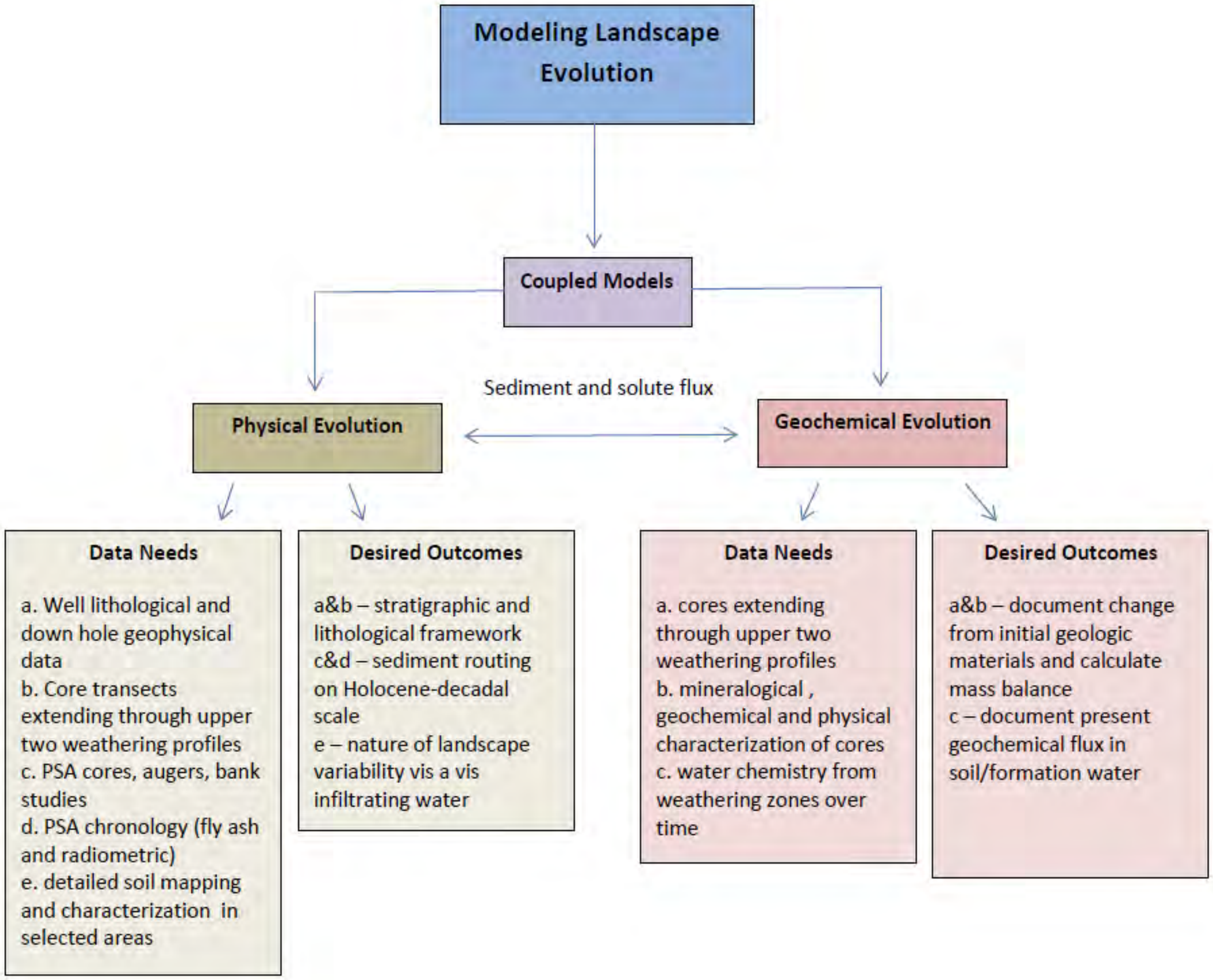
Measurement of soil profile temperature using thermal imagery (dark line) [see picture below] and using thermometers (green line, right figure only) at two drill sites. Vertical red line indicates the temperature of the slurry used in drilling [Courtesy: P. Kumar, A. Goodwell, D. Dutta, P. Lee, A. Stumpf].



Sangamon River Forest Preserve Site: Investigating the Geologic and Geomorphic Context of Weathering Profile Evolution

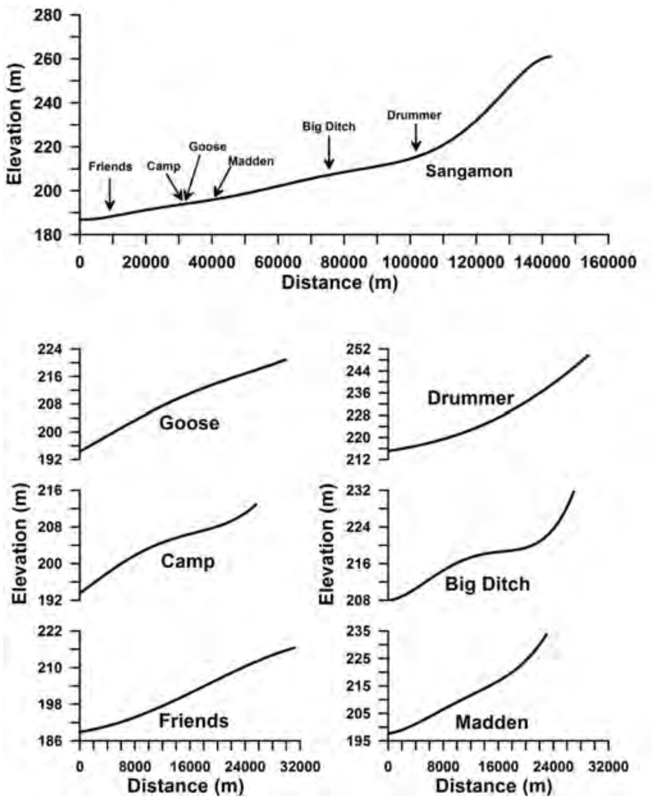
The Sangamon River Forest Preserve (SRFP) site is one of two weathering profile observatories installed in the IML-CZO (the other is in Clear Creek Watershed, Iowa). A third is scheduled for installation this year in the Minnesota River Basin. The three sites are located in three distinctly different landscapes formed on glacial or glacially-derived sediments over the past 0.5Ma. The Clear Creek (CC) site is underlain by late glacial loess that buries a glacial till deposited about 0.5Ma. Two weathering profiles are under study at the CC site; the uppermost, including the modern soil profile is formed in late glacial loess deposited between 20 and 12ka, and a separate and underlying weathering profile that includes the last interglacial paleosol (Sangamon Soil) that is developed in glacial till and buried by the loess. The SRFP site is underlain by thin last glacial loess overlying glacial till of Late Pleistocene age (~20ka). In contrast to the CC site profile, the SRFP site exhibits a composite weathering profile where the weathering in the loess has merged with and extended the profile that had been developing within the older till. The Minnesota River basing site will be located on an area underlain by glacial till of Late Pleistocene age (~12ka). The absence of loess at this site results in a single weathering profile being developed in the surficial till deposits. Together, the sites provide a range of weathering profile development patterns that are commonly found within glaciated landscapes of central North America.

Our objective at these sites is to investigate the physical, hydrologic, and geochemical characteristics of the weathering profiles to improve our understanding of weathering zone evolution in these landscapes. Core collected from CC and SRFP are undergoing physical, chemical and mineralogical characterization aimed at reconstructing the processes involved in evolution of the weathering profile in transported glacial deposits. Groundwater monitoring wells have been constructed to monitor water table and shallow groundwater levels, to conduct pumping tests for hydraulic characterization, and to facilitate water sample collection to better understand the nature of water movement and pore water chemistry through these weathering profiles. Experiments investigating the interactions of infiltrating water with the soil profile will be facilitated at these sites by draining lysimeters (30 cm diameter) that collect water from the top 20cm and upper meter of intact soil profiles. Data from these observatories will also be used by other themes investigating the flux of materials through the subsurface.


Modeling Landscape Evolution
Coupled Models
Sediment and solute flux
Physical Evolution
Geochemical Evolution
Data Needs
a. Well lithological and down hole geophysical data
b. Core transects extending through upper two weathering profiles
c. PSA cores, augers, bank studies
d. PSA chronology (fly ash and radiometric)
e. detailed soil mapping and characterization in selected areas
Desired Outcomes
a&b – stratigraphic and lithological framework
c&d – sediment routing on Holocene-decadal scale
e – nature of landscape variability vis a vis infiltrating water
Data Needs
a. cores extending through upper two weathering profiles
b. mineralogical , geochemical and physical characterization of cores
c. water chemistry from weathering zones over time
Desired Outcomes
a&b – document change from initial geologic materials and calculate mass balance
c – document present geochemical flux in soil/formation water

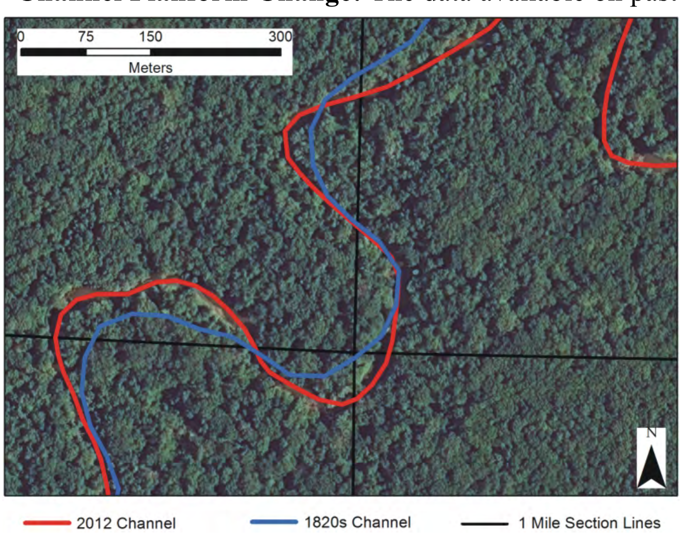
<u>Allerton Park: Valley Incision, Channel Planform Evolution & Floodplain Deposition</u>

Valley Incision: The modern floodplain of the Sangamon River is formed within a broad, shallowly incised late glacial valley. The character of the valley changes where it crosses the Champaign Moraine: the valley is generally wider (~500-600 m) and deeper (~15 m) downstream of the moraine than above the moraine (~350 m wide, 8 m deep near Fisher). A slight convexity in the main stem long profile is present approximately at the confluence with Big Ditch and the channel gradient downstream to approximately the confluence with Madden Creek is steeper than the reach above Big Ditch (0.00034 vs. 0.00024). Major tributaries from Friends Creek to Big Ditch have convex or linear long profiles in the downstream reaches, suggesting tributary incision in response to the incision of the main stem.



Research Questions: When did valley incision occur on the main stem? Was a glacial lake impounded behind the Champaign Moraine, and, if so did its drainage affect the morphology of the valley downstream? Can knickpoints be used to distinguish between tributaries present at the time of initial valley formation and more recent (i.e. Holocene) channel network evolution?

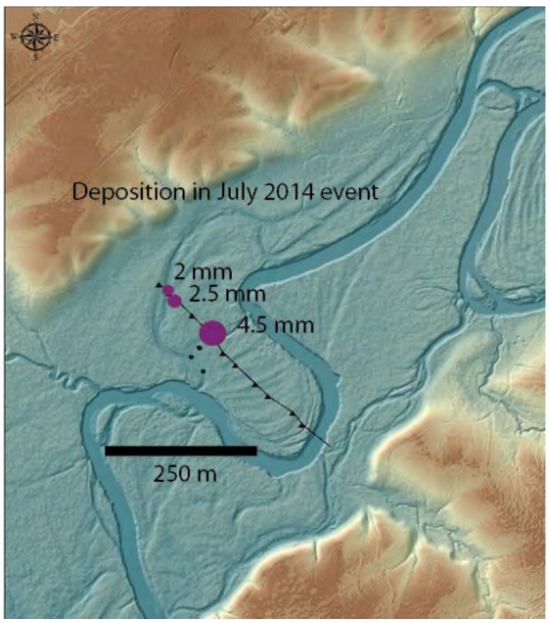
Channel Planform Change: The data available on past channel positions include plat maps generated by General Land Office surveys in ~1820 and USGS topo maps and air photos. The channel network recorded by the 1820 survey is much less extensive than at present with no channels recorded at all in several subbasins. The network had been greatly extended and straightened by the time of the first air photos (1920s-1940s) and the modern network is nearly 300% as long as the 1820 network. Comparison of the air photos and modern network indicates that recent (1940-present) meander migration is limited to a fraction of the non-channelized network that corresponds to reaches with convex to straight long profiles. The lower reaches of the Sangamon River including Allerton Park show very little meander migration



since 1820 with maximum possible rates of lateral migration of ~20-30cm/yr. Scroll bars indicative of past meander evolution are apparent in LIDAR topography of the floodplain. Meander cutoff processes are more active in Allerton Park with one cutoff occurring within the last 10 years and a growing crevasse splay potentially evolving toward an additional cutoff.

Research Questions: What factors (climate, vegetation) influenced channel network development during the Holocene prior to settlement? How rapidly was the channel network expanding before settlement? What were typical rates of meander migration during the Holocene? Is the apparent shift toward formation of cutoffs widespread in the Sangamon basin? Did land use change work to favor meander cutoffs?

Floodplain Deposition: Changes in rates of floodplain deposition corresponding to land use change can be estimated by mapping of post-settlement alluvium (PSA) based on the occurrence of fly ash from coal combustion. In the Sangamon Basin, PSA is frequently not visually identifiable, suggesting that the erosion of the uplands was limited to the organic-rich A-horizon. PSA thicknesses in the Sangamon Basin scale with valley width, ranging from ~60-70 cm in the main stem to 20-40 cm in tributaries. In contrast, at the Clear Creek site, PSA is typically visually distinct and much thicker (~1-1.2 m for ~1/10th the drainage area), indicating deeper and more extensive erosion of the uplands. In both sites, floodplain deposition rates during the post-settlement period are likely higher than Holocene average rates. In some locations including lower Clear Creek and the Sangamon headwaters near Saybrook, PSA is present on terraces now perched above the active floodplain, suggesting channel incision during the post-settlement period. Event-based sedimentation records from Allerton Park indicate strong spatial variability in deposition with the majority focused near a crevasse splay and within a floodplain channel. This variability is related to spatial variability in inundation of the floodplain. Floodplain channels are filled with water at discharges significantly below those required to inundate higher areas of the floodplain. Flooding in Allerton Park is frequent with floodplain channels inundated ~10 times per year and the floodplain surface covered ~6 times per year.



Research Questions: How do Holocene average floodplain sedimentation rates compare to post-settlement rates? What causes floodplain incision during the post-settlement period? How are spatially-variable event-based patterns of floodplain deposition integrated into floodplain deposits? Why is the floodplain so frequently inundated? How do floodplain channels form and evolve? Why do PSA records differ from Clear Creek to the Sangamon River?

Reference: Rhoads et al., accepted, Historical Channel Change in an Intensively Managed Landscape: Natural versus Human-induced Effects, Geomorphology.

Monticello, Saybrook & Goose Creek Sites: Sediment and Nutrient Dynamics

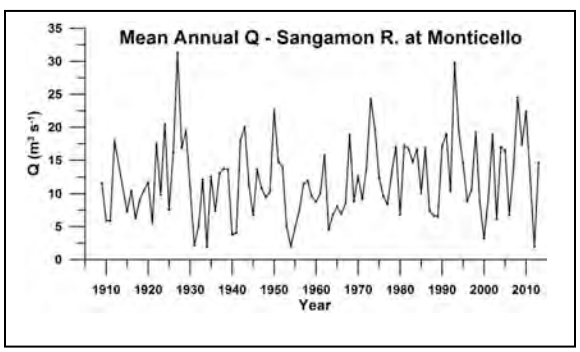
Key questions:

- 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?

Context: Sediment dynamics shape the landscape, influence soil characteristics, determine the form of alluvial river channels, and control in-stream habitat. Sediment production at the landscape level results from the integrated net contributions of gully, rill, and sheet erosion from hillslopes; remobilization of sediment stored in floodplains, and erosion of stream channels. In the upper Sangamon River basin many streams have been channelized and channel networks extended headward artificially to improve land drainage and facilitate the use of large farm equipment near streams. This channelization provides pathways for rapid movement of sediment downstream, yet also leads to complex connections between channels and hillslopes. At present the connectivity between hillslope and channel sediment systems in agricultural landscapes of the Midwest is not well understood. A critical need exists to link contemporary sediment fluxes to process mechanisms and to pathways of sediment movement. Investigation of the connectivity of hillslope and and in-stream processes will provide insight into where sediment is coming from, how sediment is moving from hillslopes into channels, how it is moving through the channel systems, and how ongoing human interaction with the landscape (e.g. working of soil, changing and cover, modifying and maintaining channels) influences the production, movement and storage of sediment.

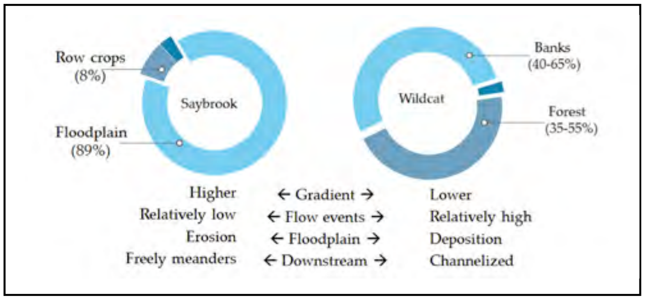
Monticello Gaging Site on Sangamon River

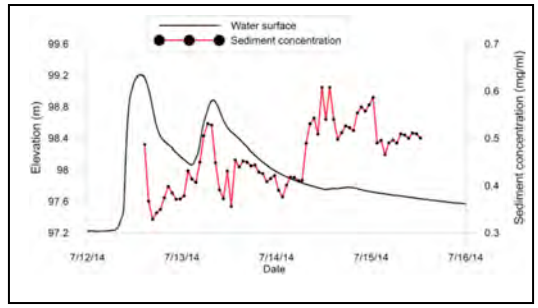
The primary purpose of this site is to provide a "super" station for measuring hydrological, sediment, and nutrient fluxes in the lower part of the watershed. The U.S. Geological Survey has been measuring discharge and stage at the Monticello location since 1908. This site has the longest record of streamflow in the watershed and provides historical insight into the hydrology of the USRB. Measurements of discharge will be supplemented by measurements of suspended sediment concentrations, phosphorus and nitrate concentrations, turbidity, and dissolved oxygen. It also will provide a context for geomorphological work on floodplain sedimentation in Allerton Park, about 10 k downstream. Not far below this location (just beyond Allerton Park) the Sangamon River becomes influenced by backwater from Lake Decatur. The site will be one of three locations along the main stream where sediment concentrations are being measured. These data will be used to explore the question: **how does the sediment response of the USRB vary spatially from upstream to downstream in relation to runoff events of different magnitude and spatial distribution?**



Saybrook Gaging Site on Sangamon River

The primary purposes of this site are to determine the hydrological and sediment responses of headwater portions of the river system to runoff events. This station will capture these responses for the morainal topography of the headwaters. Besides contributing to the basin-scale question above (see Monticello site), information for this site will address the question: **where is fine sediment that enters the headwaters of the river system coming from on the landscape and how does this delivery of**

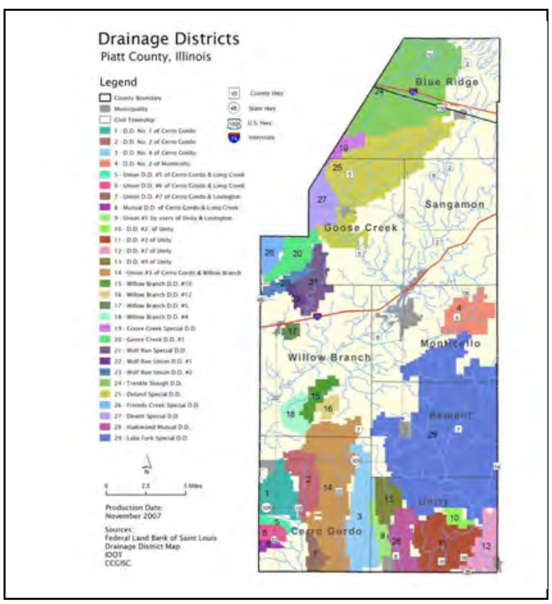




sediment from source areas vary with event timing, duration, magnitude, and spatial distribution? Source tracing studies for this location and for Wildcat Slough, a neighboring headwater tributary, initially indicate that much fine sediment is being delivered to the stream channels from either the floodplain or from within the channel.

Neal and Anders, 2015, Suspended sediment supply dominated by bank erosion in a low-gradient agricultural watershed, Wildcat Slough, Fisher, Illinois, United States, Journal of Soil and Water Conservation, 70, 145-155.

Planned Gaging Site on Goose Creek



The purpose of the planned gaging site on Goose Creek near Deland is to determine the influence of channel maintenance on sediment fluxes within headwater channels. Drainage ditches in the headwaters are managed by drainage districts, local governmental units that have the authority to levy assessments against landowners in district to raise funds for maintaining or improving land drainage systems. Goose Creek is part of the Goose Creek Drainage District in Piatt County, IL. District commissioners have decided that the ditch is in need of maintenance and plan to excavate the channel within the next year or two to remove vegetation and accumulated sediment from the bottom of the ditch. The plan is to monitor the hydrological and sediment responses of the ditch before and after maintenance to evaluate the influence of this activity, which is common throughout the central United States, on sediment fluxes within the headwaters.

Enrichment Ratio Experiments in the IML-CZO

The Enrichment Ratio (ER) for Soil Organic Matter (SOM) is a reflection of the preferential entrainment of smaller, lighter particles or aggregates by runoff. ER values are essential for determining cumulative or single event SOM losses associated with erosion. The ratios are expressed as the proportion of SOM in transported, or mobilized, sediment to that of SOM in uneroded soil.


Figure 1: Rainfall simulator used to quantify enrichment ratios.

In the IML-CZO, we are conducting Enrichment Ratio (ER) experiments to help us address connectivity issues between upland areas and the stream channel well as address the key question related to SOM transport dynamics. These experiments relate to the central IML question where we are looking at how intense management practices and drastic land use changes have affected the long-term and short-term memory of the system, reflected in the biogeochemical properties of the soil like SOM.

We have designed the enrichment ratio experiments to capture the different aspects of the IML sites and they can be used for performing cross-site comparisons within the CZO network. ERs are dependent on key constituents of soil such as soil texture, bulk density, as well as raindrop detachment and runoff. The enrichment ratio is not dependent on scale (the sediment delivery ratio instead is dependent on scale). Recent studies show that total SOM mapping must consider enrichment ratios to capture the dynamic mobilization and burial of SOM, which has implications on connectivity and solute transport.

Rainfall simulators are used to get ERs (otherwise we are at the mercy of Mother Nature). The experiments you will see performed use simulated rainfall events with known intensities over plots with representative management practices in the IML. Runoff and eroded sediment samples, containing aggregates, are collected at the end of the plot. The carbon content of the collected sediment will be compared with soil samples collected initially from the plot.

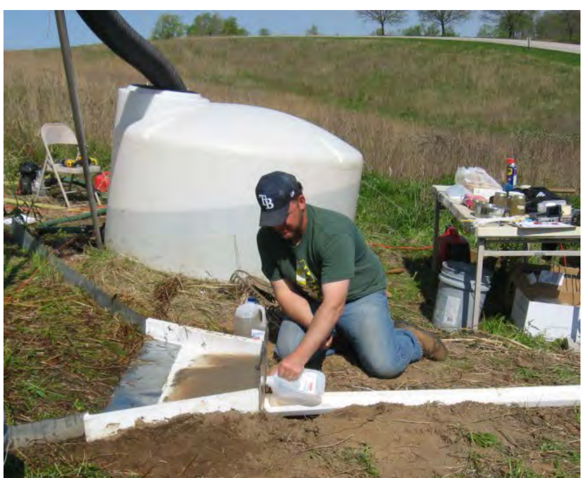


Figure 2: Collecting a sample at the plot outlet.

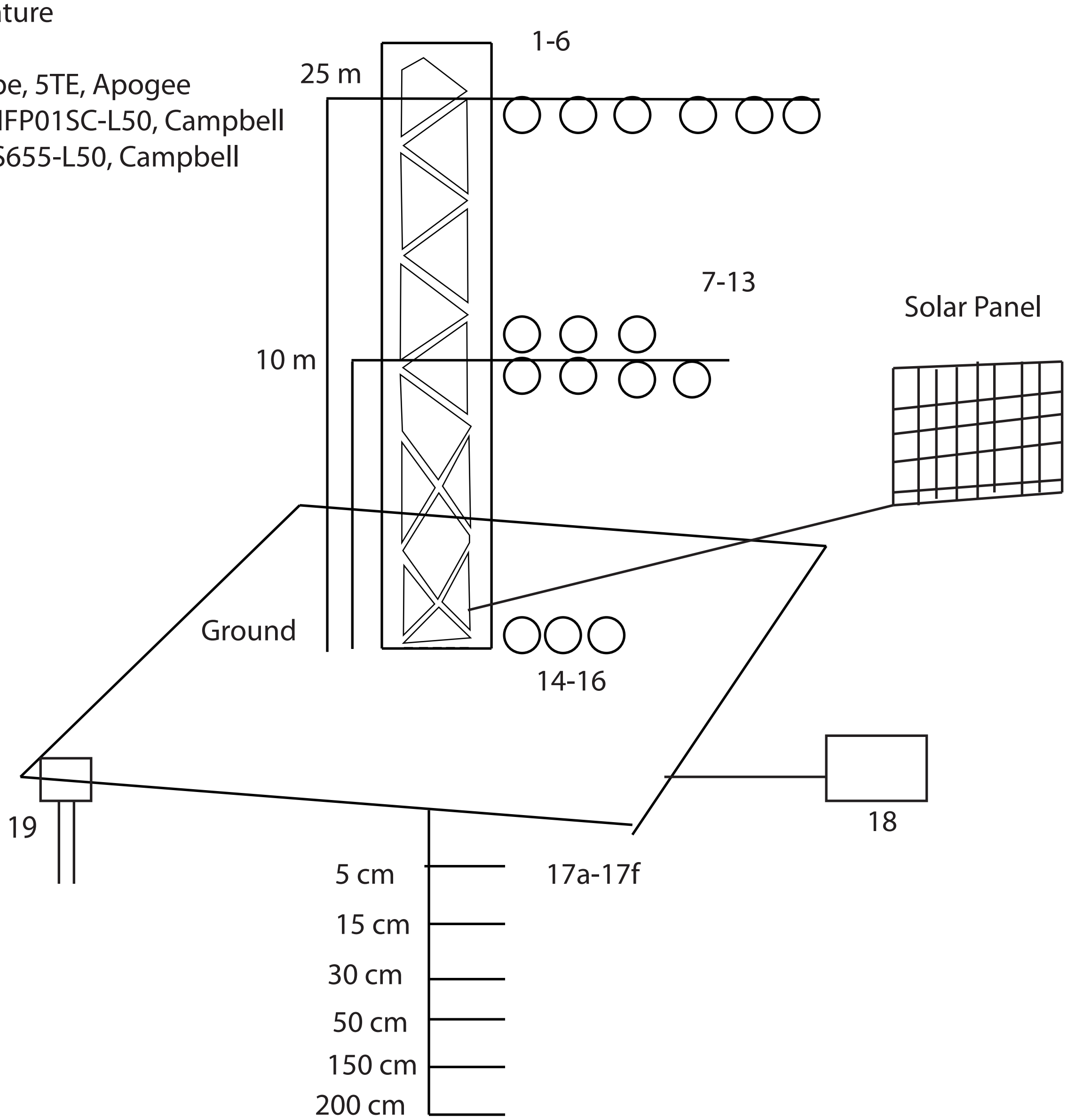
The enrichment ratio is high initially in a rainfall event, as SOM is generally highly correlated with the finer, clay-rich, easily entrainable, particles and aggregates, which are preferentially transported relative to sand and silt-dominated aggregates due to their size. As the rainfall event continues, enrichment ratios decrease as runoff depths increase eventually reaching a steady state and larger particles/ aggregates are also entrained in the runoff. For more info on ER please contact Thanos Papanicolaou and team at: tpapanic@utk.edu

Flux Tower (Goose Creek Site)

1: Open Path Gas Analyzer, LI7500, Campbell
2: 3D-Sonic Anemometer, CSAT3, Campbell
3: Radiation Flux, CG3/CM3 Pyreometer, Campbell
4: Relative Humidity, 083E-L, Campbell
5: PAR, LI190SB-L, Campbell
6: Ambient Temperature
7: SRS, NDVI-Ni, Decagon
8: SRS, NDVI-Nr, Decagon
9: SRS, PRI-PI, Decagon
10: SRS, PRI-Pr, Decagon
11: Infrared Radiometer, SI-1H1, Apogee
12: Infrared Radiometer , SI-121, Apogee
13: 2D-Sonic Anemometer, DS-2, Decagon
14: Rain Gauge, TE525-L, Campbell
15: Ambient Temperature
16: Pressure
17: Soil Moisture Probe, 5TE, Apogee
18: Heat FLux Plate, HFP01SC-L50, Campbell
19: Reflectometer, CS655-L50, Campbell

Extras

20: Cellular Modem, RAVENXTV, Campbell
21: Datalogger,



Natural and Urban Infrastructure Assessment Using Small Unmanned Systems

Prof. Joshua Peschel, PhD
Civil and Environmental Engineering
University of Illinois at Urbana-Champaign

This white paper summarizes the current platforms and sensing capabilities for using small unmanned vehicle technologies to inspect and assess of topography and other infrastructure from landscapes.

Small Unmanned Aerial Platforms

Small unmanned aerial vehicles (UAVs) represent the smallest physical size, operational range (distance of travel), altitude (elevation above ground or sea level), and endurance (time of operation) of all UAVs, and it is the vehicle type most commonly available for commercial and civilian operations, such as urban search and rescue. These UAVs allow a human team, which is usually co-located, to remotely navigate and visualize information in environments where, for example, humans or other ground-based robots are not practical (Peschel and Murphy, 2013; 2015). UAVs in the small category are traditionally of a rotor- or fixed-wing design (Figure 1). Table 1 summarizes the operational characteristics of selected small UAVs currently in operation in Dr. Joshua Peschel's research group at the University of Illinois.

Figure 1. Small unmanned aerial vehicles available from Dr. Joshua Peschel's research group (left). On the right is an interface developed by Peschel (2012a) on a tablet allowing untrained users to use the UAVs.

Table 1. Classifications of Selected Small UAVs in Operation at the University of Illinois.

UAV Platform	Size [m]	Payload [kg]	Range [km]	Altitude [km]	Endurance [hr]
3DR IRIS	0.6	0.4	Line-of-Sight*	< 0.1*	0.3-0.4
3DR X8	0.8	0.8	Line-of-Sight*	< 0.1*	0.2-0.3
3DR AERO	1.8	2.0	Line-of-Sight*	< 0.1*	0.5-1.0

* FAA regulations required line-of-sight operation under 400-ft altitude (actual range is: ~1-km with a 915-MHz control signal)

Sensing Capabilities

Small UAVs have been most effective for visual sensing over large areas, typically high-resolution video and image data gathering, at varying temporal frequencies; additional work has investigated the use of small UAVs for interaction with the environment (Peschel, 2012b; 2015). The ease of portability, quick setup time (usually less than 5-minutes), and interchangeability of payload sensors make small UAVs ideal for *ad hoc* use in dynamic and difficult environments. Small UAVs have been successfully demonstrated for high-resolution surface mapping (Perez et al., 2013), including pavement and roadside condition assessment (Hart and Gharaibeh, 2011). The Illinois UAVs each have the capability to capture georeferenced imagery to assemble high-resolution scenes for pavement analysis. In-house software at Illinois can construct a 3D topographic model based on the images for standard hydraulic flow analysis in a geographic information system (GIS) (Figure 2). The major sensing limitation for small UAVs is payload weight, which indirectly affects endurance (i.e., heavier payloads lead to shorter flight times).

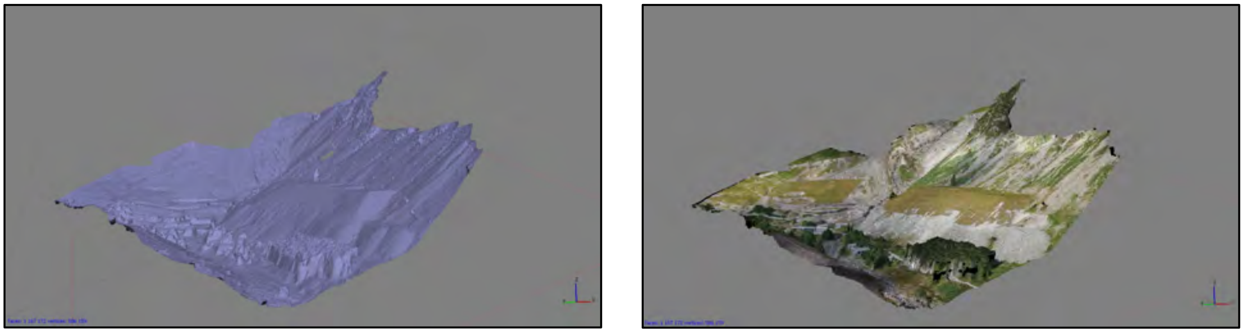


Figure 2. Solid texture rendering of topography extracted from georeferenced images captured with a UAV (left). On the right is the actual imagery superimposed on top of the 3D topographic model in a GIS.

Small Unmanned Surface Systems

Small tactical unmanned surface vehicles (USVs, effectively robot air boats) at Illinois are being used to perform longitudinal water sampling along strategic reaches of various tributaries (Peschel and Handa, 2015; Handa and Peschel, 2015). Dr. Joshua Peschel and his research group have built two different custom USVs: a 0.5-meter vehicle for small tortuous spaces and a 1-meter vehicle for larger unobstructed spaces (Figure 3). Each USV is equipped with GPS and can either operate semi-autonomously through defined waypoint tasking via a digital map or through manual control at up to 4-kilimeter range. Each vehicle carries a high definition video camera to capture and store data onboard, and a 5.8-GHz transmitter capable of sending video, telemetry, and sampling data in real-time to the science team. Continuous-operation battery life for each vehicle at a speed of 0.5-meters per hour is approximately 4-hours, giving a long range sampling mission with little or no expected return to home time.

Samples can be collected across a 2-kilometer reach hourly over a 24-hour period. Each USV carries an Arduino-based data acquisition and storage package with the following sensors: temperature, pH, dissolved oxygen, oxidation-reduction potential, and conductivity. A micro-pipette sampler can capture water samples on demand at identified locations. Samples can be analyzed for physical parameters (pH, conductivity, total suspended solids, dissolved oxygen), chemical parameters (biological oxygen demand, chemical oxygen demand, nitrate, total Kjeldhal nitrogen, heavy metals including chromium, manganese, zinc, copper and lead), and biological parameters (fecal coliforms and fecal streptococcus organisms).

Figure 3. Small unmanned surface systems developed by Dr. Joshua Peschel and his research group and being deployed for various scientific investigations in the IML-CZO, Bangalore, India and elsewhere.

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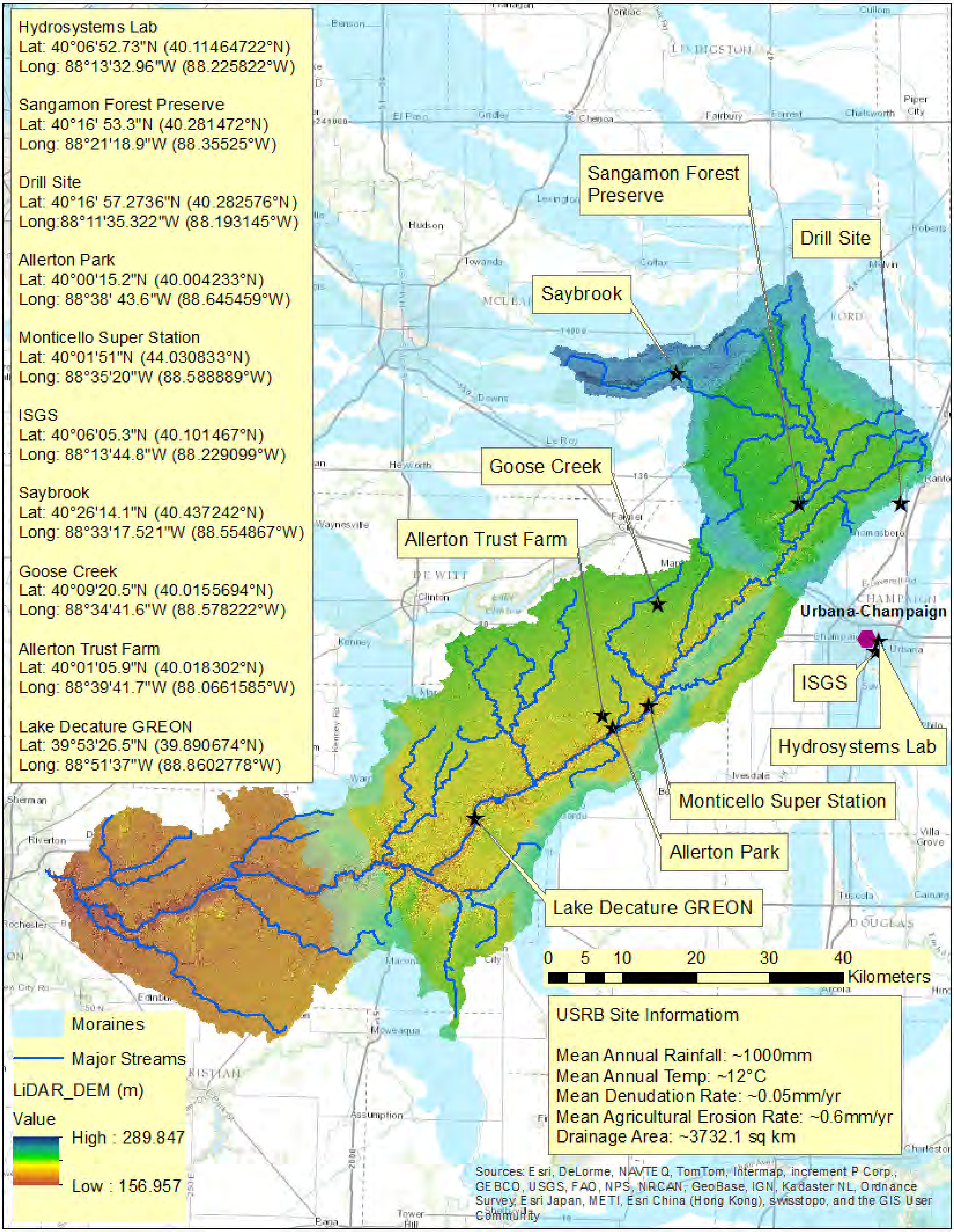
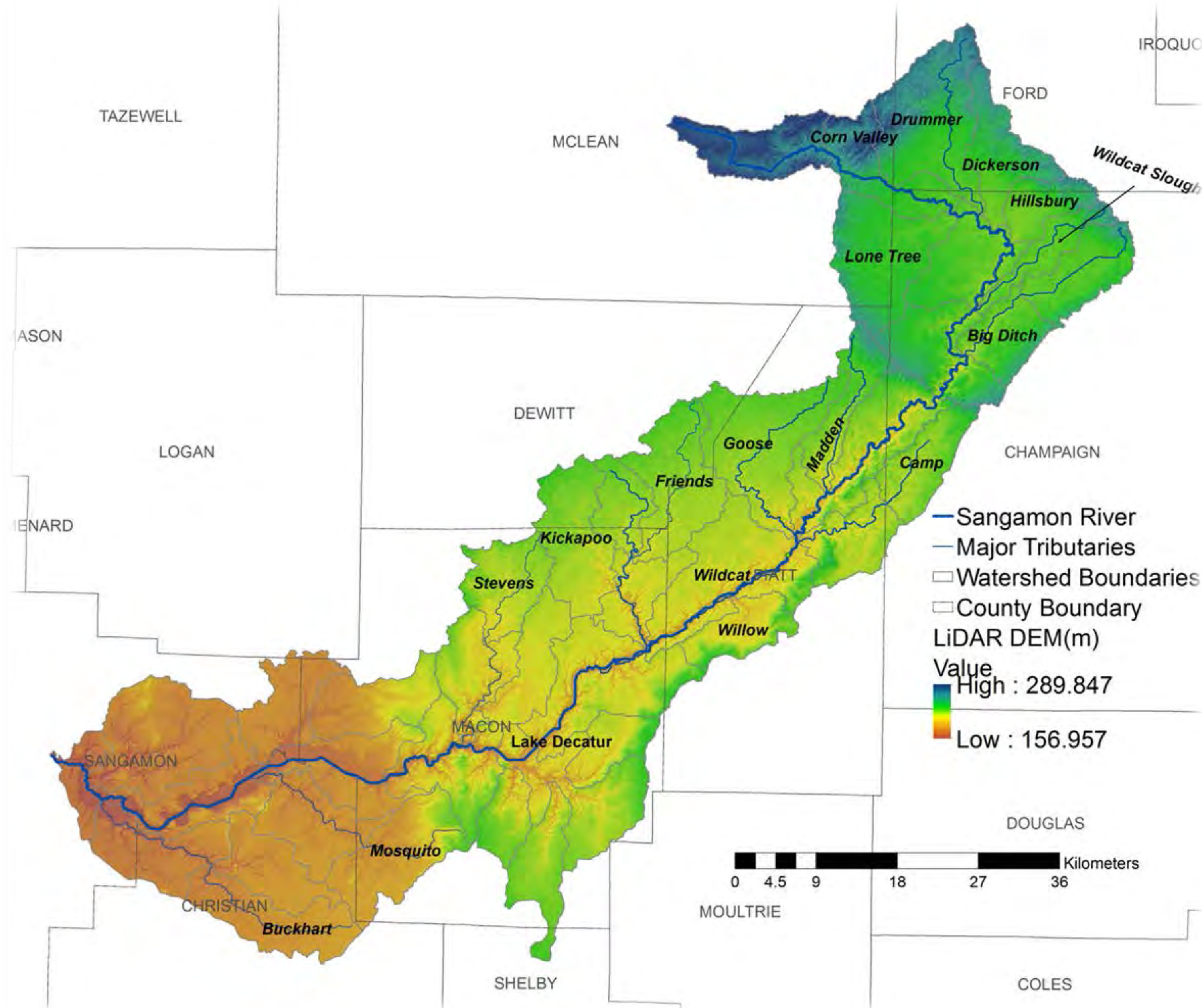
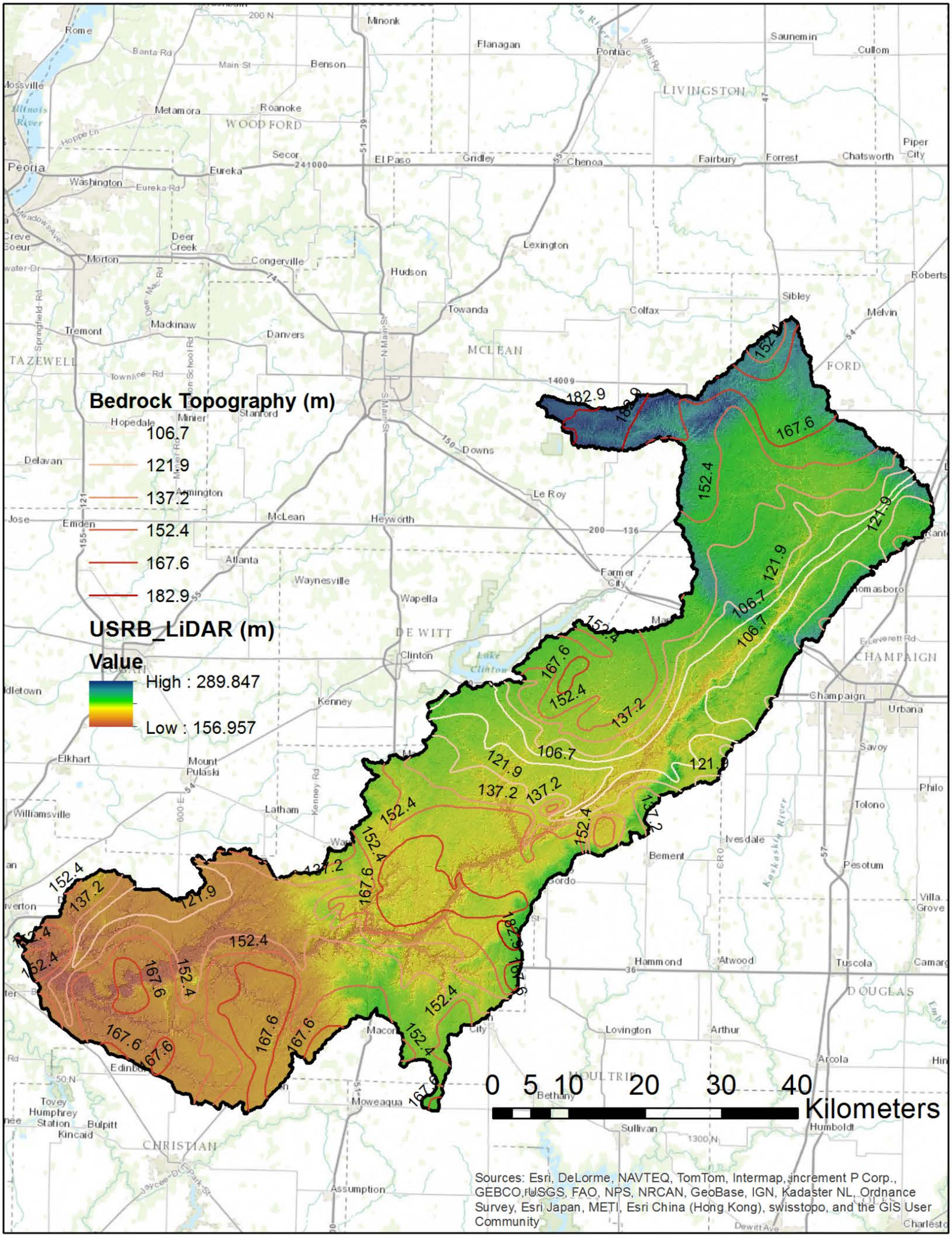
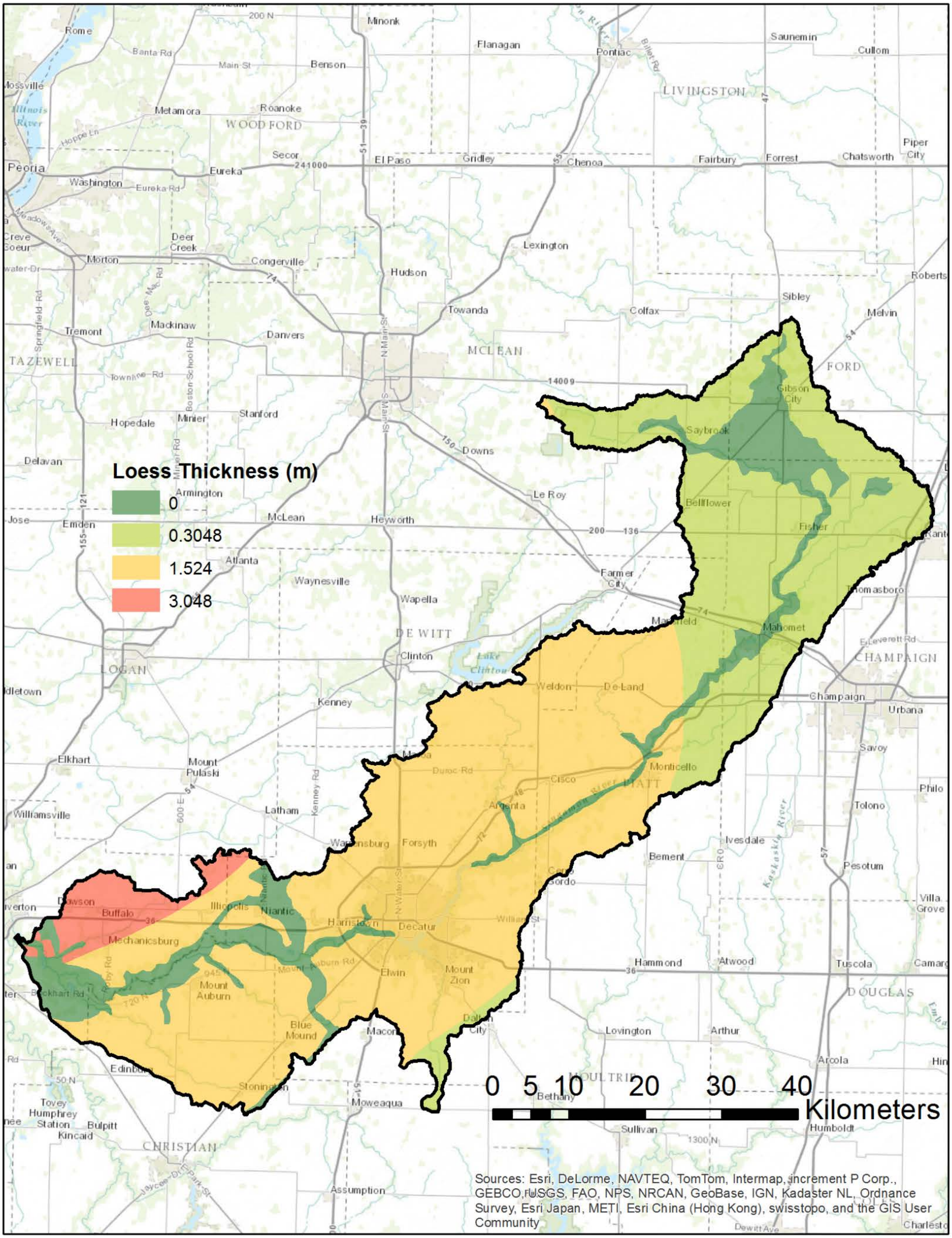
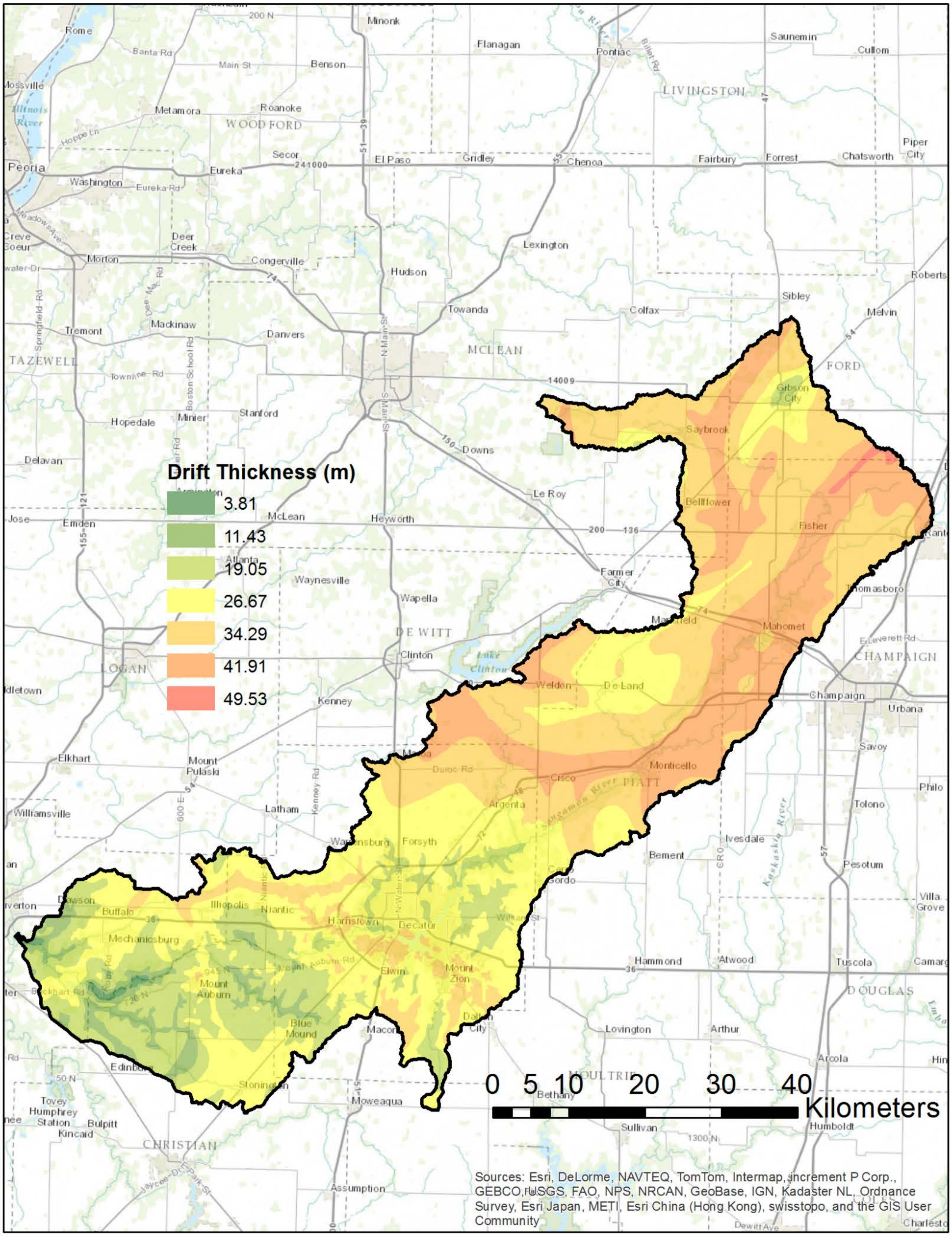

Hydrosystems Lab
Lat: 40°06'52.73"N (40.11464722°N)
Long: 88°13'32.96"W (88.225822°W)
Sangamon Forest Preserve
Lat: 40°16' 53.3"N (40.281472°N)
Long: 88°21'18.9"W (88.35525°W)
Drill Site
Lat: 40°16' 57.2736"N (40.282576°N)
Long:88°11'35.322"W (88.193145°W)
Allerton Park
Lat: 40°00'15.2"N (40.004233°N)
Long: 88°38' 43.6"W (88.645459°W)
Monticello Super Station
Lat: 40°01'51"N (44.030833°N)
Long: 88°35'20"W (88.588889°W)
ISGS
Lat: 40°06'05.3"N (40.101467°N)
Long: 88°13'44.8"W (88.229099°W)
Saybrook
Lat: 40°26'14.1"N (40.437242°N)
Long: 88°33'17.521"W (88.554867°W)
Goose Creek
Lat: 40°09'20.5"N (40.0155694°N)
Long: 88°34'41.6"W (88.578222°W)
Allerton Trust Farm
Lat: 40°01'05.9"N (40.018302°N)
Long: 88°39'41.7"W (88.0661585°W)
Lake Decature GREON
Lat: 39°53'26.5"N (39.890674°N)
Long: 88°51'37"W (88.8602778°W)
Sangamon Forest Preserve
Drill Site
Saybrook
Goose Creek
Allerton Trust Farm
Urbana-Champaign
ISGS
Hydrosystems Lab
Monticello Super Station
Allerton Park
Lake Decature GREON
0 5 10 20 30 40
Kilometers
USRB Site Informatiom
Mean Annual Rainfall: ~1000mm
Mean Annual Temp: ~12°C
Mean Denudation Rate: ~0.05mm/yr
Mean Agricultural Erosion Rate: ~0.6mm/yr
Drainage Area: ~3732.1 sq km
Moraines
Major Streams
LiDAR_DEM (m)
Value
High : 289.847
Low : 156.957
Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, and the GIS User Community

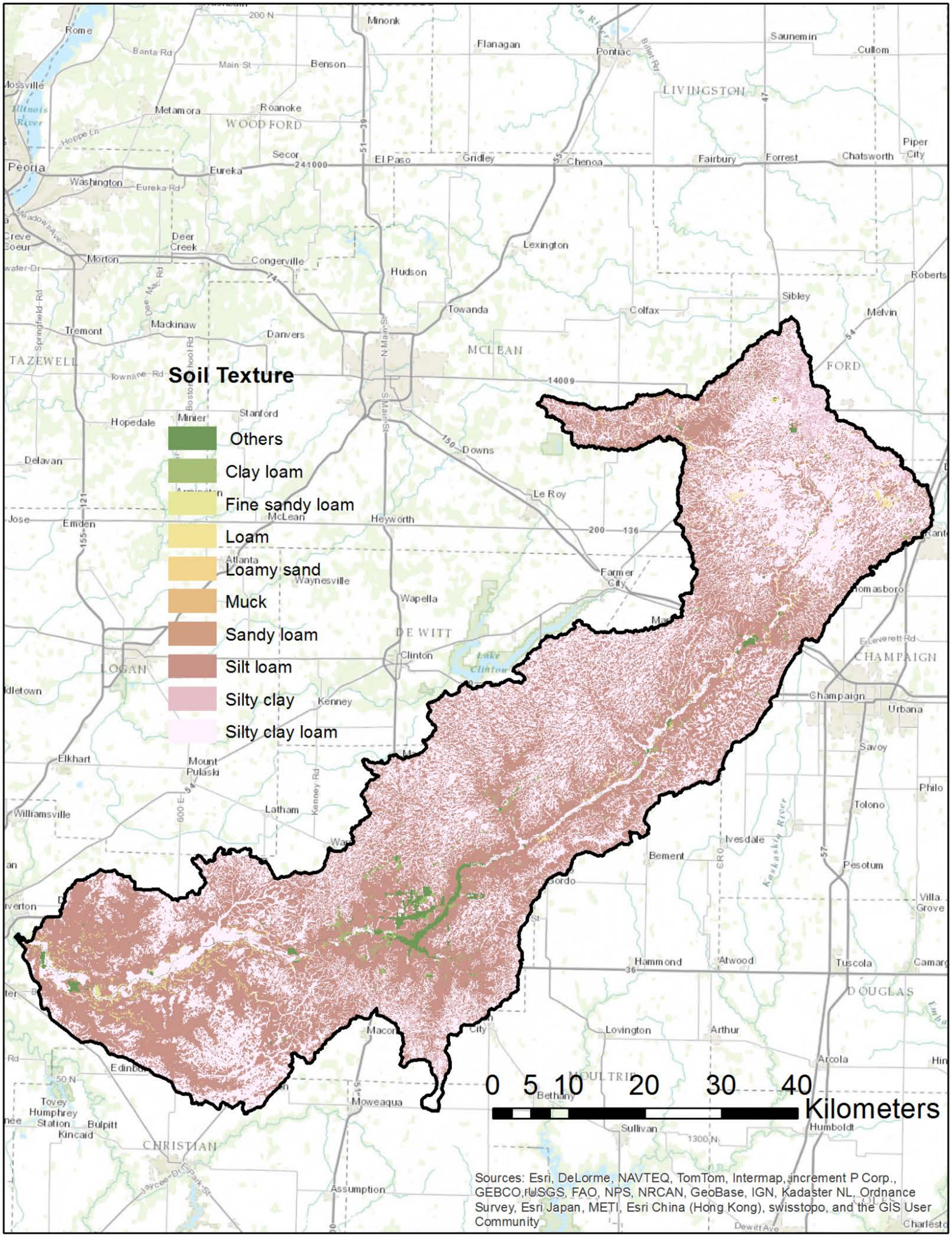


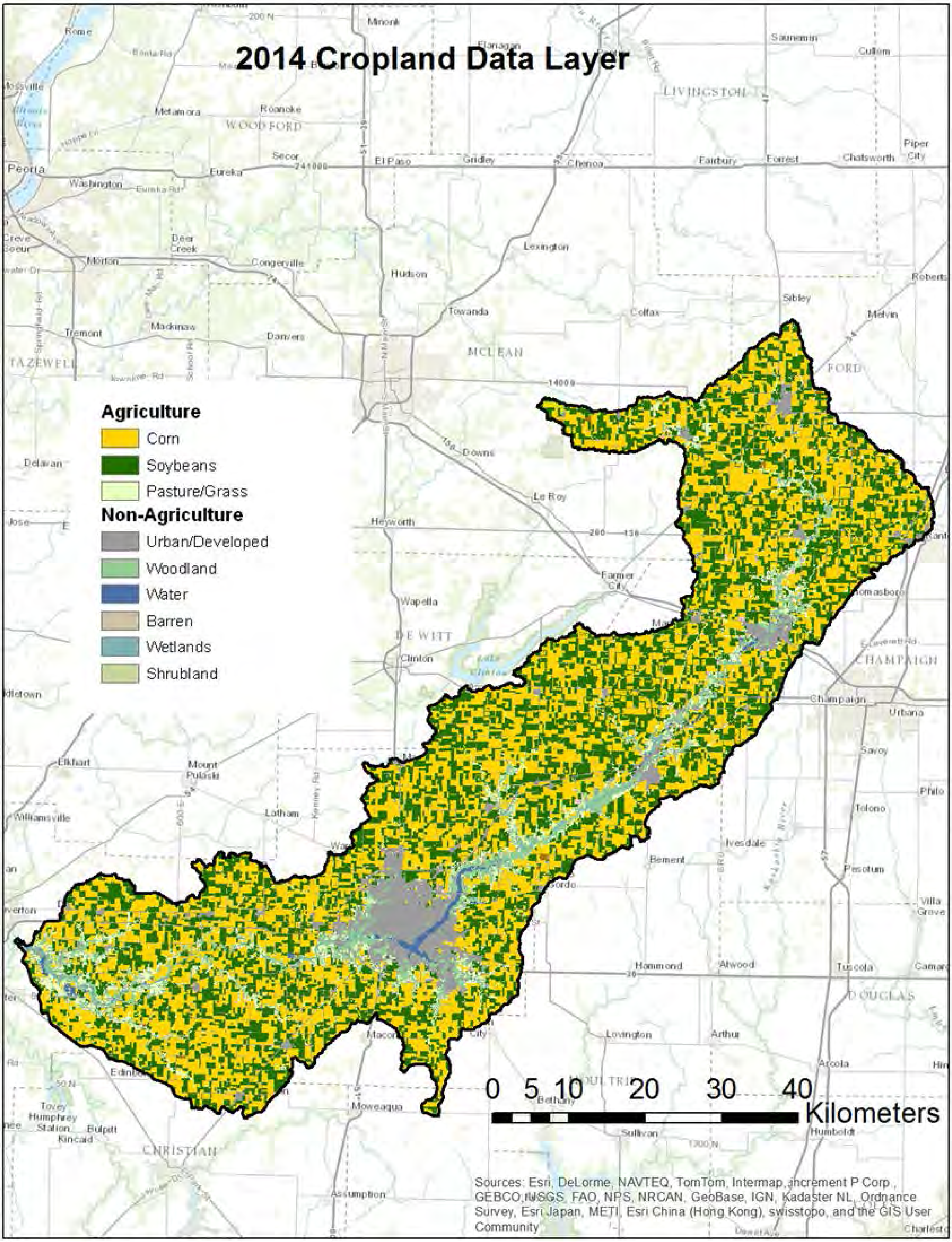
TAZEWELL
MCLEAN
FORD
IROQUO
ASON
LOGAN
DEWITT
CHAMPAIGN
ENARD
Corn Valley
Drummer
Dickerson
Hillsbury
Wildcat Slough
Lone Tree
Big Ditch
Goose
Madden
Camp
Friends
Kickapoo
Stevens
Wildcat
PIATT
Willow
MACON
Lake Decatur
SANGAMON
Mosquito
CHRISTIAN
Buckhart
SHELBY
MOULTRIE
DOUGLAS
COLES
Sangamon River
Major Tributaries
Watershed Boundaries
County Boundary
LiDAR DEM(m)
Value
High : 289.847
Low : 156.957
0 4.5 9 18 27 36 Kilometers


Bedrock Topography (m)
106.7
121.9
137.2
152.4
167.6
182.9
USRB_LiDAR (m)
Value
High : 289.847
Low : 156.957
0 5 10 20 30 40
Kilometers
Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, and the GIS User Community


Loess Thickness (m)
0
0.3048
1.524
3.048
0 5 10 20 30 40
Kilometers
Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, and the GIS User Community

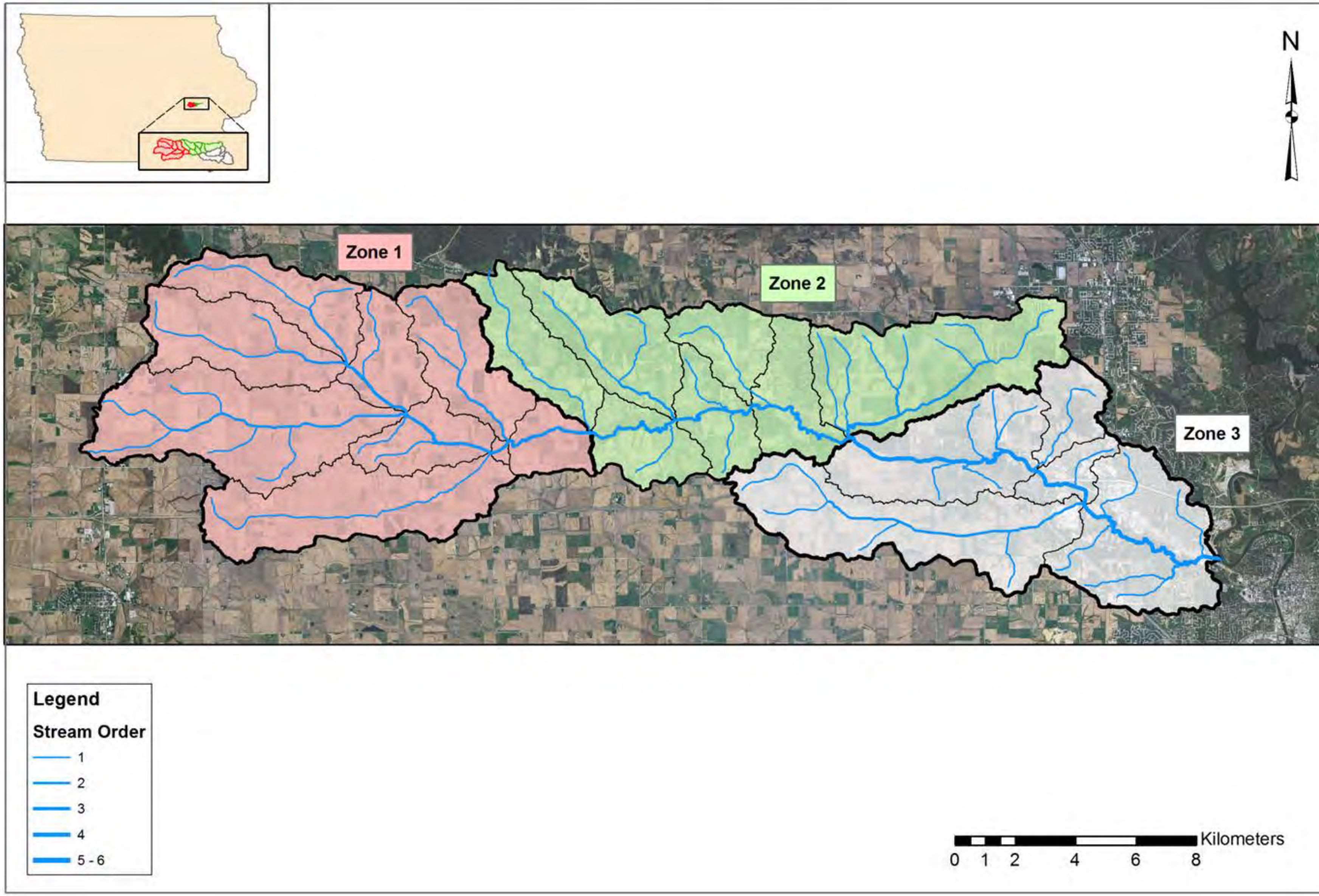

Drift Thickness (m)
3.81
11.43
19.05
26.67
34.29
41.91
49.53
0 5 10 20 30 40
Kilometers
Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, and the GIS User Community

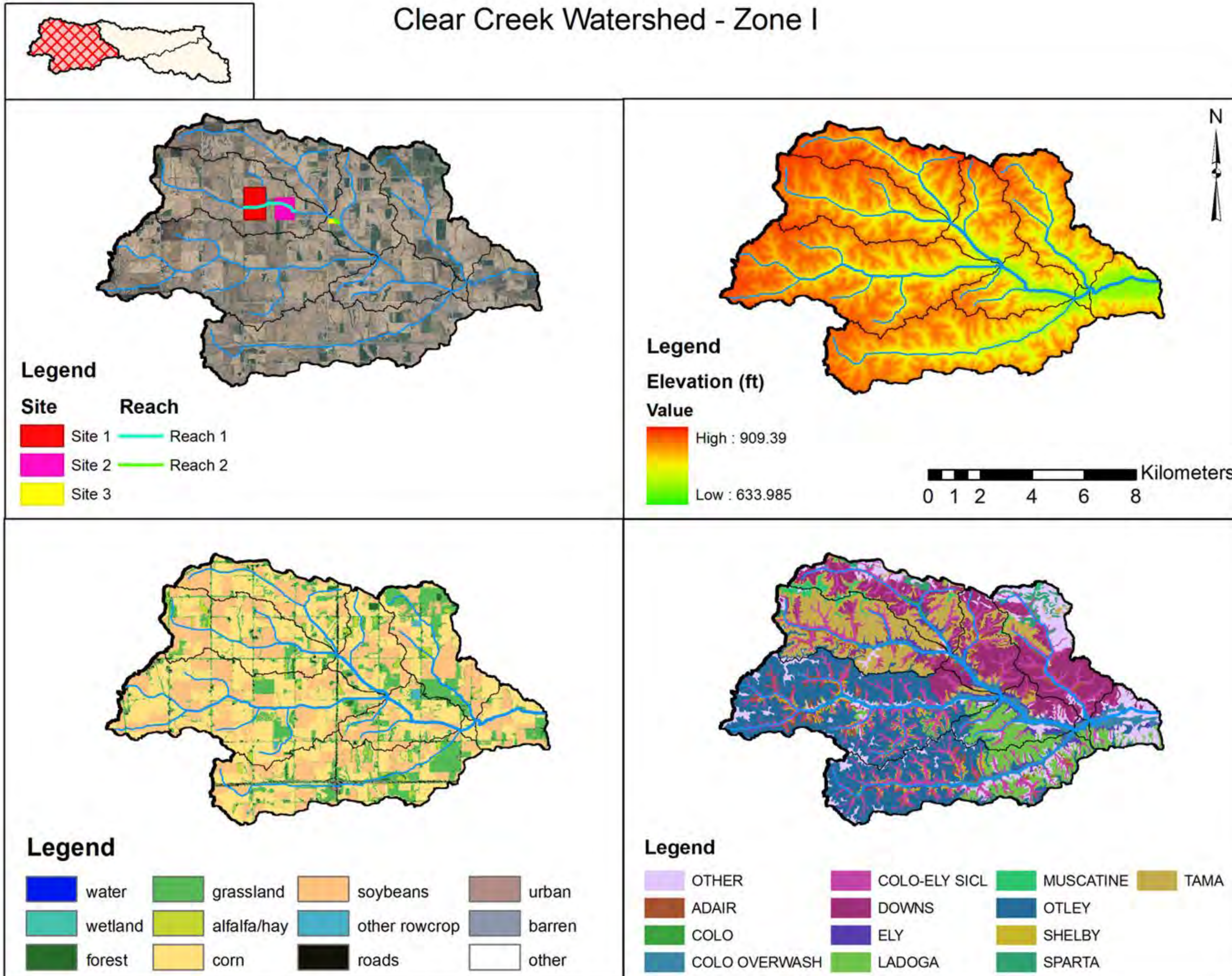

Soil Texture
Others
Clay loam
Fine sandy loam
Loam
Loamy sand
Muck
Sandy loam
Silt loam
Silty clay
Silty clay loam
0 5 10 20 30 40
Kilometers
Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, and the GIS User Community

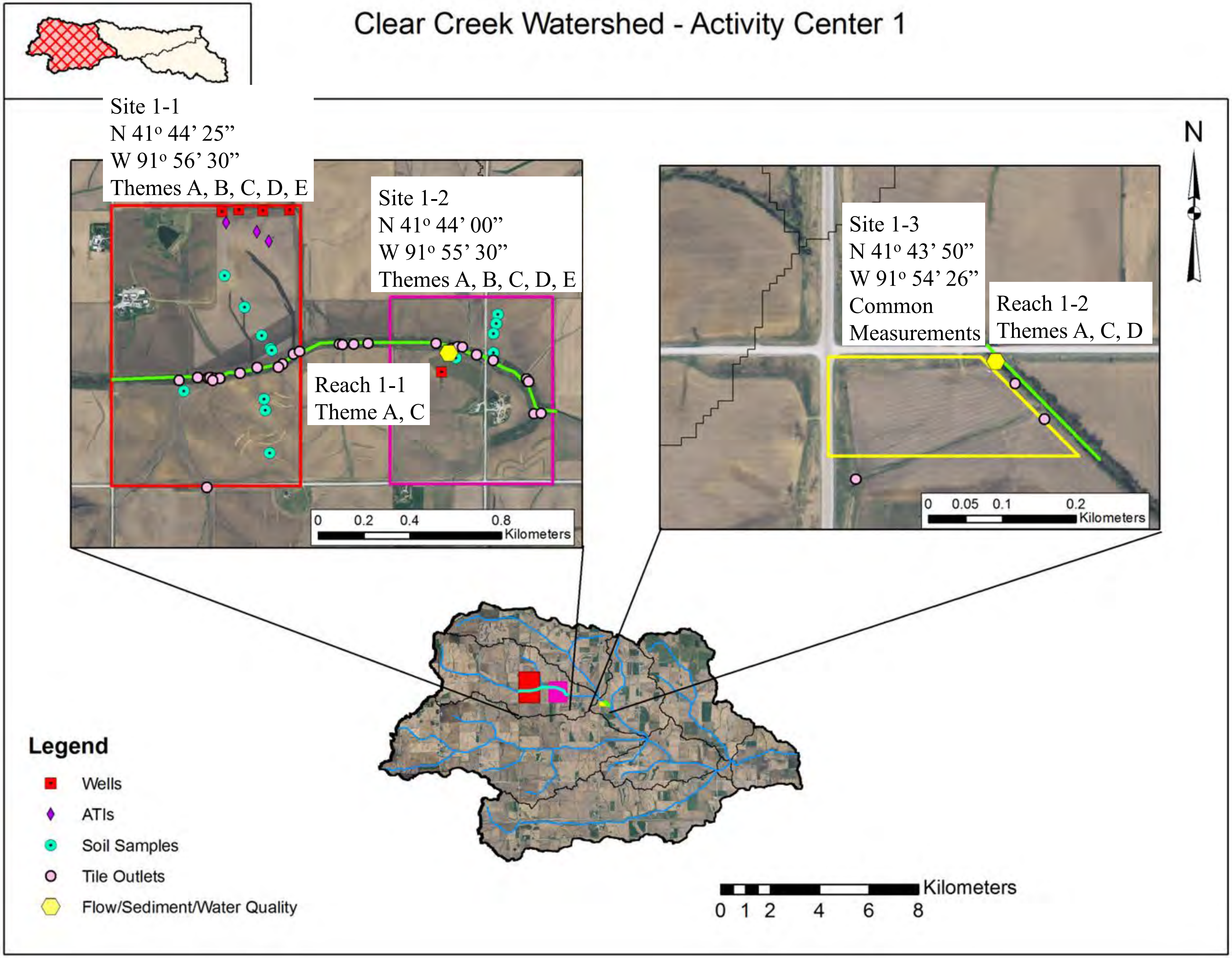


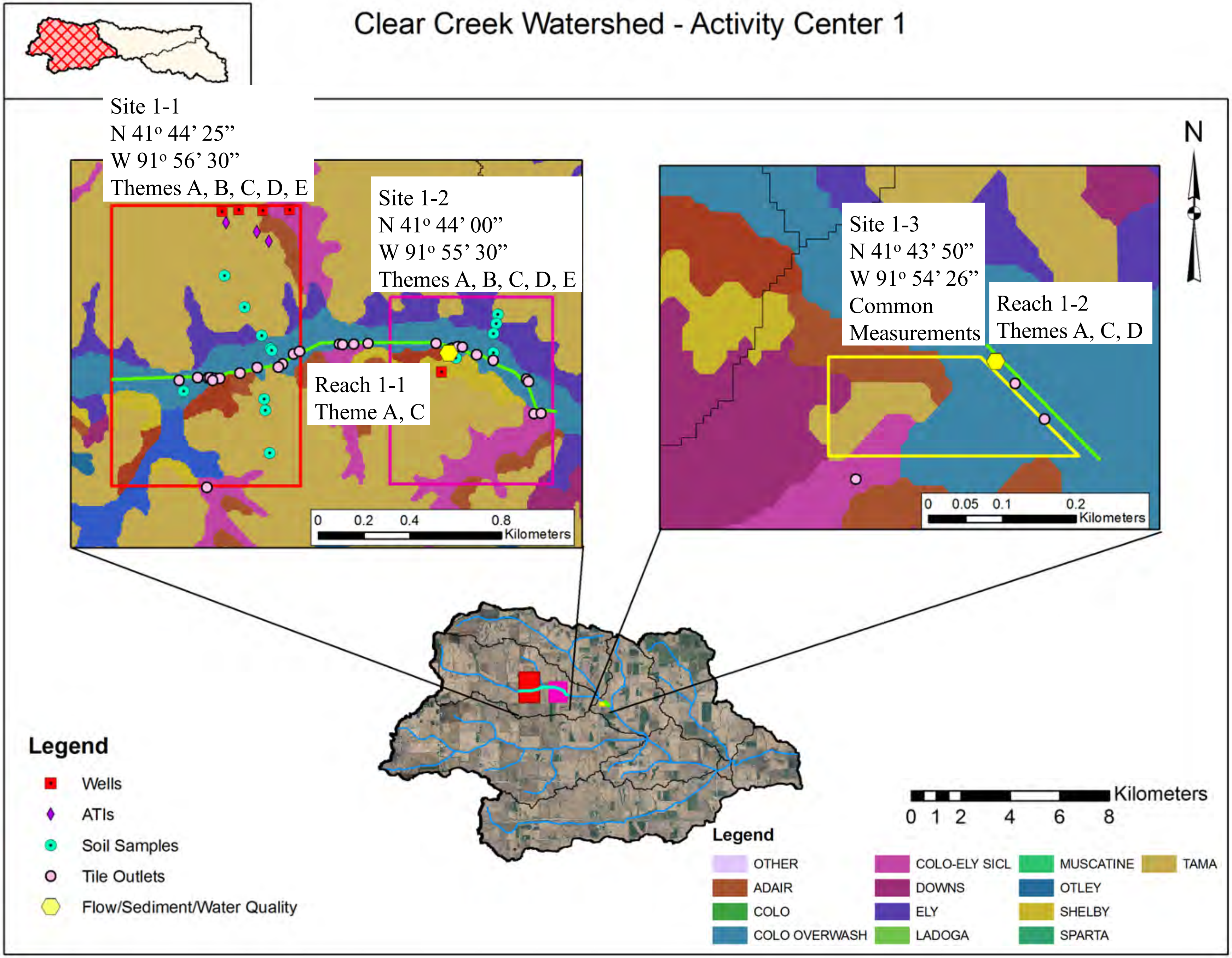
2014 Cropland Data Layer
Agriculture
Corn
Soybeans
Pasture/Grass
Non-Agriculture
Urban/Developed
Woodland
Water
Barren
Wetlands
Shrubland
0 5 10 20 30 40
Kilometers
Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, and the GIS User Community

Clear Creek Watershed

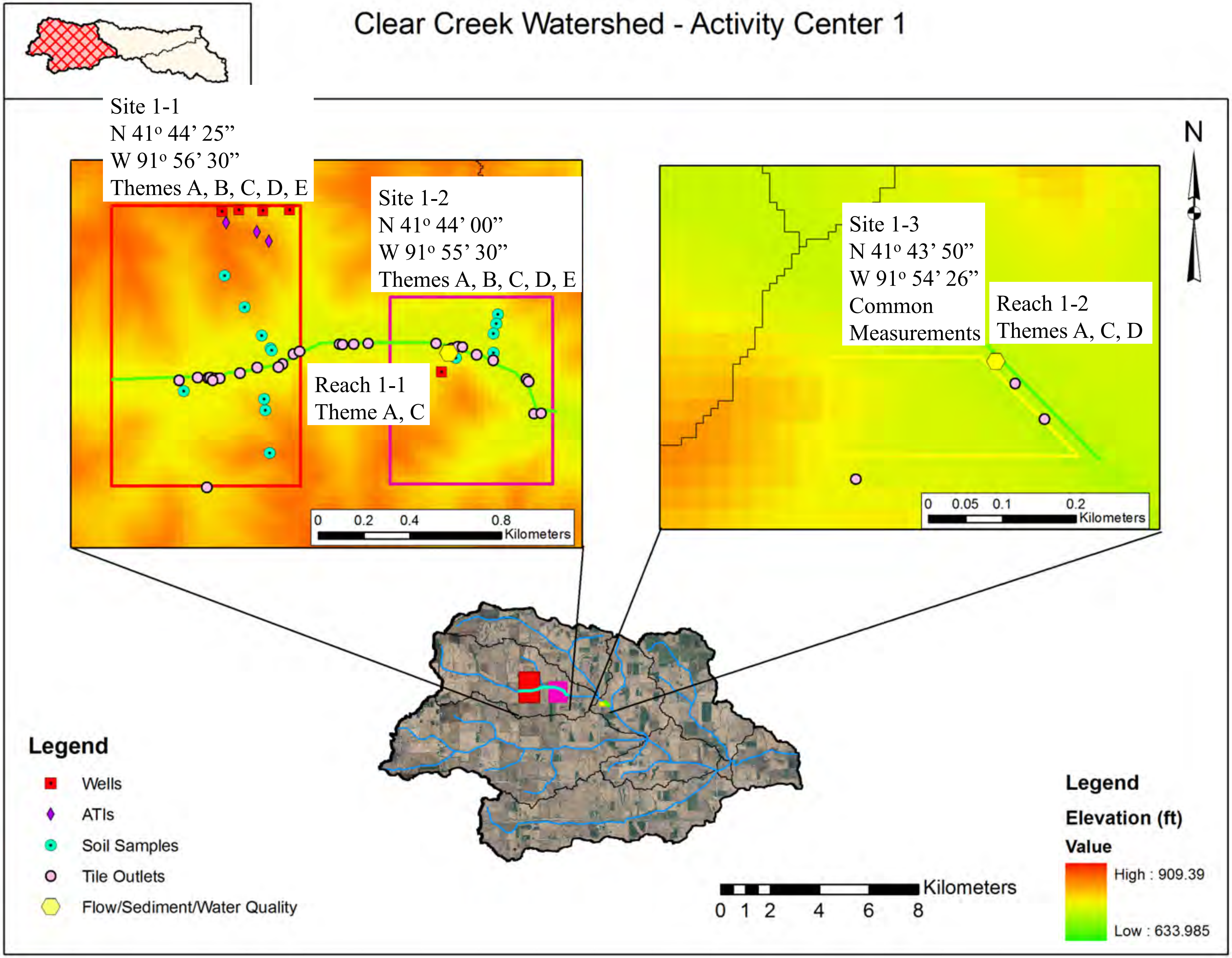



Clear Creek Watershed - Zone I
Legend
Site
Reach
Site 1
Site 2
Site 3
Reach 1
Reach 2
N
Legend
Elevation (ft)
Value
High : 909.39
Low : 633.985
0 1 2 4 6 8 Kilometers
Legend
water
wetland
forest
grassland
alfalfa/hay
corn
soybeans
other rowcrop
roads
urban
barren
other
Legend
OTHER
ADAIR
COLO
COLO OVERWASH
COLO-ELY SICL
DOWNS
ELY
LADOGA
MUSCATINE
OTLEY
SHELBY
SPARTA
TAMA

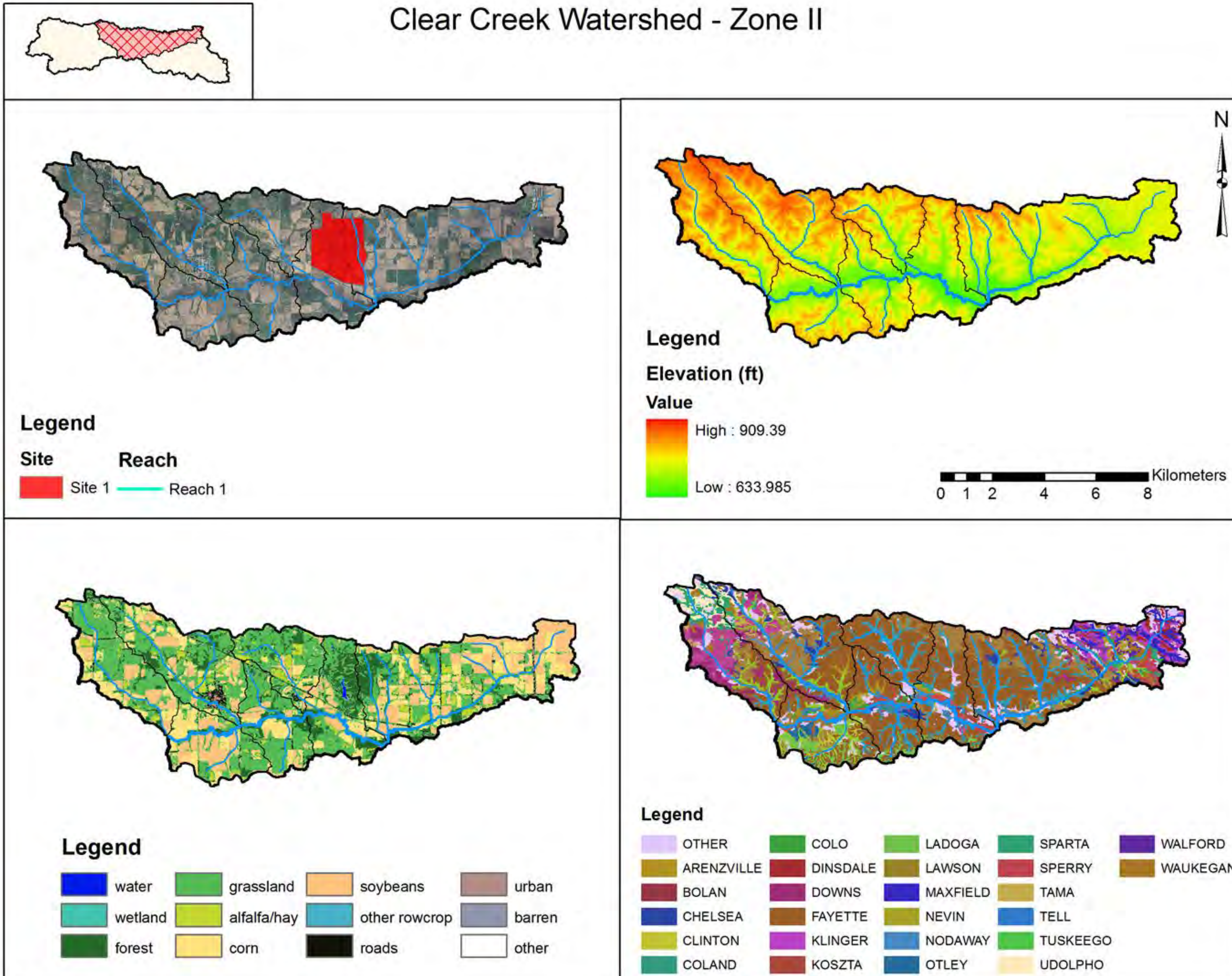

Clear Creek Watershed - Activity Center 1
Site 1-1
N 41° 44' 25"
W 91° 56' 30"
Themes A, B, C, D, E
Site 1-2
N 41° 44' 00"
W 91° 55' 30"
Themes A, B, C, D, E
Reach 1-1
Theme A, C
0 0.2 0.4 0.8 Kilometers
Site 1-3
N 41° 43' 50"
W 91° 54' 26"
Common Measurements
Reach 1-2
Themes A, C, D
0 0.05 0.1 0.2 Kilometers
N
Legend
Wells
ATIs
Soil Samples
Tile Outlets
Flow/Sediment/Water Quality
0 1 2 4 6 8 Kilometers

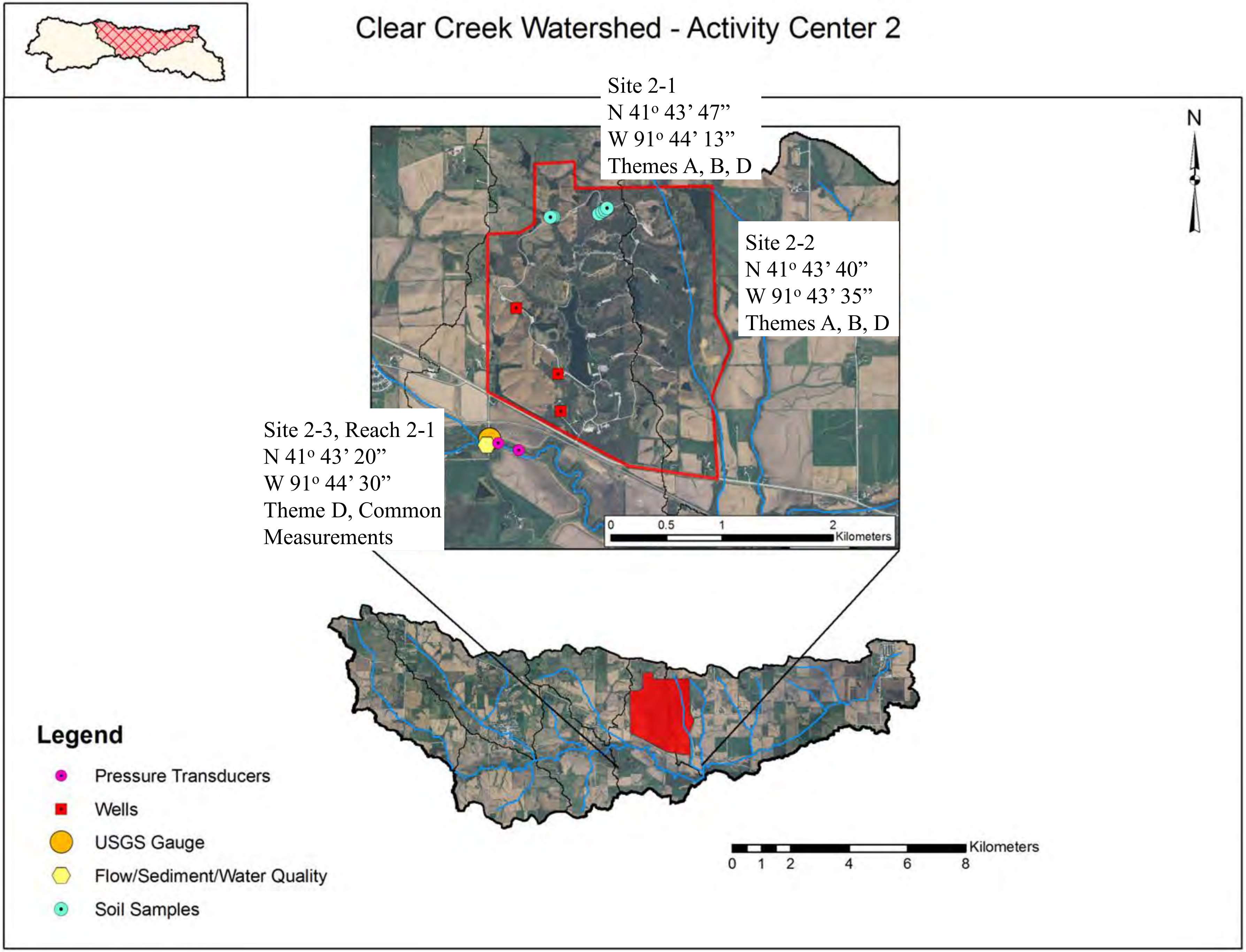


Clear Creek Watershed - Activity Center 1
Site 1-1
N 41° 44' 25"
W 91° 56' 30"
Themes A, B, C, D, E
Site 1-2
N 41° 44' 00"
W 91° 55' 30"
Themes A, B, C, D, E
Reach 1-1
Theme A, C
Site 1-3
N 41° 43' 50"
W 91° 54' 26"
Common Measurements
Reach 1-2
Themes A, C, D
N
0 0.2 0.4 0.8 Kilometers
0 0.05 0.1 0.2 Kilometers
0 1 2 4 6 8 Kilometers
Legend
Wells
ATIs
Soil Samples
Tile Outlets
Flow/Sediment/Water Quality
Legend
OTHER
ADAIR
COLO
COLO OVERWASH
COLO-ELY SICL
DOWNS
ELY
LADOGA
MUSCATINE
OTLEY
SHELBY
SPARTA
TAMA

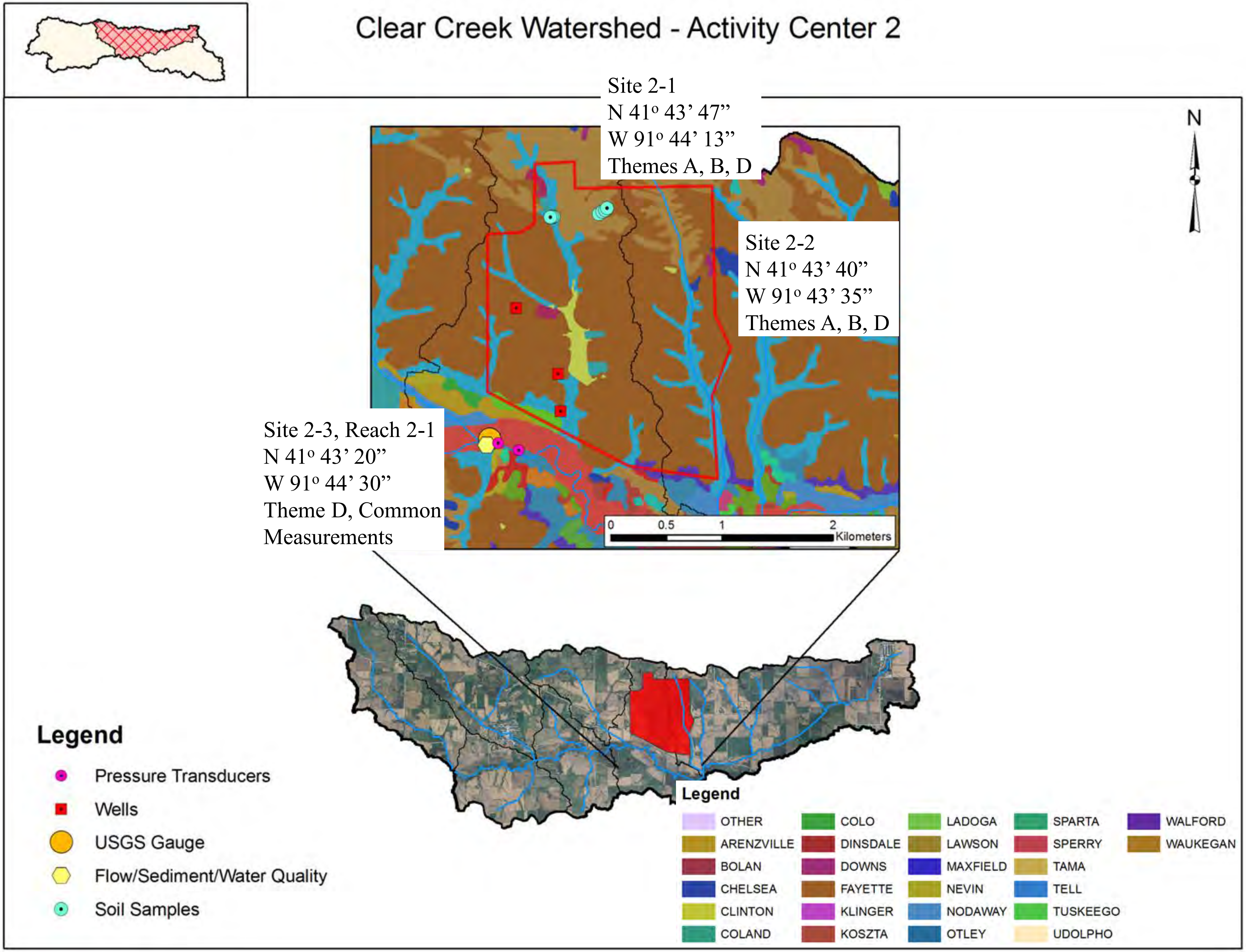

Clear Creek Watershed - Activity Center 1
Site 1-1
N 41° 44' 25"
W 91° 56' 30"
Themes A, B, C, D, E
Site 1-2
N 41° 44' 00"
W 91° 55' 30"
Themes A, B, C, D, E
Reach 1-1
Theme A, C
0 0.2 0.4 0.8 Kilometers
Site 1-3
N 41° 43' 50"
W 91° 54' 26"
Common
Measurements
Reach 1-2
Themes A, C, D
0 0.05 0.1 0.2 Kilometers
N
Legend
Wells
ATIs
Soil Samples
Tile Outlets
Flow/Sediment/Water Quality
Kilometers
0 1 2 4 6 8
Legend
Elevation (ft)
Value
High : 909.39
Low : 633.985

Clear Creek Watershed - Zone II

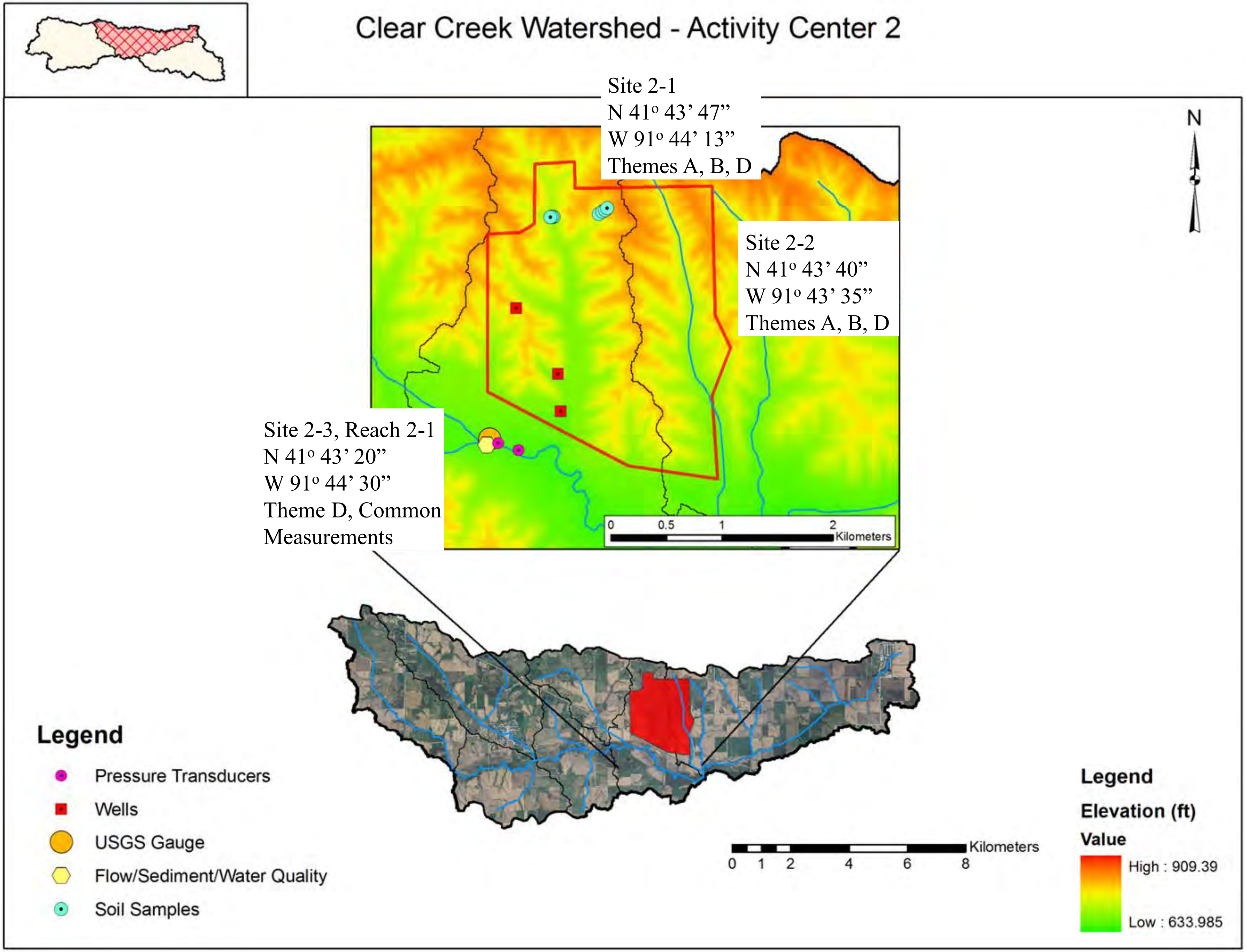


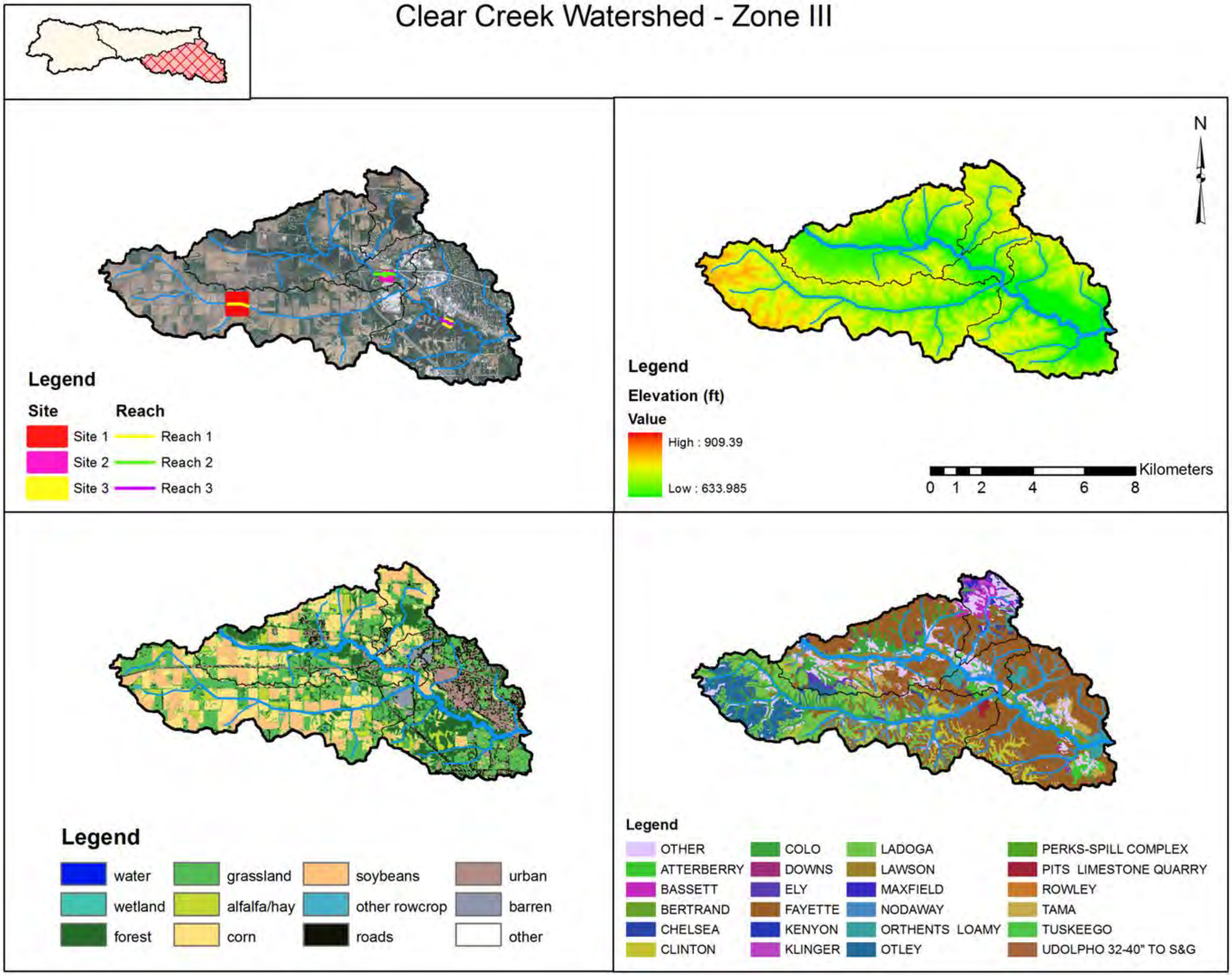


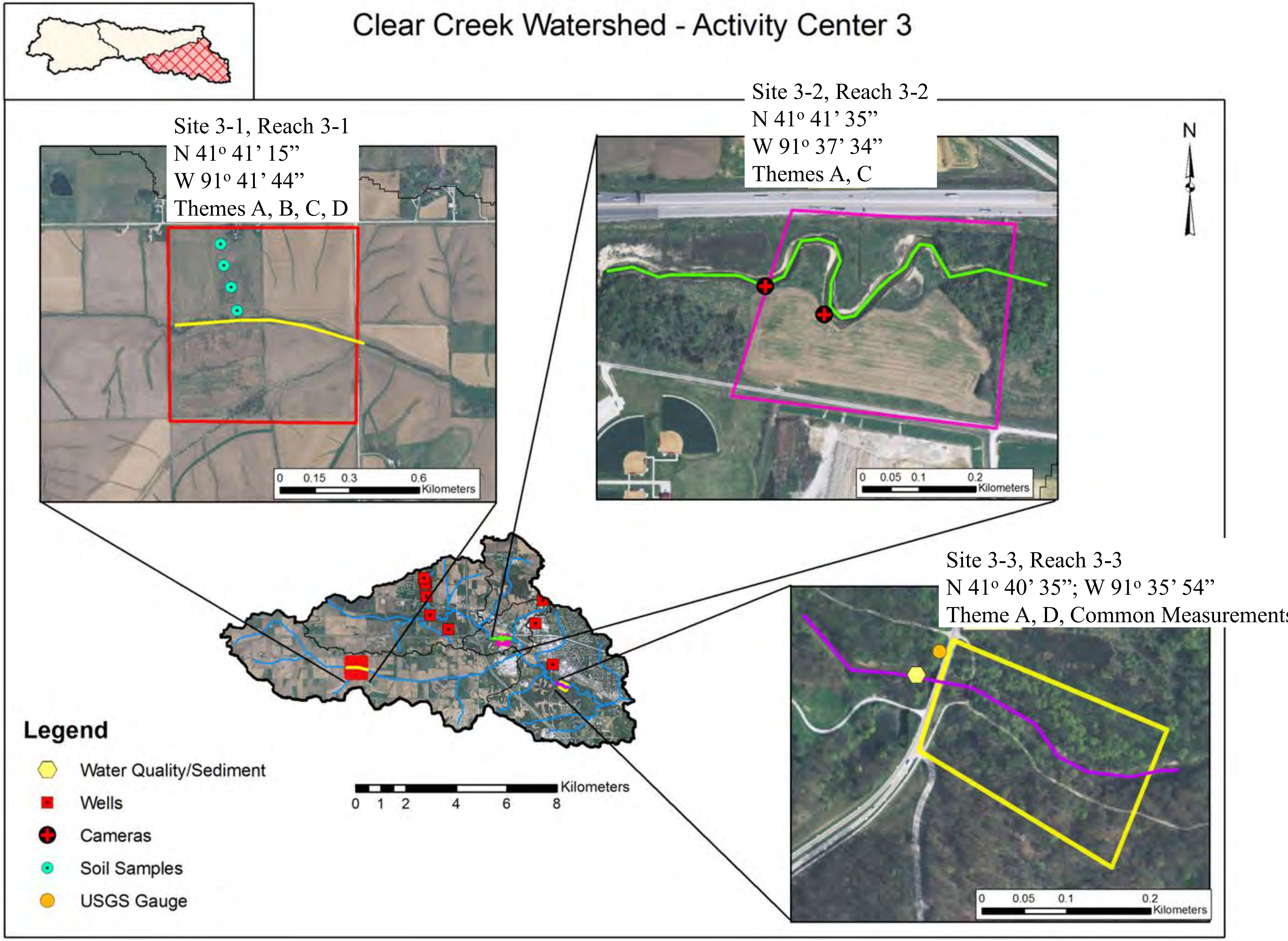
Clear Creek Watershed - Activity Center 2
Site 2-1
N 41º 43’ 47”
W 91º 44’ 13”
Themes A, B, D
Site 2-2
N 41º 43’ 40”
W 91º 43’ 35”
Themes A, B, D
Site 2-3, Reach 2-1
N 41º 43’ 20”
W 91º 44’ 30”
Theme D, Common Measurements
0 0.5 1 2 Kilometers
N
Legend
Pressure Transducers
Wells
USGS Gauge
Flow/Sediment/Water Quality
Soil Samples
0 1 2 4 6 8 Kilometers


Clear Creek Watershed - Activity Center 2
Site 2-1
N 41º 43’ 47”
W 91º 44’ 13”
Themes A, B, D
Site 2-2
N 41º 43’ 40”
W 91º 43’ 35”
Themes A, B, D
Site 2-3, Reach 2-1
N 41º 43’ 20”
W 91º 44’ 30”
Theme D, Common Measurements
N
0 0.5 1 2 Kilometers
Legend
Pressure Transducers
Wells
USGS Gauge
Flow/Sediment/Water Quality
Soil Samples
Legend
OTHER
ARENZVILLE
BOLAN
CHELSEA
CLINTON
COLAND
COLO
DINSDALE
DOWNS
FAYETTE
KLINGER
KOSZTA
LADOGA
LAWSON
MAXFIELD
NEVIN
NODAWAY
OTLEY
SPARTA
SPERRY
TAMA
TELL
TUSKEEGO
UDOLPHO
WALFORD
WAUKEGAN

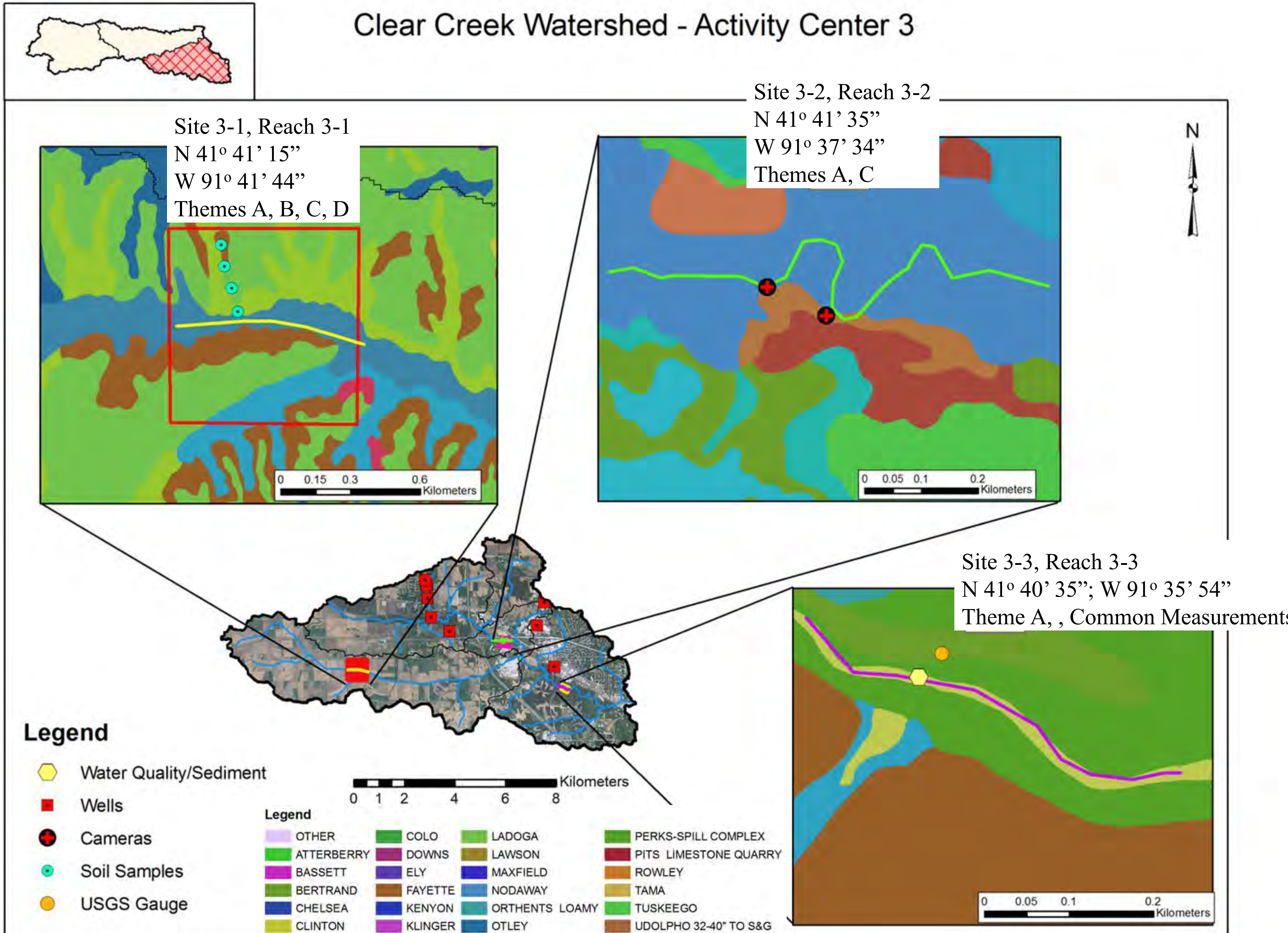
Clear Creek Watershed - Activity Center 2

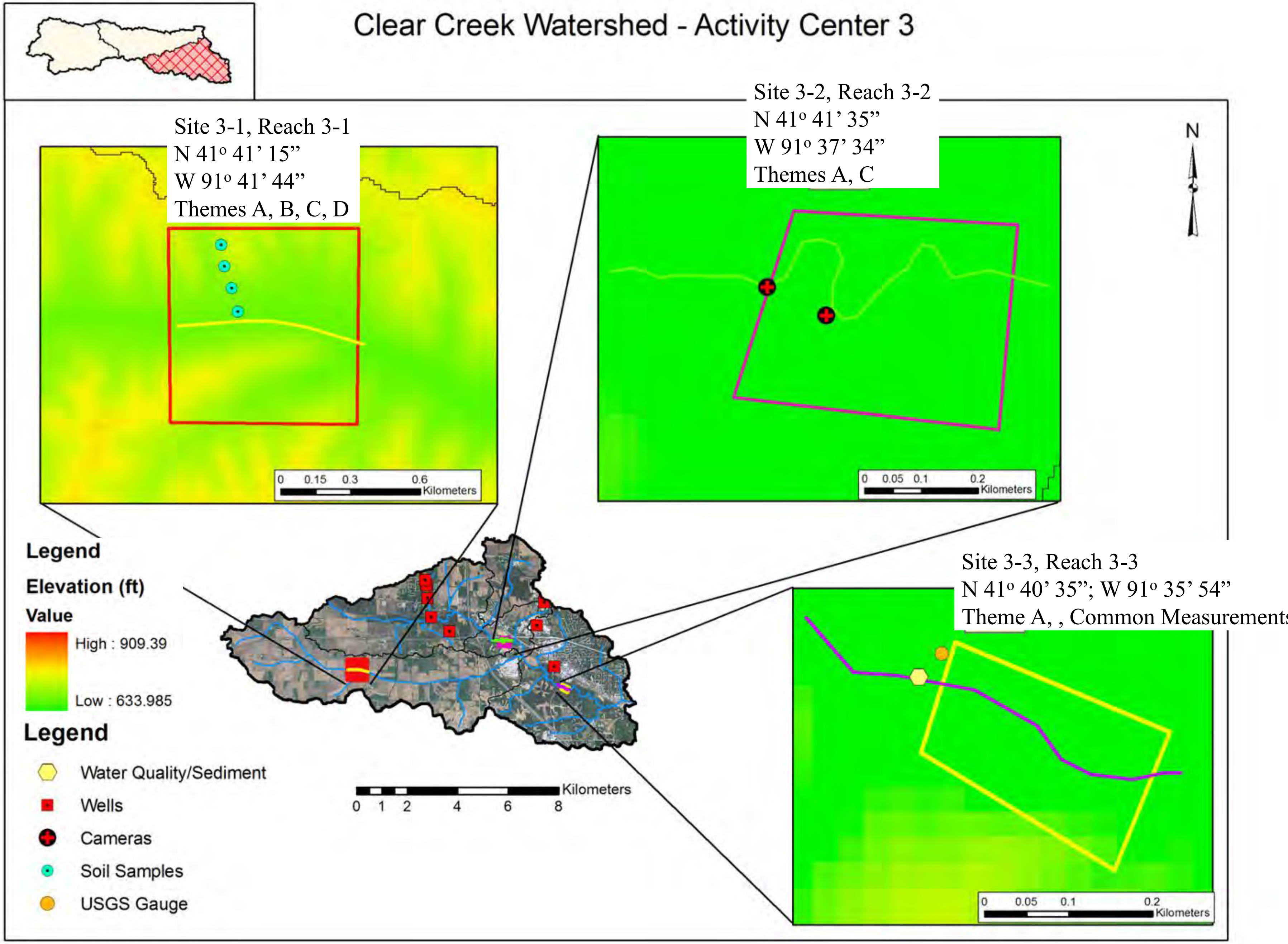



Clear Creek Watershed - Zone III
Legend
Site
Reach
Site 1
Reach 1
Site 2
Reach 2
Site 3
Reach 3
N
Legend
Elevation (ft)
Value
High : 909.39
Low : 633.985
0 1 2 4 6 8 Kilometers
Legend
water
wetland
forest
grassland
alfalfa/hay
corn
soybeans
other rowcrop
roads
urban
barren
other
Legend
OTHER
ATTERBERRY
BASSETT
BERTRAND
CHELSEA
CLINTON
COLO
DOWNS
ELY
FAYETTE
KENYON
KLINGER
LADOGA
LAWSON
MAXFIELD
NODAWAY
ORTHENTS LOAMY
OTLEY
PERKS-SPILL COMPLEX
PITS LIMESTONE QUARRY
ROWLEY
TAMA
TUSKEEGO
UDOLPHO 32-40" TO S&G



Clear Creek Watershed - Activity Center 3
Site 3-1, Reach 3-1
N 41º 41' 15"
W 91º 41' 44"
Themes A, B, C, D
0 0.15 0.3 0.6 Kilometers
Site 3-2, Reach 3-2
N 41º 41' 35"
W 91º 37' 34"
Themes A, C
0 0.05 0.1 0.2 Kilometers
N
Site 3-3, Reach 3-3
N 41º 40' 35"; W 91º 35' 54"
Theme A, D, Common Measurements
0 0.05 0.1 0.2 Kilometers
Legend
Water Quality/Sediment
Wells
Cameras
Soil Samples
USGS Gauge
0 1 2 4 6 8 Kilometers


Clear Creek Watershed - Activity Center 3
Site 3-1, Reach 3-1
N 41° 41’ 15”
W 91° 41’ 44”
Themes A, B, C, D
0 0.15 0.3 0.6 Kilometers
Site 3-2, Reach 3-2
N 41° 41’ 35”
W 91° 37’ 34”
Themes A, C
0 0.05 0.1 0.2 Kilometers
N
Site 3-3, Reach 3-3
N 41° 40’ 35”; W 91° 35’ 54”
Theme A, , Common Measurements
0 0.05 0.1 0.2 Kilometers
Kilometers
0 1 2 4 6 8
Legend
Water Quality/Sediment
Wells
Cameras
Soil Samples
USGS Gauge
Legend
OTHER
ATTERBERRY
BASSETT
BERTRAND
CHELSEA
CLINTON
COLO
DOWNS
ELY
FAYETTE
KENYON
KLINGER
LADOGA
LAWSON
MAXFIELD
NODAWAY
ORTHENTS LOAMY
OTLEY
PERKS-SPILL COMPLEX
PITS LIMESTONE QUARRY
ROWLEY
TAMA
TUSKEEGO
UDOLPHO 32-40" TO S&G


Clear Creek Watershed - Activity Center 3
Site 3-1, Reach 3-1
N 41º 41' 15"
W 91º 41' 44"
Themes A, B, C, D
Site 3-2, Reach 3-2
N 41º 41' 35"
W 91º 37' 34"
Themes A, C
Site 3-3, Reach 3-3
N 41º 40' 35"; W 91º 35' 54"
Theme A, , Common Measurements
N
0 0.15 0.3 0.6 Kilometers
0 0.05 0.1 0.2 Kilometers
0 0.05 0.1 0.2 Kilometers
0 1 2 4 6 8 Kilometers
Legend
Elevation (ft)
Value
High : 909.39
Low : 633.985
Legend
Water Quality/Sediment
Wells
Cameras
Soil Samples
USGS Gauge

Clear Creek IML-CZO Sampling Sites				
Site	Latitude	Longitude	Access	Theme
Site 1-1	41° 44’ 25” N	91° 56’ 30” W	Private	A, B, C, D, E
Site 1-2	41° 44’ 00” N	91° 55’ 30” W	Private	A, B, C, D, E
Site 1-3	41° 43’ 50” N	91° 54’ 26” W	Private	Common
Reach 1-1			Private	A, C
Reach 1-2			Private	A, C, D
Site 2-1	41° 43’ 47” N	91° 44’ 13” W	Public	A, B, D
Site 2-2	41° 43’ 40” N	91° 43’ 35” W	Public	A, B, D
Site 2-3	41° 43’ 20” N	91° 44’ 30” W	Private	Common
Reach 2-1			Private	D
Site 3-1	41° 41’ 15” N	91° 41’ 44” W	Private	A, B, C, D, E
Site 3-2	41° 41’ 35” N	91° 37’ 34” W	Public	A, C
Site 3-3	41° 40’ 35” N	91° 35’ 54” W	Public	Common
Reach 3-1			Private	A, C
Reach 3-2			Public	A, C
Reach 3-3			Public	A, D

Report of the Critical Zone Observatory (CZO) Network Science Steering Committee (SSC)
Intensively Managed Landscapes (IML)-CZO Site Visit
May 4-6, 2015

Attending: Jerad Bales, Kate Maher, Kent Keller, Peter Groffman, Gordon Grant

The SSC met in conjunction with the IML-CZO PI site visit. This report highlights key points emerging from our discussions over two days, including individual meetings with representatives of NSF, the National Office and the IML CZO. Although the role of the SSC is changing as new review policies are implemented by NSF for the CZO network, and the Committee is no longer expected to provide a detailed site review, we feel it's important to continue the tradition of providing feedback to site PIs to strengthen the program and in anticipation of future formal site reviews.

IML-CZO program

The IML-CZO program clearly is a critical and unique CZO site, emphasizing the role of land use activities in transforming the landscape and critical zone, and has the potential to produce transformative scientific understanding. All of us were impressed by the extent to which human activities, including replacement of tall grass prairie with intensive monoculture (almost exclusively corn and soybean cultivation), and concurrent installation of dense galleries of drainage tiles has changed the landscape. Formerly marshy grasslands rooted in deep organic and nitrogen-rich soils with low drainage densities that developed on Pleistocene moraines, tills, and outwash plains of low relief have been replaced by vast acreages of rich agricultural fields that are intensively farmed, drained, fertilized and repeatedly tilled. As a result, the CZ underlying the Illinois landscape is a palimpsest of a deep depocenter modified by multiple glaciations and overlain by soils recording both the Holocene and Anthropocene. The IML site is thus the most altered site in the CZO portfolio.

The IML CZO team has made impressive strides in understanding the dynamics of this landscape in the short (1+ years) time since the site become part of the CZO network. An overarching hypothesis that the CZ has evolved from being a transformer of sediment and nutrients, particularly carbon and nitrogen, to a transporter and exporter of these constituents is a provocative concept, if not entirely testable. Utilizing a multi-prong attack of deep coring (much of this utilizing Illinois State Geological Survey sites, funded in part by the USGS State Map Program), analysis of river channel change and floodplain sedimentation rates dated with fly ash and cosmogenic isotopes, water quality and sediment provenance studies, as well as erosion process modeling using rainfall simulation experiments and tracers, the team is in the process of assembling narratives of CZ and landscape change over timescales ranging from annual to millennial. Modeling is woven into testing story line components but has not been a primary focus so far. This rich mix of time, space, and process studies has the potential to reveal interesting insights into development of the Illinoisan landscape.

But as with all CZO sites, the most difficult task is integrating the individual studies into a comprehensive and coherent narrative of how the CZ is organized and why and how it is responding to the intense land use pressures, and how these insights be used to guide management of these lands. We see elements of this fundamental story emerging, but many of the dots have not yet been connected. How will results from the rainfall simulation experiments be used to inform the channel sampling and whole basin modeling schemes? How does the CZ "remember" and record its history? These are just examples of the kinds of inter-study connections that will help the audience see how the pieces connect. Clearly, a somewhat unique challenge faced by the team in "connecting the dots" is limited access to the entire flow path because of private land ownership.

Another key issue is the relation between the IML-CZO and the agricultural community, including farmers, landowners, and ag extension. It became clear that the IML team is navigating a fine line with respect to working with private landowners to get access to field sites and establish installations. Trust is an essential component of these relationships, yet the research is targeting "hot button" issues, like nutrient loading, for which there are strongly-held opinions. The SSC sees linking CZ research to the local farming communities as an important aspect of the site, and encourages the IML to continue to reach out to this community, including more visible potential partnerships with agricultural agencies.

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