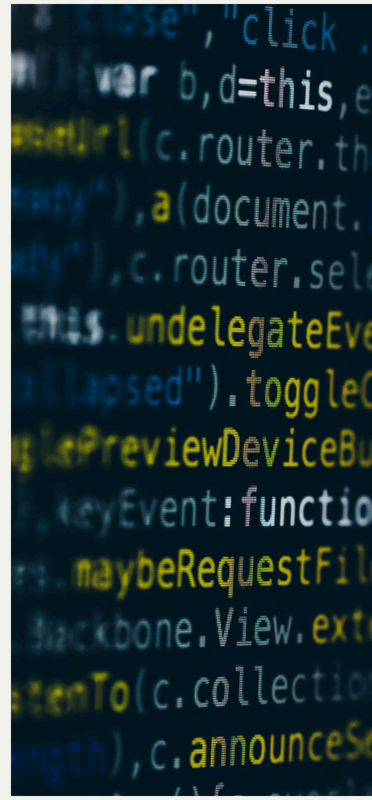
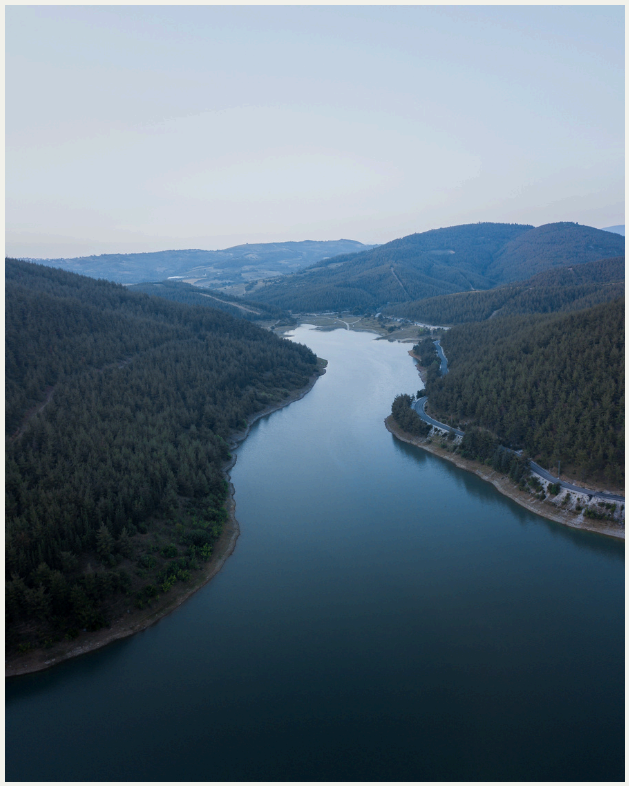
2024 I-GUIDE VIRTUAL POSTER COMPETITION

Session Proceedings








I-GUIDE
Institute for Geospatial Understanding through an Integrative Discovery Environment

TUESDAY, APRIL 30, 2024

3:00 – 5:00 pm EDT

LinkedIn

DATA-INTENSIVE CONVERGENCE SCIENCE: FAIR GEOSPATIAL DATA FOR SUSTAINABILITY RESEARCH

2024 I-GUIDE Virtual Poster Competition

I-GUIDE
Institute for Geospatial Understanding through an Integrative Discovery Environment

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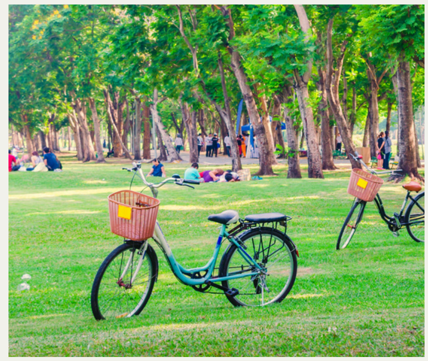
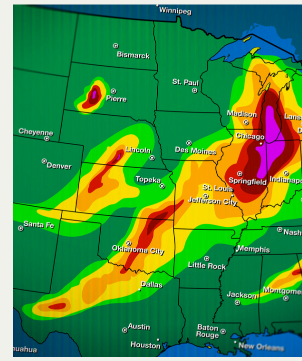
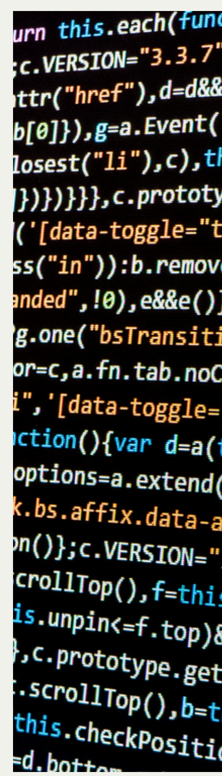






2024 I-GUIDE Virtual Poster Competition

I-GUIDE
Institute for Geospatial Understanding through an Integrative Discovery Environment

Competition Day Agenda - April 30, 2024

2:55 EDT **CHECK-IN**

3:00 EDT **WELCOME AND OPENING REMARKS**
Dr. Anand Padmanabhan, I-GUIDE Managing Director

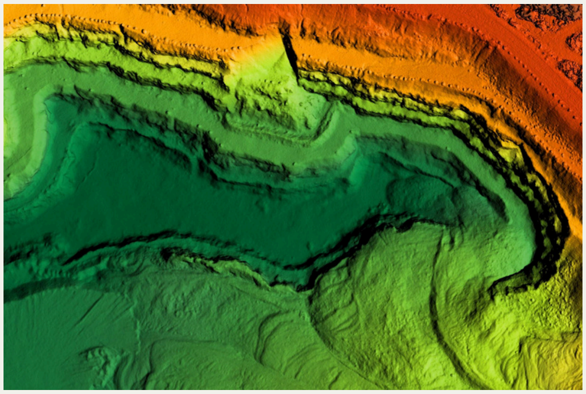
3:05 EDT **SESSION 1: RISK & RESILIENCE**
Chair: Zhaonan Wang

3:30 EDT **SESSION 2: FLOODS, STORMS, & WATER MANAGEMENT**
Chair: Bailey Holdaway

4:00 EDT **SESSION 3: CLIMATE CHANGE & ENVIRONMENTAL IMPACTS**
Chair: Iman Haqiqi

4:30 EDT **SESSION 4: AGRICULTURE & LAND USE**
Chair: Kat Fowler

5:00 EDT **WRAP UP**
Iman Haqiqi



2024 I-GUIDE Virtual Poster Competition

I-GUIDE
Institute for Geospatial Understanding through an Integrative Discovery Environment

Contact Information

LINKS

- Conference Website: https://i-guide.io/poster-competition/
- Registration Link (Open to Public): https://tinyurl.com/VirtualPosterRegister
  - Zoom link will be emailed to you after you register
- I-GUIDE:
  - https://i-guide.io/
  - https://www.linkedin.com/company/nsf-i-guide/
  - https://twitter.com/NSFiGUIDE

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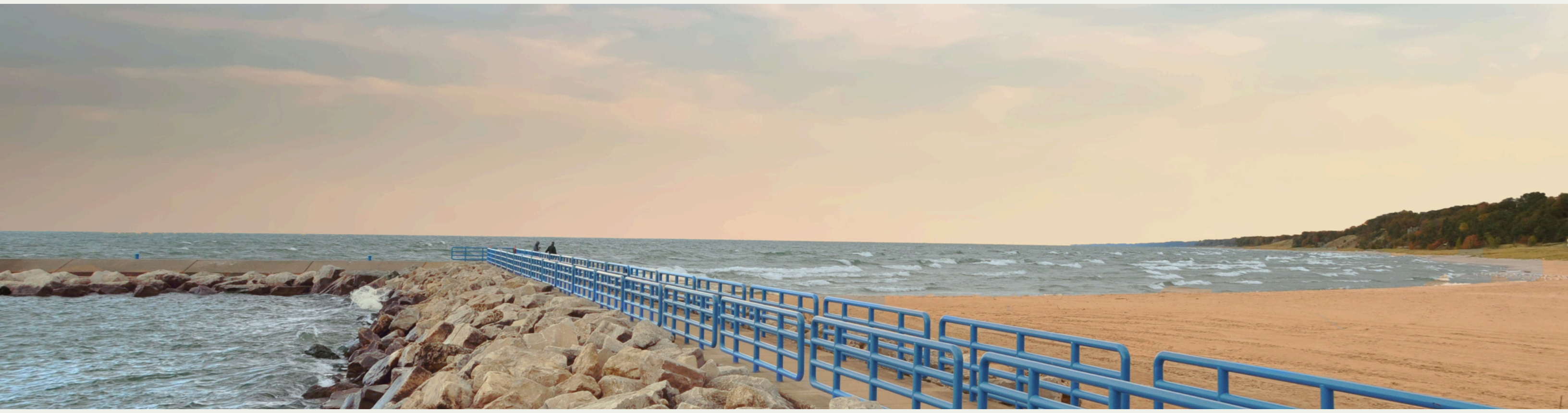
2024 I-GUIDE Virtual Poster Competition

What is I-GUIDE?

Map. Connect. Discover.

NSF Institute for Geospatial Understanding through an Integrative Discovery Environment (I-GUIDE) enables transformative discovery and innovation for tackling fundamental scientific and societal challenges that are at the cusp of achieving significant breakthroughs by harnessing the vast, diverse, and ever-growing corpus of geospatial data. As most challenging sustainability and resilience problems today require expertise from multiple domains and geospatial data science, I-GUIDE plays a central role in successfully spanning domains, leveraging its multidisciplinary collaboration team and partnerships to achieve geospatial data-intensive discovery and innovation. I-GUIDE also works with related community consortia (e.g., CUAHSI, OGC, and UCGIS) to build consensus and use their inputs when establishing priorities for developing the integrative I-GUIDE platform as a community-oriented discovery environment. The institute fosters open collaboration among diverse communities, bridging the digital divide that hinders participation from underrepresented communities. Through rich education and training programs and by providing access to cutting-edge geospatial data capabilities (e.g., CyberGIS, GeoEDF, and HydroShare), I-GUIDE enables transformative research and education advances across many geospatial-reliant communities while making significant contributions to the national cyberinfrastructure (CI) and Harnessing the Data Revolution (HDR) ecosystems.

I-GUIDE is supported by the National Science Foundation under award No. 2118329 as part of the Harnessing the Data Revolution Big Idea Initiative.



2024 I-GUIDE Virtual Poster Competition

I-GUIDE
Institute for Geospatial Understanding through an Integrative Discovery Environment

What is the virtual poster competition?

FAIR Geospatial Data for Sustainability Research

The goal of the Virtual Poster Competition is to showcase the latest research and innovation in convergence science for sustainable development through geospatial artificial intelligence (AI) and data science approaches, with a particular focus on promoting FAIR (findability, accessibility, interoperability, and reusability) data principles.

What are the competition objectives?

- Highlight the value of geospatial understanding: Showcase the potential of integrating geospatial technologies across various disciplines and their impact on addressing real-world challenges.
- Empower ECPs: Provide a platform for Early Career Professionals (ECPs) to gain visibility, share their expertise, and receive valuable feedback from established professionals.
- Spark innovation: Encourage the development of novel ideas and applications in the field of geospatial understanding through integrated environments.
- Build a community: Foster connections and collaboration among ECPs passionate about geospatial technologies.

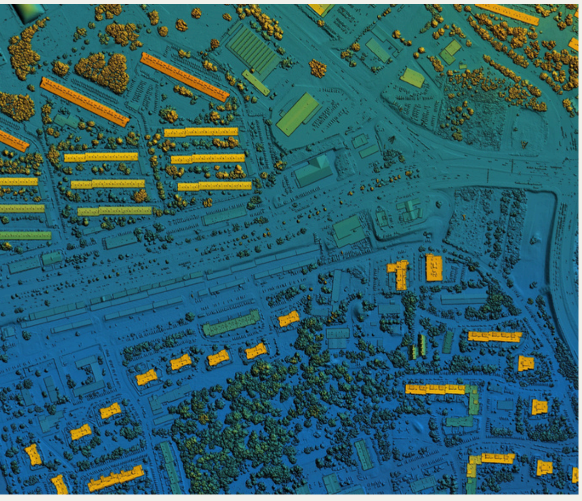
What will the winners receive?

All accepted posters will be published in an open access proceeding. In addition, four selected posters will be invited to the 2024 I-GUIDE Forum October 14-16 in Jackson, Wyoming and will be awarded travel funding provided by I-GUIDE and its partners. The winners will be notified by early May 2024.

- Open Science Champion: up to $1,500 reimbursement in travel funding
- Convergence Science Catalyst: up to $1,000 reimbursement in travel funding
- Rising Geospatial Data Scientist: up to $1,000 reimbursement in travel funding
- Policy Pathfinder: up to $500 reimbursement in travel funding

2024 I-GUIDE Virtual Poster Competition

A word from the I-GUIDE Director, Dr. Shaowen Wang



Greetings!

I am very delighted to welcome you all to the first virtual poster competition organized by the Institute of Geospatial Understanding through an Integrative Discovery Environment (I-GUIDE) that is supported by the National Science Foundation. I-GUIDE's vision is to enable digital discovery and innovation through harnessing the geospatial data revolution while its mission is to advance convergence and geospatial sciences for holistic sustainability solutions. The vision and desired impact of I-GUIDE are pursued through synergizing "Map, Connect, and Discover" approaches. In this context, this virtual poster competition is designed to showcase FAIR (findable, accessible, interoperable, and reusable) data practices for sustainability research through innovating advanced cyberinfrastructure and geospatial artificial intelligence (AI) while fostering collaborative work in data-intensive convergence science.

One of the main goals of this virtual poster competition is to nurture next-generation leaders for data-intensive convergence science. In fact, this competition has been spearheaded by I-GUIDE Climbers who are graduate students and postdocs from multiple institutions working together on the I-GUIDE project. I am greatly impressed by the wonderful program and extremely proud of our I-GUIDE Climbers for successfully planning the competition. I am looking forward to the exciting competition day!

Dr. Shaowen Wang

Competition Organizers

Kat Fowler

PhD Student, School of Informatics & Computing
Northern Arizona University

Kat (she/they) is an interdisciplinary socio-ecological systems scientist studying how trade mediates resource extraction and creates interregional economic and ecological dependencies. She is currently a PhD student in the Complex Systems Informatics Lab at Northern Arizona University. In her free time she roasts coffee, rides bikes, and helps organize I-GUIDE poster sessions.

Iman Haqiqi

Research Economist, Department of Agricultural Economics
Purdue University

Iman (he/him) is a senior research economist at Purdue University, GLASS: Global to Local Analysis of Systems Sustainability. He conducts policy-relevant research on the interaction of social and environmental systems addressing major sustainability and resilience challenges regarding international agricultural trade, land use, water resources, and climate change. He studies food security and environmental sustainability in a global-to-local-to-global approach that considers economic feedback and local conditions.

Bailey Holdaway

MS Student, Quinney College of Natural Resources
Utah State University

Bailey (she/her) is a natural resource social scientist studying the experiences and perceptions of irrigation companies in the Great Salt Lake Basin, Utah in order to better inform policy around water management in the region. She is in her MS program in Environment & Society at Utah State University working with Dr. Courtney Flint. Bailey enjoys baking, gardening, and painting in her free time.

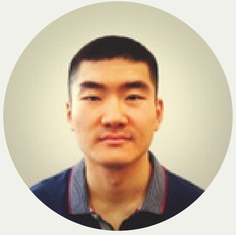
2024 I-GUIDE Virtual Poster Competition

Competition Organizers

Nick Manning

PhD Student, Department of Fisheries & Wildlife
Michigan State University

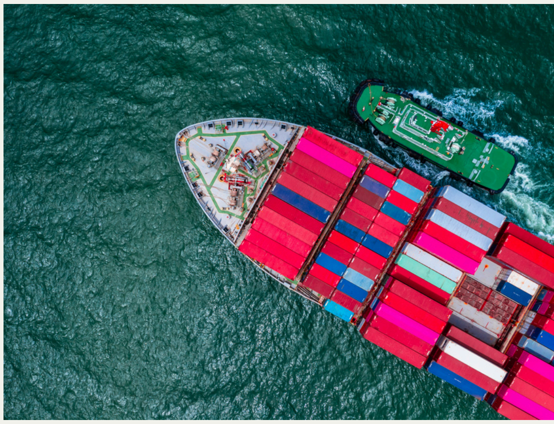
Nick (he/him) is a remote sensing scientist in the Center for Systems Integration & Sustainability at Michigan State University earning his PhD with Dr. Jianguo “Jack” Liu. He is interested in using geospatial data to understand the environmental impacts of international trade and the interconnected effects of disasters.



Zhoanan Wang

Postdoc Researcher, Department of Geography & GIS
University of Illinois Urbana-Champaign

Zhaonan is a Geographic Information Scientist (GIScientist). His research interests lie in the interdisciplinary area between Artificial Intelligence (AI) and GIScience, with a focus on developing robust algorithms for spatial networks and temporal dynamics. He leads the Geospatial AI team at UIUC CyberGIS Center. He did his PhD at the Center for Spatial Information Science, the University of Tokyo, where he was closely involved in joint projects with Tokyo Fire Department, Toyota Motor Cooperation, and NSF.



2024 I-GUIDE Virtual Poster Competition

I-GUIDE
Institute for Geospatial Understanding through an Integrative Discovery Environment

SESSION 1 *April 30, 2024, 3:05 - 3:30 pm EDT*

Risk & Resilience

Chaired by Zhaonan Wang

All abstracts may be found starting on page 13

VULNERABILITY ASSESSMENT OF ELECTRIC VEHICLES AND THEIR CHARGING STATION NETWORK DURING EVACUATIONS

Eleftheria Kontou, Denissa Purba
University of Illinois Urbana-Champaign

UTILIZING SEARCH ENGINE DATA FROM TWO SIGNIFICANT HURRICANES IN THE UNITED STATES TO IDENTIFY KNOWLEDGE DEFICIENCIES IN RESILIENCE, AIMING TO ENHANCE COMMUNITY AWARENESS

Sukanya Dasgupta, Chandana Mitra
Auburn University

PRIME: A CYBERGIS PLATFORM FOR RESILIENCE INFERENCE MEASUREMENT AND ENHANCEMENT

Debayan Mandal, Lei Zou, Rohan Singh Wilkho, Joynal Abedin, Bing Zhou, Heng Cai, Furqan Baig, Nasir Gharaibeh
Texas A&M University

CONVERGENCE OF WILDFIRE AND WATER DATA: AN OPEN SCIENCE MODEL TO HARNESS NEW GENERATION FIRE DATA FOR MAPPING POST-FIRE HYDROLOGIC CHANGES

Karen Bhattacharjee, Shihab Uddin, Adnan Rajib
University of Texas, Arlington

LEVERAGING GOOGLE STREET VIEW FOR CRIME PATTERN ANALYSIS IN BATON ROUGE

Jiyoung Lee, Michael Leitner
Louisiana State University

2024 I-GUIDE Virtual Poster Competition

I-GUIDE Institute for Geospatial Understanding through an Integrative Discovery Environment

SESSION 2 *April 30, 2024, 3:30 - 4:00 pm EDT*

Floods, Storms, & Water Management

Chaired by Bailey Holdaway

All abstracts may be found starting on page 13

FORECAST-INFORMED DEEP LEARNING METHODS FOR FLOOD PREDICTION AND MITIGATION

Jimeng Shi, Zeda Yin, Vitalii Stebliankin, Arturo Leon, Jayantha Obeysekera, Zhaonan Wang, Shaowen Wang, Giri Narasimhan
Florida International University, University of Illinois Urbana-Champaign

BUILDING A SUSPENDED SEDIMENT CONCENTRATION DATABASE ACROSS EARTH'S RIVERS WITH LANDSAT

Punwath Prum, John Gardner, Rajaram Prajapati
University of Pittsburgh

ASSESSING THE SPATIAL DISTRIBUTION OUTSTANDING NATIONAL RESOURCE WATER DESIGNATIONS OF THE CLEAN WATER ACT

Jessica Raty
Northern Arizona University

PREDICTION OF STORM SURGE ON SLOWLY EVOLVING LANDSCAPES UNDER CLIMATE CHANGE

Mohammad Ahmadi Gharehtoragh, David Johnson
Purdue University

CLIMATE CHANGE VS. HUMAN INTERVENTION: UNRAVELING THEIR IMPACT ON STREAMFLOW AND A CALL TO INCLUDE HUMAN INTERVENTION AT A FINER SCALE IN THE FUTURE PROJECTION OF WATER FLUXES

Jibin Joseph, Sanjiv Kumar, Venkatesh Merwade
Purdue University

2024 I-GUIDE Virtual Poster Competition

I-GUIDE Institute for Geospatial Understanding through an Integrative Discovery Environment

SESSION 3

April 30, 2024, 4:00 - 4:30 pm EDT

Climate Change & Environmental Impacts

Chaired by Iman Haqiqi

All abstracts may be found starting on page 13

SPATIALIZING LIFE CYCLE ASSESSMENT TO IDENTIFY LOCALIZED IMPACTS

Venkat Roy, Sameer Kulkarni, Fu Zhao
Purdue University

EVALUATING CHANGES IN LAND COVER, EVAPOTRANSPIRATION AND WATER USE ACROSS THE GREAT SALT LAKE BASIN

Bhuwan Ghimire, Ayman Nassar, David Tarboton
Utah State University

REGIONAL STRATEGIES FOR ACHIEVING U.S. NET-ZERO EMISSION TARGET BY INTEGRATING CARBON DIOXIDE REMOVAL TECHNOLOGIES WITH THE ENERGY-WATER-LAND SYSTEM

Parisa Javadi, Patrick O'Rourke, Jay Fuhrman, Haewon McJeon, Scott Doney, William Shobe, Andrés Clarens
University of Virginia, University of Maryland, Pacific Northwest National Laboratory, Korea Advanced Institute of Science and Technology

PEDALING TOWARDS EQUITY: EVALUATING EMISSION EQUITY IN BIKE-SHARING USAGE

Yunhe Cui, Xiang Chen, Chuanrong Zhang
University of Connecticut

LEVERAGING MACHINE LEARNING AND SATELLITE TECHNOLOGIES TO OPTIMIZE CROP WATER MANAGEMENT UNDER EXTREME CLIMATE CONDITIONS

Kelechi Igwe, Vaishali Sharda, Trevor Hefley
Kansas State University

2024 I-GUIDE Virtual Poster Competition

SESSION 4 *April 30, 2024, 4:30 – 5:00 pm EDT*

Agriculture & Land Use

Chaired by Kat Fowler

All abstracts may be found starting on page 13

GRIDDED LIVESTOCK DENSITY DATABASE AND SPATIAL TRENDS FOR KAZAKHSTAN

Venkatesh Kolluru, Ranjeet John, Sakshi Saraf, Jiquan Chen Brett Hankerson, Sarah Robinson, Maira Kussainova, Khushboo Jain

University of South Dakota, Michigan State University, Leibniz Institute of Agriculture Development in Transition Economies, Justus Liebig University, Kazakh National Agrarian Research University

CLIMATE YIELD IMPACTS ON US AGRICULTURE AND GLOBAL SPILLOVER EFFECTS: CROP MODEL GC6 MEETS SIMPLE-G

Elizabeth Fraysse, Kavitha Srikanth
Purdue University

SATELLITE PREDICTION OF YIELD AND SOC FOR SMALLHOLDER FARMERS IN INDIA

Sara Yavas, Shuo Yu, Mark Chechenin Gelfer, Kavina Tara Peters, Sayantan Mitra, Aprajit Mahajan

University of California, Berkeley

INTERNATIONAL FOOD TRADE'S IMPACTS ON LAND USE FOR CROP PRODUCTION

Joris Van Zeghbroeck, Jianguo Liu
Michigan State University

A FAIR METADATA STANDARD FOR URBAN HYPERSPECTRAL REFERENCE LIBRARIES

Jessica Salcido, Debra Laefer
New York University

MAP-ENHANCED DECISION-MAKING IN CONTINGENT VALUATION

Yuetong Zhang, Klaus Moeltner
Virginia Tech

ABSTRACTS

Abstracts are in alphabetical order according to the first author's last name

PREDICTION OF STORM SURGE ON SLOWLY EVOLVING LANDSCAPES UNDER CLIMATE CHANGE

Mohammad Ahmadi Gharehtoragh, David Johnson
Purdue University

Storm surges are a major concern for coastal communities, as they can cause significant damage and loss of life. In order to mitigate the impacts of storm surges, accurate prediction of their occurrence and severity is essential. However, existing numerical models used to simulate storm surge and wave, particularly high-fidelity ones needed to capture dynamics near protection features like levees, are computationally expensive. Because of that, surrogate models for the prediction of storm surge are recognized as great tools for emulating the approximation of storm surge and wave. Once these models are trained on synthetic datasets that usually come from a hydrodynamic model such as ADCIRC, they can be used to cheaply predict surge and wave from other storms not in the training set. However, existing research focuses on accurate prediction of storm surge on a static landscape, with storm parameters used as predictors. In this research, we applied artificial intelligence to storm surge and wave simulations to predict storm surge and wave as a function of storm parameters, geographic location, and landscape data (e.g., surface and bottom roughness, bathymetric/topographic elevation, vegetation canopy). The findings of this study demonstrate that this approach can produce acceptably accurate results useful for planning studies. Our method can be used to generate new landscape scenarios and estimate risk in a larger ensemble of future conditions than can feasibly be explored using more expensive hydrodynamic modeling.

CONVERGENCE OF WILDFIRE AND WATER DATA: AN OPEN SCIENCE MODEL TO HARNESS NEW GENERATION FIRE DATA FOR MAPPING POST-FIRE HYDROLOGIC CHANGES

Karen Bhattacharjee, Shihab Uddin, Adnan Rajib
University of Texas, Arlington

There has been an unprecedented increase in the frequency and intensity of wildfires in the United States. Earth data monitoring fire hazards has grown concomitantly, yet our open science capability to quantify how wildfires impact water resources remains obscure. Many models and tools exist to quantify increasing likelihoods of post-fire flash floods and degrading water quality. However, the lack of seamless interoperability between fire-related Earth data with process-based hydrologic models and machine learning tools, and more importantly their lack of reproducibility at any spatial and temporal scales of practical interest is well known. In short, there is no generalizable open science model to converge the vastly dissimilar nature and types of fire and water data, models, and tools. Considering these limitations, we are developing a first-of-its kind geospatial framework that intuitively harness myriad of available fire-related data from multiple NASA satellites, performs geospatial analytics by integrating them with vegetation and soil moisture data, and make them seamlessly interoperate with a process-based hydrologic model Soil and Water Assessment Tool (SWAT) as well as a Support Vector Machine hybrid machine learning tool. Prototype applications across multiple large, historically fire-impacted watersheds in the western United States confirm that our framework adheres to the FAIR principles let alone its high accuracy in producing streamflow and sediment results. Works are ongoing to export the framework to Purdue University's NSF-supported ANVIL high performance computing system for broader community adoption. When fully developed, our framework will fill a long-standing gap and offer a valuable open science resource to both the scientific community and stakeholders, expanding their ability to comprehend and address post-fire hydrological changes effectively.

ABSTRACTS

PEDALING TOWARDS EQUITY: EVALUATING EMISSION EQUITY IN BIKE-SHARING USAGE

Yunhe Cui, Xiang Chen, Chuanrong Zhang
University of Connecticut

Equity is a critical dimension of urban transportation planning. It ensures equitable access to mobility options across all demographic groups, irrespective of socio-economic status, race, gender, or educational level. Its importance can hardly be overstated as individual mobility directly influences an individual's ability to access healthy food, essential services, employment, and recreational facilities. This study introduces an analytical framework to assess the environmental equity implications of the dock-based bike-sharing system in New York City. This framework consists of three interrelated components: bike trip pattern analysis, carbon emission comparison between bike-sharing trips and trips with alternative transport modes, and equity assessment. This study focuses on Citi Bike, the largest bike-sharing system in North America. The Citi Bike trip data for the entire year of 2018 was collected from the public data archive and processed with open-sourced Python packages including pandas, geopandas, numpy, shapely,sklearn, and fiona via Jupyter Notebook. Additionally, the spatial regression model was applied through GeoDa, an open-access geospatial statistical analytics software. The article reveals that bike-sharing can significantly contribute to carbon emission savings, with potential reductions ranging between 56,477 kg and 341,345 kg of carbon dioxide annually, depending on the ratio of driving or public transit substitution. Through exploratory regression analyses, key socio-economic variables such as access to private vehicles and the duration of daily commuting that remain, significant predictors of bike-sharing usage and associated environmental benefits, were identified. In conclusion, this research underscores the need for inclusive urban mobility solutions that prioritize both environmental sustainability and equity.

UTILIZING SEARCH ENGINE DATA FROM TWO SIGNIFICANT HURRICANES IN THE UNITED STATES TO IDENTIFY KNOWLEDGE DEFICIENCIES IN RESILIENCE, AIMING TO ENHANCE COMMUNITY AWARENESS

Sukanya Dasgupta, Chandana Mitra
Auburn University

The incidence of significant natural hazards, such as hurricanes, has seen an uptick, attributed to climatic shifts and rapid alterations in land use patterns across the US. Leveraging data from the NOAA's International Best Track Archive for Climate Stewardship (IBTrACS) and FEMA HAZUS Hurricane Model, this research aims to delineate storm characteristics including wind speeds and pathways over an extensive temporal scale (1842-present), facilitating an evaluation and quantification of the physical impacts and subsequent recovery from hurricane events. Complementary to both datasets, an analysis of search engine queries via Google Trends is proposed to discern search behavior trends of the populace surrounding pre-, during, and post-hurricane scenarios. Such digital footprints are instrumental in identifying deficiencies in public knowledge regarding hurricane preparedness, thereby informing strategies to bolster community resilience and sustainability. This investigation will focus on dissecting and contrasting the historical data and search trends pertinent to two major hurricanes, Irma (2017) and Ian (2022), with a specific lens on the Fort Myers-Naples area in Florida, recognized for its susceptibility to hurricanes by IBTrACS. The objective is to augment the preparedness and resilience of hurricane-prone localities by enhancing public awareness and adaptive capacities to future hurricane events. The findings from this research contribute to FAIR (findability, accessibility, interoperability, and reusability) convergence science as all datasets utilized are publicly available and reconstruct-able and are designed for easy community open accessibility by stakeholders, policy makers, residents and interested readers.

ABSTRACTS

CLIMATE YIELD IMPACTS ON US AGRICULTURE AND GLOBAL SPILLOVER EFFECTS: CROP MODEL GC6 MEETS SIMPLE-G

Elizabeth Fraysse, Kavitha Srikanth
Purdue University

The new Global Gridded Crop Model Intercomparison (GGCMI-GC6) combines various crop models with climate scenarios from Coupled Model Intercomparison Project Phase 6 (CMIP6), offering new and valuable data on the impact of the changing climate on crop yield around the world. GC6 finds highly diverse climate impacts on yield, depending on the crops and geographies. These models are well-suited to be coupled with economic models to predict the consequences of yield shocks on long-term agricultural production and land use. We utilize this new data and apply it to a partial equilibrium economic model Simplified International Model of agricultural Prices, Land use, and the Environment on a Grid (SIMPLE-G), that characterizes the relationship between cropland use, crop production, consumption, and trade at a multi-regional level, allowing for analysis of local response to global changes, and the subsequent feedback effects. Using a version of SIMPLE-G that includes a gridded model of the United States (SIMPLE-G-US), we implement yield shocks predicted from climate change at the global level and take a closer look at the United States. Aggregating across crops, we implement a regional yield shock for all non-US regions, and gridded shocks for the US, allowing us to take a closer look at the gridded response to climate shocks in the US, and the consequent global spillovers. Looking at a gridded US model while still accounting for the rest of the world helps us gain insights into the geographical heterogeneity of resulting impacts and global-local feedback effects. By maintaining the gridded level of detail for the United States, we can characterize not only how the climate will impact crop production in the United States, but also how the climate and crop production changes in the rest of the world will affect outcomes in the United States. We believe that this would be of interest to the geospatial research community because it highlights the integration of state-of-the-art global gridded crop models with an economic model to better understand the spatially explicit impacts of climate change on agriculture systems and the economy. The analysis is based on tools that are publicly available on MyGeoHub - SIMPLE-G-US (https://mygeohub.org/tools/simplegus), and AgMIP(GGCMI-GC6). Building an understanding of the spatial heterogeneity in climate impacts on crop production and land-use outcomes is fundamental to addressing food security issues and developing a better understanding of the production needs to help feed the growing population.

EVALUATING CHANGES IN LAND COVER, EVAPOTRANSPIRATION AND WATER USE ACROSS THE GREAT SALT LAKE BASIN

Bhuwan Ghimire, Ayman Nassar, David Tarboton
Utah State University

The Great Salt Lake (GSL) is a closed basin lake with water level that varies and depends on a balance of inflows and outflows. In recent years, the lake level has declined and reached a historic low level of 4188 ft in the year 2022. GSL is an ecologically and economically important resource and its decline has exposed a large area (>60%) of the lake bed which that is a source of harmful dust impacting air quality. This study analyzed how evapotranspiration (ET) which is the primary process for consumptive water use varies with land cover (LC) to understand the role played by LC changes in streamflow and lake level declines. Moderate Resolution Imaging Spectroradiometer (MODIS) based satellite calculations of ET are available since 2003 were used, together with data on precipitation, temperature, and streamflow to evaluate trends in these major water balance drivers across the GSL basin. ET was also calculated for each major LC class and the change in LC from 2003 to 2021 was calculated. The results show how much of the precipitation in the GSL basin is consumed by ET for each LC class and how this has changed with LC changes and climate trends. This information helps evaluate opportunities for conservation that reduces ET consumptive use and increases streamflow from different LC classes in different watersheds of the GSL basin.

ABSTRACTS

LEVERAGING MACHINE LEARNING AND SATELLITE TECHNOLOGIES TO OPTIMIZE CROP WATER MANAGEMENT UNDER EXTREME CLIMATE CONDITIONS

Kelechi Igwe, Vaishali Sharda, Trevor Hefley
Kansas State University

Crop evapotranspiration (ET) data is a fundamental component of precision irrigation, as it represents an exact estimate of the potential water requirements of crops at any given time or stage of development. This makes ET very essential in optimizing water resource management in agriculture, particularly in arid regions like the US high plains. However, extreme climate conditions can profoundly impact on ET amount, consequently reducing crop yields and posing a significant threat to the sustainability of agricultural production. This study employs Random Forest (RF) machine-learning model to analyze 30-year climate data, identifying key extreme climate factors affecting maize ET in Western Kansas. By combining the standardized FAO-Penman-Monteith equation and remotely sensed normalized difference vegetation index (NDVI) from Landsat's satellite, we estimated crop ET and assessed its sensitivity to extreme conditions. Our results highlight the significant influence of consecutive dry days and mean weekly maximum temperatures on ET, with temperature-derived indices exerting a greater impact than precipitation-derived indices. The RF machine learning model was further used to forecast expected future changes in crop ET. Two future climate change scenarios were considered; the representative concentration pathway (RCP) 4.5 scenario which represents reduced global warming in the future due to intervention efforts, and the RCP8.5 scenario which represents increased global warming resulting from little or no intervention efforts. Our projections indicate that under RCP 4.5, maize ET would increase by 0.4%, 3.1%, and 3.8% in the near 21st century, mid-century and late century respectively. While under RCP 8.5, maize crop ET would rise by 1.7%, 5.9%, and 9.6% in the near century, mid-century and late century respectively. These predicted changes in maize crop ET provide valuable insights for agricultural producers, enabling them to make informed decisions and ultimately implementing precision irrigation practices that will optimize the management of groundwater resources, and mitigate the likely impacts of climate change on agricultural productivity.

REGIONAL STRATEGIES FOR ACHIEVING U.S. NET-ZERO EMISSION TARGET BY INTEGRATING CARBON DIOXIDE REMOVAL TECHNOLOGIES WITH THE ENERGY-WATER-LAND SYSTEM

Parisa Javadi, Patrick O'Rourke, Jay Fuhrman, Haewon McJeon, Scott Doney, William Shobe, Andrés Clarens
University of Virginia, University of Maryland, Pacific Northwest National Laboratory, Korea Advanced Institute of Science & Technology

To achieve net-zero carbon emissions by 2050, the United States may need to leverage carbon dioxide removal (CDR) strategies to compensate for emissions from sectors that are challenging to decarbonize and to address potential shortfalls in immediate mitigation efforts. CDR encompasses a variety of methods, each with distinct requirements for land, water, geologic carbon storage capacity, energy, and other resources. Given the regional variability in the availability of these resources across the U.S., it is anticipated that the deployment of CDR will be geographically uneven, potentially leading to significant impacts on regional resource demands. Our research employs the Global Change Analysis Model for the United States (GCAM-USA) to simulate the deployment of six categories of CDR technologies under four distinct scenarios: a baseline where all technologies are accessible, a scenario with limited geologic carbon storage (Low CCS), a scenario with restricted bio-based CDR options (Low bio), and a scenario where enhanced rock weathering is constrained (Low ERW). This inclusive model development provides a comprehensive assessment of the impacts that various CDR techniques have on the intertwined energy-water-land system. Our findings suggest that a diversified CDR strategy could enable the U.S. to remove between 1 and 1.9 GtCO2 per year by 2050. When a broad array of CDR methods is available, deployment is more uniformly distributed across the nation. Specifically, Texas and the agricultural Midwest emerge as leaders in CDR implementation, attributed to their extensive agricultural lands and geologic storage capabilities. In scenarios where certain CDR technologies are restricted, we observe a notable shift in the regional distribution of CDR deployment. For instance, limitations on below-ground storage (CCS) technologies reduce the burden on the energy system, as direct air capture becomes less feasible. However, the energy requirements for large-scale direct air capture, when viable, are significant, potentially accounting for up to ten percent of the U.S. primary energy demand. This study not only underscores the critical role of diverse CDR strategies in achieving net-zero emissions but also highlights the geospatial and sustainability implications of such endeavors. To facilitate ongoing research and application, we commit to ensuring that the data and software used in our project are openly accessible. This will be achieved through the use of established open-source platforms and repositories, ensuring that our methodologies, results, and insights can be freely accessed, reviewed, and utilized by the broader research community, thereby contributing to the collective effort towards sustainability and environmental resilience.

ABSTRACTS

CLIMATE CHANGE VS. HUMAN INTERVENTION: UNRAVELING THEIR IMPACT ON STREAMFLOW AND A CALL TO INCLUDE HUMAN INTERVENTION AT A FINER SCALE IN THE FUTURE PROJECTION OF WATER FLUXES

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Hydrologic behavior of a watershed or a region can be learned from its streamflow response, which in turn can help to understand the relative role of natural and human factors affecting the watershed. Data-intensive analysis of peakflow records from 3907 United States Geological Survey stations for more than 60 years revealed a significant trend in 34% of these stations. Of these trends, approximately two-thirds indicate decreasing patterns spread across the contiguous United States, while the remaining one-third show increasing trends, particularly in the Northeast and Great Lakes regions. Through the utilization of high-resolution climate (National Oceanic and Atmospheric Administration precipitation data) and land-use (National Land Cover Data) data along with geospatial analytics, this study identifies urbanization and water management as the primary drivers of peakflow variability, followed by agriculture and climate change. The change in climate is captured by quantifying the change in annual average and maximum precipitation at each location; whereas human intervention is captured by quantifying the change in land cover and water storage from dams/reservoirs. Urbanization stands out as the primary driver in the Texas-Gulf, California, and Mid-Atlantic regions, explaining a significant portion of the variance, ranging from 32% to 62%. Water management plays a predominant role in the Tennessee (37%) and Ohio River Basins (30%). Despite the utilization of a large ensemble climate realizations (Community Earth System Model version 2), the latest generation of climate and earth system models fail to adequately capture these human-induced factors, thereby limiting their use in future predictions. This highlights the need for integrating water management and urbanization effects into climate models to enhance water resource management.

GRIDDED LIVESTOCK DENSITY DATABASE AND SPATIAL TRENDS FOR KAZAKHSTAN

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Livestock rearing is a major source of livelihood for food and income in dryland Asia. Increasing livestock density (LSKD) affects ecosystem structure and function, amplifies the effects of climate change, and facilitates disease transmission. Significant knowledge and data gaps regarding their density, spatial distribution, and changes over time exist but have not been explored beyond the county level. This is especially true regarding the unavailability of high-resolution gridded livestock data. Here, we spatially disaggregate the district-level livestock numbers into gridded estimates of LSKD using a random forest (RF) regression model. We developed gridded LSKD (horses and small ruminants, i.e., sheep & goat) maps at high-resolution (1 km) for KZ during 2000-2019 using vegetation proxies, climatic, socioeconomic, topographic, and proximity forcing variables. We found high-density livestock hotspots in the south-central and southeastern regions, whereas medium-density clusters in the northern and northwestern regions of KZ. Interestingly, population density, proximity to settlements, night-time lights, and temperature contributed to the efficient downscaling of district-level censuses to gridded estimates. Mann-Kendall trends and Sen's slopes showed significant increases in livestock density across the country, with significantly higher positive trends and slopes in the southern regions of KZ (Turkistan, Zhambyl, and Almaty). Our predictions are supported by valid statistical accuracies, reasonable agreement with district-level livestock census data, and gridded livestock maps of world estimates. This database will benefit stakeholders, the research community, land managers, and policymakers at regional and national levels. The database contributes significantly to studying livestock-related topics, as it helps overcome the difficulties of obtaining accurate sub-national livestock census data. This study represents a vital advancement in understanding the distribution of livestock in Kazakhstan. The modeling framework can be applied to other regions if livestock census data is available. However, different split ratios and buffer distances around ruminant holding locations must be investigated for accurate mapping. The database can be utilized in various spatially explicit research projects, such as assessing grass-livestock balance, water consumption, methane emissions, zoonotic disease risks, and other environmental impacts. The insights and database generated from this study serve as a crucial foundation for sustainable livestock management, food security, and the development of related policies and practices in Kazakhstan. The developed database is publicly available for download from the figshare repository (https://doi.org/10.6084/m9.figshare.23528232).

ABSTRACTS

VULNERABILITY ASSESSMENT OF ELECTRIC VEHICLES AND THEIR CHARGING STATION NETWORK DURING EVACUATIONS

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Since the introduction of electric vehicles (EVs) in the US market, there have been no adjustments to evacuation planning models and practices to address their unique charging needs. EV drivers may face range anxiety, long recharging times, and navigate sparse public charging networks, which challenge both preemptive and short-notice evacuations. This research proposes a multi-criteria vulnerability assessment of coupled EV driver and charging station networks in various evacuation scenarios. We study flooding evacuations in Chicago, Illinois, and hurricane evacuations in the Southeast Florida transportation networks, by analyzing multiple geospatial and network datasets. Our findings show that vehicle and infrastructure-related characteristics (i.e., charging stations network, driving range, and vehicle type heterogeneity) and evacuation-related characteristics (i.e., transportation network scale and topology, hazard type, and warning system type) impact evacuation feasibility and performance and can increase drivers' vulnerability. We describe how pertinent geospatial datasets and evacuation modeling can improve emergency response planning for sustainable electrified mobility under a changing climate.

LEVERAGING GOOGLE STREET VIEW FOR CRIME PATTERN ANALYSIS IN BATON ROUGE

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Environmental criminology focuses on criminal patterns between specific built environments and people's behavior. This research focuses on the integration of crime analysis, image acquisition technologies, and machine learning methods to advance crime research and enhance urban safety. This study has three primary objectives: (1) identifying environmental factors that contribute to street crimes (i.e., burglary, robbery, theft, and vehicle theft); (2) making modifications to dangerous areas; and (3) proposing a foundational study for creating a secure environment in Baton Rouge (BR). A comprehensive dataset of crime incidents in Baton Rouge, Louisiana, from January 1, 2020, to December 31, 2022, is employed. During the same time period, Google Street View images were used to identify the environments where crimes were committed. Semantic image segmentation is then performed using the DeepLabV3+ model on four-directional (north, east, west, and south) GSV images. This analysis focuses on ten identifying environmental factors (construction (i.e., building, skyscraper, house, garage, fence, bridge, and tunnel), human, object (i.e., pole, pole group, traffic sign, and traffic light), road, sidewalk, sky, terrain, vegetation, vehicle, and void) that correlate with street crimes. The methodology encompasses regression analyses, including Random Forest (RF) and Geographically Weighted Regression (GWR), to establish correlations among crime rates, object class ratios in images, and socioeconomic variables. This study aims to uncover the relationships between environmental features captured in GSV and specific crime categories, providing actionable insights for crime prevention and urban planning. As part of our commitment to open science and the advancement of sustainability research, the GSV data, crime incident datasets, and Python code utilized in this study will be made accessible to the public. Specifically, we aim to publish our codes and dataset in the I-GUIDE Jupyter Notebook, enabling researchers and urban planners to access and build upon our findings freely. This initiative aligns with the broader goal of promoting transparent, collaborative efforts to create more secure and sustainable urban environments, particularly in cities similar in size and structure to Baton Rouge across the southern United States. This research offers valuable perspectives for crime prevention and urban planning while conducting a comparative analysis of regression techniques to understand urban crime's geospatial dynamics. By making our data and methodologies openly accessible, we aim to contribute significantly to environmental criminology, geospatial analysis, and sustainable urban development.

ABSTRACTS

PRIME: A CYBERGIS PLATFORM FOR RESILIENCE INFERENCE MEASUREMENT AND ENHANCEMENT

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In an era of increased climatic disasters, there is an urgent need to develop reliable models and easy-to-implement tools for evaluating and improving urban resilience to climatic hazards at multiple geographical and temporal scales. Despite various domains like ecology, engineering, and social science defining resilience, the social domain is relatively subjective due to the intricate interplay of socioeconomic factors with disaster resilience. Some earlier models also suffer from being hazard- or geography-specific. Furthermore, cyberinfrastructure is increasingly utilized to develop and implement tools that can tackle large-scale, multidisciplinary societal problems. However, there is no user-friendly, scientifically rigorous tool that can support customized resilience assessment and improvement. To address these gaps, this study has three primary objectives: 1. To develop the Customized Resilience Inference Measurement (CRIM) framework designed for multi-scale community resilience assessment and the identification of influential socioeconomic factors. 2. To implement a CyberGIS module in the CyberGISX platform that enables users to conduct disaster resilience computation and visualization using the CRIM framework. 3. To demonstrate the utility of the CyberGIS platform through a representative study that analyzes county-level community resilience to climatic hazards in the United States from 2000 to 2020. CRIM aligns with the National Research Council's resilience conceptualization by combining aspects of vulnerability and adaptability. The framework generates resilience scores derived from empirical parameters—hazard threat, damage, and recovery. The type of hazards to be included in the analysis along with the study area is based on user input. Machine Learning (ML) methods are employed to validate these scores and to explain the intricate relationships between these scores and potential socioeconomic driving factors. The platform provides workflow illustrations, score classification per county, interactive geovisualizations and interprets relationships of resilience scores to socioeconomic variables using ML through coefficients, importance scores, and causal relationships. The essence of this work lies in its comprehensive architecture that encapsulates the requisite data, analytical and geo-visualization functions, and ML models needed for resilience assessment. This setup not only enables the public, researchers, and policymakers to customize their disaster resilience assessments but also provides a foundation for strategizing interventions aimed at enhancing resilience.

BUILDING A SUSPENDED SEDIMENT CONCENTRATION DATABASE ACROSS EARTH'S RIVERS WITH LANDSAT

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Under threats from climate change and human activities, it is critical to measure and quantify change in Earth's freshwaters. Suspended sediment concentration (SSC) is a key measure of river systems and often used as an indicator of water quality. SSC can be derived from satellite images using limited in-situ measurements and data-driven modeling to generate long-term observations at basin to global scales. However, creating consistent and comparable SSC data across large extents and different satellite sensors remains a challenge in aquatic remote sensing. Here, we built a machine learning algorithm and remote sensing workflow capable of estimating SSC in rivers and other inland waters worldwide across Landsat satellites. Using 170 thousand in-situ measurements of SSC across over 75 countries from 1985 to 2021, we trained, optimized, and evaluated an Extreme Gradient Boosting (XGBoost) model. In addition, we harmonized surface reflectance data from Landsat 5 to 8 to generate a globally comparable database and enable time series analysis. Using a single global algorithm, with a performance showing a root median square error (RMSE) of 8.33 mg/L and a relative error of 25.12%, we generated a 36-year SSC database in global rivers wider than 50 meters. Here, we will discuss the algorithm, preliminary data, and potential applications of the database. Last, this database and code will be archived in repositories Zenodo with an associated digital object identifier (DOI) and metadata. The peer reviewed manuscript will be made open access through requested page charges or open access venues such as institutional repositories or preprint/postprint servers such as EarthArXiv and will be linked to the open code and databases with DOIs.

I-GUIDE Institute for Geospatial Understanding through an Integrative Discovery Environment

ABSTRACTS

ASSESSING THE SPATIAL DISTRIBUTION OUTSTANDING NATIONAL RESOURCE WATER DESIGNATIONS OF THE CLEAN WATER ACT

Jessica Raty

Northern Arizona University

The Biden Administration is committed to protecting 30% of the U.S.'s terrestrial and inland water ecosystems by 2030 under the "America the Beautiful" initiative. Since political barriers make it challenging for the U.S. to develop new legislation in time to meet its conservation goals, the U.S. must identify and implement existing policies to conserve inland waters. One policy is the Outstanding National Resource Waters (ONRW) provision within the Clean Water Act that allows state and Tribal governments to designate exceptional waterways to protect water quality from degradation. However, to date, there is no comprehensive data source containing information about where ONRWs exist nor how states vary in applying this policy. Against that backdrop, this study asks: what is the spatial distribution of ONRW designations across the U.S.?; and what is the rationale behind each government's policy implementation? To answer these questions, this study conducts a policy analysis and compiles an ONRW database for subsequent geospatial and qualitative data analysis. Results of the spatial analysis show that the distribution of ONRW designations and magnitude vary by state. Results aim to inform government agencies, conservation groups, and lawmakers on future management efforts under this policy to expand these protections and ultimately help the U.S. achieve its 30X30 targets for inland waters.

SPATIALIZING LIFE CYCLE ASSESSMENT TO IDENTIFY LOCALIZED IMPACTS

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Life Cycle Assessment (LCA) plays a pivotal role in quantifying environmental impacts throughout a product's lifecycle. However, traditional LCA methodologies often fail to account for spatial variations, overlooking critical localized effects. This study introduces a spatialized LCA approach, aimed at bridging this gap by enhancing the resolution of regional impact assessments. Applying this methodology to lithium extraction from Nevada clays, we prioritize impact categories including Greenhouse Gas Emissions, Freshwater Ecotoxicity, Land, and Water Use. Our approach systematically compiles unit processes across these categories, integrating location-specific data for key contributors, and subsequently mapping the environmental impacts directly onto affected ecosystems. The findings from applying spatialized LCA underscore significant regional disparities in environmental impacts. A notable discovery is the predominant concentration of land and water use impacts within Nevada, accounting for over 90% of the total, while a substantial share of freshwater ecotoxicity impacts—more than 70%—is distinctly observed in Arizona's freshwater ecosystems from the upstream production of Sulphur. These disparities highlight the critical need for spatial awareness in environmental assessments. Moreover, by pinpointing ecosystems at risk, the spatialized LCA method offers invaluable insights for stakeholders, facilitating informed decision-making geared towards mitigation and the development of sustainable alternatives. Beyond immediate applications, this study underscores the potential of spatialized LCA to transform environmental policy and practice by providing a more nuanced understanding of the geographic dimensions of product life cycle impacts. Through this enhanced methodological lens, we advocate for a shift towards more spatially informed environmental strategies that align with the principles of sustainability and conservation. The methodology employs the open-source LCA software, Brightway, and enhancements specific to this study will be shared on GitHub. Inventory data for lithium extraction and ecosystem maps, derived from public sources, alongside the study's findings, will be made openly accessible.

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ABSTRACTS

A FAIR METADATA STANDARD FOR URBAN HYPERSPECTRAL REFERENCE LIBRARIES

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Hyperspectral remote sensing uses advanced cameras to analyze light reflected from objects, revealing detailed information about the chemical composition of materials. This technology has a wide range of practical applications to improve our cities, from critical infrastructure maintenance, natural disaster mitigation, and microclimate analysis. Hyperspectral remote sensing relies upon access to spectral libraries for matching observed spectra to known spectral signatures. The accuracy of remote material identification requires a comprehensive and diverse set of reference spectra covering a wide range of materials. In this project, we identified 23 spectral reference libraries containing urban materials, however, only 4,593 (less than 1%) of the 464,056 spectra found were publically accessible signatures of urban materials. Content analysis of these resources based upon the principles of Findability, Accessibility, Interoperability, and Reusability (FAIR) revealed a systemic underrepresentation of urban material diversity and limited interoperability among libraries. To assess the effectiveness of reference data utilization across spectral libraries, we introduce metrics for evaluating FAIR compliance and apply them to all known urban spectral libraries. Our findings indicate incomplete FAIR compliance (78%) even among the 11 libraries offering open access, with significantly lower compliance (48%) observed among libraries with restricted access. The absence of a standardized metadata framework for urban hyperspectral data emerges as a primary obstacle contributing to this low FAIR compliance. To address this, we propose a 14-category metadata standard tailored for urban spectral data, with specific provisions to address environmentally-induced and inherent intra-material variability. To promote the reuse of the spectral data analyzed in this project, all spectra we have processed from multiple libraries will be uploaded as a single dataset via Zenodo, a reputable repository for open data (DOI: 10.5281/zenodo.10963442). Establishing either a centralized, standardized spectral library or a federated system of interoperable libraries aligned with the FAIR Principles necessitates significant and sustained participation from the research community. Despite the challenges, this shift in practice would facilitate data sharing, comparison, and analysis, fostering collaborative research and thereby enhancing our understanding of urban materials while advancing the capabilities of urban hyperspectral remote sensing.

FORECAST-INFORMED DEEP LEARNING METHODS FOR FLOOD PREDICTION AND MITIGATION

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Problem: Floods can cause horrific harm to life and property. However, they can be mitigated or even avoided by the effective use of hydraulic structures such as dams, gates, and pumps located at different locations. By pre-releasing water via these structures in advance of extreme weather events, water levels can be sufficiently lowered to reduce flood impact. Existing approaches to control hydraulic structures have used genetic algorithms with physics-based simulation tools (e.g., HEC-RAS). These tools are computationally expensive and inappropriate for real-time use. To maintain environmental sustainability, Contributions: • Phase I - Prediction: Many watersheds are outfitted with sensors and large amounts of observational data were collected. We solve the Flood prediction problems by developing a Graph Transformer Network, FloodGTN, which performs at least 500x faster than physics-based model (HEC-RAS), yet with comparable or better accuracy. • Phase II - Mitigation: We also propose a Forecast Informed Deep Learning Architecture (FIDLAR), which achieves flood mitigation with hydraulic structures in an optimal manner by balancing out flood mitigation and unnecessary wastage of water via pre-releases. • Experiments: We perform experiments with the DL-based FIDLAR on the South Florida watershed (see below), a coastal area that is highly prone to frequent storms and floods. Results show that FIDLAR performs better than the current state-of-the-art with several orders of magnitude speedup and with provably better pre-release schedules. • Explainability: Effective use of model explainability tools allows us to understand the contribution of the various environmental factors towards its decisions while confirming that our Deep Learning (DL) models are learning useful knowledge. • Open source data and code are available in the GitHub repository: https://github.com/JimengShi/FIDLAR.

ABSTRACTS

INTERNATIONAL FOOD TRADE'S IMPACTS ON LAND USE FOR CROP PRODUCTION

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The global food system uses 40% of habitable land and emits 30% of global greenhouse gases. As the system becomes increasingly globalized new challenges arise to understand the social, economic, and environmental impacts. As countries increase their participation in international food trade they increase the amount of land they use for crop exports while simultaneously saving land with crop imports. The goal of this study is to quantify the amount of virtual land used for crop exports and land saved from crop imports as well as the associated changes in soil organic carbon (SOC) and soil emissions. The flows were computed using Detailed Trade Matrix, Emissions Totals, and SoilGrids data for 217 countries and 150 food stuffs for the years of 2010-2020. Flows of virtual land, SOC, and CO2 emissions were calculated from sending countries to receiving countries for all available crop types. Estimated soil organic carbon changes were calculated by running zonal statistics on SOC and land use layers to determine the difference in SOC between natural and cultivated areas. Flows between adjacent countries and distant countries were also calculated. Additional no trade and required trade scenarios were run calculating the change in resource usage and emissions for each country. In 2020 land saved due to crop imports (240.26 Mha) was higher than virtual land usage (221.77 Mha) indicating a net land savings of 18.49 Mha. From 2010-2020 countries saved a cumulative 50% (5% per year) of their total cropland area due to crop imports. International food trade in 2020 also reduced agricultural soil emissions by 63.42 Mtonnes but increased SOC losses by 53 Ktonnes. No Trade and Required trade scenarios saw larger reductions in land use and emissions as well as reduction in SOC losses. In 2020 crop trade between high and upper-middle income countries accounted for 59.6%, 65.3%, and 69.5% of total virtual land, virtual SOC, and soil emissions respectively. Overall, international food trade is reducing the amount of land use and soil emissions due to crop production but could be optimized further. All data will be made publicly available with the corresponding code via GitHub at the end of the project.

SATELLITE PREDICTION OF YIELD AND SOC FOR SMALLHOLDER FARMERS IN INDIA

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The significant role of agriculture in the rise of atmospheric carbon dioxide is well acknowledged, with carbon credit markets like Verra emerging as a market-driven solution to decrease carbon emission. Despite this, small-scale farmers in developing countries have scarcely tapped into these markets for better carbon sequestration. This gap is notable considering the potential earnings from carbon credits in regions where they could significantly improve farmers' income. However, one of the challenges in this process of connecting India's smallholder farmers with carbon credit firms is posed by the cost-effectiveness of soil testing and monitoring in areas dominated by small fields, where testing costs could exceed the carbon benefits. This study proposes the utilization of satellite data to estimate yields and soil organic carbon (SOC) on small fields in India. We develop a Python pipeline to process open access Sentinel-2 imagery at 10-meter resolution, extracting multiple vegetation indices from its 13 spectral bands per pixel, aggregating this data at the field level, and refining the dataset to eliminate anomalies and smooth time series fluctuations. By integrating this with precise ground truth data from Odisha, India, and employing machine learning techniques such as Random Forest and Convolutional Neural Networks, we aim to predict rice yield and SOC accurately. We will then conduct a validation exercise to (a) compare predictions from state-of-the-art machine learning (ML) methods (applied to high-resolution remote sensing data) to ground truth (as represented by detailed plot level soil analyses) and assess the accuracy of rice yield and SOC prediction using satellite data; (b) update the ML tools to our context by using our soil analyses as training data; (c) explore the potential of satellite data to validate the adoption and impact of regenerative agricultural practices. Such an analysis, to our knowledge, has not been carried out in India in a field setting. For future works, we intend to enhance accuracy and broaden our research scope by integrating different data sources. Emphasizing satellite data for SOC and yield predictions could significantly streamline and economize monitoring efforts in global carbon markets and inform agricultural policy decisions, offering a convergent, scalable and cost-effective solution for sustainable development.

ABSTRACTS

MAP-ENHANCED DECISION-MAKING IN CONTINGENT VALUATION

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Despite maps' prevalent use in Stated Preference (SP) studies for environmental and resource economics, the impact of map interactions on environmental decision-making and valuation remains underexplored. We aimed to determine whether, and to what extent, engaging with these maps helps respondents make more informed decisions. Additionally, we sought to understand how such interactions influence the choices respondents make in valuation questions.Our study evaluates the contingent valuation of water quality improvements among New England residents, utilizing data from the "Water Quality in Rivers and Streams: A Survey of Northeast US Residents" 2020 survey (Johnson et al., 2023). Incorporating interactive maps, the survey enabled precise tracking of participant engagement and integrated this with demographic and water quality data from 1,608 residents. After addressing missing data by supplementing with census information and excluding variables that couldn't be supplemented, the cleaned dataset, devoid of protest responses and other missing values, consisted of 929 observations. To tackle the endogeneity from map-looking behavior in survey responses, we avoided including it directly in logistic models to reduce bias from respondent self-selection. Instead of a Heckman-type model, which has limitations on functional form and covariates, we chose a causal forest approach with residualization. This method effectively handles complex datasets, identifies varied treatment effects, and adjusts for confounders, enhancing the analysis's robustness and reliability on map interaction impact, following Athey, Tibshirani, and Wager (2019). Utilizing the Generalized Random Forests (grf) framework for causal forest analysis involves a detailed, multi-stage process. Initially, we construct two distinct regression forests: one to estimate propensity scores and another to predict expected outcomes at varying levels of treatment intensity. These regression forests play a crucial role in generating out-of-bag predictions, which are vital for the ensuing steps of the analysis. Following this, we incorporate the fitted values and conduct regression of the outcomes, now adjusted for residual effects, against the similarly adjusted map-looking behavior. This method allows for an in-depth analysis of how map interaction influences policy support, effectively handling treatment variables in binary, categorical, or continuous forms. This comprehensive approach enables us to accurately estimate the Conditional Average Treatment Effect (CATE), providing valuable insights into the effect of map interaction. Our analysis indicates that map interaction is influenced by local water quality differences and their closeness to respondents' homes. Additionally, age and a preference to avoid extra fees significantly impact engagement with the map. Besides, higher individual bids correlate with a lower likelihood of supporting new policies, whereas notable differences in upper-tier water quality levels tend to boost policy support. This indicates respondents are more inclined to vote for policies when they notice significant differences in the quality of their local environment. Furthermore, the lack of significant heterogeneous effects at the individual level regarding map-looking behavior indicates that map-looking does not causally influence voting probabilities no matter how we capture the treatment. It appears that individuals who looked at maps were able to gather information on water quality in areas of interest directly from the overview maps.

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