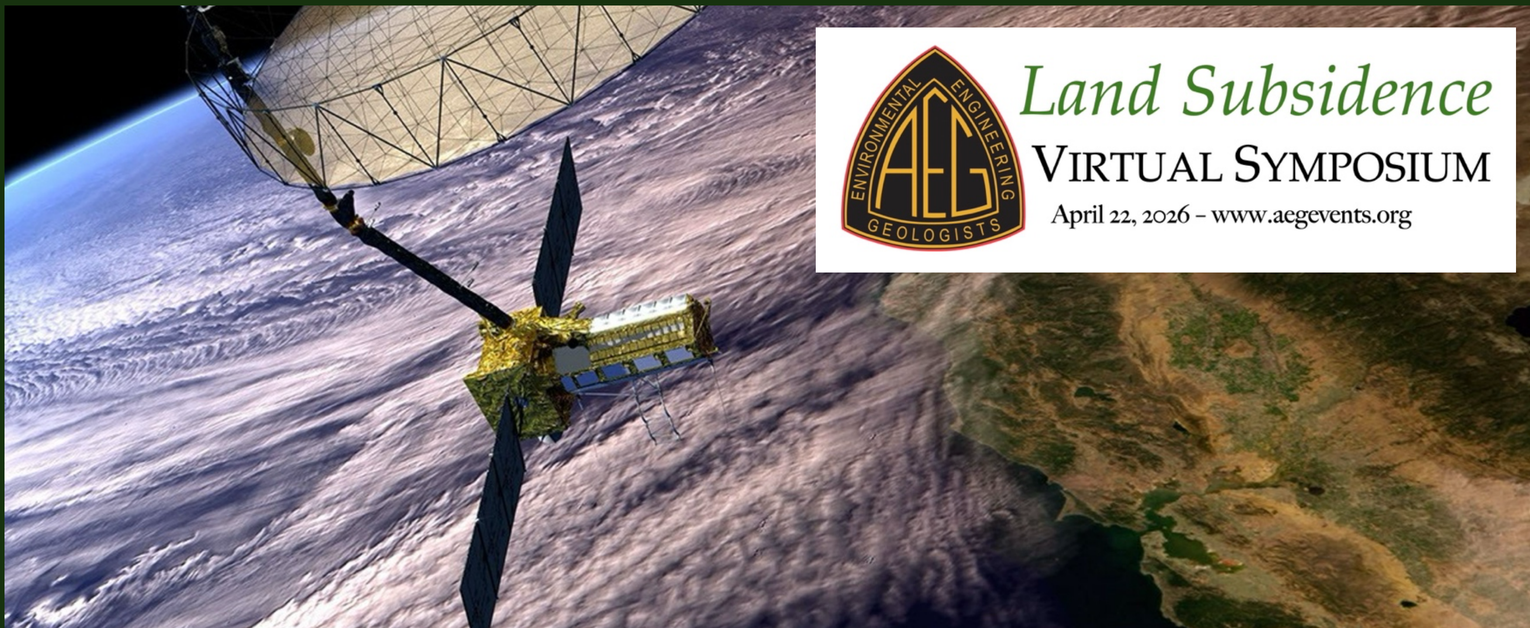

AEG 2026 Land Subsidence Virtual Symposium Program

April 22, 2026
7:45am-1:30pm Pacific Time

Convened by AEG's Land Subsidence Technical Working Group
Moderated by James Borchers

(The session will be recorded for paid attendees to view anytime. 5.5 PDHs available)

Land subsidence is a widespread geologic hazard resulting from a range of natural and anthropogenic processes, with far-reaching consequence for infrastructure stability, water-resource sustainability, and coastal resilience. This virtual symposium will illustrate subsidence processes, monitoring techniques, infrastructure damage and socio-economic impacts, and the laws, regulations, and management policies spawned by this growing global hazard.

AEG 2024-2025 Officers

President: Paul Weaver, Geotechnical Geologist-Retired
Vice President/President Elect: Mark Swank, Federal Highway Administration
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Secretary: Paco Gomez, University of Missouri Columbia, Missouri
Past President: Renee Wawczak, EPA

Association Contacts

Headquarters Association Manager:
Evelyn Neale, manager@aegweb.org
AEG Meeting Manager:
Heather Clark, heather@aegweb.org

On the Cover

Photo 1: NISAR: NASA's New Mission for Land Surface Monitoring. Photo Credit: NASA

Photo 2: Rock Springs, Florida – Karst Related Subsidence. Photo Credit: Thomas Scott

Land Subsidence
VIRTUAL SYMPOSIUM
April 22, 2026 – www.aegevents.org

SYMPOSIUM SCHEDULE

Association of Environmental & Engineering Geologists
7:45am-1:30pm Pacific Time

Time	Title	Speaker
7:45am	**Welcome and Introductions; Basics Principles of Fluid Extraction and Compaction**	**James Borchers**, Research Hydrologist USGS (ret), Consulting Hydrologist, Davis, California
8:00am	**What the Ground Remembers: Long-Term Subsidence and Critical Heads in the Central Valley of California**	**John Ellis,** Principal Hydrogeologist and National Subsidence Lead, Intera, Houston, Texas
8:30am	**Leveraging Subsidence Data from InSAR to Estimate Groundwater Storage Change in the Western United States**	**Ryan Smith**, Professor, Colorado State University, Fort Collins, Colorado
9:00am	**From Crisis to Integrated Management: Lessons on Water Scarcity, Subsidence and Desertification**	**Mahdi Motagh**, Professor, GFZ Helmholz Center for Geosciences, Potsdam Germany
9:30am	**Subsidence in Coastal and Urban United States**	**Manoochehr Shirzaei**, Professor, Virginia Tech, Blacksburg, Virginia; United Nations University
10:00am	**Mining Subsidence Geohazards in the U.S.; Mechanisms, Risk, Investigation, and Mitigation**	**David Hibbard**, Geologist, Brierley Associates, Denver, Colorado
10:30am	**Break**	
10:45am	**Subsidence in Arizona: Damage History, Monitoring and Policy**	**Brian Conway**, Geophysics Unit Supervisor, Arizona Department of Water Resources, Phoenix, Arizona
11:15am	**From Data to Decisions: Methods to Mitigate Land Subsidence in the Greater Houston Region**	**Ashley Greuter**, Director of Research and Water Conservation, Harris-Galveston Subsidence District, Friendswood, Texas
11:45am	**Karst-Related Subsidence in Florida**	**Tom Scott**, Senior Principal Geologist, Sdii-Global
12:15pm	**Effect of Subsidence on Property Values in the San Joaquin Valley, California**	**Mehdi Nemati**, Professor, University of California Riverside
12:45pm	**An Overview of NISAR: NASA's New Mission for Land Surface Monitoring**	**Cathleen Jones**, Senior Research Scientist and NISAR Science Team Leader, Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA
1:15pm	**Closing Discussion**	

James Borchers
Consulting Hydrologist

Jim Borchers is a consulting hydrologist with more than 40 years' experience leading complex, multidisciplinary investigations of groundwater flow in alluvial sediments and in fractured rocks. After 31 years with the USGS evaluating water availability and geochemistry and isotopic composition of groundwater in stress-relief-fractured rocks of the Appalachian Plateaus and in Wawona, Yosemite National Park, and land subsidence in the Sacramento Valley of California, Jim consulted on monitoring plans and infrastructure damage in subsiding areas of California. He is Cochair of the AEG Land Subsidence Working Group responsible for coordinating the AEG's yearly land subsidence symposia at the annual meetings of the Association. He has serves as an expert witness for federal and county agencies.

Abstract:
Basic Principles of Fluid Extraction and Compaction

Land subsidence occurs when fluids, groundwater or hydrocarbons, are removed from the subsurface by pumping or drainage. Reduction of fluid pressure in the pores of an aquifer system that results from fluid removal causes deformation as described by the principle of effective stress. When support provided by pore pressure is reduced, the weight of materials overlying an aquifer is transferred to the mineral skeleton of the aquifer system which then compresses. Compression is elastic and reverses when pore pressure increases. Support previously provided by the mineral skeleton is transferred back to the fluid, and the skeleton expands. The compression and expansion results in small amounts of subsidence and uplift of the land surface. This elastic compression and expansion of the aquifer system and displacement of the land surface occurs cyclically as aquifers are pumped and recharge. When the load on the aquifer skeleton exceeds the previous maximum load (the preconsolidation stress), for example when groundwater levels decline below historical low levels, the mineral skeleton undergoes a substantial, irreversible (inelastic) rearrangement leading to permanent compaction and irreversible subsidence. 'Water of compaction' is squeezed from the aquitards and flows in the aquifer to a pumping well. Because the mineral skeleton is squeezed into a denser arrangement, poor space is reduced. The loss of pore space is permanent and occurs primarily in clayey aquitards which, although they are more compressible and of higher porosity than coarser-grained aquifers, have very low hydraulic conductivity (permeability). Because of their low permeability water drains out of and into aquitards very slowly in response to changing groundwater levels in adjacent aquifers. In fact, it can take decades or even centuries for poor pressure in a thick poorly permeable aquiclude to equilibrate with changing pore pressure in adjacent aquifers. Delayed yield of water from aquicludes is responsible for subsidence that occurs after pumping ceases and groundwater levels begin to recover. Identifying the critical hydraulic head at which an aquifer system will begin to compress inelastically is crucial to effective management of land subsidence. Our next speaker, John Ellis from Intera, will describe how to estimate this critical head.

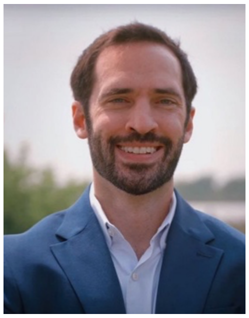
Brain Conway, GISP
Arizona Department of Water Resources

Brian Conway has worked for the Arizona Department of Water Resources since 1999 and has supervised the Hydrology Division's Geophysics/Surveying Unit since 2006. Brian has been the NASA appointed Water Resources Advisor for the Alaska Satellite Facility/NASA InSAR Working Group since 2011 and is also a NASA Envoy for the NISAR mission. Brian also serves as the administrator for the AZCORS network working closely with the National Geodetic Survey and the Arizona surveying and mapping community.

Abstract:
Subsidence in Arizona: Damage History, Monitoring, and Policy

The Arizona Department of Water Resources (ADWR) Geophysics/Surveying Unit has been monitoring land subsidence using GNSS and InSAR data since 1998 and 2002 respectively; monitoring change-in-aquifer storage using terrestrial micro-gravity data since 1998; and managing and operating the statewide AZCORS network since 2023. These different datasets provide a platform of data synergy for successfully monitoring groundwater conditions and aquifer compaction throughout Arizona. ADWR has identified more than twenty-eight active land subsidence features that cover an area of 4,300 square miles, determining the spatial extent, deformation rates, and time-series history of each land subsidence feature. The process of collecting, processing, and interpreting InSAR data has resulted in ADWR producing land subsidence maps for each land subsidence feature covering different time periods. ADWR recently released a new online land subsidence/deformation map application and also provides an online library of static land subsidence maps (currently 800 maps) available for download on ADWR's website: https://new.azwater.gov/hydrology/field-services/land-subsidence-arizona. Since taking over the management and operation of the AZCORS Network in 2023, ADWR has enhanced the Network by upgrading all legacy equipment to quad-constellation capability, constructing 20 new braced monument CORS sites, expanding existing Network Solution Clusters, and creating four new Network

Solution Clusters for end-users that cover more than 33,000 square miles. With the recent launches of higher-resolution SAR satellites such as Sentinel-1 and NISAR, ADWR has seen and will continue to see an increase in data availability (spatially and temporally) that will greatly benefit various projects. Engineers, hydrologists, geologists, GIS professionals, and scientists involved in the fields of water resources, structural engineering, geological engineering, hydrological engineering, land planning, floodplain management, and surveying greatly benefit from the InSAR, GNSS, gravity, and AZCORS data to identify and evaluate the groundwater basins of Arizona by examining the change-in-storage, land subsidence, uplift, earth fissures, faults, and many other hydrologic and geologic features. ADWR directly uses this scientific data for groundwater management, creating new groundwater active management areas, monitoring aquifer-health and overdraft, and various types of decision-making projects.



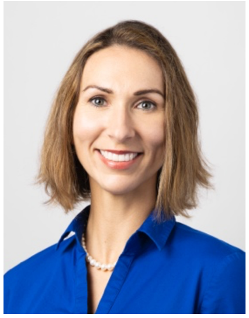
John Ellis, P.G.
INTERA Inc.

John Ellis is a Principal Hydrogeologist and National Lead on Land Subsidence with INTERA Inc. and a professional geologist with 16 years of experience in groundwater modeling, land subsidence studies, water resources planning and management, and information technology. John holds a B.S. in Geosciences from the University of Texas at Dallas, a M.S. in Environmental Science from Hardin-Simmons University, and a M.S. in Hydrogeology from the University of Alabama.

Abstract

What the Ground Remembers: Long-Term Subsidence and Critical Heads in the Central Valley of California

Land subsidence caused by groundwater extraction has long been a significant challenge in California, with impacts including infrastructure damage, permanent loss of groundwater storage, and many millions of dollars in associated costs. Minimizing and preventing future subsidence requires raising groundwater levels above critical head levels, which often aren't the same as the historical lows. Effective management of land subsidence under SGMA requires defensible estimates of critical head and a clear understanding of when groundwater-level declines translate into irreversible compaction. This presentation synthesizes empirical observations and modeling results from locations across the Central Valley to examine spatial and temporal trends in subsidence and critical head, informed by DWR's Bulletin 118 - Update 2025. Using a combination of long-term groundwater-level records, subsidence observations, and 1-D MODFLOW CSUB modeling, we evaluate subsidence and critical head trends across various hydrogeologic settings.



Ashley Greuter, P.G.
Harris-Galveston Subsidence District (HGSD)

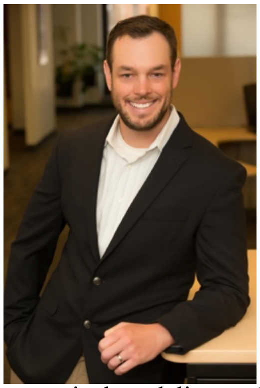
Ashley is the Director of Research and Water Conversation for the Harris-Galveston Subsidence District (HGSD) where she oversees research, monitoring, and water conservation programs to ensure that HGSD has the best available data and water conservation resources in the Texas Gulf Coast region. She proudly serves as the USA Affiliate for UNESCO's Land Subsidence International Initiative and is a licensed Professional Geoscientist in Texas. She has a Bachelor of Arts in Classical Studies and Bachelor of Science, summa cum laude, in Geology from the University of Florida as well as a Master of Science in Geological Sciences f from the University of Massachusetts (Amherst).

Abstract:

From Data to Decisions: Methods to Mitigate Land Subsidence in the Greater Houston Region

The Harris-Galveston Subsidence District (HGSD) was created by the Texas Legislature in 1975 is to regulate groundwater withdrawal to prevent further subsidence in Harris and Galveston counties in southeast Texas. The combination of continuous research and annual monitoring that provide key datasets to inform water management planning efforts along with collaboration from regional water providers has successfully stopped subsidence in the coastal region of Harris and Galveston counties.

Photo Credit: HGSD



David Hibbard, C.P.G., P.G.
Brierley Associates

David Hibbard, CPG, PG is a Certified Professional Geologist and Professional Geologist with more than 12 years of experience investigating and mitigating land subsidence in active and legacy mining environments. As a Geohazard Sector Leader and Senior Associate at Brierley Associates, he directs multidisciplinary programs that integrate geologic characterization, geotechnical analysis, and risk-informed decision making for public agencies, mining operators, and infrastructure owners. Three of his subsidence-related projects have received OSMRE awards, including the 2025 OSMRE National Award recipient for the National Association of Abandoned Mine Land Programs. David's technical work centers on subsidence mechanisms, mine-void stability, highwall and pillar failure processes, mine-fire impacts, and deformation hazards affecting surface infrastructure. He has led investigations combining drilling, downhole characterization, laboratory testing, remote sensing (LiDAR, InSAR, photogrammetry, multispectral and thermal imaging), instrumentation, and numerical modeling to develop defensible geologic and geomechanical frameworks that support mitigation design and long-term hazard management. His background also includes construction quality assurance, regulatory compliance, and field leadership on major civil and mining projects. He has published on mitigation strategies in complex hydrogeologic settings and is recognized for translating subsurface uncertainty into practical, cost-effective solutions that improve safety, constructability, and long-term asset performance."

Abstract:

Mining Subsidence Geohazards in the U.S.; Mechanisms, Risk, Investigation, and Mitigation

Mining subsidence remains a widespread and often under characterized geohazard across the United States, driven by legacy and active underground mining. This presentation provides a practical framework for understanding subsidence through its governing mechanisms, including room-and-pillar collapse, longwall-induced deformation, and void migration. Distinct surface expressions: such as trough settlement and sudden collapse features are linked to key risk drivers including mine geometry, overburden conditions, groundwater influence, and time-dependent degradation. Emphasis is placed on how these factors translate to risk for infrastructure, utilities, and development. The presentation outlines a phased investigation approach integrating historical data, targeted subsurface exploration, geophysics, and remote sensing to reduce uncertainty. Mitigation strategies are discussed within a decision-based framework, including grouting, structural solutions, and water management. The goal is to support informed, cost-effective risk management and engineering response in subsidence-prone environments.

Cathleen Jones, Ph.D.
NASA Jet Propulsion Laboratory

Cathleen Jones is a Senior Research Scientist at the NASA Jet Propulsion Laboratory in Pasadena, California, and the Applications Lead for the NASA-ISRO NISAR Earth Observing mission. Her research focusses on the use of synthetic aperture radar (SAR) to identify, monitor, and study natural and man-made hazards and involves the using SAR to monitor the status of levees and dams, measure subsidence due to groundwater withdrawal, and develop remote sensing methods for tracking and characterizing oil spills.

Abstract:

An Overview of NISAR: NASA's New Mission for Land Surface Monitoring

In June 2025, NASA and the India Space Research Organization (ISRO) jointly launched the NASA-ISRO Synthetic Aperture Radar (NISAR) mission to provide near global land imaging that supports studies of geological hazards, hydrology, ecosystems, and the cryosphere. NISAR uses advanced L-band radar imaging to map the Earth's land and ice masses twice every 12 days with ~6-m minimum resolution for U.S. and Indian lands and ~12-m resolution for most other areas. NISAR can be used to measure land surface deformation with the InSAR technique, and the regular cadence of observations enables quantification of subsidence rates, trend analysis to establish normal variability and identify anomalous changes, and evaluation of the underlying processes causing ground movement. In late February 2026, the NISAR mission released a large subset of the imagery acquired since November 2025, and the full data release is expected to begin in summer 2026. This presentation will discuss the mission status and provide overviews of the technology, observation plan, data products, and data access, along with early examples of land subsidence observed by the mission.

Mahdi Motagh, Ph.D.
Leibniz University Hannover

Mahdi Motagh is a Professor of Radar Remote Sensing and Geohazards at Leibniz University Hannover (LUH) and the GFZ Helmholtz Centre for Geosciences in Potsdam, Germany. His research focuses on the application of radar remote sensing to study a wide range of geohazards, including landslides, land subsidence, tectonic deformation, volcanic activity, glacier dynamics, and flood processes. Since joining GFZ Potsdam in 2003, he has accumulated over two decades of experience and has led pioneering research on satellite-based assessment of land subsidence driven by water scarcity, solution mining, and other anthropogenic factors. His work effectively bridges advanced remote sensing technologies with practical approaches for understanding and mitigating natural hazards.

Abstract:
From Crisis to Integrated Management: Lessons on Water Scarcity, Subsidence and Desertification

Iran exemplifies a water crisis where persistent groundwater depletion drives large-scale land subsidence and accelerates desertification. Using the first consistent national InSAR-based subsidence map with quantified uncertainties we reveal >56,000 km² of sinking land with hotspots exceeding 35 cm/yr, and ~14 million people exposed. Over two-thirds of subsiding areas are agricultural, linked to ~1.7 billion m³/year of groundwater loss, primarily from irrigated farming. These remote sensing-derived deformation products, integrated with land cover dynamics and field observations, expose the interconnection between groundwater exploitation, anthropogenic activities, and desertification. Our open platform, SubsMap (https://subsmap.github.io/iran/), streamlines InSAR-based monitoring for adaptive management in data-scarce regions. Beyond Iran, the Taiyuan case in northern China offers a critical lesson, where big water diversion projects had limited success in addressing water scarcity. However, integrated management, combining water transfer with on-farm conservation, tree planting, and irrigation modernization partially balanced the aquifers and reversed subsidence. We argue that water-stressed regions like Iran, northwest India, etc... would do well to learn from this integrated approach.

Mehdi Nemati, Ph.D.
School of Public Policy, UC RiversideUniversity of California, Riverside.

Dr. Mehdi Nemati is an Assistant Professor of Environmental Economics and Policy at the School of Public Policy, University of California, Riverside. With a strong focus on applied econometric methods and big data analysis, Dr. Nemati's policy-oriented research centered around economic issues associated with water management. He actively collaborates with government agencies and industry leaders in California and beyond to tackle pressing water policy challenges. Dr. Nemati earned his Ph.D. and master's in agricultural economics from the University of Kentucky. He currently leads the Water Dialogue lab at UC Riverside.

Abstract:
Effect of Subsidence on Property Values in the San Joaquin Valley, California

This study assesses the impact of land subsidence on housing sale values in the San Joaquin Valley, California. The study uses home sale transactions and vertical land-surface displacement data from Interferometric Synthetic Aperture Radar techniques. Using fine-scale fixed effects, matching, and a repeat-sales approach, our results indicate that land subsidence resulted in a 2.4%–5.8% reduction in housing sale values, with the largest reductions occurring in areas where substantial subsidence occurred. Such findings may have implications for groundwater management and can potentially help inform policy design to mitigate the causes and impacts of land subsidence.

Photo Credit: UC Riverside

Thomas M. Scott, Ph.D., P.G.
Sdii-Global

SELECTED AREAS OF SPECIALIZATION
- Florida geology and hydrogeology
- Stratigraphy and sedimentology
- Economic geology and geology of phosphate deposits
- Karst geology
- Geomorphology
- Geology of springs
- Origin, geotechnical properties, and prediction of sinkholes
- Forensic geologic and hydrologic investigations

EDUCATION
Ph.D. Florida State University, Geology
M.S. Eastern Kentucky University, Geology
B.A. University of South Florida, Geology

PROFESSIONAL HISTORY
2016 - Present - Florida Geological Survey Assistant State Geologist Emeritus/Volunteer and Intern
2009 – Present - SDII Global Corporation
1974 – 2009 - Florida Department of Environmental Protection. 1993- 2009 – Professional Geologist Administrator, Assistant State Geologist. 1974-1993 – Geologist II to Senior Geologist/Administrator, Assistant State Geologist

Abstract:
Karst-Related Subsidence in Florida

Subsidence in Florida is primarily related to karst geologic processes. Large areas of Florida's landscape are dominated by karst landforms. Land surface subsidence and sinkhole development of affects infrastructure and individual lives. This presentation will provide an overview of Florida's geology and karst processes. Discussions will include the effect of karst subsidence on Florida's geomorphology and infrastructure, identification of sinkhole activity affecting structures, and remediation processes.

Manoochehr Shirzaei, Ph.D.
Virginia Tech and United Nations University Institute for Water, Health, and Environment

Dr. Manoochehr (Manoo) Shirzaei is a remote sensing and environmental security expert with the Department of Geosciences and National Security Institute at Virginia Tech and United Nations University Institute for Water, Health, and Environment. Dr. Shirzaei specializes in space-borne synthetic aperture radar, groundwater resources management, green energy, and coastal hazards. He has authored over 90 publications in high-profile peer-reviewed journals. Dr. Shirzaei has been a PI and Co-PI on several national-level programs such as the NASA Earth Surface and Interior, NASA Sea Level Change Science Team, NASA GRACE Satellite Science Team, DOE Office of Basic Science, DoD Strategic Environmental Research and Development Program and NSF Earthcube. He is also a member of the Center for Space Science and Engineering Research, the Global Change Center at Virginia Tech, the Southern California Earthquake Center planning committee, and the USGS flood modeling team. Dr. Shirzaei is also the U.S. representative at the UNESCO Land Subsidence International Initiative.

Abstract:
Uneven Ground: Measuring Risk and Inequality on a Sinking Coast

The increasing threat of coastal land subsidence significantly intensifies the vulnerability of coastal cities to flooding and infrastructure damage. In this presentation, I explore advanced remote sensing techniques, particularly Interferometric Synthetic Aperture Radar (InSAR), to enhance the monitoring and assessment of land subsidence and infrastructure stability within coastal metropolitan areas. By integrating satellite-based observations with complementary geophysical methods, I demonstrate scalable approaches to detect ground deformation, evaluate infrastructure integrity, and assess environmental impacts.

Case studies will illustrate the practical applications of these advanced technologies for monitoring subsidence in densely populated coastal regions and critical economic hubs, highlighting their effectiveness in identifying vulnerabilities in both built and natural systems. Additionally, I discuss the importance of multidisciplinary collaboration in advancing geotechnical engineering practices, emphasizing how these innovations support proactive risk management and enhance community resilience.

This presentation aims to foster dialogue on adopting cutting-edge monitoring solutions to tackle complex coastal geosystem challenges and effectively mitigate the associated risks posed by natural hazards.

Ryan Smith, Ph.D.
Colorado State University

Dr. Ryan Smith is an Associate Professor in the Civil and Environmental Engineering Department at Colorado State University. He earned his Ph.D. at Stanford University in Geophysics in 2018, and his B.S. in Geology at Brigham Young University, Utah in 2014. Dr. Smith is a remote sensing hydrologist. He studies groundwater resources and quality at regional and local scales by combining satellite, airborne and ground-based geophysical and in-situ datasets, using both process-based models and machine learning techniques. Dr. Smith's research is funded by NASA, ERDC, NGA, USGS, NIH and NSF. He is the recipient of the AGU Near-Surface Geophysics Early Career Award, and the CSU College of Engineering Early Career Award. For more information on Dr. Smith and his research group, see www.remote-sensing-hydrology.com.

Abstract:

Leveraging Subsidence Data from InSAR to Estimate Groundwater Storage Change in the Western United States

Many aquifers of the world are being depleted, but traditional methods for estimating storage loss can vary by up to an order of magnitude due to uncertainty in aquifer properties and spatio-temporal sparsity of in-situ measurements such as groundwater levels and withdrawals. Satellite observations from Interferometric Synthetic Aperture Radar (InSAR) provide high-resolution estimates of one component of storage loss that could be leveraged for improved estimates of groundwater storage. However, gaps in measurements of other components of groundwater storage challenge efforts to utilize this dataset for improved groundwater monitoring. Here I will discuss multiple frameworks our group has been developing for combining in-situ measurements from wells, including water level and withdrawal data, with InSAR observations to improve estimates of groundwater storage loss. I will also discuss how combining in-situ and InSAR data can enhance physically based groundwater models for improved future projections of storage loss. The methods span regions with both extensive and limited in-situ measurements, offering a path towards improved groundwater monitoring and disaggregating groundwater storage change estimates to confined and unconfined aquifers in several depleted aquifers of the western US, including California, Utah and Colorado.

Photo Credit: Colorado Starte University