

Synopses of Planned Jahns Lectures

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A Case Study of Novel Landslide Activity Recognition Using ALOS-1 InSAR on the Western Hillslope of Ragged Mountain in Gunnison County, Colorado, USA

The “East Muddy Creek Landslide Complex” in Gunnison County, Colorado, destroyed Colorado State Highway 133 between 1986 and 1987 and has been studied for decades during periods of reactivation. This project presents a case study on advanced detection of landslide activity using Advanced Land Observing Satellite-1 (ALOS-1) Interferometric Synthetic Aperture Radar (InSAR) analysis. We compare these results with traditional field investigations of ground motion across a watershed. Line-of-Sight (LOS) velocity mapping helps characterize displacement zones, failure modes, and hazard levels. We also discuss mass-wasting estimates derived from existing geological models and their implications for landslide dynamics. ALOS-1 InSAR reveals new ground displacement at very slow to extremely slow velocities, covering a much larger area than in situ monitoring. The study explores how this increased displacement affects landslide geomorphology, mountain erosion, exhumation, and future hazard monitoring and risk assessment.

GIS-Based Landslide (and Debris Flow) Susceptibility Analyses: Case Studies at Different Scales

Landslide hazards occur worldwide and cause thousands of deaths each year. Furthermore, landslides are often triggered by other newsworthy hazards, such as earthquakes and hurricanes. As a result, the economic losses from landslides are generally greater than those recognized. With advances in geographic information systems (GIS), landslide hazards can be analyzed at different scales in a time- and cost-efficient manner. However, methods must be selected carefully with respect to the study’s scale to fully leverage GIS. This project focuses on landslide susceptibility analysis at different scales using different GIS-based methods through case studies. The results of the GIS-based landslide susceptibility studies can be used to direct limited resources to areas in need of detailed research and mitigation, which is beyond the scope of this project.

Monitoring Ground Subsidence from Underground Excavation or Tunneling in Urban Environments Using Advanced InSAR Techniques

Ground subsidence is the downward movement of the ground surface caused by natural processes or human activities. When Earth materials are extracted from underground, rock or soil can collapse into voids due to a loss of support. This process redistributes stress and strain within the rock mass and soil, damaging above-ground infrastructure such as roads, buildings, utility lines, and pipelines. Ground subsidence resulting from underground excavation or tunneling must remain within tolerable limits to prevent damage to surface structures. Therefore, monitoring tunnel-induced ground settlements is essential, especially in urban environments. Researchers and practitioners have studied tunnel-induced ground subsidence using various methods, including in situ monitoring, analytical or numerical modeling, and Interferometric Synthetic Aperture Radar (InSAR) monitoring, and have demonstrated its applications in a few recent case studies conducted at the Colorado School of Mines. Our case studies demonstrate that InSAR complements conventional methods for measuring ground subsidence. Because SAR satellite images are collected regularly, InSAR could serve as a routine monitoring technique for ground subsidence induced by underground excavation and tunneling in urban environments.

Sustainability of Earth Dams and Levees (EDLs): Case Studies in the Lower Mississippi Valley, USA, and Rhine–Meuse Delta, Netherlands

Earth Dams and Levees (EDLs) provide important societal benefits by storing clean water, preventing floods, and supporting renewable energy efforts. However, they also have adverse environmental impacts, including disconnecting rivers from floodplains and disrupting natural hydrology and ecosystems. This research aims to improve predictions of levee sustainability by examining the environmental characteristics around them. Backward erosion piping (BEP), a common internal erosion failure mode along levees, remains difficult to predict despite more than a century of study. This work introduces new analytical methods to improve the prediction of BEP initiation, with broad applicability.

Formation Process of a Large Paleolandslide-dammed Lake and Sedimentary Evidence of Outburst Deposits on the Southeastern Tibetan Plateau: Constraints from OSL and ^{14}C Dating

A large number of landslide dams on major rivers along the southeastern margin of the Tibetan Plateau have been identified through remote sensing and field investigations. This research indicates that during the prehistoric era (approximately 30 ka BP), a significant damming event occurred in the upper Minjiang River at the southeastern edge of the Tibetan Plateau, forming a large lake. Major landslides triggered by paleoseismic activity likely directly caused the river damming. The dam eventually failed, leading to a substantial outburst flood approximately 27,000 years ago. In the area of the ancient dam and the downstream zone within 5 km, numerous diamicts—poorly sorted deposits with a wide variety of particles, including gravel, sand, and smaller amounts of silt and clay—have been identified.

Flood Hazards in the Context of Land Use and Land Cover and Communities at the Intersection of Flood Risk and Social Vulnerability: Case Studies in Lagos, Nigeria, and New Orleans, USA

Urban flooding is becoming more frequent and severe due to climate change, underscoring the urgent need for effective flood risk management. Furthermore, population growth, increased urbanization, and accelerating urban expansion rates are worsening the situation. In the Nigerian case study, Land Use and Land Cover (LULC) changes over time are examined in the context of flood hazard mapping to evaluate the correlation between poorly planned land use and increased flooding in the State over 35 years. In the New Orleans case study, social vulnerability was evaluated at the census-tract level using a 16-parameter matrix, alongside flood risk assessments. This research also explores the spatial patterns of socially vulnerable neighborhoods and how they have changed over the past two decades. The findings of these studies demonstrate how integrated data-driven analysis can inform better land-use planning, urban infrastructure, and policy development, thereby promoting discussions on urban resilience and a nuanced understanding of interactions between urban settings and flood risks, potentially aiding the implementation of adaptive strategies to build resilience in urban communities.

Design and Construction of a Centralized Geospatial Infrastructure for Geological, Surface Water, Groundwater, and Dynamic System Models for the Piceance Basin, Northwestern Colorado

This project focuses on designing and constructing a centralized geospatial infrastructure to manage large volumes of baseline data on geology and water resources and to establish frameworks for analytical and numerical models, including, but not limited to, three-dimensional (3D) geologic, energy resource development, and surface water models. This infrastructure enables direct generation of model inputs from the same database and indirect coupling of different models through their inputs and outputs. This approach ensures consistency across analyses conducted by researchers from different institutions and helps decision-makers balance the water budget based on the spatial distribution of water resources and the spatial variations in the basin's geologic, topographic, and hydrogeologic characteristics.

Short talks on

- Ground-based Interferometric Radar (GBIR) for Monitoring a Slow-moving, Translational-failure Landslide in Granby, Colorado, USA.
- Comparison of Two Logistic Regression Models for Landslide Susceptibility Analysis: A Case Study in Colorado Springs, Colorado, USA
- Assessment of Debris-Flow Susceptibility in Mining Communities in Peru Using Different Logistic Regression Models for Source and Depositional Areas
- Mapping and Analysis of the Rio Chama Rockslide and Landslide, and Evaluation of Regional Landslide Susceptibility, Archuleta County, Colorado
- Effectiveness of Predicting Tunneling-induced Ground Settlements Using Machine Learning Methods on Small Datasets
- Uncertainty Assessment for 3D Geologic Modeling of Fault Zones Using Geologic Inputs and Prior Knowledge
- GIS-based Nitrogen Removal Model for Assessing Florida's Surficial Aquifer Vulnerability