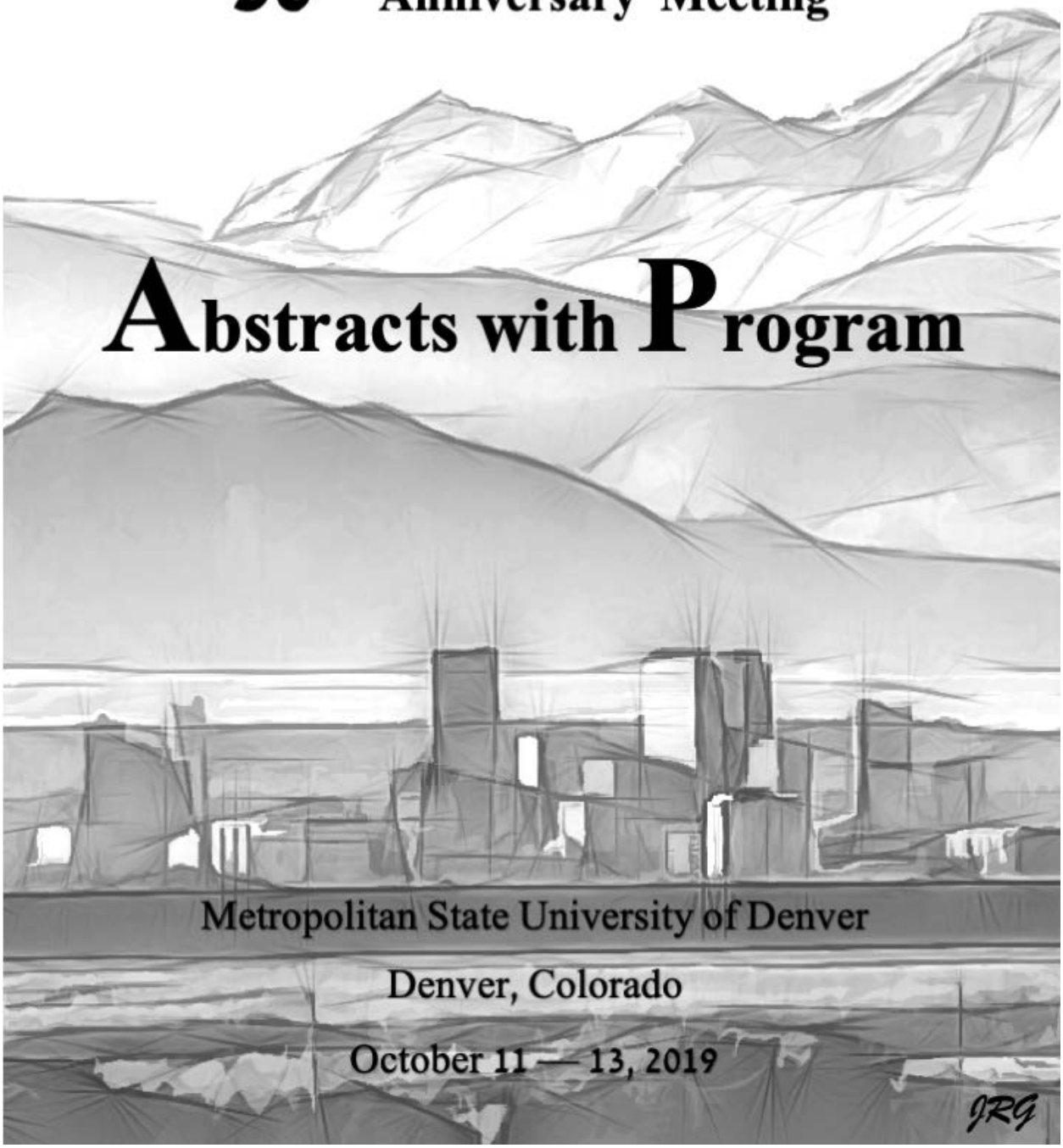
Binghamton Geomorphology Symposium

50th Anniversary Meeting



Abstracts with Program

Metropolitan State University of Denver

Denver, Colorado

October 11 — 13, 2019

JRG

Welcome to Metropolitan State University of Denver and the 50th annual meeting of the Binghamton Geomorphology Symposium!

The 50th Binghamton Geomorphology Symposium (BGS) will provide a perspective of geomorphology from its historical past to potential advancements in the future. The BGS: 50 years of enhancing geomorphology will have six main themes based on the foundation of topics presented at the previous symposia. Themes include:

- Forces 1 – Glacial, fluvial, and Periglacial;
- Forces 2 – Tectonics and Gravity;
- Biogeomorphology and Soils;
- Concepts and Paradigms;
- Anthropogenic influences; and
- Applications.

Each theme will have an introductory perspective talk and will provide a perspective of how the BGS has advanced the research frontier. This will be followed by several presentations that will focus on the present and future state of research related to the BGS themes.

Conference website: http://sites.msudenver.edu/jjanke1/
Twitter: BGS50Denver @Bgs50D
Instagram: bgs50denver
Email: bgs50denver@gmail.com

Jason Janke, Associate Dean, College of Letters, Arts and Sciences, Metropolitan State University of Denver jjanke1@msudenver.edu

John (Rick) Giardino, Professor of Geology & Geophysics and Water Management and Hydrological Science, Texas A&M University rickg@tamu.edu

John (Jack) Vitek, Professor Emerita, Texas A&M University jvitek@tamu.edu

Logistics

The conference will be held at three different locations on campus. Please see the attached map and presentation schedule to confirm locations.

SpringHill Suites conference center (Salon A, B, & C)

- Evening reception (10/11) - Rocky Mountain Rendezvous Event 1
- Lunch and Poster session A (10/12) - Rocky Mountain Rendezvous Event 2
- Dinner and Banquet Speaker (10/12)

Science Building

- All invited speaker presentations will take place in Science building room 1067. (10/12 & 10/13)
- To access the building, it is easiest to head south from the hotel and pass through North classroom.

Tivoli Turnhalle

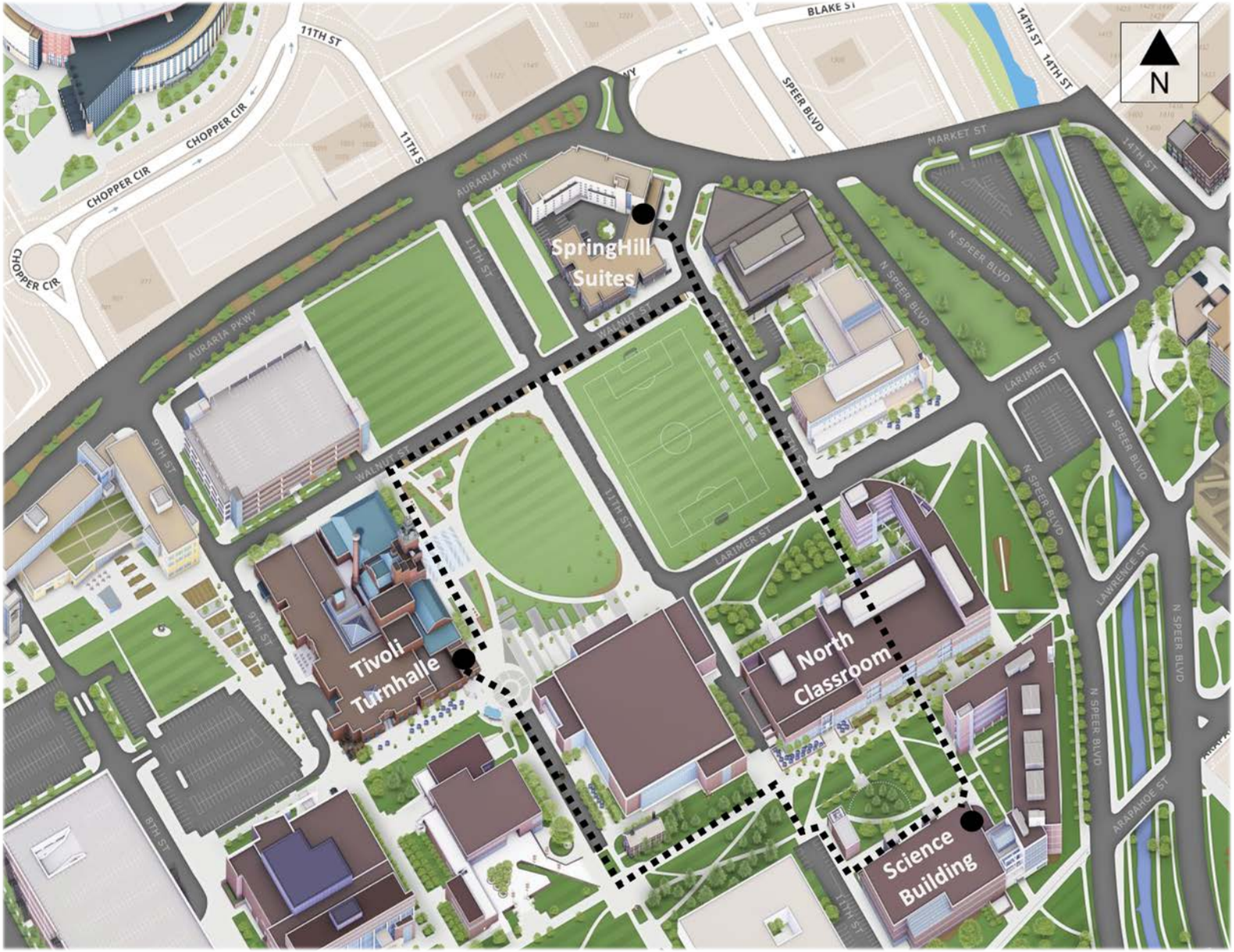
- Poster session B (10/12) - Rocky Mountain Rendezvous Event 3

Rocky Mountain Rendezvous Events

In the Rocky Mountains, the early fur trappers would meet in the fall at various locations for fellowship and to discuss the success of their trapping as well as share new areas and techniques. These meetings were referred to as a "Rendezvous." Borrowing from this idea and playing on the word, we have created a "Rocky Mountain Rendezvous" peer-mentoring series to connect students and senior researchers. Collect stickers on the Trapper's log to collect your souvenir at the end of the conference.

Date	Time	Theme/Event	Title	Presenter	Location
10/11/19	7:30 – 5:00	Field trip to Rocky Mountain National Park			
	6:00 – 7:00	Pick-up Conference Materials			
	7:00 – 9:00	*Rocky Mountain Rendezvous Event 1*			Salon A&B&C
10/12/19	7:00 – 8:15	Pick-up Conference Materials			IMA Reception Hall
	8:15 – 8:30	Introduction			
	8:30 – 9:00	Forces 1 - Water, Wind, Waves and Ice	*Water, Wind, Waves and Ice Reshaped Geomorphology: A Review*	Gardner	Science 1067
	9:00 – 9:30		*Struggles with Stream Power: Connecting Theory across Scales*	Venditti et al.	
	9:30 – 10:00		*Vignettes for Wind-Blown Sand: The Persistent Vexations*	Sherman	
	10:00 – 10:15	*Coffee Break*			
	10:15 – 10:45		*Trends in Research on Beaches and Dunes on Sandy Shores, 1969-2019*	Jackson & Nordstrom	Science 1067
	10:45 – 11:15		*Constraining Dates and Rates of Geomorphic Processes using Luminescence Techniques: From Past Applications to Recent Advances and Future Avenues for Development*	Rittenour	
	11:15 – 11:30	Discussion			
	11:30 – 1:00	*Rocky Mountain Rendezvous Event 2 - Poster session & Lunch*			Salon A&B&C
	1:00 – 1:30	Forces 2 - Planetary Geomorphology/Tectonics/Gravity	*Wind-Blown Landscapes in the Solar System*	Ewing	Science 1067
	1:30 – 2:00		*Geomorphological Debates in Japan related to Surface Processes, Tectonics, Climates, Research Principles, and International Geomorphology*	Oguchi	
	2:00 – 2:30		*Detailed Mapping of Shallow Landslides in Eastern Oklahoma and Potential Triggering by Oklahoma Earthquakes*	Regmi & Walter	
	2:30 – 2:45	Discussion			
	2:45 – 3:00	*Refreshment Break*			
	3:00 – 3:30	Biogeomorphology and Soils	*Biogeomorphology: Past, Present and Future*	Viles	Science 1067
	3:30 – 4:00		*Critical Zone Geomorphology in the Anthropocene: Back to the Future*	Granados-Aguilar et al.	
	4:00 – 4:15	Discussion			
	4:30 – 6:15	*Rocky Mountain Rendezvous - Event 3*			Tivoli Turnhalle
	6:30 – 8:30	Dinner Presentation by Vic Baker	*The Modern Evolution of Geomorphology - Binghamton and Personal Perspectives, 1970-2019 and Beyond*		Salon A&B&C

10/13/19	8:00 – 8:30	Concepts/Paradigms/Field tradition	*Portable controlled Field Experiments to Resolve Human Impacts in Geomorphology*	Marston et al.	Science 1067
	8:30 – 9:00		*The Camera and the Geomorphologist*	Fonstad	
	9:00 – 9:15	Discussion			
	9:15 – 9:30	*Coffee Break*			
	9:30 – 10:00	Anthropogenic Influences	*The Human Impact in Geomorphology – 50 Years of Change*	Goudie	Science 1067
	10:00 – 10:30		*Rivers in the Anthropocene: The U.S. Perspective*	Wohl	
	10:30 – 11:00	Applications	*Applications in Geomorphology*	Keller et al.	Science 1067
	11:00 – 11:30		*Changing Landscapes: Five Decades of Applied Geomorphology*	Hooke	
	11:30 – 11:45	Discussion			
	11:45 - 1:00	Steering Committee Meeting			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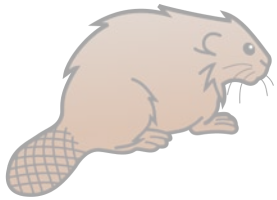
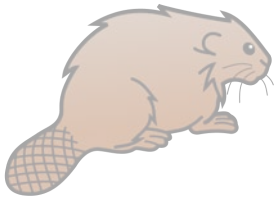
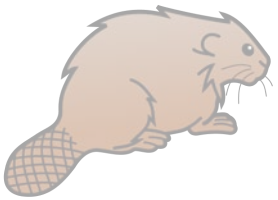
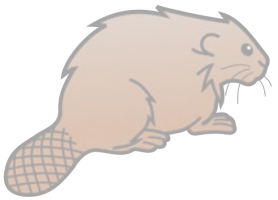
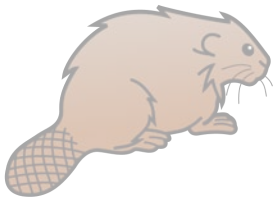
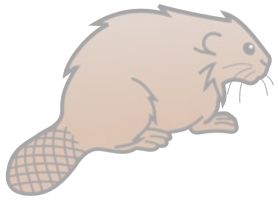
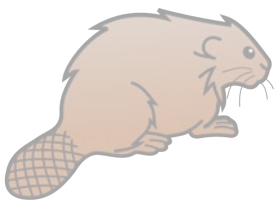
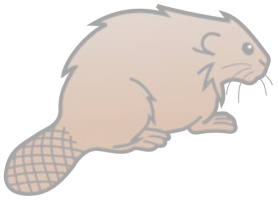
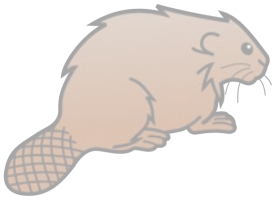
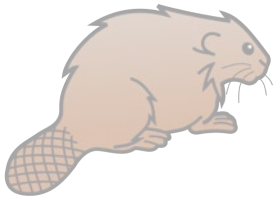
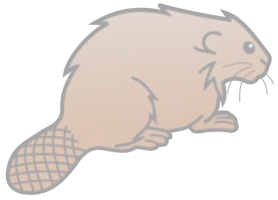
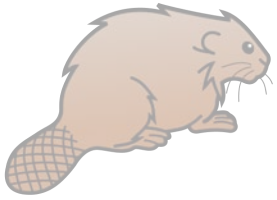
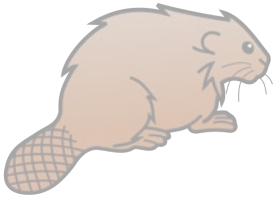
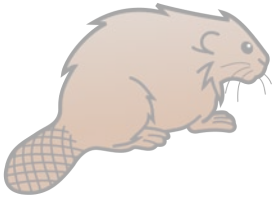
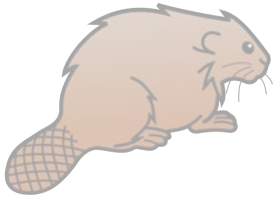
Trapper's log

Gather stamps to collect your conference souvenir!

Water, Wind, Waves and Ice Reshaped Geomorphology: A Review

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Keywords: Fluvial, Aeolian, Coastal, Glacial

Research over approximately 200 yr on the geomorphic effects of the force of water, wind, waves and ice is reviewed. In a changed scientific, technological, institutional and socio-political context, several trends emerge. Increased focus on measurement of processes from the 1930s onwards was facilitated by new technologies, leading eventually to a blurring of disciplinary boundaries and the emergence of geomorphology as an Earth system science. Human impact research and applications have blossomed and are contributing to an emerging understanding of the Anthropocene. Absolute dating techniques have reinvigorated landform and landscape evolution research, while remote sensing and geospatial science generally have enhanced observation, measurement and modelling of terrestrial and planetary surface and subsurface forms and processes. The historical record demonstrates that geomorphology has attained scientific vigour and societal relevance through fascinating journeys of curiosity, exploration, mapping, measurement, modelling and explanation.

Struggles with stream power: Connecting theory across scales

Authors: Jeremy George Venditti[1], Tingan Li[1], Eric Deal[2], Elizabeth Dingle[1], and Mike Church[3]

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Keywords: Bedrock, Rivers, Erosion, Stream Power Law, Scientific laws

Two empirically consistent explanations exist for the morphology and dynamics of bedrock rivers. The stream power law appears to explain rates of rock incision at large scale (large drainage basins or landscape scale), but appears to be of limited value in predicting reach-scale morphology and dynamics. The underlying reason why stream power is such an effective tool for understanding landscape evolution is because it is an explicit representation of the inverse power relation between slope and area in rivers incising bedrock. This morphometric relation is nearly universal, subject to exogenous contingencies. Independent testing and validation of the stream power incision model is challenging because of the contingencies that exist in almost all landscapes. Mechanistic models of erosion have been tested and validated at small scales, generally below the reach scale, and opportunities exist for independent testing and validation by using them to predict reach-scale morphologies. Predicting larger scale bedrock river morphology requires the assumption that flow, sediment fluxes and bedrock erosion processes that occur at smaller scale are adequately averaged at larger scales, which is not well supported. Reconciling these two scales of explanation is one of the grand challenges of fluvial geomorphology, unless we accept that theory and explanations will be scale-delimited.

Vignettes for wind-blown sand: the persistent vexations

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Keywords: Aeolian, Transport, Model Uncertainty

The study of aeolian geomorphological systems over the last half century has advanced along several important fronts. Understanding of dust emission, transport, and deposition has improved substantially, supported by developments in remote sensing technologies and analyses and the evolution of modeling approaches. Remote sensing has led to a wealth of knowledge concerning the distribution and dynamics of dunes on Earth and elsewhere, and specialized wind tunnels have elucidated the roles of aeolian processes in reshaping extraterrestrial surfaces. Improvements in laboratory and field instrumentation allows measurement of aeolian sand transport systems at levels of detail unimaginable when the Binghamton Geomorphology Symposium began. We have seen the advent of large, sophisticated field campaigns and advanced modeling approaches using cellular automaton and computational fluid dynamics methods. We have not seen proportional advances in our ability to predict rates of sand transport in natural environments, one of the most basic challenges. This review treats five, principle theoretical and empirical vexations that have made sand transport an intractable problem: predicting rates of transport; predicting threshold of motion; predicting slope effects; quantifying the effects of sand moisture content; and quantifying vegetation effects. In ideal transport environments only the first two vexations warrant attention. In natural environments, such as a coastal dune, all five vexations are liable to be in play. At least eight, commonly-cited sand transport rate models do not agree with each other and do not replicate field observations. Nested within most of those models is a threshold term also derived for perfect conditions never met in the field, with imprecise definitions of threshold and assumptions of uniform sands and steady wind. Damp sands, with increased resistance to transport, are common in many environments. Theoretical and empirical obstacles have precluded a commonly accepted correction to a transport model. Even greater complications arise when trying to quantify the two and three dimensional effects of surface slopes and vegetation on wind flow and consequent impacts on sand transport. The effect, models, methods, and vexation of each of these are summarized, and a next-generation of vexations described.

Trends in Research on Beaches and Dunes on Sandy Shores, 1969-2019

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Keywords: Barrier Islands, Beach-dune Interaction, Developed Coasts, Morphodynamics, Sediment Transport

Trends in research on morphologic changes on beaches and foredunes on sandy shores are identified from the 1960s to the present. Research during this period evolved from early descriptive explanation and classification of profile change, to instrumented field investigations, to modelling of landform change at larger scales. Research efforts have become increasingly more collaborative, with increasing use of field instrumentation, data acquisition systems and remote sensing. Rich datasets are resulting in more comprehensive computational models. Human-altered systems are of increasing interest, but knowledge of these systems lags far behind knowledge of natural systems. Research is becoming more relevant to societal needs as the vulnerability of coastal populations increases. The need for investigation of understudied or unexplored environments, including human altered ones, is ongoing. Many basic research issues remain, but future studies would profit from the development of new models rather than validating or reconfiguring old models. Collaboration between geomorphologists and engineers may open up research opportunities, particularly in modifying beaches and dunes built for shore protection to provide natural values in restricted space. Application of models to enhance knowledge of effects of sea level rise and coastal storms would be useful to managers developing resiliency plans.

Constraining Dates and Rates of Geomorphic Processes using Luminescence Techniques: From Past Applications to Recent Advances and Future Avenues for Development

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Keywords: Dating Methods, Luminescence, Transport

Luminescence techniques provide an age estimate of the last time quartz and feldspar minerals were exposed to light or heat. Over the last 50 years, dating methods have evolved from early thermoluminescence (TL) to more refined optically stimulated luminescence (OSL) techniques. Modern applications use small aliquots (20-100 grains) to single-grain analysis and include age distribution models such as the minimum age and finite mixing model. Advancements in methodologies and instrumentation has allowed a wide range of deposits and archaeological materials to be dated including new applications to rock surfaces. Advances in characterization of the luminescence signal properties has also allowed for applications related to sediment source fingerprinting and qualification of transport distance. Recently developed thermochonometric trapped-charge methods allow determination of past fire exposure and exhumation rates. Applications of luminescence techniques to provide dates and dates of geomorphic processes are presented with a focus on recent advances and future avenues for development.

Wind-blown landscapes in the Solar System

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Keywords: Planetary Geomorphology, Wind-blown Systems, Exotic Conditions

Planetary exploration missions to Mars, Jupiter, Saturn, Pluto, comet 67p/churyumov-gerasimenko, Ryugu, and Bennu over the last 15 years have made the Solar System seem more like a familiar neighborhood than science fiction. Landscaped shaped by glacial, fluvial, eolian, periglacial, mass wasting, and weathering processes abound. Analysis of such landscapes using familiar datasets such as optical images, digital elevation models, and multi- and hyperspectral data show that, by-in-large, Earth-based geomorphic approaches can be used to assess the rates, fluxes, magnitudes of these processes. However, several cases demonstrate that new and creative approaches are required to understand geomorphology of landscapes formed in exotic boundary conditions. Wind-sculpted landscapes discovered on Venus, Mars, Titan (moon of Saturn), Pluto, and comet 67p/churyumov-gerasimenko demonstrate familiar patterns that require exotic explanations. The robustness of wind-blown bed form (dunes and ripples) development across a wide range of planetary boundary conditions (e.g., gravity and air density) requires both traditional and new approaches to explain their origins. Further, the existence of bed forms in such wide-ranging conditions challenges the notion of typical boundaries between fluvial and eolian transport systems. This abstract focuses on atmosphere-solid surface interactions discovered during recent planetary exploration missions. Current and future planetary exploration missions and opportunities for the geomorphology community will be discussed.

Geomorphological debates in Japan related to surface processes, tectonics, climate, research principles, and international geomorphology

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Keywords: History of Geomorphology, Scientific Debates, Imported Ideas, Japan

Debates contribute to the development of science and technology. This is also the case with geomorphology, and past geomorphological debates in countries like Japan were often related to concepts and methods imported from western countries in Europe and North America, where advanced studies tended to be conducted. Applications of imported ideas often led to debates because some researchers thought the applications were successful, but some others did not, and indicated problems including the neglect of differences in the local environment between Japan and the West. Therefore, the history of geomorphological debates in Japan is not a mere national issue but informative in discussing international exchange of geomorphological thoughts and global diversity in geomorphological environments. This paper provides a review of geomorphological debates in Japan with attention to geomorphic processes, climates, tectonics, research principles, and international geomorphology. The examined representative debates concern 1) effects of glaciers versus mass movements and running water, 2) effects of periglacial processes versus mass movements and running water, 3) effects of tectonics versus climates, and 4) descriptive/historical geomorphology versus process geomorphology. Classic geomorphological studies in Japan, mostly published in Japanese and, thus, not well-known to international communities, are introduced here. The relations with international geomorphology are also discussed in relation to the progress and consequences of the geomorphological debates.

Detailed Mapping of Shallow Landslides in Eastern Oklahoma and Western Arkansas and Potential Triggering by Oklahoma Earthquakes

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Keywords: Eastern Oklahoma, Shallow Landslides, LiDAR Data, Surface Roughness

Landslides have long been considered one of the main erosive drivers that sculpt hillslopes over time. Tectonic forces raise slopes that can be sculpted by climate and the degree to which they can be sculpted depends upon the underlying lithology and hillslope geomorphology. Landslides destroy life and property and contribute to the evolution of mountain landscapes by generating and transporting hillslope sediments. In this study, we investigate the dynamics of soil-mantled hillslopes in eastern Oklahoma and western Arkansas, USA, by mapping shallow landslides, evaluating the frequency and magnitude of the landslides, and quantifying the surface geometries.

We mapped 185 shallow landslides in a 150 km2 area. The approximate ages of landslides and the frequencies and magnitudes (area, volume and runout) were estimated using historical aerial photographs. The landslide database was then used to compute rate of landslide occurrence and sediment yield. In addition, landslide surface geometries, including slope, curvature and surface roughness, were determined from 10 m NED and 2 m LiDAR elevation data. The hillslope susceptibility studies, derived from elevation data, were augmented by our review of common historical accounts that link landslides in the study region to the 1952 M 5.4 El Reno, Oklahoma earthquake ~300 km away. In light of that case study, we determined the frequency of historical earthquakes that impart >2 kPa dynamic stresses for the study area since 1900 and find an increased potential for dynamic stress perturbation of landslide activity since ~2010. All these characteristics were then evaluated to understand the dynamics of hillslopes and hillslope susceptibility to shallow landslides.

Frequency assessment of mapped landslides suggested that frequency of landslides increased significantly during 2005-2016 compared to 1995-2005. On average ~10 shallow landslides occurred every year during 2005-2016. These landslides alone contributed ~1.5×105 m3/yr (sediment yield rate: ~0.10 mm/yr) of sediments. Surface roughness values were relatively higher in landslide areas compared to that of surrounding non-landslide areas. The surface roughness index mapped ~84% of observed landslides, and suggests that the index could be used to map hillslope susceptibility to landslides for future planned studies.

Biogeomorphology: Past, Present and Future

Authors: Heather Viles

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Keywords: Ecogeomorphology, Zoogeomorphology, Ecosystem Engineering

Since the 1970s there has been a considerable expansion in biogeomorphological research which considers the complex, two-way relationships between biological, ecological and geomorphological systems over a wide range of spatial and temporal scales. Advances have been made in theoretical, methodological, thematic and applied aspects of biogeomorphology. A review of key publications and symposia over the period illustrates growth in biogeomorphology with particular advances in quantitative understandings of biogeomorphic interactions, in interdisciplinary participation, and in theoretical framings. Theoretical advances have been influenced by the desire to answer four fundamental questions: How do ecological and geomorphological systems interact? Is there a geomorphological signature of life? How important is biodiversity to landscape evolution and vice versa? How have life and landscape co-evolved? A review of methodological advances in biogeomorphology confirms the continuing importance of field monitoring, and the increasingly tight collaboration between experimental and modelling-based research. Thematically, particularly strong progress has been made in disentangling the complex bidirectional biogeomorphic interactions in coastal sedimentary environments, and fluvial and riparian systems. It is increasingly obvious that variation in ecological traits leads to large differences in biogeomorphic impacts of different species in different circumstances. This poses challenges for applications of biogeomorphology to environmental management and conservation. Seven key topics emerge from this review and provide the basis for a biogeomorphological research agenda to usher in the next 50 years of progress.

Critical zone geomorphology in the Anthropocene: Back to the Future

Authors: Raquel Granados-Aguilar, Rebecca Owens, and John R. Giardino

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Keywords: Critical Zone, Anthropocene, Anthropogeomorphology, Global Change

Studying and understanding geomorphic processes in the Anthropocene requires new conceptual models, as well as a strong technology-assisted approach. Two major factors are unmanned aerial vehicles (UAV, drones) and artificial intelligence-driven machine learning for landscape mapping. Drones have become a staple of remote-sensing centered field work. Machine-Learning assisted mapping is used in applications including hazard assessment, oil and gas exploration, and automatic landform detection from planetary imagery. This trend will continue especially with increased planetary exploration and mapping. The rapid increase in human population, which is causing a brisk spread of built environments over the surface of Earth, is catapulting anthropogenic geomorphic processes to a dominant role in the Anthropocene. The critical zone concept was introduced by the National Research Council to address the increasing role of human impact on Earth surface processes, especially on life sustaining resources. The critical zone was originally defined as extending from the bottom of the groundwater aquifer to the top of the vegetative canopy, but the definition has since been modified to include atmospheric components. Water drives and connects geomorphic processes from the atmosphere to the subsurface and thus is the connecting thread through each critical zone component. Critical zone observatories have been established around the world to enable interdisciplinary research focus on the various systems across temporal and spatial scales, and to facilitate the collection of site-specific relevant data from a wide range of environmental systems. The study of systems is well-grounded in geomorphology since Chorley introduced the system concept in 1962 and is experiencing renewed focus with the introduction of the critical zone concept. This approach is a necessity for studying geomorphic processes in the Anthropocene epoch. Based on our review of the literature along an optic of the future, we think climate change and land cover change driven by human activity are currently and will continue to disturb the rate and occurrence of geomorphic processes. These will make it increasingly difficult to predict and manage the risks associated with catastrophic events. We think that the impact on geomorphic processes extending from weathering to changing rates of erosion and deposition will continue to expand. Changing climatic conditions are increasing and will continue to increase in the future thus enhancing climate variability and delivery of water to the critical zone as well as causing an absence of water and expansion of arid lands. Land cover change is also decreasing infiltration, armoring some surfaces, increasing surface runoff and enhancing rates of erosion and will continue to expand in the future. Thus, the benefit of using the geomorphic lens to study the critical zone will result in a broad, unified interdisciplinary study of the Anthropocene.

The Modern Evolution of Geomorphology - Binghamton and Personal Perspectives, 1970-2019 and Beyond

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Keywords: Geomorphology, History, Philosophy, Processes

The annual Binghamton Geomorphology Symposia (BGS) began in 1970, initiated by Professors Donald R. Coates and Marie Morisawa of the State University of New York at Binghamton. The 50 BGS meeting topics through 2019 can be organized into five general themes, as follows: (1) Applications; (2) Methods; (3) Process and Form; (4) History, Philosophy, and Theory; (5) Systems. My own geomorphological research can be divided among these themes, though it has not always been in tune with any prevailing paradigm. The experience of the BGS meetings suggests that the immediate future of geomorphology will follow current trends involving technological advances in such areas as geochronology, geospatial analysis, lidar mapping, computer simulation, and systems-based predictive modeling. For the longer term it may be that the research frontiers will lie in outer and inner space, with the former involving the discovery and analysis of the surfaces of Earth-like planets within and beyond our own solar system. The challenges of inner space may be even more profound as they are imposed against the background of rapidly accelerating advances in artificial intelligence.

Portable controlled Field Experiments to Resolve Human Impacts in Geomorphology

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Keywords: Portable Rain Simulators, Wind Tunnels, Field Work

Geomorphologists have long been challenged by the need to separate the impact of human activities from change that would have occurred without human interference. One research strategy is to utilize controlled field experiments, in which the magnitude and frequency of driving forces (e.g., rain or wind) can be set and it is possible to sample the landscape according to the variety in natural variables and human effects. This paper reviews the use of portable field rainfall simulators and portable field wind tunnels, with two case studies explored in detail. The first case study involves a portable field rainfall simulator that was used to examine magnitude and persistence of erosional impacts from wildfires in the Greater Yellowstone Ecosystem. The second case study involves a portable field wind tunnel that was used to examine impacts on sand transport rates from military maneuvers on the Fort Bliss Military Reservation in southern New Mexico. Both pieces of equipment proved ideal for hypothesis testing and yielded results that could not have been easily achieved by other research strategies.

The Camera and the Geomorphologist

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Keywords: Camera, Photography, Data Collection Tool

The methods we use to produce geomorphic data are deeply interwoven with the geomorphic questions we choose to ask, and with the geomorphic theories we construct. Authors have described major changes in the history of geomorphology in terms of theoretical shifts and/or social-cultural changes, but it seems clear that shifts in methodological practices also can produce deep changes in geomorphology as a whole. The camera has had a long, illustrious, and complex history as a geomorphic tool, and as such is useful for assessing larger geomorphological concerns and themes. The camera is also a symbol of the ongoing revolution in geomorphology from a data-poor to a data-rich subject; this revolution is built upon many methodological changes, and it has had many side-effects. The interrelated history of cameras and fluvial geomorphology provides an illuminating case study in past and present changes in the geomorphic sciences. Some past geomorphic practices, such as using photos as descriptive evidence for verifying geomorphic theory, remain as important approaches today. Other camera-based practices have dwindled, such as the production of large-area topographic maps through traditional aerial-photogrammetry, which have been overtaken by alternative methods such as Lidar and interferometric radar. And newer camera-based techniques, such as structure from motion photogrammetry, are at the heart of the recent democratization of geomorphic data. As the modern data revolution progresses, it is important to ask questions such as "who has been part of the data revolution, and what have been their motivations?" and "have winners and losers been produced as part of the data revolution?" Not all effects of the data revolution have been completely positive; many geomorphologists feel overwhelmed by big data expectations and methodological concerns. From a philosophy of science perspective, the moves toward population-like geomorphic data have strained "normal" inductive inference procedures, and recent research has brought to light inferential alternatives such as advanced data mining and the hypothetical-deductive approach. Even so, most current analytical techniques appear to be lagging behind their newly-introduced big data, producing "new wine in old bottles:" new data for old analyses. Beyond pure geomorphic research, the camera and its derivatives are also part of profound shifts in educational and outreach expectations and practices. Clearly, the data revolution in geomorphology is still in its infancy, and much of that revolution has been wrought by the humble camera.

The Human Impact in Geomorphology – 50 years of change

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Keywords: Anthropocene, Global Change, Great Acceleration, Global Warming

Concern with the human impact in Geomorphology has a long history. What is new is that since 1969 a number of developments have taken place which have led to an increasing realisation of its importance. These developments are in four main areas: (i) intellectual and policy-related; (ii) technological developments that alter geomorphological processes (iii) demographic trends; and (iv) the proliferation of techniques for the study of landform and process change. There has been a realisation of the role of humans in landscape transformation in ancient times. The human impact has developed through time, but particularly notable are the potential early effects of fire, extinctions and deforestation on geomorphological processes. The spread of European agriculture, particularly in the nineteenth century, transformed erosion and sedimentation rates in many parts of the world. Notwithstanding the importance of some of these changes in prehistoric and historic times, recent researches have demonstrated that humans have become an increasingly important agent of geomorphological change during the period of the Great Acceleration of the past five or six decades. The interest in global warming that has developed since the early 1980s has created considerable interest in its consequences for a range of geomorphological phenomena. It is also becoming apparent that anthropogenic geomorphological change is having an impact on the Earth System as a whole. Finally, Geomorphologists have taken an increasing interest in how they can make an impact in the field of landscape conservation.

Rivers in the Anthropocene: the U.S. Perspective

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Keywords: Flow Regulation, Large Wood, Legacy Sediment, River Restoration

During the past 50 years, the number and variety of papers written by U.S. fluvial geomorphologists that examine human alterations of rivers has accelerated substantially. From an initial focus primarily on how human-induced changes in land cover influence sediment yield and river dynamics, the literature has expanded to emphasize the effects of flow regulation, channel engineering, removal of large wood and beavers, and changing climate. These multiple human influences are now widely recognized to have resulted in global-scale cumulative effects including significantly altered fluxes of water, sediment, nitrogen, and carbon, and complete transformation of river networks across much of the planet. One outgrowth of this recognition is the increasing involvement of geomorphologists in diverse forms of river restoration, a form of river management that thus far has largely been dominated by engineers. Acknowledging the ubiquity of human alteration of rivers implies that (i) investigators cannot assume that even the most remote and seemingly pristine river segment has not been affected at least indirectly by people, (ii) the use of reference conditions requires careful consideration with respect to what reference sites indicate about past conditions, as well as their relevance for the future, (iii) detailed geomorphic understanding of the nature and timing of past human alterations of rivers is likely to be critical to effective restoration, and (iv) each scientist must decide how to engage within the context of research and advocacy with the issues of ecosystem degradation and loss of river form and function.

Applications in Geomorphology

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Keywords: Applications in Geomorphology, Wildfire-Debris Flow Cycle, Hazard Reduction, Assessment, and Perception, Boulder Geomorphology

Geomorphology is a pure science with the goal of understanding earth surface processes and landscape evolution, and it is also an applied science with the goal of addressing the needs of society. With many new high-resolution methods of depicting topography and much improved numerical dating, geomorphologists are working on problems involving rates of surface processes, landscape evolution, and applications to areas of concern to society that were impossible to address a few decades ago.

Some of the areas of enquiry where geomorphology has been applied include: natural hazards (landslides, floods, earthquakes, and tsunamis), ecosystem management, site anthropology, land use planning, engineering geology, expert witness testimony, and hazard reduction, assessment, and perception. How people perceive and respond to potential hazards, how their vulnerability can increase their risk, and how preparedness and response can be improved depends as much on the social sciences as on physical science.

Changing Landscapes: Five Decades of Applied Geomorphology

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Keywords: Applied Geomorphology, Sustainable Environmental Management, River and Coastal Management, Working with Nature

Much geomorphological research has potential to be applied but this paper examines the extent and nature of actual applications to environmental management. It reviews how this work has expanded and changed and reflects on the stimuli, types of involvement, and attitudes. These aspects, and how geomorphology can be applied effectively, are exemplified by developments in coastal and river management in the UK, highlighting the contributions made by geomorphology to sustainable strategies. Applied geomorphology has been recognised as a topic and component within geomorphology throughout the last 50 yr, contributing about 10% of published research papers in the subject. Major increase in direct involvement with environmental policy and practice came in the 1980s and 1990s but it has been followed by enormous expansion since then, including employment of professional geomorphologists in all stages and scales of projects, from provision of specific solutions, to design and initiation of projects, through to national policy development. Major stimuli to this increase in application encompassed the evident failure and detrimental effects of earlier approaches using hard engineering, changes in environmental awareness and attitudes of the public, and increased threat of climate change and incidence of major storms and natural disasters. These led to developments in approaches that 'work with nature', implementation of demonstration projects in river restoration, managed coastal retreat and now Natural Flood Management, and the explicit need for geomorphological assessment of water bodies following EU legislation. These have all lead to the present situation where applied geomorphology is 'booming', with high demand for geomorphologists. Evidence is provided that geomorphologists have contributed significantly to this change in thinking and are now very actively involved in developing and applying means of using their understanding and skills to implement more sustainable management, to the benefit of the environment and society.

Session A: Conference Salon, SpringHill Suites

Anthropogenically Accelerated Sediment Accumulation within High Plains Playa Wetlands

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Keywords: Agriculture, GIS, Land Cover

Playa wetlands are upland-embedded depressional wetlands found throughout semi-arid and arid regions around the world. They are particularly abundant on the High Plains of the central United States, with over 90,000 playas mapped within the states of Colorado, Kansas, Nebraska, New Mexico, Oklahoma, and Texas. Thus, playas are an important element of the High Plains landscape that provide a range of essential ecological functions such as groundwater recharge, surface water storage, wetland habitat, biodiversity, flood mitigation, sediment and pollutant filtering, and nutrient cycling.

Playas occupy the lowest position within internally drained upland watersheds, and, as a result, accumulate sediment eroded from the surrounding watershed. Sediment is primarily delivered to playas via overland flow. Under native grassland, playas existed on the landscape for thousands of years, maintaining a quasi-equilibrium with sediment accumulation, deflation, and soil formation. Conversion of significant portions of the High Plains to row-crop agriculture has accelerated rates of sediment accumulation within playas. Accumulated sediment reduces playa ecological functions and may ultimately result in the total disappearance of playas from the landscape.

Objectives of this study were to estimate the amount of anthropogenically accelerated sediment accumulated within playas, determine how watershed and playa morphometry and land cover influenced sediment accumulation, and assess the role of grass buffers in reducing sediment accumulation.

Results indicate watershed and playa morphometry have minimal influence on sediment accumulation within playas, and land-cover change is the primary driver. Playas in cropland-dominated watersheds without grass buffers on average accumulated 8.5 cm of sediment and lost 30% volume of storage capacity, while those with grass buffers accumulated an average of 1.8 cm of sediment and lost 7% volume. Playas within 100% grassland watersheds on average accumulated 2.3 cm of sediment and lost 13% volume. Grass buffers, while rarely utilized, could be highly effective at reducing the impacts of anthropogenically accelerated sediment accumulation and protecting playa ecosystem functions.

Step-Pool Channel Morphology and Forcing Effects in Mark Twain National Forest, Ozark Highlands

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Keywords: Step-pool Morphology, Forcing Effects, Ozark Highlands

Step-pool channel form is generally controlled by gradient, substrate characteristics, and sediment supply. Geomorphic forcing can also influence channel geometry due to geologic factors such as colluvial inputs and resistant bedrock and biologic factors due to fluvial wood and tree growth in the channel. How and where these geomorphic variables effect step-pool channel characteristics is poorly understood in the Ozark Highlands. This study reports a geomorphic assessment of step-pool characteristics in Deer Camp Hollow (0.2 km^2) draining the Salem Plateau in Mark Twain National Forest in southeastern Missouri. Topographic surveys, pebble counts, and step measurements were used to assess channel form and forcing effects. Step-pool forms occur along >80% of the stream length with an average bed slope of 11.5 %, average D90 of 185 mm, and 89 of 122 total steps assessed indicating forcing. Step-spacing typically varies from 1.2 to 3.2 m and decreases with the frequency of forcing. Forced steps had greater step heights (2x) and H/L ratios (1.5x). Wood and trees affected only 13% of the forced steps. A resistant sandstone outcrop resulted in large colluvial boulders and uneven substrates along middle reaches and increased step heights to >1 m.

The Geomorphic Effect of Beaver Dam Analogs in the Colorado Front Range

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Keywords: Beavers, Sedimentation, Groundwater

Beaver dam analogs (BDAs) have been installed to help restore incised channels and riparian vegetation in the Colorado Front Range. BDAs are expected to create a similar channel response to natural beaver dams by causing channel bed aggradation and overbank flow, which subsequently raise water tables and support vegetation growth. Previously, natural beaver dams caused significant sedimentation partly as a function of stream gradient and pool surface area, as well as significant rise in the water table partly as a function of permeability. Lack of funding for monitoring projects post-restoration has limited research on whether BDAs actually cause channel change that mimics natural beaver dams in the Front Range and beyond.

To understand how BDAs change river corridors post-restoration, I studied hydrology and sedimentation in two BDA restoration projects in Front Range watersheds. BDAs are hypothesized to (i) behave like natural beaver dams by accumulating sediment and raising water tables, with (ii) aggradation correlating to pond surface area and stream gradient, and (iii) groundwater rise correlating to river corridor grain size. BDAs were studied in Fish Creek, - a steep, mountainous catchment underlain by crystalline igneous rock, - and Campbell Creek, - a lower gradient, piedmont catchment underlain by sedimentary rocks. Restoration occurred in summer 2017 and river corridor response was studied from May to October 2018 at both sites. Residual pool surveys recorded sediment and pool volumes in four BDA ponds and one reference pool in both catchments. Hydrology was monitored using recording stream gauges and shallow groundwater wells proximal to two BDAs and a reference reach at Fish and Campbell Creeks. BDAs created upstream ponding and significantly increased sediment storage, but BDAs did not have a significant influence on shallow groundwater. Sediment storage correlated strongly to BDA height and surface area, but not channel gradient. The lack of groundwater response proximal to BDAs could indicate that local watershed factors have a stronger influence on groundwater response in the first year after restoration than restoration design. Systematic, long-term studies of channel and floodplain response to BDAs are needed to better understand how BDAs will influence geomorphology and hydrology.

Examining the Links between Upstream Erosion and Downstream Floodplain Forest Establishment in the Yampa River Basin, Colorado

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Keywords: Arroyos, Channel Change, Cottonwoods

Cottonwood floodplain forests along the Yampa River, the last lightly regulated major tributary to the Colorado River, are diverse ecosystems providing essential ecological and human benefits disproportionate to forest size. These forests are disturbance-driven ecosystems dependent on sediment-laden floods that form new bars for seedling establishment. On the Yampa River, we hypothesize that cottonwood forest establishment is linked to a sequence of events beginning with arroyo incision in erosive semiarid low-elevation tributary watersheds in the Little Snake River Basin. No published records of widespread arroyo incision in this basin exit, and the influence of legacy sediment on cottonwood establishment in largely natural systems remains a critical knowledge gap. Nearly 60% of the present annual Yampa sediment load is derived from Sand Wash, Sand Creek, and Muddy Creek in the Little Snake River Basin. Here, we use historical survey notes and maps, sequential aerial photographs, and field measurements to estimate both the timing and the volume of sediment exported from these three tributary watersheds during a period of active arroyo incision. Preliminary examination and analysis of historical maps and aerial photographs indicates that Muddy Creek and Sand Wash incised, widened and then narrowed over the last 140 years. This suggests the period of active arroyo incision occurred from ~1880-1940 and that sediment export from the tributary watersheds has declined substantially since. Estimates of cottonwood forest age in Deerlodge Park, an area of particularly extensive cottonwood floodplain forest on the Yampa, indicate that most of the forest was also established during this period. Correlation between forest establishment dates and tributary arroyo incision provides early support for the hypothesized linkages between upstream erosion and downstream forest establishment.

Hydrological Monitoring of an Oak-Pine Forest Under Prescribed Fire Management, SE Missouri

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Keywords: Forest Hydrology, Prescribed Fire, Headwater Streams

Big Barren Creek watershed (191 km^2) drains Mark Twain National Forest in the Ozark Highlands in southern Missouri. Historically, the distribution of shortleaf pine within the region was reduced by over 80% due to exploitive logging between 1880 to 1920. Since the early 2000s, U.S. Forest Service has used prescribed fire to restore shortleaf pine-oak woodlands. Increased flooding and channel instability over the last decade raised concerns among managers and the local community about the impact of prescribed fire on runoff rates from forest areas. However, there is a lack of understanding about the hydrology and geomorphic response of headwater streams in these karst, high relief, forested landscapes. To address this knowledge gap, this study reports on the results from a continuous discharge monitoring network in sub-watersheds with varying forest composition and management practices. The objectives are to: (i) monitor discharge in small streams with variable burn histories; (ii) evaluate the spatial variability of annual runoff rates and flow; and (iii) compare runoff characteristics of burned versus unburned watersheds. Overall, rainfall records indicated increased flooding in the watershed is due to an order of magnitude increase in high intensity rainfall events (>7.5 cm/day) since 2005. While burned catchments yielded about 50% higher runoff rates, overall runoff rates remained relatively low from all catchments (<10% of total rainfall). Runoff patterns reflect a strong seasonal influence with most flow events occurring in the late winter-early spring prior to deciduous leaf production and just after the burning season. Preliminary results suggest that runoff rates increase when leaf litter depth is reduced by burning during leaf-off periods. However, runoff rates tended to decrease with increased percentage of coniferous tree cover in burned catchments. This suggests prescribed burning may have less of an impact on runoff rates in more mixed stands where interception by pine canopy can offset the loss of forest floor interception by burning. Furthermore, increased runoff rates and sediment delivery due to the post-settlement conversion from pine- to oak-dominated forests may have caused the geomorphic transition from multi-threaded to single channel forms in headwater streams in the Missouri Ozarks.

Long-term Sediment Yields from Forested Catchments in the Ozark Highlands, Missouri

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Keywords: Sediment Yields, Forested Watersheds, Ozark Highlands

This study evaluates the causes of historical sediment yields determined from dry pond sedimentation rates in five small (<4 Ha) forest catchments in Mark Twain National Forest in the Ozarks Highlands of Missouri. The region was heavily logged for pine and oak between 1880 and 1920 and has been under Forest Service control since 1939 with the present system of forest management since 1976. Little is known about the legacy impacts of early logging on these forested watersheds. Beginning in the 1890s, light rail tram lines were used to haul cut timber to large saw mills, often more than 40 km away. We take advantage of past tram construction practices to sample sediment from impoundments created by the damming of small drainage ways with berm fill to level rail beds. Field work for this project was just completed in July 2019, so this poster reports preliminary results on site history, core sampling, sediment characteristics, and long-term sediment yields. Sedimentation pond areas were typically about 15-20 m long and 10-15 m wide. Two sites draining a rolling forest landscape with little disturbance by roads contained sediment deposits up to 63 cm depth with silty texture and yellow-brown colors reflecting inputs from the erosion of surface soils formed in Pleistocene loess that thinly mantles the level upland divides. The Wolf Pond site averaged sediment depths of 21 cm and indicated a long-term sediment yield of 6 Mg/km2/yr. Three other sites draining a common ridge line where the tram bed was cut into the lower hillside along the valley margin contained sediment deposits with maximum depths up to 170 cm with clayey texture and red brown colors reflecting contributions from the erosion of weathered colluvium and carbonate residuum from road cuts and the tram/road bed. Preliminary results suggest long-term erosion rates over the past 120 years were low for forested uplands, but increased greatly in higher relief catchments affected by tram bed excavation and road disturbances. Future work will focus on using Cs-137, geochemical, pollen, and charcoal profiles to better constrain sediment sources and temporal variations in sedimentation.

Developing Metrics and Protocols for Evaluating Restoration Success for the Little Thompson River

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Keywords: Restoration, Geomorphology, Vegetation

During September 2013, the Front Range of Colorado experienced an extreme rainfall event that caused mass flooding throughout the region, damaging infrastructure such as roads. Many Front Range river reaches were subsequently restored in conjunction with rebuilding efforts. Not only is there little standard in restoration approaches, there is even less precedence for evaluating project success. We will develop a framework to assess restoration success of the Little Thompson River using an approach that integrates both ecological and geomorphic aspects of the project in addition to project-specific objectives, with the ultimate goal of contributing to the knowledge of best practices in river restoration. We develop this framework by integrating data collected from high-resolution topographic surveys with hydraulic modeling with functional traits and vegetation composition at both the restored reach and an upstream reference for a direct comparison. At the restored site, a step-pool/pool-riffle morphology design was implemented. While the pool-riffle morphology is reasonable for the setting of the Little Thompson (2.5% slope and 112 km2 drainage area), preliminary analysis from reoccupied as-built cross sections suggests the designed channel is larger than expected for the ~two-year flow. Furthermore, grain-size analysis indicates a coarse-tailed distribution (D90= 118 mm) and a steeper slope than expected for this channel type. We predict that typical flows will not connect to the floodplain nor mobilize bed material, two design objectives. Preliminary analysis from vegetation surveys indicates that of the five woody vegetation types planted, only willows are thriving comprising 72% of present vegetation. In contrast, 5 years after project completion, 22% of living woody vegetation recruited naturally, consisting predominantly of cottonwoods that require flood disturbance for recruitment. The reference reach's plant community is denser and more diverse. We hypothesize flood disturbance and subsequent human intervention has resulted in stilted plant community succession compared to the reference reach, which has recovered naturally. We will continue to test this hypothesis by linking topographic data to vegetation functional traits. Remaining tasks include acquiring high-resolution topography data from structure-from-motion such that a detailed comparison of hydraulic and geomorphic function of the sites in relation to vegetation traits can be established.

Effects of Urbanization on Three Major Rivers in Texas: A New Method for Assessing Channel Stability of Low-Gradient Rivers

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Keywords: Urbanization, Fluvial, Stability

During the years 1997-2012, the population of Texas grew 15 times faster than the United States' national average, mostly in urban settings (Lund, 2017; Ura and Daniel, 2018). Much of this growth centered around the Dallas-Fort Worth Metroplex (DFWM) and in the Austin area, cities built on the banks of the Trinity River and the Colorado River, respectively. Further, the effects of land cover change, such as that which occurs with urbanization, have yet to be fully determined at a large scale. Given the current population growth and projections for the region, it is necessary to understand effects of urbanization on the major rivers in the Gulf Coast to prepare for fluvial adjustments induced by the rapid expansion of its urban centers. This study assesses the effects of urbanization on three major rivers in the Gulf Coast region of the United States: the Red River, Colorado River, and Trinity River in Texas. Objectives for this study are: (1) Determine the effects of urbanization on overall geomorphic channel stability of rivers in the Gulf Coast region, (2) Determine the effects of land use/land cover (LULC) on sediment size range of select rivers in the Gulf Coast region, and (3) Establish a channel stability assessment system for low-gradient rivers typical of those in the Gulf Coast region. Qualitative assessment of channel stability is based upon the Modified Johnson et al. (1999) Method for Assessing Channel Stability, developed by Doyle et al. (2000). Local stream power and unit stream power are used as a quantitative indicator of stream stability. It is determined that because rivers no longer exist in a "natural" state, free from anthropogenic influence, river management must be considered as a fundamental component of any river assessment. This is included in a newly proposed channel stability assessment for low-gradient rivers.

Development of the Upper Colorado River Basin from Grand Mesa to Grand Valley, Colorado: An Example of Quaternary Glacial-melt Floods ("Kilo-floods")

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Keywords: Colorado River, Glacial-melt floods, Grand Mesa

Recent geomorphic studies within the Colorado River Basin have concentrated primarily on the relation between tectonics of the Colorado Plateau and channel incisions. Unfortunately, few studies have focused on the evolution of the upper Colorado River Basin. And, although the terrace in Grand Valley has been dated at 64–68 ka, no study has examined the connection between glaciation on Grand Mesa with the development of Grand Valley. Researchers have suggested that the sub-rounded imbricated basalt boulders found in along the upper reaches of the tributaries in the region were transported by debris flows and glacial floods from Grand Mesa. Regrettably, the dating of these geomorphic events was unknown. The purpose of this study was to determine the timing and characteristics of the terraces and river incisions of the upper Colorado and Gunnison Rivers. We used Optically Stimulated Luminescence (OSL) dating to determine age estimates of the deposits in the tributaries. A glacial outwash deposit nearby the terrace in Grand Valley has been dated at 44–68 ka. New OSL dates for the tributaries around Grand Mesa show an age of 58–84 ka. In addition to the OSL dating, we characterized the fluvial terraces using Electrical Resistivity Tomography (ERT). The profiles of the floodplains of the tributaries show clear distinctions between ancient and modern deposits. The Pleistocene deposits contain more of the larger gravels throughout the profiles, whereas the morphology of the modern deposits is convoluted and consist of greater amounts of finer grains. The new OSL dates and the analysis of the ERT data offer new perspectives of the evolution of the upper Colorado drainage basin. The ERT results suggest that the fluvial terraces were deposited during episodic glacial floods consisting of discharges greatly exceeding modern-day floods. The compositional properties of the Pleistocene terraces are very distinct from modern floodplain deposits and probable outwash plains. Based on the age data for terraces and subsequent incision episodes, we suggest that these are all linked to deglaciations of Grand Mesa around 44–84 ka.

Comparisons between Large Wood in the River, on the Active Floodplain, and on Abandoned Terraces on the Merced River in Little Yosemite Valley, Yosemite National Park, California

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Keywords: Large Wood, Floodplain, Habitat

Little Yosemite Valley in Yosemite National Park, California is an unlogged, old growth forest abundant with incense cedars, Jeffrey pines, and white fir. The Merced River, undammed in Yosemite, flows into and meanders through Little Yosemite Valley and continues over Nevada and Vernal Falls before running west out of the park into California's Central Valley. The Meadow Fire in 2014 burned part of the valley, leaving behind standing and fallen burnt trees. This setting is ideal for a comparison of large wood and logjam characteristics between the river, the active floodplain (floodplain), and the abandoned terraces (valley); and between burned and unburned sites. We investigate significant differences between the volumes of wood in each location; the average widths of the river, floodplain, and valley in each location; and the characteristics of the wood in each location (average diameter, average length, decay class, and burn class), with the aim of better understanding the relationship between valley-floodplain-river wood and the differences between burned and unburned wood loads and characteristics. We estimated wood volume in the river by surveying all the marginal and channel-spanning jams, and in the floodplain and valley by assigning random transects and measuring the wood along those transects. Preliminary results suggest that the floodplain has the largest volume of large wood, while the river has the greatest proportion of total wood in logjams. Results also suggest that logjams in the burned floodplain have smaller diameter wood than in the river or in the unburned floodplain. Additionally, the data indicate that there is a positive correlation between river width, floodplain width, and valley width. This research will provide the National Park Service with a better idea of the wood loads and distribution of wood in Little Yosemite Valley, and how size and location of large wood affect volume of wood in the river and associated habitat and geomorphic processes.

Monitoring Strategy for Stage 0 Restoration of the South Fork McKenzie River, Oregon

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Keywords: Restoration, Wood, Stage 0

The South Fork McKenzie River (SFMR) in the western Oregon Cascade Mountains hosts the largest Stage 0 stream restoration project implemented to date. One of the primary goals of Stage 0 restoration is to create a complex valley floor environment that can be subsequently reshaped by natural processes, and in this case, to allow those natural processes to build high-quality habitat for salmon in what was an anthropogenically altered river reach below a large flood-control reservoir. Stage 0 restoration follows the Stream Evolution Model of Cluer and Thorne 2014, and was implemented on the SFMR by re-grading the channel and floodplain to a "geomorphic grade line" as described by Powers et al 2018. The actual restoration of the 900-m long reach involved using 65,000 cubic meters of sediment from leveed channel banks and other high portions of the floodplain to raise the channel bed and reconnect flows with the adjacent floodplain. Thousands of large logs were added during restoration, and the ends of some logs were buried in the sediment to provide foundations for future log jams. Effectiveness monitoring is an important aspect of any restoration, and especially here, given the relative novelty of the Stage 0 methods. However, monitoring using traditional channel-based protocols was made difficult by the large-scale of the SFMR project, the lack of a distinct channel, and the expectation of substantial future geomorphic processes that will reshape the floodplain and future development of riparian vegetation. We considered these challenges as opportunities to develop a new monitoring protocol based on newly available technologies from Unmanned Aircraft Systems (UAS; i.e. drones). Here, we share the initial monitoring protocol and our preliminary results. We used repeated UAS remote sensing surveys of large wood volume, substrate distribution, inundated area, water surface velocity, and water surface temperature from UAS photogrammetry, thermography, and multispectral orthomosaics. Field measurements were designed specifically to calibrate and validate the remotely sensed data. We will present preliminary relationships between field and remotely sensed data, discuss the influence of remote sensing on sample design efficiency, and provide qualitative hypotheses of post-treatment channel evolution.

Geomorphology, Quaternary Stratigraphy, and Western U.S. Flood Hazards

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Keywords: Paleohydrologic Bounds, Flood Hazard Assessment, Non-Exceedance

Geomorphology, Quaternary Stratigraphy, and Western U.S. Flood Hazards For more than 25 years the Bureau of Reclamation (Reclamation) has evaluated extreme flood hazards for dams using fluvial geomorphology and Quaternary stratigraphy. In the early 1990s it became clear that the hypothetical maximum floods previously used as a measure of dam safety had extremely low probabilities based on the geomorphic record of floods in the western U.S. During this time, it also became clear that some of the indirect discharge estimates used to support these hypothetical flood calculations contained substantial errors. Streams in the West are bounded by geomorphic surfaces that limit the magnitude of floods over time periods much longer than historical records. This realization led to the concept of paleohydrologic bounds. These bounds are not actual floods but represent long-term geomorphic limits on flood magnitude. These bounds represent non-exceedance limits on floods over 100s to 1000s of years. This concept has been applied to flood hazard assessment of 100s of Reclamation dams throughout the 17 western states in a wide range of environments. The realization that geomorphic bounds on the magnitude of floods spanned thousands of years in the West led to a dramatic shift in Reclamation dam safety from a standards-based approach to an approach based on quantitative hazard estimation. Once non-exceedance information was properly incorporated into flood frequency calculations, it became clear that there was a lack of equivalence in the estimated hazard to dams posed by floods and earthquakes. Just as the largest floods in the western U.S. leave a clear geomorphic record, a clear record of geomorphic stability limits the magnitude of floods over time. These geomorphic records directly allow for the assessment of flood hazard for critical structures. Basic fluvial geomorphology clearly shows the inaccuracy of some indirect flood discharge estimates that control the perception of flood hazards in the West. Non-exceedance information is widely applicable to understanding extreme flood hazards across Reclamation's inventory. The concept of bounding floods over time provides powerful information for flood hazard assessment.

Highly Mobile Wood and Sediment in Northeast Ohio Urban Streams

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Keywords: Urban streams, Fluvial Geomorphology, Wood

In urban areas, fluvial geomorphology is heavily influenced by human activities in the channel, riparian area, and watershed. Many urban streams are subject to burial, channelization, and hardening, but where they are allowed to have self-formed channels, they are dynamic geomorphic environments. In northeast Ohio, many stream reaches around Cleveland are protected within parklands, but subject to the effects of urbanization within their watersheds, through stormwater-driven hydrographs, changes to sediment supply, and loss of connected riparian forests. In seven watersheds along an urbanization gradient in the Cleveland area, we have collected data on the abundance, sizes, and mobility of large wood, bed sediment sizes, and turbidity dynamics. Wood abundance and the size of wood jams decrease as watershed urbanization increases. Conversely, wood mobility increases and jams become more transient in more intensely urbanized watersheds. Wood mobility in the urbanized watersheds is much higher than reported for temperate forested watersheds. Wood is observed to interact with sediment, leaf litter, and anthropogenic material, but does not exert a major influence on channel geometry or bed sediments. Turbidity dynamics are tightly linked to the flow regime, and bed material is frequently mobilized, but bed sediment size distributions do not show a relationship to intensity, instead reflecting the region's glacial history. Linkages between hydrology and sediment dynamics are stronger than between hydrology and wood dynamics, which are more strongly mediated by riparian conditions. For both sediment and wood in urban streams, assessing causes and consequences of high mobility requires understanding processes occurring throughout the watershed.

Signatures of Varying Climate on Geomorphic and Topologic Characteristics of Channel Networks

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Keywords: Landscape Evolution, Peclet Number, Branching Structure

River networks are important landscape features that serve as pathways to transport water, sediment, and nutrients. Their emergence and evolution are controlled by the competition between the hillslopes and fluvial processes on the landscape. It is important to investigate the geomorphic and topologic properties of these networks for understanding and quantifying the roles of processes in creating distinct patterns of channel networks, as well as to develop models for predicting the network dynamics under changing environment. Here, we study the response of landscapes to changing climatic forcing via numerical modeling and field observations. We use a physically-based numerical landscape evolution model to investigate the channel network structure for varying hillslope and fluvial processes represented by different magnitudes of the diffusion (D) and advection (K) parameters in the landscape evolution model. We show that the landscapes with the same Péclet number (defined as the ratio of advective (fluvial) to diffusive (hillslope) processes) and thus the same characteristic length scale, may exhibit different geomorphic and topologic structure. In particular, we show that by increasing (decreasing) D and K with the same proportion while keeping the same Péclet number, the relief decreases (increases) exponentially. However, we observe that the drainage density increases in both cases. This increase in the drainage density is manifested in the channel network branching structure distinctly. Decreasing D and K (mimicking dry climatic conditions) results in a higher number of branching channels whereas increasing D and K (mimicking humid climatic conditions) results in a higher number of side-branching channels. Side-branching channels are defined as the channels which are connected to the channels with different orders, whereas the branching channels are the channels which are connected to the same order channels and create a higher-order channel in the downstream of their junction. These results are consistent with the field observations from the basins across the United States and suggest that varying climatic conditions imprint distinct signatures on the branching structure of river networks.

Poster Session B: Tivoli Turnhalle

33 Years of Publishing in Geomorphology

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Keywords: Geomorphology, Nationality of Authorship, Impact Factor

The Elsevier journal Geomorphology was first published in July 1987, with Marie Morisawa as the founding editor. All journals that publish in this discipline have increased in size and influence over time. Geomorphology has published over 6,100 articles covering 88,000 pages and currently publishes two issues per month. The journal publishes open access articles (17 in 2018) and has published 146 special issues, including the Binghamton Geomorphology Symposia from 1995 and 1997-2018. The nationality of authors has become increasingly diverse. Authors from the U.S. and U.K. have produced the greatest number of articles, but their proportion of the total has declined markedly from 51% (1987-1999) to 26% (2010-2018) while the proportion of articles from China and Europe have increased substantially. To handle the increase in number of manuscripts, the number of editors has increased to the current seven, supported by an international editorial board with ~75 members. The 2-year impact factor increased steadily from 0.713 in 1996 to 3.681 in 2018. By comparison, the impact factor in 2018 is 3.598 for Earth Surface Processes and Landforms, 3.851 for Catena, 3.765 for Earth Surface Dynamics, 0.987 for Zeitschrift fur Geomorphologie, and 0.650 for Geomorphologie-Relief, Processus, Environnement. The editorial speed has improved so that the average time from submission to first decision was 10.2 weeks in 2018, and the time from submission to final decision (accept or reject) was 5.0 months. The rejection rate has increased from 53% in 2016, to 57% in 2017, and to 64% in 2018. Nearly 1 million full-text articles are downloaded from Geomorphology each year.

Soil Carbon Stability in Subalpine and Alpine Systems

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Keywords: Global Change, Soil Carbon, Biogeochemistry

Globally, soils represent the second largest pool of active carbon, behind only the ocean. Tundra systems containing permafrost, with year-round freezing temperatures have historically been sinks for soil carbon as the diminished temperature suppressed microbial activity. With warming temperatures, it is thought that these systems could transition from sinks to sources of carbon. This ongoing project is focused on the stability of soil organic matter and soil carbon in subalpine and alpine systems. In June of 2015, 11 sites were established in Rocky Mountain National Park, Colorado. Sites were distributed across plots two tundra ecosystems: 1) Fellfield tundra characterized by shallow soil and minimal vegetation consisting of herbs and lichens; and 2) Wet meadow tundra characterized by organic-rich, deep soil and abundant vegetation consisting of grasses and sedges. Soil respiration was measured throughout the snow-free periods of 2015 - 2019. Soil carbon was measured annually during the same time period.

Throughout the study period, soil respiration rates were similar across all sites (maximum 4.9 $\mu mol/m^2/sec$). Soil carbon levels were significantly higher in the wet meadow (mean 13% soil C, by mass), compared to the fellfield sites (mean 5.5% C, by mass). If tundra soils were transiting from sink to source, it would be reasonable to assume that the wet meadow site would show the highest levels of soil respiration as historically accumulated soil carbon was decomposed by microbes. This preliminary data seems to suggest that under some circumstances, alpine tundra soil carbon may be more stable than might be assumed. The form of carbon present in the soils may also play a role in carbon stability as some functional groups are quite recalcitrant (e.g. aromatics, phenolics, and carboxyls) while others are more easily broken down by soil microbes (e.g. sugars and lipids). Future work further will investigate the chemical nature of the carbon in greater detail.

Soil Respiration in High Elevation Alpine and Subalpine Systems

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Keywords: Carbon stability, Global Change, Soil Respiration

As the climate warms, high elevation ecosystems and alpine geomorphic processes will be exposed to novel conditions as the snow-free period extends further into the spring and fall. Alpine and sub-alpine systems rely on snowmelt for moisture through the summer months. With snowmelt beginning earlier, these systems will be exposed to dryer, warmer conditions for much of the summer. This ongoing project is focused on the influence of soil moisture, soil temperature, air temperature, and soil chemistry on soil respiration. In June of 2015, 12 sites were established in Rocky Mountain National Park, Colorado. Sites were distributed across plots in three different alpine/ subalpine ecosystems: 1) Conifer forest at the upper limit of tree line; 2) Fellfield tundra characterized by shallow soil and minimal vegetation consisting of herbs and lichens; and 3) Wet meadow tundra characterized by organic-rich, deep soil and abundant vegetation consisting of grasses and sedges. Soil respiration, soil temperature, air temperature, and soil moisture were measured throughout the snow-free periods of 2015 - 2019.

When considered individually, soil moisture and air temperature were each negatively correlated with soil respiration. When considered together, the interactions of soil moisture and air temperature were also significant ($p < 0.05$). Respiration rates were significantly different in the three cover types and were highest in the forest (maximum 9.8 $\mu mol/m^2/sec$) and lower in the tundra (maximum 4.9 $\mu mol/m^2/sec$). From these results, it appears that soil moisture and air temperature are both influencing soil respiration. In this system, these variables generally have an inverse relationship: when soil moisture is high (due to snowmelt in the spring), air temperature is low and when soil moisture is low (in late summer), air temperature is high. If soil moisture and air temperature both influence the respiration rate, the inverse relationship between soil moisture and air temperature could explain the negative correlation between these variables and soil respiration. Future work will focus on soil chemistry to determine the role (if any), soil nutrient availability and pH have on soil respiration in these high elevation systems.

Glacial Fluctuations and Change of Ice Mass in the Southern Patagonia Icefield (SPI) Glaciers from 2000 to 2017: A Geospatial Technology Approach

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Keywords: Glacier, Remote Sensing, Mass Change

Study of changes in the terminus and mass balance of glaciers can reveal their responses to changing climatic conditions. In the Southern Patagonia Icefield (SPI), contrasting patterns of glacier fluctuations have been observed. Unfortunately, no explanation has been proposed to explain these differing responses. To address this question, we investigated recent changes of these glaciers and potential linkages between the changes and the processes controlling the different responses under similar climatic conditions. To do this, we measured surface-elevation change from 2000 to 2017 and terminus positions from 2000 to 2017 using various types of satellite data. Regrettably, the traditional DEM-differencing approaches to measure mass change have neglected surface characteristics. Thus, these approaches have resulted in measurement inaccuracy. In our research, we adapt satellite-derived short-wave albedo measurements to better estimate the density of the surfaces of the glaciers. To further examine the controlling factors of changes in the glaciers, we used an object-oriented approach to quantify glacier-surface change from a temporal perspective. We combined the surface structure change with mass change to create a new method to illuminate what factors could lead to the contrasting patterns. Our research suggests that topographic forcing is a major variable impacting variation in the response of the glaciers.

Weathering Fronts: A Critical Review

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Keywords: Weathering Profile, Regolith, Bedrock

A distinct boundary between unweathered and weathered rock that moves downward as weathering proceeds, - the weathering front, - is explicitly or implicitly part of landscape evolution concepts of etchplanation, triple planation, dynamic denudation, and weathering- and supply-limited landscapes. Weathering fronts also figure prominently in many models of soil, hillslope, and landscape evolution, and mass movements. Clear transitions from weathered to unweathered material, increasing alteration from underlying bedrock to the surface, and lateral continuity of weathering fronts are ideal or benchmark conditions. Weathered to unweathered transitions are often gradual, and weathering fronts may be geometrically complex. Some weathering profiles contain pockets of unweathered rock, and highly modified and unmodified parent material at similar depths in close proximity. They also reflect mass fluxes that are more varied than downward-percolating water and slope-parallel surface processes. Fluxes may also be upward, or lateral along lithological boundaries, structural features, and textural or weathering-related boundaries. Fluxes associated with roots, root channels, and faunal burrows may potentially occur in any direction. Just as pedology has broadened its traditional emphasis on top-down processes to incorporate various lateral fluxes, studies of weathering profiles are increasingly recognizing and incorporating multidirectional mass fluxes. Examples from karst systems may also be useful, where concepts of laterally continuous weathering fronts, rock-regolith boundaries, and water tables; and an assumption of dominantly diffuse downward percolation are generally inapplicable. We also question the idea of a single weathering front, and of a two-stage process of weathering rock to regolith, and transforming regolith to soil. In many cases, there appears to be three stages involving conversion of bedrock to weathered rock, weathered rock to regolith, and regolith to soil. As a tool to reflect key developments in our understanding of weathering fronts, we develop a timeline of key volumes and papers in the Binghamton Geomorphology Symposium advancing the understanding of weathering profile evolution and the interface between parent rock and weathered material.

Geomorphic Impacts of Human-Altered Rangelands

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Keywords: Water Development, Earthworks, Gully Erosion

Many rangelands are relatively sparsely populated; however, infrastructure to develop water in support of livestock production is distributed extensively over these large landscapes. Human-made earthworks such as stock tanks, lateral channel berms, water spreader berms, and diversion channels can be found across lands that support commercial grazing. Once built, these structures are a primary control on drainage pathways that are altered intentionally to detain, redistribute, or store runoff, or unintentionally as re-organized runoff creates incised channels, exacerbates erosion and sedimentation, and creates gully knick points. A spatially explicit database of runoff and erosion control structures in the 72 km long Altar Valley in southern Arizona was created by visually interrogating imagery from 2016 within Google Earth complimented with 1m digital elevation models (DEMs) created using aerial LiDAR data. Breaks through structures (breach) and scour around structures (flank) were identified. A total of 377 stock tanks are distributed throughout the valley where they are a control on runoff and sediment transfer. Almost half of 59 identified lateral channel berms (41%) have been breached and 17% have experienced lateral scour; 15% of 667 shorter water spreader berms have been breached and 29% have experienced lateral scour. 41.3% of the length of the Altar Wash, an arroyo that longitudinally bisect the valley, is protected from lateral channel bank erosion by long earthen berms, however, only nine of the 59 channel bank protection berms did not show evidence of a breach or flank. Many of the berms that are breached or flanked are posing an erosion risk to adjacent floodplains as breaches become gully knick points. Although landscape evolution in the valley is ultimately driven by regional geomorphic instability caused by channel incision and land cover changes, human-made structures are currently an important control on hydrologic and geomorphic processes, especially where not operating as intended. Due to the spatial extent of rangelands managed for livestock grazing and the large number of human-made structures distributed within, the results of this study are important for informing the role of humans in altering even seemingly sparsely impacted lands.

Critical Zone Processes in an Alpine Environment: A First-Approximation of the Uncompahgre Watershed, San Juan Mountains, Colorado

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Keywords: Critical Zone, Rock Glaciers, Uncompahgre Watershed

The Critical Zone (CZ) of Earth is a terrestrial, life-sustaining, heterogeneous and complex environment consisting of subsystems of surface hydrology, groundwater, geomorphology, soils, biota, and climatology, interacting closely with ever expanding anthropomorphic influences. The CZ extends from the top of the canopy to the bottom of the aquifer encompassing the various subsystems of Earth. One of the most sensitive and fragile environments in the Critical Zone is the alpine. Unfortunately, humans have caused considerable degradation to many of these alpine environments through their various anthropogeomorphic activities. One can ask how have these activities impacted the various components and subsystems of the alpine? Understanding these impacts on this fragile environment requires a variety of observations at all scales, especially at the watershed scale. Remotely-sensed data are particularly effective for spatiotemporal observations, and can provide valuable insight to alpine CZ systems. The Uncompahgre Watershed ((2888 km^2) has been spatially and temporally impacted by numerous and various human activities. These activities include dams and reservoirs, mining, off-roading, logging and alpine urban development. The Uncompahgre Watershed was analyzed from an integrated systems approach using StellaTM modeling combined with field mapping and monitoring. The inputs, outputs, pathways, storages, and thresholds of the watershed were stimulated in StellaTM. The various subsystems in the watershed were linked, which allowed modeling of the flows of energy, mass, and transport, providing a deeper understanding. Field data and monitoring were used to calibrate the model. Long-term USGS gauging data were utilized to add a temporal framework. Pathways from rainfall, to surface runoff, to storage as ice in rock glaciers and water in lakes and reservoirs, to stream runoff was modeled. Considerable attention was given to rock glaciers because they are becoming the water towers of the watershed. Geophysical techniques including ground penetrating radar (GPR), radio echo sounding, and coupled electrical resistivity tomography (CCERT) offer encouraging datasets and effective observations of rock glaciers. The linkage of processes from one subsystem to another has an influence throughout the Critical Zone in the Uncompahgre Watershed. Thus, we think it is essential to undertake long-term monitoring of the watershed.

Ground Surface Roughness and Trail Morphology

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Keywords: Anthropogeomorphology, Trail Erosion, Recreation Geomorphology

As the population continues to grow and active lifestyles are encouraged, more people are using trail systems for leisure and/or fitness activities. To understand the impact that increased traffic has and to plan sustainable trails in the future, it is important to understand the processes involved with trail erosion and morphological evolution. Trail surface roughness is an indicator of soil and geologic conditions, but from a trail user forcing perspective, trail roughness changes the way that the trail user interacts with the trail. This study draws from spatial soil data sets, in-situ measurements of surface roughness, and trail morphology characterizations to show how surface texture can influence trail morphological evolution. Field data were collected at several multi-use trail systems in the Austin, TX area. Theoretical discussions and literature reviews can show how trail surface texture can change how a trail user interacts with the trail, thereby altering its geomorphologic evolutionary trajectory.

Future of Periglacial Landscape: alpine ecosystems and deglaciation in the Tropical Andes and French Alps

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Keywords: Periglacial, Plant Ecology, Deglaciation

Glacier retreat is accelerating in most mountain regions of the world and additional periglacial areas will become ice-free opening up new ecological spaces for plant colonization, potentially forming new grasslands, shrublands, and wetlands. These deglaciated lands will soon represent a large total land area that scientists and decision-makers need to consider in landscape management policy. This research aims to assess how physical, ecological, and social processes interact to drive ecosystem changes in alpine periglacial landscapes and what this tells us about adaptation to sustain livelihoods and downstream services. The study of biodiversity and ecosystem functioning relies on understanding the micro and meso scale geodiversity of the periglacial landscape. We hypothesize that geomorphological processes and landforms produce microhabitat diversity along alpine slopes. Based on our previous study, held in the Tropical Andes, we consider that the increasing time lag between the velocity of global warming and the slowness of primary succession drive species range shifts and possible species extinctions in alpine regions. We found consistent patterns in plant succession along post-glacial chronosequences. Dispersal limitation, deficient facilitation among plants, and competition processes are limiting factors for primary succession, as well microbial community plays a key role during ecosystem establishment. We now begin to apply a similar methodology to multiples sites in the Andes and Alps, setting up a biogeographical comparison between continents. We focus on functional and experimental approaches to study the patterns of upward migration of alpine plant communities and soil processes. The methodology is based on field sampling, imagery analyses, and field experiments. Our main hypothesis is that the alteration of alpine plant communities will have potential consequences on ecosystem function, and new post glacier ecosystems won´t provide the same services as actual adjacent ecosystems. We aim to understand the relations between shifts in alpine plant community and ecosystem establishment. Ultimately, we plan to experimentalize alpine deglaciated area management methods that can benefit to ecosystem development and facilitate human adaptation to climate change.

A Digital Surficial Geologic Map Database for the Intermountain West

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Keywords: Geologic Map, Landscape Evolution, Natural Hazards

Quaternary sedimentary deposits preserve a record of landscape evolution across the intermountain west that is cataloged in hundreds of geologic maps produced over many decades. These maps have made invaluable contributions to our understanding of the influence of climate and tectonics on geomorphic processes and resulting landscape evolution. However, many are only available as static representations, are inconsistent with their neighbors, are decades out of date, and are seldom focused on Quaternary sedimentary deposits and surfaces. As a result, it is challenging to utilize geologic maps to assess regional problems in Quaternary geology and geomorphology. To address this challenge, we are developing a new 'living', seamless digital geologic map database of Quaternary sedimentary deposits that provides an internally consistent framework to emphasize depositional process, materials, and age. This 'surficial' geologic map layer represents one component of a larger effort by the Geologic Framework of the Intermountain West project of the U.S. Geological Survey's National Cooperative Geologic Mapping Program. This project was established to produce a digital geologic map database and 3D geologic model of a regional transect from the western Great Plains to the eastern Sierra Nevada (2 degrees latitude by 14 degrees longitude; centered on the 37th parallel). Our new map synthesis was developed in a versioned database that supports multi-user editing and is constructed through compilation and integration of existing geologic mapping supplemented with mapping from remotely sensed imagery and data, resulting in a target scale no less detailed than 1:250k and as detailed as 1:100k where possible. Here we present a prototype of this map database covering 60,000 square kilometers of southwestern Colorado and northwestern New Mexico. In addition, we demonstrate some potential applications for the database including searching for key types of deposits, examining spatial variability in deposit age, and exploring regional correlation of deposits with significance for landscape evolution.

Glacier Climate Interactions in the Andes of Central Chile: Juncal Norte Glacier (33° S)

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Keywords: Chile, Juncal Glacier, Recession, Discharge Regime

Glaciers in Central Chile are a critical source of freshwater. They provide more than 50% of water to river streamflow during the warm season. Andean glaciers have been experiencing a generalized retreat and shrinkage. In recent decades, the wasting trend has been enhanced by the changing climate in the catchments of the high Andes. The associated reduction in streamflow has caused water shortages. The Juncal Norte glacier originates in the Nevado Juncal (6110 m) and it has an area of ~9 km^2. Is one of few large glaciers in central Chile with a North orientation (or, faces north). The glacier has retreated at a rate of 14 m/year. However, its tongue is experiencing a rapid process of wasting; a large crevasse is carving the glacier tongue into two parts and a generalized surface melting and area reduction is triggering a transition from a glacier to a debris-covered glacier. We use meteorological data from an automatic weather station (AWS) on the Juncal Norte Glacier, and trend analysis of historical records of hydroclimatic variables to investigate the glacier–climate interactions and their impacts on the melt regime. The objective of this study is to look at the effects that climate change and regional/local weather is having on the glaciers of central Chile with empirical evidence form the Juncal Norte glacier. According to the objective of this work, we first explore, using the meteorological data sets collected on the glacier during a 1-year campaign, the recent climatological regime of the catchment and then we compare this information with the historical trends to identify short- and long-term climatological changes. We then correlate weather events with data on water discharge at the base of the glacier tongue to analyze changes in the melt regime of the glacier. We use terrestrial photographs from 15 years of field campaigns and aerial/satellite imagery to detect morphological changes and glacier variation. The main findings are the following: a sustained upper air warming, a marked decrease of solid precipitation in winter, and an increase of summer storms that bring liquid precipitation at higher elevations are associated with the retreat of the Juncal glacier. The increase glacier melting has not resulted in excess river discharge, because the reduction of precipitation in the upper catchment has been higher than the increase in glacier input to discharge.

Water Towers of the San Juan Mountains, CO: A Preliminary Model of the Hydrological Characteristics of Rock Glaciers

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Keywords: Rock Glaciers, Hydrology, Water Towers, Stella Model

Changing climatic conditions are dramatically impacting water resources in the San Juan Mountains (SJM) as snow fields and accumulations of winter snows are rapidly being melted by early summer. Stream-flow, which extends into late summer, was supplied by meltwater from the snow fields and winter snows. Unfortunately, with early melting, late-summer stream flow is being less maintained by these snow fields. In cirques and glacial valleys where rock glaciers are present, the ice present in these landforms is insulated by several meters of rock debris allowing the internal ice in the rock glaciers to be preserved and their meltwater to maintain stream flow throughout the summer. Because of the increasing role these rock glaciers are playing as the water towers of the future in the SJM, it is important to understand their hydrologic characteristics and to gain an appreciation of their response to climatic changes. We began by mapping over 700 rock glaciers in the SJM, conducting GPR surveys and field observations, sampling water chemistry, and using StellaTM modeling. We reconstructed the internal structure, mapped the extent of ice present, and identified meltwater pathways with GPR. GPR profiles suggest that the water pathway changes course within the upper layer. Meltwater was mapped penetrating the upper layer and subsequently flowing along the interface with the frozen matrix before reemerging at the terminus of the rock glaciers. Meltwater sampled at the terminus of rock glaciers indicated two separate water signatures: surface water flow and meltwater flow. The StellaTM model was constructed to highlight the interaction between inputs, pathways, and potential sinks in the rock glacier and serves as the basis for future study. As changing climatic conditions increase their impact on water resources in the SJM, it is important that we have an appropriate understanding of the important role rock glacier hydrology will play.

Radionuclide Concentration Patterns in Forest Soils and Topography

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Keywords: Radionuclide Accumulation, Forest Soils, Topography

Topographic attributes affect how contaminants accumulate and move in the environment. This project examines the relationship between radionuclide, specifically radiocesium accumulation patterns and topographic characteristics. The study site is a village in Fukushima, Japan where the land was contaminated by radioactive fallout emitted from the Fukushima Daiichi Nuclear Power Plant (FDNPP) following a strong earthquake and tsunami in March 2011. The village is located 40 km northwest of the plant and the total study site area is approximately 0.25 km^2. Soil samples were collected using a 30 cm long tube in a forest during the summers of 2016, 2017, and 2018 to assess the Cesium-137 (Cs-137) contamination levels in soils. The forest is characterized by micro topography with hillslopes and channels and is covered with broadleaf and conifer trees. Typically, Cs-137 concentration is analyzed from two- or three-dimensional perspectives (e.g., kriging) and/or from a one-dimensional perspective (e.g., vertical migration). This project first attempts to formalize topographical and temporal parameters involved in Cs-137 movement and then analyzes Cs-137 concentration patterns based on those definitions. Lastly, this project utilizes a new spatiotemporal parameter, which combines topographical and temporal dimensions, in the analysis. General additive models (GAM) and mixed models are used as statistical analysis methods where the parameters are selected based on correlation analysis. Presumptive results show that topographic parameters such as slope and curvature and locational parameters such as distance to watershed boundary show their particular levels of effects on Cs-137 concentrations. Also, the results show that in a micro topography, which is often seen in humid mountainous areas, an analytical approach based on multiple topographical and temporal dimensions is necessary to obtain an insight into radionuclide contamination. The results from this project will contribute to improving geomorphological research using radionuclides, either natural or anthropogenic genesis.

Digging for Diamonds: A New Approach for Colorado

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Keywords: Diamonds, Kimberlite, Colorado

The Natural State and the Centennial State share many geologic qualities, one is the occurrence of diamond-bearing volcanic material. Lamproite and Kimberlite have been mined commercially for diamonds in both Arkansas and Colorado, but that approach has proven uneconomic for one reason or another over the years in both states. Arkansas has developed a mechanism for diamond extraction with minimal environmental impact, at low operating costs, which educates and engages the public. Tourists from all over the world and locals alike flock to Crater of Diamonds State Park in Pike County Arkansas to search for a variety of gemstones, most notably diamonds. Could Colorado deposits provide material for a viable tourist operation like the one in Arkansas? This study examines the land use implications of a potential diamond-producing state park in Colorado based on the Arkansas model.

Intercomparison of Eco-Geomorphologic Models: Toward a Unified View of Hydro-Eco-Geomorphological Process Sensitivities for Coastal Wetland Evolution

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Keywords: Ecogeomorphology, Coastal Wetlands, Numerical Modeling

A growing number of eco-geomorphologic models have been developed to understand the interactive roles of coastal eco-geomorphologic processes on coastal marsh landscape. These models vary in complexity and formulation but share the same objective of simulating marsh topographic change as a function of sedimentation and erosion, however, various formulations have been used in these models to represent erosion and sedimentation processes. Although these models have been increasingly applied to understand coastal marsh dynamics at multi-scales, a quantification of how the differences in the formulation of these models contribute different simulation outcomes is still lacking. Additionally, the resulting sensitivity to the chosen formulation and parameter selection has not been rigorously tested to date. In this study, we present the results of a comparison of two eco-geomorphologic models by investigating the sensitivity of their elevation profiles, sediment fluxes, vegetation biomass, and hydrodynamics to model processes and parameterizations. We used four simulation scenarios to compare the two models including a bare soil scenario, sea-level rise scenario, wave scenario, and vegetation scenario. The similarity and difference in the sensitivity of the two models under the four scenarios are analyzed and discussed. We also investigated how the use of morphological acceleration technique affects simulations. Lastly, this study discussed the influence of initial condition selection on model sensitivity and hydrodynamics in the eco-geomorphological simulations. This study provides a framework and efficient metrics for eco-geomorphologic model evaluation and comparison. This study represents the first step in a continuing effort toward a unified view of eco-geomorphological model integration.

Improved UAV Data Processing for Generating Correct High-Resolution Digital Elevation/Terrain Models

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Keywords: UAV, Filtering method, DEM

Unmanned Aerial Vehicles (UAVs) are gaining increasing popularity as a reliable tool for environmental applications and water resource management. In particular, combining light weighted low-cost UAVs with Structure-from-Motion (SfM) and Multi-View Stereo (MVS) algorithms allows for producing Digital Elevation/Terrain Models (DEM/DTM) with very high resolution for various topography-based applications. A common challenge encountered in this process is filtering elevation noise propagated from point cloud data to DEM and derived from protruding ground objects. This study proposes a workflow of analyzing UAV data with a focus on elevation noise filtering, which is structured in three steps: (1) Optimizing UAV images processing parameters using Pix4D software; (2) Selecting an effective elevation noise filtering method based on the comparison of four approaches; and (3) Assessing DEM accuracy using field reference data. Results from statistical analyses of elevation and point cloud density at various spatial resolutions were utilized to select appropriate processing parameters in Pix4D. Three out of the four noise filtering methods compared here performed poorly in all topographic conditions: (i) the moving window smoothing filter embedded in Pix4D; (ii) the Statistical Outlier Removal (SOR) using K-Nearest Neighbor search adopted in Cloud-Compare; and (iii) elevation histogram stretching applied in ArcMap. The fourth method, utilizing point cloud density information to capture the spatial pattern of elevation noise, effectively reduced error propagation and got promising results in all topographic conditions. The UAV-derived DEM had a low Root Mean Square Error, in the order of 0.05 m. Issues related to elevation noise filtering are discussed further. Our workflow provides a general standard for producing high-quality DEM data in the future.