SUMMARY OF RESEARCH INTERESTS
Patrick Pease

During my career I have developed a diverse research agenda. My primary interests are in geomorphology, rooted in empirical field studies that address topics in process geomorphology, paleoenvironmental reconstruction, and landscape development. Much of my work has involved the study of sediment transported in aeolian environments and the use of geochemical techniques to aid in understanding sediment sources and sinks. In addition to my primary research fields, I often see myself as an opportunistic researcher and am happy to jump at a chance to do something new.

I've published in a variety of quality geomorphology/geography journals including *Earth Surface Processes and Landforms*, *Geomorphology*, *Quaternary International*, and the *Annals of the AAG*. Since my work is often interdisciplinary in nature, I've also published in journals outside my discipline including *Spectrochimica Acta, Deep Sea Research,* and *Environmental Geology.* My eclectic interests leave me with a multiplicity of past and future projects that complement my main themes of research. The following provides a summary of my primary research work in geomorphology along with some insight on current and future projects that I have in various stages of completion. Additional publications not related to geomorphology are not referenced hear, but are listed on my vita.

Sediment Transport

Fluid dynamics and transport mechanisms in coastal sand dunes

Sediment transport processes is one of the fields I work in and is best exemplified in my recent research on airflow dynamics in coastal dune blowouts [2]. For that study a spatial array of anemometers/wind vanes were installed throughout a blowout. Most wind flow studies focus on vertical profiles of wind, so examining horizontal, spatial variations was unique. The conclusion of the study showed that topography exerts a strong control on local airflow direction and speed, but the characteristics of the influence changes with approach angle of the wind due to changing topographic profiles. Wind approaching the same feature, but from different directions, experience altered topographies that impact wind flow in unique ways. Furthermore, erosion and sand transport in blowouts is highly variable and changes with fluctuating wind directions; depending on the approach angle the blowout can change from a highly erodible feature to a depositional basin.

Sediment transport and Landscape Development in arid environments

Much of my research has examined large-scale landscapes and the use of geochemical data to interpret sediment provenance. This is well exemplified by a project on the development of the Wahiba Sand Sea [11, 13]. The goal of that research was to reconstruct the sources and transport pathways of sediments in the dunes and thereby constrain the developmental history of the area. I used geochemical "fingerprinting", mineralogy, and remote sensing methods to identify regions of distinct sediment composition within the sand sea. Those data were then used to interpret sediment sources, delivery pathways, and the developmental history of the sand sea along its relationship to fluvial and coastal systems.

In a similar project in the Mojave Desert I used geochemical characterization to establish the source variability in aeolian sand supplied to sand ramps [9]. Sand ramps contain a variety of deposits formed in different environments and are a valuable source of paleoenvironmental information. It was important to determine if the aeolian sediment in the sand ramps was derived from discrete, local sources, or if the sand had moved a long distance through wind corridors. Geochemical data from units within the sand ramps indicated that sources for each sand ramp changed through time, probably as sediment availability from different local fluvial/playa systems changed in response to climate fluctuations; however, each sand ramp is composed of sediment from discrete, local sources suggesting that the wind corridors in the Mojave do not act as coherent sand transport pathways.

Erosion and Transport of Dust in arid environments

In addition to sand transport in aeolian environments, I've conducted research projects on dust in a number of settings. A large-scale project focused on seasonal climatic controls on dust production in the Middle East. I looked at seasonal dust concentrations in the atmospheric boundary layer over the Arabian Sea. Using geochemical characterization, I examined the relative significance of the dust to the total aerosol load, the flux of mineral dust into the Arabian Sea, and the sources of the dust and the atmospheric pathways of transport. This project brought together concepts including aeolian process, climatology, geochemical characterization, and ecosystem analysis [15, 16].

Erosion and Transport of Dust from Agricultural Fields

I've also researched local-scale issues of aeolian dust from agricultural fields [6, 8]. I conducted research on coastal plain fields in eastern North Carolina and established that wind erosion is an important mechanism for agricultural soil loss in the region despite the widely held belief that aeolian processes are of little significance in that humid environment. Aeolian sediment loss can be significant when poor land management practices are employed. This type of erosion is particularly insidious in that it appears to removal of the most nutrient rich portion of the soil.

I am currently working on a follow up project that looks specifically at the nitrogen and phosphorus loss from agricultural fields due to wind erosion. The early data analysis reveals that there is significant loss of nutrients in the dust component of deflated sediment. There is an inverse relationship between the decrease in sediment transport mass with height above the bed and the concentration of nutrients. This is because the concentration of clay increases with height above the saltation layer which carries a much higher proportion of nutrients than the relatively sterile sand near the bed. The consequence is that, since sand stays on the field but the fine particles are deflated as dust, fields subject to wind erosion become coarser and increasingly sterile over time.

Fluvial Erosion and Deposition

Hurricanes Dennis and Floyd produced a flood of record in eastern North Carolina. That event was a classic example of my "opportunistic" attitude toward research. Even though I don't consider myself a fluvial geomorphologist, I co-authored an early synopsis of that event [10] and conducted two research projects. One of the papers presented data on the amount of sedimentation that occurred during the flood and compares the findings with those from other large floods. The final conclusion was the event sequencing is a more critical variable for the availability of sediment than is the magnitude of the event [7].

I also examined heavy metal contamination of the fluvial overbank deposits following the flood [3]. That project revealed high levels of arsenic in flood sediments, reworked from agricultural soil. Arsenic-based defoliants had been used extensively in the past on cotton fields and the stored arsenic was mobilized with clay from the fields during the flood. The study also showed spatial variability in metal content in the flood sediment controlled partly by differential deposition of clay and organic content throughout the flood zone. An interesting outcome highlighted in the work was the difficulty in determining what constitutes contamination. There are several indices related to metal contamination and the final conclusion of a study like this depends on which is used.

In addition to flood sedimentation, I've worked with colleagues on fluvial-based research associated with agricultural erosion. I worked on projects that examined the role to drainage ditches in the sediment cycles of agricultural fields [4, 12]. Ditches are used to lower the water table, but serve as a site for erosion due to over steepening and facilitate a complex dynamic between sediment transport and storage.

Another fluvial-based project I work on examined seasonal controls on sediment delivery to agricultural watersheds [5]. This study demonstrated the variability in sediment erosion between different seasons, controlled by crop cover and rotation, weather patterns, and antecedent conditions.

Methodology Research

Recently I've begun looking more at methodologies associated with the collection of geochemical data, specifically in regards to geologic and geomorphic applications of laser-induced breakdown spectroscopy (LIBS). A recent paper published in *Spectrochimica Acta Part B: Atomic Spectroscopy* [1], looked at sample preparation methods to maximize quantitative results using LIBS for geochemical bulk analysis. The paper systematically compared results from traditional sample preparations with a new method I proposed which showed marked improvements in accuracy and repeatability. That is an especially noteworthy paper in regard to the interdisciplinary nature of much of my work. *Spectrochimica Acta* is a chemistry journal, well outside of my discipline, and publishing in it marks a broadening of my research scope.

Modeling and Landscape Evolution

Although most of my work is empirical, I also have an interest in theoretical issues in geomorphology. I conducted a study, working with a theoretical mathematician, which examined the sedimentary processes that govern the morphology of alluvial fans [14]. The findings were compelling because we found that a single diffusion-based model in non-dimensional space could explain the longitudinal profiles of all fans we examined, implying a ubiquitous control on morphology without regard for specific environmental variations or the absolute size of the fan.

My earliest research interests were in the evolution of karst landscapes. I conducted research that focused on environmental and landscape changes in southern Indiana during the reconstruction of the Ohio River at the end of the Pleistocene glaciations [17]. Using a paleomagnetic stratigraphy of cave sediments I developed a model of environmental and hydrologic change for that area. I was able to identify local scale responses in the development of the landscape to regional scale changes rooted in the termination of the Pleistocene ice age. Of particular note, I identified the first regional scale correlation of cave development in North America [18].

Future Work

Following a few years focused on my administrative position, I have reestablished a full research agenda and I resumed field and lab work a couple years ago. Those efforts are now paying off with new papers in print, review, and preparation. Some of my current projects that are well underway are described here.

Presently I am working on another methodology-based project that develops a new method for analyzing sediment provenance. Most studies are accomplished with bulk geochemical analysis; however, bulk analysis yields a mixed, averaged composition. Recently I developed a new analytical method to isolate and classify individual sand grains using LIBS to create geochemical fingerprints. The process allows researchers to target grain groups based on a specific mineralogy, size, or other characteristic. This method opens new opportunities to better refine our ability to link sediment to source. I am using the Wahiba Sand Sea samples as the case study because those dunes have a ubiquitous concentration of carbonate grains which has lead previous studies to conclude the sand must be derived from a coastal source.

I am continuing work on airflow dynamics in coastal dunes with my colleague and we have a second paper on the interaction of topography and wind in review at *Earth Surface Processes and Landforms*. This paper looks more specifically at variation in wind speed resulting from wind approaching from different angles and the consequences on sand transport. Following this same line of research, we have begun new work on the application of a computational fluid dynamics (CFD) model to the airflow pattern in coastal dunes. Although our anemometer work allowed us to measure a spatial pattern of airflow through a complex topography, there are still gaps in the distribution of instrumentation. I have been able to develop theoretical wind field maps using our existing data as input/training sites.

In the summers of 2012 and 2013 I spent time in Wyoming at a new field site where I am resuming work on provenance studies along with a UNI colleague. The dune field is unusually long in the downwind direction and we are examining sand sources to determine if the dunes on the downwind end have migrated some 60 miles, or if dunes have been created *in situ* throughout the field and undergone more modest migration. The results will have implications on our understanding of climate patterns in the region.

I’ve been working on in unique project along with a colleague using Lab-based hyperspectral imaging to examine lake cores. Traditional lab methods used to analyze cores suffers from the necessity to subsample and homogenize material resulting in a loss of temporal resolution. Furthermore, lab techniques are both time consuming and costly, and often there is insufficient material for a full suite of studies. We are testing the capabilities of lab-based hyperspectral imagery as a rapid, non-destructive supplement or alternative to traditional lab analysis for investigating key components of core composition.

Publications referenced in this **Summary of Research Interests** document
Additional publications are listed on my vita

[1] Patrick Pease, 2013. "Fused Glass Sample Preparation for Quantitative Laser-Induced Breakdown Spectroscopy of Geologic Materials", *Spectrochimica Acta Part B: Atomic Spectroscopy*, 83/84: 37-49.

[2] Patrick Pease and Paul Gares, 2013. "The Influence of Topography and Approach Angles on Local Deflections of Airflow within a Coastal Blowout", *Earth Surface Processes and Landforms*, 38: 1160-1169.

[3] Patrick Pease, Scott Lecce, Paul Gares, Catherine Rigsby, 2007. "Heavy metal contamination in sediment deposits on the Tar River floodplain following Hurricane Floyd", *Environmental Geology*, 51(7): 1103-1111.

[4] Scott Lecce., Paul Gares, and Patrick Pease, 2007. Drainage ditches as sediment sinks on the Coastal Plain of North Carolina. *Physical Geography*, 27(5): 447-463. [2006 date but published in 2007]

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[6] Paul Gares, Michael Slattery, Patrick Pease and Jonathan Phillips, 2006. Eolian Sediment Transport on North Carolina Coastal Plain Agricultural Fields. *Soil Science*, 171(10): 784-799.

[7] Scott Lecce, Patrick Pease, Paul Gares, and Catherine Rigsby, 2004. "Floodplain Sedimentation During an Extreme Flood: The 1999 Flood on the Tar River, Eastern North Carolina". *Physical Geography*, 25 (4): 334-346.

[8] Patrick Pease, Paul Gares, and Scott Lecce, 2003. "Eolian Dust Erosion From an Agricultural Field on the North Carolina Coastal Plain", *Physical Geography,* 23 (5): 381-400.

[9] Patrick Pease and Vatche Tchakerian, 2003. "Geochemistry of Sediments from Quaternary Sand Ramps in the Southeastern Mojave Desert, California", *Quaternary International*, 104: 19-29.

[10] Scott Lecce, Patrick Pease, Paul Gares, and Catherine Rigsby. "Sedimentation in the Tar River floodplain associated with Hurricane Floyd". In <u>Hurricane Floyd and its Aftermath</u>. Coastal Carolina Press.

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[13] Patrick Pease, Gregory Bierly, Neil Tindale, & Vatche Tchakerian, 1999. "Mineralogical Characterization and Transport Pathways of Dune Sand using Landsat TM Data, WahibaSandSea, Sultanate of Oman", *Geomorphology*, 29: 235-249.

[14] Lawrence De Chant, Patrick Pease, & Vatche Tchakerian, 1999. "Modelling Alluvial Fan Morphology", *Earth Surface Processes and Landforms,* 24: 641-652.

[15] Neil Tindale & Patrick Pease, 1999. "Aerosols over the Arabian Sea: Atmospheric Transport Pathways and Concentrations of Dust and Sea Salt", *Deep Sea Research*, 46: 1577-1596.

[16] Patrick Pease, Vatche Tchakerian, & Neil Tindale, 1997. "Aerosols Over the Arabian Sea: Geochemistry and Source Areas for Aeolian Desert Dust", *Journal of Arid Environments,* 39: 477-496.

[17] Patrick Pease & Basil Gomez, 1995. "Landscape Development as Indicated by Basin Morphology and the Magnetic Polarity of Cave Sediments, Crawford Upland, South-Central Indiana", *American Journal of Science*, 297: 842-858.

[18] Patrick Pease, Basil Gomez, & Victor Schmidt, 1993. "Magnetostratigraphy of Cave Sediments, Wyandotte Ridge, Crawford County, Indiana: Towards a Regional Correlation", *Geomorphology*, 11:75-81.