Geomorphology 200 (2013) 34–41

Contents lists available at ScienceDirect

Geomorphology

journal homepage: www.elsevier.com/locate/geomorph

Geomorphology in context: Dispatches from the field

Carol P. Harden *

Department of Geography, 304 Burchfiel Geography Building, University of Tennessee, Knoxville, TN 37996-0925, USA

ARTICLE INFO

Article history:
Accepted 28 March 2013
Available online 5 April 2013

Keywords:
Field research
Geomorphology
Spatial context
Site selection biases
Field experience

ABSTRACT

Field research enables a researcher to view geomorphic systems in broader contexts than those envisioned while at a desk and can yield unanticipated insights that change the course of an investigation or affect the interpretation of results. Geomorphological field research often produces 'aha!' moments, epiphanies that enhance understanding and lead toward more complete explanation of the processes and landforms under study. This paper uses examples from 'aha!' moments in the field to demonstrate the importance of field observation as a way of gaining information about the broader contexts of research sites, especially in process geomorphology. Spatial contexts include the scales of processes and features, linkages between a study site and its surroundings, and information observed in the field about other processes, anthropogenic activities, or unexpected factors that might affect a study. Temporal contexts, not as evident in the field, place a research site in a longer term history of changes and adjustments. Finally, exploring an abstract set of mental contexts reveals reasons that expectations differ from the realities encountered in the field—constraints and biases that a researcher may not have noted—and the possibility that the unexpected can potentially advance geomorphic research. Time spent in the field complements scientific reductionism and provides opportunities to appreciate the richness and complexity of Earth surface systems.

1. Introduction

Planning for new research typically occurs indoors, away from the geomorphic system or site to be studied, and necessarily involves reducing complex systems to key factors or indicators to design manageable research projects. The reductionist nature of science and resultant need to isolate individual factors can mean that, even in the field, a researcher might focus on equipment or on a small area without examining its surroundings. Such focus can cause the researcher to overlook important characteristics of the landscape, even to the point of missing essential elements of a system under study. The combined effects of scientific reductionism and limited first-hand experience have the potential to create eye-opening moments—epiphanies—and foster new insights for observant field researchers.

The purposes of this paper are to promote the importance of understanding the broader contexts of a geomorphic research site and to call attention to types of eye-opening realizations of those contexts that can occur in the field. Revealed contexts are divided into three types: spatial, temporal, and mental. When this paper was presented at the Binghamton Geomorphology Symposium, some observations were introduced as 'dispatches from the field' to reflect their serendipity and anecdotal nature. Table 1 provides examples of those 'dispatches.'

2. Spatial/biophysical contexts

2.1. Scale

A common cause of an 'aha' moment in the field, for researchers as well as for students, comes with the experience of seeing a particular feature first-hand and finding that its size is much different from that imagined in the mind's eye. The size of glacial features, for example, is often underestimated when based on textbook knowledge. A researcher familiar with small, Little Ice Age terminal moraines of mountain glaciers (perhaps only 1–2 m in height) may feel quite stunned to recognize that an entire tree-covered ridge, such as that flanking Moraine Park in Rocky Mountain National Park, is a moraine. Likewise, the size of major eskers and large glacial erratics conveys a sense of the magnitude of glacial action likely to exceed that imagined by most readers. The Madison boulder in New Hampshire, considered to be the largest glacial erratic in North America, exemplifies such a larger-than-expected feature (NH State Parks, 2012). At the other extreme, someone accustomed to looking at river terraces in mountain regions might be quite surprised at the submeter subtlety of difference in terrace heights in the lower Mississippi River valley. Developing a

* Tel.: +1 865 974 8357; fax; +1 865 974 6025.
E-mail address: charden@utk.edu.

0169-555X/$ – see front matter © 2013 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.geomorph.2013.03.025

Table 1
Dispatches from the field: examples of discovering the unexpected while doing field research.

- I never expected the moraine to be so high. I was looking down, but I should have been looking up. The whole ridge is a moraine! (– graduate student)
- Until I saw the tractor-track rills, it had never occurred to me to think about driving a tractor on such a steep slope. They must go directly down the hill because sideways is too dangerous. Of course, the tractor tracks are ready-made channels for runoff. (– the author)
- There's more happening to these streambanks than we had imagined. The rising stage sampler was dry, but the bank near it and above it had eroded. That means that the erosion wasn't caused by hydraulic action. (– professor and graduate students)
- When I do the pebble count, what should I do about things like shopping carts, bedsprings, and old tires? Should I measure the B axes and record them as bedload? (– graduate student)
- After we finished measuring the stream discharge, we walked upstream. What a surprise — there was a hose attached to a pump on the left bank. (– professor and graduate students)
- What's wrong with this picture? The stream is turbid, but it hasn't rained in days. (– the author)
- The rainfall runoff isn't being generated in the field. It's spilling onto the field from the path! (– the author)
- Bears chewed on the hoses, so we had to start over with the soil–water experiment. (– field technician, National Park Service)

sense of spatial scale in the field is an important calibration process that can be developed through field experience.

2.2. Being there

The Gros Ventre, Wyoming, rockslide of 1925, as detailed by Voight (1978), was a high magnitude, catastrophic event that provided early warning signs to individuals who had been observing the land. According to Nelson's descendents, Albert Nelson (a trapper) and Billy Bierer (a prospector and bear hunter who lived in the Gros Ventre Valley) had discussed the newly flowing springs they had encountered on the mountainside. At least one of the springs had created a swampy pool, and Bierer predicted that water with no outlet would follow underground strata and eventually cause the entire mountainside to fail (Voight, 1978). Bierer sold his property in 1920, and the new owner (Huff) had to race for his life on 23 June 1925, when the slope catastrophically failed, burying Bierer's old cabin during the ~3-min mass movement. Huff had noticed numerous new disturbances earlier in the day and, fortunately, was already mounted on horseback when the slide began. Stories of the observations of Nelson and Bierer and eyewitness accounts added important details of the precursors and duration of motion to what can be gleaned from the geomorphic record of the Gros Ventre rockslide, the largest historical rockslide in the United States.

Being present in the field allows a researcher to look beyond specific field sites and better understand other processes that may affect those places. Among the author's field experiences, while studying soil erosion rates in the Ecuadorian Andes, were three observations revealing important physical contexts of soil erosion that would have otherwise gone unnoticed. First, a rate of rainfall that is not sufficient to initiate rainfall runoff within a field can generate runoff on nearby road or trail surfaces (Harden, 1992, 2001). Downhill from a road or trail, a bare field becomes vulnerable to erosion when rainfall runoff, generated on the denser surface, spills over onto the field. In other words, soil erosion at one site is not necessarily a function of rainfall runoff generated within the site. Second, tractor use on steep slopes can promote rainfall runoff and accelerate rill erosion. On steep slopes, tractors must be driven directly down the fall line. Tractor wheels, thus, compact the soil along downslope tracks that promote the initiation of rainfall runoff, provide ready-made channels for the flow of water, and serve as effective conduits for soil removal. Eroded tractor tracks can persist through the growing season, especially if seeds were washed away in the track channels (Fig. 1). Third, although a trained eye should be able to observe the effects of soil erosion in the form of rills, gullies, or sediment deposits, the absence of such evidence might not indicate the absence of erosion. During an early morning field visit, the author found local workers out in the fields, reconstructing furrows by hand to erase rills formed by rain the previous evening. Several hours later, the residents were gone, as was visible evidence of the erosional episode. In each of these examples, being present to observe the broader context of these sites, including the relationship of study sites in agricultural fields to lands external to the fields and the practices of local farmers, led to the discovery of a previously unforeseen explanation for the measured rates of soil erosion.

A sometimes-overlooked geomorphic process that becomes evident to those who actually spend substantial amounts of time in streams is streambank erosion. Streambanks have been shown to contribute up to 80% of the sediment eroded from incised channels in the loess area of the American midwest (Simon et al., 1996). Although hydraulic action is generally assumed to cause bank erosion, and stream channel width and depth have been shown to be functions of discharge (Leopold and Maddock, 1953), more recent attention to streambanks has called attention to the importance of mass wasting processes in bank erosion (Simon et al., 2000; Darby et al., 2007; Rinaldi and Darby, 2007) and the need to consider factors other than excess shear stress (Lawler et al., 1997). Hydraulic action is not the sole explanation for streambank erosion, as field observations, combined with reference markers and water stage recorders, confirm that some streambank erosion occurs subaerially (e.g., Lawler, 1993; Wynn and Mostaghimi, 2006; Harden et al., 2009).

2.3. Human activity

Few landscapes are pristine. Rather, most are affected in some way by human activity. Although classical training and methods of hydrology and fluvial geomorphology are based on 'natural' environments, few streams and rivers remain in the natural form. Many streams, particularly those in urban areas, contain particles and roughness elements not represented in the literature (e.g., Barnes, 1967). To move beyond the temptation to overlook bedload in the form of cinderblocks, shopping carts, tires, bedsprings, and other large particles of anthropogenic origin, Grable and Harden (2006) coined the term CRUD for *coarse-riparian-urban-debris*. Even particles that are not natural affect the flow of water and movement of sediment.

Many other examples exist of human intervention unanticipated by researchers. How often have hydrologists or fluvial geomorphologists in the field found evidence of activities, such as water being pumped or discharged, that had not been recorded in official documents? In the eastern states of the U.S., where water law is based on the riparian doctrine (essentially, that the riparian landowner may use water if downstream riparians are not injured by the use), finding pumps that remove water from a stream is not uncommon. This is allowable, up to the point of exceeding a state limit (the state of Tennessee, for example, does not set a limit, but issues permits for withdrawals that exceed 10,000 gal/d; Christy et al., 2005) or being contested in court by a downstream riparian. Withdrawals, however, confound measurements of discharge for researchers. Similarly, whereas good records can be expected for authorized modifications to channels, unauthorized (informal) channel modification (straightening, damming, and sand extraction) or unauthorized discharges into a stream might only be discovered in a first-hand visit. Such discoveries highlight the importance of looking beyond the designated sites in field studies.

Readers of textbooks would expect the amount of suspended sediment in a stream to be a function of rainfall-initiated erosion of the land. Being in the field, however, reveals other sediment sources, such as direct dumping of fines into the stream, instream mining of sand and gravel for construction (Fig. 2), streambank degradation by cattle (Trimble, 1994), or all-terrain-vehicles being driven in and out of the stream. One important clue for these interventions is that