Project Summary - *Collaborative Research*
The Textbook Reconsidered -- Creating the Shortbook of Geomorphology

As a model for the STEM disciplines, we seek support to create and assess, a new style of textbook - an economical, succinct, and focused guide to the most important tenets of *Geomorphology*, the study of Earth's dynamic surface. This *Shortbook* will be made up of 15 chapters, each 15 to 18 pages long, and each focused specifically on core concepts identified though a process of community consensus building. The goal of this book, and its accompanying public-domain e-media, will be to organize and present the most important knowledge about Earth's surface in a concise fashion relevant to the way in which today's students deal with information. This project will provide a generalizable model for textbook creation in the STEM disciplines while directly benefiting a fast-growing and dynamic discipline of the Geosciences.

The textbook, which will be designed, printed, and distributed by a commercial publisher, will be linked to a public-domain website that will host a suite of e-media we term *Vignettes*. These *Vignettes* are short (<1000 word) case studies that supplement the text and allow customization of the learning environment. Some will be place-based geologic examples; some will be quantitative treatments of significant equations or problems in Geomorphology; others will feature videos or animations that clarify difficult concepts. *Vignettes* will be created by experts, vetted by others, linked to the textbook, searchable on line, and available free, both on line and as PDF versions.

Intellectual Merit – Textbooks remain the primary means by which scientists and engineers are trained; yet, despite major advances in pedagogy, most textbooks remain costly, expansive compendiums of knowledge that idiosyncratically reflect their authors' experiences. The novel *Shortbook* concept we propose comes directly from the recommendations of a 2006 NSF/National Academy of Sciences workshop, *Reconsidering the Textbook*, which suggested that textbooks of the future would be short, economical, reflect community consensus, be student-centered, and be well and purposefully integrated with e-media. This project seeks to test the workshop recommendations by creating a new textbook in the growing discipline of *Geomorphology* for which the existing texts were first published between 12 and 30 years ago. An assessment plan, which is integral to this proposal and our textbook development process, will improve the quality of the final product and determine whether the project has met its goal of creating a book that is widely accepted and useful for both students and faculty. Broad community participation in textbook creation is new idea that serves both to vet content and improve the book's chance of broad acceptance.

Broader Impacts – By piloting a new type of textbook and by assessing its success, the impacts of this project will be broad and significant for STEM disciplines in general and for the field of *Geomorphology*, specifically. The consensus-building process of content selection will formalize links between Geomorphologists and engage them in meaningful discussions of pedagogy related to defining the core concepts of the discipline. At a more local level, the project will support the training of two graduate students in Science Education. The public domain website will provide, free of charge to all, a diverse, vetted set of geomorphological *Vignettes* useful for teaching and learning.

TABLE OF CONTENTS

For font size and page formatting specifications, see GPG section II.C.

*Proposers may select any numbering mechanism for the proposal. The entire proposal however, must be paginated. Complete both columns only if the proposal is numbered consecutively.

TABLE OF CONTENTS

For font size and page formatting specifications, see GPG section II.C.

	Total No. of Pages	Page No.* (Optional)*
Cover Sheet for Proposal to the National Science Foundation		
Project Summary (not to exceed 1 page)		
Table of Contents	1	
Project Description (Including Results from Prior NSF Support) (not to exceed 15 pages) **(Exceed only if allowed by a specific program announcement/solicitation or if approved in advance by the appropriate NSF Assistant Director or designee)**	0	
References Cited		
Biographical Sketches (Not to exceed 2 pages each)	2	
Budget (Plus up to 3 pages of budget justification)	4	
Current and Pending Support	2	
Facilities, Equipment and Other Resources	1	
Special Information/Supplementary Documentation	32	
Appendix (List below.) **(Include only if allowed by a specific program announcement/ solicitation or if approved in advance by the appropriate NSF Assistant Director or designee)**		
Appendix Items:		

*Proposers may select any numbering mechanism for the proposal. The entire proposal however, must be paginated. Complete both columns only if the proposal is numbered consecutively.

Results from Relevant and Recent NSF Support

Bierman, P.R., *Eroding the Appalachians*, National Science Foundation, $199,856, 6/1/03–6/1/09.

This award has supported 3 MS students and a doctoral candidate as they worked in various areas of the southern Appalachian Mountains including the Susquehanna Basins (Reuter et al., accepted), the Blue Ridge Escarpment (Sullivan et al., accepted), the Great Smoky Mountains (Jungers et al., 2007), and the southern Appalachian Piedmont. Their work, using more than 400 cosmogenic isotope analyses of soil and river sediment, shows that the mountain chain is slowly eroding (on average about 17 m/My) and that there is a significant dependence of erosion rate on average basin slope but not on lithology. This award is one of many provided by the NSF to Bierman and the UVM cosmogenic nuclide laboratory since 1993 that have led to >50 refereed publications, nearly 200 abstracts, and supported more than 20 graduate students. Full details of supported projects and a list of publications can be found at the lab web-site (*uvm.edu/cosmolab*).

Bierman, P.R., *Bringing Relevance to Earth Science Introductory Curricula through Images Showing Human/Landscape Interaction*, NSF Educational Materials Development $75,000, 5/1/05-4/30/07.

This award supported the development of web-based, e-media designed to help students in introductory Geomorphology understand the landscape through the analysis of historic photographs (Massey et al., 2005, 2006). Extensive concept mapping was used to develop 5 modules detailing how rivers work. These modules were built for the web (*uvm.edu/learninglandscapes*) and tested by Co-PI Massey for efficacy and student response using formative and summative evaluations including interviews, knowledge surveys, and web-use observations. Based on this assessment, the interface design was improved. This program is linked to the NSF-supported image archive we maintain, the *Landscape Change Program*.

Bierman, P.R., Watzin, M., Wemple, B., Rizzo, D. and Druschel, G., *Piloting an Interdisciplinary Watershed Fieldcamp*, National Science Foundation, $151,522, 9/1/06-8/31/09.

This award supported the development of an interdisciplinary field-based learning environment centered on the concept of a watershed (Pearce et al, 2007a). Five faculty worked together in teams to teach Geology, Ecology, Hydrology, and Geochemistry using the Winooski watershed in northern Vermont as the catalyst for student learning (*uvm.edu/watercamp*). The summative assessment of the program's first year indicated that both the field and interdisciplinary components were well received and educationally effective for the students (Pearce et al, 2007b).

Bierman, P.R.: *Landscape Imagery: a catalyst for formal and informal science education*, National Science Foundation Distinguished Teaching Scholar Award, $306,496, 8/1/05-7/30/09.

A four year award has supported further development of the *Landscape Change Program* (*uvm.edu/landscape*) including support for a MS student in Computer Science to completely rebuild the web interface and the development of an on-line, undergraduate, 3-credit course tied to the archive content (*Changing Face of Vermont Landscapes*). This revision was done iteratively with feedback from formative assessment sessions and occurred concurrently with the development of learning resources (*uvm.edu/landscape/learn*) through workshops with K-12 teachers. Currently the project is supporting 6 undergraduate interns to collect an additional 8,000 images this summer and vet the Standard Operating Protocols developed for image collection and description.

Bierman, P.R.: Workshop proposal - *Reconsidering the Textbook*, National Science Foundation, $99,983, 10/1/05-10/31/08.

This three-year award supported planning for, execution of, and follow-up from a 50+ person workshop at the National Academy of Sciences. The workshop brought together academics, professionals, and National Science Foundation personnel for three days of discussions focused on the current state and future of the textbook as a learning resource (Bierman et al., 2006). The goal of the workshop was to record the breadth of thinking and then derive a consensus view on the future of textbooks. The goal was achieved using catalytic speakers followed by a series of short break-out groups. The process and results of the workshop are reported on an extensive web site (*serc.carleton.edu/textbook*). The workshop's conclusion, that the textbook of the future will be short, authoritative, reflect community consensus, and be well integrated with e-media is the catalyst for this current proposal.

Hallet, B. H., Stone, J., **Montgomery, D. R.,** and Nelson, B.: *Geodynamics of Indenter Corners (collaborative research with P. Zeitler et al.),* National Science Foundation, 8/17-01-8/16/06, $490,335.

A five-year collaborative study of the tectonics and geomorphology of the Namche Barwa region supported 2 Ph.D. theses (Alison Anders and Noah Finnegan) and has so far resulted in the publication of 6 papers. Advances included the discovery of glacially impounded lakes and resulting outburst floods (Montgomery et al., 2004), documentation of strong coupling between erosional forcing and regional tectonic deformation (Montgomery and Stolar, 2006; Finnegan et al., 2005, 2008), and documentation of the role of precipitation pattern (Anders et al., 2006) and phase (Anders et al., in press) in the evolution of mountainous topography.

Project Description - Creating the Shortbook of Geomorphology

What's the Problem?

For decades, the printed textbook has been the means by which factual knowledge is both organized and distributed to students in the STEM (science, technology, engineering, and mathematics) disciplines. Textbooks serve to gather and bound an established body of knowledge; they function both as a mechanism for initial learning and as a reference for the future (Issitt, 2004). Some type of peer-review process usually vets information in texts (a good thing in most cases) while the time lag from writing to publication tends to date material in rapidly evolving fields (a drawback).

Textbooks remain the primary means by which scientists and engineers are trained; yet, most textbooks reflect a model that has remained unchanged for more than a century (Issitt, 2004). The traditional model developed, and the multi-hundred page textbook matured, when access to information was limited. In those days, the faculty member and the textbook served as both repositories for and gateways to information.

Fast-forward to the twenty-first century. Enter the Internet and Google and the situation has changed dramatically (Wittenberg, 2006). Today, almost any student anywhere can access more information than they can possibly digest. The limit is no longer access to information; rather, learning is in many ways limited by the quality of information and

the lack of a novice learner's ability to parse and organize that information. No longer is information itself power; rather, power is gained from the ability to access the right information quickly. Electronic media are a commonplace and comfortable part of academic life for most of today's higher-education students (Skelly, 2007). How then does a thousand-page introductory science textbook fit into the cultural and learning environment of today's student? So would argue, it doesn't (Murray, 2004). Others, such as publishers, argue that textbooks continue to have great value (www.textbookfacts.org).

During the past decade, the maturation of the world-wide-web, the escalating costs of traditional textbooks, and the ability of nearly every student to have a virtually unlimited pool of information at their finger tips, suggest that the time has come for a different approach to creating textbooks (Ansary, 2004; Bierman et al., 2006; New York Times, 2008). Today's textbooks are no longer the exclusive holders of information; rather, if textbooks are to survive, they must become the means by which the core knowledge of a discipline is organized, vetted, and delivered to the student in an efficient, attractive, and cost-effective way.

Here we present our approach for designing a model textbook for the 21st century. This is a textbook built on community consensus; it is designed to capture the core knowledge of a discipline, presenting the most important and central information in an easily accessible format. We intend this textbook as an example for all the STEM disciplines while filling a specific need in the growing and rapidly changing field of *Geomorphology*, the study of Earth's dynamic surface.

Philosophy of this Project

Using extensive community input, we will create a new kind of textbook. It will be a short, concise, and internally consistent volume that clearly presents the most important information students need. Our goal is to produce a text that will function as a readable guide to the discipline of Geomorphology without being encyclopedic or idiosyncratic.

Critical to this effort has been and will continue to be inclusion of the broader community in the book and associated e-media development process so that the final volume will be accepted and used by the majority of those teaching about Earth's surface. Our goal is to avoid the idiosyncratic nature of current texts, which tend to reflect individual authors' experiences and specialties. Because of the deep and on-going community involvement, there should be a wide base of vested faculty prepared to adopt the text immediately upon publication.

Current situation – Geomorphology

Multiple lines of evidence indicate that the field of Geomorphology is healthy and growing. The National Science Foundation recently established a program specifically to support Geomorphic Research (*NSF 05-7458, Geomorphology and Land Use Dynamics*). Many journals are specifically targeted toward geomorphological audiences including:

Geomorphology, *Journal of Geophysical Research—Earth Surface*, *Physical Geography*, *Quaternary Research*, *Earth Surface Processes and Landforms*, and *Quaternary Science Reviews*. Together, these journals publish several hundred refereed papers each year. In addition, many more general journals including *Science*, *Nature*, *Geological Society of America Bulletin, Annals of the American Association of Geographers*, *Geology,* and the *American Journal of Science* routinely publish geomorphological papers.

Not only is Geomorphological research thriving but Geomorphology is taught in many Geology and Geography departments around the country. Nearly 70 people have registered for the NSF Cutting Edge workshop "Teaching Geomorphology" in summer 2008. Geomorphology graduate programs are growing and thriving at many universities around the United States and elsewhere in the world. Despite the resurgence of Geomorphology as a field, there has not been a new textbook written in 15 years and the last revision of a Geomorphology textbook was a decade ago.

There are currently four Geomorphology textbooks, each differing from the other in significant ways (*Table 1*). The books cover many of the same topics but none consider advances in the field over the past decade, specifically, consideration of Earth surface processes as an integrated system and the impact of human-induced climate change. The current books tend either to concentrate on process (Ritter et al.) or landforms and history (Easterbrook and Bloom). All are long (510 - 576 pages) and none were authored with community input; three of the four are single-authored. Two of the texts were out of print (Ritter and Bloom) and have recently been re-issued (but not revised). Three of the four lead authors are retired. The time is ripe for a new textbook in Geomorphology; one that reflects the current status of the field.

Table 1. Summary of Major Geomorphology Textbooks

Author	*First Published*	*Last Revised*	*Length*	*Cost*	*Number of Chapters*
Bloom	1978	1997	510 pages	$69	20
Easterbrook	1993	1998	546 pages	$129	18
Ritter et al.	1978	1995	576 pages	$65	13
Summerfield	1991	1996	560 pages	$117	19

Relevance to CCLI

This proposal is directly relevant to the CCLI phase I call in several ways. Specifically, the project will:

- Create new learning materials that will improve the quality of science education for undergraduate students.
- Respond to a recognized need for new and different textbooks in STEM education and in a discipline (Geomorphology) where all current textbooks are dated.
- Establish and expand faculty networks through the community-based approach we employ to define and vet content.

- Guide the textbook creation process through formative assessment (including both faculty and student input). Summatively assess the resulting book during its first year of use.
- Serve as a model for other STEM disciplines seeking to create modern textbooks that respond to the needs of today's students.
- Result in a product that is widely disseminated and serves to integrate high quality education with relevant and up-to-date research findings.

Work to Date

Over the past 18 months, we have begun the process of creating a new textbook in Geomorphology. Below, we detail the steps we have taken so far.

1. Reconsidering the Textbook – STEM Disciplines

In response to the seeming disconnect between modern pedagogical techniques and the continued publication of traditional textbooks, PI Bierman, along with collaborator Manduca, convened a three-day intensive workshop at the National Academy of Sciences in May, 2006. At the workshop, which was supported by NSF (DUE-0549185), more than 50 leading scientists, educators, and technology professionals "Reconsidered the Textbook". These STEM professionals participated in numerous joint sessions and breakout groups designed to explore the range of thinking represented by the group. Through small and large group discussions, the assembled group examined the current state of the STEM textbook and its relationship to the growing number of electronic tools that also serve as learning resources for today's student. Together, the participants looked forward and, based on their knowledge of student learning, technology, and effective educational strategies, imagined the textbook of the future.

As coordinator of this workshop, Bierman prepared the workshop report based on condensing the work of many breakout groups and reporting out sessions over three days. The consensus conclusions of the workshop were clear and dictate the overall structure of the book we propose here: focus on knowledge core to the discipline, involve the community, integrate e-media, vet the textbook, keep the book affordable, and use a short format. Our overall approach to writing the *Shortbook of Geomorphology* is guided by the findings of this National Academy workshop as detailed in the workshop web pages (*serc.carleton.edu/textbook*)

2. Soliciting Initial Input from Geomorphologists

At the National GSA meeting in Philadelphia (November 2006) more than 70 Geomorphologists assembled for the first annual Kirk Bryan fieldtrip. At the conclusion of the trip, we announced to the group our intention to write a new Geomorphology textbook and solicited their opinion on our doing that and on the content of the book. On the 2+hour bus ride back from the field site, people worked in teams to identify the overarching themes that the text should reflect as well as chapters they would like to see

in a new text. A summary of 18 responses (each representing 2 or 3 people working together) is included as *Table 2*.

Table 2. Summary of Geomorphologists' Responses on GSA Kirk Bryan Field Trip (2006)

Chapters
weathering, chemical
weathering, physical
soils
hillslopes
river processes and landforms
eolian processes and landforms
periglacial processes and landforms
mass wasting processes and landforms
glacial processes and landforms
coastal processes and landforms
groundwater processes and landforms
climate change, natural and human
tectonic landforms and processes
structural landforms
bio/eco/geomorphology
hydrology
arid region processes and landforms
physical geography - landform provinces
planetary geomorphology

Overarching Themes
linking slope and channel processes
interpreting process from form^
geomorphologist's tools
landscape response to human impact^
geomorphic impacts on society^
models, advances and limitations^
multiple spatial and temporal scales^
force and mass balances^
endogenic/exogenic forcing^
inheritance/antecedence^
magnitude/frequency^
catastrophic vs. gradual change^
reading the geologic record^
history of the science
rates of change; dates of change^
thresholds and feedbacks^
leads and lags
remote sensing information
importance of water
uncertainty and variability^
solid Earth influence^

^ Theme also identified by April 2008 NSF workshop participants.

3. Chapter-Defining Workshop at the National Science Foundation

In April 2008, we brought together 10 Geomorphology faculty (*Table 3*) for a one-day workshop at the National Science Foundation. These faculty were specifically selected to provide a broad cross-section of Geomorphologists based on the following characteristics: school type, discipline, location, rank, approach, focus, gender, and specialty. In advance of the meeting, we provided these faculty with the results of the GSA survey (*Table 2*) and the *Reconsidering the Textbook* workshop (*serc.carleton.edu/textbook*). Over the course of the four morning hours at NSF, these 10 faculty worked in small groups and then shared their ideas to build a consensus outline for the book (*Table 4*) including overarching themes (marked with ^ in *Table 2*).

In the afternoon, workshop participants returned for 5 more hours during which in small groups and then as an entire workshop, they identified the *Core Knowledge* to be included in 9 of the 14 chapters of the book (marked with asterisk in *Table 4* and shown

Table 3. Geomorphologists attending the April 2008 NSF workshop

	1	2	3	4	5	6	7	8	9	10
	Paul Bierman	**Dave Montgomery**	**Ray Torres**	**Eric Leonard**	**Cam Wobus**	**Ellen Wohl**	**Mary Savina**	**Missy Eppes**	**Pat McDowell**	**Milan Pavich**
SCHOOL	U of Vermont	U of Washington	U of S Carolina	Colorado College	U of Colorado	Colorado State U	Carelton	UNC	U of Oregon	USGS
SCHOOL TYPE	Public	Public	Public	Liberal Arts	Public	Public	Liberal Arts	Public	Public	NA
DISCIPLINE	geology	geology	Geology	Geology	Geology	Geology	Geology	Geography	Geography	Geography
LOCATION	Northeast	Northwest	Southeast	Rockies	Rockies	Rockies	Plains	Southeast	Northwest	Southeast
RANK	Midcareer	Midcareer	Midcareer	Midcareer	Junior	Midcareer	Senior	Junior	Senior	Senior
APPROACH	Mixed	Mixed	Process	Stratigraphy	Process	Process	Mixed	Stratigraphy	Stratigraphy	Stratigraphy
FOCUS	Mixed	Research	Research	Teaching	Research	Research	Teaching	Mixed	Mixed	Research
GENDER	Male	Male	Male	Male	Male	Female	Female	Female	Female	Male
SPECIALITY	rates/geochron	slopes and rivers	coastal, hydro	glaciers	tectonics; thermochron	rivers	geo-education	soils	rivers	weathering and soils

by example in *Figure 1*). At the end of the NSF workshop and over a working dinner, the group had extended discussions about the process of editing the text and creating the e-resources that will accompany the textbook. Many of the ideas put forward in the work plan that follows reflect this community input.

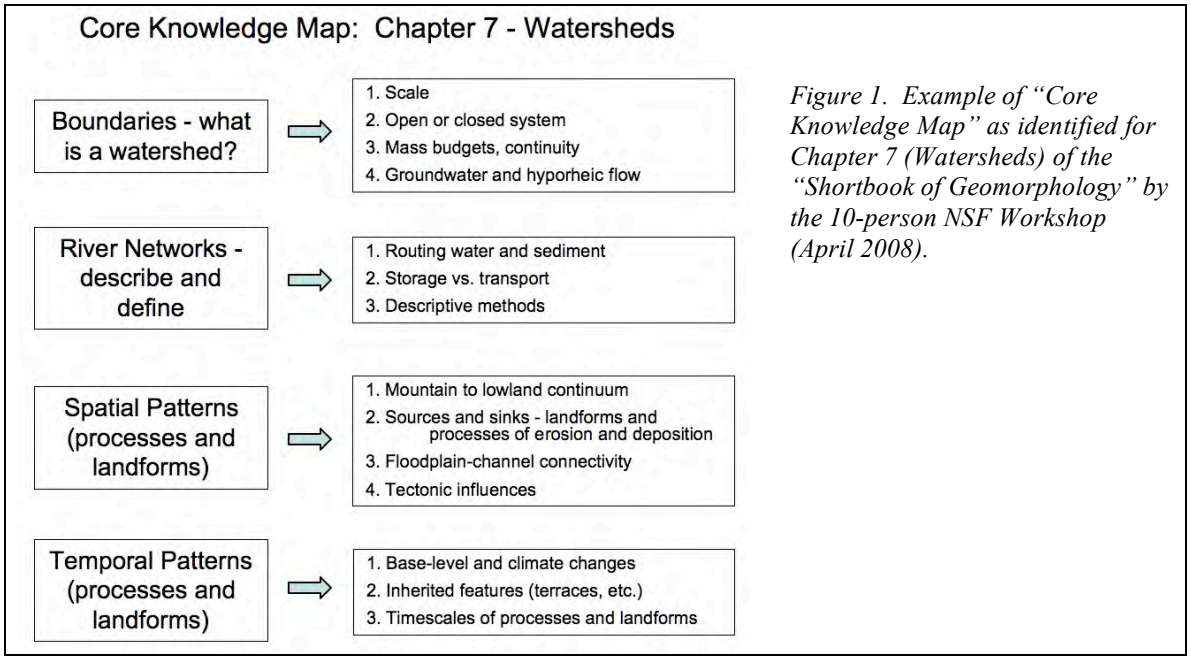

Figure 1. Example of "Core Knowledge Map" as identified for Chapter 7 (Watersheds) of the "Shortbook of Geomorphology" by the 10-person NSF Workshop (April 2008).

Look, Feel, and Organization of the *Shortbook of Geomorphology*

The *Shortbook of Geomorphology* that we are creating is designed to appeal to today's students and be highly visual. There will be many four-color illustrations, with extended captions. The font and layout will be modern and the entire book length will be about half that of current texts in Geomorphology, between 225 and 250 pages. In order to keep costs reasonable, the book will likely be issued as a paperback. We have been in contact with and provided a prospectus to 6 different publishers and plan to select one in summer 2008, based on their ability and interest in creating a short, well illustrated text.

We will write the book's text and caption the illustrations in an accessible style minimizing the use of jargon while introducing vocabulary necessary for communication

Table 4 – Topical Coverage for "Shortbook of Geomorphology" Compared to Other Geomorphology Textbooks (chapter numbers cited below)

	Short Book of Geomorphology **Bierman and Montgomery**	Bloom 3e	Easterbrook 2e	Ritter et al. 4e	Summerfield 2e
INTRO	**1. About Geomorphology: the Geosphere, Biosphere, & Hydrosphere**	1. Overview of Geomorphology 2. Energy Flow in Geomorphic Systems	1. Introduction 2. Basic Concepts	1. Process Geomorphology: An Introduction	1. Approaches to Geomorphology
	2. Geomorphologist's Tool Kit: dates, rates, and data		18. Dating Geomorphic Features		15. Rates of Uplift & Denudation
SOURCE TO SINK	**3. Making Soils & Sediment***	7. Rock Weathering	3. Weathering	3. Chemical Weathering & Soils	6. Weathering & Associated Landforms
	4. Geomorphic Hydrology*		7. Groundwater		
	5. Hillslopes*	9. Mass Wasting & Hillslopes	4. Mass Wasting	4. Physical Weathering, Mass Movement, & Slopes	7. Slope Processes & Forms
	6. In-channel Processes*	10. The Fluvial Geomorphic System	5. Fluvial Processes 6. Fluvial Landforms	6. Fluvial Processes 7. Fluvial Landforms	8. Fluvial Processes
	7. Watersheds*	11. Evolution of the Fluvial System		5. The Drainage Basin	9. Fluvial Landforms
	8. Glacial & Periglacial Systems*	14. Periglacial Geomorphology 16. Glaciers as Landforms: Glaciology 17. Glacial Geomorphology	12. Glacial Processes 13. Glacial Landforms 15. Periglacial Processes & Landforms	9. Glaciers & Glacial Mechanics 10. Glacial Erosion, Deposition, & Landforms 11. Periglacial Processes & Landforms	11. Glacial Processes & Landforms
	9. Aeolian Systems	13. Arid & Savanna Landscapes; Eolian Processes & Landforms	17. Eolian Processes & Landforms	8. Wind Processes & Landforms	10. Aeolian Processes & Landforms
	10. Volcanic Geomorphology	6. Volcanoes	11. Landforms Developed on Igneous Rocks		5. Landforms Associated with Igneous Activity
	11. The Coastal System*	19. Shore-Zone Processes & Landforms 20. Explanatory Description of Coasts	16. Shorelines	13. Coastal Processes & Landforms	
SYSTEMS THINKING	**12. Tectonic Influences & Feedbacks***	3. Cenozoic Tectonism 12. Structural Control of Fluvial Erosion	5. Tectonic Landforms	8. Tectonic Landforms. 9. Topographic Expression of Folded Strata. 10. Topographic Expression of Joints/Faults.	2. Global Morphology & Tectonics 3. Landforms & Tectonics of Plate Margins 4. Landforms & Tectonics of Plate Interiors 16. Tectonics & Drainage Development
	13. Climatic Influence & Feedbacks*	4. Changing Climates 18. Late Quaternary Climatic Geomorphology	14. Quaternary Climatic Changes & the Ice Ages	2. Internal Forces & Climate	17. Sea Level Change
	14. Human Influences & Feedbacks				
	15. Landscape Evolution	15. Landscape Evolution			18. Long–term Landscape Development
		8. Karst & Speleology		12. Karst Process & Landform	
					19. Planetary Geomorphology

* Core knowledge mapped by NSF workshop participants, April 2008.

with the discipline of *Geomorphology*. Our goal is to create a book that is useful across the undergraduate curriculum because it focuses on the core knowledge of Geomorphology as a discipline rather than dwelling on specific places or emphasizing specific processes or landforms.

The *Shortbook of Geomorphology* will have three sections and 15 chapters, each between 15 and 18 pages long (*Table 4*). The *Shortbook* is designed in three sections, each increasing in complexity with the latter section requiring more synthetic thinking, abstract thought, and linkages by the reader. Each chapter will begin with a description of the germane physical processes, move on to describe the landforms that these processes create and modify, dwell on the importance of time and rates of change in understanding landscapes, and conclude by considering the interaction between society and the topical focus of the chapter. Critical to the creation of these chapters is the community involvement we have already begun, specifically the chapter list and *Core Knowledge Maps* (e.g., *Figure 1*) defined for chapters by the NSF workshop in April 2008 with further refinement by 60+ participants of the *Cutting Edge Teaching Geomorphology* workshop (summer 2008, see work plan below). During the *Cutting Edge* workshop, we will also lead an afternoon workshop that will engage the same 60+ participants in the process of identifying the most germane figures (visualizations) to include in each of the 15 chapters of the *Shortbook of Geomorphology*.

Using community input (*Tables 2 and 3*), chapters in the *Shortbook of Geomorphology* have been selected to provide a more balanced view of the discipline of Geomorphology than the existing texts to which it is compared in *Table 4*. In that context, is interesting to examine Table 4 in detail, noting the similarities and differences between the four existing books and the *Shortbook of Geomorphology*. For example, three of the four existing books dedicate numerous chapters to glacial and periglacial processes and landforms, perhaps reflecting their authors' research and teaching experiences in northern latitudes. Similarly, three of the four existing texts have multiple chapters related to tectonic and structural Geomorphology. All existing books have single chapters about weathering, slopes, aeolian processes, and climate. Most existing textbooks consider coasts and volcanoes and some consider dates and rates as well as watersheds, karst, and landscape evolution.

E-media will be used to expand the range of students served by the book and its geographic applicability. We have termed the e-media associated with the book, *Vignettes*. They will be created by the community and serve multiple purposes.

- Vignettes allow students a path to delve more deeply into specific subject matter.
- Vignettes provide the means by which learning environments can be customized so that they are place- or region-specific.
- Vignettes allow class levels and approaches to be customized. Faculty interested in teaching at a higher level or teaching more quantitative methods could assign relevant vignettes to supplement the fundamentals covered in the text.
- Vignettes, because they are open access and written by the community, become a voice of the Geomorphology community and a resource shared by all.

Vignettes developed for this project will be hosted at by the Science Education Research Center (SERC) at Carleton College. They will be searchable and freely available on the web 24/7 to anyone who wishes to use them for teaching and learning.

Work Plan

We propose a two-year project which at its conclusion will produce the first of what will be a new generation of textbooks – textbooks that meet the needs of today's students and reflect a common, community vision of a field's core knowledge. Not only will this project produce a modern textbook for *Geomorphology*, a field in great need of such a book (*Table 1*) but this project will also function as a widely applicable model for creating similar texts to serve students in other natural science and engineering disciplines.

The project timeline (*Figure 2)* is geared toward publication in 2010 and reflects the PI's arrangement of concurrent sabbatical leaves in Spring 2009; this schedule has several benefits to the project and to NSF. These simultaneous leaves ensure that partial salary support is available to both PI's through their Universities, lowering the cost of book creation substantially. The leaves also provide large blocks of time that Bierman and Montgomery can dedicate exclusively to research for the book and for writing.

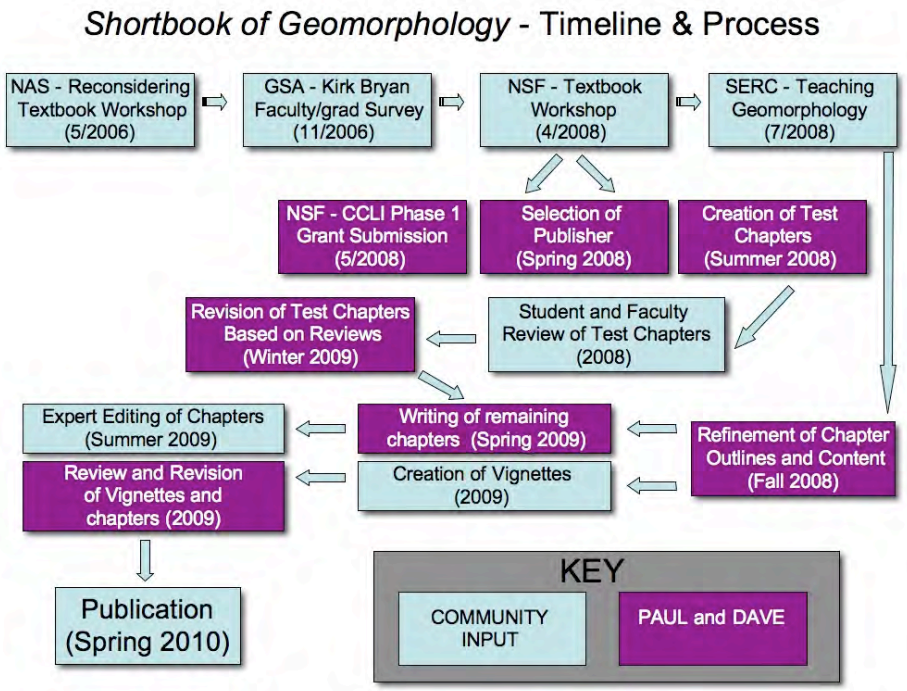

Figure 2. Schematic diagram (timeline) showing process of creating "Shortbook of Geomorphology".

Content Creation and Assembly

Writing Pilot Chapters – Over the summer of 2008, Bierman and Montgomery will write, co-edit, revise and submit for layout, two pilot chapters. These chapters will be produced by the publisher in several different formats and used in different Geomorphology classes during fall 2008 (UVM) and winter (Western Washington and Univ. of Washington) to gather student and faculty input regarding preferred design and writing style (see below).

Refining Core Knowledge Maps for Shortbook Chapters – Using community input to refine the *Core Knowledge* maps for each chapter of the *Shortbook* is a high priority. We will do this in a think/pair/share fashion during a half-day session with the 60+ participants attending the Cutting Edge (SERC) *Teaching Geomorphology Workshop* in July 2008 (serc.carleton.edu/NAGTWorkshops/geomorph08) for which Bierman and Montgomery are co-conveners. Each participant will work in small groups on two different chapters so that we can gauge the variability of opinions. At the conclusion of group work, there will be a general *charrette* during which participants will contribute their ideas to other chapters. While mapping *Core Knowledge*, groups will generate lists of figures and animations they believe are best suited to communicate important ideas visually.

E-materials creation and collection – Although the *Shortbook of Geomorphology* will be a published volume, it will be backed by extensive e-media. These e-media, termed *Vignettes,* will be created by the Geomorphology community (faculty, working scientists, and advanced graduate students) in various settings. There will be a uniform format for *Vignette* web presentation and a template for producing PDFs from the web for faculty and student use. All e-materials associated with this project will be public access as they will be hosted on the SERC website (*serc.carleton.edu*); see attached commitment letter from SERC Director Manduca. Each person creating a pair of *Vignettes* will be paid an honorarium and will be credited with authorship. *Vignettes* will be vetted by Bierman and Montgomery during 2009. All publishers that we have approached are enthusiastic about this different and community-centered approach to e-media creation and are comfortable with producing a text linked to a public access (no-fee) web site.

We will develop a list of *Vignettes* most useful for supplementing the text in several ways. First, during the Cutting Edge *Teaching Geomorphology Workshop* groups will propose *Vignettes* chapter by chapter as they refine *Core Knowledge Maps*. Then during the writing and editing of each chapter, Bierman, Montgomery, and the *Editorial Experts* will compile lists of *Vignettes* we consider important to supplement the *in-text* material.

Vignettes will be created in several ways. The initial *Vignettes* will be created by attendees of the *Teaching Geomorphology Workshop* and will be based on their interests and experience. The primary setting for specific *Vignette* creation will be workshops held: 1. the day before or after national geologic meetings including GSA and AGU and 2. and at other times in three cities central to campuses with large numbers of Geomorphologists (Seattle, Philadelphia, and Denver). Geomorphologists will be invited to and apply for these workshops with the goal of creating all *Vignettes* needed for the first edition of the book. If the list is not completed during the workshops, we will seek

out qualified individuals to create specific *Vignettes*. Most critical *Vignettes* will be created and vetted before the text is launched and indicated symbolically in the printed text. Others will be added over time and tracked on the book's website for easy chapter-by-chapter and topic-by-topic access (using the SERC search engine). The idea here is to involve as much of the community as possible in the creation of e-media.

In addition to *Vignettes* created by the community, a Masters-level graduate student with expertise in Geomorphology and an interest in pedagogy will be recruited and supported to gather and vet animations and movies that illustrate Earth surface processes and dynamics. These animation *Vignettes* will be linked to specific chapters in the book both in the text and on the website. Bierman will supervise this student.

Chapter Writing – The book will be written during the winter and spring of 2009 when both Bierman and Montgomery are on leave. During part of this six-month period, they will be together in the same location, most likely in Scotland (University of Edinborough or Glasgow). Each chapter will be written to incorporate the Core Knowledge Maps created by the April 2008 NSF workshop panel and refined by the 60+ attendees of the July 2008 *Teaching Geomorphology* workshop. Each author will write the first draft of seven or eight chapters; Bierman and Montgomery will each edit and revise the chapters that the other wrote.

Assessment

Assessment of several kinds is key to production of a quality text that is accepted by the community as a vetted, consensus view of the field of *Geomorphology* and which is deemed useful by the community of students who will be the end users. We believe strongly in the merit of the peer-review system and will rely on it heavily to produce and refine the *Shortbook of Geomorphology*.

Traditional textbook production involves multi-chapter manuscript review by faculty who publishers engage because it is faculty who select books for purchase. We propose that this approach, while a reasonable business model, does not serve students as well as it could. Instead, we propose a multi-phase model based on soliciting student input on pilot chapters, recruiting *Editorial Experts* to review and revise all chapter drafts, full external editing by senior Geomorphologists of the finished chapters for consistency of voice and approach, and summative assessment of the finished book after its first semester of use.

Formative Assessment - Testing of Pilot Chapters

Over the summer of 2008, Bierman and Montgomery will create two pilot chapters, most likely *Hillslopes* and *In–channel Processes*. We will work with our publisher to create several alternate layouts for these chapters and then use the chapters in several *Geomorphology* classes including those at the University of Vermont, Western Washington University, and the University of Washington. We will work to develop appropriate qualitative assessment tools that help us understand from faculty and students

which layout was most effective and to determine ways in which the writing and organizational style could be improved to increase student interest in the text.

External Chapter Vetting – the role of Editorial Experts

Critical review and editing of the chapter drafts we write is imperative for the creation of an authoritative text. The typical approach employed by publishers, sending many "finished" chapters to one reviewer is not optimal for the condensed, focused text we will create. Rather, we have identified (*Table 5*), a pair of experts to edit and vet each chapter of the book. Experts are paired by various criteria including geographic location, climatic, and tectonic expertise. For example, experts reviewing the *Making Soils and Sediment* chapter were selected to represent individually, humid and arid regions. Our *Editorial Experts* were selected not only based on their research and sub-disciplinary expertise but on their dedication to pedagogy and their commitment to the success of the community-based text we propose. All have agreed to serve in this capacity (see attached commitment letters). First, the selected *Editorial Experts* will review the chapter outlines and comment on them. Then, each expert will edit their draft chapter according to a uniform and specified approach, assessing not only the breadth and centrality of the material covered but also the written presentation and the visuals. If additional material needs to be added, the *Editorial Experts* will be expected to supply that material in form of additional paragraphs/visuals to be added to the text.

Vignette Vetting

Bierman and Montgomery will each read, edit if needed, and approve the *Vignettes* prepared by the community. This review will ensure the quality and readability of the e-media associated with this project.

Whole Book Editing

To ensure continuity of voice, we have enlisted the help of two senior Geomorphologists with very different backgrounds and research interests, Tom Dunne (UC Santa Barbara) and Mary Savina (Carleton College). Each will read and edit the completed book manuscript after each chapter has been edited by the 30 *Editorial Experts* (*Table 5*) and revised by Bierman and Montgomery. Their letters of commitment are attached to this proposal.

Summative Assessment

Summative assessment of this project is important if it is to become a model for textbook creation in the future. We will take two approaches. First, whole book and chapter-by-chapter assessment of faculty and students at schools adopting the text will follow publication and first usage of the book. This summative assessment will be used for eventual revision of the text. Second, we will undertake a broad survey of the Geomorphology community to determine how many people are aware of this NSF-supported effort and to assess results both in terms of the text itself and the process by which it and the associated e-media were created.

Table 5. Geomorphologists who have Agreed to be Editorial Experts (see commitment letters)

	Chapter	Editorial Expert #1	Editorial Expert #2
INTRO	**1. About Geomorphology**	Yehouda Enzel	Scott Linneman
	2. Geomorphologist's Tool Kit	Sara Mitchell	Ari Matmon
SOURCE TO SINK	**3. Making Soils and Sediment**	David Dethier	Missy Eppes
	4. Geomorphic Hydrology	Ellen Wohl	Beverley Wemple
	5. Hillslopes	Scott Burns	Arjun Heimsath
	6. In-channel Processes	Lisa Ely	Derek Booth
	7. Watersheds	Pat McDowell	Frank McGilligan
	8. Glacial and Periglacial Systems	Doug Clark	Eric Leonard
	9. Aeolian Geomorphology	Leslie McFadden	Nick Lancaster
	10. Volcanic Geomorphology	Gordon Grant	Carolyn Dredger
	11. The Coastal System	Paul Komar	Orrin Pilkey
SYSTEMS THINKING	**12. Tectonic Influences and Feedbacks**	Cam Wobus	Frank Pazzaglia
	13. Climatic Influence and Feedbacks	Eric Steig	Richard Alley
	14. Human Influences and Feedbacks	Roger Hooke	Dorothy Merritts
	15. Landscape Evolution	Milan Pavich	Paul Bishop

Broader Impacts

This project has a number of broader impacts – at the local, national, and international levels and spanning STEM disciplines. The community-based textbook creation process that is integral to this project will be a model for the future books across disciplinary and political boundaries. This consensus-building process will formalize links between Geomorphologists and engage our community in a meaningful discussion both of content and pedagogy as together we define the core concepts of *Geomorphology* as a discipline. The public domain website associated with the *Shortbook of Geomorphology* and hosted by SERC will provide, without cost, a diverse, vetted set of geomorphological *Vignettes* useful for teaching and learning in a variety of environments and at a variety of educational levels; association with the SERC website will ensure both the quality of presentation and ease of distribution. At a local level, two graduate students will be trained in Science Education and both will be deeply involved in the creation of a new textbook, an unusual opportunity. The impacts of the book we create will last for decades and touch tens of thousands of students' lives as the text they use in class shapes their future as scientists and community members. The book's lower cost than current texts will positively and broadly impact the community.

Intellectual Merit

Textbooks remain the primary means by which scientists and engineers are trained; yet, most textbooks remain costly, expansive and expensive compendiums of knowledge that idiosyncratically reflect their authors' experiences. The *Shortbook of Geomorphology* we

are writing responds directly to the recommendations of the 2006 NSF/National Academy of Sciences *Reconsidering the Textbook* workshop that suggested textbooks of the future would be short, reflect community consensus, be student-centered, remain affordable, and be well integrated with e-media. Our assessment plan, which is integral to this proposal and the textbook development process, will improve the quality of the final product and determine whether the project has met its goal of creating a book that is widely accepted and useful for both students and faculty. Broad community participation at all stages of the project both vets content and provides a ready market for the textbook improving its chances of acceptance – increasing the impact of NSF support.

Proposer's Qualifications

Together, Bierman and Montgomery are well qualified to organize and create a new and different type of textbook (and associated e-media) to catalyze student learning in Geomorphology. Both investigators are established and respected researchers with extensive records of publication in their discipline and both are dedicated educators of both students and the general public. Bierman, along with students and colleagues has authored >50 peer-reviewed papers and co-authored an *Environmental Geology* textbook of the traditional variety (Pipkin et al., 2008). Montgomery has authored >190 papers and edited 3 technical books. Together, their status in the field of Geomorphology is indicated by Bierman's *Donath Medal* and Montgomery's *Kirk Bryan award*, both high honors from the Geological Society of America.

Not only are both authors well-known researchers, but both know how to communicate and teach through the written word. Montgomery is the author of two popular books, *King of Fish* and *Dirt* while Bierman is a 2005 recipient of the National Science Foundation's Director's highest award, the *Distinguished Teaching Scholar*, for his work in bringing landscape history to the general public through electronic media (*uvm.edu/landscape*). Bierman is also a 1996 recipient of an NSF Career award for integrating research on human-landscape interactions with hands-on teaching strategies as well as the PI for NSF grants focused on education (see prior results).

Bierman and Montgomery have complimentary expertise and interests. Working all around the world and beyond (Africa, Middle East, South America, Asia, Greenland, Australia, New Zealand, and Mars), both authors have very broad disciplinary knowledge bases as well as complimentary regional foci (east and west coast of North America). Both are well-connected in the geologic community having trained many graduate students and worked with many of the most respected faculty in Geomorphology.

Cathy Manduca and Carleton College's Science Education Research Center are the ideal host for the e-media associated with the *Shortbook of Geomorphology*. For years, SERC has hosted an extensive collection of learning resources in the Geosciences. They have deep experience in designing and developing effective web-based strategies for delivering learning materials to the community. Massey, who will advise the students doing assessment work, has extensive experience working with Manduca assessing other educational resources related to Geomorphology including, the *Landscape Change Program* web-ware and the *Learning Landscapes* website.

REFERENCES CITED

Anders, A. M., Roe, G. H., Hallet, B., Montgomery, D. R., Finnegan, N. J., and Putkonen, J., 2006, Spatial patterns of precipitation and topography in the Himalaya, in *Tectonics, Climate and Landscape Evolution*, edited by S. D. Willett, N. Hovius, M. T. Brandon, and D. M. Fisher, Geological Society of America Special Paper 398, pp. 39-53.

Anders, A. M., Roe, G. H., Montgomery, D. R., and Hallet, B., in press, The influence of precipitation phase on the form of mountain ranges, *Geology*.

Ansary, T. 2004, The Muddle Machine: Confessions of a Textbook Editor, Edutopia, p. 31-35.

Bierman, P. R., Massey, C., and Manduca, C. (2006). Reconsidering the Textbook, EOS, v. 87 n. 30, p. 316.

Finnegan, N. J., Hallet, B., Montgomery, D. R., Zeitler, P. K., Stone, J. O., Anders, A. M., and Yuping, L., 2008, Coupling of rock uplift and river incision in the Namche Barwa-Gyala Peri massif, Tibet, *Geological Society of America Bulletin*.

Finnegan, N. J., Roe, G., Montgomery, D. R., and Hallet, B., A scaling relationship for channel width in bedrock rivers, *Geology*, v. 33, p. 229-232, 2005.

Issitt, J., 2004, History of Education, v.33, n. 6, p. 683-696.

Jungers, M.C., Bierman, P.R., Matmon, A., Nichols, K. K., Larsen, J., And Finkel, R. (2007), Accepting our differences: the power of amalgamation and 10-Be as a geomorphic tracer for hillslope soil transport. Geological Society of America Abstracts with Programs.

Massey, C., Bierman, P., Lavoie, J.P., Manduca, C., Berrizbeitia, I., Henry, J., (2005), Learning visually with historic "geo-images". Geological Society of America Abstracts with Programs.

Massey, C.A. and Bierman, P.R. (2006) Historic landscape photographs inspire local teachers to create engaging curricula. Geological Society of America Abstracts with Programs.

Montgomery, D. R., and Stolar, D., Revisiting Himalayan river anticlines, *Geomorphology*, v. 82. p. 4-15, 2006.

Montgomery, D. R., Hallet, B., Yuping, L., Finnegan, N., Anders, A., and Gillespie, A., Evidence for Holocene megafloods downs the Tsangpo River gorge, Southeastern Tibet, *Quaternary Research*, v., 62, p. 201-207, 2004.

Murray, C., 2004, Textbooks dumped in favor of laptops, eSchool News, http://www.eschoolnews.com/

New York Times, 2008, That Book Costs How Much?, Editorial, April 25.

Pearce, A., Bierman, P., Druschel, G., Massey, C., Rizzo, D., Watzin, M. and Wemple, B. (2007) Developing a watershed field course to inspire interdisciplinary learning. Geological Society of America Abstracts with Programs.

Pearce, A., Bierman, P., Druschel, G., Massey, C., Rizzo, D., Watzin, M. and Wemple, B. (2007) Teaching a New Generation of Students: Developing an Interdisciplinary Watershed Field Course, Eos. Trans. AGU.

Pipkin, B., Trent, D.D., Hazlett, R, and Bierman, P., 2007, Geology and the Environment, 5th edition, Thompson, Belmont, CA, 505 p.

Reuter, J., Bierman, P.R., Larsen, J., Pavich, M., and Finkel, R., (accepted) Sediment dynamics in the Susquehanna River Basin inferred from in situ-produced ^{10}Be and contemporary sediment yield. American Journal of Science.

Skelly, S. 2007, Beyond Paper, Ink and Cardboard, Community College Journal, April/May. P 44-48.

Sullivan, C.L., Bierman, P.R., Reusser, L., Larsen, J., Pavich, M.J., Finkel, R.C. (accepted) Erosion and landscape evolution of the Blue Ridge escarpment, southern Appalachian Mountains, Earth Surface Processes and Landforms.

Wittenberg, K., 2006, Beyond Google: What Next for Publishing?, The Chronicle of Higher Education, Volume 52, Issue 41, Page B20.