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PI/PD Name: Paul R Bierman

Gender: ☒ Male ☐ Female

Ethnicity: (Choose one response) ☐ Hispanic or Latino ☒ Not Hispanic or Latino

Race: (Select one or more)
- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or Other Pacific Islander
- ☒ White

Disability Status: (Select one or more)
- ☐ Hearing Impairment
- ☐ Visual Impairment
- ☐ Mobility/Orthopedic Impairment
- ☐ Other
- ☒ None

Citizenship: (Choose one) ☒ U.S. Citizen ☐ Permanent Resident ☐ Other non-U.S. Citizen

Check here if you do not wish to provide any or all of the above information (excluding PI/PD name): ☐

REQUIRED: Check here if you are currently serving (or have previously served) as a PI, co-PI or PD on any federally funded project ☒

Ethnicity Definition:
Hispanic or Latino. A person of Mexican, Puerto Rican, Cuban, South or Central American, or other Spanish culture or origin, regardless of race.
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Black or African American. A person having origins in any of the black racial groups of Africa.
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PI/PD Name: Klaus Keller

Gender: ☒ Male ☐ Female

Ethnicity: (Choose one response) ☐ Hispanic or Latino ☐ Not Hispanic or Latino

Race: (Select one or more)
- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or Other Pacific Islander
- ☒ White

Disability Status: (Select one or more)
- ☐ Hearing Impairment
- ☐ Visual Impairment
- ☐ Mobility/Orthopedic Impairment
- ☐ Other
- ☒ None

Citizenship: (Choose one) ☐ U.S. Citizen ☒ Permanent Resident ☐ Other non-U.S. Citizen

Check here if you do not wish to provide any or all of the above information (excluding PI/PD name): ☐

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PI/PD Name: Eric Kirby

Gender: ☒ Male ☐ Female

Ethnicity: (Choose one response) ☐ Hispanic or Latino ☒ Not Hispanic or Latino

Race: (Select one or more)
- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or Other Pacific Islander
- ☒ White

Disability Status: (Select one or more)
- ☐ Hearing Impairment
- ☐ Visual Impairment
- ☐ Mobility/Orthopedic Impairment
- ☐ Other
- ☐ None

Citizenship: (Choose one) ☒ U.S. Citizen ☐ Permanent Resident ☐ Other non-U.S. Citizen

Check here if you do not wish to provide any or all of the above information (excluding PI/PD name): ☒

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PI/PD Name: Kyle K Nichols

Gender: ☒ Male ☐ Female

Ethnicity: (Choose one response) ☐ Hispanic or Latino ☒ Not Hispanic or Latino

Race: (Select one or more)
- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or Other Pacific Islander
- ☒ White

Disability Status: (Select one or more)
- ☐ Hearing Impairment
- ☐ Visual Impairment
- ☐ Mobility/Orthopedic Impairment
- ☐ Other
- ☒ None

Citizenship: (Choose one) ☒ U.S. Citizen ☐ Permanent Resident ☐ Other non-U.S. Citizen

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PI/PD Name: Donna Rizzo

Gender: ☐ Male ☒ Female

Ethnicity: (Choose one response) ☐ Hispanic or Latino ☒ Not Hispanic or Latino

Race: (Select one or more)
- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or Other Pacific Islander
- ☒ White

Disability Status: (Select one or more)
- ☐ Hearing Impairment
- ☐ Visual Impairment
- ☐ Mobility/Orthopedic Impairment
- ☐ Other
- ☐ None

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List of Suggested Reviewers or Reviewers Not To Include (optional)

SUGGESTED REVIEWERS:

REVIEWERS NOT TO INCLUDE:

COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

PROGRAM ANNOUNCEMENT/SOLICITATION NO./CLOSING DATE/if not in response to a program announcement/solicitation enter NSF 11-1

NSF 11-564 **10/19/11**

FOR NSF USE ONLY

NSF PROPOSAL NUMBER

FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.)

OISE - PIRE

DATE RECEIVED	NUMBER OF COPIES	DIVISION ASSIGNED	FUND CODE	DUNS# (Data Universal Numbering System)	FILE LOCATION
				066811191	

EMPLOYER IDENTIFICATION NUMBER (EIN) OR TAXPAYER IDENTIFICATION NUMBER (TIN)

030179440

SHOW PREVIOUS AWARD NO. IF THIS IS
☐ A RENEWAL
☐ AN ACCOMPLISHMENT-BASED RENEWAL

IS THIS PROPOSAL BEING SUBMITTED TO ANOTHER FEDERAL AGENCY? YES ☐ NO ☒ IF YES, LIST ACRONYM(S)

NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE

University of Vermont & State Agricultural College

AWARDEE ORGANIZATION CODE (IF KNOWN)

0036962000

ADDRESS OF AWARDEE ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE

University of Vermont & State Agricultural College
340 Waterman Building
Burlington, VT. 054050160

NAME OF PRIMARY PLACE OF PERF

University of Vermont & State Agricultural College

ADDRESS OF PRIMARY PLACE OF PERF, INCLUDING 9 DIGIT ZIP CODE

University of Vermont & State Agricultural College
340 Waterman Building
Burlington ,VT ,054050160 ,US.

IS AWARDEE ORGANIZATION (Check All That Apply) (See GPG II.C For Definitions)
☐ SMALL BUSINESS ☐ MINORITY BUSINESS
☐ FOR-PROFIT ORGANIZATION ☐ WOMAN-OWNED BUSINESS

☒ IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE

TITLE OF PROPOSED PROJECT **PIRE: Shaping Resilient, Sustainable Landscapes in a Rapidly Developing Nation - Brazil**

REQUESTED AMOUNT	PROPOSED DURATION (1-60 MONTHS)	REQUESTED STARTING DATE	SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE
$ **2**	**60** months	**12/01/12**	

CHECK APPROPRIATE BOX(ES) IF THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW

☐ BEGINNING INVESTIGATOR (GPG I.G.2)
☐ DISCLOSURE OF LOBBYING ACTIVITIES (GPG II.C.1.e)
☐ PROPRIETARY & PRIVILEGED INFORMATION (GPG I.D, II.C.1.d)
☐ HISTORIC PLACES (GPG II.C.2.j)
☐ EAGER* (GPG II.D.2) ☐ RAPID** (GPG II.D.1)
☐ VERTEBRATE ANIMALS (GPG II.D.6) IACUC App. Date _____
PHS Animal Welfare Assurance Number _____

☐ HUMAN SUBJECTS (GPG II.D.7) Human Subjects Assurance Number _____
Exemption Subsection _____ or IRB App. Date _____
☒ INTERNATIONAL COOPERATIVE ACTIVITIES: COUNTRY/COUNTRIES INVOLVED (GPG II.C.2.j)
BR
☐ HIGH RESOLUTION GRAPHICS/OTHER GRAPHICS WHERE EXACT COLOR REPRESENTATION IS REQUIRED FOR PROPER INTERPRETATION (GPG I.G.1)

PI/PD DEPARTMENT
Department of Geology

PI/PD FAX NUMBER
802-656-0045

PI/PD POSTAL ADDRESS
Delehanty Hall
180 Colchester Ave
Burlington, VT 05405
United States

NAMES (TYPED)	High Degree	Yr of Degree	Telephone Number	Electronic Mail Address
PI/PD NAME **Paul R Bierman**	**PhD**	**1993**	**802-656-4411**	**pbierman@uvm.edu**
CO-PI/PD **Klaus Keller**	**PhD**	**2000**	**814-865-6718**	**klaus@psu.edu**
CO-PI/PD **Eric Kirby**	**PhD**	**2001**	**814-865-0732**	**ekirby@psu.edu**
CO-PI/PD **Kyle K Nichols**	**PhD**	**2002**	**518-580-5194**	**knichols@skidmore.edu**
CO-PI/PD **Donna Rizzo**	**PhD**	**1994**	**802-656-1495**	**drizzo@cems.uvm.edu**

CERTIFICATION PAGE

Certification for Authorized Organizational Representative or Individual Applicant:

By signing and submitting this proposal, the Authorized Organizational Representative or Individual Applicant is: (1) certifying that statements made herein are true and complete to the best of his/her knowledge; and (2) agreeing to accept the obligation to comply with NSF award terms and conditions if an award is made as a result of this application. Further, the applicant is hereby providing certifications regarding debarment and suspension, drug-free workplace, lobbying activities (see below), responsible conduct of research, nondiscrimination, and flood hazard insurance (when applicable) as set forth in the NSF Proposal & Award Policies & Procedures Guide, Part I: the Grant Proposal Guide (GPG) (NSF 11-1). Willful provision of false information in this application and its supporting documents or in reports required under an ensuing award is a criminal offense (U. S. Code, Title 18, Section 1001).

Conflict of Interest Certification

In addition, if the applicant institution employs more than fifty persons, by electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative of the applicant institution is certifying that the institution has implemented a written and enforced conflict of interest policy that is consistent with the provisions of the NSF Proposal & Award Policies & Procedures Guide, Part II, Award & Administration Guide (AAG) Chapter IV.A; that to the best of his/her knowledge, all financial disclosures required by that conflict of interest policy have been made; and that all identified conflicts of interest will have been satisfactorily managed, reduced or eliminated prior to the institution's expenditure of any funds under the award, in accordance with the institution's conflict of interest policy. Conflicts which cannot be satisfactorily managed, reduced or eliminated must be disclosed to NSF.

Drug Free Work Place Certification

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Drug Free Work Place Certification contained in Exhibit II-3 of the Grant Proposal Guide.

Debarment and Suspension Certification

(If answer "yes", please provide explanation.)

Is the organization or its principals presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency? Yes ☐ No ☒

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Debarment and Suspension Certification contained in Exhibit II-4 of the Grant Proposal Guide.

Certification Regarding Lobbying

The following certification is required for an award of a Federal contract, grant, or cooperative agreement exceeding $100,000 and for an award of a Federal loan or a commitment providing for the United States to insure or guarantee a loan exceeding $150,000.

Certification for Contracts, Grants, Loans and Cooperative Agreements

The undersigned certifies, to the best of his or her knowledge and belief, that:
(1) No federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.
(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, ''Disclosure of Lobbying Activities,'' in accordance with its instructions.
(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

Certification Regarding Nondiscrimination

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative is providing the Certification Regarding Nondiscrimination contained in Exhibit II-6 of the Grant Proposal Guide.

Certification Regarding Flood Hazard Insurance

Two sections of the National Flood Insurance Act of 1968 (42 USC §4012a and §4106) bar Federal agencies from giving financial assistance for acquisition or construction purposes in any area identified by the Federal Emergency Management Agency (FEMA) as having special flood hazards unless the:
(1) community in which that area is located participates in the national flood insurance program; and
(2) building (and any related equipment) is covered by adequate flood insurance.

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant located in FEMA-designated special flood hazard areas is certifying that adequate flood insurance has been or will be obtained in the following situations:
(1) for NSF grants for the construction of a building or facility, regardless of the dollar amount of the grant; and
(2) for other NSF Grants when more than $25,000 has been budgeted in the proposal for repair, alteration or improvement (construction) of a building or facility.

Certification Regarding Responsible Conduct of Research (RCR)
(This certification is not applicable to proposals for conferences, symposia, and workshops.)

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative of the applicant institution is certifying that, in accordance with the NSF Proposal & Award Policies & Procedures Guide, Part II, Award & Administration Guide (AAG) Chapter IV.B., the institution has a plan in place to provide appropriate training and oversight in the responsible and ethical conduct of research to undergraduates, graduate students and postdoctoral researchers who will be supported by NSF to conduct research.
The undersigned shall require that the language of this certification be included in any award documents for all subawards at all tiers.

AUTHORIZED ORGANIZATIONAL REPRESENTATIVE	SIGNATURE	DATE
NAME **Julie Macy**		**12/06/10**

TELEPHONE NUMBER	ELECTRONIC MAIL ADDRESS	FAX NUMBER
	julie.macy@uvm.edu	

* EAGER - EArly-concept Grants for Exploratory Research
** RAPID - Grants for Rapid Response Research

Project Summary - *Shaping Resilient, Sustainable Landscapes in a Rapidly Developing Nation*

Landscapes, the interface between Earth's dynamic surface and human civilization, are a key nexus of sustainability. For example, soil loss from deforestation or agriculture on steep slopes and water pollution from untreated sewage limit the long-term ability of societies to sustain healthy, thriving populations. Communities built in areas where surface processes are active, including river bottoms and unstable slopes, are routinely devastated by high-magnitude, low-frequency events such as debris flows, floods, and landslides. A predictive understanding of the rate, frequency, and spatial distribution of surface processes is prerequisite to resilient, sustainable development; yet, such scientific and engineering knowledge is not enough. For development to produce more sustainable landscapes, we must understand and respond to the social and economic drivers that place people and their communities in harm's way and cause populations to so damage their environments that civilizations suffer and may even fail.

Brazil, with its diverse landscapes and cultures, expanding science, technology, engineering, and mathematics (STEM) infrastructure, and exceptionally rapid development trajectory, provides the ideal setting both for collaborative sustainability research and for training the next generation of globally fluent scientists, engineers, and teachers. Building upon established collaborations, students, faculty, and K-12 teachers engaged in this PIRE will use cutting edge geochemical and modeling techniques as well as their expertise in geology, hydrology, forest ecology, engineering, complex systems, ecological economics, human geography, and risk analyses to characterize and predict natural and human-induced rates of change at Earth's surface. Their work will consider the climatic, tectonic, cultural, economic, and development gradients that characterize Brazil. They will use these insights to create a series of metrics that identify areas where current development practices are most consilient with natural systems, thus creating a template for development most likely to produce more resilient and sustainable landscapes over the long term.

This PIRE will provide diverse international educational and research (field and laboratory) experiences for 12 graduate students, 9 teachers (K-12), 18 undergraduates, 2 post-docs, and an outreach coordinator. Our goal is to do the science needed to purposefully alter development trajectories so that the environmental impact of development is reduced and the resulting developed landscapes have the least possible impact on the people who inhabit them.

Personnel and Collaborating Institutions - P. Bierman (PI), D. Rizzo, W. Keeton, J. Farley, C. Massey (Univ. of Vermont), E. Kirby, K. Keller (Penn State), K. Nichols (Skidmore College), D. Rood (Livermore National Laboratory), T. Dunne, D. Roberts, D. Lopez-Carr (UCSB), N. Fernandes (UFRJ, Brazil), S. Bhering (Embrapa, Brazil). The University of Vermont has not participated in past PIRE awards.

Intellectual Merit - We approach a fundamental problem in Sustainability Science – how can development proceed in a way that both minimizes human acceleration of erosion and also makes society more resilient to the shifting mosaic of processes that move soil and sediment across Earth's surface? Using isotopic tracers and both deterministic and stochastic modeling to estimate the rate, timing, and spatial distribution of surface processes, in concert with economic, social, vegetation, and retrospective land-use data, we will identify areas where development has progressed most sustainably and consider why this is the case – providing a model for the future.

Broader Impacts - Broader impacts for this project are significant and varied including: active strategies to recruit and retain undergraduate and graduate students from underrepresented groups, easy web-based access to data critical to a wide variety of disciplines, training the next generation to have a broad, international view of coupled human/natural dynamic systems, and integrating research and education through *Recruitment Seminars*, *Training Workshops,* and *Short Courses* that disseminate project results to the scientific community including students and faculty.

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Project Description

Administrative Summary

Title: *Shaping Resilient, Sustainable Landscapes in a Rapidly Developing Nation - Brazil*
Principle Investigator: *Paul Bierman, University of Vermont, Geology Department*
Length of Study: *5 years*
Estimated Total Budget: $*4,200,000 over 5 years*
Lead Institution: *University of Vermont*
Partner Institutions and Key Researchers:

Federal University of Rio de Janeiro, Brazil: Nelson Fernandes
EMBRAPA (Solos), Brazil: Silvio Bhering
Pennsylvania State University: Eric Kirby and Klaus Keller
UC Santa Barbara: Thomas Dunne, Dar Roberts, and David Lopez-Carr
Skidmore College: Kyle Nichols
Lawrence Livermore National Laboratory: Dylan Rood
Perkins Geology Museum, University of Vermont: Christine Massey
University of Vermont, College of Engineering: Donna Rizzo
University of Vermont, School of Environment and Natural Resources: William Keeton
University of Vermont, The Gund Institute for Ecological Economics: Josh Farley

Additional Funding Opportunities: *US AID and IAI*

Project Management Plan

This project is a collaborative venture among 5 US institutions, 2 Brazilian institutions, and 5 PIs of varying rank and experience, all of whom have worked together co-advising students, and 6 key personnel who have worked closely with one or more of the PIs over the past 10 years. Because we have well-established professional relationships, project management will be collaborative with face-to-face team meetings every 6 months and monthly scheduled web conferences between US and Brazilian researchers. PI Bierman will oversee the project and direct cosmogenic isotope studies along with Rood. Bierman will manage a project administrator and lead the interaction with foreign collaborators. Kirby will focus on solid Earth/surface process interactions and predictive landscape modeling while Rizzo will lead the experimental design, data analysis, complex systems modeling, and engineering considerations. Nichols will mentor the Postdoctoral Associate, oversee undergraduate recruiting, and direct short-lived radionuclide studies. Farley and Keeton will consider the impact of forestry practices on landscape stability and the economic means by which forestry practices can change while maintaining or improving the economic status of Brazilians. Dunne, with experience training developing nation students and professionals in hazard assessment and conservation, will focus on prediction of hydrologic and erosion processes in mountainous and developed terrains. Keller will lead the risk analysis and minimization research. Lopez-Carr will examine the human geography of current land use while Roberts will work with remote sensed imagery to understand land-use change and the spatial distribution of erosion over time. Massey will recruit, advise, and interface with K-12 teachers as they travel to Brazil and then develop curricular modules. Graduate student admission will be coordinated between Vermont, Penn State, and UCSB. Graduate students will have a lead advisor at their institution but will be co-advised by project faculty at other institutions. PIRE Students and faculty will gather every July in Brazil before fieldwork and every January at one of the US campuses for *Project Conferences*.

Research Summary - *Background and Justification*

Civilization, despite a massive expansion in technology over the past century, still depends on the hydrosphere, biosphere, and the thin veneer of soil known as the *critical zone,* to provide for basic needs: food, water, and shelter. With ~7 billion people inhabiting Earth and altering Earth's surface, vegetation, atmosphere, and climate at an unprecedented pace (IPCC, 2007), understanding how the thin mantle of soil and water that covers our planet will respond to human-induced landscape change (development) is critical. Such advances will only come if we gather relevant data, construct predictive models, and train a community of scientists capable of deducing the rate, distribution, and social impact of Earth Surface processes (GLD SEES, 2011).

Nowhere is the interaction between people and the landscape on which they live more clear than in the developing world where landscapes are rapidly changing in the face of growing populations and increasing mechanization. The contrasts are vivid; satellite dishes hang off homes that discharge raw sewage to streams from which people downstream draw their drinking water. Debris flows tear through villages, ripping homes from their foundations while on steep hillslopes, deforestation and land-use conversion to intensive agriculture accelerates the loss of fertile topsoil (Haggett, 1961). Human actions are altering the trajectory of natural systems and the response of those systems is impoverishing human communities (Turner II et al., 2007).

Sustainability, the concept that humans can inhabit the planet in a way that minimizes harm to the environment, optimizes societal resilience to hazards arising from natural systems, and provides for future generations, is more than a lofty goal - in the face of dramatic population growth and a finite resource base - sustainability is a necessity. Analysis of the historical record is not optimistic; unsustainable societies collapse (e.g., Diamond, 2007; Montgomery, 2008). Such collapses were triggered by a variety of proximal mechanisms including economic and social upheavals; however, underlying the demise of many societies was something simpler - soil erosion, the loss of soil fertility, and thus a lack of food (Montgomery, 2008). Failed societies of the past have an important system characteristic in common, lack of resilience. Resilient systems are diverse, complex, and stable in the face of perturbations; they can recover from large-magnitude, low-frequency events (Fiksel, 2003). In short, resilient systems are more sustainable.

This PIRE has three closely interrelated goals: 1) performing basic research to understand the rate and spatial distribution of erosion and related hazards in Brazil before and after development, 2) using the new knowledge to develop and implement informed, sustainable, land-use strategies, and 3) training the next generation of STEM researchers and educators holistically to implement evidence-based changes in landscape management approaches around the world, because such a STEM workforce is critical for steering our global society toward sustainability.

Why Brazil? Why now?

Brazil provides an ideal test-bed for determining how to shape sustainable landscapes; the country is in the midst of rapid development, and with the resources provided by one of the world's fastest-growing emerging economies, now is the time to institute changes that could lead to a more sustainable future. Brazil has a diverse suite of climates and cultures; there are large cities and small towns impacted by natural hazards and extensive rural areas where agricultural practices degrade soil fertility. Knowledge of erosion rates in Brazil is limited (e.g. Whittman et al., 2011; Merten et al., 2010) so that PIRE research will make a significant impact. Brazil has a large community of young scientists ready to employ novel techniques for assessing natural resources and hazards, if (as this PIRE plans to do) they are given access to new approaches and technologies. Brazil is easily reached by one flight from the US, good roads allows easy field access, and political stability provides an efficient work environment. Bierman, Dunne, Farley, and Lopez-Carr already have active collaborations with Fernandes and other Brazilian scientists.

Research Summary - *Overarching Research Objectives*

Fig 1. Debris flow, Teresopolis, Brazil 2011

Objective 1. Determine and compare background and human-induced rates of landscape change

In order to evaluate and improve landscape-level sustainability, we need data sufficient to compare long-term (background) rates of landscape change to those that result from human activities. PIRE science will focus on two styles of landscape change: 1) low-frequency, high-magnitude events (rock falls, debris flows, and landslides) and 2) the persistent, on-going loss of soil from landscapes by incremental erosion. The former - dramatic natural hazards - kill people and disrupt infrastructure - as exemplified by the 2011 Brazilian events (Fig. 1), including debris flows, landslides, and flooding. The latter is ubiquitous due to deforestation and land-use change. Even though soil loss is incremental and largely unseen, it can spell disaster over the long term because it impacts the ability of a nation to feed its people (Montgomery, 2008).

To deduce long-term rates of landscape change, we will analyze ^{10}Be, a cosmogenic nuclide produced at Earth's surface (Bierman and Nichols, 2004). ^{10}Be in stream sediment can be used at a drainage basin scale to determine landscape rates of sediment generation (e.g. Brown et al., 1995; Bierman and Steig, 1996; Granger et al., 1996). Measured in hillslope soils, ^{10}Be can be used to constrain rates of soil movement (Nichols et al., 2002; Jungers et al., 2010). ^{10}Be ages of debris flow boulders can be used to estimate the recurrence interval of large, damaging flows (e.g. Bierman et al., 1995; Zefuss et al. 2001). A recent compilation of published ^{10}Be measurements shows how little we know about the background rate of soil formation in South America (Portenga and Bierman, 2011). PIRE research will fill that gap (Fig. 2) and provide the information on the geospatial patterns of erosion and soil formation in eastern South America.

We will constrain short-term, human-induced rates of landscape change using analysis of short-lived radionuclides (Fornes, et al, 2005; Mabit et al., 2008), modeling of soil erosion at the plot scale (Porto et al., 2001), mass balance calculations using sediment yield data, and land-cover change mapping over the last several decades using remote sensing analysis (Landsat). These data directly address the challenges articulated in GLD SEES (2011). *"What is the relative importance of anthropogenic vs. natural changes?* If current rates of erosion exceed the rate of soil production, the present agricultural system is unsustainable.

We will compile maps of historical debris flows and landslides (aided by remote sensing data) and visit these areas to sample older deposits for dating, using ^{10}Be and fallout radionuclides. The results will indicate relative risk (recurrence interval) in different catchments and for different styles of development. By working across climatic and human impact gradients, and by incorporating climate predictions into numerical slope stability and soil erosion models, we will strive to predict landscape response to future climate and as a function of land-use intensity, i.e, what is the relationship between land-use/land-cover change (deforestation and agronomy) and landslides, debris flows, floods, and soil loss.

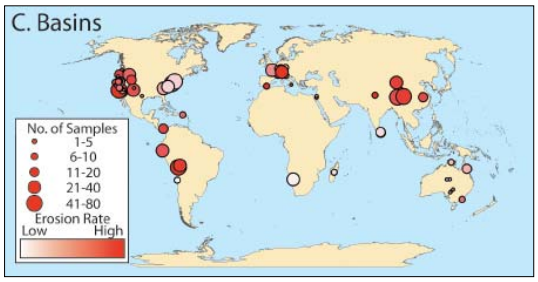

Fig 2. Compilation (Portenga and Bierman, 2011) of cosmogenically estimated erosion rates

Objective 2. Identify and quantify thresholds beyond which a landscape becomes unsustainable

Identifying and understanding thresholds (tipping points) beyond which changes in system behavior become irreversible on human time scales is critical to determining the sustainability of any development trajectory. PIRE research will focus on two very different thresholds. 1) We will investigate the abrupt physical thresholds that define slope instability and the generation and distribution of the destructive and deadly debris flows that result. Slope stability thresholds are not static; they change as land is developed and deforested (Montgomery et al., 2000) and as climate change alters precipitation patterns (Dehn et al., 2000). Mapping and dating older flows will define hazard zones; stochastic physical models will enable prediction. 2) We will examine less discrete thresholds, for example, how much topsoil must erode before loss of

fertility forces farmers to switch crops or abandon fields? Our analysis will consider how erosion responds to slope, soil characteristics, and the distribution of vegetation patches in agricultural, early-successional, and old-growth conditions. In the case of soil loss, a relevant metric might include comparison of long-term soil generation rates (measured with ^{10}Be) with short-term soil loss rates. For debris and flood flows, metrics will include predictions (varying land use and climate) of the number of people and properties impacted by flows.

Smart experimental design will allow us to design spatially representative sampling plans. Because Brazil is a very large country with diverse physiography and culture, we will focus our analysis on the heavily settled eastern coast and nearby rugged hinterland. Extrapolation from our study sites, to broader spatial and temporal scales, will require the implementation of both physical models and models of population behavior. While some of these models may be deterministic, others will need to incorporate the stochastic properties of transport events and so will consider the emergent behaviors of complex systems (e.g., Benda and Dunne, 1997; Gabet and Dunne, 2003). A major goal of the PIRE is to identify a series of *resilient thresholds* – intensities of and styles of land use that allow for development but prevent catastrophic failures of either the human or natural system. Completing *Objective 2*, will allow us to index the relative "sustainability" of different land-use practices and land-use intensities, for example by estimating a number of years remaining to a threshold if current land use is projected into the future.

Objective 3. Design and implement more resilient landscape development approaches

Shaping resilient, sustainable human/landscapes systems in rapidly developing nations requires an understanding of both natural systems and those engineered by humans. Optimal designs take into account not only how the land behaves naturally and how it will behave during and after development but most importantly, how the population uses the land. Risk and cost-benefit analyses are important as is the grounding of solutions in historical data, mechanistic understanding of landscape processes, and engineering technologies appropriate for the culture, landscape, scale, and available materials. Designing and implementing more resilient approaches to landscape management and development will require fieldwork coupling erosion analysis with land use and attitude surveys. For example, Carr (2009) used household surveys in the agricultural frontiers of the Amazon, in combination with diverse spatial and hierarchical regression models, to quantify varying levels of "sustainable" (or not) land use.

Trickiest to achieve will be implementation including not only sustainable agriculture and forest practices but also development. Solutions will vary spatially but that all will incorporate diversity and redundancy (different approaches that lead to the same result), trademarks of resilient systems. For example, reforestation, know to decrease erosion, landsliding, and flood hazard, could be encouraged by local economic incentives, by better enforcement of the Brazilian forestry code, and by global incentives such as carbon offsets (Farley 2010; Farley et al., 2010). Our goal, posed in terms of natural hazard reduction and soil sustainability, is to provide strategies encouraging land use that does not exceed resilience thresholds.

How do we most effectively distribute the knowledge we gain to a culture and governance structure different from the United States? First, all PIRE research (and each PIRE thesis) will explicitly address sustainability through the application and implementation of research results. Meaningful dissemination will require expanding the understanding of surface processes and landscape patterns through the use of visual, text, and computational products appropriate for various levels of technical expertise ranging from schools to agencies and research institutes entrusted with land conservation and planning of development. Our PIRE research will be important to non-scientists and non-students; yet, the research methodology can be difficult for a non-scientist to understand. We will strive to ensure the results of PIRE research are accessible to the Brazilian public. Such technology transfer will be done in concert with our Brazilian partners, those in *EMBRAPA* and at the University. The Bren School (Dunne, UCSB), with its distinctive education program designed specifically for environmental professionals, and having a large cohort of Latin American students, provides a model for effective transfer of scientific knowledge and skills.

Our undertaking is ambitious, certainly, but the integration of observations that characterize the response of natural systems, models that enable prediction of future behavior, and assessment of the risks associated with various decision-response scenarios, provides the best chance of preparing the next generation of researchers and environmental management professionals to solve the mosaic of sustainability science questions at a landscape scale.

Education Summary

We have designed an educational environment that builds bridges between different cultures, institutions, ages, experience levels, and expertise. PIRE research will be done in the field and lab by PhD- and MS-level graduate students teamed with undergraduates (recruited nationwide in an REU-like program). All US students will work in collaboration with Brazilian faculty and graduate students when in Brazil. PIRE students will be supervised by faculty from four different US institutions – each with different expertise and institutional cultures. K-12 educators will engage in international research and work closely with faculty, graduate students, Brazilian teachers, and Outreach Coordinator Massey to develop curriculum for dissemination in their schools and across the web. The integration of different STEM disciplines including engineering, geochemistry, complex systems modeling, surface Earth geoscience, risk analysis, hydrology, economics, human geography, and the nature of our approach will provide a uniquely stimulating environment for the 18 undergraduates, 12 graduate students, 9 teachers, and the Postdoctoral Associate supported by this PIRE.

The Student Experience – Our goal is to provide a rich, interdisciplinary, supportive, intensively mentored, and vertically integrated learning environment for all involved in the PIRE. January, before the *Project Conference* (which will rotate between US campuses), we will hold a one-day *Training Workshop* for all project participants. Each year at the *Training Workshop*, different faculty will present 90-minute seminars introducing the key concepts of their disciplines – thus broadening the training and interdisciplinary awareness of all involved in the PIRE. Although the project is distributed between four campuses and two countries, there will be many opportunities for interaction, both on campus, because there will always be several PIRE participants on each campus, and because the entire team (faculty, students, K-12 participants) will gather twice yearly to share their findings at the bi-annual *Project Conferences*.

Recruiting and Retaining Members of Under-represented Groups – Diversifying graduate and faculty ranks in the STEM disciplines is not easy (O'Connell & Holmes, 2011); thus, we have designed an active recruiting/retention program co-led by an experienced undergraduate educator (Nichols) and a PIRE Postdoctoral Associate stationed with Nichols. We will begin by engaging undergraduate STEM faculty at a variety of US undergraduate schools, focusing on those with large under-represented populations (e.g., Historically Black, Latino, and Tribal Colleges and Universities). Project participants will travel to 6 schools a year and recruit students during two-day, hands-on *Recruitment Seminars* that both introduce us as mentors and teach about the dynamic nature of Earth's surface as it relates to sustainability (human/landscape interaction). During years 2, 3 and 4, we will select a diverse group of 6 undergraduates, representing different schools, backgrounds, and geographic areas to participate in the equivalent of a summer REU. Each undergraduate will engage in a series of distance learning seminars during the spring and will be paired with a graduate student for summer fieldwork in Brazil. All students will present their results in the bi-annual *Project Conferences (*in Brazil in July and the US in January*)*. We will strive to retain the best undergraduates as graduate students, further diversifying the PIRE.

International Exchanges – Brazilian partners (students, faculty, and professionals) are integral to the educational objectives of this project. The active US project team will travel yearly to Brazil for fieldwork and to share our findings and approach with Brazilian scientists including students and faculty during the *Project Conferences*. Because Brazil fully funds their doctoral students to spend one research year abroad (including a housing stipend) during dissertation research, Vermont, Skidmore, UCSB, and Penn State will host Brazilian graduate students in our labs at no cost to NSF. The visiting students will generate and interpret data, further diversifying the project team and providing cross-cultural experiences for students associated with the PI's research groups but not directly with the PIRE. Brazilian faculty and graduate students will travel to undergraduate institutions with students involved in the PIRE to give lectures and meet students, thus broadening the impact of the PIRE far beyond the 4 core academic institutions.

Educational Materials Development and Dissemination – During the first 6 months of the project, all of the faculty and the Postdoctoral Associate will work individually and together to develop educational materials

(hand-on activities) at two levels – one for undergraduate education (*Recruitment Seminars*) the other for training professionals including graduate students and faculty both within and outside of the program (*Training Workshops*). In year 5, the faculty and PhD students will develop and present *Short Courses* disseminating our approach and results at relevant professional venues in the US and in Brazil. Such courses will be interdisciplinary, considering the relevant science, social science, and policy in the context of development and land management.

K-12 Involvement – During the core 3 years of the PIRE, we will seek out four highly motivated K-12 teachers to join our team, one each from the areas near Skidmore, Vermont, UCSB, and Penn State. The teachers will begin their involvement during the January *Conference*, design a sustainability-related research project appropriate to their expertise in consultation with project faculty and Outreach Coordinator Massey during the spring, then travel to Brazil during the summer field season to do research, attend the July *Project Conference*, and meet and work with Brazilian K-12 teachers and students. Returning to the US, they will summarize their research and develop curricular material that links their home town to the work they did in Brazil. PIRE staff will encourage linkages (Skype, letter writing) between US and Brazilian K-12 classrooms. K-12 teacher involvement leverages PIRE support to broaden the cultural and scientific awareness of the next American generation while personally linking graduate students to pedagogical professionals outside the academy. If funding and logistics allow, we will link to the Vermont Governor's Institutes (http://giv.org, a program for high motivated high school students with which Bierman and Massey have been involved for nearly 20 years) and thus expand the international research experience to incorporate pre-college students interested in science and social change.

Assessment of Program – The short- and long-term success of the project depends on flexible response to comprehensive assessment of the research and educational goals throughout the five years of the PIRE. Each year, external evaluators (UVM Education Department) will perform formative assessments using both attitude surveys of all participants and quantitative metrics of research and training productivity. By assessing the education and scientific programs on an annual basis, we will be able to make mid-course adjustments. During the final two years of the PIRE, assessment will broaden to include metrics related to technology transfer. At the end of the program, a summative assessment will determine how well we have met the PIRE goals of interdisciplinary education, teacher training, and technology transfer.

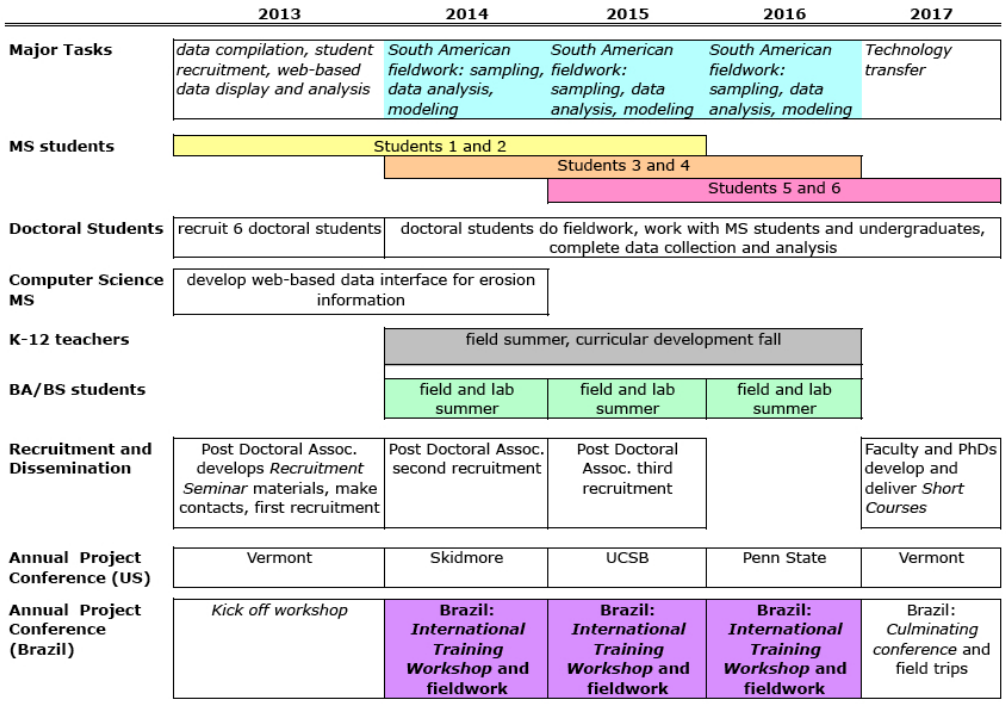

Fig. 3. *Project timeline showing, major tasks, timing of student recruitment and field work and conference timing.*

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MS, 1990, Geology, University of Washington, Seattle, WA with A. Gillespie
"*Accuracy and Precision of Rock Varnish Cation Ratio Dating*"
Ph.D., 1993, Geology, University of Washington, Seattle, WA with A. Gillespie
"*Cosmogenic Isotopes and the Evolution of Granitic Landforms*"

(ii) Appointments

2002-present	Professor	Univ. Vermont, Geology and Natural Resources
1998-2002	Associate Professor	Univ. Vermont, Geology and Natural Resources
1993-1998	Assistant Professor	Univ. of Vermont
1992-1993	Lecturer	University of Washington
1993	Visiting Researcher	University of Adelaide
1987-1992	Research and Teaching Assistant	University of Washington

(iii) Publications

(a) 5 publications most closely related to the proposed project

Graly, J., Bierman, P. R., Reusser, L., and Pavich, M., (2010). Meteoric ^{10}Be in soil profiles – a global meta-analysis. **Geochimica et Cosmochimica Acta**, doi:10.1016/j.gca.2010.08.036

Reusser, L. J., Graly, J., Bierman, P., and Rood, D. (2010). Calibrating a long-term meteoric ^{10}Be accumulation rate in soil. **Geophysical Research Letters** 37, L19403. doi: 10.1029/2010GL044751

Reusser, L. and Bierman, P.R. (2010). Tracking fluvial sand through the Waipaoa River Basin, New Zealand, with meteoric ^{10}Be. **Geology**, v. 38; no. 1; p. 47–50; doi: 10.1130/G30395.1

Jungers, M.C., Bierman, P.R., Matmon, A., Nichols, K., Larsen, J., and Finkel, R. (2009) Tracing hillslope sediment production and transport with in situ and meteoric ^{10}Be: **Journal of Geophysical Research**, v. 114, doi:10.1029/2008JF001086,

Cox, R. Bierman, P. Jungers, M., and Rakotondrazafy. M. (2009). Erosion rates and sediment sources in Madagascar inferred from ^{10}Be analysis of lavaka, slope, and river sediment, **Journal of Geology**, v. 117, p. 363–376, DOI:10.1086/598945.

(b) 5 most significant publications,

Reusser, L., Bierman, P.R., Pavich, M., Zen, E., Larsen, J., and Finkel, R. (2004) Rapid Late Pleistocene Incision of Atlantic Passive-Margin River Gorges, **SCIENCE**, v. 305, 409-502

Bierman, P. R. and Nichols, K.K. (2004) Rock to sediment - Slope to sea with ^{10}Be - Rates of landscape change, **Annual Review of Earth Science**. v. 32. p. 215–255

Noren, A., Bierman, P.R., Steig, E., Lini, A., and Southon, J., (2002), Millennial scale storminess variability in the northeastern United States during the Holocene epoch, **NATURE**, v. 419, 821-824.

Bierman, P. and Steig, E. (1996) Estimating rates of denudation and sediment transport using cosmogenic isotope abundances in sediment. **Earth Surface Processes and Landforms,** 21, 125-139.

Bierman, P. (1994) Using in situ cosmogenic isotopes to estimate rates of landscape evolution: A review from the geomorphic perspective. **Journal of Geophysical Research** (special issue on Tectonics and Topography), 99, B-7, 13,885-13,896.

(iv) Synergistic Activities

Development and refinement of research tools – Fundamental work with graduate students developing and refining use of cosmogenic nuclides for monitoring rates of surface processes. Five major review publications (1994, 1998, 2001, 2003, 2004) and 28 refereed articles and book chapters with new cosmogenic data. Developed tools for reconstructing Holocene paleostorminess history of New England under NSF CAREER support. Donath Medal for Research by Young Scientist, Geological Society of America, 1996.

Innovations in teaching and training – Development of student-centered, inquiry-based, data collection courses in Geomorphology, Geohydrology, and Interdisciplinary Watershed studies documented in 4 refereed papers in the Journal of Geologic Education (2010, 2003, 1999, 1996). Creation of introductory Earth Hazards class for non-science majors to increase student interest and involvement, documented in refereed lead article in EOS (2003). NSF Directors Distinguished Teaching Scholar award, 2005.

Service learning and service to community -- Urban hydrology projects with classes and interns working with Burlington city government to document loss of greenspace and increase in run off from campus neighborhoods. Documented in Nichols et al. (2003, Journal of Geologic Education). Associate Editor, Geology and GSAB; editorial board, DLESE. Chair, GSA Quaternary & Geomorphology Division (2009)

(v) Collaborators & Other Affiliations

(a) Collaborators and Co-Editors (48 months)

J. Gosse, Dalhousie Univ; J Briner, Buffalo; D. Dethier, Williams College; P. Davis, Bentley College;; E. Steig, UW; A. Matmon, USGS; M. Pavich, USGS;. K. Nichols, Skidmore; A. Gellis, USGS; J. Larsen, UVM; R. Finkel, LLNL, S. Southworth, USGS, A. Noren, U Minn; D. Rizzo, UVM

(b) Graduate and Postdoctoral Advisors

Alan Gillespie, University of Washington, graduate advisor
Rowl Twidale, University of Adelaide, postdoctoral sponsor

(c) Thesis Advisor and Postgraduate-Scholar Sponsor

A. Matmon, Postdoctoral advisor, USGS; K. Nichols, Doctoral advisor, Skidmore College; E. Clapp, Doctoral advisor, Sevee and Mahar; L. Reusser, Doctoral advisor, University of Vermont; primary advisor, 4 PhD. and 22 MS students

Klaus Keller

Associate Professor of Geosciences
436 Deike Building
The Pennsylvania State University
University Park, PA 16802-2714

Phone: (814) 865-6718
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klaus@psu.edu
http://www.geosc.psu.edu/~kkeller

EDUCATION

Technische Universität Berlin: B.S. (Vordiplom) in Environmental Engineering, 1991.

Massachusetts Institute of Technology: M.S. in Civil and Environmental Engineering, 1994.

Technische Universität Berlin: Engineer's Degree in Environmental Engineering, 1995.

Princeton University: M.A. in Civil Engineering and Operations Research, 1998.

Princeton University: Ph.D. in Civil and Environmental Engineering, 2000.

PROFESSIONAL EXPERIENCE

Penn State, Director of the Center for Climate Risk Management, July 2008 – present.

Macquarie University, Visiting Professor, July 2009 – December 2009.

Penn State, Associate Professor of Geosciences, July 2008 – present.

Penn State, Assistant Professor of Geosciences, January 2002 – June 2008.

Princeton, Research scientist, July 2001 - December 2001.

Princeton, Lecturer, spring term, 2001.

Princeton, Postdoctoral research associate, July 2000 - July 2001.

Gesellschaft für Umwelttechnik, Berlin, engineer, 1995.

FIVE PUBLICATIONS RELEVANT TO THE PROPOSED PROJECT (OUT OF A TOTAL OF 40 PEER-REVIEWED)

McInerney, D., R. Lempert, and K. Keller What are robust strategies in the face of uncertain climate threshold responses? Accepted for publication in Climatic Change (2011).

Svoboda, T., Klaus Keller, Marlos Goes, and Nancy Tuana: Sulfate Aerosol Geoengineering: The Question of Justice. Public Affairs Quarterly, Public Affairs Quarterly, 25, p. 157-180, (2011).

Goes, M, K. Keller, and N. Tuana: The economics (or lack thereof) of aerosol geoengineering, Climatic Change, published online April 5, DOI 10.1007/s10584-010-9961-z, (2011).

McInerney, D. and K. Keller: Economically optimal risk reduction strategies in the face of uncertain climate thresholds. Climatic Change, 91, 29-41 (2008).

Keller, K., G. Yohe, and M. Schlesinger: Managing the risks of climate thresholds: Uncertainties and needed information. Climatic Change, 91, 5-10 (2008).

FIVE OTHER PUBLICATIONS

Schienke, E.W., N. Tuana, D. A. Brown, K. J. Davis, K. Keller, J. S. Shortle, M. Stickler, and S. D. Baum: The Role of the NSF Broader Impacts Criterion in Enhancing Research Ethics Pedagogy, Social Epistemology, 23, 317–336 (2009).

Keller, K. and D. McInerney, The dynamics of learning about a climate threshold. Climate Dynamics, 30, 321-332 (2008).

Keller, K., M. G. Hall, S.-R. Kim, D. F. Bradford, and M. Oppenheimer: Avoiding dangerous anthropogenic interference with the climate system. Climatic Change, 73, 227-238 (2005).

Keller, K., B. M. Bolker, and D. F. Bradford: Uncertain climate thresholds and economic optimal growth. Journal of Environmental Economics and Management, 48, 723-741 (2004).

Gruber, N., K. Keller, and R. M. Key: What story is told by oceanic tracer concentrations? Science, 290, 455 (2000).

SYNERGISTIC ACTIVITIES

Co-PI on several related ongoing projects that use large-scale observation networks and data-sets to analyze mechanistic hypotheses about climate feedbacks and use this information to inform climate change mitigation and adaptation decisions.

Lead or Co-Principal Investigator on, thus far, 23 grants (e.g., from NSF, DOE, NOAA, EPA, NASA, as well as industry) with a total research budget exceeding 11 million U.S.$.

Editorial board of Climatic Change Letters, Environmental Research Letters, and Earth System Dynamics.

Proposal review panelist for the National Science Foundation, the Department of Energy, and the National Oceanographic and Atmospheric Administration.

Active outreach to K-12, decision-makers, and the general public. My research was covered, for example, by Science, Nature, and Central Daily Times and by movies shown by the Discovery Channel and WPSX. I have given talks to citizens groups, local and regional administrating bodies, as well as kindergarten- and school-classes.

Past member of the Diversity Council of the College of Earth and Mineral Sciences.

Past Diversity representative for the Geosciences Department.

NON-PSU COLLABORATORS IN THE PAST 48 MONTHS

(This excludes the member of the editorial boards specified above, as this would be beyond the two-page limit and people who are have died in the meantime)

Applegate, P. (University of Stockholm), Baehr, J. (Hamburg U., Germany), Bhat, S. (Los Alamos), Brennan, C. (U. Victoria, Canada), Bradford, D. (Princeton), Budescu, D. (Fordham), Burton, I. (U. Toronto, Canada), Corfee-Morlot, J. (OECD, France), Crutzen, P. (MPI for chemistry, Germany), Deutsch, C. (UCLA), Duong, M. (CNRS, France), Easterling, D. (NOAA), Finkel, A. (Princeton), Fuessel, H-M. (PIK, Germany), Hall, M. (U. Michigan), Kolstad, C. (UCSB), Laabs, B. J. C. (SUNY Geneseo), Lempert, R. (RAND), Lowell, T. V. (University of Cincinnati), Magadza, C. (University of Zimbabwe, Zimbabwe), Marotzke, J. (MPI, Germany), Matear, R. (CSIRO, Australia), Mastrandrea, M. (Stanford), Matthews, D. (Concordia U., Canada), McInerney, D. (U. Chicago), MacMynowski, D. (Stanford), O'Neill, B. (NCAR), Oppenheimer, M. (Princeton), Patwardhan, A. (IIT, India), Pittock, B. (CSIRO, Australia), Pepper, W. (ICF), Rahman, A. (Bangladesh Centre for Advanced Studies, Bangladesh), Ricciuto, D. (ORNL), Robinson, A. (PIK, Germany), Schlesinger, M. (UIUC), Schmittner, A. (U. Oregon), Saliendra, N.Z. (U. Maryland), Smith, J. (Stratus Consulting),), Semenov, S. (IGCE, Russia), Smith, S. (JGCRI), Due-Wing, I. (Boston U.), Sukumar, R. (IIS, India), Timmerman, A. (U. Hawaii), Terando, A. (NC State), Tol, R. (ESRI, Dublin), Todorov, A. (Princeton), Suarez, A. (Cuban Environmental Agency) , Ulph, A. (Manchester U., United Kingdom), Urban, N. (Princeton), van Ypersele, J-P. (UCL, Belgium), Xiao, J. (U. New Hampshire), Yamin, F. (University of Sussex, UK), Yohe, G. (Wesleyan University), and Zillman, J. (Bureau of Meteorology, Australia),

GRADUATE AND POSTGRADUATE ADVISOR

F. M. M. Morel, graduate advisor, Blake Professor of Geosciences, Princeton University.

D. F. Bradford, postgraduate advisor, Professor of Economics and Public Affairs, Princeton University (deceased).

POSTDOCTORAL AND RESEARCH ASSOCIATES OF THE PAST FIVE YEARS

Marlos Goes (NOAA), David McInerney (U. Chicago), Dong-Ha Min (UT, Austin), Ryan Sriver (PSU), Robert Nicholas (PSU), and Nathan Urban (Princeton).

GRADUATE STUDENTS OF THE PAST FIVE YEARS

Katherine Brennan (U. Victoria), Joshua Dorin (teacher), Rob Fuller (private), Louise Miltich (private), A. Robinson (PIK), Deneyse Serino (teacher), and Roman Tonkonojenkov (PSU).

Eric Kirby
Department of Geosciences
Pennsylvania State University
University Park, PA 16802
ekirby@psu.edu

Professional Preparation:

B.A. Geology (1992)	Hamilton College
M.S. Geology (1994)	University of New Mexico
Ph.D. Geology (2001)	Massachusetts Institute of Technology
NSF Post-Doctoral Fellow	UC, Santa Barbara (2001 – 2002)

Appointments:

2010 – 2011	Humboldt Fellow – University of Potsdam, Germany
2008	Associate Professor – The Pennsylvania State University
2002 – 2008	Assistant Professor – The Pennsylvania State University

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PUBLICATIONS (*denotes student author)

Relevant to current proposal

*Hu, X., **Kirby, E.**, Pan, B., Ganger, D., and Su, H., 2011, Cosmogenic burial ages reveal sediment reservoir dynamics along the Yellow River, China: *Geology,* v. 39, p. 839-842, doi:10.1130/G32030.1.

*Craddock, W., **Kirby, E.**, Harkins, N., Zhang, H., and Shi, X., 2010, Rapid fluvial incision along the Yellow River during headward basin integration: *Nature Geoscience*, v. 3, p. 209-213, doi:10.1038/ngeo777.

Kirby, E., Johnson, C., Furlong, K., and Heimsath, A., 2007, Transient channel incision along Bolinas Ridge, California: Evidence for differential rock uplift adjacent to the San Andreas fault: *Journal of Geophysical Research, Earth Surface*, 112, F03S07, doi: 10.1029/2006JF000559.

*Harkins, N., **Kirby, E.**, Heimsath, A., Robinson, R., and Reiser, U., Transient fluvial incision in the headwaters of the Yellow River, northeastern Tibet, China: *Journal of Geophysical Research, Earth Surface*, 112, F03S04, doi:10.1029/2006JF000570.

*Duvall, A., **Kirby, E.**, and Burbank, D., Tectonic and lithologic controls on channel profiles and processes in coastal California: *Journal of Geophysical Research: Earth Surface,* v. 109, F03002, doi:10.1029/2003JF000086.

Other recent publications

*Craddock, W.H., **Kirby, E.** Zheng, D., and Lui, J., 2011, Tectonic setting of Cretaceous basins on the NE Tibetan Plateau: Insights from the Jungong basin: Basin Research, doi: 10.1111/j.1365-2117.2011.00515.x.

Kirby, E. and Ouimet, W., 2011, Tectonic geomorphology along the eastern margin of Tibet: Insights into the pattern and processes of active deformation adjacent to the Sichuan Basin, *in*, Gloaguen, R. and Ratschbacher, L., eds., *Growth and Collapse of the Tibetan Plateau*: Geological Society, London, Special Publications, v. 353, p. 165-168. doi: 10.1144/SP353.9.

Wang, W., Zhang, P., **Kirby, E.**, Wang, L., Zhang, G., Zheng, D., and Chia, C., 2011, A revised chronology for Tertiary sedimentation in the Sikouzi basin: Implications for the tectonic evolution of the northeastern corner of the Tibetan Plateau: *Tectonophysics*, v. 505, p. 100-114.

*Harkins, N.W., **Kirby, E.,** Shi, X., Wang, E., Burbank, D., and Chun, F., 2010, Millennial slip-

rates along the eastern Kunlun fault: Implications for the dynamics of intracontinental deformation in Asia: *Lithosphere*, v.2, p. 247-266., doi: 10.1130/L85.1.

*Regalla, C., Fisher, D., and **Kirby, E.**, 2010, Timing and magnitude of shortening within the inner fore arc of the Japan Trench: *Journal of Geophysical Research*, v. 115, doi:10.1029/2009JB006603.

SYNERGISTIC ACTIVITIES

I am have been intimately involved in the development of an ArcGIS-based tool for analysis of river gradients and topographic data. We hosted a short course at 2007 GSA Annual Meeting entitled *New tools for Quantitative Geomorphology: Extraction and interpretation of stream profiles from digital topographic data*. The tool has been made freely available to colleagues at other institutions for use in research and instructional environments (http://www.geomorphtools.org).

I am currently serving as an Associate Editor for *Tectonics* (2004-2012), for *GSA Bulletin* (2007-2012), and Geology (2009-2012); I begin a 4-year term as Science Editor for Lithosphere in January, 2012. I co-led of a GSA field trip in Eastern California (2008), co-organized a recent NSF workshop on Future Directions in Research in Tibet (2010), and I have been an invited participant in recent science planning workshops (Earthscope, 2009; MARGINS, 2010).

COLLABORATORS

Doug Burbank (UCSB), Sue Brantley (PSU), Paul Bierman (UVM), Clark Burchfiel (MIT), Marin Clark (Michigan), Nancye Dawers (Tulane), Ken Deuker (Wyoming), Ken Farley (Caltech), Kevin Furlong (PSU), Carmala Garzione (Rochester), John Gosse (Dalhousie), Arjun Heimsath (ASU), Matt Heizler (NMT), Kip Hodges (ASU), Chen Jie (UCSB), Karl Karlstrom (UNM), Eric McDonald (DRI), Peter Molnar (Colorado), Tom Parsons (USGS), Fred Phillips (NMT), Marith Reheis (USGS), Pete Reiners (Yale), Gerard Roe (Washington), Wiki Royden (MIT), Kamini Singha (PSU), Rudy Slingerland (PSU), J. Doug Walker (Kansas), Kelin Whipple (ASU).

GRADUATE AND POSTDOCTORAL ADVISORS

Doug Burbank (Postdoctoral advisor – UCSB)
Clark Burchfiel and Kelin Whipple (Ph.D. advisors – MIT)
Karl Karlstrom (M.S. advisor – UNM)

STUDENTS AND POSTDOCTORAL ASSOCIATES

M.S. – Tye Numelin (2005), Charlie Angerman (2006), Andrea Mullen (2007), Will Hoffman (2009), Shi Xuhua (2011), Russell Rosenberg (current), Nooreen Meghani (starting Jan. 2012)
Ph.D. – Nate Harkins (2008), Bill Craddock (2011), Nicole West (current), Shi Xuhua (current)
Postdoc – Will Ouimet (2007)

Total students: 11 Total postdocs: 1

BIOGRAPHICAL SKETCH

Kyle K. Nichols
Department of Geosciences, Skidmore College, Saratoga Springs, NY 12866

A. Professional Preparation

University of Washington	Geological Sciences	BA, 1996
University of Vermont	Geology	MS, 2000
University of Vermont	Natural Resources	PhD, 2002

B. Professional Experience

2008 – present	Associate Professor and Chair of Geosciences	Skidmore College
2002 – 2008	Assistant Professor of Geosciences	Skidmore College
1997 – 2002	Research and Teaching Assistant	University of Vermont

C. Publications

i. Most relevant to proposed research

Nichols, K.K., Bierman, P.R., Finkel, R., Larsen, J., 2005, Long-term sediment generation rates for the Rio Chagres basin; evidence from cosmogenic ^{10}Be: in The Rio Chagres, Panama: A Multidisciplinary Profile of a Tropical Watershed, R.S. Harmon, ed., p. 297-313.

Nichols, K.K., Bierman, P.R., Caffee, M.W., Finkel, R., and Larsen, J., 2005, Cosmogenically enabled sediment budgeting: Geology, v. 33, 133-136.

Nichols, K.K., Bierman, P.R., Eppes, M.C., Caffee, M.W., Finkel, R., and Larsen, J., 2007, Long-term erosion and deposition of a Mojave Desert piedmont: Implications of sediment supply and climate change: Quaternary Research, v. 68, p. 151-161.

Jungers, M. C., Bierman, P.R., Matmon, A., Nichols, K., Larsen, J., and Finkel, R., 2009, Tracing hillslope sediment production and transport with in situ and meteoric ^{10}Be: Journal of Geophysical Research, Earth Surface, v. 114, F04020, doi:10.1029/2008JF001086.

Bierman, P.R., Nichols, K.K, 2004, Rock to sediment, Slope to sea with 10-Be, Rates of landscape change: Annual Reviews of Earth and Planetary Sciences, v. 32, p. 215-255.

ii. Other significant publications

Nichols, K.K., Bierman, P.R., Foniri, W.R., Gillespie, A.R., Caffee, M., Finkel, R., 2006, Dates and rates of arid region geomorphic processes from analysis of cosmogenic nuclides: GSA Today, v. 16, n. 8, p. 4-11.

Nichols, K.K., Bierman, P.R., Eppes, M.C., Caffee, M.W., Finkel, R., and Larsen, J., 2005, Late Quaternary history of the Chemehuevi Mountain piedmont, Mojave Desert, deciphered using ^{10}Be and ^{26}Al: American Journal of Science, v. 305, p. 345-368.

Nichols, K. K., Bierman, P. R., Hooke, R. L., Clapp, E., Caffee, M., 2002, Quantifying sediment transport on desert piedmonts using ^{10}Be and ^{26}Al: Geomorphology, v. 45, p. 105-126.

Matmon, A., Nichols, K.K., Finkel, R., 2006, Isotopic insights into smoothening of abandoned fan surfaces, southern California: Quaternary Research, v. 66, p. 109-118.

Clapp, E.M., Bierman, P.R., Nichols, K.K., Pavich, M., Caffee, M., 2001, Rates of sediment supply to arroyos from upland erosion determined using in situ produced cosmogenic ^{10}Be and ^{26}Al: Quaternary Research, v. 55, no. 2, p. 235-245.

D. Synergistic Activities

1. ***Service to geoscience community*** – Co-technical program chair of the 2005 Northeastern GSA meeting and Local organizing committee member of the 2003, 11th Symposium on Water Rock Interactions.
2. ***Interdisciplinary education*** – Co-founder of the GIS Center for Interdisciplinary Research at Skidmore College.
3. ***Outreach*** – Environmental Science Coordinator of Skidmore College's *Water Resource Initiative.*
4. ***Innovations in teaching*** – Co-author of two manuscripts published in *Journal of Geoscience Education*. One describes (2003) a service-learning hydrology project (lead author with several undergraduate co-authors) and the other (1999) describes winter geohydrology projects (co-author).
5. ***Campus community leader*** – Co-author of the Science Vision for Skidmore and mentor for the New Faculty Learning Community that helps junior faculty balance life and workload.

E. List of Collaborators and Advisors

Paul Bierman, Univ. Vermont
Marc Caffee, Purdue Univ.
Martha Eppes, UNC Charlotte
Robert Finkel, Lawrence Livermore Lab
Alan Gillespie, Univ. Washington
Bruce Harrison, New Mexico Tech
Matthew Jungers, Arizona State University Ari Matmon, Hebrew University
Robert Webb, USGS

Graduate Advisor

Paul Bierman, Univ. Vermont

Undergraduates Theses Advised Last Six Years (no graduate students)

David Stein-Cowan, 2010 – Geomorphic effects of 19th Century Adirondack Logging
Matthew Shrensel, 2009 – Long Term Erosion Rates across Panama: A GIS approach Lindsay Bourgoine, 2009 – Digging in: Examining soil composition of Cerro Punta, Panamá
Jeff Narva, 2008 – Buffer mapping of Kayaderosseras Creek
Melissa Ng, 2008 – Hydrology of the Kayaderosseras Creek Watershed
Kim Rich, 2008 – Pediment modification of Namibia
Thomas Arnold, 2007 – Flash Flood Caused by Railway Embankment Failure
Allison Stafford, 2007 – Hydrology of the Wilton Sand Plain
Erin Black, 2006 – Turbidity of the Kayaderosseras Creek Watershed
Megan Chadwick, 2006 – Buffers on the Battenkill: Mapping Riparian Zones Using GIS
Michael Cleveland, 2006 – Long-term Erosion Rates of the Grand Canyon Using ^{10}Be
Davin Lyons, 2006 – Holocene Climate Change of Keuka Lake, Finger Lakes Region
Derek Eaton, 2005 – Initiation and Growth Processes of the Miller Brook Gully, VT
Daniel Feuer, 2005 – GIS Analysis of Tributary Basins in the Colorado River Basin
Luca Peppe, 2005 – Reinterpretation of the Deglacial History, Kayaderosseras Valley
Veronica Russell, 2005 – History of the Goldstone Piedmont, Fort Irwin, CA, Using ^{10}Be

DONNA M. RIZZO

(I) PROFESSIONAL PREPARATION:

Institution and Location	Major	Degree & Year
University of Connecticut, Storrs	Civil Engineering	B.S., 1984
University of Florence, Italy	Art and Archeology	N.A., 1985
University of California, Irvine	Civil Engineering	M.S., 1990
University of Vermont, Burlington	Civil & Environmental Engineering	Ph.D., 1994

(II) APPOINTMENTS:

2002-present **Associate Professor**, Department of Civil & Environmental Engineering, and Dept. of Computer Science, University of Vermont, Burlington, VT.

1995-2002 **Co-founder**, Subterranean Research, Inc., Burlington, VT.

1991-1994 **Research Assistant**, University of Vermont, Burlington, VT. *Research*: geohydrologic site characterization, artificial neural networks, optimal groundwater remediation design, highly-parallel implementation of numerical methods for geohydrological applications.

1992-1995 **Instructor & PC Laboratory Instructor**, Princeton Transport Code Short Course, with G. F. Pinder, S. Stothoff, J. Guarnaccia, and G. Karatzas; and IBM PC Applications in Ground Water Pollution & Hydrology Short Course, by R. W. Cleary, M. Ungs, and G. Pinder.

1992-1994 **Participating Guest**, Lawrence Livermore National Laboratory, Livermore CA.

1986-1990 **Research Assistant and Graduate Teaching Assistant**, University of California, Irvine, CA. *Research*: mathematical modeling multi-phase flow & transport in unsaturated soils.

1986-1988 **Civil Engineer**, Born Barrett & Associates, Civil Engineering & Consulting, CA.

1984-1986 **Civil Engineer**, State of Connecticut Department of Environmental Protection.

(III) 10 SELECTED PUBLICATIONS:

Mouser, P.J., D.M. Rizzo, G. Druschel, S.E. Morales, P. O'Grady, N.J. Hayden and L. Stevens, "Microbial Community Profiles Enhance Detection of Groundwater Contamination from Leaking Waste Disposal Sites", *Water Resources Research*, Accepted, 2010.

Besaw, LE., D.M. Rizzo, M. Kline, K.L. Underwood, J.J. Doris, L.A. Morrissey and K. Pelletier, "Stream Classification using Hierarchical Artificial Neural Networks: A fluvial Hazard Management Tool", *Journal of Hydrology*, doi:10.1016/j.jhydrol.2009.04.007, 2009.

Kollat, J.B., P. M. Reed, and D.M. Rizzo, "Addressing Model Bias and Uncertainty in Three-dimensional Groundwater Transport Forecasts for a Physical Aquifer Experiment", Geophysical Research Letters, 35, L17402, doi: 10.1029/2008GL035021, 2008.

McBride, M., D.M. Rizzo, W.C. Hession. "Riparian Reforestation and Channel Change: A Case Study of Two Small Tributaries to Sleepers River, Northeastern Vermont, USA", Geomorphology, 102 (3-4) 445-459, doi: 10.1016/j.geomorph.2008.05.008, 2008.

Besaw, L.E. and D.M. Rizzo, "Spatial Prediction and Stochastic Conditional Simulation using Artificial Neural Networks", *Water Resources Research*, 43, W11409, DOI: 10.1029/2006WR005509, 2007.

Clark, J.S., D.M. Rizzo, M.C. Watzin, and W.C. Hession, "Geomorphic Condition of Fish Habitat in Streams: An Analysis Using Hydraulic Modeling and Geostatistics", *River Research and Applications*, 23, DOI: 10.1002/rra.1085, 2007.

Mouser, P.J., D.M. Rizzo, W.F.M. Röling, B.M. and van Breukelen. "A multivariate geostatistical approach to spatial representation of groundwater contamination using hydrochemistry and microbial community profiles". *Environmental Science & Technology*. 39 (19) pp. 7551-7559. 2005.

Rizzo, D.M. and D.E. Dougherty, "Artificial Neural Networks in Subsurface Characterization", Book Chapter in *Artificial Neural Networks in Hydrology*, R.S. Govindaraju and A.R. Rao (eds.), pp. 111-133, 2000.

Rizzo, D.M. and D.E. Dougherty, "Characterization of aquifer properties using artificial neural networks: Neural Kriging", *Water Resources Research*, 30 (2), pp. 483-497, 1994.

Rizzo, D.M. and D.E. Dougherty, "Design Optimization for Multiple Management Period Groundwater Remediation", *Water Resources Research*, 32 (8), pp.2549-2561, 1996.

(V) SYNERGISTIC ACTIVITIES

Dr. Rizzo and has over 15 years of experience with optimization methods and 20 years of groundwater and modeling experience. Her tenure-track position is more recent, yet she has a strong record of accomplishment in research and development, having procured five Small Business Innovation Research (SBIR) grants from the Federal government (NSF, DOE and USDA) during the five years that she co-founded a small business. She was PI for DOE funded SBIR Phase I and Phase II projects that developed tools for rapid joint inversion and imaging of multiple geophysical and geotechnical data types to characterize subsurface fluids and media. Her optimization work includes projects at the Lawrence Livermore National Lab, published in Water Resources Research in 1996. She is known for work on the use of artificial neural networks on subsurface problems, including interpolation, inversion and nonparametric statistical methods. She has experience improving code performance, direct development involvement in optimization codes that use linear programming, simulated annealing, outer approximation, Gauss-Newton, tabu and genetic methods; and was one of 15 people selected in a national competition to attend a 12-week workshop at the Advanced Computing Laboratory at Los Alamos National Laboratory, Spring, 1993.

NSF undergraduate education projects:

- NSF DBI, Undergraduate Mentoring in Environmental Biology: Diversity & Excellence in Environmental Biology. L. Stevens (PI), D. Rizzo (co-PI). 07/04-06/09.
- NSF EEC – Engineering Education: A Systems Approach to Civil and Environmental Engineering Education: Integrating Systems Thinking, Inquiry-Based Learning and Catamount Community Service-Learning Projects. N. Hayden (PI), Rizzo, Dewoolkar and Sadek (co-PI). 09/05- 10/08.

Broadening underrepresented groups in science, mathematics, engineering and technology

- Secured $300,000 endowment in undergraduate research fellowships (Barrett Foundation)
- 1995-present: organizer, committee member Annual Design TASC (Technology And Science Connection) competition, high school students
- Faculty advisor, UVM chapter of the Society for Women Engineers
- Attended workshops focusing on promoting women in science and engineering;

Service to the scientific and engineering community

- Vice Chair, ASCE Task Committee on Long Term Monitoring Optimization
- Experience in consulting firms
- Developed multidisciplinary research programs for a private high school
- Worked with the Federal Emergency Management Agency during 1998 VT floods
- Peer review for EPA, NSF and DOE

Transfer of knowledge, Patented software

- APPRIZE, U. S. Patent 6,067,340. “Three-Dimensional Stochastic Tomography with Upscaling”, a key technology in Subterranean Research’s JEDII™ software. Combines simulation, stochastic filtering, and a unique “data-driven zonation” method to improve parameter estimation.

(VI) COLLABORATORS & OTHER AFFILIATIONS

(a) Collaborators and Co-editors (other than students or advisors)

Christopher J. Bianchi (Applied Research Associates), Paul Bierman (UVM), David E. Dougherty (Subterranean Research, Inc.), Greg Druschel (UVM), Sara Gran (U. Washington), W. Cully Hession (Virginia Tech), Peter S. Huyakorn (HydroGeoLogic, Inc.), Virginia M. Johnson (LLNL), George P. Karatzas (University of Crete), Barbara Minsker (University of Illinois), George F. Pinder (UVM), Patrick Reed (Penn State), Leah L. Rogers (LLNL), Lori Stevens (UVM), Mary C. Watzin (UVM).

(b) Graduate and Postdoctoral Advisors

M.S. ***Gary L. Guymon***, University of California, Irvine, CA
Ph.D. ***David E. Dougherty***, University of Vermont, Burlington, VT

(c) Thesis Advisor for **11 M.S.** (Current: D. Grover, K. Jones, and C. Savidge; Graduated: R. Butryn, M. Lee, J. Clark, L. Besaw, J. Doris, Z. Li, C. Mark and P. Sullivan) and **7 Ph.D.** (Current: A. Pechenick, N. Fytilis, A. Pearce and B. Mathon; Graduated: P. Mouser, L. Besaw and M. McBride) students.

THOMAS DUNNE: CURRICULUM VITAE

PROFESSIONAL PREPARATION:

Cambridge Univ., UK, Geography, B.A. 1964
Johns Hopkins University Geography Ph.D. 1969 (Advisor M. G. Wolman (deceased)

APPOINTMENTS:

1995- Professor, Donald Bren School of Environmental Science and Management, and Department of Earth Science, University of California, Santa Barbara
1973-1995 Asst. Prof. to Professor, Dept. of Geological Sciences, Univ. of Washington
1971-1973 Assistant Professor, Department of Geography, McGill University, Canada,
1969-1971 Assistant Professor, Department of Geography, University of Nairobi, Kenya.

CURRENT RESEARCH INTERESTS

1. Field and theoretical studies of runoff and hillslope erosion
2. Field studies and modeling of river-basin sediment budgets.
3. Hydrology, sediment transport, and sedimentation in river channels and floodplains

PUBLICATIONS (five most relevant recent publications):

R. E. Beighley, K. G. Eggert, T. Dunne, Y. He, V. Gummadi and K. L. Verdin, Simulating Hydrologic and Hydraulic Processes Throughout the Amazon River Basin, **Hydrological Processes,** 23, 1221-1235, DOI: 10.1002/hyp.7252, 2009

T. W. Biggs, T. Dunne, D. Roberts, and E. Matricardi, The rate and extent of deforestation in watersheds of the southwestern Amazon basin: implications for regional stream biogeochemistry, **Ecological Applications**, 18(1), 31–48, 2008.

R. E. Beighley, T. Dunne and J.M. Melack**,** Impacts of climate variability and land use alterations on frequency distributions of terrestrial runoff loading to coastal waters in southern California, **J. Amer. Water Resources Assoc.**, 44(1), 62-71, 2008.

J. M. de Moraes, A. E. Schuler, T. Dunne, R. O. Figueiredo, and R. L. Victoria, Water storage and runoff processes in plinthic soils under forest and pasture in Eastern Amazonia, **Hydrological Processes**, 20 (12), 2509-2526, 2006.

E. J. Gabet and T. Dunne, Landslides on coastal sage-scrub and grassland hillslopes in a severe El Nino winter: The effects of vegetation conversion on sediment delivery, **Geological Society of America Bulletin**, 114, 983-990, 2002.

PUBLICATIONS (five other recent relevant publications):

T. W. Biggs, T. Dunne, T. Muraoka, Transport of water, solutes, and nutrients from a pasture hillslope, Southwestern Brazilian Amazon, **Hydrological Processes**, 20 (12), 2527-2547, 2006.

G. M. Kondolf, … T. Dunne, … and eleven others, Projecting Cumulative Benefits of Multiple River Restoration Projects: An Example from the Sacramento-San Joaquin River System in California, **Environmental Management**, 42(6), 933-945, 2008.

T. Dunne, J. A. Constantine, and M. B. Singer, The role of sediment transport and sediment supply in the evolution of river channel and floodplain complexity, **Japanese Geomorphological Union Transactions**, 31-2, 156-170, 2010.

T. Dunne, D. Western, and W.E. Dietrich, Effects of cattle trampling on vegetation, infiltration, and erosion in a tropical rangeland, **Journal of Arid Environments,** 75, 58-9.doi:10.1016/jaridenv.2010.09.001, 2011.
L. R. Harrison, C. J. Legleiter, M. A. Wydzga,and T. Dunne, Channel dynamics and habitat development in a meandering, gravel bed river, **Water Resources Research**, 47, doi:10.1029/2009WR008926, 2011.

SYNERGISTIC ACTIVITIES (last five years):

Two current NRC committees (5 in last 5 years)

Program reviews for: US Naval Research Lab on River and Coastal Sedimentation; Natural Heritage Institute Dam Re-operation Animation Project; US Geol. Survey on Missouri River Pallid Sturgeon Restoration Project; NSF Steering Committee for the Community Surface Dynamics Modeling System ; NSF Steering Committee for MARGINS; NSF Review Committee for the Hydrological Synthesis Project ; California Bay-Delta Program on Adaptive Management.

Teaches courses on: Earth System Science for Environmental Management, Watershed Analysis, River Systems, River Restoration, and Fluvial Geomorphology in an interdisciplinary graduate program designed to train environmental problem-solvers as well as research scientists. Supervises 4 Ph.D. students and 3 postdocs studying hydrology, geomorphology, and habitat use by fish.

Ph.D. STUDENTS GRADUATING IN LAST FIVE YEARS:

J. Andrew Ballantine, Faculty member, University of Connecticut
Jose Constantine, Faculty member, Cardiff University, UK
Carl J. Legleiter, Faculty member, University of Wyoming

POSTDOCS SUPERVISED IN LAST FIVE YEARS

Dr. Edward Beighley, San Diego State Univ. Engineering faculty
Dr. Lee Harrison, U.S. Fish & Wildlife Service Researcher

OTHER RECENT COLLABORATORS:

P. D. Bates, Bristol University, UK
K. Eggert, Los Alamos National Lab (retd.)

Thomas Dunne has conducted research on hydrology, erosion, and river sedimentation in East Africa, Northern Canada, Japan, Brazil, and Bolivia, as well as various regions of the United States, including the coastal mountains and Central valley of California. He has expressed some of that experience in teaching courses, advising government and international agencies, publishing journal articles, and co-authoring two textbooks.

Nelson F. Fernandes, Professor of Geomorphology
Department of Geography, Geosciences Institute,
Federal University of Rio de Janeiro, Brazil

(i) Professional Preparation

BA, 1984, Geology, Federal University of Rio de Janeiro, Brazil
MS, 1990, Geology, Federal University of Rio de Janeiro, Brazil
"Geological and Geomorphological Controls on Landsliding in Southeastern Brazil"
Ph.D., 1994, Geology & Geophysics, University of California, Berkeley, CA with William Dietrich
"Hillslope Evolution by Diffusive Processes"

(ii) Appointments

1986-present Professor Federal University of Rio de Janeiro, Brazil
1994-2002 Associate Professor Federal University of Rio de Janeiro, Brazil
1990-1994 Assistant Professor Federal University of Rio de Janeiro, Brazil
1986-1990 Lecturer Federal University of Rio de Janeiro, Brazil

(iii) Publications

(a) 5 publications most closely related to the proposed project

Bertolino, A.V.F.A., Fernandes, N.F., Miranda, J.P.L., Souza, A.P., Lopes, M.R.S., Palmieri, F., *"Effects of Plough Pan Development on Surface Hydrology and on Soil Physical Properties in Southeastern Brazilian Plateau"*. **Journal of Hydrology** (ISSN 0022-1694), 393, 94-104, 2010. (doi:10.1016/j.jhydrol.2010.07.038).

Vieira, B.C., Fernandes, N.F., Augusto Filho, O., *"Shallow Landslide Prediction in the Serra do Mar, São Paulo, Brazil"*. **Natural Hazards and Earth System Sciences**, 10, 1829-1837, 2010. (doi: 10.5194/nhess-10-1829-2010).

Gomes, R.A.T., Guimarães, R.F., Carvalho Jr., O.A., Fernandes, N.F., Vargas Jr., E.A. Martins, E.S.. "*Identification of the affected areas by mass movement through a physically based model of landslide hazard combined with an empirical model of debris flow"*. **Natural Hazards** (ISSN 0921-030X), 45, 197-209, 2008.

Guimarães, R.F., Montgomery, D.R., Greenberg, H.M., Fernandes, N.F., Gomes, R.A.T., Carvalho Júnior, O.A., *Parameterization of Soil Properties for a Model of Topographic Controls on Shallow Landsliding*. **Engineering Geology**, 69, 1-2, 99-108, 2003.

Ramos, V. M. ; Guimarães, R. F. ; Carvalho Jr., O. A.; Redivo, A. L. ; Gomes, R. A. T. ; Cardoso, F. B. F. ; Fernandes, N. F. . *Algorithm Development for Incorporating Soil Physical Properties of each Different Soil Class in a Landslide Prediction Model (SHALSTAB)*. **Soils and Rock**s **– International Journal of Geotechnical and Geoenvironmental Engineering**, 30, 139-148, 2007.

(b) 5 most significant publications

Fernandes, N.F. and Dietrich, W.E.. Hillslope Evolution By Diffusive Processes: The Time Scale For Equilibrium Adjustments. **Water Resources Research**, Vol. 33, nº 6, 1307-1318p., 1997.

Fernandes, N.F., Coelho Netto, A.L. and Lacerda, W.A.. *Subsurface Hydrology of Layered Colluvium Mantle in Unchannelled Valleys: Southeastern Brazil.* **Earth Surface Processes and Landforms**, Vol. 19, 609-626, 1994.

Vieira, B.C. e Fernandes, N.F.. *Landslides in Rio de Janeiro: The Role Played by Variations in Soil Hydraulic Conductivity.* **Hydrological Processes**, 18, 791-805, 2004.

Fernandes, N.F., Guimarães, R.F., Gomes, R.A.T., Vieira, B.C., Montgomery, D.R., Greenberg, H.M.. *Topographic Controls of Landslides in Rio de Janeiro: Field Evidence and Modeling.* **Catena**, 55, 163-181, 2004.

Fernandes, N.F., Tupinambá, M., Mello, C.L. e Peixoto, M.N.O. "*Rio de Janeiro - **Metropolis Between Granite-Gneiss Massifs"***. In: Migon, P. (Org.). **Great Geomorphological *Landscapes* of the World**. Springer, New York, páginas 89-100, 2010 (ISBN: 9789048130542, Doi 10.1007/978-90-481-3055-9).

(iv) Synergistic Activities

Development and refinement of research tools – Fundamental work, based both on monitoring and modeling, on the effects of soil and land cover changes on hillslope and watershed hydrology, resulting in eleven refereed articles (two in English). Basic work the role played by geomorphology in landslide generation in southeastern Brazil, based both on field mapping and mathematical modeling. Sixteen refereed articles (8 in English). Basic work on the application of landscape evolution models, combined with cosmogenic isotope studies, to investigate the retreat of escarpments.

Service learning and service to community – Implementation of field studies trying to improve the safety of poor people living I slums, especially on steep slopes. President of the UGB (Brazilian Geomorphological Union) from 2001-2003. Editorial board of the Brazilian Geomorphological Journal.

(v) Collaborators & Other Affiliations

(a) Collaborators and Co-Editors (48 months)

B. Vieira, Univ. of São Paulo, A. Bertolino, State Univ. of Rio de Janeiro, R. Guimarães, Univ. of Brasília, D. Montgomery, Univ. of Washington, W. Dietrich, Univ. of California at Berkeley, Jeff McDonnell, Oregon State Univ., Michael Crozier, Univ. of New Zealand.

(b) Graduate and Postdoctoral Advisors

William Dietrich, University of California, Berkeley, graduate advisor

Maria R. Mousinho de MeisRowl Twidale, Federal Univ. of Rio de Janeiro, máster advisor

(c) Thesis Advisor and Postgraduate-Scholar Sponsor

L. Hernani, Postdoctoral advisor, Embrapa; B. Vieira, Doctoral advisor, Federal Univ. of Rio de Janeiro UFRJ; R. Guimarães, Doctoral advisor, UFRJ; V. Martins, Doctoral advisor, UFRJ; R. Gomes, Doctoral advisor, UFRJ; A. Bertolino, Doctoral advisor, UFRJ; S. Bhering, Doctoral advisor, UFRJ; J. Lumbreras, Doctoral advisor, UFRJ; I. Moreira, Doctoral advisor, UFRJ; H. Jardim, Doctoral advisor, UFRJ; E. Marchioro, Doctoral advisor, UFRJ; E. Rodrigues, Doctoral advisor, UFRJ; E. Luiz, Doctoral advisor, UFRJ; primary advisor, 12 PhD. and 14 MS students

BIOGRAPHICAL SKETCH – William S. Keeton

ADDRESS: Rubenstein School of Environment and Natural Resources
343 George D. Aiken Center for Natural Resources
University of Vermont
Burlington, VT 05405 USA
Phone: 802-656-2518 Email: william.keeton@uvm.edu
Website: www.uvm.edu/envnr/wkeeton

EDUCATION

2000 Ph.D. Forest Ecology. University of Washington, College of Forest Resources, Seattle, WA
1994 M.E.S. Conservation Biology. Yale University, Schl. of Forestry and Env. Science, New Haven, CT
1990 B.S. Natural Resources. Cornell University, College of Ag. and Life Sciences, Ithaca, NY

CURRENT APPOINTMENTS

2007-present Associate Professor of Forest Ecology and Forestry. Rubenstein School of Environment and Natural Resources, University of Vermont, Burlington, VT.
2010-present Chair, UVM Undergraduate Forestry Program
2007-present Co-Chair, UVM Graduate Program in Forest and Wildlife Science
2001-present Lead scientist, Vermont Forest Ecosystem Management Demonstration Project
2008-present Lead scientist, University of Vermont Carbon Dynamics Laboratory (www.uvm.edu/cdl)
2008 -present Fulbright Senior Specialist, U.S. Fulbright Scholarship Program
2008-present The Nature Conservancy, Vermont Chapter, Science Advisory Board
2009-present Co-Chair, Vermont Climate Collaborative, Agriculture, Forestry, and Waste Working Group
2007-present Vermont Monitoring Cooperative, Science Advisory Committee
2009 –present New England Society of American Foresters, Chair of Silviculture Group
2009- present Belgian Research Programme for Earth Observation (STEREO II), Remote sensing of ecosystem impacts in mountain environments, Advisory Committee
2007-present Deputy Chair, International Union of Forest Res. Organizations, Old-growth Forest Working Group
2009-present IUCN (World Conservation Union), Commission on Ecosystem Management

CLOSELY RELATED PUBLICATIONS:

Keeton, W.S., A. A. Whitman, G.G. McGee, and C.L. Goodale. 2010. Late-successional biomass development in northern hardwood-conifer forests of the northeastern United States. Forest Science (in press)

Keeton, W. S., M. Chernyavskyy, G. Gratzer, M. Main-Knorn, M. Shpylchak, and Y. Bihun. 2010. Structural characteristics and aboveground biomass of old-growth spruce-fir stands in the eastern Carpathian Mountains, Ukraine. Plant Biosystems 144: 1-12.

Nunery, J.S. and W.S. Keeton. 2010. Forest carbon storage in the northeastern United States: net effects of harvesting frequency, post-harvest retention, and wood products. Forest Ecology and Management 259:1363-1375.

Keeton, W.S., C.E. Kraft, and D.R. Warren. 2007. Mature and old-growth riparian forests: structure, dynamics, and effects on Adirondack stream habitats. Ecological Applications 17: 852-868

Keeton, W.S. 2006. Managing for late-successional/old-growth characteristics in northern hardwood-conifer forests. Forest Ecology and Management 235: 129-142.

OTHER RELEVANT PUBLICATIONS:

Schwenk, W.S., T.M. Donovan, W. S. Keeton, and J. S. Nunery. 2011. Carbon storage, timber production, and wildlife occurrence: comparing forest ecosystem services using multi-criteria decision analysis. Ecological Applications. Accepted.

Kraft, C., D. Warren, W.S. Keeton. 2011. Identifying the spatial pattern of wood distribution in northeastern North American streams. Geomorphology 135: 1-7

Stovall, J., W.S. Keeton, and C.E. Kraft. 2009. Late-successional riparian forest structure results in heterogeneous periphyton distributions in low-order streams. Canadian Journal of Forest Research 29: 2343-2354.

Curzon, M.T. and W.S. Keeton. 2010. Spatial characteristics of canopy disturbances in riparian old-growth hemlock-northern hardwood forests, Adirondack Mountains, New York, USA. Canadian Journal of Forest Research 40:67-80.

Warren, D.R., C.E. Kraft, W.S. Keeton, J.S. Nunery, and G.E. Likens. 2009. Dynamics of wood recruitment in streams of the northeastern U.S. Forest Ecology and Management 258:804-813.

SYNERGISTIC ACTIVITIES:

Fulbright Senior Specialist, U.S. Fulbright Scholarship Program. Fulbright Scholar advising Ukrainian agencies on forest carbon quantification and management in the Carpathian Mountain region.

P.I.: Global meta-analysis of temperate old-growth forests, focusing on carbon storage dynamics, 2008-present.

P.I.: USDA McIntire-Stennis Forest Research Program. 2008-2011. Evaluation of options for forestland owner participation in carbon markets: forest management alternatives and institutional and economic constraints– $111,850.

P.I. Northeastern States Research Cooperative. 2011-2014. Effects of long-term forest recovery pathways and management history on carbon sequestration and co-varying ecosystem services. $72,223.

P.I. Trust for Mutual Understanding. 2011-2013. Capacity building for community-based forest carbon and bioenergy projects in western Ukraine. Keeton, W.S. (P.I.) and C. Danks (Co-PI). $20,000.

P.I. Northeastern States Research Cooperative. 2010-2013. Evaluating supply and demand of northern forest branded carbon credits. $109,500.

Co-P.I. Northeastern States Research Cooperative. 2010-2013. Evaluating the influence of riparian forest structure on stream ecosystems across the northern forest. $149,568.

P.I. Northeastern States Research Cooperative. 2009-2012. Biomass fuel harvesting in the northern forest: effects on stand structural complexity and in-situ forest carbon storage. $92,056.

Professional activities: Forest Guild Working Group on Climate Change and Forest Carbon; Green Mountain National Forest Climate Change Advisory Committee; Vermont Governor's Advisory Panel on Carbon Markets; Vermont State Legislature, Biomass Energy Working Group, Vermont Roundtable on Parcelization and Forest Fragmentation

COLLABORATORS

Collaborators in the past 48 months:

Scott Swenck, Charles Kerchner, Cecilia Danks, Jennifer C. Jenkins, Clifford E. Kraft, Gregory McGee, Christine Goodale, Gene Likens, Dana Warren, Brian Beckage, Tim Perkins, Georg Gratzer, Patrick Hostert, David Ray, Robert Seymour, Mark Twery, Teri Donovan, Mykola Chernyavskyy, Yurih Bihun, Tom Spies, David Lindenmayer, Mark Swanson, Jerry F. Franklin, Tobias Kuemmerle, Mark Ashton, Brian Foster, Gene Likens, David Foster, David Ray

Graduate and Postdoctoral Advisor: Jerry F. Franklin, University of Washington

Thesis Advisor and Postgraduate Advisor in Past Five Years:

Charles Kerchner, Dima Karabchuk, Jared Nunery, Katie Manaras, Heather McKenny, Erin Copeland, Jeremy Stovall, Miranda Curzon, Brian Foster, Caitlin Littlefield, Anna Mika, Sabina Burrascano, Thomas Buchholz, Emily Russel-Roy, Amanda Egan

BIOGRAPHICAL SKETCH
DAVID LÓPEZ-CARR

Professional Preparation:

1993 **B.A.** Bates College, Lewiston, ME, Hispanic Literature, Minor in Geology, 1993.
- *Phi Beta Kappa, Magna Cum Laude, Highest Departmental Honors*.

2002 **Ph.D.**, University of North Carolina at Chapel Hill, Chapel Hill, NC, Geography.
- *Rural-frontier migration and deforestation in the Sierra de Lacandón National Park, Guatemala* (**Nystrom Award** for best paper based on a dissertation in Geography, 2004). **President: Alpha Epsilon Lambda, UNC-CH chapter.** Graduate Student National Honor Society. *Royster Society of Fellows.* UNC-CH Graduate Honor Society .
- *Selected Dissertation grants and fellowships:* NASA Earth System Science Fellow, Fulbright-Hays Dissertation Fellow, Institute for the Study of World Politics Dissertation Fellow, Rand Field Research Grant, Social Science Research Council Pre-Dissertation Fellow, UNC Graduate School Fellow.

2002-2004 **NIH Biostatistics Post-doctoral fellow**, Carolina Population Center, Chapel Hill, NC.

Appointments:

2008-present **Associate Professor**, Department of Geography, University of California, Santa Barbara. Affiliate faculty: Latin American and Iberian Studies, Marine Sciences.

2004-2007 **Assistant Professor**, Department of Geography, University of California, Santa Barbara. **Former Chair** of the Population Geography Specialty Group and of the Human Dimensions of Global Change Specialty Group of the Association of American Geographers (AAG).

1998-present **Consultant**, Guatemalan Planning Ministry, Conservation International, The Nature Conservancy, and the Instituto Nacional Guatemalteco de Estadística. WWF, USAID

1994-1995 **Translator** and Interpreter for former Presidents Alfonsín of Argentina, de la Madrid of Mexico and Betancourt of Colombia; for ecotourism guides in the Ecuadorian Amazon; for Texaco and Shell Oil Companies..

1992 **Legislative Aid** for Senate Majority Leader George Mitchell, Washington, D.C.

Publications most closely related to the proposed project

López-Carr, D., J. Davis, M. Jankowska, L. Grant, A.C. López-Carr, M. Clark (2011). Space versus Place in Complex Human-Natural Systems: Spatial and Multi-level Models of Tropical Land Use and Cover Change (LUCC) in Guatemala. *Ecological Modeling*.

López-Carr, D., M. Jankowska, C. Funk, G. Husak, Z. Chafe (2011). Climate Change and Human Health: Spatial Modeling of Water Availability, Malnutrition, and Livelihoods in Mali, Africa. *Applied Geography*.

Cheon, So-Min, D. Brown, K. Kok, **D. López-Carr** (in press) Mixed Methods in Land Change Research: Towards Integration. *Transactions of the Institute of British Geographers.*

Pan, WK**, D.L. Carr**, A Barbieri, R.E. Bilsborrow, and C. Suchindran. (2007). Forest clearing in the Ecuadorian Amazon: A study of patterns over space and time. *Population Research and Policy Review.* 26(5-6): 635-659.

Carr, D. L., L. Suter, A. Barbieri, (2006). Population dynamics and tropical deforestation: State of the debate and conceptual challenges. *Population and Environment*. 27(1): 89 – 113.

Other significant publications

Carr, D.L., A.C. Lopez, R.E. Bilsborrow (2009). The Population, agriculture, and environment nexus in Latin America: Country-level evidence from the latter half of the 20th century. *Population and Environment* 30: 222–246.

Carr, D. L. (2008). Migration and Tropical Deforestation: Why Population Matters. *Progress in Human Geography*. 33(2): 22pp.

Carr, D. L. (2008). Farm households and land use in a core conservation zone of the Maya Biosphere Reserve, Guatemala. *Human Ecology*. 36(2): 231-248

De Sherbinin, A, **DL Carr**, S. Cassels, L. Jang (2007) Population and Natural Resources. *Annual Review of Environment and Resources.* 32(5):1-29.

Carr, D.L. (2004). Proximate population factors and deforestation in tropical agricultural frontiers. *Population and Environment* 25(6): 585-612.

Synergistic Activities

I work on links among population, health, rural development, agriculture, and marine and forest resource use and conservation through ongoing projects in Latin America, Africa, and Asia. I have (co)authored over 100 conference papers and approximately 100 articles, chapters, proceedings, books, and reports. My research is conducted with colleagues and students thanks to over three million dollars raised through over 50 fellowships, grants, and awards from NASA, NSF, NIH, the Mellon and Fulbright Foundations, and numerous other sources. Notable among my scholarly achievements are paper awards from the University of North Carolina School of Medicine, the Latin American Specialty Group (SG) of the Association of American Geographers (AAG), the Population SG of the AAG, the Nystrom Prize for best paper based on a dissertation in Geography, a University of North Carolina Post-doctoral Award for Research Excellence, and an Athgo International VIP Award for participation in the 2007 Nobel Peace Prize winning Intergovernmental Panel on Climate Change (IPCC)

My research has developed synergistically through collaborations with conservation and development organizations, including the following work with the United States Agency for International Development (USAID): the regional implementation of the *Millenium Development Goals,* the development of the *Regional Plan for Amazonian Biodiversity Conservation*, the research, evaluation and planning of integrated population, health, and environment programs in global priority conservation zones (also with WWF, Conservation International, and BALANCE), and the conceptual framework for *Emerging Trends in Environment and Economic Growth in Latin America and the Caribbean*. I have also worked for National Geographic and Population Reference Bureau on the *AP Population Teaching Initiative*; for Direct Relief International on mapping health-environment dynamics, for the Obama administration's $63 billion six year *Global Health Initiative*. Currently I am coordinating lead author of the "Land" chapter with the United Nations Environment Program's (UNEP) *Global Environmental Outlook* (*Geo-5)* in preparation for the Rio de Janeiro 2012 World Summit.

I have served in several positions for the AAG including Chair of the Human Dimensions of Global Change (HDGC) and the Population Specialty Groups (PSG) and Cultural Ecology and Population Geography Representative for the AAG Outreach Project. I serve as associate editor for *Population and Environment* and on the editorial board of the *Journal of Global and International Studies*. I am a steering member of the International Geographical Union (IGU) Land Use/Cover Change (LUCC) Commission, of the Population-Environment Research Network (PERN), of the International Human Dimensions Program, and of the UN-sponsored Project on Global Environmental Change and Human Health (GECHH). I have served on research proposal review and planning committees for the Social Science Research Council, National Science Foundation and the National Institutes of Health (NIH). I also served on the Eco-agriculture Action Committee at the 2002 World Summit on Sustainable Development in Johannesburg, South Africa. At UCSB I have collaborated on over 20 University and Departmental committees. For the larger UC system, I am a representative to the University of California Global Health Institute (UCGHI) and a steering member of the University of California's Center of Expertise on Migration and Health (COEMH).

Collaborators & Co-Editors:

Michael Goodchild, UCSB Geography Department
Billy Lee Turner II, Department of Geography, Clark University
Neil Adger, School of Environmental Sciences, University of East Anglia, UK.
T. Mitchell Aide, University of Puerto Rico Department of Biology.

PhD students advised: *current:* Daniel Ervin, Laurel Suter*,* Felipe Murtinho, Lumar Pardo, Cheryl Chen, Alex Zvoleff, Magdalena Benza-Fiocco, Sarah Wandersee, Leah Bremmer, Justin Stoler
Postdoctoral students advised: *current*: Sadie Ryan Simonovich, Narcisa Pricope.

Christine Ann Massey, Outreach and Education Specialist
Geology Department, University of Vermont, Burlington, VT 05405

(i) **Professional Preparation**

Carleton College	Geology (with Natural History and German)	B.A.	1986
University of Washington	Geology	M.S.	1995

(ii) **Appointments**

1995-present	Adjunct Lecturer, Outreach Specialist Geology Dept., Univ. of Vermont
1995-present	Director Science & Technology Governor's Institute for VT H.S. Students
2004-2007	Adjunct Instructor Education Department, Univ. of Vermont
1998-2004	Museum Education Specialist Perkins Museum, Univ. of Vermont
1993-1995	Environmental Consulting Geologist WH&N, Burlington, VT
1989-1993	Research and Teaching Assistant (Geology/Chemistry/Environmental Sciences/Northwest Center for Research on Women) Univ. of WA
1988-1989	Hydrologic Field Assistant U. S. Geological Survey, Menlo Park, CA
1986-1987	Naturalist Intern Foothill Horizons Outdoor Educ. Center, Sonora, CA

(iii)**Publications** *(5 related to this project)*

Bierman, P.R., Gould, P., Lamb, J., Norton, S., Massey, C.A., Olson, J., Reusser, L., and Ungerleider, J. (2008). Global Climate Change - Motivated High School Students Gain their Voice, **National Association for Gifted Children Journal,** p. 1-9.

Massey, C.A. and Bierman, P.R. (2007). Teachers and kids dig old photos, **National Association for Gifted Children Journal**.

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

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., Elvin, D. W., and Mora-Klepeis, G., (2002). Digitizing the Collections of the Perkins Geology Museum to Support On-line Learning Applications about Vermont Geology, **Geological Society of America—2002 National Mtg. Abstracts with Programs**, 34 (6), p. 455.

Significant Publications *(5 other)*

Pearce, A., Bierman, P. R., Druschel, G.K. , Massey, C., Rizzo, D.M., Watzin, M.C., and Wemple, M.C. (2010) Pitfalls and successes of developing an interdisciplinary watershed field camp. **Journal of Geoscience Education,** v. 58 (3), 213-220.

Bierman, P.R., Howe, J., Stanley-Mann, E., Peabody, M., Hilke, J., and Massey, C.A., (2005). Old landscape images record landscape change through time **GSA Today**. V. 15, n. 4, 10:1130/1052-5173(2005)015, p.1 –6

Massey, C. A., Hilke, J., and Bierman, P. R., (2003). Landscape Metamorphism in Vermont: Building an Image Archive of the Past and Present with Students, Historical Societies, and Towns. **Geological Society of America—2003 National Mtg. Abstracts with Programs**, 35 (6), p 121,

Massey, C. and Snyder, S., (1999). Geologic field trips sites for teachers in Northwestern Vermont. In Wright, S. F. ed., **New England Intercollegiate Geologic Conference Guidebook**, 91, 159-177.

Massey, C. A., (1998). Learning through inquiry and community service--The Science & Technology Institute for Vermont high school students. **Geological Society of America--1998 National Mtg. Abstracts with Programs**, 30, 7, A-350.

(iv) **Synergistic Activities**

Assessment and Development of Image Archives and Educational Webware

-Coordinate and manage creation of case study *Vignettes* for an on-line database associated with *Key Concepts in Geomorphology*, an NSF-funded textbook.

-Coordinate and direct educational materials development and assessment activities for the *Landscape Change Program*, NSF-funded project to collect and display images of Vermont. Directed assessment of web pages and site structure (www.uvm.edu/landscape).

-Coordinated assessment and revision of educational materials developed for *Learning Landscapes*, an NSF-funded project to teach about Geomorphology with images. Directed assessment of web pages and site structure (www.uvm.edu/~lcplearn).

-Coordinated and direct activities for the Institute for Museum and Library Services (IMLS)-funded project to digitize the collections of the Perkins Museum (www.uvm.edu/perkins).

-Participate in digital library conferences/meetings: Digital Library for Earth System Education (DLESE), WebWise (IMLS-sponsored), NE Document Conservation Center (NEDCC), National Science Digital Library (NSDL), and UVM Digitization Center.

Formal Science Education

-Teach *Intro. Geology, Fire and Ice,* and *Geology of Nat. Parks* courses through the Continuing Education Division at the University of Vermont; *Regional Geology* to Geology Majors; and *Science in Vermont* to Elementary Teachers and Educ. Majors.

Informal Science Education

-Direct summer science programs at the UVM Perkins Geology Museum including: *Governor's Institute on Science and Technology* for capable high school students and *Environmental Science Day Camp* for elementary students.

-Facilitated outreach for Perkins Museum visits, tours, teacher geology resource needs, and teacher professional development.

-Coordinated the *JASON Project* in Vermont (interdisciplinary, multi-media, supplementary science curriculum for grades 4-9).

Service and Equity Training

-Three-year appointment on the UVM *President's Commission on the Status of Women*.

-Short course participant in *Engaging Middle School Girls in Math & Science*, *Diversity at UVM*, *Equity Workshop for K-12 Educators*, *Accessibility to Websites,* and *Lead-Scientist Institute on Systemic Reform of Elementary Science Education.*

-*Science-By-Mail* volunteer scientist mentoring elementary students (1992-2000).

Professional Memberships

-GSA, AGU, NAGT, AWG, Vermont Geological Society (Vice President-1999; Education Chair-2000-2007), and Vermont Science Teacher's Association.

(v) **Collaborators and Other Affiliations**

(a) *Collaborators (last 48 months):* Paul Bierman (UVM Geology and Natural Resources), Jean Olson (Governor's Institutes of VT), and Donna Rizzo (UVM Engineering).

(b) *Graduate Advisors:* Minze Stuiver and Pieter Grootes, University of Washington.

(c) *Thesis Advisor (1 grad; 2 undergrad; 4 high school):*

Graduates: Eric Butler, UVM Geology M.A. *Landscape Change in Shelburne*, 2004.

Undergraduates: Allison Brigham, UVM Education BA, *Final Project for EDSS course,* 2002; Jill Wagner, UVM Env. Studies BA, *Env. Education at Burlington High School,* 1997.

Dar A. Roberts

(i) Professional Preparation:

UC Santa Barbara	Double major Environmental Biology & Geology	B.A. 1981
Stanford University	Applied Earth Science	M.S. 1986
Univ. of Washington	Department of Geological Sciences	PhD 1991
Univ. of Washington	Department of Geological Sciences	Postdoc 91-93

(ii) Appointments

2002-2011	Full Professor, Dept. of Geography, Univ. of California, Santa Barbara
1998-2002	Associate Professor, Dept. of Geography, Univ. of California, Santa Barbara
1994-1998	Assistant Professor, Dept. of Geography, Univ. of California, Santa Barbara

(iii) Publications

5 Most Related

Adams, J.B., Sabol, D., Kapos, V., Almeida Filho, R., Roberts, D.A., Smith, M.O., Gillespie, A.R., 1995, Classification of Multispectral Images Based on Fractions of Endmembers: Application to Land-Cover Change in the Brazilian Amazon, *Rem. Sens. Environ.* 52:137-154.

Powell, R.L., and Roberts, D.A., 2010, Characterizing Urban Land-cover Change in Rondonia, Brazil: 1985-2000, *Journal of Latin American Geography* 9(3), 183-211.

Roberts, D.A., Keller, M. and Soares, J.V., 2003, Studies of Land-Cover, Land-use, and Biophysical Properties of Vegetation in the Large Scale Atmosphere Experiment in Amazonia (LBA), *Remote Sens. Environ*. 87 (4): 377-388.

Roberts, D.A., Numata, I., Holmes, K.W., Batista, G., Krug, T., Monteiro, A., Powell, B., and Chadwick, O., 2002, Large area mapping of land-cover change in Rondônia using multitemporal spectral mixture analysis and decision tree classifiers, *J. Geophys. Res. Atm*., 107 (D20), 8073, LBA 40-1 to 40-18.

Souza, C., Roberts, D.A., and Monteiro, A.L., 2005, Multi-temporal Analysis of Degraded Forests in the Southern Brazilian Amazon, *Earth Interactions,* 9 (Paper No. 19), 25 pp.

5 Significant Publications (out of 117)

Roberts, D.A., Adams, J.B., and Smith, M.O., 1993, Discriminating Green Vegetation, Non-Photosynthetic Vegetation and Soils in AVIRIS Data, *Rem. Sens. Environ.*, 44: 2/3 255-270.

Roberts, D.A., Green, R.O., and Adams, J.B., 1997,Temporal and Spatial Patterns in Vegetation and Atmospheric Properties from AVIRIS, *Remote Sens. Environ* 62: 223-240.

Roberts, D.A., Gardner, M., Church, R., Ustin, S., Scheer, G.,and Green, R.O., 1998, Mapping Chaparral in the Santa Monica Mountains using Multiple Endmember Spectral Mixture Models, *Rem. Sens. Environ.* 65: 267-279.

Roberts, D.A., Ustin, S.L., Ogunjemiyo, S., Greenberg, J., Dobrowski,S.Z., Chen, J. and Hinckley, T.M., 2004, Spectral and structural measures of Northwest forest vegetation at leaf to landscape scales, *Ecosystems*, 7:545-562.

Ustin, S.L., Roberts, D.A., Gamon, J.A., Asner, G.P., and Green, R.O., 2004, Using Imaging Spectroscopy to Study Ecosystem Processes and Properties, *Bioscience,* 54(6) 523-534.

(iv) Synergistic Activities

Dr. Roberts has made a number of scientific and educational contributions of broad impact. Educational contributions include the design of four courses that actively engage students in collecting data as part of the learning process and the development of an educational website supported by the NSF CCLI program. Scientifically, Dr. Roberts has played a lead role in land-cover classification, change detection and analysis of land-cover using advanced analysis techniques. He has been a participant in several major research programs, including LBA Ecology, the Boreas Follow on project, EO-1 Validation and, most recently, the North American Carbon Program. As a part of the LBA program, he was guest editor of the LBA special issue for Remote Sensing of Environment. Most recently he played a critical role in coordinating the 2010 AVIRIS response to the Gulf Oil Spill.

Dr. Roberts has also contributed significantly to algorithm development, most notably in developing the concept of Multiple Endmember Spectral Mixture Analysis and standardized methods for land-cover mapping using Decision Tree Classifiers. These techniques have been applied to a

wide range of data sources and problems, ranging from improved estimates of LAI in boreal forest, to urban remote sensing and methane detection. Dr. Roberts has recently supervised the development of Viper Tools, a free software package designed to enable researchers to build spectral libraries, select appropriate spectra and run advanced mixture models on any form of optical data. Finally, Dr. Roberts is the UCSB director of a NASA Regional Earth Science Applications Center (RESAC) called the Southern California Wildfire Hazard Center. This center is designed to provide an integrated measure of fire danger through a combination of fuels mapping (using remote sensing), fire weather modeling (using MM5) and assessment of evacuation vunerability. Currently Dr. Roberts serves as Chair of the Department of Geography.

(v) Collaborators

(a) Collaborators and Co-Editors

Asner, Greg P. (Carnegie Inst. Stanford)
Caviglia-Harris, J. (Salisbury University)
Chadwick, Oliver (UC Santa Barbara)
Chambers, Jeff (Lawrence Livermore Lab)
Clark, Roger (USGS Denver)
Cochrane, M.A. (South Dakota State)
Dozier, Jeff (UC Santa Barbara)
Dubayah, Ralph (Univ. of Maryland)
Franklin, Janet (San Diego State Univ.)
Galvao, Lenio (INPE, Brazil)
Goulden, Michael (UC Irvine)
Helmer, Eileen (USFS, Puerto Rico)
Hinckley, Thomas (Univ of Washington)
Hook, Simon (Jet Propulsion Laboratory)
Kokaly, Raymond (USGS Denver)
Kyriakidis, Phaedon. (UC Santa Barbara)
Leifer, Ira (UC Santa Barbara)
Melack, John. (U.C. Santa Barbara)
Michaelsen, Joel. (UC Santa Barbara)
Nelson, Bruce. (INPA, Manaus)
Parker, Geoffrey (SERC, Md)
Perry, Eileen (University of Idaho)
Quattrochi, Dale (NASA Marshall SFC)
Rahman, Faiz (Ball State University)
Schimel, Josh (UC Santa Barbara)
Sills, E., (Univ. North Carolina)
Soares, Joao (INPE, Sao Jose Dos Campos)
Still, Chris (UC Santa Barbara)
Stow, Doug (San Diego State Univ.)
Ustin, Susan (UC Davis)
Weise, David (USFS Riverside Fire Lab)

(b) Graduate and Postdoctoral Advisors

Adams, J.B (Univ of Washington, Emeritus)
Gillespie, Alan (Univ. of Washington)
Hinckley, Thomas (Univ. of Washington)
Lyons, R.J.P. (Stanford University, Emeritus)
Volkenburg, Elizabeth (Univ. of Washington)

(c) Thesis/Postdoctoral Advisor: Total Advised (68)

Ballantine, Andy (UCSB), PhD08, Member
Belyea, Bree (UCSB), MA, Chair
Bradley, Eliza (UCSB), MA08, PhD Chair
Clark, Matt (Sonoma State), PhD05, Chair
Collins, Edward (UCSB), PhD, Chair
Dennison, Phil (U. Utah), MA1999, PhD03, Chair
Eckmann, Ted (UCSB), PhD09 CoChair
Gardner, Margaret (UCSB), MA1997, Chair
Gaston, Stefan (UCSB), MA07, Chair
Goldstein, Noah (UCSB), PhD06, Member
Green, Robert (JPL), PhD03, Member
Halligan, Kerry (UCSB), MA02, PhD07, Chair
Kilham, Nina (UCSB), PhD Member
Legleiter, Carl (UCSB), MA CoChair, PhD08, Member
McMichael, Christi (Morehead St. KY**),** PhD04, Member
Matzke, Nick (U Berkeley), MA03, Chair
McDonald, Margot (UCSB), Member
Morais, Marco (CalTech), MA01, Chair
Numata, Izaya (S Dakota State), PhD06, Chair
Ogunjemiyo, Segun (Cal State Fresno), Postdoc
Painter, Thomas (CSIS, Boulder, CO), MA1998 PhD02, Member
Perroy, Ryan, (UCSB), PhD, Member
Peterson, Seth (UCSB), PhD Chair
Powell, Becky (Univ. of Denver), PhD06, Chair
Reith, Ernie (UCSB), PhD Chair
Rogan, John (Clark Univ. NY), PhD05, Member
Roth, Keely (UCSB), MA Chair
Schneider, Philipp (JPL), PhD08, Chair
Souza, Carlos (Imazon, Belem), PhD05, Chair
Syphrad, Alexandra (SDSU), PhD06 Member
Sutton, Paul (Univ. of Denver, CO), PhD 1999, Chair
Toomey, Michael, PhD Co-Chair
Thorpe, Andrew (UCSB), MA, Chair
Waller, Eric (Colorado Division of Wildlife), MA1999, Chair

Curriculum Vitae

DYLAN H. ROOD

a. Professional Preparation

Wesleyan University, Earth and Environmental Science, B.A., 2002
University of California at Santa Barbara, Geological Sciences, Ph.D., 2010
University of California, Irvine, postdoctoral research and undergraduate teaching, 2010-present
Lawrence Livermore National Laboratory, postdoctoral research, 2010-present

b. Appointments

Post Doctoral Research Staff Member, Center for Accelerator Mass Spectrometry, Lawrence Livermore National Laboratory, 2010-present

NSF Earth Sciences Postdoctoral Fellow, University of California at Irvine, 2010-present

Assistant Researcher, Earth Research Institute, University of California at Santa Barbara, 2010-present

Lawrence Scholar, Center for Accelerator Mass Spectrometry, Lawrence Livermore National Laboratory, (Mentors: Dr. Bob Finkel and Dr. Tom Brown), 2006-2010

Teaching Assistant, Undergraduate courses: Introduction to Field Methods, Optical Mineralogy, and Sedimentary Petrology, Department of Earth Science, University of California at Santa Barbara, 2003-2005

Teaching Assistant, Summer Field School, Department of Earth Science, University of California at Santa Barbara, 2003, 2005

Postgraduate Researcher, Institute for Crustal Studies, University of California at Santa Barbara, 2002

Awards and Honors

PLS AEED SPOT Award for "Exceptional Postdoctoral Achievement of Publishing Many Papers in 2010-2011," Lawrence Livermore National Laboratory, 2011

NSF EAR Postdoctoral Fellowship, 2010

Top Student Presenter, Seismological Society of America Annual Meeting, 2009 (recognized in *Seismological Research Letters*)

Honorable Mention, AAAS Student Poster Competition, 2007 (recognized in the April 20, 2007, issue of *Science* and abstract published on AAAS website)

Student Employee Graduate Research Fellowship, Lawrence Livermore National Laboratory, 2006

Outstanding Graduate Oral Presentation Award, Geological Society of America, 2005

Graduate Student Research Grant, Geological Society of America, 2004

Glicken Award, Department of Geological Sciences, University of California at Santa Barbara, 2004

c. Selected Publications (i) Publications related to the present proposal

Rood, D.H., Hall, S., Guilderson, T.P., Finkel, R.C., Brown, T.A., 2010, Challenges and opportunities in high-precision Be-10 measurements at CAMS, *Nuclear Instruments and Methods B: Beam Interactions with Materials and Atoms*, 268, 7-8, 730-732, doi:10.1016/j.nimb.2009.10.016.

Reusser, L. J., Graly, J., Bierman, P., and **Rood, D.**, 2010, Calibrating a long-term meteoric ^{10}Be accumulation rate in soil, *Geophysical Research Letters*, 37, L19403, doi: 10.1029/2010GL044751.

Moon, S., Chamberlain, C.P., Le, K., Levine, N., **Rood, D.H.**, Hilley, G., 2011, Climatic control of denudation in the deglaciated landscape of the Washington Cascades, *Nature Geoscience*, 4, 469-473, doi:10.1038/NGEO1159.

West, N., Kirby, E., Bierman, P., **Rood, D.**, 2011, Preliminary estimates of regolith generation and mobility in the Susquehanna Shale Hills Critical Zone Observatory, Pennsylvania, using meteoric ^{10}Be, *Applied Geochemistry*, 26, S146-S148.

Rood, D.H., Burbank, D.W., Finkel, R.C., 2011, Chronology of glaciations in the Sierra Nevada, California from ^{10}Be surface exposure dating, *Quaternary Science Reviews*, 30, 646-661, doi:10.1016/j.quascirev.2010.12.001.

(ii) Five additional related publications

Rood, D.H., Burbank, D.W., Finkel, R.C., 2011, Spatiotemporal patterns of fault slip rates across the central Sierra Nevada Frontal Fault Zone, *Earth and Planetery Science Letters*, 301, 457-468, doi:10.1016/j.epsl.2010.11.006.

Young, N.E., Briner, J.P., Stewart, H.A.M., Axford, Y., Csatho, B., **Rood, D.H.**, Finkel, R.C., 2011, The response of Jakobshavn Isbræ to Holocene climate change, *Geology*, 39, 2, 131–134, doi:10.1130/G31399.1.

Corbett, L.B., Young, N.E., Bierman, P.R., Briner, J.P, Neumann, T.A., Graly, J.A., **Rood, D.H.**, 2011, ^{10}Be concentrations in bedrock and boulder samples resulting from early Holocene ice retreat near Jokobshavn Isfjord, western Greenland, *Quaternary Science Reviews*, 30, 13-14, 1739-1749.

Amidon, W.H., **Rood, D.H.**, and Farley, K.A., 2009, Cosmogenic ^{3}He and ^{21}Ne production rates calibrated against ^{10}Be in minerals from the Coso volcanic field, *Earth and Planetary Science Letters*, 280, 194-204, doi:10.1016/j.epsl.2009.01.031.

Behr, W.M., **Rood, D.H.**, Fletcher, K.E., Guzman, N., Finkel, R., Hanks, T.C., Hudnut, K.W., Kendrick, K.J., Platt, J.P., Sharp, W.D., Weldon, R.J., Yule, J.D., 2010, Uncertainties in slip rate estimates for the Mission Creek strand of the southern San Andreas fault at Biskra Palms Oasis, southern California, *Geological Society of America Bulletin*, 122, 9-10, 1360-1377, doi:10.1130/B30020.1.

d. Synergistic Activities

(1) Instructor for undergraduate course, Natural Disasters, at University of California, Irvine

(2) Participation in recruitment of underrepresented undergraduate students to participate in Earth science research at University of California, Irvine

(3) Co-supervisor for graduate student researcher at Earth Research Institute, University of California, Santa Barbara

(4) Calibration of production rates for cosmogenic ^{10}Be, ^{26}Al, and ^{36}Cl for a wide variety of Earth science applications

(5) Development of high-precision ^{10}Be and AMS measurements for the geosciences

e. Selected Collaborators and Affiliations

Finkel, Bob (UCB)
Burbank, Doug (UCSB)
Hanks, Tom (USGS)
Kendrick, Katherine (USGS)
Simpson, Dave (URS)
Hall, Sarah (McGill)
Farber, Dan (LLNL/UCSC)
Whitney, John (USGS)
Prentice, Carol (USGS)
Kelson, Keith (Fugro-WLA)
Ritz, Jeff (U. Montpellier)
Balco, Greg (BGC)
Purvance, Matt (UNR)
Stirling, Mark (GNS)
Briner, Jason (SUNY Buffalo)
Ramelli, Alan (UNR)
Brune, Jim (UNR)
Grant Ludwig, Lisa (UCI)
Hudnut, Ken (USGS)
Hilley, George (Stanford)
Amidon, Willy (Middlebury)
Farley, Ken (Caltech)
Guilderson, Tom (LLNL)
Brown, Tom (LLNL)
Johnson, Joanne (BAS)
Stone, John (UW)
Anooshehpoor, Rasool (NRC)
Gosse, John (Dalhousie)
Sharp, Warren (BGC)
Bierman, Paul (UVM)
Refsnider, Kurt (CU Boulder)
Amos, Colin (UCB)

Doctoral Advisors

Douglas Burbank, University of California, Santa Barbara
Robert Finkel, University of California, Berkeley & Lawrence Livermore National Laboratory

Postdoctoral Advisors

Lisa Grant Ludwig, University of California, Irvine
Jim Brune, University of Nevada, Reno