3. Project Summary: The HERO REU Site

Global environmental change is essentially a human problem. It results from countless human actions occurring in local places. At the same time, people experience and respond to global environmental change in localities. If society is to understand how people cause, experience, and respond to global environmental change, then it is necessary to study and monitor local human-environment interactions. Similarly, if society is to study and monitor the local dimensions of global environmental change in the future, then it is essential to develop a cadre of young scientists trained in this research area today.

In response to these needs, the Human-Environment Regional Observatory project (HERO) is developing the infrastructure to study and monitor the human causes and consequences of global environmental change in local areas. An important component of that infrastructure development is the training of young scientists. Accordingly, the HERO REU Site will engage advanced undergraduate students in field and laboratory research on human-environment interactions in general and on global change in local places in particular. The HERO REU Site is a collaboration of geographers and other global change scientists at Pennsylvania State University, Clark University in Massachusetts, Kansas State University, and University of Arizona.

The HERO REU Site activities will follow the same plan each year. In the spring, the local HEROs will select three students from Pennsylvania, from Massachusetts, from Kansas, and from Arizona to participate in the HERO REU Site. These 12 students will start their summer research activities by taking a two-week short course that will introduce them to the concepts and tools needed to study the local dimensions of global environmental change. The short course will rotate from Penn State (2002), to Clark (2003), Kansas State (2004), and Arizona (2005). After the short course, the REU students will return to their home states where they will conduct parallel research activities at the local HEROs. The three-person REU student teams will work for six weeks with a faculty research mentor, a student (peer) mentor, and other faculty, post-doctoral researchers, and graduate students working at the local HEROs. Students will be introduced to such tools as geographic information systems, aerial photographs, remote sensing images, and geo-positioning systems. The activities will include the mapping and field checking of: land cover and land use; natural and technological hazards; essential facilities (e.g., fire, rescue, and police services, emergency shelters, hospitals, schools, water pumping stations, and waste treatment plants); potentially vulnerable socioeconomic groups (e.g., elderly, children, single-mother households, minorities, and poor); businesses, factories, resource extraction and processing facilities, and other commercial sites; and critical biological habitats. Students will also engage in interviews and focus groups. They will stay linked to their colleagues at the other local HEROs through HERO remote collaboration (collaboratory) tools.

In the following spring, each cohort of HERO REU Site students will participate in a special illustrated paper session at the Annual Meeting of the Association of American Geographers. The 2003 meeting will be in New Orleans and the 2004 meeting will be in Philadelphia; the location of later meetings will be announced later.

For more information, see http://hero.geog.psu.edu. To apply, please contact Penn State Professor Brent Yarnal (814-863-4894; alibar@essc.psu.edu). The HERO REU Site especially encourages applications from women and other groups typically underrepresented in American science.
5. Project Description

5a. Overview

Physically based, global-scale approaches to global change research dominated the young field before the 1990s. In 1992, however, the development of a social science agenda added a new perspective called the human dimensions of global environmental change (HDGEC; National Research Council 1992). Today, HDGEC is an integral part of the United States Global Change Research Program (National Research Council 1999a).

By the late 1990s, the global change field continued to expand its outlook by taking a local and regional perspective (e.g., USGCRP 1998). Scientists and policy makers came to realize that localities and regions play a central role in addressing the causes and consequences of such global environmental problems as climate change and land-use change. For example, to mitigate climate change by reducing greenhouse gas emissions, governments need to take actions in specific places, including cutting point-source emissions from energy production facilities and managing forests to maximize carbon sequestration. At the same time, it is at the local level that people most directly experience the positive and negative impacts of climate change and implement adaptation strategies.

Despite the recognition that the human and local dimensions are critical to the field, the physical-global emphasis still dominates global change science. Part of the reason for this continued bias is that most human processes, and therefore most social science studies, take place at much smaller spatial scales than the global. Linking global to regional and local scales has proved to be a difficult scientific problem even in a purely physical context, so it is not surprising that linking global scale physical changes to local and regional scale socioeconomic systems has made limited progress.

Another problem that has limited progress beyond the physical-global approach is that the theoretical, model, and empirical integration of human-environment interactions has not been forthcoming (Rayner and Malone 1998). There is no overarching theory or holistic numerical model of human-environment interactions at any scale. There are few empirical studies integrating biophysical and socioeconomic systems for a local area, for a region, or for the globe. Still, such integration is at the top of global change (National Research Council, 1999a) and sustainability agendas (National Research Council 1999b). These calls advocate local and regional efforts to integrate nature and society, especially because such efforts facilitate stakeholder inputs to the scientific enterprise (e.g., National Assessment Synthesis Team 2000; Yarnal et al. 2000).

Based on the need to develop theoretical, model, and empirical research at local to regional scales, science is starting to develop systematic efforts to study and to monitor the local dimensions of global environmental change. One such effort is the Sustainability Geoscope project under development by the German National Committee on Global Change Research (http://www.sustainability-geoscope.net). Another is the proposed addition of social science to the United States Long-Term Ecological Research (LTER) network (Redman et al. 2000). Perhaps the most advanced of these efforts is the Geography-based, NSF-funded Human-Environment Regional Observatory project (HERO), which is helping to develop the infrastructure needed for studying and monitoring the local dimensions of global environmental change (http://hero.geog.psu.edu). HERO is using four strategies to build this infrastructure. First, it is developing research protocols and data standards for collecting human-environment
data at individual research sites. Second, it is constructing a Web-based networking environment that will help investigators share data, analyses, and ideas from different locations around the globe. Third, it is testing these concepts by applying the protocols, standards, and networking environment to an important research question in four localities across the United States. Finally, it is helping to organize a network of domestic and international researchers who are investigating the local dimensions of global environmental change and who will use the HERO infrastructure.

The HERO proof-of-concept sites (known collectively as the HEROs) represent four contrasting biophysical and socioeconomic contexts and four collaborating research teams based in Geography departments. They are the HERO for Central Massachusetts (HERO-CM, at Clark University), the Susquehanna River Basin HERO (SRB-HERO, at Penn State), the High Plains-Ogallala HERO (HPO-HERO, at Kansas State University), and the Southwest-Mexico Border Region HERO (SOMBRHERO, at The University of Arizona). To develop and test the project infrastructure, the HEROs are trying to answer the question, “How does changing land use affect the vulnerability of people and places to climate variation and change?” This question presents the investigators with the challenge of addressing three major global environmental change themes simultaneously: land-use/land-cover change, vulnerability, and climate change.

The proposed HERO REU Site. An important aspect of science infrastructure is its human infrastructure. To conduct long-term study and monitoring of the local dimensions of global environmental change, HERO and similar efforts must develop a cadre of young scientists steeped in the general field of HDGEC (National Research Council, 1992) and the specific topic of global change in local places (GCLP; Wilbanks and Kates 1999; The GCLP Project Team, Forthcoming). To reach that goal, we, the HERO investigators, propose to build four cohorts of young researchers by developing a four-year HERO REU Site that will:

- Run an annual two-week short course, each year introducing 12 undergraduate students to the concepts and tools of HDGEC and GCLP.

- Distribute each cohort to the four HERO proof-of-concept sites where they will conduct parallel research activities for six weeks and we will engage them in hands-on, place-based, collaborative global environmental change studies.

- Reconvene each cohort at the Annual Meeting of the Association of American Geographers (AAG), where the students will present the results of their research in a special illustrated paper session.

A unique feature of the HERO REU Site is that it will not take place at just one site. Each year, the short course will be held at a different HERO proof-of-concept site, moving from Penn State, to Clark, to Kansas State, and finally to Arizona. Our idea is to develop the short course so that it can be taught at any college or university with a geographic information science (GIScience) laboratory, extending the methodology to other geographic regions and beyond the life of this REU project and thereby becoming part of the HERO infrastructure. After each summer’s short course, each of the four HERO sites will host a three-student team, which will conduct local-area global environmental change research. The annual activities will run at roughly the same times each year: the short course will take place about the second and third
weeks of June, followed by the team research, which will occur in a six-week block extending from approximately late June to early August.

During each of the four years of the project, we will draw three student participants from each of the four states — Massachusetts, Pennsylvania, Kansas, and Arizona. We propose this strategy because it is desirable for HERO researchers to be familiar with the local and regional contexts and because it insures broad geographic representation; i.e., students will be from New England, the Mid-Atlantic Region, the Great Plains, and the Southwest. One student will be from the host university (which will make certain that one student knows the university and local community well) and two will be from other institutions in the state. At least one student in each state will come from a college or university with a limited research program. Each year, recruitment efforts and applications will take place from January to March and selections will be made in April.

The recruitment and selection focus will be on groups that are underrepresented in American science — women, minorities, and persons with disabilities. (HERO presently has five HERO REU Supplements consisting of five women, one of whom is a minority.) Each of the four universities involved in this collaborative research and educational effort has a significant commitment to expanding opportunities in science for underrepresented groups. Each university is also committed to supporting global change research in general and HERO in particular. The facilities provided to the students will be excellent and the mentoring will be based on extensive experience.

5b. Nature of Student Activities

As outlined above, each cohort will engage in three activities: a short course, research at one of the four HERO sites, and an illustrated paper session at the Annual Meeting of the AAG.

The annual short course will take place over 10 weekdays with an intervening weekend field trip. Each weekday will address a different topic. A typical day will involve introductions to concepts, data collection techniques, data analysis tools, and professionalization. If the topic of the day were land-use/land-cover change (LUCC), for example, the morning session would start with a brief presentation of the topic followed by discussion. Then, students would be introduced to LUCC data and would be taught how to find these data (by contacting local, county, and regional planners, by accessing them over the Web, etc.) and how to download them to a geographic information system (GIS) for manipulation, display, and analysis. After lunch, students would be taught basic LUCC analytical techniques. Issues of classification, scale, incompatible data, missing data, and presentation would be discussed and exercises would be provided to make students grapple with these issues. Besides LUCC, other daily topics will include the following human-environment data: census; survey and focus group; interview; remote sensing; digital elevation model and topographic map; climate, hydrology, and water resource; natural and technological hazards; and pollution and environmental. Some of these topics will involve fieldwork, including interaction with members of the local community through pre-arranged interviews and focus groups. At the end of the short course, the students will have been introduced to many of the ideas, techniques, and issues involved in HDGEC and GCLP research. This information and skill set will give students a starting point for research at their HERO sites.

An important part of the short course will be daily professionalization discussions. During these periods, we will cover issues facing professional scientists, including ethics, “dos and
Another important component of the short course will be the weekend field trip through the local study area. During this trip, students will see the physical and human landscape and will gain insights on how to read and interpret those landscapes and on how to think about human-environment interactions on the ground.

To help students make the transition from the classroom setting of the short course to the research environment at the HEROs, faculty research mentors or other representatives of the HERO teams will join the co-instructors during the last two days of the short course. For example, when the short course is at Clark in 2003, members of the Kansas State and Arizona HERO teams will join the co-instructors from Penn State and Clark. The discussion, research, and professionalization activities on those days will focus on comparative studies among diverse research sites, of problems encountered in remote collaboration, and with other difficulties to be experienced by the students in the coming weeks. More important, meeting a member of their research team will start the process of connecting students with their sites and of becoming part of a team.

Immediately following the short course, students will move to one of the four HERO sites. The faculty research mentors or their representatives will accompany the students back to the HEROs. There, they will engage in full-time, 40-hour research for six weeks, working alongside faculty, post-doctoral, and graduate investigators to determine LUCC-induced vulnerability to climate. Specific investigations will change from annual cohort to cohort, but will be the same across sites in any one year. At this time, we hesitate to commit to precise research topics for the second through fourth years because HERO will determine these topics as that project evolves. In the first year of the HERO REU Site, however, the students will test a research protocol for assessing community vulnerability to contemporary climate-related hazards and to projected socioeconomic development and climate change. This research protocol will require each three-student team to:

- Map and ground truth land cover and land use;
- Identify, locate, and evaluate natural and technological hazards endemic to a particular geographical domain (e.g., flood zones, drought);
- Identify, locate, and map essential facilities (e.g., fire, rescue, and police services, emergency shelters, hospitals, schools, water pumping stations, and waste treatment plants);
- Identify and map potentially vulnerable socioeconomic groups (e.g., elderly, children, single-mother households, minorities, and poor);
- Map businesses, factories, resource extraction and processing facilities, and other commercial sites;
- Identify and map critical biological habitats.

Using GIS, they will analyze the interactions of these map coverages (e.g., hazard zones with critical facilities, vulnerable populations, and critical habitats). In addition, they will:

- Locate and use projections of population and development to derive scenarios of future vulnerability, leaving climate constant;
- Locate and use projections of future climate to develop scenarios of future climate-related hazards, leaving population and development constant;
• Develop scenarios showing the intersection of future development and future climate-related hazards.

In the end, the students’ research will provide a baseline for recognizing present vulnerability, which could be updated periodically so that trends in vulnerability could be identified. It also will furnish an assessment of potential vulnerability given realistic scenarios of land-use change and climate change, which will be useful to local decision-makers. Although this activity might sound ambitious, we have tested it successfully this summer using two HERO REU Supplement students and one graduate student.

Critical to the success of the proposed HERO REU Site experience is the model that we have developed to insure student-faculty interaction and student-student communication. At the SRB-HERO (Penn State), for instance, we established a HERO project office and provided networked computers for the HERO REU Supplement students. There, the students worked on HERO research alongside the PI, a post-doctoral scholar, and a graduate student, all of whom resided in that office during the duration of the HERO REU Supplement. The primary responsibility of the graduate student was to help the HERO REU Supplement students (not the other way around), providing them with assistance on data gathering, manipulation, and analysis. Daily interaction and mentoring fostered enthusiasm for the scientific enterprise and inspired confidence in the students that their work was valuable. CM-HERO (Clark) used a similar model and physical setup, with one faculty member and a post-doctoral scholar providing constant mentoring and assistance to one HERO REU Supplement student and other students funded from other resources. HPO-HERO (Kansas State) and SOMBRHERO (Arizona) will adopt this model for the proposed HERO REU Site.

Other keys to success are the diversity of activities, collaboration, and a sense of ownership. At the HEROs, the HERO REU students will not be chained to their computers. Instead, they will traverse the study area, getting to know its physical and socioeconomic landscape. They will ground truth satellite images, air photos, and maps. They will interact with local planners and stakeholders, gathering data through interviews and focus groups. The students also will be active collaborators in the HERO enterprise. They not only will work one-on-one with assigned faculty research and peer mentors, but also they will take part in collaboration with other faculty, post-docs, and graduate students, in team meetings at the local site, and in internet-based collaborations with the other HEROs through the HERO collaboratory. To keep abreast of the progress of the HERO REU students at the other sites, to share ideas and problems with them, and to maintain the bond within the cohort their progress, we will encourage the students to hold a weekly chat session over the HERO collaboratory. Despite our promotion of collaboration and teamwork, we believe that it is essential that each student feel a sense of ownership for his or her research. Although each student will be part of a three-student HERO REU student team, part of a 12-person cohort, and part of a HERO proof-of-concept site team, and although we want to stress collaboration, we will make sure that each student has a discrete research project that has their distinctive stamp. One way to achieve this goal is to make sure each student can prepare a stand-alone thesis, paper, or poster from his or her research.

Thus, after the short course and site research, the third activity that the students will undertake is an illustrated paper session at the Annual Meeting of the AAG. The first cohort will attend the March 2003 Annual Meeting in New Orleans, the second will attend the March 2004 Annual Meeting in Philadelphia, and so forth. Each year, HERO team members and HERO REU students will attend an all-hands meeting the day before the start of the Annual Meeting.
At that meeting, the students will present their research informally to the full HERO team. Later in the week, the students will present their research formally to the Geography community. We believe that having the HERO REU students attend the Annual Meeting of the AAG is crucial for several reasons. Attending a meeting will open the students’ eyes to the wider professional world and will allow them to see their research in a broader context. Preparing the poster and five-minute oral overview required at an illustrated paper session will be valuable professional experience. Bringing the cohort together will enable the students to see what their colleagues accomplished and will create a sense of closure to the HERO REU experience. Finally, seeing the products of each HERO REU cohort will reinforce the value of undergraduate research to the HERO team members and to the Association of American Geographers.

To sum up the research activities, each cohort of HERO REU students will encounter the entire research experience from project development through dissemination of the results. Although they will not choose the topic or protocol, each three-person team will be actively involved in working out the application of the protocol to the local context. In addition, each student not only will gain experience in collaborative research, but also will have an element of the project that they will identify as their “own.”

5c. The Research Environment

The HERO REU experience will start with students driving or flying to the annual short course. When the short course is at Penn State in Year 1, for instance, Massachusetts and Pennsylvania students will drive to the University and Kansas and Arizona students will fly. All twelve will stay together in a campus dormitory (we will request that the one student enrolled at that university stays in the dorm for group cohesion).

Each year, the short course will be co-taught by the PI and a co-instructor. The PI will organize the course and its content and will be the primary instructor. The co-instructor’s chief responsibilities will be to organize computer access, software, data sets, interviews, and focus groups and, importantly, to provide local knowledge. At Penn State, since the PI has intimate knowledge of the local data and context, the co-instructor will be a post-doctoral scholar. When the short course is at Clark, Kansas State, or Arizona, the co-instructor will be the faculty research mentor. Other HERO faculty, post-doctoral scholars, and senior graduate students will be called upon to participate on those days when they have topical expertise. The short course will be taught in three locations: a traditional seminar room, a GIScience laboratory, and in the field (see above). Each of the participant university Geography departments has GIScience laboratories.

The PI, Brent Yarnal, has an extensive record of involvement with and commitment to undergraduate education and research. He has 17 years of teaching experience at the undergraduate level, including writing-intensive classes, research and field seminars, and directed group and individual studies. In a continuing appointment, he has been the Penn State Geography Department’s Undergraduate Officer for over five years. He has advised the Department undergraduate organization for eight years. He has served as the Department Intern Advisor. He has chaired or served on several undergraduate curriculum and advising committees at College and University levels. He has advised 21 undergraduate theses and 2 undergraduate Honors theses; he currently is advising three undergraduate Honors theses on HERO-related topics—two resulting from REU Supplements. He has provided research experience (both for wages and for course credit) for dozens of undergraduates, including many women and minority
students. Many of these students have continued into graduate school through the master’s and Ph.D. levels. He has an extensive record of accomplishment of publishing with his post-doctoral and graduate students and is presently expanding that success to include publishing with his undergraduate advisees, which is not a tradition in Geography.

Robert G. (Gil) Pontius, John Harrington, and Diana Liverman will serve as co-instructors when the short course is at Clark University, Kansas State University, and The University of Arizona, respectively. Gil Pontius is Assistant Professor in the Graduate School of Geography and the Department of International Development, Community Planning and Environment, where he coordinates the Masters of Arts program in Geographic Information Science for Development and Environment. He has been directing funded research in Massachusetts for several years, using GIS to examine the environmental consequences of land-use change. Most important, he has considerable experience in supervising undergraduate student research. Clark University runs an independently funded 12-month undergraduate HERO research program (http://earth.clarku.edu/hero/index.html), and Pontius is the supervisor and faculty research mentor for Clark’s six HERO fellows.

John Harrington, Jr. is Professor and Head of the Department of Geography and the Director of the Natural Resources and Environmental Sciences (NRES) Secondary Major. The undergraduate NRES program has a capstone course serving about 40 students per year that is project orientated and involves local fieldwork. Harrington also has considerable experience in developing and implementing summer short-courses in the areas of: remote sensing and physical geography (an NSF-funded project at Indiana State University), human impacts and environmental change (at Kansas State), and general geographic education (for the Colorado Geographic Alliance). In addition, he has taught several undergraduate field courses with an emphasis on cultural biogeography oriented around a trip to the Great Smoky Mountains. In recent years, Harrington has worked with McNair Scholars and supervised several undergraduate researchers working on GCLP research. He is Associate Director of the Department’s GIS lab, which typically employs about a dozen undergraduates working on USDA NRCS and other funded research contracts.

Diana Liverman is Professor of Geography and Regional Development and Director of the Center for Latin American Studies at the University of Arizona. She works closely with other interdisciplinary environmental programs on campus such as the Office of Arid Lands, the Udall Center for Studies in Public Policy, and the Institute for the Study of Planet Earth. Together with her strong collaborative relationships with research institutions in northern Mexico, these programs will provide a valuable resource for the REU program when it convenes in Arizona. Liverman teaches courses on the environment and on Latin America from the freshman undergraduate through graduate levels, has won teaching awards, and has taken several groups of undergraduates on fieldtrips to study the environmental problems of Mexican border region. In recent years, she has involved undergraduates in border environmental research through internships with local conservation and environmental management organizations, and has supervised several honors theses that involved undergraduate summer field research on land-use change in the border region.

For logistical, financial, and pedagogic reasons, each summer, there will be only one formal faculty research mentor for each three-student team at each HERO research site. In discussions with students who have gone through REU Site programs in the past, we learned that when a single faculty member has a single student assigned to him or her, he or she often treats the student as a “gofer” and does not engage the student in a meaningful research experience. We
believe that having a three-student team assigned to one faculty research mentor will avoid this undesirable outcome. Nevertheless, HERO is a collaborative project and students will receive informal mentoring from HERO faculty, post-docs, and graduate students. Our experience with this summer’s HERO REU Supplement students suggests that, indeed, interaction among all HERO personnel is intense because of the collaborative nature of the project.

The six weeks of research that follows the education and bonding provided by the short course is fundamental to the HERO REU experience. For the students to believe that they are valued parts of the collaborative enterprise, it is critical that they are not given second-class space and are not treated like second-class citizens. As noted above, at each of the four HEROs, we will provide each HERO REU student with quality space where they will work next to their HERO colleagues. They will have first-quality computing equipment with the software needed for their research. They will get challenging research tasks that will make fundamental contributions to HDGEC in general and to HERO in particular and that are of sufficient import for publication.

We recognize it will be difficult to balance the provision of challenging science with the inexperience of the HERO REU students. We also recognize that six weeks is a relatively short time and that the more time that students spend learning where data are and assembling those data, the less time that they have for analysis. One of our solutions to these conflicts is for the three-person student teams to work collaboratively with graduate students and post-doctoral scholars who, as part of their job description, will help the students assemble the data sets and guide them through their analyses. This approach has worked successfully with HERO REU Supplement students.

Another appealing solution is to provide each three-student HERO REU team with a peer, or student mentor. That student mentor will be an alumnus from the previous year’s HERO REU cohort. The advantages are obvious: the alumnus will have local knowledge and experience assembling and analyzing local human-environment data; the job of the alumnus will be to provide research support to the three-student HERO REU team; and the alumnus will provide peer-level emotional support, thus lessening some of the anxieties students inevitably feel when confronted with the unfamiliar role of researcher. In Year 1 of the proposed HERO REU Site, it is likely that we will not be able to persuade four of the five HERO REU Supplement students currently working on the HERO project to return as student mentors. Thus, we expect to continue relying on graduate student and post-doctoral support for the HERO REU students in Year 1, at least at some of the HEROs. In subsequent years, we do not anticipate a problem in recruiting student mentors. If we do run into a problem, we will hire graduate students with HERO experience to mentor the REU students.

In addition to the hands-on help provided by the proposed student mentors and by graduate students and post-docs, the PI will be the faculty research mentor of the HERO REU students at Penn State. As discussed above, HERO REU students will be located in the Penn State HERO research office with the PI, the co-instructor post-doc, and the graduate students. At Clark and at Arizona, Gil Pontius and Diana Liverman, respectively, will be the faculty research mentors. At Kansas State, the faculty research mentors will rotate among the HERO faculty collaborators. The Kansas State faculty research mentors will be Lisa Harrington (2002), Max Lu (2003), Steve White (2004), and John Harrington (2005). At all four HEROs, the faculty research mentor will meet with the student teams on nearly a daily basis to discuss progress, strategy, problems, and solutions. If physically possible, they will work together in the same space to maximize collaboration and mentoring.
A final component of the research environment is the collaboratory (i.e., virtual collaboration networking environment) afforded by the HERO Web-site. Each HERO REU cohort will have a dedicated chat room for discussing travails among the four HERO sites. They also will take part in pan-HERO virtual discussions, experiments, and other on-line activities. Given the heavy use of instant messengers, chat rooms, and other computer-based communication tools by today’s college students, we expect this cross-site linkage to be successful.

5d. Student Recruitment and Selection

We will recruit students in four states — Massachusetts, Pennsylvania, Kansas, and Arizona — with each HERO drawing only from its home state. This strategy is a compromise between the desire to have a broad geographic distribution in potential HERO REU students and the need to have local and regional knowledge for our local-area studies.

Within each state, we will recruit one student from our home institutions: Clark, Penn State, Kansas State, and Arizona. It is critical that this student has detailed local knowledge so that he or she can share this knowledge with his or her colleagues, who will be from outside the immediate vicinity.

To build a more diverse base, we will recruit the remaining two students from other institutions in our states. Although these “external” students might not have specific local knowledge, they will have understanding of the regional context and a good acquaintance with the human-environment problems facing residents of their states. In each state, at least one of these two students will come from a college or university that does not have a strong research basis.

Although each HERO site will address recruitment independently, each one will rely upon established formal and informal networks within its state to find the best possible students. For example, the SRB-HERO will exploit two formal networks in Pennsylvania. This HERO will advertise through the Pennsylvania Consortium for Interdisciplinary Environmental Policy (http://www.dep.state.pa.us/hosting/paconsortium), an organization devoted to improving environmental policy and education through government and academic cooperation. The Consortium is currently comprised of the Commonwealth of Pennsylvania's Department of Environmental Protection (DEP) and Department of Conservation and Natural Resources (DCNR), Sustainable Pittsburgh, RAND, and 41 Pennsylvania universities and colleges (see the “Participating Institutions” page at the Web-site listed above). Included in these 41 academic institutions are dozens with limited research opportunities for undergraduate students. A second formal network that the SRB-HERO will target is the Geography departments of the state, which it will access through the Pennsylvania Geographical Society (http://planetx.bloomu.edu/~geog/pennggeo). The PGS emphasizes geographic education at all levels, especially non-research institutions. These two formal networks, plus the informal networks that the PI has developed over his 16 years at Penn State, will provide access to a large pool of potential HERO REU students within Pennsylvania. The other faculty research mentors have access to similar formal and informal networks in Massachusetts, Kansas, and Arizona.

Our advertising and networking specifically will aim at members of groups underrepresented in global change research (i.e., women, minorities, and persons with disabilities). Our recruitment efforts with the current five HERO REU Supplements hired five women students, one of whom is a minority, to work on the HERO project in summer 2001. We see no reason to believe that our focused recruitment and hiring efforts will be any less successful in the future. HERO is dedicated to promoting underrepresented groups in its educational efforts — currently,
in addition to our five HERO REU Supplement students, we have four (of four) post-doctoral researchers and two (of four) graduate students from underrepresented groups.

5e. Project Evaluation and Reporting

To maintain the integrity of the proposed HERO REU Site and to improve the methods we use to engage undergraduate students in research, it is important that we assess project activities, evaluate immediate project success, promote continued interest in HERO REU alumni after they complete the research experience, and track these alumni to see the career paths they take. To assess the project, we will conduct exit interviews at each site. At the end of the six-week research period, the student mentor will perform this task using a set of standardized open-ended questions across sites. Questions will probe the students’ impressions of the content and structure of the short course and of the research activities. The focus will be on what they liked and found useful versus what they did not like and did not find useful. We will use this feedback to improve the short course in subsequent years. This information also provides a useful gauge of the improvement of the HERO REU Site over time. (As Undergraduate Officer for his department, the PI has conceived and written such an instrument and supervised its peer-based administration to graduating seniors.)

Evaluating immediate project success will be measured by the number of undergraduate theses that result from the project, from the number of papers submitted to refereed journals by the students and their collaborators, and by the number of presentations made by students at professional meetings. Our goal is for each REU student to engage in at least one of these activities, not counting the illustrated papers presented at the Annual Meeting of the AAG.

Nevertheless, the real proof of success of the proposed HERO REU Site will be if the students — especially those from underrepresented groups — continue into graduate school and undertake research careers. One way of promoting continued interest is to select Honors students with Honors thesis requirements, which means that the students will stay engaged in the research beyond the summer. In addition, and as noted above, we will take each cohort to the Annual Meeting of the AAG and we will hire four from each cohort to be student mentors in following years, both of which will extend the experience beyond the eight summer weeks. Yet another way to sustain interest is to continue to include the HERO REU students in HERO activities during the academic year. We will invite the HERO REU alumni to regular HERO meetings, special seminars, field trips, other activities, we will include them in group email and collaboratory interactions, and we generally will treat them as part of the team. We have used this simple procedure successfully in other large collaborative projects with undergraduate researchers and found it highly successful in maintaining a bond among faculty, staff, graduate students, and undergraduates. We have found that our students who feel like an integral, valued part of a large project tend to go to graduate school and to develop careers in areas of research related to the topic of the large project.

We will track HERO REU Site participants informally and formally. Our long experience in mentoring undergraduate researchers has led many to attend graduate school and choose careers in research. We keep in contact with these old friends, sometimes for life. This anecdotal approach is not sufficiently rigorous, however, so we will administer a short alumni survey after Years 2, 3, and 4 to find out the career choices made by the first three cohorts of HERO REU students and how the HERO REU experience influenced those choices. Again, in his Undergraduate Officer role, the PI has developed such an instrument to track alumni.

In the end, we believe that the proposed HERO REU Site project will produce a cadre of
students from which some will become a core group in the next generation of researchers working on HDGEC and GCLP problems. Given the growing importance and emphasis on these fields and the dearth of trained specialists, it is critical that we build this human infrastructure now. It is especially important that we take advantage of this ground-floor opportunity to build diversity into this group.

5f. Results from Prior Support

Not applicable because we have not been awarded a REU Site grant previously.
6. References Cited


