

2003 INSTAAR

SELF STUDY

PUBLIC VERSION
(PARTS C - N, NO APPENDICES)



Self Study Committee

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INSTAAR Director: Professor James Syvitski

Associate Director: Professor Tad Pfeffer

Chair Strategic Plan: Professor Scott Lehman

Mountain Research Station Self Study: Director William Bowman

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INSTAAR'S MISSION

The Institute of Arctic and Alpine Research develops scientific knowledge of natural and anthropogenic physical and biogeochemical environmental processes at local, regional and global scales, and applies this knowledge to improve society's awareness and understanding of environmental change. The world's high-altitude and high-latitude regions are the Institute's traditional focus, but the pursuit of understanding of these regions has led INSTAAR to a geographically wide range of interdisciplinary studies of Quaternary and modern environments, which include research in geochronology, human and ecosystem ecology, hydrology, oceanography, landscape evolution, biogeochemistry, and climate. INSTAAR's national and international research leadership in these areas is augmented by exceptional strength in graduate education and exposure of undergraduates to the research process, as well as by outreach to the public both locally and nationally.

INSTAAR'S ORGANIZATION

At the end of 2003, the governing body (Directorate) was comprised of 33 Fellows and Research Scientists led by a Director, an Associate Director and an Executive Committee. The Directorate consisted of 13 tenured or tenure-tracked teaching faculty (3: EE Biology; 2: Geography; 4.5: Geological Sciences; 2: Civil, Architectural and Environmental Engineering; 0.5: Environmental Studies; 1: Anthropology); 6 Emeritus Faculty; 3 Research Professors; 3 Federal Research Scientists (NOAA, USGS); and 12 Research Faculty. The Directorate is supported by 29 professional scientists, 11 post-doctoral scientists, and 63 graduate students. Other Ph.D.-level Institute scientists include 33 Research Affiliates and 6 Visiting Scientists. Affiliates usually have hard-money positions elsewhere, often at a university (CSU, CU-Denver, CU-Boulder, Regis U, U Wyoming, Northern Kentucky, U Arizona, Moscow U, Duke, Portland State, Bentley, MIT, U Washington, U Alberta) or with one of the front-range federal laboratories (NOAA, NCAR, USGS). Affiliates contribute to both the educational and research mission of the Institute. Visiting Scientist positions are available to those able to take a part, or all, of their sabbatical at INSTAAR. The Institute supported 292 undergraduate research assistants during the review period, either through part time academic year appointments, or full time summer employment. The Mountain Research Station has a staff of 10 including instructors, operating the mountain campus of the university. The Institute's administrative staff of 10 includes an Information Librarian; a Managing Editor of *Arctic, Antarctic & Alpine Research*; a Chief Finance Officer; an Assistant to the Director; a Systems Administrator; and five accountant technicians and clerks; to support the activities of the 287-member institute (for details see <http://instaar.colorado.edu/people/index.html>).

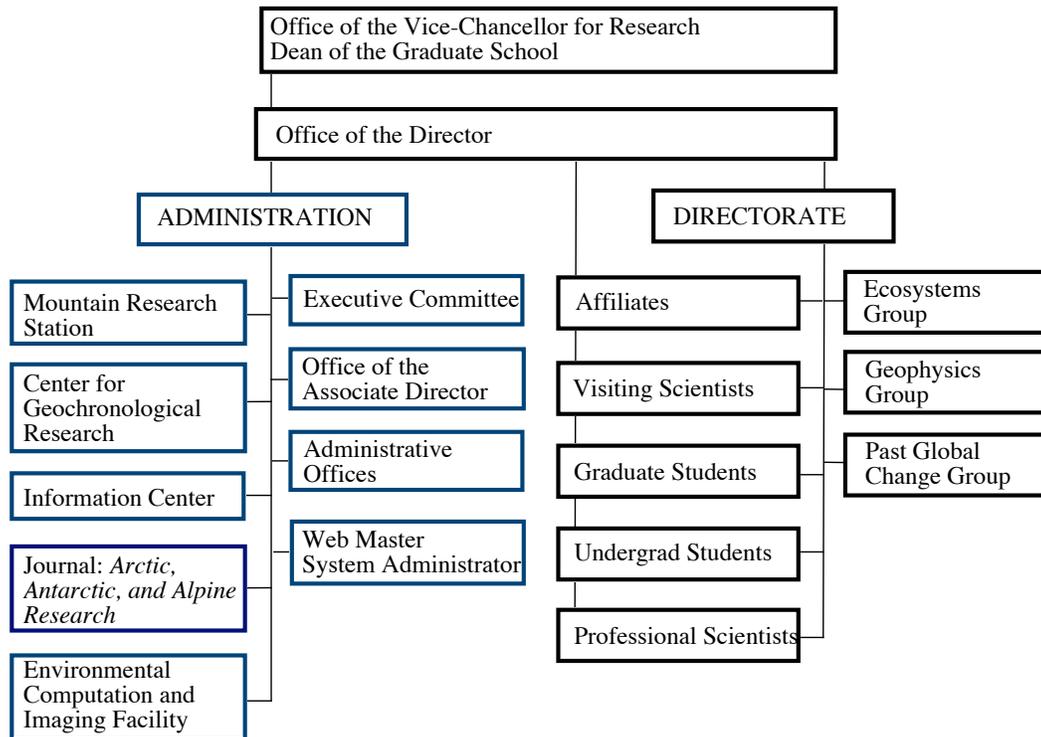
Institute members are subdivided into three research groups: Ecosystem Science, Geophysics, and Past Global Change. These groups serve an internal administrative function but scientists commonly work between groupings. The groups also serve to coordinated interdisciplinary research.

The *Ecosystems Group* focuses on the biological components of alpine and polar systems, global carbon and nitrogen cycling, the dynamics of biodiversity, and ecosystem disturbance and recovery. *Long-Term Ecological Research (LTER)* studies in alpine and Polar Regions are emphasized, involving populations and communities, biogeochemistry, and ecophysiology. Modern tools include geographic information systems (GIS), remote sensing, and ecosystem modeling. The *Mountain Research Station* offers a complex of laboratory and field facilities to support these year-round research efforts.

The *Geophysics Group* applies quantitative field and numerical methods to discover the properties and dynamics of snow, ice, water, sediments, and crystalline rock in the world's oceans, glaciers, and land areas. Methods of analysis include theoretical and numerical development, remote sensing, and land, airborne and ship-borne field geophysical experiments, all applied to problems in hydrology, glaciology, volcanology, frozen-ground studies, climatology, oceanography, and marine geology. To facilitate these interests, the Environmental Computation and Imaging Facility provides researchers with supercomputer

power and global connections to geophysical databases

The *Past Global Change Group* focuses on the reconstruction of the dynamics of paleoenvironments and past climate variability to enhance our understanding of the interactions between all components of the earth system, including atmosphere, ocean, land, ice, and the biosphere. Integration of a variety of records from a global network of sites, from the polar ice caps to continental alpine regions and to the world's oceans, provides the capability to test conceptual and predictive global change models and to facilitate the differentiation between natural and human-induced change. To facilitate these interests, the *Center for Geochronological Research (CGR)* provides scientists with state-of-the-art analytical facilities to address the cause, timing, and rates of environmental change in recent Earth history. The CGR fosters synergistic relationships across traditional disciplinary boundaries in order to understand the global circulation system.



INSTAAR's Organization Chart.

INSTAAR is administratively part of the CU-Boulder Graduate School with interactions with the UCB College of Arts and Sciences, and the UCB College of Engineering. Departmental Chairs and Deans advise the Institute through an INSTAAR Council. A Scientific Advisory Committee of world scholars and leaders also advises the Institute.

INSTAAR EDUCATION AND OUTREACH

INSTAAR's role within the University

Among the three areas of excellence identified by the Cu program, Quality for Colorado, two converge with INSTAAR's expertise, research, and educational mission. The first of CU's areas of excellence, *environmental science and sustainability*, is mainstream to INSTAAR's mission. The second area of interest, *the American West*, includes INSTAAR's research interests in the Rocky Mountain region and the operation of the Mountain Research Station. Our interests in biogeochemistry, hydrology, ecosystem Studies, landscape ecology, and conservation biology of high elevation ecosystems substantially contribute to UCB's ability to pursue the American West as an area of excellence. These acknowledged

and accepted UCB missions strongly reinforce INSTAAR's interests to maintain and enhance its current strengths in environmental science and develop a regional focus for research excellence.

INSTAAR's teaching activities

On average, INSTAAR Faculty teach 2.5 courses per year per faculty, not including summer courses taught at the Mountain Research Station through Continuing Education. The distribution through the University levels is, on average, 7 courses/yr at the 1000 level, 2 courses/yr at the 2000 level, 7 courses/yr at the 3000 level, 9 courses/yr at the 4000 level, and 6 courses per year at the Graduate level. In addition INSTAAR Faculty teach 7 students per year through Undergraduate Independent study, and 4 students per year through Graduate Independent study. Graduate theses production has increased 45%, from 51 to 74 theses, when comparing this performance review period to the previous period.

While CU Boulder has a long tradition of successful interdisciplinary collaborations in research, for a variety of reasons, establishing and maintaining interdisciplinary educational programs is more difficult. As a national leader in environmental research, CU must ensure that environmental education is as valued and supported as environmental research. Only this way can we continue to attract top graduate students and the best new Faculty. INSTAAR supports the Graduate Task Force on Interdisciplinary Studies (GTIS) at CU, whose task is to make “concrete recommendations for ways that this campus can better facilitate interdisciplinary educational programs.” INSTAAR will play an active role on this Task Force.

INSTAAR has a strong commitment to supporting K-12 education and reaching out to the local and regional community. Activities include the annual Open House, Alpine Ecology course for teachers at the MRS, books for children, participation in judging Science Fairs, participation in opportunities for minorities (SURF, SMART and SOARS), public talks at schools, museums, community organizations such as Rotary Club and Elks Club, and the Chancellor's lecture series, numerous articles and interviews in the popular press, including newspapers, magazines, local and national television and radio, documentaries and educational programs on PBS, The Discovery Channel and The Learning Channel, participation in the development of K-12 educational materials, expertise used by local, State and Federal governmental officials, and finally, general questions answered via instaar-info@instaar.colorado.edu. Outreach activities at the Mountain Research Station are detailed in Appendix 5.

INSTAAR'S UNIQUENESS

INSTAAR maintains internationally recognized strengths in observational studies and field research in alpine and polar environments- systems that are responding dramatically to global change processes. The institute is particularly well known for its long- standing programs in the areas of past global change, geochronology, glaciology, and alpine ecology (including the NSF LTER program), and for its interdisciplinary science journal “Arctic, Antarctic and Alpine Research”.

The key to INSTAAR's enduring and growing success is threefold. First, it has provided a distinctive and functional interdisciplinary environment that brings researchers together to define and understand linkages within the coupled Earth system. Second, it has the ability to quickly increase the field of expertise of its scientists to analyze and understand these linkages, as demonstrated by the development of a strong human dimension group (human ecology in polar environments) and its interactions with biological and physical scientists. Third, it has the continuing capacity to integrate research findings into the educational fabric of University departments co-rostering INSTAAR faculty and staff. Accordingly, INSTAAR's expertise is often unique at the university and national levels, including areas such as biogeochemistry, global mass balance and sea level change composition, hydrological routing, ice mechanics, paleo-oceanography, process geomorphology environmental modeling, and spatial modeling for ecological assessments. The Institute will continue to grow in stature and success, and play a central

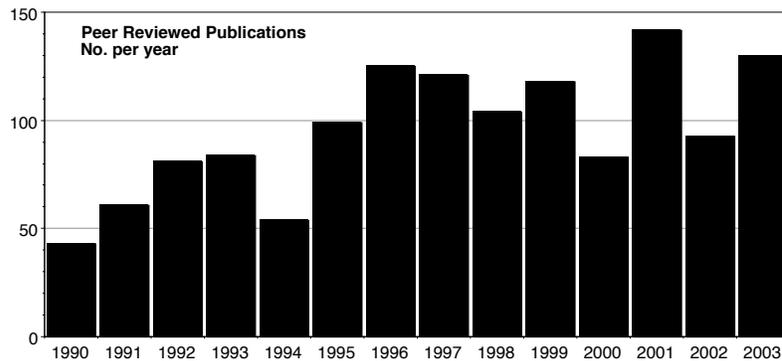
role in realizing the aims of CU-Boulder's strategic plan: to maintain and expand excellence in teaching and research in environmental sustainability and studies of the Rocky Mountain West.

PROMINENCE AND POTENTIAL FOR RESEARCH EXCELLENCE

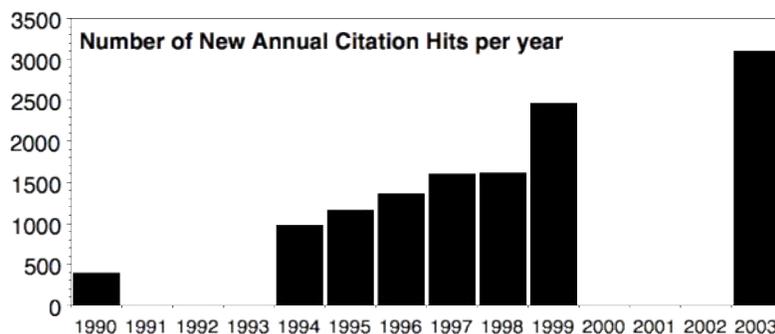
There are many ways of measuring research prominence and the potential for excellence within an academic unit. Means for measuring collaborative research include: (i) number and quality of peer-reviewed publications, (ii) setting agendas through committees, panels, editorships (below and Appendix 12), and (iii) recognition through various awards (below and Appendix 12), and (iv) number and level of funded research projects. Over the last six years, researchers at INSTAAR have collaborated with investigators from six continents, thirty-five countries, and eighty-seven different institutions within the United States. These linkages with scientists outside of the CU system attest to the national and international prominence and reach of INSTAAR.

Publications

The quantity and quality of publications by INSTAARs has increased since the last program review and attests to the excellence of the Institute. Close to 800 peer-reviewed publications have been published during the review period (a 45% increase over the prior review period), with a per capita average of 3.5 publications per INSTAAR Teaching and Research Faculty (all are listed in INSTAAR Annual or Biennial Reports). These publications have appeared in fifty journals, including prominent journals such as *Nature* and *Science*. INSTAARs have edited or authored 26 books and journal special issues (listed in the Appendix 12 to demonstrate breadth).



Another measure of the quality of publications is the *Scientific Citation Index* (SCI). Per capita SCI references have greatly increased steadily and exceed 3000 new citations in 2003 (note years with missing data). This increase in the SCI references reflects the breadth and depth of INSTAAR research and the interest in research topics pursued at INSTAAR. The future vigor and excellence of INSTAAR research looks promising.



Setting Agendas

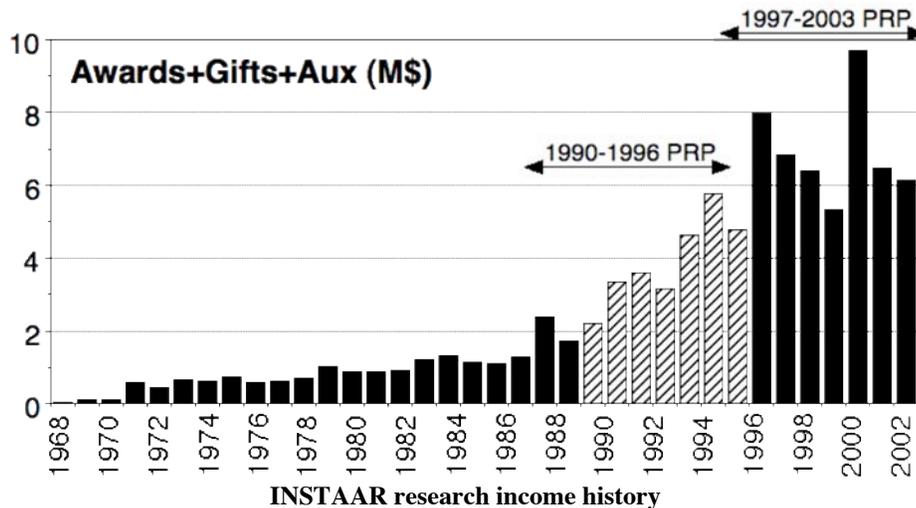
During the review period, INSTAARs have convened or chaired over 135 sessions/symposia at the national level, and over 60 at the international level. INSTAARs are on the editorial boards of 34 journals (see Appendix 12) and have or continue to edit 9 journals (see Appendix 12). INSTAARs have or continue to hold numerous positions in professional societies and or organizations including President, Association of Ecosystem Research Centers, Secretary and Executive Committee of the Arctic Research Consortium of the US, Board of Directors, Executives of IGBP PAGES (Past Global Change) and LOICZ (Land Ocean Interaction of the Coastal Zone). They support the research agendas of federal agencies (e.g. NSF, ONR, EPA) through extensive work on Advisory Panels, authoring of Science Implementation and Funding Plans (see Appendix 12).

Honors and Awards

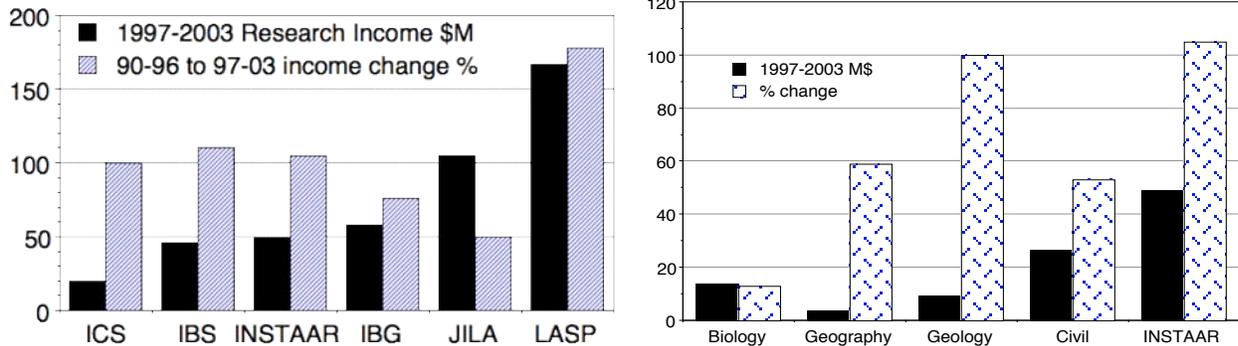
Peer recognition of INSTAAR Faculty across the review period is documented through more than 65 awards or honors from regional, national and international bodies (listed in the Appendix 12), including the CU Medal, the first Ippilito Gold Medal for Antarctic Research, the Blaise Pascal Chair in Ecology, the first American Polar Society Special Award, and the Richard P. Goldthwaite Polar Medal. INSTAAR Faculty have chaired numerous (>150) prestigious conferences and sessions at the national and international level. INSTAAR scientists have presented more than 160 keynote and invited talks to scientific and government assemblies

Funding

Research income over the 1997-2003 period of review doubled compared to the previous review period. Of the \$60.3M in income that the Institute acquired during the review period, \$41M was through Research Awards, \$6.1M was through Auxiliary income (principally laboratory service contracts), \$1.8M through gift sources, \$2.7M through subcontracts with other CU units (e.g. CIRES), and \$8.7M from the CU Graduate School. The institute was awarded 450 multi-year contracts and awards during the review period, and this provides the majority of funding (see Appendix 12). INSTAAR prepared research proposals have averaged a steady $50\pm 5\%$ success rate. CU General Funds variably supports the salaries of the teaching faculty, institute operations, and match on some equipment grants (see Appendix 12). Auxiliary income is sizable (see Appendix 12) and relates to the national prominence of a few of the Institute's analytical laboratories. Gift income increased from virtually nothing during the last review period to nearly \$2M in this review period due to a concerted fundraising effort (see Appendix 12). The institute also worked to support \$2.7M in proposal funding run through other CU units (see Appendix 12).



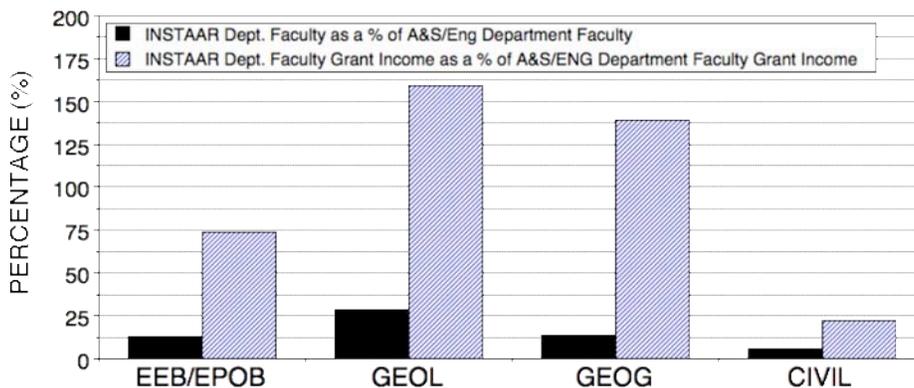
Like most other CU institutes, research income doubled during the present review period compared to the previous review period. Most of the affiliated CU departments do not show a similar increase in their research income during the period.



Research income for CU Institutes (exclusive of CIRES with NOAA partnership) and affiliated Departments across the 97-03 review period. Also shown is the percent increase in funding between this period of review (97-03) and the prior (90-96) period. INSTAAR income includes auxiliary (lab) research income.

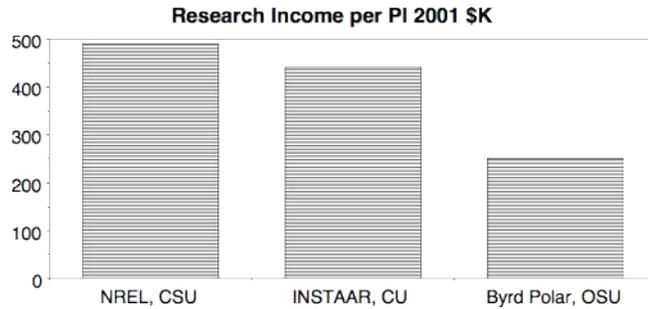
INSTAAR income across the review period, by Federal Agencies, includes \$0.65M from the Dept Agriculture, \$0.79M from the Dept Commerce, \$0.16M from the Dept of Energy, \$0.63M from the Dept Interior, \$3.41M from the Dept Defense, \$1.98M from the Environmental Protection Agency, \$1.14M from the National Aeronautics and Space Agency, \$32.89M from the National Science Foundation, and \$3.38M from the non federal sources. Directorate teaching and research faculty contribute on average \$220,000 per investigator per year. INSTAAR's relies heavily on funding from the National Science Foundation (NSF), a strong testimonial to the excellence and competitiveness of our Principal Investigators. In an effort to diversify, the Institute increased its non-NSF funding from 22% (last review period) to 27.5% (this review period). The Department of Defense is the second largest supplier of research income, followed closely by non-federal sources.

INSTAAR faculty accounted for 13, 29%, 13% and 5% of the faculty respectively in EE Biology, Geological Sciences, Geography, and Civil Engineering, yet generated a research income that was 74%, 159%, 139% and 23% respectively of the non-Graduate School research grant dollars generated by these departments.



INSTAAR faculty proportion and grant income proportion for the four main cognate departments.

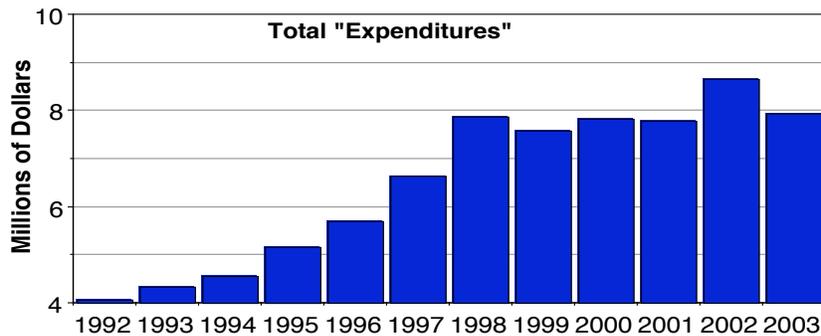
On a per capita basis, INSTAAR funding success in 2001 was 43% better than our polar peer at the Byrd Polar Institute (Ohio State University) and 10% below our ecology peers at Colorado State University Natural Resources and Ecology Laboratory (NREL).



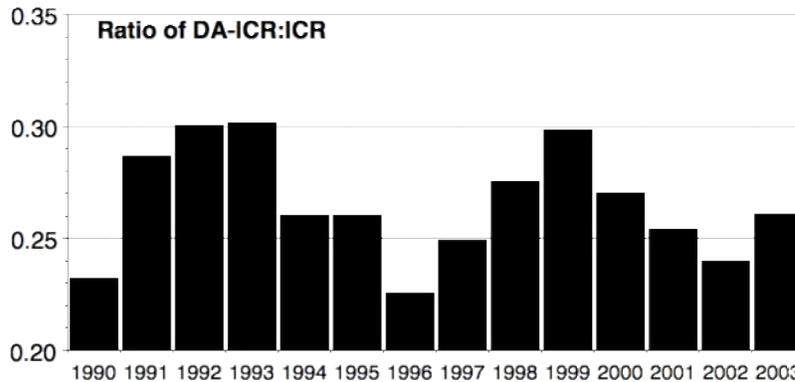
Comparison of INSTAAR Research Income per Investigator to selected Peer Institutes.

INSTAAR'S OPERATIONS AND COSTS

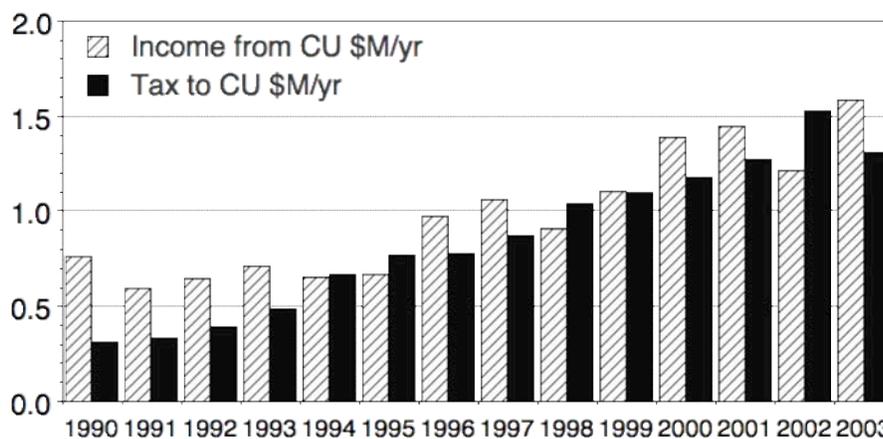
During the review period, the cost of running the Institute was \$54.5M. Expenditures provide a true picture of the cost of operating the income, regardless of source of funds. Over half of the expenditure are as salaries (52%, \$28.1M), followed by operating expenses (18%, \$9.9M), tax by university through indirect cost recovery (16%, \$8.9M), equipment (5.3%, \$2.9M), travel (4.2%, 2.3M), subcontracts (3.5%, \$1.9M), and tuition (1%, 500K). Departmental allocated funds (DAICR) supplied by the university is set at 29% but due to skims for university initiatives, the DAICR was effectively 26.5% during the review period. This reduction impairs INSTAAR's ability to fulfill its mission. In general there is almost the same level supplied to the University by the Institute as received by the Institute from the University.



Recent expenditure history of INSTAAR.



Departmental allocated funds as a ratio to Indirect Cost Recovery paid to CU by the Institute.



Income from CU supplied to the Institute as General Funds and income supplied to the University by the Institute in the form of Indirect Cost Recovery.

In addition to the \$8.9M supplied to the University by INSTAAR since 1997, the Institute has invested \$2.1M in bldg renovations, \$2.9M on equipment, \$0.7M in start-ups for new faculty. Most of the money supplied back to the Institute is to cover the salaries of the Institute’s Teaching Faculty. In return Institute members taught 80 Graduate and 310 Undergraduate courses at CU. In addition these same faculty supported the entire cost of a graduate education for 175 students during the period of review. When the faculty salary is subtracted from the general fund contribution to the Institute, then the Institute has provided a net contribution to the University of \$5.33M during the review period. Even when incorporating the CU cost of building space and maintenance the Institute is net provider to the University (\$2.1M). Compared to academic units within the College of A&S, CU institutes pay a much larger percentage (sometimes 100%) of the cost of startups for new faculty, and much larger percentage in the cost of equipment match. In addition the Institute also pay for its own Accounting Staff (4) and System Administrator on grant income.

INSTAAR FACILITIES

With the timetable for a new ENVIS Grandview complex pushed off University planning horizons, we acknowledge that RL-1 and RL-3 will be the major home of INSTAAR for the foreseeable future (MRS facilities are reviewed separately below). Accordingly, INSTAAR is committed to creating efficient, modern laboratories within these facilities. Collectively, over the last few years (1999 to present) INSTAAR scientists have invested over \$700K in RL-1 infrastructure needs. These included \$160k in electrical and airflow upgrades for the mass spectroscopy laboratory, \$400K for a new inductively coupled mass spectroscopy laboratory, \$65K in physical structure housing the AMS 14C preparation and organic geochemistry facilities, and over \$70K to improve the physical structure of the biogeochemistry laboratories. These figures exclude the state-of-the-art instrumentation housed within these labs. Accompanying this, the modeling group renovated space in RL-3 and created a million-dollar computing facility. All of this has been done using federal grant dollars, leveraged with Graduate School and INSTAAR funds. INSTAAR was forced to borrow funds from the University to complete the inductively coupled mass spectroscopy laboratory, the essential component of a new hire, and therefore INSTAAR has limited its flexibility with future ICR returns.

Main East Campus Facility, RL-1 & RL-3: INSTAAR’s main operations are housed in approximately 39,724 sq. ft. of office and lab space located in buildings on the CU East Campus. The total is composed of a combination of laboratory space (20,464 sq. ft.), office space (17,099 sq. ft.) and communal space

(Classroom and Reading Room, 2161 sq. ft.). The space is divided between RL-1 and RL-3 (ARC), but all wet laboratory space is confined to RL-1. RL-3 contains a computer lab and workrooms, but RL-3 is not equipped for wet laboratory facilities. 150 INSTAAR members are assigned office space in RL-1 and RL-3 (excluding periodic space made available to the 35 affiliates and 80 undergraduates). Per capita office space allotment is approximately 114 sq. ft./person.

Mountain Research Station: See separate section below and Appendix 5.

RL-6: The Geophysics Group at INSTAAR maintains 400 sq. ft. of space in RL-6: a 200 sq. ft. cold room surrounded by 200 sq. ft. of warm lab space. The laboratory is devoted to snow hydrology research and frequently used by students from the College of Engineering for a variety of ice-related experimental work. INSTAAR and USGS personnel also use the facility for frozen storage of samples. The warm lab is used for experimental control and electronics and parts fabrication for lab and field experiments.

Changes since 1996 Self-Study: The major change in the main East Campus INSTAAR facility is the acquisition in January of 2000 of approximately 10,000 sq. ft. of office and dry lab space in RL-3 (adjacent to RL-1 and formerly occupied by NOAA). This space consists of 41 offices and 4 work rooms/dry labs. The addition of this space has relieved office crowding in RL-1 enormously. Overcrowding in 2000 and recent growth has been accommodated by consolidation and judicious assignment of RL-3 space.

Current status: Most space problems are concentrated in RL-1, for 2 reasons: the acquisition of RL-3 did not increase wet laboratory space, and those persons whose work is centered around the wet labs need to have their offices located nearby, so office use remains congested near the RL-1 labs. As a consequence RL-1 remains very crowded. The inadequacy of laboratory facilities in RL-1 remains INSTAAR's most pressing facilities issue. The existing laboratory infrastructure (HVAC, fume hoods, safety, etc) remains woefully inadequate in RL-1 except in those cases where INSTAAR has renovated laboratory space. All new laboratory activities coming into INSTAAR must be accommodated either by absorption into existing lab space, through displacement, or by extremely expensive remodeling efforts in space inadequately configured for lab use. This situation is exacerbated by the presence of asbestos throughout the building, substandard infrastructure, and incomplete knowledge of the details of building infrastructure. Additionally, lack of year round temperature control in the building (no cooling capacity October through May) compromises heat-generating analytical instrumentation in interior labs.

Solutions: Office space can be accommodated in the immediate future by consolidation and judicious reorganization of existing offices. Growth in the next 6-year review period will require additional office space, expanding into underused areas of RL-3 outside of INSTAAR's present space assignment. Laboratory facilities are problematic, being an immediate health and safety issue for users of RL-1 labs; this problem will only be made greater by further crowding without proper renovation. Essential health and safety issues in RL-1 include deficiencies in temperature control, smoke alarms, fire doors, asbestos abatement, and ADA compliance. Investing Institute funds into lab renovations on an as-needed basis is very cost-ineffective and a poor investment in the long run given the overall state of the building. *The University administration could consider contributing to these renovations from non-INSTAAR general fund sources to offset the inflated cost of renovations in RL-1 compared to other buildings on campus. Any long-term solution to INSTAAR's deficient laboratory facilities should include vacating RL-1. All future development of lab activities in RL-1 will involve some combination of costly and inefficient investment in a decrepit building and compromises to health and safety.* While the likelihood of a new building is remote, this should remain a top priority for INSTAAR's future.

Growth in lab space is limited for the following key reasons:

- 1) Future fume hood installations are required by EH&S to be in rooms that have two exits;

2) Air handling capacity of RL1 to accommodate more labs.

The following building infrastructural needs are identified:

- Year-round temperature control in RL-1. Facilities Management believes this is an excellent project for FY04 “ICR Projects”, but we need to support the idea to assure funding.
- Smoke alarms in the labs- this is a must.
- Funding for fume hood installations when required (fume hood itself is only part of the cost, due to the needs for system wide re-balance).
- Building wide distribution of DI water and higher quality (clean) compressed air.
- Funding assistance for Fire Doors when applicable
- Higher speed (100 mb) Internet connections
- Funding assistance when renovations occur for ADA/Fire/EHS/asbestos compliance.

INSTAAR’s COMPOSITION REVIEW 2003

As of spring 2003 the Institute’s current membership is approximately 287 (see table below: note a 2001 census was not conducted). Since 1996 the Institute has grown nearly 65% and has seen a nearly threefold increase in undergraduate involvement.

	INSTAAR PERSONNEL					
	1997	1998	1999	2000	2002	2003
<u>Scientists (Ph.D. level)</u>						
Teaching Fac.	12	12	11	11	12	13
Research Fac.	14	13	9	12	10	13
Federal Scientists	4	4	4	4	3	3
Emeritus Faculty	2	3	4	4	3	6
Post Doctoral	10	17	18	10	15	12
Research Aff.	16	19	21	27	31	35
Visiting Sci.	6	14	15	16	14	6
TOTAL	64	82	81	84	91	89
<u>Prof. Scientists</u>	38	39	39	43	32	29
<u>Graduate Students</u>	52	50	58	65	54	63
<u>Undergrads</u>	35	80	79	70est	54	82
Staff	9	8	8	8	10	10
<u>MRS (staff)</u>	13	15	14	14	13	10
Grand TOTAL	212	274	280	284est	254	287

Of the present members, there are 20 hard-money positions (≥6 months of salary), another 25 hard-money positions salaried through other Federal labs or universities, and 242 personnel supported on Institute research income. During INSTAAR’s last review the following questions were raised: (1) is the disciplinary distribution of INSTAAR faculty based on our mission, and (2) are the age and seniority distributions within disciplines likely to affect the stability of Institute research into the future? The disciplinary distribution has not varied significantly since INSTAAR’s last review and there has been at least 25% growth in each of the Institute’s groups. The age and seniority distributions have not significantly changed, or affected, the stability of INSTAAR’s research. The following review is divided into two sections. The first section addresses teaching and research faculty lines and the second section describes the composition of the subgroups.

Teaching and Research Faculty

INSTAAR hosts 13 *teaching faculty* in five academic departments: 4.5 Geology, 3 Biology, 2 Geography, 2 Civil Engineering, 1 Anthropology, and 0.5 Environmental Studies. In 1996 INSTAAR hosted 14 teaching faculty (including two 50%FTE Professional Exempt faculty): 5 Geology, 5 Biology, 2 Geography, 1 Chemical Engineering, 1 Civil Engineering. Thus INSTAAR ends its review period with fewer Teaching Faculty members than at its start. Four of the teaching faculty are new hires since the last analysis. In 1996 INSTAAR housed 15 *research faculty* members (six have left CU for Faculty positions elsewhere, another has been hired as a Teaching Faculty at CU). As of fall 2003 there are 18 *research faculty* associated with INSTAAR. This includes 3 federal scientists (NOAA, USGS), and 4 faculty who are semi-retired from their academic or federal positions.

The research groups within INSTAAR exist to provide a mechanism for communication and to support the Institute's interdisciplinary balance. The **Ecosystem Group** places emphasis on ecosystem dynamics, biogeochemical processes, biodiversity, ecosystem disturbance and recovery, the modeling of biotic pattern distribution, ecological assessments and conservation planning. The group consists of 5 Teaching Faculty, 2 Research Faculty, 10 Affiliates and 3 Postdoctoral Fellows. Seven members are on the directorate. The **Geophysics Group** seeks to understand how processes act to create the environment we live in today, how past environments were produced, how predicted climatic forcing will affect future environments, and how deep-earth processes have been involved in the development of the modern earth environment. The group consists of 4 Teaching Faculty, 3 Research Faculty, 1 Federal Scientist, 3 Emeriti, 9 Affiliates and 5 Postdoctoral Fellows. Ten members are on the directorate. The **Past Global Change Group** aims to reconstruct the dynamics of past environmental and climatic variability to understand interactions among components of the global system, including the atmosphere, ocean, land, ice, biosphere, and humans. Integration of a wide variety of records provides the capability to test conceptual and predictive global change models, and to facilitate the differentiation between natural and human-induced change. The group consists of 4 Teaching Faculty, 6 Research Faculty, 2 Federal Scientist, 4 Emeriti, 15 Affiliates and 6 Postdoctoral Fellows. Thirteen members are on the directorate.

Professional Scientists (PRAs) help both Teaching and Research Faculty to achieve their goals. At present there are a total of 26 Professional Scientists compared to 23 in 1996. The Front Office Staff includes 7 classified (4 Accounting Technicians, 1 Clerk, 1 Assistant to the Director, 1 Finance Officer) and three non-classified positions (1 System Administrator, 1 journal Editor, 1 Information Officer). This is the same number as in 1996. The salaries of the Accounting Technicians are internally support on research grants. Graduate and undergraduate students are an integral part of INSTAAR, and they play important roles in the research conducted by the institute and its members. All INSTAAR students are registered for degree programs in an appropriate department and college. Both graduates and undergraduates have increased since the last review.

RECRUITMENT AND DIVERSITY

INSTAAR is committed to building and maintaining a diverse institute, as we believe that encompassing a diverse mixture of people will enrich both personal and scientific lives. An analysis of diversity, completed as part of our 12/03 diversity plan (Appendix 3), indicates that we have made progress since the last self study in some portions of the institute, whereas we still have much to achieve in others. As a whole, ethnic and racial minorities and women compose about 6% and 44% of the Institute, respectively. As of the 1996 Self Study, the majority of the individuals contributing to this diversity were undergraduates and classified staff; as of 2003, we are pleased to report that improvements in diversity have occurred in other portions of INSTAAR, most notably in the graduate student population. For example, women now comprise just over half of INSTAAR graduate students (51%). 36% of INSTAAR's current postdocs are women, and women comprise 27% of the soft money research

faculty. These statistics place INSTAAR roughly equal to or ahead of national averages, although we are well behind such averages for minority representation.

However, overall diversity in our teaching faculty has declined since the last Self Study; of the 13 current members of this population, only one is female, and none are minorities. INSTAAR is committed to increasing diversity in our teaching faculty for multiple reasons, including a large discrepancy that now exists between the graduate student population and their mentors. Our Diversity Plan (Appendix 3), discusses in greater detail our plans for recruiting and retaining women and minorities into faculty positions at INSTAAR. We wish to note that in the past seven years, INSTAAR made three attempts to increase our diversity in teaching faculty through special opportunity hires, but that in all cases these attempts failed for reasons beyond the institute's control. *We note that in the past seven years, INSTAAR made three attempts to increase our diversity in teaching faculty through special opportunity hires, but that in all cases these attempts failed for reasons beyond the institute's control.* In addition, faculty diversity is not solely in the hands of the Institute, since the Institute is obliged to hire jointly with cognate departments.

Finally, we note that in the 1996 Self Study, a "gender gap" emerged from our analysis of INSTAAR salary equity. Over the past seven years, considerable effort has gone into addressing salary inequities for the institute as a whole, and for women faculty members, and significant progress has been achieved on this front. INSTAAR remains committed to aggressively pursuing salary equity for any individuals who are not within the equity range.

STRATEGIC PLAN

INSTAAR continues to play a national and international leadership role in its core disciplines of alpine, cold region and past global change studies, and is increasingly competitive nationally in securing extramural funding in these areas. However, the Institute recognizes that traditional disciplinary funding sources are subject to growing pressure and that opportunities for future growth and advancement of research and education will depend on providing community leadership in the form of new scientific and funding initiatives. Such efforts are all the more important in view of the present restrictive fiscal environment within the State and the University, and INSTAAR now proposes to pursue extramural funding initiatives as an additional mechanism for securing new faculty (with extramurally-supported faculty bridging eventually to University support). The Institute's Strategic Plan therefore focuses on new initiatives that combine our core strengths with new and evolving analytical and computational capabilities and expanded collaborative ties with federal research labs and agencies. Each is motivated by the need to monitor and evaluate natural and human impacts (such forces as climate change, industrialization and population growth) on environmental and social systems at a wide range of temporal and spatial scales, including present-day impacts on Colorado's sensitive alpine regions and waterways. INSTAAR's mission, core strengths, and proposed initiatives align naturally with the University's *Quality for Colorado* program, which proposes to invest in academic areas of high demand and national distinction. Among the three areas of excellence identified by the University, two of them, namely "*environmental science and sustainability*" and "*the American West*", are central to INSTAAR's current and planned research agenda. INSTAAR's proposed initiatives are also aligned strongly with the top priority set forth in NSF's road map for future research / funding in Earth Sciences ("GEO 2000") – the study of Earth's water, carbon and biogeochemical cycles- and with a similar international programs.

Institute initiatives:

Front Range Carbon Cycle Studies Consortium

INSTAAR personnel have taken the lead in bringing together area experts in analytical chemistry and carbon cycle science in order to develop new analytical tools for evaluation of the fate of carbon in

soils, terrestrial aquatic systems, and the atmosphere. The consortium draws on and focuses expertise within the Institute spanning a wide range of environmental science disciplines, including atmospheric chemistry, aqueous geochemistry, soil biogeochemistry, ecology, and stable isotope and ^{14}C geochemistry, and includes internationally-recognized carbon cycle scientists from Boulder-area federal laboratories (NOAA and NCAR). One of the Consortium's initial efforts resulted in a \$2.5M NSF graduate training grant (IGERT program) entitled "Carbon, Climate and Society" which seeks to train graduate students from natural sciences, social sciences and journalism in interdisciplinary research teams. The Consortium is also presently revising a Major Research Instrumentation (MRI) proposal to the NSF entitled "Development of Molecular and Isotopic Tools for Carbon Cycle Research", which seeks funding for establishment of a new \$2M analytical research facility at INSTAAR. The aim of the facility is to promote development of new compound-specific isotope measurement capabilities as needed to evaluate the environmental stability of carbon, and to provide unique opportunities for student training in analytical biogeochemistry. The MRI also calls for establishment of an "Analytical Advisory Board", consisting of outside experts, to assist and guide the proposed analytical development effort.

The Consortium continues to provide a mechanism for development of inter-disciplinary carbon-cycle science proposals, graduate research opportunities in method development in the broad area of carbon biogeochemistry and graduate training at the interface between science and policy. The Consortium will attempt to formalize its status as a national, interdisciplinary research entity by seeking NSF support for a "Center of Excellence" in carbon cycle studies.

Community Surface-Dynamics Modeling Initiative

INSTAAR is a leading force in the development of the *Community Surface-Dynamics Modeling System* (CSDMS). CSDMS is a comprehensive, multi-institutional effort to integrate existing expertise and develop new expertise in marine and terrestrial landscape dynamics. A specific objective of CSDMS is the development of a modular process-driven modeling platform able to 1) predict the transport and accumulation of sediment and solutes in terrestrial landscapes and sedimentary basins, and 2) simulate the evolution of landscapes and sedimentary basins over a broad range of temporal and spatial scales. Originally conceived as a modeling platform for sediment transport and deposition, the project was expanded at an early stage to encompass the gamut of dynamic processes at the earth's surface, including the roles played by tectonics, surface and ground water, snow and glaciers, and the atmosphere.

An NSF-sponsored organizational workshop was held at INSTAAR in February 2002, with INSTAAR continuing to play a leadership role in the national CSDMS initiative. Importantly, the INSTAAR Environmental Computation and Imaging Facility has been offered to serve as the national computational center, whose role it would be to help the community coordinate its efforts, to ensure that standards for code are maintained, and to develop protocols for information exchange. The Facility will support a dedicated CSDMS server and support personnel. INSTAAR will also provide strong leadership in other aspects of the initiative, including (1) coupling of glacial processes with landscape evolution and stratigraphic processes, (2) continued advances in fluvial and hillslope modeling, and (3) continued global leadership in marine-based sediment transport and stratigraphic modeling. At present, few other institutions have quantitative expertise that so comprehensively spans the terrestrial and marine realms.

The CSDMS effort would provide increased support to graduate and post-graduate education, and facilitate collaboration between the world's top scientists working in landscape evolution processes. In addition the INSTAAR component of CSDMS will interface with other cu programs, including new graduate programs in hydrology, and will strengthen ties between cu and various national labs and private institutions.

CU Hydrologic Sciences Center

INSTAAR houses the largest concentration of hydrologic scientists on campus, including internationally recognized leaders in the areas of aqueous geochemistry, terrestrial-aquatic interactions, alpine hydrology, snow hydrology, glacier mass balance, and sea level change. Recently, the CU hydrology community has endorsed an effort to integrate campus-wide research and education in the hydrologic sciences under the leadership of INSTAAR's D. McKnight and the Graduate School has agreed to support initial administrative costs of this effort. An integrated campus-wide effort will provide an effective mechanism for promoting, and benefiting from, national and international hydrologic programs. INSTAAR scientists are already involved in developing several national hydrology initiatives, such as an NSF-Geosciences planned network of Hydrologic Observatories to be implemented by a consortium of US universities (CUHASI), and a US Global Change Research Program initiative on the global water cycle that features the role of snow and ice on the land, as well as aquatic-terrestrial interactions and decision support for water resources. At the international level, four entities - the International Geosphere-Biosphere Program, the World Climate Research Program, the International Hydrologic Program and the DIVERSITAS International Program of Biodiversity Science - have agreed to develop a joint project on the water cycle. Establishment of a coordinated CU effort under INSTAAR leadership early in the planning and implementation of these extra-mural programs is clearly desirable. Coordinated research programs and educational opportunities in hydrologic science will be critical to improved water resource management under increasing pressures human activities and environmental change- which are expected to be especially pronounced in the Rocky Mountain west and in polar regions.

As part of a campus-wide coordinated effort, INSTAAR will also continue to development of cross-departmental degree opportunities in the hydrologic sciences- such as "Certificate" and "Geophysics Option" program curricula.

High Altitude/High Latitude Human Ecology Initiative

The Human Ecology Initiative (HEI) evolved in response to recommendations by INSTAAR's Scientific Advisory Committee (SAC) and INSTAAR's growing awareness of the need to emphasize the relevance of understanding human adaptations to changing environments and social systems. With collective expertise in anthropology, cultural ecology, archeology, history, paleoecology, geography, and historical climatology, the HEI core group conducts interdisciplinary research in human ecology. Numerous national and international funding agencies and organizations promote and support human ecology and human-dimensions research. Examples include NSF's Directorate for Social, Behavioral, and Economic Sciences, and the Social Science Program of NSF's Office of Polar Programs (OPP). The Human Dimensions of the Arctic System (HARC) initiative, part of the NSF's Arctic System Science Program, emphasizes human dimensions in the causes and consequences of arctic environmental change. HEI members have actively participated in the development of these and other programs. In 2004, HEI members will respond to the NSF's recent announcement for a new research priority area, "Human and Social Dynamics".

Human-dimensions research in high-latitude environments will be a priority in the upcoming International Polar Year (IPY-4 in 2007-8). Unlike previous IPYs, arctic residents, indigenous communities, and other stakeholders will be key players in research and policy development. Research results relating to climate change, pollution, cultural heritage, subsistence, health, economic development, and other key issues, will play a critical role in subsequent planning, public discussion, and policy development.

HEI group members respond to the challenge of integrating human ecology with natural science research and education by aggressively seeking extramural funding to: 1) Acquire state of the art technology, e.g., GIS, hardware, software, geospatial, demographic and biological databases, etc.,

necessary for multi-level modeling, analysis, and interpretation of complex systems; 2) Strengthen graduate and undergraduate teaching programs and create student research opportunities in human ecology in the context of high-altitude/high-latitude environments; and 3) Increase education and public outreach through the usual channels, such as publication, website development, workshops, and symposia.

Re-incorporation of National Snow and Ice Data Center (NSIDC)

NSIDC began its life at CU in 1976 as part of INSTAAR under the direction of INSTAAR Faculty member Roger Barry. The transfer from the USGS Tacoma Office was made possible through the actions of Dr. Mark Meier (Chief of the Project Office in Tacoma who later became Director of INSTAAR in 1985). During a time of personnel strife within the Institute in 1979, INSTAAR was re-organized, with former members having the option of re-applying or joining another unit. Roger Barry chose to re-locate in CIRES taking NSIDC with him. During its 27-year history, both as part of INSTAAR and later as part of CIRES, the NSIDC has grown to be a \$7M per year operation with 65 full-time positions.

Both INSTAAR and NSIDC conduct data management and have complimentary super-computational and data-server capabilities. Most reviewers of the two organizations note that the stronger field and laboratory side of INSTAAR provides a compelling basis for the recruitment and training of graduate students providing shared opportunities between those who generate data and those that serve the data internationally. On a number of projects, scientists from NSIDC and INSTAAR presently work together as collaborative PIs on projects. However the interaction can be described as opportunistic. By true functional integration, it is argued that both NSIDC and INSTAAR will be invigorated. Joint facilities, such as the merger of the now separate polar information libraries, should also provide better service with reduction in cost of operations.

NSIDC accounts for ~10% of CIRES employees, and ~15% of CIRES budget. The proposed re-incorporation of NSIDC within INSTAAR would not alter CIRES position as the largest Institute on the CU campus. On the other hand, the restoration of historical ties between INSTAAR and NSIDC would surely make CU a towering world leader in polar science. *INSTAAR seeks a commitment from CU Administration to consider the benefits of restoring NSIDC to the Institute early in the current performance review period.*

Institute Needs and Priorities

Faculty hires:

The primary need is for new faculty to support the expanded research and education agenda outlined above, and to strengthen core Institute programs. INSTAAR's hiring priorities, relating both to new initiatives and core programs, are:

- *an Organic Geochemist*
- *an Earth Surface Process Modeler*
- *a Surface Water Hydrologist*
- *a Human Ecologist*
- *a Paleoclimatologist*
- *a Quantitative Landscape Ecologist*

We note that at the close of the last PRP in 1996, the INSTAAR Directorate included 14 full time teaching faculty while it now numbers only 13. INSTAAR grant revenues have doubled over the same interval, as have the number of undergraduate students employed, student credit hours generated, and the number of graduate students completing advanced degrees.

INSTAAR seeks a commitment of 3 new FTE's during the upcoming performance review period, over and above replacement hires relating to faculty retirements or unanticipated faculty departures. This would constitute a net growth of 2 faculty members in 14 years. INSTAAR will also seek extramural funding for the additional 3 faculty in connection with initiatives outlined above. The Institute seeks a commitment from the administration to stand behind any INSTAAR effort to obtain extramural funding of new faculty by providing an eventual bridge to University salary support.

Space:

Growth anticipated in connection with the above activities will place additional demands on already restricted office and laboratory space within INSTAAR. Addition of wet laboratory space, and renovation of existing laboratory space, is an especially critical need. At least 3 of the proposed new hires can be expected to require state-of-the-art laboratory space. Presently, there is very limited capacity to accommodate additional fume hoods in RL-1, and no such capacity in RL-3. It may be possible to consolidate further into existing hoodable space, but to do so will require substantial University support for division and renovation of existing space. Based on our recent experience, we can anticipate that these infrastructural requirements will cost in the vicinity of \$200,000 – \$400,000 per affected investigator. *INSTAAR seeks a commitment from CU Administration to fund the portion of the costs of future renovations in RL-1 that arise from the special circumstances associated with this building. INSTAAR also emphasizes the need to vacate RL-1 and move to a new facility as the only long-term solution to the Institute's laboratory infrastructural problems.*

MRS SELF-STUDY SUMMARY

The Mountain Research Station (MRS) is an interdisciplinary facility of the University of Colorado dedicated to the advancement of mountain environmental science. It is the sole field station of CU and functions as the infrastructure for the 24-year old LTER program. A description of its programs, facilities, and future plans can be found in Appendix 5.

Research activity at the MRS has increased since the last PRP. The number of senior researchers using the station has increased from 37 in 1996 to 52 in 2002. Similarly funding for research at the MRS has increased from \$1.62 million per year to around \$1.94 million per year. Much of the increased research activity reflects new research initiatives brought in by Professor Russ Monson from Ecology and Evolutionary Biology and CIRES, who has established a tower facility near C1 for measuring CO₂ and trace gas fluxes between the forest ecosystem and the atmosphere. Other new research programs include a NSF sponsored Microbial Observatory by Professor Steve Schmidt in EEB. Both of those large research programs are administered through Arts and Sciences, but both were facilitated and remain partially funded by INSTAAR's LTER program.

Professor Mark Williams of INSTAAR expanded his snow hydrochemistry studies by constructing a new subnivean laboratory in the subalpine of Niwot Ridge. In addition several new monitoring programs have been initiated, including an EPA sponsored Brewer UV measurement system, a Colorado Department of Transportation weather monitoring system for pilots, and a new NOAA long-term climate station, part of a new national program. The addition of new research programs has shifted the bulk of auxiliary research support away from the Niwot Ridge LTER program, which provided 80% of the auxiliary funding 10 years ago to 52% of current support.

The major infrastructure improvement obtained during the review period is a year-around facility, the Science Lodge. As described in our response to the prior PRP, the first phase of construction of this building was completed during 1998 with NSF and Graduate School funds. Fundraising provided an additional \$400K to complete the lodge and construction of the final phase has begun.

The CU Mountain Research Station has been reviewed both by an Internal CU committee in 2002, and much more extensively by an External Committee of national station leaders in the fall of 2003. In the spring of 2004, the Director of the MRS will have received an extensive review (the first major review in 12 years). Together these reviews, along with the MRS Self Study (Section M & Appendix 5), will likely lead to recommendation of a new governance structure, and of greater integration with the CU main campus education and INSTAAR research initiatives. As these various reviews are not completed and integrated, we request CU Administration to support the ongoing review process and any recommendations that would lead to improved integration of MRS educational and research programs.

CENTER FOR GEOCHRONOLOGICAL RESEARCH (CGR) SUMMARY

CENTER FOR GEOCHEMICAL ANALYSIS OF THE GLOBAL ENVIRONMENT (GAGE)

The Center for Geochronological Research (CGR) was founded with a seed grant from the University's Program for Excellence in 1986. Since then, it has developed into a strong force in quantifying the nature of climate change based on records preserved in geological archives, and on contemporary carbon cycle studies. CGR is a consortium of scientists and analytical facilities committed to addressing the causes, timing, and rates of environmental change occurring at present and in the recent past. The Center's initial emphasis was on improving our ability to provide reliable time constraints on changes in the recent past to better define the nature of natural climate variability. This thrust in geochronology led to the Center's name.

Over the past decade, the national research agenda has evolved, and the central focus of the Center has moved in response, from a common theme of geochronology to a more focused effort at improving our capability of detecting past and present changes in Earth's environments using increasingly sophisticated geochemical tools. This has led to a proposal to rename the Center for Geochronological Research to the Center for Geochemical Analysis of the Global Environment (GAGE). This name more closely reflects the research activities of Center personnel and we expect will aid in attracting the very best graduate students and postdoctoral fellows to the University. The Institute's Scientific Advisory Committee endorses unanimously by the INSTAAR Directorate, and the name change.

***Mission:** The Center for Geochemical Analysis of the Global Environment (GAGE) promotes fundamental research in the development and application of analytical methods that reveal past and present changes in Earth's climate, its land surface, and major biogeochemical cycles. Center members have expertise in marine and isotope geochemistry, biogeochemistry, and geochronology, which are combined with geomorphology, Quaternary stratigraphy and ecosystem ecology to address scientific questions of recognized importance.*

GAGE Faculty capitalize on the rapidly advancing tools in geochemistry to more accurately characterize changes in Earth's environments. Research foci include: i) isotopic and molecular approaches to understanding the modern carbon cycle, ii) quantitative reconstruction of past environmental changes to reveal links between components of the global climate system, and iii) documenting the processes in the geomorphic system that result in large-scale landscape evolution and the rates at which those processes act. The active participation of graduate and undergraduate students is encouraged and ensured through formal course offerings, the development of the Carbon, Climate and Society Initiative IGERT program for graduate education, access to specialized research facilities and employment opportunities.

At the time of our last Program Review, the Center consisted of eight research scientists, four of whom held tenure-track lines in the University, two were soft-monied scientists, and two were employed by Federal Agencies (NOAA/USGS). Presently, the Center is composed of eight research scientists, six of whom hold tenure-track appointments in the University, and two who are soft-monied researchers. Four are new members since the last Program Review. Additional human resources are found in the postdoctoral fellows, and a strong cadre of graduate students and professional scientists who work closely

with Center faculty. Excellence of GAGE faculty is demonstrated by their roles in setting the directions of science at the national level, their strong publication records, excellence in raising external support, and the placement of their graduate students.

To complement existing strengths within the Center, we seek authority to recruit a new faculty line in organic geochemistry. Furthermore, as an instrument-intensive Group the deficiencies of RL-1 raise serious limitations to continued growth of the Center. Inherent RL-1 building design limitations translate to very expensive renovation costs to create modern laboratory space. These expenses limit our ability to recruit new faculty or expand existing programs, and they present significant safety issues that are expensive to overcome. The obvious long-term solution is a new building; in the short-term, a CU commitment to lab renovation funds in start-up packages is essential.