

## NASA PAIR

# Partnership for Spatial and Computational Research PaSCoR



## Annual Report AY 2000-2001

<http://www.ece.uprm.edu/pascor>

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## PROJECT IMPLEMENTATION

### Mission

The University of Puerto Rico at Mayagüez (UPRM) has established, through NASA Grant number NCC5-340, *the Partnership for Spatial and Computational Research (PaSCoR)*. The main goal of this 5-year project is to strengthen academic programs and integrate research at the undergraduate level in various science, math and engineering/technology (SMET) disciplines, following the strategy of the Learning Factory model implemented by the NSF Manufacturing Engineering Education Partnership. PaSCoR program is outcomes-based and student centered, focused on hands-on learning activities provided throughout the student's academic career. The program's outcomes will be a SMET graduate that is knowledgeable of the technology and applications of remote sensing (RS) and geographical information systems (GIS), and, possesses the necessary skills either to enter graduate school or becomes a professional in these areas with success. The program also aims at developing values such as diversity, teamwork, global awareness and communication. PaSCoR goals will be achieved through five tasks, namely: 1) curriculum development, 2) undergraduate research & student mentoring, 3) industry collaboration, 4) outreach, and, 5) assessment.

Students from various SMET colleges and departments at UPRM (Agricultural Sciences, Biology, Geology, Electrical & Computer Engineering, Civil Engineering, and Mathematics) will be able to earn a certificate in RS/GIS upon completion of 12 credit-hours in course work and 6 credit-hours in undergraduate research. Courses and resources are open to all SMET student on Campus. There are currently (7) faculty members involved in student mentoring and course innovation/development, more than 30 students engaged in undergraduate research and around 750 students taking RS/GIS-related courses. PaSCoR students have spent summers learning about RS-GIS and developing leadership skills in sites such as USGS, NASA, Caribbean Pictometry and the Puerto Rico Planning Board. Forty-one (41) papers and presentations have helped disseminate this curriculum model in local, national and international forums.

The program has established the following vision and mission statements (as stated in the strategic plan):

*Vision: PaSCoR will integrate Science and Engineering education with practical experiences to produce a more competitive professional to face the global challenge of the new millennium.*

*Mission: To facilitate, enhance and strengthen the undergraduate research and education program in SMET in the areas of GIS and Remote Sensing, facilitating opportunities for underrepresented minorities.*

## Program Goals, Objectives and Outcomes

PasCoR started at UPRM in the Fall of 1998. Our strategic and operational plan – which integrates outcomes assessment - has been carefully followed and assessed during these 3 years. With the assistance and guidance of the project's Advisory Board, the project has been able to address challenges and opportunities to enhance its performance successfully, achieving and, oftentimes, exceeding many of its expectations. The following table summarizes the project's outcomes, metrics for success and actual achievements to date:

<b>Project Outcome</b>	<b>Metrics for Success</b>	<b>Actual Achievement</b>
To develop new undergraduate interdisciplinary courses in areas such as remote sensing, geographic information systems & GPS	<ul style="list-style-type: none"> <li>• RS/GIS Options in 4 departments</li> <li>• Courses/curriculum compliant with ABET 2000 criteria</li> <li>• Develop an outcomes assessment strategy for continuous curriculum quality improvement</li> <li>• Design a curriculum integrating opportunities for application and hands on activities, balancing content with soft skills</li> <li>• Create 10 new courses, revise 7 with RS/GIS topics</li> <li>• Train participating faculty in curriculum innovation &amp; assessment</li> <li>• Motivate SMET faculty to incorporate GIS/RS topics in their courses through small grants</li> </ul>	<ul style="list-style-type: none"> <li>• RS/GIS options in 6 departments</li> <li>• 462, 783 &amp; 1229 students registered in PasCoR courses in AY 1998, 1999 &amp; AY 2000</li> <li>• All courses developed with integrated outcomes assessment, as per ABET requirements. Pattern Recognition course revised with students learning styles inventory</li> <li>• Revised 9 courses (already in catalogue), 12 new courses (4 already in catalogue)</li> <li>• Offered 3, 3-day Faculty Retreats</li> <li>• Four (4) SMET faculty incorporated /RS topics in their courses</li> </ul>
To develop an effective undergraduate research program integrated into the curriculum	<ul style="list-style-type: none"> <li>• Provide research training for undergraduate students</li> <li>• Develop skills such as oral, scientific literacy, independent work and team work</li> <li>• Mentoring</li> <li>• Assign students to individual research mentors</li> <li>• Recruit a minimum of 35 freshman undergraduate students every year</li> <li>• Facilitate participation of undergraduate students in technical meetings</li> </ul>	<ul style="list-style-type: none"> <li>• 79 students have participated in Summer Station: 40 in 1999 and 39 in 2000 &amp; 40 expected in the Summer 2001, with 24 student mentors</li> <li>• Offered 2 workshops per year to students (196 students AY 1999, 80 AY 2000)</li> <li>• Each PasCoR student has a mentor assigned, UTEP's Affinity Group model adapted</li> <li>• 102 students in research (34 in AY 1998, 38 in AY 1999 and 34 in AY 2000)</li> <li>• All Summer station and undergraduate research students participate in technical meetings/presentations</li> </ul>
To develop partnerships to	<ul style="list-style-type: none"> <li>• Create an Advisory Board and establish MOU's for collaboration</li> </ul>	<ul style="list-style-type: none"> <li>• 3 MOU's signed to date</li> <li>• 9 internships sponsored by</li> </ul>

advise, support and provide guidance in this new educational paradigm		<p>other parties</p> <ul style="list-style-type: none"> <li>• \$16,500 video sponsored by HP</li> <li>• Advisory Board created in year 1, has met twice.</li> <li>• Microsoft grant to offer outcomes-based model program to Latin America</li> </ul>
To disseminate PaSCoR program results to the academic, industrial and government communities as a potential national model to enhance SMET	<ul style="list-style-type: none"> <li>• Disseminate PaSCoR program results and the RS/GIS curriculum track and certificate</li> <li>• Dissemination of curricular materials</li> <li>• Develop &amp; implement an assessment strategy to determine the critical success factors of the PaSCoR model</li> <li>• CD-ROM and WEB Page</li> <li>• Preparation of poster, brochure and video</li> <li>• Offer workshops &amp; presentations to stakeholders</li> <li>• Generate new proposals using the PaSCoR model</li> <li>• Organize an Annual Meeting to present the abstracts of the papers to submitted or in the process to be submitted</li> </ul>	<ul style="list-style-type: none"> <li>• 41 papers and presentations</li> <li>• Web page created, monthly editions of newsletter, program flyers, brochures and posters</li> <li>• PaSCoR Booth in 5 Dias con Nuestra Tierra &amp; UPRM Job Fair</li> <li>• Annual Advisory Board Meetings. Presentations to department heads and counselors.</li> <li>• Student Paper/Poster presentation held December 8<sup>th</sup>, 2000.</li> <li>• Faculty research presentations offered each semester</li> <li>• NSF ERC grant approved (Subsurface Sensing), UPRM Co-PI; 2 curriculum grants submitted or in process of submission to NSF (wireless technology and materials science)</li> </ul>
To develop and implement a project outcomes assessment strategy	<ul style="list-style-type: none"> <li>• Develop &amp; implement an outcomes assessment strategy evaluate the project results in terms of its objectives</li> <li>• Create an assessment team with stakeholders representation</li> <li>• Study project goals &amp; objectives, develop criteria, assessment tools and performance indicators and schedule</li> </ul>	<ul style="list-style-type: none"> <li>• Outcomes assessment plan in place</li> <li>• Student Portfolio initiated in Summer Station &amp; Pattern Recognition course to be expanded to all PaSCoR student populations</li> </ul>

## Partnering

PaSCoR values all of its stakeholders, specially its industrial and government partners. Thus the program devotes a lot of effort in identifying and nurturing their relationship. One important body is our Advisory Board. Composed of industry, government and academic individuals, these group provides valuable outcomes assessment as well as strategic guidance on all aspects of the project. The Advisory Board meets yearly (see two reports in the Appendix). Collaborative partners are also sought to sponsor and support different phases of the program, for example summer internships. During this past year, PaSCoR has continued to partner with entities to expand the scope and provide continuity and institutionalization of some of the project's activities. The following partnerships were established:

Entity	Purpose/scope
UTEP	Member Advisory Board
University of Connecticut	Member Advisory Board
Ohio State University	Member Advisory Board. Student full summer internship
Microsoft	Member Advisory Board (Coordinator)
Raytheon	Member Advisory Board
NASA Glenn	Member Advisory Board. Full student summer internship <sup>1</sup>
SOARS Program, Boulder, Co	Student full summer internship
USGS	Member Advisory Board. MOU signed. Full student summer internship. Keynote Lecturer at December 2000 PaSCoR Fair and Membership in Advisory Board
NASA Goddard	Student full summer internship
Puerto Rico Telephone Co.	Student full summer internship. MOU signed.
US Army Research Labs	Membership in Advisory Board. MOU in process. Student full summer internship.
Mississippi State University	Student full summer internship
Purdue University	Student full summer internship
Hewlett-Packard Puerto Rico	12 minute video production (\$16,500 value)
Northeastern University, Boston	NSF- ERC CenSSIS Project (UPRM Co-PI Luis Jiménez). Student full summer internship
PR NASA EPSCoR	High School 2-week Workshop "Climate Summer Camp" (22 students)

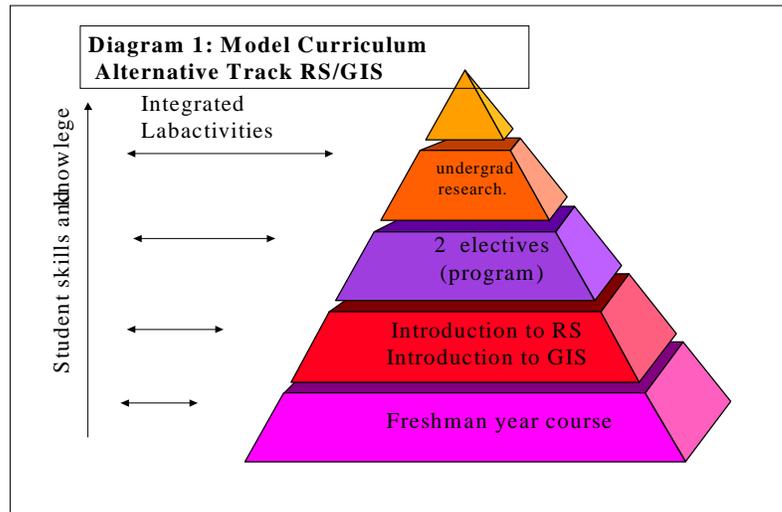
In summer 2000, we were able to place 5 more students sponsored by partner institutions/sites, ensuring institutionalization of summer internship opportunities for our students once NASA funds expire. To this date, in the Summer of 2001 we already have 12 full internships (5 sponsored by the project and 7 sponsored by other parties).

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<sup>1</sup> Full student summer internships are estimated at \$4,000 (including travel, room & board and stipend). Figures may vary with entity.

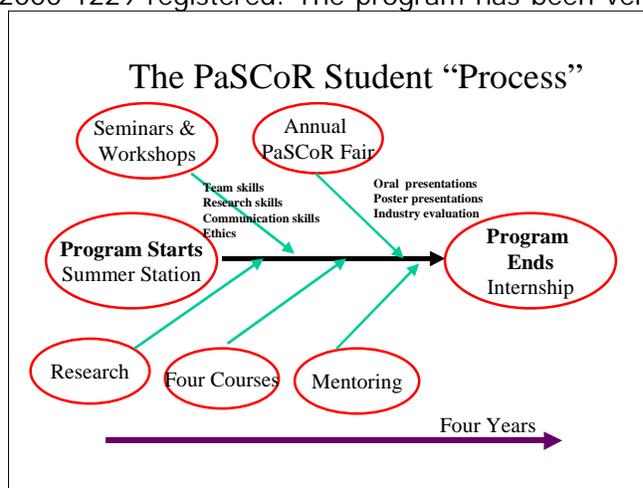
## INTEGRATION OF RESEARCH AND RESEARCH TRAINING IN UNDERGRADUATE STUDIES

The RS-GIS interdisciplinary curriculum in development consists of a continuous progression of courses spanning the student's entire academic career. This curriculum makes extensive use of active learning techniques and integrates laboratory experiences for hands-on activities. At the freshman level, the freshman year course, University 101, which the entire freshman class (2200 students, approximately) takes, has been revised to include concepts of RS/GIS. This course in addition to



UPRM's Freshman Orientation Week presentations provide students the opportunity to become aware of this technology and motivate them to consider taking the alternative curriculum tracks in the various SMET departments. To this date, twenty one (21) courses have been created or revised to include RS-GIS topics at 6 SMET departments. An additional four (4) SMET courses were revised in which RS/GIS modules have been added through small grants.

The RS/GIS track consists of 12 credit hours of courses and 6 credit-hours of undergraduate research in an area related to RS/GIS. Upon completion of these 18 credit-hours, participating departments will issue the student a CERTIFICATE in RS/GIS. The PaSCoR student "process" encompasses a 5—day research preparatory Summer Station, courses, seminars & workshops, research, mentoring, annual fair and opportunities for summer internships. Even though the program is currently limited to 40 students, PaSCoR courses are open to all SMET students. During academic year 1999-2000 more than 783 students took PaSCoR courses, while in AY 2000 1229 registered. The program has been very successful recruiting SMET students. All the



thirty-nine (39) students who participated in Summer Station 2000 (54% female), registered in the introductory course (Remote Sensing and its Applications, in the Fall 2000). This academic year there are 45 undergraduate students actively participating undergraduate research with a PaSCoR mentor and team. Ten (10) students participated in summer internships in mainland USA and Puerto Rico (5 sponsored by PaSCoR) in 2000 and 12 in 2001.

The research experience provided by the program has positively impacted the students. Mentors supervising PaSCoR summer interns are asked to evaluate their performance. They are highly satisfied with their work. For example, Summer 2000 mentors perceptions are as follows: 100% believe the student has enthusiasm for the job and potential graduate work; 80% think they possess good organizational and interpersonal skills, and have good opportunity for future research collaboration; 80% would

hire the student; 75% believe the student is good at team work and work knowledge; 60% believe they have good oral and writing skills. Some of the comments made by mentors: "The student needs little supervision" "A great opportunity for both, agency and program"; "The interdisciplinary integration was very fruitful".

Moreover, the kinds of experience and opportunities the program provides makes graduate school attractive: ***4 out of the 33 students in the 1998 cohort (or 12%) who were involved in undergraduate research with PaSCoR have continued to pursue graduate studies.***

Among the most outstanding curriculum innovations made so far is the revision of the Pattern Recognition course offered by Dr. Luis Jimenez. With the collaboration of Dr. Buxeda, the course was revised taking into account, among other things, student-learning preferences, course activities to match learning diversity, soft skills development, as well as integrated assessment of the learning process. The learning profile provided the framework for the design of course activities to match the learning style preferences of the student population. Course activities included ensemble a pattern recognition system to classified remotely sensed multi-spectral data, and a performance comparison of Bayesian, K-nearest neighbor and Neural Network classifiers. Case studies were designed to applied pattern recognition to solve problems in the science, engineering agriculture and geology fields. This approach allowed the understanding of pattern recognition from a global perspective and social context. Furthermore, an ethics workshop was designed for the students to enhance the understanding of the engineer's responsibilities and its social implications. Transformation of the teaching methodology also included the development of soft skills such as teamwork, conflict resolution and written communication. Team skills were developed using cooperative learning activities as well as student workshops in team building skills and conflict resolution. The learning profile was used in team formation to ensure diversity and assessment of team performance was monitored by assessment tool design by the team. Finally the assessment of student learning was documented using student portfolios.

The project carries regular meetings with faculty and staff. The PI meets almost daily with the Program Coordinator and the Executive Committee meets about twice a month. Faculty and staff involved carry a 3-day retreat during the summer for assessing the project outcomes, planning the project's activities, in addition to offer faculty development workshops (e.g., "Developing an outcomes-based workshop", "Integrating and mentoring students in undergraduate research"), and a one-day Progress Meeting is carried in mid-year.

## PROJECT IMPACT

### Organization and Management Structure

PaSCoR has developed a thorough Strategic Plan. This plan, which details the mission and vision statements, tasks, strategies, sub-strategies and time schedule, define the performance metrics to be assessed. ***Both the program goals and objectives and student learning outcomes are assessed and evaluated periodically.*** Therefore, together with the project's assessment plan, reporting and process re-engineering, we "close the loop" or cycle for continuous quality enhancement.

The project's assessment strategy is detailed in the Appendix. The assessment plan was developed by an Assessment Committee composed of 3 members of the project led by the

project PI. The purpose of assessment is to determine the effectiveness and efficiency in achieving the project's goals and objectives and to provide all stakeholders with evidence of the project's progress in order to make informed decisions in the strategic planning process. In order to have comprehensive and valid results, the assessment plan has the following elements: internal (self-assessments), external, multiple criteria, holistic, and have qualitative as well as quantitative components. The Assessment Committee has the following responsibilities:

- Design and implement the strategy
- Develop assessment tools
- Collect data
- Analyze data
- Report to stakeholders
- Disseminate strategy & results to the academic community for process continuous quality enhancement.

An assessment matrix containing the project's tasks, goals/objectives, performance indicators, data collection/approach/tools and schedule serves as a guiding tool for the project outcomes assessment. This, together with the valuable input on all the project's task outcomes from the Advisory Board, provides continuous and timely formative assessment and project tasks re-engineering (see Appendix). Duly and focused recommendations on all aspects of the program from the Advisory Board in addition to frequent revision of the project's goals by the Executive Committee has allowed the program to re-engineer its strategies. Examples of changes made as a result of the abovementioned during AY 1999-2000 are:

- Dr. Ramón Vásquez became Co-PI in charge of research due to becoming Dean of Engineering. Lueny Morell is now PI (in charge of curriculum & assessment).
- Although one participating faculty from Geology resigned from our institution late in the summer 2000 (Pamela Jansma) and could not be replaced, we were able to recruit two new faculty members into our project (Fernando Bird from Biology, and Linda Vélez from Civil Engineering) bringing diversity and two more departments developing their RS/GIS options.
- The project ceased its relationship with CECORD (ECE Department's project management office) and hired a Program Coordinator and administrative assistant.
- Prof. Luis Olivieri accepted the task to organize activities and mentor intermediate-level students in research.

This year the portfolio as a student learning assessment tool was initiated both Pattern Recognition course and the Summer Station experience will be expanded to all the PaSCoR student population. Next academic year, we hope to expand portfolios to all PaSCoR students (see Appendix).

Dissemination of PaSCoR best practices in curriculum and planning/assessment strategies has exceeded expectations. Some outcomes are:

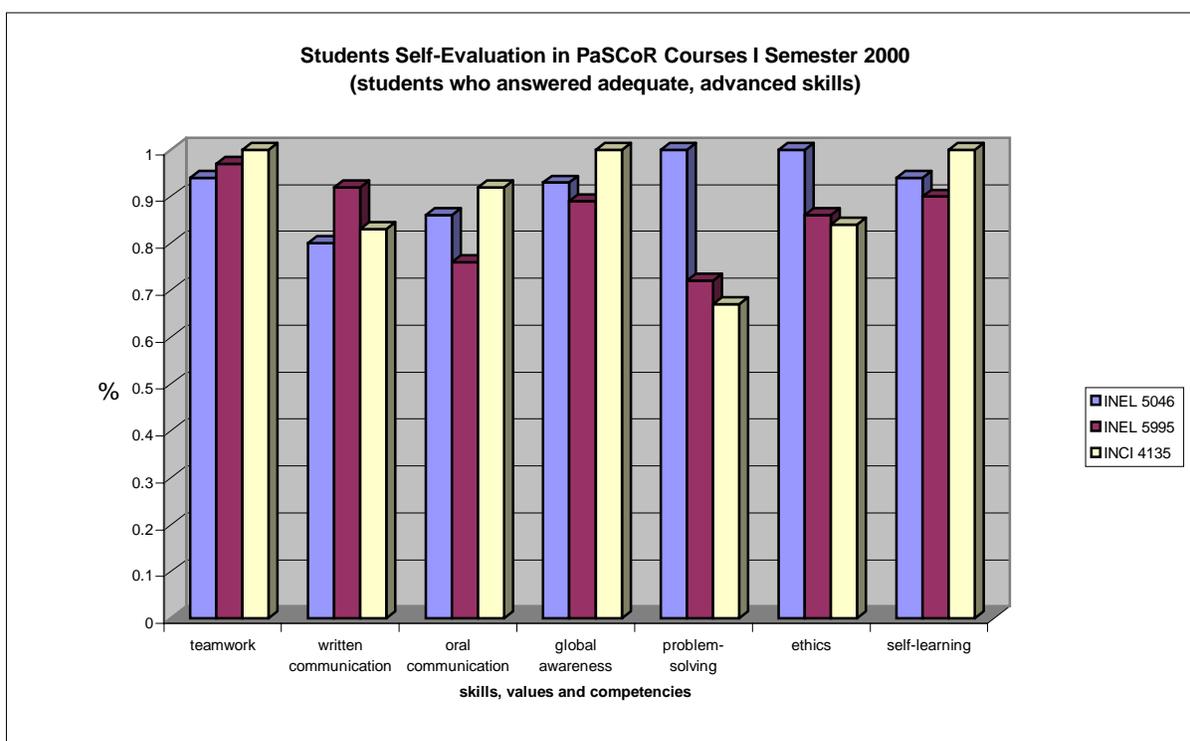
- 41 papers and presentations in 2.5 years
- Curriculum model with integrated hands-on activities and assessment model is being used by the College of Engineering faculty as part of the ABET 2000 strategy and activities. The PaSCoR workshop "Developing an Outcomes-Based Course" has been offered to about 80 faculty members so far, and has been accepted as a pre-conference workshop at the 2001 American Society for Engineering Education Conference in Albuquerque, NM sponsored by the Minorities in Engineering Division. NSF is entertaining a proposal to sponsor travel for 3 PaSCoR faculty to facilitate this workshop.
- The model curriculum has served as basis for UPRM submission of two additional curriculum proposals to NSF to establish two other options in wireless

science/technology (to be submitted in June of 2001) and material sciences (submitted December 2000).

- Various PAIR institutions have shown interest and requested our planning & assessment strategy. Our website now contains the assessment strategy and tools for access and CD ROMs with assessment files have been mailed to interested parties.

## Improvement to Academic Infrastructure

The PaSCoR curriculum and undergraduate research experiences have proven to be valuable for students. Student learning outcomes assessment demonstrates the students are not only learning remote sensing, GIS and its applications, but also developing important skills for the job, as demonstrated in the following table.



PaSCoR research and curriculum model has been extensively disseminated by various means. Up to date there have been forty-one (41) faculty papers and presentations. In addition, all of the students involved in research have at least presented twice through posters and presentations their work. The model program has also been presented in various workshops offered local, national and international venues.

	Presentations		Publications	
	Title	Audience	Title	Publisher
<b>Faculty</b>	See list in Addendum	Various	See list in Addendum	Various
<b>Students</b>	Various Titles July 30, 1999	Summer Station Closure -Open to UPRM Academic Community	See student tracking table	
	Various titles June 2, 2000	Summer Station Closure -Open to UPRM Academic Community	See student tracking table	
	Various Titles January 21, 2000	NASA Site Visit Team	See student tracking table	
	Various Titles December 5, 2000	Advisory Board Meeting + Academic Community	See student tracking table	

In terms of courses development and institutionalization, to date, twenty-one **(21) courses have being created or revised with RS-GIS topics**. Of those, thirteen (13) courses appear in the UPRM catalogue, as follows:

**9 courses revised already in the catalogue:** UNIV 101, Geo 3047, Geo 4048, CFIT 3005, AGRO 4018, AGRO 4025, MATE 4061, ESMA 3101, ESMA 4001, INCI 4135)

**12 new courses created:**

- **4 already in the catalogue:** INEL 5046, GEOL 3105, GEOL 4060, COMP 4046
- **8 in the process to be institutionalized:** INEL 5995 (3 different courses), AGRO xxxx, GEOL xxxx, MATE xxxx (2 new courses), BIOL 4xxxx)

## Improvement in Quality of SMET Education (retention, graduation, applications to graduate studies, etc.)

SMET majors data appears in the table below. Unfortunately, at present, the PaSCoR counselor keeps PaSCoR courses registration data by enrollment numbers only (see Appendix- course data). Nonetheless, we have made a request to the UPRM Academic Affairs Office to provide course registration data by sex. To strive for diversity we make an effort to select students that represent the population (e.g., sex, department, college). For example, in the 2000 Summer Station session, 54% were women, and there was representation from various SMET departments. Overall, at UPRM 99% of students are Hispanic and 51% are women. More than 50% of the students at UPRM are first generation in their families to attend college, while 2/3 of the population receives financial assistance. Women in SMET programs at UPRM are well represented: 43% in engineering, 40% in agricultural sciences and 60% in science and mathematics.

SMET Majors Enrollment AY 1999-2000					
College/Department	Female		Male		Total
<b>Engineering</b>					
Civil	295	31%	642	69%	937
Electrical	215	26%	600	74%	815
Industrial	348	55%	280	45%	628
Mechanical	174	21%	674	79%	848
Chemical	447	61%	289	39%	736
Computer	147	29%	356	71%	503
<b>Total Engineering</b>	<b>2,136</b>	<b>43%</b>	<b>2,841</b>	<b>57%</b>	<b>4,977</b>
<b>Agricultural Sciences</b>	<b>Female</b>		<b>Male</b>		<b>Total</b>
AGGE	36	39%	56	61%	92
AGRO	72	31%	159	69%	231
ECAG	8	67%	4	33%	12
EDAG	18	45%	22	55%	40
EXAG	12	34%	23	66%	35
HORT	25	31%	55	69%	80
INPE	100	49%	103	51%	203
MEAG	16	15%	90	75%	106
PVET	49	63%	29	37%	78
PROC	15	71%	6	29%	21
AGNE	12	50%	12	50%	24
SUEL	18	46%	19	54%	39
<b>Total Agriculture</b>	<b>381</b>	<b>40%</b>	<b>578</b>	<b>60%</b>	<b>959</b>
<b>Science &amp; Mathematics</b>	<b>Female</b>		<b>Male</b>		<b>Total</b>
Biology	567	67%	324	33%	891
Chemistry	205	71%	85	29%	290
Math	31	27%	82	73%	113
Physics	20	28%	51	72%	71
Geology	62	52%	57	48%	119
<b>Total Science</b>	<b>885</b>	<b>60%</b>	<b>599</b>	<b>40%</b>	<b>1,484</b>

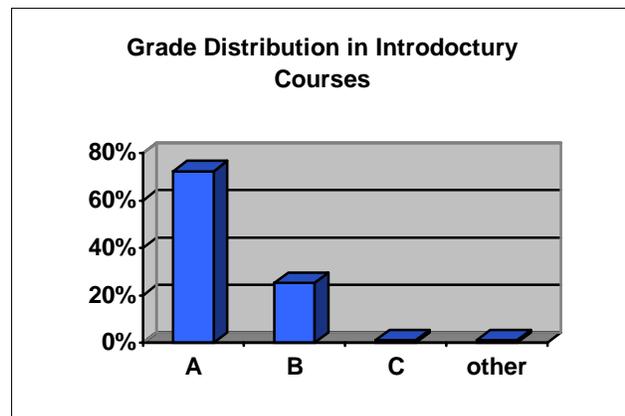
The Executive Committee has established guidelines for sponsoring students in undergraduate research. These include stipends & maximum number of hours dedicated to research, periodic reporting by faculty and end-of-semester research presentations.

<b>Student Stipends/Research Funding</b>			
Research Project	Semester	No. of Students	Avg. Funding per Student
Experiments in anisotropic diffusion <i>Prof. Robert Acar</i>	First 2000-2001	1	\$1158.75
Remote Sensing <i>Prof. Fernando Bird-Picó</i>	First 2000-2001	4	\$1158.75
Hyper-spectral Data Analysis Tool Box <i>Prof. Luis O. Jimenez</i>	First 2000-2001	5	\$1158.75
Highly erodible cans <i>Prof. Luis Olivieri</i>	First 2000-2001	6	\$1158.75
Algorithms in Image Processing and Compression <i>Prof. Hamed Parsiani</i>	First 2000-2001	4	\$1158.75
Genetic Algorithms <i>Prof. Ramón Vásquez</i>	First 2000-2001	4	\$1158.75
Land Use Land cover digital maps for El Yunque in 1995 <i>Prof. Linda Vélez</i>	First 2000-2001	4	\$1158.75

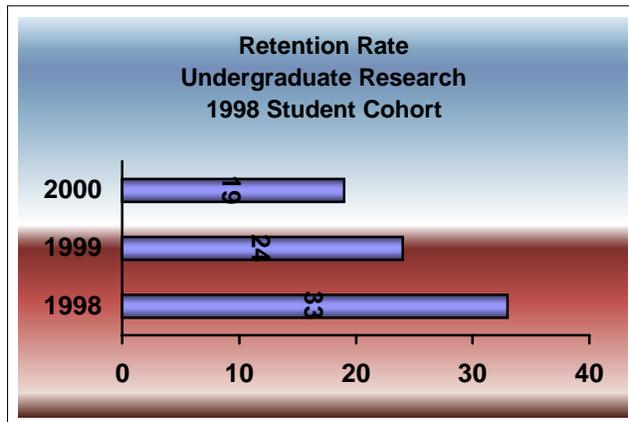
Student retention in this project is defined as the fraction of students who earn the RS/GIS certificate that were accepted in the program. There have yet to be granted RS/GIS certificates because the program is still in its developmental phases and not enough time has elapsed for any student to be able to complete all the requirements. Nevertheless, we hope to have at least one student earn the certificate this academic year.

The project has developed a student tracking system whereby all the students that are accepted in the program or are sponsored are tracked. Some of the variables tracked include: department, GPA, PaSCoR courses taken (and grades), stipends received and activities participated (e.g., Summer Station, summer internships), papers and presentations (See Appendix).

In order to encourage retention, we are doing several things. Students have a PaSCoR counselor (Ms. Josefita Gonzalez), who advises them on registration procedures, courses, etc. Both the PaSCoR coordinator (Ms. Yakaira Pérez) and the internship coordinator (Ms. Carmen Lugo) serve as an information and liaison to students, providing them with up-to-date information of opportunities available. In addition, we have adapted the University of Texas at El Paso Affinity Group Model, to integrate and mentor students in undergraduate research. Intermediate level students have Prof. Luis Olivieri as coordinator. He has the task to organize lectures and activities in order to initiate the match between student



and the mentor. Upper level students meet regularly with their research mentor. Professional and social activities such as the Summer Station, the PaSCoR Pizza night, Job FAIR, PaSCoR Fair and Student Recognition Day provide opportunities for all those involved in the project to meet and exchange ideas. This academic year we have begun to recognize excellence in student and faculty performance. Thus, a formal recognition award was carried during the December 2000 Advisory Board Meeting and PaSCoR Fair where 3 students and 1 faculty member were distinguished. The Deans and the Interim Chancellor presented the awards.



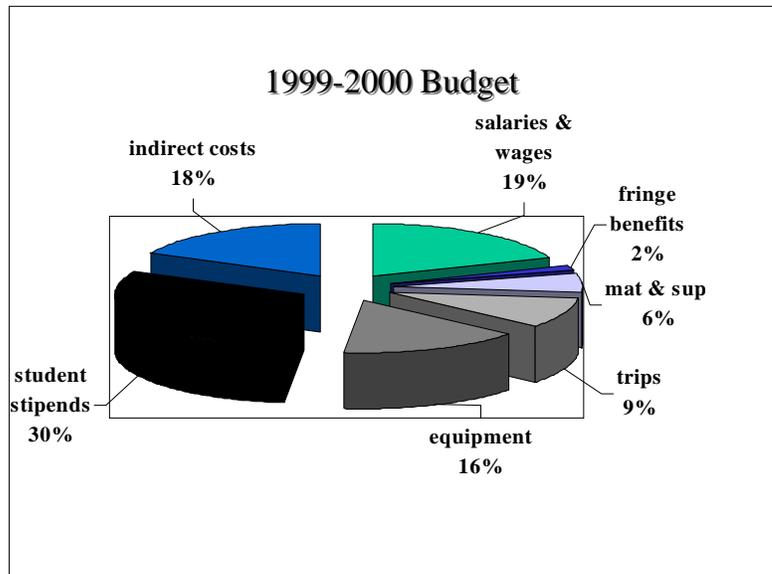
Retention data shows that the majority of PaSCoR students remain in the program. The following chart shows retention rate data for the first cohort of students (entering in 1998) in undergraduate research (those who received stipends). In year 1 of the project (1998-99), thirty-three (33) 3<sup>rd</sup> year students MSET majors were involved in undergraduate research in the project. Of those twenty-four (24) or 73% remained in year 2 of the project (1999-2000). Of the 24, 13 graduated in academic year 2000 (at least 4 or 12% went

on to graduate school) and 6 continued to their 4<sup>th</sup> year in undergraduate research (58% retention rate). Grade distribution in the two introductory courses (Remote sensing and its applications & Introduction to GIS) to date indicates 98.8% of students approved successfully the course. We believe that students and faculty are highly motivated and challenged, creating an extraordinary teaching /learning environment.

## RESOURCES

### *Execution of Budget (1 page)*

The project's total budget adequately supports the project implementation. Thus, during the first two years there have been no significant budget changes. In year one, start-up of the program was delayed due to Hurricane Georges. Consequently, student stipends were not spent entirely. Moneys were transferred to sponsor travel to faculty and summer interns as well as carry out a very successful high school outreach program. In addition, in year one, there were un-budgeted expenses that had to be covered (e.g., graduate students to assist faculty in course development and other related duties, like web-site development, as compensate the student counselor). These items have been budgeted henceforth.



As can be seen from the 1999 budget chart, other than personnel, student stipends and equipment have been the largest expenditures for the project (30% and 16% respectively). These budget expenditures have allowed creating and enhancing much needed laboratory facilities and sponsoring students in undergraduate research.

### *Use of institutional resources*

In addition to laboratory space, the University of Puerto Rico has committed resources for the execution of this project in terms of cash and faculty release time, as evidenced in the following table:

	Year 1	Year 2	Year 3	Year 4	Year 5	Total
NASA FUNDS	\$461,916	456,530	457,185	462,561	463,095	<b>\$2,301,287</b>
UPRM	64,492	66,185	67,931	69,729	71,581	<b>339,918</b>
UPR President	88,000	88,000	88,000	88,000	88,000	<b>440,000</b>
<b>Total</b>	<b>\$614,408</b>	<b>610,715</b>	<b>613,116</b>	<b>620,290</b>	<b>622,676</b>	<b>\$3,081,205</b>

Long-term evidence that illustrates the extent to which the project has been institutionalized:

1. New and revised courses towards the RS/GIS certificate in catalogue to date
2. Summer internships coordination by the College of Engineering COOP Office
3. MOU's for summer internships signed
4. Other RS/GIS research projects funds leveraged (e.g., CenSSIS).

The budget vs. actual for the project to-date has been as follows:

Line Item	Year 1 (1998-1999)		Year 2 (1999-2000)	
	Budget	Actual	Budget	Actual
Personnel	\$79,569	94,792	87,330	87,330
Benefits	7,320	7,796	8,034	8,034
Supplies	30,000	19,434	26,315	27,749
Travel	43,200	53,229	43,200	40,994
Equipment	48,705	53,495	71,190	71,180
Stipends	175,000	155,049	140,000	140,779
Indirect Costs	78,124	78,124	80,461	80,461

### NASA Budget Narrative by Line Item

- ❑ Personnel: PI and Co-PI earn 6.25% salary during the academic year and 2/9-summer salary. Senior personnel earn 6.25% salary during the academic year and 1/9 summer salary (except Luis Olivieri who is paid an additional 1/9 salary in the summer to coordinate intermediate level students in research). The professional counselor earns 15.65% of her yearly salary per year.
- ❑ Benefits: 9.2% of salaries
- ❑ Supplies
- ❑ Travel: for faculty (to present papers, supervise students in internships, and attend NASA PAIR meetings) and students (summer internships and present papers)
- ❑ Equipment: for enhancement of laboratories (GPS, computers, etc.)
- ❑ Stipends: student stipends for undergraduate research (\$2,317/10 months/student; \$618/8 summer weeks; summer internships- \$4,000/student)
- ❑ Indirect Costs: 48.8% of total direct costs

