

# Certificación Núm. 94

## Año Académico 2010-2011


Yo, VALERIE VÁZQUEZ RIVERA, Secretaria Temporera del Senado Académico del Recinto de Río Piedras, Universidad de Puerto Rico, CERTIFICO QUE:

**E**l Senado Académico en la reunión ordinaria celebrada el 24 de mayo de 2011, consideró el **Punto Núm. 8 – Preguntas en torno al Informe del Comité de Asuntos Académicos sobre la Propuesta para la Creación de un Departamento en Ciencias Ambientales de la Facultad de Ciencias Naturales**, y acordó:

- Aprobar la propuesta para la **Creación del Departamento de Ciencias Ambientales** de la **Facultad de Ciencias Naturales**.

**Y PARA QUE ASÍ CONSTE**, expido la presente Certificación bajo el sello de la Universidad de Puerto Rico, Recinto de Río Piedras, a los veinticinco días del mes de mayo del año dos mil once.

rema

  
Valerie Vázquez Rivera  
Secretaria Temporera



PROPOSAL FOR THE CREATION OF THE DEPARTMENT OF ENVIRONMENTAL SCIENCES  
COLLEGE OF NATURAL SCIENCES  
RIO PIEDRAS CAMPUS – UNIVERSITY OF PUERTO RICO



**APPROVED BY THE ENVIRONMENTAL SCIENCES PROGRAM – AUGUST 10, 2010**  
**APPROVED BY THE INSTITUTE OF TROPICAL ECOSYSTEM STUDIES – AUGUST 10, 2010**  
**APPROVED BY THE ACADEMIC AFFAIRS COMMITTEE – SEPTEMBER 17, 2010**  
**APPROVED BY THE COLLEGE OF NATURAL SCIENCES – NOVEMBER 12, 2010**  
**APPROVED BY THE ACADEMIC SENATE’S ACADEMIC AFFAIRS COMMITTEE – MAY 10, 2011**  
**APPROVED BY ACADEMIC SENATE – MAY 24, 2011**  
**(CERTIFICATION NUM. 94, 2010-2011)**

**REQUEST TO ESTABLISH A DEPARTMENT OF ENVIRONMENTAL SCIENCE AT  
THE UNIVERSITY OF PUERTO RICO RIO PIEDRAS CAMPUS**

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## INTRODUCTION

We request approval to establish the UPR-RP Department of Environmental Sciences (DES) beginning January, 2011, to include the undergraduate and graduate programs in Environmental Sciences currently housed in the College of Natural Sciences, and to merge human, academic, fiscal, and physical resources, as well as research and education infrastructure currently under the Institute for Tropical Ecosystem Studies (ITES) and the Environmental Science Program (ESP) into a single administration, the DES. Merger of the ESP academic programs and ITES into a single department will allow for better integration and more effective use of resources to support the undergraduate academic programs in ESP, and particularly the newly created ESP graduate program soon to be expanded to the doctoral level. Through this merger, ITES faculty will benefit tremendously from the recruitment of ESP students to their research initiatives and in their various student training programs. Likewise, the merger will allow for a better integration of ITES faculty into programs managed by the ESPs administrative structures. Increased links and academic and research collaborations among faculty currently affiliated with ESP and ITES are a major goal. The creation of the Department will help maintain an environment that promotes research -- a prerequisite to UPR-RP's achieving its goal of becoming a leading Doctoral Research University with very high research activity (Carnegie Commission on Higher Education Basic Classification).

Environmental issues at the global and regional scale are inherently complex and need highly qualified professionals for their solution. The missions of both the ESP and ITES include meeting the need for professionals that can tackle applied scientific problems related to a rapidly changing environment. The merger of these two units will provide a critical mass of human and physical resources to increase the breadth of academic and mentorship opportunities available to students of the ESP, to improve research and teaching in environmental and applied ecological sciences, and to achieve effective dissemination of solutions for society.

The ESP is characterized by growth and great potential for expansion. The ESP has served students well, but the need for expansion to a full-fledged department is clear, as demonstrated by:

- \* Current and projected increases in the number of students in the program (see Figure 1).
- \* Creation of MS (2009) and PhD (2010) Programs in Environmental Science at UPR-RP. Results of an internal evaluation of programs in 2007 (Appendix 1).
- \* Projected growth in the US in employment opportunities (Table 1).

At the national level, jobs for environmental scientists and specialists in the United States are expected to increase from 85,900 in 2008 to 109,800 in 2016, an increase of 28% (Lacey and Wright 2009).

**Table 1.** 2006-2016 Employment projections in Environmental Science from the National Employment Matrix.

<b>Occupational title</b>	<b>SOC Code</b>	<b>Employment, 2008</b>	<b>Projected employment, 2018</b>	<b>Change 2008-18 Number</b>	<b>Change 2008-18 Percent</b>
<b>Conservation scientists</b>	19-031	18,300	20,500	2,200	12
<b>Environmental scientists and specialists, including health</b>	19-2041	85,900	109,800	23,900	28
<b>Hydrologists</b>	19-2043	8,100	9,600	1,500	18

(from Lacey and Wright, 2009. (Employment Projections Program, U.S. Department of Labor, U.S. Bureau of Labor Statistics))

The creation of DES will support efforts at the College of Natural Sciences, The Río Piedras campus and the UPR system to meet the Environmental science needs of Puerto Rico and the mainland United States. A Department of Environmental Sciences will be able to:

- \* Improve the administration and development of the Environmental science programs.
- \* Support the soon to be approved Ph. D. Program in ESP.
- \* Serve more students.
- \* Expand and diversify course offerings.
- \* Attract more faculty engaged in cutting-edge research in Environmental Sciences.
- \* Increase the amount of research in environmental science.
- \* Meet the environmental science needs of Puerto Rico and the mainland U.S. more efficiently.
- \* Assist Puerto Rico in changing to an environmentally sustainable economy.
- \* Serve as a model for the University of Puerto Rico.

## **THE NEED FOR A DEPARTMENT OF ENVIRONMENTAL SCIENCE**

A Department of Environmental Science is timely for UPR-RP. Nationally many major universities have established Departments of Environmental Science in the last 20 years. The ESP at UPR has experienced a steady increase in student enrollment since its creation and is now one of the fastest growing undergraduate programs of CNS. The demand for expertise in this area in Puerto Rico and at UPR led to the creation of a graduate program in Environmental Science currently at the masters level and soon to be approved at the doctoral level. Since its incorporation into CNS in 1996, ITES has trained 263 students at the undergraduate and graduate levels from various academic programs (Biology, Environmental Science, Mathematics, Chemistry, Physics). **A department combining ESP and ITES will certainly strengthen teaching and research in environmental and applied ecological sciences by uniting the forces of these two units.**

The environment of the island of Puerto Rico faces unprecedented threats because land use change, economic globalization, and global climate change (López and Villanueva 2007). Environmental Science is key to addressing these issues. Since it is interdisciplinary by nature,

environmental science prepares students to integrate information from and to interact with a variety of disciplines. Today's students must be well versed in these issues to be a part of future solutions to our problems and university research must be integrative and multidisciplinary to arrive at these solutions. The combination of resources by ESP and ITES will support research and training in ESP in more effective ways.

Many positions are available in environmental science in Puerto Rico and nationally in government, business, academia, and other organizations. These range from environmental educators, to environmental analysts, waste disposal specialists, renewable energy specialists, natural resource managers, researchers, conservationists, and policy makers. A new corps of scientists will be needed to conduct research, develop new environmentally based enterprises, and provide an academic home base for the scientific experts who can advise industry and government. Because the Puerto Rico Department of Education has moved to include environmental education and training for teachers and students, the Island will need many more individuals with environmental expertise than it presently has. The Mainland U.S. need for Environmental Scientists parallels that of PR. Well prepared environmental scientists representing a variety of perspectives are essential to the intellectual, economic, and social health of the mainland U.S. If science, business, industry, academia, and the social structure are to thrive, all sectors of society must be represented among professionals. The need for bilingual (English-Spanish) scientists is also large. A visit to a job board for Hispanic and bilingual scientists revealed 125 job postings on a single day on just one job Web site (<http://sciencejobs.latpro.com/>), June 20, 2008). **The diversity of faculty and initiatives to be housed under DES will provide an excellent platform for the development of a more diverse and global scientific workforce in Puerto Rico.**

The current fiscal crisis of Puerto Rico also requires that resources be used as efficiently as possible. **The merger of ESP and ITES will optimize use of university resources by streamlining administration.**

Finally, if the University of Puerto Rico-Río Piedras is to achieve the University's objectives of elaborated in UPR-Río Piedras's Vision Universidad 2016 (UPR-RP 2006), it must expand the academic program in Environmental Science and prepare more individuals in the discipline. That expansion relies on the creation of a Department of Environmental Science. The University of Puerto Rico has acknowledged the academic importance of environmental science and the role it plays across disciplines by supporting the establishment of its graduate program. **An autonomous Environmental Science Program housed within a Department at the University of Puerto Rico-Río Piedras will be better prepared to respond to the need for environmental scientists and address educational and research demands that will necessarily accompany the expansion of its graduate and undergraduate programs.**

## **GOALS AND OBJECTIVES**

The goals of the Environmental Science program are aligned with those of the University of Puerto Rico in its pursuit of educational excellence, *making scientific knowledge available for the service of the general public*. The new Department of Environmental Science (DES) will meet Puerto Rico's and the Mainland U.S. need for professionals in Environmental Sciences and will support Puerto Rico's transition to an environmentally sustainable economy and way of life. It will accomplish these objectives by (1) assuming responsibility for offering bachelor's, MS, and PhD programs, (2) supporting the research efforts of faculty members of the College of Natural Science whose research and training activities address environmental science issues, and (3) attracting and supporting additional faculty members engaged in research in environmental science

The Department's specific objectives are four-fold:

1. To prepare undergraduate students for careers or graduate study in environmental science.
2. To prepare graduate students for appropriate careers in academia, industry, government, or other organizations.
3. To promote research in environmental science.
4. To contribute to the solution of environmental problems in Puerto Rico and beyond.

*To prepare students to pursue graduate study or careers in Environmental Science, the Environmental Science Department will:*

- Provide students with a foundation in the theoretical and applied principles of environmental science;
- Provide students a broad selection of electives;
- Provide students supplementary experiences/training at other academic institutions, government, industry, or other organizations;
- Provide students with broad access to research opportunities, and training in conducting research;
- Prepare graduates to use their environmental science not only to further their careers but also to be aware of the social costs and benefits of its use;
- Cultivate students' abilities to contribute effectively to the progress of science and technology; and
- Promote students' development of a responsible, ethical, and professional attitude toward work and colleagues.

*To prepare graduate students for appropriate careers in academia, industry, government, or other organizations, the Environmental Science Department will:*

- Provide students with a broad array of advanced training opportunities in courses and exchanges;
- Provide students with broad access to research opportunities in different sectors, training in conducting research, and opportunities to achieve professional productivity;
- Promote the development of ethical professional conduct; and
- Promote awareness of the social implications of their research and professional activities.

*To promote research in Environmental Science, the Department will:*

- Support current faculty members engaged in research;
- Recruit additional faculty;
- Develop a long term research plan; and
- Develop and submit proposals to implement that plan.

## **BENEFITS OF THE NEW DEPARTMENT**

We aim for a Department with a balance between undergraduate and graduate education. The new Department of Environmental Science will combine the mainly educational program of the ESP with the mainly research program of ITES. The combination will create a synergy for

education and research supported by a new, critical mass of faculty, support staff, and physical resources. The new unit will have strong research and teaching capacities in ecology, earth sciences (water, soil, and atmosphere), socio-ecology, urban ecology, habitat and species conservation, ecosystem and land-use management, and environmental education, in addition to the existing areas which include water management, geomorphology, urban systems, risk management, sustainability (energy and infrastructure), and other areas. Moreover, the merger will foster collaboration between basic and applied researchers, fulfilling the mutual goals of the heretofore separate units and helping achieve UPR's strategic goals in education, research, and public outreach.

Environmental science is broad and multidisciplinary, encompassing basic research and the development and application of solutions to real world problems. By its nature, environmental science requires connection to real world problems. Therefore, we seek a balance between basic and applied research. ITES will bring much capacity in basic research in ecology and environmental assessment to the academic programs (Appendix 2). This is particularly important to the recently created graduate program. Recruitment of additional faculty is already approved and will provide additional content breadth. To respond effectively to the changing needs of students and society, the graduate program will be restructured to be more interdisciplinary. Future interdisciplinary areas for growth include pollution control and remediation, the consequences of planning, law, and regulation; environmental chemistry, and environmental social science, economics, and geography.

At the undergraduate level, the Department will continue to provide basic courses in environmental science for all CNS undergraduates with additional faculty allowing for smaller and more interactive classes. Additional faculty will also allow for the diversification of courses, and an increase in mentors for research training. The development and management of academic programs will be shared by a larger community of peers allowing for the incorporation of diverse areas of expertise, teaching, as well as more effective administration of tasks inherent to running academic programs (college and campus level-committee service, reports etc.).

It is academically and organizationally difficult to provide bachelor's, MS, and PhD academic programs without a departmental framework. Therefore a new and independent department will better serve environmental science. The advantages of providing greater autonomy for the Environmental Science program are manifold. The proposed Department will benefit the College of Natural Sciences (CNS), the UPR, and Puerto Rico by:

- **Serving Puerto Rico better.** The Department is the only place in Puerto Rico for students to obtain both graduate and undergraduate degrees in the emerging and high-demand field of Environmental Science. Trained environmental scientists representing a variety of perspectives are essential to the intellectual, economic, and social health of the island.
- **Serving students better.** A full-fledged Department will permit the program to expand quickly to meet enrollment needs. It will attract and retain more students in environmental sciences and for ITES initiatives. It will strengthen the current environmental science undergraduate and graduate curricula by adding faculty mentors for academic and professional counseling, research supervision, new research themes, and more elective courses encompassing the major areas of environmental science. Students will have expanded opportunities for learning through research integrated into their education. A core of faculty members directly responsible to the Department will be better able to respond to changes in the field, and revise and add new courses in a timely manner. Academic advising of students will be shared by a greater number of faculty thus providing a better service to students in the undergraduate and graduate programs.
- **Creating a critical mass of environmental researchers by incorporating ITES faculty, and additional hires.** An expanded corpus of environmental science faculty is



essential for effectively guiding both the undergraduate and graduate programs in environmental science and to develop new research themes. Autonomy will increase the visibility of the program thereby attracting new faculty members engaged in high-quality teaching and research as well as high-caliber students. Desirable Environmental Science faculty members will seek autonomous programs because of tenure and promotion guidelines and issues, and programs with colleagues who understand the parameters of teaching, research, and service in the discipline.

- **Increasing research in environmental science.** An independent department will attract more environmental science faculty engaged in cutting-edge research. The new Department will assist Puerto Rico in resolving environmental issues, promote interaction among environmental scientists and ecologists, broaden spatial scales of environmental studies at UPR-R, and meet the environmental science needs of Puerto Rico and the mainland U.S. more efficiently and quickly. Students will be involved in a research culture from the bachelors through the PhD levels. This structure will help to develop collaborations with other resources in Puerto Rico and beyond.

- **Using resources more efficiently.** The creation of the department will streamline administration by combining two academic units (ESP and ITES), which follows the general policy of UPRRP of combining and reorganizing existing resources in order to maximize them and increase efficiency. It will increase human resources, laboratory space and equipment available for environmental science. It will promote interaction among environmental scientists and ecologists.

## THE ENVIRONMENTAL SCIENCES PROGRAM

**Current status.** The Environmental Sciences Program’s mission is to prepare scientists with broad knowledge of theory and techniques in environmental sciences for application towards the solution of problems resulting from the interaction of humans and the environment. Under the name of Environmental Management, the ESP began in 1976 as the first of its kind in Puerto Rico, awarding Bachelor’s degrees in the subject. In 1986, the name was changed to Environmental Sciences. Since that time, the number of undergraduates enrolled in the program has increased dramatically from 24 to 189 students in 2009-2010 (6% of total enrollment within the college). The Program has developed a strong curriculum in environmental science and many of the courses are taught by lecturers from outside the university, providing hands-on, practical training for the students. However, the assignment of only one tenure track faculty member limited student retention and growth of the program. From a UPR Office of Planning Report in 2004, 28% of the students were lost by their third year. This figure is slightly higher than the campus rate of 22% (average for cohorts from 2000-2004). The program recruited a new Director in August 2007 and the current full time and contract faculty include:

<b>Name</b>	<b>Area of Interest</b>
Rafael Rios Dávila, Director	Water resources for communities, analysis of the vulnerability of potable water systems, and the natural-human system in the urbanizing tropics.
José Molinelli	Geomorphology.
Loretta Roberson*	Impacts of anthropogenic factors on coastal marine communities, the ecology and evolution of RNA editing in eelgrass and algae, and marine biomechanics.
Daniel Díaz*	Geographic information systems and remote sensing.
Qiong Gao*	Multiscale ecosystem modeling, modeling of ecosystem adaptation

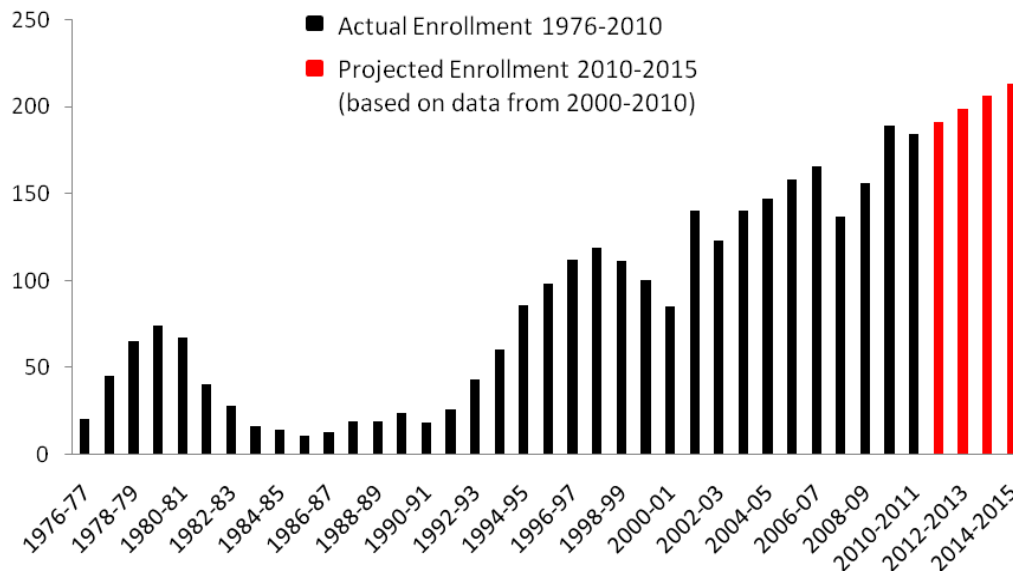
	to environmental changes, and coupling ecosystem processes with changes in anthropogenic activities such as land use changes.
Gary W. Gervais*	Anaerobic treatment of high strength industrial wastewaters, biofuels from algae, science and technology policy for economic development, and sustainable economic development.

\*contract faculty

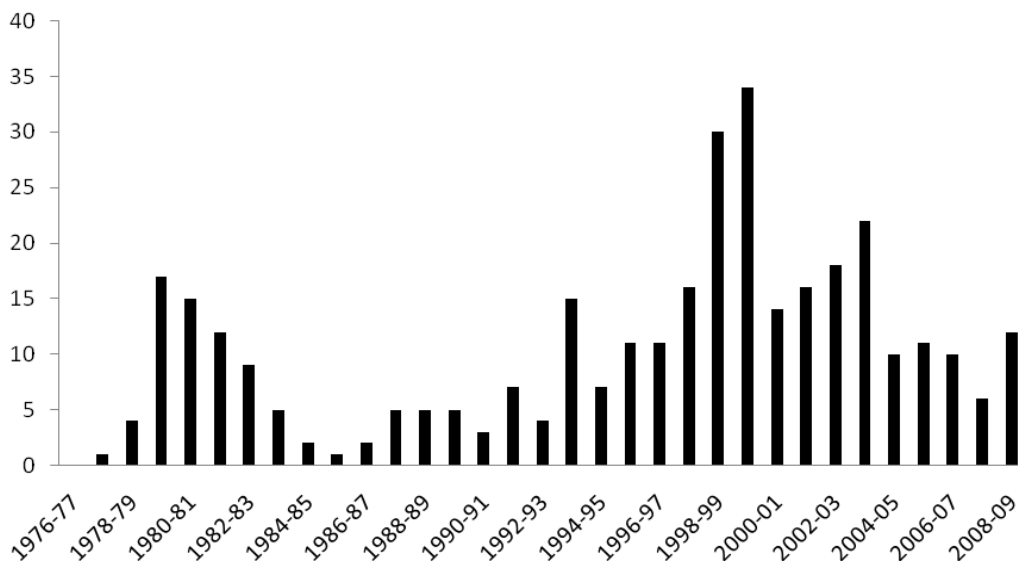
To date, the program has graduated over 350 students who have made significant contributions to academia, government, and industry.

However, a large gap exists between recruitment and retention in the undergraduate program. Figures 1 and 2 show the number of students majoring in environmental science and the number of BS degrees awarded since the beginning of the program. The disparity between recruitment and graduation can be attributed to the lack of mentors for the senior theses in the program, since until 2007 there was only one full time faculty member in the program. This, however is changing. One additional position has been advertised for the Program. The merger with ITES will add 8 additional faculty to serve as mentors for theses, academic and professional counseling, additional research themes, elective courses, and facilities to complete thesis requirements. Administrative staff have traditionally done academic advising for undergraduate students. With projected student recruitment increases at the undergraduate and graduate levels, incorporating ITES faculty will help meet the need for academic advisement.

**Figure 1. ESP Student Enrollment**



**Figure 2. ESP BS degrees awarded 1976-2009**



The Bachelor's curriculum was revised to be more flexible to meet the interests of individual students and was implemented in August 2009. This revised curriculum includes 33 credits of core science courses and 9 credits of optional science courses. There are in addition 13 credits of free electives. The Profile of the BS graduate in environmental science indicates that students should be trained to effect change, not just to be researchers. The undergraduate capstone experience, a culmination of the Bachelor's program in which students integrate the knowledge gained in their studies, was previously a small thesis based on a research project on an environmental problem in Puerto Rico. The options for this capstone experience have been expanded beyond a research thesis to include internships at other institutions, at government agencies, and industry where applied projects such as environmental impact statements can be conducted (Appendix 3).

The ESP and Miami Dade College (one of the nation's preeminent Hispanic-serving institutions) are collaborating to benefit Hispanic and other low-income students, the environment, and our nation's growing science, technology, engineering, and mathematics (STEM) workforce. These two institutions have obtained a US Department of Education Cooperative Arrangement Development Grant to implement a *Partnership for Undergraduate Education in the Natural Sciences for Transformational Engagement of STEM Students: PUENTES*. Project PUENTES will build both Miami Dade and UPRRP's capacity to educate Hispanic and other low-income students in environmental science. This two-year project has been funded for a total of \$2,346,030 (of which \$1,096,352 will go to the ESP for, among other things, a new environmental laboratory). The National Science Foundation has also awarded a grant for internships for environmental science and geography undergraduates in cooperation with the private and public sector (*An integrated internship, mentoring, and skill-building program promoting the geosciences at the University of Puerto Rico-Río Piedras: a track 1 initiative* (NSF grant no. 0914614). Thirteen public agencies, private businesses, and other institutions have formally agreed to work with us in offering these internships (Appendix 3) and we continue to forge new relationships through additional initiatives.

A new MS program in Environmental Science began in 2009 and the PhD program started in August 2010. The Environmental Science MS and PhD graduate programs focus on the

sustainable development of tropical regions and the environmental problems of tropical islands. There are three areas of emphasis: (1) management of environmental resources, (2) mathematical modeling and remote sensing and spatial analysis, (3) and interdisciplinary approaches. An Integrative Graduate Education, and Research, and Traineeship Program (IGERT) grant from the National Sciences Foundation (*Natural-Human Systems in the Urbanizing Tropics*, NSF grant no. 0801577, \$2,960,067 over 5 years) has been awarded to the ESP for fellowships to train Ph.D. students in interdisciplinary and collaborative approaches to environmental problems in the urbanizing, tropical landscapes. Public agencies, businesses, and non profits are collaborating with real-world problem solving and research topics for ESP graduate students (Appendix 3).

Projects relevant to the community are emphasized in the ESP. The students are exposed to the environmental problems faced by communities and work in teams to propose solutions to these problems. A current example of this type of work is the development of a solid waste management plan for the urban area of Río Piedras, in which students worked closely with the community/UPRRP organization CAUCE (*Centro de Acción Urbana Comunitaria y Empresarial de Río Piedras*). Further work includes management of the quality of the local water supply and drinking water supply problems in rural communities. This community work requires an interdisciplinary collaboration with the School of Public Health of the Medical Sciences Campus. See Appendix 4 for a list of senior thesis topics from 2005-2010.

In order to function, these expanding undergraduate and graduate programs need appropriate facilities. Current laboratory space and equipment inventory at ESP are inadequate to support the activities of the Environmental Science Undergraduate Program (Appendix 5 and 6) let alone the new Graduate Program. The incorporation of ITES laboratory space and equipment from eight faculty will support the projected growth in environmental science (Appendix 7 and 8). The ESP is also developing a Memorandum of Understanding with the UPR-Mayagüez San Juan Agricultural Experimental Station to expand the number of faculty and lab resources available to environmental students. All new ESP initiatives will benefit from the incorporation of new faculty members.

## **SUMMARY OF ACCOMPLISHMENTS**

The Environmental Science program has achieved the following since its creation:

- A Bachelor's program in Environmental Science was established in 1976;
- Five new positions in Environmental Science have been approved;
- Established research programs in technical assistance for small water systems, vulnerability analysis and emergency response for small water systems, modeling of ecosystem adaptation to environmental changes, and environmental impacts on coastal communities;
- 350 students have graduated from the Environmental Science program;
- 2,669 students have declared ES as a major; and
- Students have participated in internships and research experiences in Puerto Rico and abroad, including University of Hawaii, Harvard University, Rocky Mountain Biological Lab, University of Vermont, Oregon State University, University of Minnesota, Bermuda Institute of Ocean Sciences, University of Pennsylvania, NASA's Marshall Space Flight Center, University of Alabama, Western Washington University, University of Montana, and the University of North Carolina.

## THE INSTITUTE FOR TROPICAL ECOSYSTEM STUDIES

**History.** The Institute for Tropical Ecosystem Studies (ITES) is a research institute that operates as a departmental unit and since 1996 has been part of the Faculty of Natural Sciences of UPR-RP. ITES was established as a research unit in 1957 by the US Atomic Energy Commission and has gone through several stages of development. In 2007, ITES celebrated 50 years of research history and is one of the most active research centers of the Río Piedras Campus. ITES has seven tenured faculty members and an eighth one in a tenure track position.

**Current Status.** The ITES mission is to serve as a world center for advanced research and education in tropical ecosystem ecology and management. ITES meets this mission through long-term experimental and reference studies of tropical ecosystems, emphasizing the application of knowledge gained to the management and restoration of tropical ecosystems (ITES 2005). Since 1989, ITES has overseen the NSF-funded Luquillo Long Term Ecological Research Program (LTER) at El Yunque National Forest (<http://luq.lternet.edu/>) which studies multiple dimensions of tropical forest function and recovery and involves scientists from 11 institutions in Puerto Rico and the mainland US. ITES has managed the Luquillo LTER program with matching funds from UPR that support the core ITES administrative infrastructure.

The ITES strategic plan aims to expand involvement in undergraduate and graduate education in the ESP, and to promote directly related interdisciplinary research themes, including urban ecology, human-natural system interactions, sustainability, and restoration of degraded systems (ITES 2005). The various ITES funded research, education, and outreach projects that will strengthen the DES are outlined in Appendix 9. Current research areas include urban stream ecology (A. Ramírez and J. Ortiz), landscape ecology (M. Yu), biogeochemistry and soil ecology (X. Zou), atmospheric chemistry of aerosols and clouds (O. L. Mayol-Bracero), forest response to disturbance and land use change (J. Zimmerman), forest conservation (N. Brokaw), and applied ecology and conservation (E. Meléndez-Ackerman). Climate and land use are changing, resulting in potential compromise of vital ecosystem services. In response to these changes and in accord with its recent strategic plan (ITES 2005), ITES is expanding its scope to evaluate ecosystem processes associated with human impacts and increasing ongoing environmental monitoring. ITES is also building up its network of environmental sociologists, economists, and anthropologists on and off the island to strengthen the social dimensions of its core ecological research (J. Zimmerman). These research areas are integral to environmental science issues at the local, regional and global scales.

ITES does not have its own curriculum or graduate program but its faculty teach undergraduate and graduate courses in the Departments of Biology and Chemistry and the ESP, and supervise students in the graduate programs of the Departments of Biology and Chemistry (Fig. 3). After incorporation into the DES, ITES faculty will continue to participate in these graduate programs. Since 2003, ITES faculty have supervised at least 32 ESP undergraduate research projects (Appendix 10). ITES also runs or is key to four externally-funded undergraduate research training programs, two graduate training programs, and three outreach programs (Appendix 69). Both the LTER and ITES are increasing outreach efforts in order to disseminate scientific information and opportunities to a variety of audiences. ITES also manages the EL Verde Field Station, the main site for the Luquillo LTER, and a major asset for environmental science research. The station promises to be a valuable asset for DES; the Station Master Plan seeks tighter linkages with undergraduate and graduate education at UPR, including the DES (ITES 2009).

Number of sponsored students and postdocs – ITES  
1996-2010

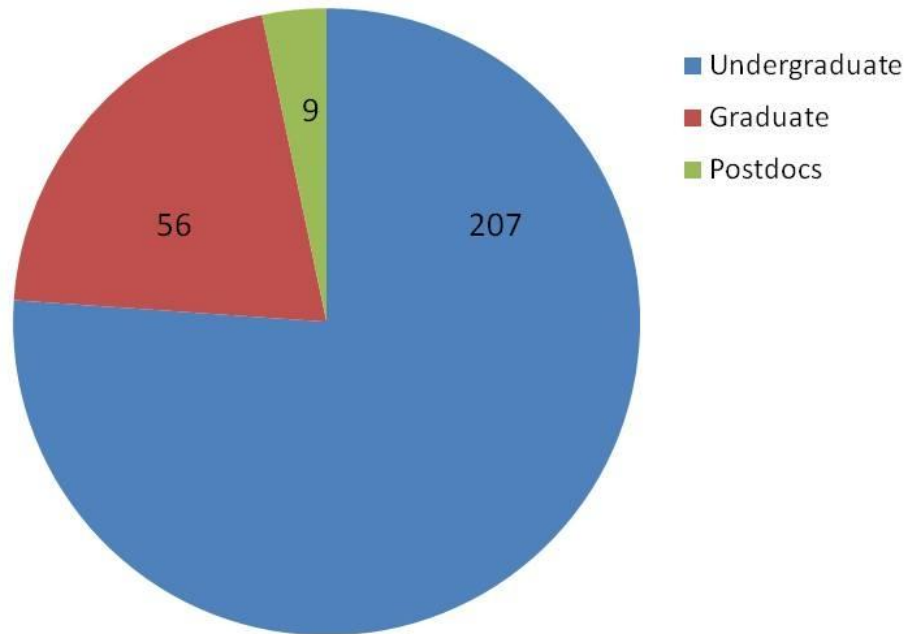


Figure 3. Number of ITES-sponsored students and postdocs (1996-2010).

## **THE PROPOSED DEPARTMENT OF ENVIRONMENTAL SCIENCE**

### **Administrative Structure of the Department of Environmental Sciences**

The Department of Environmental Science will be a part of the College of Natural Sciences in the same way as the existing departments of Biology, Chemistry, Mathematics, Computer Science, and Physics. It will be governed and will operate according to the existing policies and procedures of the College of Natural Sciences. In the College of Natural Sciences, department and program directors report directly to the Dean, as will the Director of the proposed Department of Environmental Science.

### **Mechanics of the Merger**

The incorporation of ITES into the Department of Environmental Science can be achieved directly since the administrative structures of each have relatively distinct functions. With integration, the ITES administrative unit becomes the LTER Program Office which maintains fiscal autonomy and current institutional monetary commitments to focus on administering the LTER and maintaining the El Verde Field Station where much of the LTER research takes place. Most of the current ITES staff is supported by the LTER grant, and these positions are necessary to maintain LTER research programs and the El Verde Station. The LTER PI will head this unit which will be placed under the Director of the DES, creating a single administrative unit. The executive secretary of ITES will become the DES director executive

secretary, which will now support DES academic programs and to a minor extent ongoing and new research grants.

Integration of the ITES professors into the DES can be implemented upon an annual performance evaluation. ITES faculty will maintain its nine credit release time for research for a period of three years to ensure that ongoing commitments are met. Thereafter, release time for research and other activities will be determined by departmental guidelines to be set following the formation of DES. The faculty of the new department would guide the undergraduate curriculum, implement the new graduate program, create mechanisms to evaluate faculty and staff, etc. Several ITES faculty already teach in ESP (see Appendix 1). ITES faculty have identified courses that they can teach in the undergraduate and graduate ESP programs (Tables 2 and 3). The ITES strategic and faculty evaluation plans can be easily incorporated into the new department's strategic plan and guidelines. Recruitment of new faculty underway within ESP will complement the strengths of current faculty.

The proposed department will grow with the addition of new faculty, new grants, new research direction, new programs, and new students. This growth will necessarily lead to changes in the department's strategic plans, to reevaluation of administrative and academic structures, and perhaps to changes in the administrative structure. ITES professors will continue to advise biology and chemistry graduate students and to teach courses in these departments.

## **ACADEMIC PROGRAMS**

The Environmental Science program offers a BS and MS, and soon a PhD to meet the needs of Puerto Rico for well trained professionals and researchers in the environmental sciences.

In keeping with the UPR-RP's emphasis on preparing students for graduate study, the faculty members responsible for the Environmental Science program offer a rigorous curriculum. The Environmental Science undergraduate curriculum consists of 60 credit hours of courses, 27 credits of which are in directed electives; the MS program consists of 38 credit hours, and the PhD program consists of 60 credit hours. Faculty members in the ESP and ITES have also worked with faculty and staff members at other institutions, both academic and commercial, to provide Environmental Science students academic exchange and internship opportunities. In recent years Environmental Science students have studied for a semester or academic year at such places as USGS, DNER, Conservation Trust, and had internships at numerous universities (see list above in ESP accomplishments)

Students majoring in Environmental Science are admitted and retained in the program in keeping with the policies and procedures of the College of Natural Sciences. Those policies and procedures for admission and retention will remain in place. The Environmental Science program has had no difficulties in recruiting students into the program. In fact, until new faculty positions in Environmental Science are approved, a major concern of the program is the ability to serve an increased number of students.

To assess the progress of the new Department and assure that it meets its goals, the Department will establish an Advisory Committee made up of four to five Environmental Science experts from well-established and recognized Environmental Science programs or professional agencies. The members of the Advisory Committee will serve as consultants to the program for five years following its creation. They will meet with the UPR-RP Department of Environmental Science director and the Dean of the College of Natural Sciences once a year. Prior to the first meeting, each member of the Advisory Committee will be sent information about the Environmental Science program, including the curriculum, profiles of current students and graduates, grant applications and awards, and fiscal, physical, and human resources. In the

first year, the focus of their work will be the launching of the department, with priority given to expanding the faculty.

## **RESEARCH PROGRAM**

The faculty members of the DES will stay current in the field and promote and support the Environmental Science program with outside funds (Appendix 11). In the DES, proposal submission, publications, grant awards, other activities will be encouraged. The prospective DES faculty members from ITES have strong records in publications and external funding, proven research capabilities, well-developed research programs with undergraduate and graduate students, and are actively extending their research programs into new areas especially relevant to environmental science. These new areas include interdisciplinary research on urban and human-natural systems.

## **SERVICE PROGRAM**

The ESP offers environmental science courses that are open to all students in the College of Natural Sciences. CIAM 3005 is offered for undergraduates in the Interdisciplinary Science Program. ITES faculty have numerous programs serving the campus and the larger public (Appendix 9). Additional faculty members and students will enhance the Environmental Science program's ability to serve the campus and the general public.

## **HUMAN RESOURCES**

**Teaching personnel.** Faculty at ITES, and ESP, and other departments at UPR-RP have the relevant training, experience, and interest to teach courses and supervise research at the undergraduate and graduate levels in Environmental Science. See Appendix 12 for the table of over 60 professors at UPR-RP and beyond who have agreed to participate in the Environmental Science undergraduate or graduate programs, with their PhD institutions, specializations, and current research indicated. As can be seen in the tables in the next section, and in Appendix 1 on courses currently taught in ESP by ITES faculty, the professors of ITES figure strongly in the undergraduate and graduate course offerings.

In the short term, current faculty members who teach Environmental Science courses, adjuncts who have offered courses in the past, will be able to offer the full range of required courses and directed electives. In addition, faculty members who have the qualifications and interest in participating in Environmental Science may be considered for a joint appointment.

The plan to hire new faculty members depends heavily on the creation of a department, primarily because faculty members seek positions with programs that are able to direct the curriculum and budget and provide oversight of tenure and promotion. UPR-RP administrators have recently approved 5 new positions for Environmental Science because they realized the positions are essential to UPR-RP's role in supporting Puerto Rico's increasing need for environmental science research capability. As per the existing recruitment plan, it is expected that 2 faculty members will be recruited for the 2010-2011 academic year and 3 for subsequent year. With the merger and new hires, by the fall of 2011 the department will have at least 10 full time tenured or tenure-track faculty members. Visiting faculty members and/or adjuncts will be hired on a semester or academic year basis, in keeping with existing policies.

**Non-teaching personnel.** Appendix 13 details the non-teaching staff of the ESP and ITES and their respective duties. The ESP has 2 administrative personnel and ITES has 2.5 non-teaching personnel covered by institutional funds. ITES also has 7 full or part-time staff at the Rio Piedras Campus, and 4.5 staff at the El Verde Field Station who are paid from LTER funds. In addition, ITES has 2 staff paid from other external grants. Staff paid from LTER funds are



essential to the success of the LTER research program, and will be segregated into an ITES LTER Office upon the merger. The El Verde staff are critical to the operation of the field station and will remain assigned there. Duties of the administrative personnel in ESP will be re-written in accordance with the needs of the new department and ES graduate program.

### **COURSES AND FACULTY AVAILABLE TO TEACH**

Table 2 in this section indicates the faculty who are available to teach the required courses and directed electives for Environmental Science undergraduate students, assuming that the required courses from other colleges and departments will be offered according to the schedule maintained in the past, including those in the Biology, Chemistry, Physics, and Mathematics Departments. Table 3 indicates the faculty who are available to teach the required courses and directed electives for Environmental Science graduate students. ITES faculty are well qualified to teach many of these courses and incorporating these professors into the department will greatly strengthen the internal teaching capacity.

As new faculty members are hired, more sections of existing courses will be offered to accommodate additional students. In addition, it is expected that new courses will be developed at both the undergraduate and graduate levels.

ITES faculty currently have commitments to teaching in the Departments of Biology and Chemistry. The new Department of Environmental Sciences will be able to maintain these commitments for the foreseeable future. Nevertheless, it is recognized that teaching of certain courses (e.g., BIOL 3011) and content common to the Department of Environmental Sciences and other departments will require regular consultation among departments to avoid duplication of effort and ensure that all courses are covered by available faculty. As a minimum, we propose that the directors and other relevant personnel of the collaborating departments meet each year to agree to a two-year teaching plan to ensure close coordination of common courses and content.

**Table 2. Projected undergraduate course offerings and professors who can teach them**

<b>Course</b>	<b>Course Name</b>	<b>Credits</b>	<b>ITES professors</b>	<b>Other professors</b>
<b>FIRST SEMESTER</b>				
CINA 3005*	Introduction to Environmental Sciences	3	NV Brokaw, OL Mayol-Bracero, E Melendez-Ackerman, J Ortiz, A Ramirez, M Yu, JK Zimmerman, X Zou	J Molinelli, R Rios
CINA 3126	Populations, Resources and the Environment	2	NV Brokaw (PART), J Ortiz, A Ramirez (PART)	Nancy Villanueva (UPR Bayamon)
CINA 3127	Natural Resource Economics			J Vogel (Economics)
CINA 3128*	Planning and Regulation of Natural Resources	2		J Martinez (contract)
CINA 4071*	Seminar in Environmental Sciences	1	NV Brokaw, OL Mayol Bracero, J Ortiz, A Ramirez, X Zou	L Roberson (contract), G Gervais (contract)
CINA 4167	Land use and Management	2		J Molinelli
CINA 4995	GIS I	3	M Yu	D Diaz (contract), Q Gao (contract)
CINA 4995	Environmental Emergency Management	3		J Ramos (OPASO)
CINA 4995	Solid Waste Management	3		R Rios, G Gervais (contract)
CINA 4995	Geographic Information Systems II	3	M Yu	D Diaz (contract), Q Gao (contract)
CINA 4995	Remote Sensing	3		Q Gao (contract), D Diaz (contract)
CINA 4995	Marine Resources	3		L Roberson (contract)
CINA 4997	Research in Env. Sci.*	3	NV Brokaw, OL Mayol-Bracero, E Melendez-Ackerman, J Ortiz, A Ramirez, M Yu, JK Zimmerman, X Zou	Coordinator: R Rios
BIOL 3110	Ecology of Puerto Rico	3	E Melendez-Ackerman, J Ortiz, JK Zimmerman	R Joglar (Biology)
<b>Course</b>	<b>Course Name</b>	<b>Credits</b>	<b>ITES professors</b>	<b>Other professors</b>

**SECOND SEMESTER**

BIOL 3111*	Ecology	3	NV Brokaw, E Melendez-Ackerman, J Ortiz, A Ramirez, M Yu, JK Zimmerman, X Zou	Q Gao (contract)
BIOL 3112*	Ecology Lab		NV Brokaw, E Melendez-Ackerman, J Ortiz, A Ramirez, M Yu, JK Zimmerman, X Zou	Q Gao (contract)
FISI 3017	Production of Energy, its Technology, and the Environment	3		G Morell (Physics)
QUIM 3025	Analytical Chemistry	4	OL Mayol-Bracero	Chemistry
<b>SECOND SEMESTER</b>				
CINA 3005*	Introduction to Environmental Sciences	3	NV Brokaw, OL Mayol-Bracero, E Melendez-Ackerman, J Ortiz, A Ramirez, M Yu, JK Zimmerman, X Zou	
CINA 3126	Populations, Resources and Environment	2	NV Brokaw (PART), J Ortiz, A Ramirez (PART)	
CINA 4072*	Seminar in Environmental Sciences	1	NV Brokaw, OL Mayol Bracero, J Ortiz, A Ramirez, X Zou	
CINA 4127*	Techniques for Environmental Management and Protection	2	OL Mayol Bracero, E Melendez- Ackerman, J Ortiz	L Roberson (contract) G Gervais (contract)
CINA 4147*	Physical Geology	3		J Molinelli
CINA 4157*	Water Resources	3	J Ortiz, A Ramirez	
CINA 4177*	Air Resources	2	OL Mayol Bracero	
CINA 4995	Geographic Information Systems I	3	M Yu	Q Gao (contract)

<b>Course</b>	<b>Course Name</b>	<b>Credits</b>	<b>ITES professors</b>	<b>Other professors</b>
<b>SECOND SEMESTER</b>				

CINA 4995	The Environment: Integration of Human and Scientific Aspects	3	NV Brokaw, OL Mayol Bracero, E Melendez-Ackerman, J Ortiz, A Ramirez, M Yu, JK Zimmerman, X Zou	
CINA 4995	Environmental Regulations and Permits	3		J Ramos (OPASO)
CINA 4995	Environmental Emergency Management	3		J Ramos (OPASO)
CINA 4995	Remote Sensing	3		D Diaz (contract), Q Gao (contract)
CINA 4997	Research in Env. Sci.	3	NV Brokaw, OL Mayol-Bracero, E Melendez-Ackerman, J Ortiz, A Ramirez, M Yu, JK Zimmerman, X Zou	Coordinator: R Rios
BIOL 3110	Ecology of Puerto Rico	3	E Melendez-Ackerman, J Ortiz, JK Zimmerman	R Joglar (Biology)
BIOL 3111	Ecology		NV Brokaw, E Melendez-Ackerman, J Ortiz, A Ramirez, M Yu, JK Zimmerman, X Zou	Q Gao (contract)
BIOL 3112	Ecology Lab	3	NV Brokaw, E Melendez-Ackerman, J Ortiz, A Ramirez, M Yu, JK Zimmerman, X Zou	Q Gao (contract)
FISI 3017	Energy Production, Technology, and the Environment	3		G Morell (Physics)
QUIM 3025	Analytical Chemistry	4	OL Mayol Bracero	
ECON XXXX*	Introduction to Economics	3		Economics Department
CIAM 3XXX <sup>1</sup>	Introduction to Renewable Energy	3		G Gervais (contract), G Morell (Physics)
CIAM 4XXX <sup>1</sup>	Wastewater treatment	3		R Rios, G Gervais (contract)
CIAM 4995 <sup>1</sup>	Solid waste management	3		R Rios, G Gervais (contract)
CIAM 4XXX <sup>1</sup>	Water supply and treatment	3		R Rios
CIAM 4XXX <sup>1</sup>	Environmental Microbiology	3		G Gervais (contract)

\* Required courses for the major in Environmental Sciences. <sup>1</sup> Proposed courses.

**Table 3. Projected graduate course offerings and professors who can teach them.**

Course	Course Name	Credits	ITES professors IGERT Courses	Other professors
C1	Human Dimensions of Environmental Change	2	J Ortiz*, A Ramirez*, JK Zimmerman	
C2	Urban Environment, Expansion, and Design	2	A Ramirez*, JK Zimmerman	
C3	Ecosystem Services and Ecological Economics	2	E Melendez-Ackerman*, J Ortiz*, A Ramirez*, M Yu*, JK Zimmerman	
C4	Policy and Ethics for the Environment	2		
C5	Socio-Ecological Models and Ecological Informatics	2	M Yu*	
C6	Communication on the Environment	2	E Melendez-Ackerman*	
<b>Other Graduate Courses</b>				
CIAM 6115	Terrestrial Environment	3	E Melendez-Ackerman*, JK Zimmerman, X Zou	TM Aide (Biology)
CIAM 6116*	Tropical Ecosystems	3	NV Brokaw*, J Ortiz*, A Ramirez*, JK Zimmerman, X Zou	
CIAM 6117	Coastal Environment	3		L Roberson* (contract), V Vicente (contract)
CIAM 6118	Urban Environment	3	A Ramirez*, JK Zimmerman	
CIAM 6235	Remote Sensing	3		M Barreto*(Geography), Q Gao* (contract)
CIAM 6256	Statistical Methods for Environmental Systems	3	A Ramirez*, JK Zimmerman	Q Gao* (contract), ME Pérez*(Math), L Pericchi (Math)
CIAM 8205	Modeling and Spatial Analysis Seminar I	2	M Yu*	Q Gao* (contract), C Restrepo* (Biology)

<b>Course</b>	<b>Course Name</b>	<b>Credits</b>	<b>ITES professors</b>	<b>Other professors</b>
CIAM 8206	Modeling and Spatial Analysis Seminar II	2	M Yu*	Q Gao* (contract), C Restrepo* (Biology)
CIAM 8225	Spatial Analysis Methods	3	M Yu*	Q Gao* (contract),
CIAM 8236	Remote Sensing II	3		M Barreto*(Geography), Q Gao* (contract),
CIAM 8257	Techniques for Building Environmental Models	3		M Marcano (Comp. Sci.), ME Eglee*(Math), L Pericchi*(Math)
CIAM 8345	Landscape Ecology in Islands and Tropical Regions	3	NV Brokaw (Part) M Yu* (Part)	C Restrepo* (Biology)
CIAM 8405	Topics on Sustainable Management in Tropical Islands I	2	J Ortiz*, A Ramirez*	
CIAM 8406	Topics on Sustainable Management in Tropical Islands II	2	J Ortiz*, A Ramirez	
CIAM 8545	Environmental Noise	3		equivalent course in Architecture
CIAM 8765	Environmental Impact Assessment	3	J Ortiz	D Roman* (DECEP)
CIAM 8775	Management and Disposal of Residues	3		R Rios, G Gervais*(contract)
CIAM 8785	Energy Generation	3		G Morell (Physics), E Resto* (Physical Sciences), G Gervais*(contract)

<b>Course</b>	<b>Course Name</b>	<b>Credits</b>	<b>ITES professors</b>	<b>Other professors</b>
CIAM 8845	Natural Dangers in Islands and Tropical Regions	3	J Ortiz*	R Rios
CIAM 8901	Graduate Seminar I	1	NV Brokaw*(PART), OL Mayol- Bracero, J Ortiz*, A Ramirez*, JK Zimmerman, X Zou	
CIAM 8902	Graduate Seminar II	1	OL Mayol-Bracero, J Ortiz*, A Ramirez*, JK Zimmerman, X Zou	
CIAM 8990	Special Topics in Environmental Sciences	1-3	NV Brokaw*, OL Mayol- Bracero*, E Melendez- Ackerman*, J Ortiz*, A Ramirez*, M Yu*, JK Zimmerman, X Zou	

\* Available professors added to the list after the approval of the Environmental Sciences Graduate Program by the Academic Senate in 2003. All faculty not on the original list approved by the UPR-RP Academic Senate will be evaluated for inclusion in the Graduate Program by the Environmental Sciences Graduate Affairs Committee (see Section). Potential adjuncts to the program from outside of the UPR-RP College of Natural Sciences will be evaluated for inclusion as per Certification 024 1996-1997 of the Board of Trustees.

## FISCAL RESOURCES

The University of Puerto Rico System and the University of Puerto Rico-Río Piedras Campus have approved five new positions in Environmental Science, 2 of which will be hired in 2010. The attached budgets reflect institutional funds for operating expenses provided for academic year 2009-2010 and the projection for 2010-2011 for the ESP (Table 4) and ITES (Table 5). External funds will support research and provide indirect cost funds.

**Table 4. Fiscal resources of the Environmental Sciences Program.**

	<b>2009-2010 Institutional Funds</b>
<b>Faculty salaries, contracts, compensations, and bonuses*</b>	\$295,085
Director and other faculty salaries, contracts, compensations, and bonuses	
<b>Non-teaching staff</b>	\$88,765
Administrative Assistant IV, Administrative Secretary III	
Student workers	
Graduate student Research and Teaching Assistantships	
	\$383,850
<b>Salary Total</b>	
<b>Fringe Benefits</b>	\$116,087
<p>This includes the employer's contribution to Social Security, Medicare, "Fondo de Seguro del Estado", Unemployment Insurance, and Retirement (for an estimated 24.20% of the total salaries) for 7 employees. It also includes the Christmas Bonus, the employer's contribution to Medical Insurance, and 9.2% of the compensations for teaching personnel from outside of the College.</p>	
<b>Materials</b>	\$13,850
<b>Equipment maintenance</b>	\$2,000
<b>Office expenses</b>	\$150
<b>GRAND TOTAL</b>	<b>\$515,937</b>

\* Salary and benefits of other Faculty and non-teaching personnel are paid by USDE PUENTES funds.



**Table 5. Fiscal Resources of the Institute for Tropical Ecosystem Studies.**

	<b>2009-2010</b>
	<b>Institutional Funds</b>
<b>Faculty salaries, contracts, compensations, and bonuses*</b>	
Director and 7 professors	\$615,286
<b>Non-teaching staff*</b>	
Executive Secretary I, Custodian, El Verde Administrator (1/2 salary)	\$79,604
Student workers	
Graduate student Research and Teaching Assistantships	
<b>Salary Total</b>	
<b>Fringe Benefits</b>	
This includes the employer's contribution to Social Security, Medicare, "Fondo de Seguro del Estado", Unemployment Insurance, and Retirement (for an estimated 24.20% of the total salaries) for 7 employees. It also includes the Christmas Bonus, the employer's contribution to Medical Insurance, and 9.2% of the compensations for teaching personnel from outside of the College.	\$239,055
<b>Materials</b>	\$15,000
<b>Equipment maintenance</b>	\$2,000
<b>GRAND TOTAL</b>	<b>\$950,945</b>

\*Salary and benefits of additional ITES personnel are paid by LTER funds and related matching. These personnel will remain associated with an LTER office or with the El Verde Research Station as elements critical to the successful operation of the LTER program.

### **PHYSICAL RESOURCES**

Space assigned to the ESP is listed in Appendix 5 and to ITES in Appendix 7. See Appendix 6 for the equipment owned by the ESP, and Appendix 8 for the equipment of ITES. Most of the ITES equipment was purchased with LTER funds, but will be more broadly accessible to the ESP faculty and students for research.

### **ACADEMIC RESOURCES**

Resources in the Natural Science Library for Environmental Sciences are given in Appendix 14.

## **IMPACT ON OTHER CNS PROGRAMS**

Faculty members and administrators have discussed at some length the various issues raised by creating a Department of Environmental Science, including budget/funding, coverage of courses, particularly those in the newly established PhD in Environmental Science, and mentoring of graduate students. The budget of the ESP will be changed by incorporating the institutional elements from ITES into the DES as one administrative unit. The creation of a Department of Environmental Science will have minimal, if any, effect on the budgets of other CNS departments. As mentioned previously, course offerings will be coordinated with other departments in the College to ensure regular offerings of common courses and continuity in content. To minimize impacts on mentoring capabilities, there is an existing plan to add a total of 5 faculty to the Environmental Sciences Program in the next 2 years. Additionally, all faculty will be available to mentor students from other programs.

**Administration of the new department.** The DES will be distinct and independent from other CNS departments, and all future collaborations with regard to adjunct appointments and collaborations in offering academic programs will be undertaken in accordance with university guidelines and regulations (Appendix 15).

## **CONCLUSION**

Puerto Rico, the mainland United States, and the entire industrialized world face an acute shortage of individuals with expertise in environmental science. It is clear that a dramatic need for people with skills and knowledge in environmental science will persist well into the 21st century.

Additional autonomy is essential to the College of Natural Sciences' efforts to increase the number of students in the area of environmental science, expand the environmental science curricula, take advantage of funding opportunities in environmental science, increase its research capability, and offer graduate programs. This proposal, which does not require an increase in funding (indeed, a minor reduction in cost will be accomplished by the elimination of one Director position) will solve the shortage of professors in the Environmental Sciences Program. By housing the Environmental Science program in a Department, it will make a significant change in the culture of Environmental Science at UPR-RP, making it more attractive for recruiting faculty and students who generally seek a defined and independent discipline capable of responding quickly to change and looking to the future in accordance with a Doctoral Research Extensive University. If the Environmental Science program at UPR-RP is to play a significant role in meeting academia's and society's increasing need in this field, the program must grow into a department.

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Appendix 2. Research areas and projected academic ITES load.

Appendix 3. Organizations and Institutions cooperating with ESP undergraduate and graduate programs.

Appendix 4. Environmental Science Program Undergraduate Senior Thesis Topics, 2005-2010.

Appendix 5. Physical Space of the Environmental Sciences Program.

Appendix 6. Equipment of the Environmental Sciences Program.

Appendix 7. Physical Space of the Institute for Tropical Ecosystem Studies.

Appendix 8. Equipment of the Institute for Tropical Ecosystem Studies.

Appendix 9. ITES research, educational, and outreach programs.

Appendix 10. Undergraduate students from the Environmental Sciences Program Mentored by

ITES 2003- 2009. Appendix 11. Existing and pending external funding for the Environmental Sciences Program and the Institute for Tropical Ecosystem Studies, 2010.

Appendix 12. Faculty at UPR-RP and beyond who have agreed to collaborate with the Graduate Program in Environmental Sciences.

Appendix 13. Non teaching staff for the Environmental Science program and the Institute for Tropical Ecosystem Studies.

Appendix 14. The College of Natural Sciences Library resources in Environmental Science.

Appendix 15. Proposed Department of Environmental Science organizational structure.

## Appendix 1. CIEPA Study Results, Environmental Sciences Program.



**Proyecto de Evaluación de Programas**  
**Decanato de Asuntos Académicos-Oficina de Planificación Académica**  
**Universidad de Puerto Rico-Recinto de Río Piedras**  
Teléfonos: (787)764-0000, ext. 3448, 7881 / Página Web: <http://opa.uprrp.edu>



### **Informe de Logros y Estado de Situación**

*Programas Participantes en el Proceso de Evaluación de Programas Académicos  
a Nivel de Bachillerato, en el Recinto de Río Piedras  
(Preliminar)*

*Abril 2007*

**Informe de Logros y Estado de Situación de los programas participantes en el proceso de evaluación de programas académicos, nivel de bachillerato**

Abril 2007

*Ciencias Ambientales*

<b>HALLAZGOS POR AREA DE EVALUACION</b>	
<b>Área</b>	<b>Hallazgos</b>
<b>Misión, Metas y Objetivos</b>	<ul style="list-style-type: none"> <li>⌘ Cuenta con un documento revisado de misión, metas y objetivos</li> <li>⌘ Se escribió un documento de misión. Visión, metas y objetivos, ya que no existía formalmente.</li> <li>⌘ Se escribió un perfil del egresado.</li> <li>⌘ Existen áreas del perfil que el programa actual no atiende.</li> <li>⌘ Se está revisando a la luz del perfil y de la reconceptualización del bachillerato</li> <li>⌘ Se han tomado acciones preliminares en lo que se implanta el nuevo currículo.</li> </ul>
<b>Perfil del Egresado/Curriculo</b>	<ul style="list-style-type: none"> <li>⌘ Tiene un perfil del egresado que incluye las competencias que son necesarias para desempeñar las funciones esperadas del egresado y a tono con los requisitos para estudios graduados.</li> <li>⌘ Tiene requisito de tesina; es un programa interdisciplinario.</li> <li>⌘ El programa no cuenta con un plan de avalúo del aprendizaje.</li> </ul>
<b>Estudiantes</b>	<ul style="list-style-type: none"> <li>⌘ Del 1995 al 2004 la matrícula total ha aumentado un 505 (98 a 147).</li> <li>⌘ Cuenta con estudiantes de alto potencial académico.</li> <li>⌘ Sus estudiantes utilizan los servicios de apoyo de la facultad de Ciencias Naturales.</li> </ul>
<b>Facultad</b>	<ul style="list-style-type: none"> <li>⌘ El programa tiene un solo profesor adscrito al mismo. Utiliza los servicios de profesores de la Facultad de Ciencias Naturales.</li> <li>⌘ Esta situación limita el desarrollo del programa.</li> <li>⌘ Hacen falta especialistas e investigadores en áreas esenciales a las ciencias ambientales.</li> </ul>
<b>Administración/Presupuesto</b>	<ul style="list-style-type: none"> <li>⌘ Presupuesto no es suficiente para llevar las necesidades del Programa.</li> </ul>
<b>Planta Física Equipo</b>	<ul style="list-style-type: none"> <li>⌘ Falta equipo de investigación, espacio de oficina y laboratorios de investigación.</li> <li>⌘ Se ha adquirido equipo científico mediante propuestas de fondos externos.</li> </ul>
<b>Planes de Desarrollo</b>	<ul style="list-style-type: none"> <li>⌘ Ofrecer nuevas opciones de estudio a nivel de bachillerato haciendo uso del mecanismo de créditos flexibles.</li> <li>⌘ Comenzar el programa graduado en Ciencias Ambientales, según la propuesta aprobada por el Senado Académico en el 2003.</li> </ul>
<b>Otras</b>	
<b>Recomendaciones</b>	<ul style="list-style-type: none"> <li>⌘ Que se asignen los fondos necesarios para iniciar el programa graduado.</li> <li>⌘ Nombrar un consejero académico.</li> <li>⌘ Aumentar el número de plazas del programa.</li> <li>⌘ Asignar espacio adicional de oficina, enseñanza e investigación.</li> <li>⌘ Establecer sistema efectivo de mantenimiento de facilidades y equipo (CN).</li> </ul>

**Appendix 2. Research areas and projected academic ITES load.**

<b>Professor</b>	<b>Fall 2010</b>	<b>Spring 2011</b>	<b>Fall 2011</b>	<b>Spring 2012</b>
Jess Zimmerman (Human-Natural Coupled Systems Land-Use History Urban Forests)	Graduate Coordination 3crds.	Graduate Coordination; Tropical Ecosystem 6crds	Graduate Coordination 3crds.	Graduate Coordination; Tropical Ecosystem 6crds
Mei Yu (Landscape Ecology/Spatial Analysis/Ecosystem Modeling)	Ecology (Biol 3111 co-taught w.X. Zou) 3crds each  <i>New course preparation- Env.Sci</i>	Geospatial Analysis (CINA5990) 3crds.	Intro Env Sci (CINA3005). 3crds.	IGERT Core Course Ecoinformatics 3crds.
Xiaoming Zou (Soil Biogeochemistry, Carbon cycling)	Ecology (Biol 3111 co-taught w. Mei Yu) 3crds each	Intro Env Sci (CINA3005) 3crds.	Biogeochemistry (Grad) 3crds.	Intro Env Sci (CINA3005) 3crds.
Jorge Ortiz (Limnology, Hydrology, Water Resource Management, Nitrogen and Carbon Cycling in Streams)	Terrestrial Resources (CIAM 6115) 3crds.  <i>Conversion of course to online model</i>	Aquatic Resources CINA 4157 3crds.	Terrestrial Resources (CIAM 6115) 3crds.	Aquatic Resources CINA 4157 3crds.
Elvia Melendez-Ackerman (Bioconservation, Species management, Invasive species, Phenological responses to climate, urban biodiversity)	Spatial Analysis Seminar 8205 2crs	Plant Rep Ecol. (Grad. 3crds)  OTS-Ad honorem  <i>New course preparation- Environmental Ethics – prepare as online model</i>	Intro Env Sci (co-taught w. Mayol) 3crd.  OTS-Ad honorem	Environmental Ethics (to be described grad level 50XX). 3crd.
Alonso Ramirez (Ecology of Urban Streams, Stream Resources, Freshwater Resources)	Limnology Biol 5540	Urban Environment (CIAM 6118) 3crds.	Aquatic entomology (BIOL5538) 3crds.	Urban Environment (CIAM 6118) 3crds.
Olga Mayol, (Atmospheric Chemistry, Natural and Antropogenic contributions to atmospheric aerosols, Saharan dust events and their relation to clouds and precipitation, Aerosols and Climate)	Quim 8206 (Analytical Chemistry Seminar), 2crd  Quim 8992 (Special Topics in Chemistry) 3crd	Cina 6990 (Special Topics in Environmental Sciences), 1crd Cina 4177 (Conservation and Management of Air), 3crd. Quim 8206 (Analytical Chemistry Seminar) 2crd	Intro Ciencias Ambientales (co-taught w. Melendez-Ackerman – 3crds each) Quim 8206 (Analytical Chemistry Seminar) 2crd	Cina 6990 (Special Topics in Environmental Sciences), 1crd Cina 4177 (Conservation and Management of Air), 3crd Quim 8206 (Analytical Chemistry Seminar) 2crd
Nicholas Brokaw (Forest dynamics, Biodiversity impacts of Land-use history)	Intro Env Sci (CINA3005) 3crds	Intro Env Sci (CINA3005) 3crds	CINA 6990 (Special Topics in Environmental Sciences) 3crds	Biology 3111, Ecology 3crds

**Appendix 3. Organizations and Institutions cooperating with ESP undergraduate and graduate programs.**

The following organizations and institutions are cooperating with the UPR-RP Program in Environmental Sciences in offering internships, research collaborations, and/or special trainings to undergraduate and graduate students. Letters of commitment are on file.

El Yunque National Forest (former Caribbean National Forest)

International Institute of Tropical Forestry

US Geological Survey

US National Weather Service

Puerto Rico Water and Sewer Authority

Terrestrial Division of the Puerto Rico Department of Natural and Environmental Resources

Caribbean Alliance for Sustainable Tourism

Biotechnical Processes International, Limited

San Juan Bay Partnership

Water Planning Office of the PR Department of Natural and Environmental Resources

Drinking Water Plan of the PR Department of Health

CSA Engineering

PR Conservation Trust

Vicente and Associates, Inc.

Puerto Rico Louis Stokes Alliance for Minority Participation (NSF funded)

UPR-RP Honors Program

Vermont EPSCOR (NSF funded)

University of Colorado



**Appendix 4. Environmental Science Program Undergraduate Senior Thesis Topics, 2005-2010.**

<b>Year</b>	<b>Student Name</b>	<b>Title</b>	<b>Advisor</b>
2010	Cruz-Ramos, Zuleika	Effects of Mink Urine on Trapability of Small Mammals: <i>Peromyscus maniculatus</i> , <i>Peromyscus leucopus</i> , <i>Tamias striatus</i> , <i>Myodes gapperi</i> and <i>Blarina brevicauda</i>	Dr. Michael Cramer
2010	Deliz-Delgado, Aurivette	Does the increase in the concentrations of atmospheric particles affect the precipitation in Puerto Rico?	Dr. Olga L. Mayol-Bracero
2010	Erazo-Oliveras, Angelica	Improving Slow Sand Filters for Communities with Low Incomes and Limited Water Access	Dr. Olga L. Mayol-Bracero & Dr. Rafael A. Rios-Dávila
2010	Sosa-González, Verónica	A GIS-based analysis of the impacts of landscape level variables on water quality in selected Vermont watersheds	Dr. Jorge L. Ortiz-Zayas
2009	Colón, Johanna	Socioeconomic change as drivers of water quality regimen shifts in the Río Grande de Arecibo Watershed	Dr. Carla Restrepo
2009	Colón-Otero, Luis Javier	Influencia del polvo del África, de las cenizas del volcán Soufriere y de contaminación antropogénica en la química del agua de lluvia de acuerdo a los archivos del Programa Nacional de Deposición Atmosférica para la estación de El Verde en Río Grande, Puerto Rico	Dr. Olga L. Mayol-Bracero
2009	Beltrán-Jiménez, Jammilys	Viabilidad de Energía Eólica en Puerto Rico	Wilfredo Mattos-Cintrón
2009	Fuentes-Viera, Kaira T.	Caracterización de un río urbano: Caso quebrada Juan Méndez en Río Piedras	Dr. Jorge L. Ortiz-Zayas
2009	Meléndez-Oyola, Melissa	Estimates of Calcium Carbonate Dissolution Rates Under Elevated CO <sub>2</sub> Conditions in Devil's Hole, Bermuda	Dr. Andrew Peters & Dr. Loretta Roberson
2009	Mendoza-Martinez, Annette	Dinámica de oxígeno en el estuario altamente estratificado del Río Mameyes, Río Grande y Luquillo, Puerto Rico	Dr. Jorge L. Ortiz-Zayas
2009	Sánchez-García, Mayra A.	Photosynthetic response of <i>Thalassia testudinum</i> to chronic and pulse disturbance using chlorophyll fluorescence	Dr. Loretta Roberson
2009	Quiñones-Vilches, Norberto	Effects of ionic liquids on respiration in freshwater lakes	Dr. Rafael A. Rios & Dr. Konrad Kulacki
2009	Santiago-Pagán, Lourdes	Implicaciones Legales del Cambio Climático en el Mundo y su Relevancia en Puerto Rico	Dr. José Molinelli

2009	Toledo-Rivera, Jennifer	Anthropogenic influence on the rank-order abundance of living and death assemblages of sea grass associated mollusks at Chadwick Bay, Onslow County, North Carolina	Dr. Patricia Kelley
2008	Bonal-Flores, Carmen M.	Disminución de Consumo Energético en Puerto Rico, Utilizando las Energías Renovables	Dr. José Molinelli
2008	Castro-Voltaggio, Brenda I.	Análisis de Tendencias en la Calidad de Agua en Cinco Cuencas Hidrográficas en Puerto Rico y su Relación con el Cambio en el Uso de Terreno	Dr. Jorge L. Ortiz-Zayas
2008	Dávila-Olmo, Katherine	Impacto de las Canteras en el Carso Norteño de Puerto Rico	Dr. José Molinelli
2008	Erazo-Oliveras, Alfredo	Estudio de la Distribución de los Invertebrados Plecópteros y Efemerópteros en las Partes Alta, Media y Baja del Río Mameyes en Luquillo, Puerto Rico y el Río Espíritu Santo en Río Grande, Puerto Rico y sus Funciones como Bioindicadores.	Dr. Edwin A. Hernández Delgado
2008	Vargas, Catherine & Rosario, Héctor	Fine root standing crop among five tree species at the coastal plateau of the Guánica dry forest, Puerto Rico, during the dry month of February	Dr. Elvira Cuevas
2007	Castro-Aparicio, Irene	Estimado de emisiones de CO2 asociados al transporte en automóvil privado de los alumnos de la UPR, Río Piedras y descripción del manejo de uso de terrenos de la Universidad desde 1936 al 2004	Dr. Gabriel Moreno Viqueira
2007	Cepero-Pérez, Keren	Exporte Fluvial de nitrógeno en cuatro cuencas de Puerto Rico	Dr. Jorge L. Ortiz-Zayas
2007	Coca-Durand, Ileana M.	El Impacto Sonoro del Tren Urbano de Puerto Rico en el 2007	Dr. Jorge Rocafort
2007	Negrón-Hernández, Krizia	Accuracy of United States Tropical Cyclone Landfall Forecasts in the Atlantic Basin (2004-2005)	Dr. Mark D. Powell
2007	Roque-Rivera, Raysa	Evaluation of the difference in saturated hydraulic conductivity in green areas and walking paths in the University of Puerto Rico, Río Piedras Campus	Víctor Snyder
2007	Torres-Báez, Pedro J.	Arthropods as a linkage between terrestrial and aquatic ecosystems: Does stream phosphorus concentration matter?	Dr. Luis Alonso Ramirez
2006	Cartagena-Colón, Marianne	Análisis de Riesgo del Uso Recreativo de los Ríos en Puerto Rico	Dr. Jorge L. Ortiz-Zayas
2006	Caraballo, Angie	Análisis de la densidad de bolos de composición granítica según la inclinación de la pendiente en la cuenca del Río Guayanés en Yabucoa, Puerto Rico	Dr. José Molinelli

2006	Fridman-Rutzen, Ana Victoria & Pérez-Castro, Sherlynnnet	Análisis de Riego Sobre los Nueve Rellenos Sanitarios Activos en la Region Carstica del Norte de Puerto Rico	Dr. José Molinelli
2006	Mercado, Marianela & Berrios, Emil	Frecuencia y severidad de los eventos del polvo de Sahara en Puerto Rico	Dr. Osvaldo Rosario
2006	Navarro-Colón, Isalyn	Relación entre el uso del terreno y la calidad del agua de dos subcuencas: Norte de Raleigh, Carolina del Norte, Estados Unidos	Dr. Stacy Nelson
2006	Rodríguez-Calderón, Cielomar	Effects of land use on shelf sedimentation off the Waipaoa River, New Zealand	Dr. Steve Kuehl & Ms. Lisa Addington
2006	Rodríguez-Andino, David	Análisis comparativo entre las emisiones de CO2 generadas por el Tren Urbano y la posible reducción de emisiones de CO2, en el sector de la transportación de Puerto Rico debido al uso del sistema de Tren Urbano mediante la evaluación del Plan de Acción para reducir las Emisiones de Gases de Invernadero en Puerto Rico del 1999	Dr. José Molinelli, Dr. Jorge L. Ortiz-Zayas, Wilfredo Mattos & Rafael Ortiz
2005	Adrover-Muntaner, Antonia V. & Ramirez-Garcia, Zynthia M.	Estado actual de las poblaciones del coral Cuerno de Ciervo ( <i>Acropora cervicornis</i> ) y Cuerno de Alce ( <i>Acropora palmata</i> ) en la Isla de Culebra, PR.	Dr. Edwin Hernández Delgado
2005	Archer-Malpica, Rosa D. & Vélez-Razón, Valerie	Deslizamientos Reportados en Veintiún Municipios desde el año 1986 al presente	Dr. José Molinelli
2005	Camacho-González, Angélica M. & Monge-Gómez, José J.	Uso de la Educación Universal de Perdida de Suelo Revisada, versión 2, para el análisis cuantitativo de erosión y sedimentación producida en la Cuenca Hidrográfica del Río Guaynabo	Dr. Jorge L. Ortiz-Zayas
2005	Juarbe-García, Coraly & Rosado-González, Arelys	Estudio comparativo de la dinámica de oxígeno disuelto en los Estuarios de los ríos Mameyes y Fajardo en el noreste de Puerto Rico durante marzo de 2005	Dr. Jorge L. Ortiz-Zayas
2005	López-Burgos, Viviana & Muñoz-Tirado, Madeline	Estudio comparativo de la calidad de agua, histórica y actual en la cuenca de Río Guaynabo, Puerto Rico	Dr. Jorge L. Ortiz-Zayas
2005	Martínez-Robles, Alma & Calle-Maldonado, Paulina	Depression Forest Mapping for Mona Island Reserve using Ikonos High resolution imagery	Dr. Elvia Meléndez-Ackerman

2005	Nicolau-López, Eduardo L. & Rosado- González, Arelis	Estudio sobre la composición de Desperdicios sólidos en el Sistema de la Universidad de Puerto Rico por medio de caracterizaciones en los Recintos de Río Piedras, Mayagüez y Carolina	Dr. Rafael A. Rios
2005	Ortiz-Maldonado, Coralys	Influence of Habitat morphology on shrimp communities in a headwater stream: Quebrada Prieta, Luquillo Forest	Dr. Fred Scatena
2005	Rosario-Castro, Cristina	Análisis del cambio en los patrones espaciales de las parcelas de vegetación de un cauce decapitado en la desembocadura del Río Bayamón	Dr. José Molinelli
2005	Sandoz-Vera, Betzaida & Torrado- Fernandez, Marla	Hydrologic Impact of Land use changes and Runoff generation in a Sub-Watershed of Río Guaynabo, Puerto Rico	Dr. Jorge L. Ortiz-Zayas
2005	Vera-Pérez, Arleen	Influencia de las oscilaciones del Sur y Atlántico norte en la precipitación del Región suroeste de Puerto Rico	Dr. Juan F. Blanco

## Appendix 5. Physical Space of the Environmental Sciences Program.

The Table below indicates the space currently assigned to the Environmental Sciences Program and the Institute for Tropical Ecosystem Studies. The Environmental Science Program (ESP) has 2,782 square feet of teaching laboratories, 556 sq. ft. of research laboratories, access to CN class rooms, and 1,091 sq ft of space for the program office and faculty offices.

<b>BUILDING</b>	<b>ROOM NO.</b>		<b>UNIT</b>	<b>sq ft</b>	<b>USE</b>	<b>USE DETAIL</b>
CN I	B	28 0	ESP	170	DEPT FAC	CIAM ALMACEN
CN II	C	221 0	ESP	1113	TEACH. LAB	LAB USO Y MANEJO DE TER
CN II	C	223 0	ESP	76	DEPT FAC	ALMACEN
CN II	C	224 0	ESP	349	DEPT OFC	OFICINA ALIANZA GEOGRAF
CN II	C	225 0	ESP	293	DEPT OFC	OFICINA AMBIENTAL
CN II	C	226 0	ESP	0	DEPT OFC	ALMACEN
CN II	C	228 0	ESP	144	DEPT OFC	OFIC DIRECTOR CS AMBIEN
CN II	C	229 0	ESP	1113	TEACH. LAB	LABORATORIO DE GEO FISI
CN II	C	231 0	ESP	135	DEPT OFC	OFICINA DE PROFESOR
CN II	C	233 0	ESP	556	TEACH. LAB	LAB SISTEMA INF GEOGRAF
CN II	C	234 0	ESP	556	RES LAB	LABORATORIO CS TERRESTR
CN I		118 0	ESP	1242	RES LAB	Water Quality Lab

## **Appendix 6. Equipment of the Environmental Sciences Program.**

<b>Environmental Science Laboratory</b>	<b>Quantity</b>
Aquarium, various sizes	5
Atomic Absorption Spectrometer	1
Balance, Analytical	6
Bath, Refrigerated Circulating, Thermo Sci Neslab RTE7	1
Camera, Digital Olympus Stylus Tough-800, Underwater	2
Camera, Digital Panasonic Lumix DMC-FS15	1
CHNSO Analyzer	1
Coliscan Easygel Micrology Labs.	1000
Colorimeter, HACH DR820	5
Computer (Laptop), Dell Vostro 1520	20
Computer (Laptop), HP Mini 110	2
Conductivity meter	2
Data Logger, LI-COR LI-1400	1
Desiccator Cabinet (horizontal)	1
DO Meter -YSI Portable	5
Dri-Bath, Thermo Scientific	2
Fins, Cressi Sub Clio	1
Flow Tracker, YSI 2-D	1
Fluorometer, Diving PAM	1
GPS, MAP 76-Garmin	6
Handheld Meter, YSI PRO 63 pH/conductivity/temperature	5
Hot plates, Stirring Corning 6795-420D	5
Inductively Coupled Plasma Mass Spectrometer (ICP-MS)	1
Incubator (5ft. <sup>3</sup> ), Fisher Isotemp	2
Light Meter, LI-COR Bioscience LI-250-A	1
Light Sensor, LI-COR Spherical	1
Light Sources, Fiber Optic	2
Logger, weather station (rain, temperature, light), HOBO	2
Loggers, Light and temperature	1
Mask and snorkel sets	12
Muffle furnaces	4
National Instruments Data Acquisition System	1
Oxygen electrode, Rank Brothers Dual Chamber	1
Refractometer, Portable Salinity	5
Save-A-Dive Kit Black	2
Save-A-Dive Kit PVC	2
Secchi disk	5
Shaker Bath	1

Snorkeling Package 8.5/9.5, Cressi Sub Pluma	2
Soil sampling kit	2
Sonar, Digital Hawk eye H22PX	5
Spectrophotometer, HACH DR5000-01	2
Spectrophotometer, NanoDrop 2000	1
Tektronix Digital Storage Oscilloscope	1
Test Kit, Ammonia	2
Test kit, HACH Saltwater Aquaculture, Digital Titration	6
Test Kit, Hach Stream Survey	6
Test Kit, Nitrate	2
Test Kit, Phosphosphate	2
Test kits -Nine-Parameter, Drop Count Titration	1
Thermocycler, MJ Mini	1
Thermoreactor, Hach DRB-200 and test kits for COD/TOC	1
Transect tapes	10
Turbidimeter, Hach 2100P	5
Vacuum Pump and Filters	4
Video Camera, Digital Cannon	1
Wild Dissecting scopes	1

<b>GIS and Remote Sensing Laboratory</b>	<b>Quantity</b>
Color Plotter, IBM	2
Computer, PC Dell Dimension XPS T-450 MHz	5
Computer, PC Gateway 2000 486 MHz	1
Computer, PC Gateway P5-60	3
Dell PowerEdge 6100 workstation	1
Digitizing tables, CalComp	2
GPS, GeoExplorer II	1
GPS, XR Surveyor systems	2
Level and tripod, Zeiss	1
Planimeters (Ushikata and others)	
Printers, HP inkjet including large format and color	
Stereoscope, Cartographic Engineering Heightening	1
Stereoscope, Cartographic Engineering SB-190 Mirror	1
Stereoscope, Wild ST-4	1
Transfer Scopesm, Bausch & Lomb Zoom	1
Workstation, Sun Sparc	1

### **Software**

ArcInfo, mapping & data integration analysis  
ArcView, geospatial processing programs  
Corel Draw, graphic design program  
EndNote, publishing & managing bibliographies  
ENVI, processing & analyzing geospatial imagery  
Imagine, remote sensing analysis & spatial modeling  
Office 2010  
Statistica, Data Analysis  
PRIMER-E, Data Analysis  
STELLA, modeling



## **Appendix 7. Physical Space of the Institute for Tropical Ecosystem Studies.**

At the Rio Piedras campus 6 faculty direct four research laboratories with four of the faculty sharing 2 lab spaces (2 faculty/lab). Laboratory facilities include the Atmospheric Chemistry Atmospheric Aerosols Lab (PI: Olga Mayol – FB building), The Limnology and Aquatic Ecology Lab (PI: J. Ortiz and A. Ramirez-FB building), Tropical Plant Ecology and Evolution and Biogeochemistry Lab (PI: Elvia Melendez-Ackerman and X. Zou FB building), Landscape Ecology Lab (PI: New Faculty recruit, CNN phase II). In addition to the regular laboratories ITES maintains a water sample library (CNN phase I). Off campus the Institute manages two fieldwork facilities, The El Verde Field Station and the Toa Baja Research Sites. The EVFS is a major off-campus operation and is explained in more detail below. The Toa Baja Site is an urban field site that houses historical plots set up by the International Institute for Tropical Forestry. Office space is allocated for four students advised by ITES.

*El Verde Facilities.* The El Verde Field Station is a productive research facility home of the Luquillo-Long Term Ecological Research Program, a multidisciplinary/multi-campus project supported by NSF. The station plays a fundamental role for that project where scientists have been monitoring the environment and ecosystems to improve our understanding of the function of tropical forests and the value of organisms that inhabit these systems as well as the factors that effect changes on tropical ecosystems. El Verde Field Station has two dormitory buildings. An original building with historic value was constructed in 1937 and renovated in the early 1960s at the start of the Rain Forest Project by the Atomic Energy Commission. This building can presently accommodate up to 28 visitors in four rooms. A second dormitory building was recently constructed to accommodate 16 individuals in four apartments (see “results from prior support” for details). This new building is providing substantial relief from severe overcrowding during peak usage at the station and has improved significantly the quality of the accommodations at El Verde.

Laboratory facilities were constructed in 1963 and augmented in 1977. In combination, they house 11 offices (two of which serve as wet and dry laboratories), two storage rooms, a locker room, a carpentry shop, a reference collections room, and a combination of conference and computer room, a server with support for a local area network and high speed wireless internet connection. The high volume of scientists and students that visit El Verde Field Station creates a substantial demand for office and laboratory space, which always exceeds the current capacity of the station.

<b>BUILDING</b>	<b>ROOM</b>			<b>USE DETAIL</b>	<b>Assigned to:</b>
	<b>NO.</b>		<b>sq ft</b>		
AFB	208	0	288	Hallway	Admin
AFB	208	C	129	Office	Faculty Office
AFB	208	D	129	Office	Grad Student Office
AFB	208	E	98	Office	Storage
AFB	208	F	129	Office	Faculty Office
AFB	208	G	98	Utility Room	Admin
AFB	208	H	129	Office	Faculty Office
AFB	208	I	98	Office	Faculty Office
AFB	208	J	148	Office	Faculty Office
AFB	208	K	148	Office	Faculty Office
AFB	207	0	288	Hallway	Admin

AFB	207	A	131	Office	Faculty Office
AFB	207	B	101	Office	Admin
AFB	207	C	131	Office	Faculty Office
AFB	207	D	101	Office	Admin
AFB	207	E	131	Office	Data management
AFB	207	F	101	Office	Storage
AFB	207	G	131	Office	Admin
AFB	207	H	101	Office	Admin
AFB	207	I	136	Office	Data management
CN	20		156	Laboratory	Ortiz and Ramirez
NCN	C	235	556	Laboratory	M Yu
FB		4	425	Laboratory	E Melendez-Ackerman
FB		004	425	Laboratory	X Zou
FB		318	125	Laboratory	Ortiz and Ramirez
FB		256	400	Laboratory	Ortiz and Ramirez
FB	305	0	572	Laboratory	O Mayol-Bracero
El Verde	101			Laboratory	Water lab
El Verde	102			Laboratory	
El Verde	103			Office	A Ramirez
El Verde	106			Computer Center	
El Verde	107			Herbarium	
El Verde	108			Office	
El Verde	109			Laboratory	
El Verde	110			Office	
El Verde	111			Office	
El Verde	113			Drying Room	
El Verde	116A			Laboratory	
El Verde	116C			Laboratory	
El Verde	116D			Office	

**Appendix 8. Equipment of the Institute for Tropical Ecosystem Studies.**

<b>Equipment</b>	<b>Brand</b>	<b>Model</b>
Ion Chromatograph & Autosampler	Dionex	ICS-1000 & AS-40
TOC/TN Analyzer	Tekmar/Teledyne	Apollo 9000
Analytical balance	Ohaus	Adventurer Pro AV114C
COD Thermoreactor	WTW	CR2200
Muffle furnace	Barnstead Thermolyne	F62735
Drying oven	Precision	Cat# 51221129
UV-VIS Spectrophotometer	Turner SP-830	SM110215
DI water generator	Millipore	Synergy 185/Rios 3
DO meter	YSI	58-115V
DO meter	Accumet Excel	XL40
DO Meter	YSI Incorporated	550A
DO Meter	YSI Incorporated	550A
DO Meter / LDO Sensor	HACH	HQ30d
Vacuum pump	Fisher Scientific	DOA-P704-AA
E/S Portable Sampler	Masterflex	7571-00
Dissecting microscopes	Wild Heerbrugg	
	Nikon SMZ645	1019443
Incubator	VWR	2020
Refrigerator	Kenmore GD21	253.6419240N
Freezer	Kenmore Elite	258.267521
PC (6)	Dell Optiplex 745	DCC4
Licor Data Logger	LI-COR	LI-1400
Light Meter	LI-COR	LI-250A
Light Sensor	LI-COR	Spherical
Hydrolab Surveyor (3)	HACH	
Hydrolab Minisonde	HACH	MS5
Hydrolab Minisonde	HACH	MS5
Hydrolab Minisonde	HACH	MS4a
Hydrolab Datasonde	HACH	DS5
Hydrolab Datasonde	HACH	DS5
Hydrolab Quanta	HACH	Quanta
Hydrolab Quanta	HACH	Quanta
SpC / TDS Meter	HANNA	HI9835
GLP pH / ORP Meter	HANNA	HI98150
Flowmeter	Swoffer	2100
Flowmeter	Marsh-McBirney	2000
Multi-Analyte Photometer	CHEMetrics	V2000
Tri Meter	LaMotte Company	TC3000e
Portable Salinity Refractometer	Extech Instruments	RF20
ISCO Portable Sampler	ISCO	

GPS (1)	Garmin	
Digital Camera	Cannon	
Licor LI-3100C AREA METER	Licor	LI-3100
HP Color Laserjet 2840 printer	HP	
PC computers (8)	Dell	
a sunphotometer	CIMEL	CE318-1
EC/OC analyzer	Sunset Lab	
a TOC/TN analyzer	Shimadzu	TOC-5000A
weather stations (4)	Davis	
a 3-wavelength nephelometer	TSI	Model 3563
an aethalometer	Magee Scientific	AE-31
3-wavelength particle soot absorption photometer (PSAP, Radiance Research)		
a condensation particle counter	TSI	3022A
pH meters		
conductimeter		
Ceptometer	Licor	
Spetroradiometer	Apogee	
Digital video cameras (4)	Sony	
Compound microscopes (4)	Nikon and Olympus	
Disecting microscopes (3)	Olympus	
Microscope cameras (2)		
Submetric GPS	Trimble	
Submetric GPS	Topcon	
Solar pannel	Telekkon	
Digital camera w. fisheye lens (1)	Nikon	
Digital Cameras Video (3)	Sony	
Upright ovens (2)		
Refrigerators (3)		
Growth Chamber	Sanyo	
Micromet stations (12)	Onset	

### El Verde

Computers (9)	8 Dell, 1 MacIntosh
Printer (1)	HP
SUV Jeep (2)	Cherokee
Van	Dodge
Pickup truck	
Binocular Microscope	Nikon
Disecting Scope	Olympus

## Appendix 9. ITES research, educational, and outreach programs.

- *Luquillo LTER Program 4: Understanding Change in the Ecosystems of Northeastern Puerto Rico* (NSF grant no. 0620910). The Luquillo Long-term Ecological Research Program (LUQ-LTER; <http://luq.lternet.edu/>) is the only tropical site within the LTER locations on US soil. This is a large scale, multi-institutional NSF-funded project that has supported long-term ecological research at the Luquillo Mountains and adjacent areas since 1989. ITES PI: N.V. Brokaw, almost all ITES faculty participate.

- *Collaborative Research: LTREB: Long-term Studies of Flowering, Fruiting and Seedling Recruitment in Neotropical Forests: Global Change, Climate Variability and Species Coexistence*. (NSF grant no. 0614659). Supports long-term quantitative studies of plant reproduction and seedling establishment in three Neotropical forests to examine causes of interannual variation and mechanisms facilitating species coexistence. Project trains undergraduate and graduate students. PI: J.K. Zimmerman.

- *Impact of African Dust on Clouds and Precipitation in a Caribbean Tropical Montane Cloud Forest* (NSF grant no. 0936879). Understanding the factors that may influence climatic patterns is a current ITES research priority. ITES faculty: O. Mayol-Bracero.

- *Center for Applied Tropical Ecology and Conservation: Biodiversity Conservation Under the Scenario of Climate Change (CREST-CATEC)*(NSF Grant 0734826). CATEC's mission is to train graduate, undergraduate and post-doctoral students, develop state-of-the-art research in conservation biology and environmental issues relevant for policy and conservation management, and improve infrastructure. Participating ITES FACULTY: E. Melendez-Ackerman (CoPI), J. Ortiz

### Research - Future

- Socio-ecological and ecological-economic studies. As urban development continues to expand in tropical areas, increased knowledge of the effects of human actions on ecosystem processes becomes imperative if we are to be able to manage natural resources sustainably. Assess the relationship between urban development and ecosystem services in Puerto Rico (see Urban Ecology – ITES Strategic Plan 2005-2015). Submitted to NSF coupled human and natural systems program. ITES faculty: J.K. Zimmerman.

- *National Ecological Observatory Network (NEON)* (<http://www.neoninc.org/>). This project will establish 20 permanent sites across the US to monitor ecological change related to climate, land use, invasive species, and disease outbreaks. The Guánica Biosphere Reserve has been preliminary selected as the core site for Atlantic Neotropical Domain. Submitted to NSF. Participating ITES Faculty: O. Mayol-Bracero, E. Meléndez-Ackerman, J. Ortiz.

- *Urban Long- Term Research Areas (ULTRA)*. This will be a nationwide initiative sponsored by federal agencies to monitor and manage urban forest resources incorporating the human component into urban ecology. Exploratory grant Ultra-Ex was granted by NSF to Fundación Puertorriqueña para la Conservación. Participating ITES Faculty: Elvia Melendez-Ackerman, Jess Zimmerman, A. Ramírez and J. Ortiz.

### Undergraduate and Graduate Training

- *Research Experiences for Undergraduates (REU) in Tropical Ecology and Evolution* (NSF grant no. 0552567): Summer internship program established 2000 providing mentored

research experiences for undergraduates at the El Verde Field Station (<http://ites.upr.edu/REU/>). Application is open to qualified US students from undergraduate institutions in Puerto Rico and the Mainland. ITES PI: A. Ramírez

- *Undergraduate Mentoring in Environmental Biology: From Forest to the Cities* (<http://ites.upr.edu/UMEB/>) (NSF grant no. 0602642) since 2006. Year-long intensive training program for undergraduate students interested in environmental problems in which students are paired with a research mentor (usually from ITES) and develop publishable research projects. ITES PI: A. Ramírez

- *An integrated internship, mentoring, and skill-building program promoting the geosciences at the University of Puerto Rico-Rio Piedras: a track 1 initiative* (NSF grant no. 0914614). Internships for undergraduates in geoscience-related areas in cooperation with the private and public sector. ITES Faculty: J. Ortiz, O. Mayol-Bracero. ESP faculty: R. Rios.

- *Mentoring of undergraduates*. Research mentoring and in particular undergraduate mentoring within ITES is substantial and has increased since our last external evaluation in 2004 (Fig 4; Table 1).

- *Strengthening Educational Capacities in Geospatial Science and Technology For Agricultural and Natural Resources Management* (USDA grant no. 2008-38422-19211). Project develops open access GIS facilities for students, improves GIS curricula and offers summer internships in the management and conservation of natural resources. ITES PI and CoPI: M. Yu and E. Meléndez-Ackerman.

- *IGERT: Natural-Human Systems in the Urbanizing Tropics* (NSF grant no. 0801577). The goal of this program is to train Ph.D. students to apply an interdisciplinary and collaborative approach to environmental problems in urbanizing, tropical landscapes. DES PI: R. Rios; ITES CoPIs: N. Brokaw, J. Zimmerman.

- *From Hectares to Nanometers: GK-12 Multidisciplinary Explorations of Functional Nanoscience and Tropical Ecosystems*. (NSF grant no. 0841338). This graduate fellowship program will strengthen 7th-9th teachers and students' scientific knowledge through multidisciplinary explorations of tropical ecosystems and functional nanoscience, while improving graduate students' abilities to communicate and teach science. ITES coPI: E. Meléndez-Ackerman

ITES has and will continue to sponsor undergraduate research opportunities for students within ESP and other academic programs. To date, ITES has sponsored undergraduate research experiences for at least 40 students from ESP (Appendix 6).

### **Public Outreach**

- *Luquillo LTER Schoolyard Program* for increasing K-12 ecological literacy <http://luq.lternet.edu/outreach/schoolyard/index.html>. ITES faculty: J. Zimmerman.

- "Journey to El Yunque" outreach activity (<http://elyunque.net/journey.html>). ITES faculty: J. Zimmerman.

- *Ecoplexity*: one of five LTER sites creating resources to facilitate instruction on ecological complexity [www.ecoplexity.org](http://www.ecoplexity.org).

- *HELP*: community outreach program for the transfer of information on water resource management [http://luquillohelp.upr.edu/areas\\_accion.htm](http://luquillohelp.upr.edu/areas_accion.htm).

- *AKKA-SEEDS ecology student chapter* based at the UPR-RP (cosponsored by ITES and the UPR-RP Center for Applied Tropical Ecology and Conservation). ITES mentor: E. Meléndez-Ackerman
- Initiated under the Ecological Society of America's SEEDS program (Strategies for Sustainable Ecology, Education and Development)
- 2007 "SEEDS Chapter of the Year", Ecological Society of America for its outstanding achievements.
- Brings research and educational opportunities to undergraduates and increases the ecological literacy of the general community (<http://akkaseeds.org/page11.aspx>). Members from a range of UPR-RP departments (geography, planning, humanities, biology, and environmental sciences)
- Interdisciplinary activities and outreach efforts in the Rio Piedras community.
- *Public-interest* posters, newspaper and magazine articles, radio and TV appearances.
- *Inventio* (Vol 4, October 2007), the science magazine of UPR-Río Piedras focused on ITES research.
- *Community service by ITES researchers on environmental issue*: ITES tenure and promotion criteria give weight to community service. ITES faculty: J. Ortiz
- *Teen University*: interactive middle school seminar on cloud formation by world-renowned scientist Stephen Borgman (Max Plank Institute), May 2008. Attended by hundreds of Puerto Rican middle school students from various private and public schools. ITES faculty: O. Mayol-Bracero
- *Hands-on outdoor activity* at El Verde Field Station for the High School Program „Operacion Exito' and its international science knowledge competition for the top-five students from Costa Rica, Colombia, Chile, Spain and Puerto Rico ([www.operacionexito.com](http://www.operacionexito.com)), December 2008. ITES researchers: E. Meléndez-Ackerman, J. Zimmerman, D. García-Montiel and J. Bithorn (EVFS Tech)
- *FUTURE*: ITES plans to recruit an environmental outreach/education research specialist.
- The new El Verde Field Station master plan will diversify education opportunities to include more K-12 outreach.

### **Research Facilities**

- *El Verde Field Station* (<http://ites.upr.edu/EVFS/>).
- Internationally recognized biological station
- One of the oldest in Puerto Rico and the Caribbean
- Widely used by local and international researchers
- New master plan for the El Verde Field Station (available upon request). Plan includes facilities for the study of atmospheric aerosols and their effects on cloud formation (NSF grant no. 0730445). A workshop to outline this plan was held in October of 2008 and was attended by local and off-island experts from (US, Costa Rica, Mexico and Germany). ITES faculty: A. Ramírez, O. Mayol-Bracero and E. Meléndez-Ackerman.

- *Las Cabezas de San Juan Station*: monitoring facilities for atmospheric aerosols and meteorological parameters (funding from NOAA-ESRL since 2003)
- *East Peak Atmospheric monitoring facility*.
- *Mona Island*: automated meteorological station since 2005.
- *ITES urban forest in Toa Baja*. Site for urban forest research.

#### **Internationalization at UPR**

- *Organization for Tropical Studies* (OTS; <http://www.ots.ac.cr/>). The Organization for Tropical Studies is a consortium on over 60 academic institutions that offers research and education opportunities at the graduate and undergraduate level in international locations around the tropics. ITES Director E. Melendez Ackerman serves as one of two UPR Delegates to OTS and as Chair of the OTS Advisory Committee on Academic Diversity. Meléndez-Ackerman has worked to promote and institutionalize these international educational opportunities for undergraduates within the UPR-System.
- *College of Natural Sciences Liason*: for student experiences at international sites and UPR-RP internationalization committee. ITES faculty: O. Mayol-Bracero
- *Support to UPR Central Administration*: in developing academic partnerships with the Peoples Republic of China, such as the Confucius Institute at the University of Puerto Rico, Río Piedras Campus. Participating ITES faculty: X. Zou, M. Yu.



**Appendix 10. Undergraduate students from the Environmental Sciences Program Mentored by ITES 2003- 2009.**

<b>Name</b>	<b>Title of Undergraduate Reserach Project</b>	<b>Date</b>
Debora Figueroa	Ecología de la Quebrada Chiclana, Rio Piedras, PR	May-03
Kary García Robledo	Estudio de calidad de hábitat acuático para probar un método de evaluación en los ríos de PR	Dec-03
Angélica Camacho	Hydrologic effects of impermeabilization in the Rio Piedras watershed	Dec-03
Carlos Soto	Hydrologic effects of impermeabilization in the Rio Piedras watershed	Dec-03
Mayreni Acevedo Class	Evaluación de la Calidad del Agua en la Laguna del Condado	May-04
Yesika Fernández García	Evaluación de la Calidad del Agua en la Laguna del Condado	May-04
Rahiza de Thomas (REU)	Drifting organisms in a tropical rainforest stream	Summer 2004
Marianne Cartagena	Environmental risk assessment; recreation, river management	May-06
Carmen García (REU)	Testing rapid bioassessment protocols in Puerto Rican streams	Summer 2005
Betzaida Sandoz-Vera	Hydrologic impacts associated with urban sprawl	Jun-05
Viviana López Burgos	Water quality changes associated with urban sprawl	Dec-05
Madeline Muñoz	Water quality changes associated with urban sprawl	Dec-05
José Monge	Sediment delivery associated with urban sprawl	Dec-05
Angélica Camacho	Sediment delivery associated with urban sprawl	Dec-05
Coraly Juarbe García	Dinámica diurna de oxígeno en un estuario	Dec-05
Arellys Rosado González	Dinámica diurna de oxígeno en un estuario	Dec-05
Arleen Vera	Climatology of Southwestern Puerto Rico	Dec-05
Sharon Machin (REU)	Light measurements in aquatic environments	Summer 2006
Keren Cepero	Water quality repercussions of historic land use changes in Puerto Rico	Oct-06
Josué Sánchez	Effects of invasive species on arthropod biota in Mona Island and Nitrogen retention in a channelized urban river.	Summer 2007
Lourdes Santiago	Evaluation of the positive and negative artifacts in the sampling of carbonaceous aerosols	Aug-07
Alexandra Marcano	DOC quality as a function of land use changes in NE Puerto Rico	May-08
Miriam Toro	Fauna of cave ecosystems in Puerto Rico and its relation to environmental gradients and public accessibility.	Dec-08
Loreli Sepúlveda	Determinación de caudales ecológicos en el Río Fajardo con el método del perímetro mojado.	Dec-08
Doryan De Angel	Determinación de caudales ecológicos en el Río Fajardo con el método del perímetro mojado.	Dec-08
Kaira Fuentes Viera	Hidrología de la Quebrada Juan Méndez, Río Piedras.	Dec-08
Bianca Rodríguez	Biodegradabilidad de carbono orgánico disuelto en ríos urbanos	Dec-08
Annette Mendoza	Dinámica de oxígeno disuelto en un estuario tropical estratificado.	Dec-08
Aura Alonso	Influence of invasive bamboo on earthworm communities and soil processes in a subtropical wet forest.	Dec-08
Luis Javier Colón Otero	Influencia del polvo del África, de las cenizas del volcán y de masas de aire con contaminación antropogénica en la química del agua de lluvia	Dec-08
Angelica Erazo	Improving Slow Sand Filters (SSF) for Communities with Low Incomes and Limited Water Access	Jan 2009
Wilmarie Marrero	Inorganic and organic chemical composition of atmospheric particles in the Guanica's dry forest	Jan 2009

**Appendix 11. Existing and pending external funding for the Environmental Sciences Program and the Institute for Tropical Ecosystem Studies, 2010.**

Environmental Sciences Program - Existing Funding

1. Natural-Human Systems in the Urbanizing Tropics (NSF IGERT) \$3.2 million five years
2. Partnership for Undergraduate Education in the Natural Sciences for Transformational Engagement of STEM Students (PUENTES) (USDE) \$2.2 million two years
3. An integrated internship, mentoring, and skill-building program promoting the geosciences at UPR-RP (GeoInternados) (NSF) \$197,341 two years

Total Environmental Sciences Program external funding 2010: \$7.4 million

Environmental Sciences Program - Pending Funding

1. Education to Advance Renewable Technology for Hispanics (USDE) \$3.8 million five years
2. UPR-UGA Partnership for a Research Center of Excellence in Renewable Energy (DOD) \$4 million four years
3. Science and Math Education in the Context of a Disposing Society (NSF) \$1.25 million five years
4. University of Puerto Rico-Rio Piedras Earth System Processes and Human Relationships Center (NSF) \$9.5 million five years

Total Environmental Sciences Program pending funding 2010: \$18.6 million

Institute for Tropical Ecosystem Studies - Existing Funding

1. LTER: Ecosystem Change in NE Puerto Rico \$4.9 million (NSF) six years
2. CREST: Tropical Ecology and Conservation \$5 million (NSF) five years
3. ULTRA-Ex: Socio-ecological change in a tropical city \$300,000 (NSF) two years (with Forest Service)
4. Geo-spatial science, agriculture, natural resources \$290,000 (USDA)

Total ITES external funding 2010: \$16.7 million

Institute for Tropical Ecosystem Studies - Pending Funding

1. RCN: Socio-ecological hurricane impacts \$495,555 (NSF) Society (NSF) \$1.25 million 5 years
2. Forest successional dynamics, climate change, and human impacts \$471,932 (NSF)
3. Undergraduate research in tropical ecosystems \$596,189 (NSF)
4. Groundwater/surface water interactions \$447,319 (NSF)

Total ITES pending funding 2010: \$5.2 million

**Appendix 12. Faculty at UPR-RP and beyond who have agreed to collaborate with the Graduate Program in Environmental Sciences.**

<b>NAME</b>	<b>AFFILIATION</b>	<b>DEGREE AND SPECIALTY</b>	<b>INSTITUTION AND YEAR</b>	<b>RESEARCH AREA</b>
Rafael A. Rios*	UPR-RP Environmental Sciences	PhD Environmental health engineering	University of Texas-Austin, 1975	Pollution control
Loretta Roberson*	UPR-RP Environmental Sciences	PhD Biological Sciences	Stanford University, 2001	Coastal processes
Qiong Gao*	UPR-RP Environmental Sciences	PhD Agricultural and biological engineering	Cornell University, 1987	Ecosystem modeling, carbon balance, scaling
Gary Gervais*	UPR-RP Environmental Sciences	PhD Microbiology	University of Puerto Rico, 2000	Anaerobic digestion for wastewater treatment
Nicholas Brokaw*	UPR-RP Institute of Tropical Ecosystems	PhD Tropical forest ecology	University of Chicago, 1980	Forest ecology
Olga Mayol-Bracero	UPR-RP Institute of Tropical Ecosystems	PhD Analytical chemistry	University of Puerto Rico-Río Piedras, 1998	Chemistry and physics of atmospheric particles, aerosols and climate
Elvia Meléndez-Ackerman*	UPR-RP Institute of Tropical Ecosystems	PhD Plant ecology, bioconservation	University of California, Irvine, 1995	Population ecology and biodiversity
Jorge Ortiz*	UPR-RP Institute of Tropical Ecosystems	PhD Environmental Biology, Limnology	University of Colorado-Boulder, 1991	Tropical limnology, hydrology
Alonso Ramírez*	UPR-RP Institute of Tropical Ecosystems	PhD Limnology	University of Georgia-Athens, 2001	Aquatic ecology
Mei Yu*	UPR-RP Institute of Tropical Ecosystems	PhD Spatial analysis, modeling	Chinese Academy of Sciences, 1998	Environmental spatial analysis, GIS and remote sensing
Jess Zimmerman	UPR-RP Institute of Tropical Ecosystems	PhD Plant ecology	University of Utah, 1989	Plant communities and response to disturbances
Xiaoming Zou	UPR-RP Institute of Tropical Ecosystems	PhD Forest ecology	Colorado State University, 1992	Soil nutrients and biogeochemical cycles
James Ackerman*	UPR-RP Biology	PhD Taxonomy, plant ecology	Florida State University, 1981	Plant ecology and taxonomy
Thomas Mitchell Aide	UPR-RP Biology	PhD Community ecology	University of Utah, 1989	Tropical plant ecology, restoration ecology

Paul Bayman*	UPR-RP Biology	PhD Mycology	University of California-Berkeley, 1987	Fungal microbiology
Patricia Burrowes*	UPR-RP Biology	PhD Ecology, herpetology	University of Kansas	Amphibian population dynamics
Elvira Cuevas*	UPR-RP Biology	PhD Plant Ecology	Instituto Venezolano de Investigaciones Científicas, 1983	Soil/plant relationships, terrestrial ecosystem function
María Gloria Domínguez*	UPR-RP Biology	PhD Microbial ecology	University of Aberdeen, 1990	Microbial ecology
Tugrul Giray*	UPR-RP Biology	PhD Animal behavior	University of Illinois, 1997	Animal behavior (bees)
Edwin Hernández*	UPR-RP Biology	PhD Marine ecology	University of Puerto Rico, Río Piedras,	Reef and coral ecosystems
Tomas Hrbek*	UPR-RP Biology	PhD Animal genetic conservation	Washington University-St. Louis, 2000	Animal bioconservation
Rafael Joglar	UPR-RP Biology	PhD Ecology, herpetology	Kansas State University, 1986	Ecology and biogeography of Antillean fauna
Carla Restrepo*	UPR-RP Biology	PhD Landscape ecology	University of Florida, 1995	Landscape ecology, landslides
Alberto Sabat*	UPR-RP Biology	PhD Population ecology	State University of New York at Albany, 1990	population ecology
Eugenio Santiago*	UPR-RP Biology	PhD Plant taxonomy	University of Washington, 1999	Plant taxonomy and biogeography
Richard Thomas*	UPR-RP Biology	PhD Taxonomy, herpetologic biogeography	University of Louisiana, 1976	Biogeography, reptile and amphibian biodiversity
Gary Toranzos*	UPR-RP Biology	PhD Microbiology	University of Arizona, 1985	Environmental microbiology
Rafael Arce	UPR-RP Chemistry	PhD Physical chemistry	University of Wisconsin-Madison, 1971	Photochemistry of atmospheric pollutants
Nestor Carballiera*	UPR-RP Chemistry	PhD Organic chemistry	Universität Würzburg, 1983	Natural products
Oswaldo Rosario	UPR-RP Chemistry	PhD Organic chemistry	University of Puerto Rico, Río Piedras, 1978	Analysis of environmental pollutants, bioaccumulation
Mariano Marcano	UPR-RP Computer Science	PhD Applied mathematics and modeling	State University of New York-Stony Brook, 1998	Numerical systems, linear and nonlinear optimization, mathematical modeling
Gabriel Moreno	UPR-RP Interdisciplinary Science	PhD Sustainable urban systems	State University of New York-Stony Brook, 1990	Urban systems
Heeralal Janwa*	UPR-RP Mathematics	PhD Applied mathematics	Syracuse University, 1986	Information theory, combinatorics

María Eglee Pérez*	UPR-RP Mathematics	PhD Statistics and applied mathematics	Universidad Central de Venezuela, 1994	Statistics and mathematical modeling
Luis R. Pericchi	UPR-RP Mathematics	PhD Statistics and applied mathematics	University of London (Imperial College), 1981	Statistics and mathematical modeling
Gerardo Morell*	UPR-RP Physics	PhD Nanotechnology	University of Puerto Rico-Río Piedras, 1995	Impact of nanotechnology, energy and human systems
Edgardo Resto*	UPR-RP Physical sciences	PhD Biochemistry	University of Puerto Rico-Río Piedras, 1988	Energy and human systems
Indira Luciano*	UPR-RP Economics	PhD Regional economics	Universidad Nacional Autónoma de México, 2005	Regional Economics
Joseph Vogel*	UPR-RP Economics	PhD Ecological economics	Rutgers University, 1987	Ecological economics
Maritza Barreto*	UPR-RP Geography	PhD Marine geography	Universidad de Puerto Rico-Mayagüez, 1997	Coastal resources
Angel D. Cruz*	UPR-RP Geography	PhD Demography, agricultural geography	University of Wisconsin, Madison, 1977	Demography, climate, agricultural geography
Carlos J. Guilbe	UPR-RP Geography	PhD Urban geography	University of Wisconsin, Milwaukee, 1999	Urban geography
Camilo Gomides*	UPR-RP Foreign Lang.	PhD Eco-criticism	Tulane University, 2003	Theory of eco-criticism
Humberto Cavallín*	UPR-RP Architecture	PhD Architecture	University of California-Berkeley, 2006	Design theory, methods
David Román*	UPR-RP DECEP	JD Environmental Law	Tulane Law School, 1994	Environmental Law
Mario Rodríguez*	UPR-RM Public Health	PhD Ind.-Org. Psychology	Carlos Albizu University, 2002	Public Health
Cecilio Ortiz García*	UPR-M Social Sciences	PhD Urban systems	Arizona State University, 1999	Social context of environmental themes
Marla Pérez*	UPR-M Social Sciences	PhD Environmental Sociology	Rutgers University, 2003	Ecological sociology
Vance Vicente	Consultant	PhD Marine sciences	University of Puerto Rico-Mayagüez, 1987	Marine Sciences
Griselle González*	USDA International Institute of Tropical Forestry	PhD Soil ecology/biology	University of Colorado-Boulder, 1999	Soil ecology
William Gould*	USDA International Institute of Tropical Forestry	PhD GIS, landscape ecology	University of Colorado-Boulder, 1998	Landscape ecology, GIS, bioconservation

Jean Lodge*	USDA Forest Products Laboratory	PhD Fungal ecology	North Carolina State University- Raleigh, 1985	Fungal ecology
Ariel Lugo	USDA International Institute of Tropical Forestry	PhD Tropical ecology	University of North Carolina, 1969	Tropical forest ecology
Joseph Wunderle*	USDA International Institute of Tropical Forestry	PhD Avian ecology	University of Minnesota, 1980	Avian ecology
Maria Cruz-Torres*	Arizona State U Transborder Chicana(o)/Latina(o) Studies	PhD		Anthropology-coastal communities
William McDowell*	U New Hampshire Natural Resources	PhD Aquatic ecology	Cornell, University, 1982	Biogeochemistry
David Pijawka*	Arizona State U School of Planning	PhD Geography: Environmental Resources	Clark University, 1983	Environmental planning
Fred Scatena	U Pennsylvania Earth and Environmental Science	PhD Hydrology and geomorphology	John Hopkins University, 1987	Hydrology
Anibal Sepúlveda	UPR-RP School of Planning	PhD Urban planning	Cornell University, 1986	Urban planning
Luis Santiago*	UPR-RP School of Planning	PhD City and regional planning	Cornel University, 1999	Valuation of environmental and natural resources

\* Available professors added to the list after the approval of the Environmental Sciences Graduate Program by the Academic Senate in 2003. All faculty not on the original list approved by the UPR-RP Academic Senate will be evaluated for inclusion in the Graduate Program by the Environmental Sciences Graduate Affairs Committee (see Section). Potential adjuncts to the program from outside of the UPR-RP College of Natural Sciences will be evaluated for inclusion as per Certification 024 1996-1997 of the Board of Trustees.

**Appendix 13. Non teaching staff for the Environmental Science program and the Institute for Tropical Ecosystem Studies.**

<b>EMPLOYEE</b>	<b>POSITION</b>		<b>FUNDING FOR POSITION</b>
<b>Environmental Sciences Program</b>			
Lourdes Figueroa	Secretaria Administrativa III	Administrative and secretarial duties	UPR-RP
Gisela Porras Rivera	Asistente Administrativo IV	In charge of administration of ESP undergraduate program	UPR-RP
<b>ITES at UPR-RP</b>			
Andrew McFadden	Computer Technician	In charge of function, configuration, and installation of computer programs and equipment	LTER
Eda Meléndez Colón	Computer Center Manager	In charge of management, analysis, documentation, and publication of all LTER-generated data. Also in charge of ITES and LTER websites	LTER
Eva Cortés Coss	Executive Secretary I	Head secretary of ITES Director and in charge of travel authorizations for personnel, students and visitors.	UPR-RP
Félix Zurcher	Research Assistant I	Administrator for O Mayol laboratory. Field work and assisting undergraduates with research projects	External grant
John Monge Astacio	Registrador Datos Sist. Línea I	Review and register data compiled from research projects. Produce reports and datasheets for recording field data	LTER
Karla Arenas Acevedo	Asistente Administración I	Maintain ITES sub-accounts	LTER
Wanda Rivera Gutierrez	Oficial Ejecutivo I	In charge of ITES administration; maintain ITES administrative processes and research in conformation with established UPR regulations and policy; support the administration of the El Verde Field Station	LTER
Wanda Ruiz De León	Secretaria Adm. IV	Works directly with the ITES Administrator to carry out secretarial and administrative tasks for teaching and administrative personnel and students	LTER
Widalys Morales López	Asistente Administración III	Maintain requisitions and inventory of ITES property	LTER
<b>ITES at El Verde</b>			
José Rivera Vargas	Trabajador de Conservación	In charge of cleaning, organization, and maintenance of green and external areas of the El Verde Field Station	LTER
Francisco Pérez Rivera	Asistente Administración III	In charge of El Verde administration; maintain administrative processes and research in conformation with established UPR regulations.	UPR-RP/LTER
John Bithorn Torrens	Aux. de Investigaciones II	Collect data and samples from field reseach	LTER
Samuel Matta Cardona	Aux. de Investigaciones I	Collect data and samples from field reseach	LTER

Paola Olaya Arenas	Aux. de Investigaciones II	Collect data and samples from field reseach	LTER
Keysa Rosas Rodríguez	Técnico de Laboratorio I	Administrare research lab of A Ramirez. Collaborate directly with A Ramirez in administration of research lab	External grant
Hilda Lugo Class	Trabajador de Conservación	In charge of cleaning, organization, and maintenance of internal areas of the El Verde Field Station	UPR-RP



## **Appendix 14. The College of Natural Sciences Library resources in Environmental Science.**

The Natural Sciences library has 2,800 book titles catalogued in environmental sciences that deal with subjects related to environmental pollution, environmental problems, environmental engineering, environmental toxicology, conservation, biodiversity, ecology, terrestrial sciences, hydrology, geology, geographic information systems and climate change. It also has hundreds of other educational and reference books on environmental subjects catalogued under the areas of biology, chemistry, physics, and mathematics. This library also has various data bases which allow access to information on the environmental sciences. These are:

1. BIOSIS – Biological Abstract
2. Biological and Agricultural Index
3. Chemical Abstracts
4. General Science Full Text
5. Applied Science Full Text
6. Web of Science

There are also 81 journals in environmental science-related areas. Some of the active journal titles catalogued under environmental sciences, as well as the available years, are indicated below:

1. Ambio 1983-
2. Applied Geography 1983-84, 1995-
3. Bulletin of the Polish Academy of Sciences: Earth Science 1983-
4. Catena 1994-
5. Chemical Geology, Chemical Geology-Isotope, Geosciences 1983-
6. Coastal Management 1995-
7. Conservation Biology 1994-
8. Coral Reefs 1983-
9. Disasters 1995-
10. Dynamics of Atmospheres and Oceans 1982-
11. Ecological Applications 1995-
12. Ecology 1920-
13. Environment 1969-
14. Environment Business 1995-
15. Environmental Conservation 1982-
16. Environmental Geology 1975-1984, 1993-
17. Environmental Impact Assessment Review 1993-
18. Environmental Management 1976-82, 1986-
19. Environmental Monitoring and Assessment 1981-
20. Environmental Pollution 1970-
21. Environmental Science and Technology 1967-
22. Environmentalist, The 1982-
23. EOS Transactions of the American Geophysical Union 1969-
24. Evolutionary Ecology 1994-
25. Geological Magazine 1924-
26. Geological Society of America (Bulletin) 1994-
27. Geophysics 1936-
28. Geotimes 1995-
29. Global Environmental Change 1995-
30. Global and Planetary Change 1989-
31. Ground Water 1995-
32. Helictite 1995-
33. Hydrogeology Journal 1995-

34. International Journal of Geographical Information Science 1998-
35. International Research in Geographic and Environmental Education 1993-
36. Journal of Atmospheric and Oceanic Technology 1984-
37. Journal of Atmospheric and Solar-Terrestrial Physics 1997-
38. Journal of Contaminant Hydrology 1994-
39. Journal of Environmental Economics and Management 1974-
40. Journal of Environmental Management 1995-
41. Journal of Environmental Planning and Management 1994-
42. Journal of Geology 1950-
43. Journal of Geophysical Research 1959-
44. Journal of Geoscience Education 1996-
45. Journal of Hazardous Materials 1975-84, 1991-
46. Journal of Hydrology 1983-
47. Journal of Physical Oceanography 1983-
48. Journal of Soil Contamination 1995-
49. Journal of the Air and Waste Management Association 1989-
50. Journal of the Institute of Environmental Sciences 1995-
51. Journal of Wildlife Diseases (and supplements) 1982-
52. Journal of Wildlife Management (and supplements) 1946-
53. Land Degradation and Development 1995-
54. Landscape Ecology 1995-
55. Limnology and Oceanography 1956-
56. Malaysian Journal of Tropical Geography 1995-
57. Marine Policy 1983-
58. Marine Pollution Bulletin 1970-
59. Molecular Ecology 1994-
60. Mountain Research and Development 1995-
61. North American Journal of Fisheries Management 1981-
62. Ocean and Coastal Management 1995-
63. Oceanus 1995-
64. Oikos 1949-
65. Palaeogeography, Palaeoclimatology, Palaeoecology 1965-
66. Physical Geography 1995-
67. Progress in Oceanography 1984-
68. Remote Sensing of Environment 1994-
69. Resources Conservation and Recycling 1995-
70. Restoration Ecology 1994-
71. Singapore Journal of Tropical Geography 1995-
72. Smithsonian Contributions to the Earth Sciences 1969-
73. Surveys in Geophysics 1986-
74. Tellus, Serie A 1984-
75. Terranova 1994-
76. Water, Air and Soil Pollution 1971-
77. Water Environment and Technology 1989-
78. Water Environment Research 1992-
79. Water Research 1971-
80. Water Science and Technology 1981-
81. Wildlife Monographs 1969-

Because it is an interdisciplinary area, much of the research carried out in the fields of environmental sciences is published in scientific journals catalogued under other disciplines. These journals are cited in the *Environmental Abstracts*. The College of Natural Science library has 49 of these journals cited in the *Environmental Abstracts*, which are not included in the previous list. The titles of the most relevant of these journals are:

1. Accounts of Chemical Research
2. Agricultural and Forest Meteorology
3. American Journal of Science
4. Analytical Chemistry
5. Annals of Nuclear Energy
6. Annual Review of Energy and Environment
7. Applied and Environmental Microbiology
8. Archives of Biochemistry and Biophysics
9. Australian Journal of Zoology
10. BioScience
11. Bioscience, Biotechnology & Biochemistry
12. Biotechnology Progress
13. Bulletin of Marine Sciences
14. Bulletin of the American Meteorological Society
15. California Agriculture
16. Canadian Journal of Microbiology
17. Chemical Research in Toxicology
18. Chemistry & Ecology
19. Chemistry & Industry (UK)
20. Chemosphere
21. Climatic Change
22. Critical Reviews in Environmental Science and Technology
23. Economic Botany
24. Energy Sources
25. Environmental Entomology
26. Environmental Geology and Water Sciences
27. FEMS Microbiology and Ecology
28. FEMS Microbiology Reviews
29. Fisheries
30. Fishery Bulletin
31. Ibis (UK)
32. Industry Week
33. Issues in Science and Technology
34. Journal of Agricultural and Food Chemistry
35. Journal of Aquatic Animal Health
36. Journal of Arid Environments
37. Journal of Atmospheric Chemistry
38. Journal of Ecology
39. Journal of Environmental Education
40. Journal of Power Sources
41. Journal of the Acoustical Society of America
42. Nature
43. New Scientist
44. Science News
45. Scientific American
46. Soil Science Society of America Journal
47. Solar Energy Materials and Solar Cells
48. Trends in Analytical Chemistry
49. Trends in Ecology and Evolution

Through the University of Puerto Rico's Library System, the Environmental Sciences Program also has access to books and journals at other colleges, schools and dependencies of the University of Puerto Rico. Among these are the library in the School of Law which has all environmental regulations on file, in addition to journals and books on related subjects; the library at the Graduate School of Planning; the library at the School of Architecture, the José M.

Lázaro General Library, where the Puerto Rican Collection as well as the Caribbean Regional Collection contain works on topics related to environmental studies on islands; and the libraries at the different campuses such as the Medical Sciences Campus, Mayagüez, and others whose collections are available by interlibrary loans. The libraries at the US International Institute of Tropical Forestry as well as the Agricultural Experimental Station will also be available to students and researchers.

*Other primary sources*

Undergraduate research projects in the past have required information, data or access to public domain data bases produced by local and federal government agencies. If this information is required for graduate research, it will be requested through the same channels. The primary sources for these available data bases include the following, among many others:

*USGS Water Resources Data for Puerto Rico and the Virgin Islands*

Contains water flow registries for 85 gauging stations, sediment transport registries at 26 stations, partial registries at 21 stations, lake level fluctuations for 18 dams, water quality registries at 16 gauging stations, and information for about 42 additional riverside locations. It also contains water quality data from eleven lakes, two lagoons, and a bay, and water level registries for 108 observation wells.

*The Division of Photogrametry and Topographical Maps of the Puerto Rico Highway Authority*

Possesses aerial photos of all of Puerto Rico in 1:15,000 and 1:20,000 scales from the years 1936-1937, 1950, 1960, 1962, 1979, 1980, 1985 and 1997, as well as photos from different years that cover specific areas of the Island.

*SPOT Satellite Images (Satellite Pour L'Observation de la Terre), Multi-spectral Scanner (MSS) and Thematic Mapper*

**SPOT** produces digital images with the greatest resolution currently available. Panchromatic images can be obtained with a resolution of 10 x 10 meters. Because of this, it is used for map making, detecting changes and identifying natural and cultural features. Multispectral images are available in both visible and infrared light spectra with a resolution of 20 x 20 meters, which permits their use in making land use maps, land surface cover, monitoring of the environment and flooded lands, as well as for study of ecological systems, forests, environmental change, land formations, natural resources and environmental pollution. **MSS** is obtained at a low resolution (80 x 60) in order to cover greater areas. It is used in regional planning, large scale cartography and environmental monitoring. The data captured in the **THEMATIC MAPPER** platform has a 30 x 30 meter resolution and is used worldwide for regional planning, environmental monitoring, conservation, mining exploration and many other uses.

*US Census (International and USA Data Bases)*

Provides statistical information on population by census blocks, neighborhoods, towns, municipalities, states, regions, and countries. The available data include mortality and birth rates, natural growth, emigration and immigration, life expectancy, demographic structure, income, number of persons per family, head of family, number of children, age, location, and origin, among others.

*National Climatic Data Center*

Primary source of information for time series data on daily and hourly precipitation, maximum and minimum temperatures, wind speed and direction, atmospheric pressure, cloud coverage, relative humidity, visibility, solar radiation, and other local, regional, and global meteorological parameters.

*USGS WATSTORE Database*

Contains point information as well as statistical summaries on all observed values, seasonal registries for the years when data was collected, and a physical description of each unit of hydrological measure. Each database station has values for diverse observed parameters including flow, water volume in reservoirs, elevation over the base level, water temperature, pH, and total dissolved solids.

*EPA STORET*

Contains water quality data for the 10 EPA regions. These include diverse parameters such as dissolved oxygen, nitrogen, sodium, phosphorus, salinity, electric conductivity, total suspended solids, turbidity, bacteria, organics and inorganics, metals, pesticides and descriptive statistics.

*EPA Toxic Release Inventory (TRI)*

This data base includes all reports submitted to the EPA by facility owners and operators that manufacture, process, or import toxic substances in excess of 25,000 pounds annually, as required by SARA, Title III, Section 313. This data base, which includes Puerto Rico, contains information on more than 20,000 different sites.

*Soil Conservation Service Map Unit Information Record (MUIR): SCS PEDON y SCS Soils 5*

These data bases contain detailed information on laboratory analyses done on more than 16,000 soil series, including the 256 series and different soil types in Puerto Rico. These data include detailed descriptions of soil profiles, including granulometric analysis, organic material content, permeability, Atterberg limits, acidity, structure, chroma, depth, expansiveness, corrosiveness, length, slope, agrological capacity, and water table depth, among others.

*Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS)*

This database contains more than 32,000 different sites that have been identified by the EPA as dangerous places that could potentially require cleaning using funding from the *Superfund* program.

*EPA Leaking Underground Storage Tanks (LUST)*

Provides information on the location of underground tanks from which all type of liquids have escaped into the subsoil causing a significant contamination problem in soil and subterranean waters.

*National Environmental Data Information Systems (NEDIS)*

Identifies all contaminated sites that could be close to commercial, industrial, or residential locations, and that could impact property value or affect the owner. Includes all *Superfund* sites, places with dangerous wastes, registered underground tanks, places where polychlorinated biphenyls (*PCB's*) are handled, sites where spills of dangerous materials have been reported and places where dangerous chemical substances are handled, among others.

*National Resource Recovery Act (RCRA)*

Provides select information on sites whose facilities are registered with the RCRA division of the EPA, with the purpose of legally treating, storing and disposing of toxic residues.

*USGS DIGITAL ELEVATION MODEL (DEM)*

This model consists of a surface of points that provide digital elevation values (z) for any specific location (x,y). Data are available at a scale of 1:250,000 where every degree in the quadrangle contains more than 22,000 elevation values. Those that contain the 7.5 minute series have more than 140,000 elevation values.

*National Earthquake Information Center (NEIC)*

Provides real time information on global seismic activity. Produces summaries of seismic magnitudes and frequencies at the local, regional and global scales. Establishes the magnitude, intensity, hypocenter, epicenter, P, S, L, and R wave arrival times, shadow zone, and diagrams of fault orientation and directions of compressional and tensional forces.

**Appendix 15. Proposed Department of Environmental Science organizational structure.**

