An Undergraduate Intern Program at PACES

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INTRODUCTION

The University of Texas at El Paso (UTEP) established the Pan American Center for Earth and Environmental Studies (PACES) in 1995 to conduct basic and applied research that contributes to NASA's Mission to Planet Earth [1]. Specifically, PACES provides a repository of remote sensing and other information that supports investigations into an improved understanding of geological, ecological and environmental processes occurring in the southwestern United States and Northern Mexico,

Approximately 85% of UTEP's students come from El Paso County, a fast growing urban region representative of many large cities in the Southwest that have, or will soon have, a majority of their population composed of groups currently underrepresented in the scientific and technical workforce. UTEP's student population has an ethnic distribution (63% Hispanic, 32% Anglo, 3% African American, 1.5% Asian American, and less than 1% Native American) that closely matches the demographics of the region it serves. Thus, UTEP has a mission to serve a multicultural population where minority students comprise the majority.

Most Hispanic students at UTEP are primarily of Mexican origin. A large number are first or second-generation U.S. citizens. Characteristics that unite Hispanic students, in particular those of Mexican-origin, are a strong sense of family loyalty and a belief that all family members are responsible for contributing to the economic stability and well-being of the family. Most of their families are larger in number than the national average, and a variety of generations live together or share considerable resources. Thus, many young people feel an obligation and a desire to go to work at a young age and to continue working while in college, thereby assisting their parents and other family members. Older siblings understand that they have responsibilities to do household chores, to aid their younger siblings economically, and to assist elderly family members. This "work ethic" within the context of family responsibilities is often viewed as being as important as higher education aspirations by both parents and university students. As a consequence, much effort at UTEP has been placed in recent years upon creating opportunities for students to earn income while working on campus as undergraduate research assistants on research projects related to their majors. Work assignments of this sort serve to promote retention efforts, to introduce students with the possibility of graduate study and to develop students professionally. Also, the involvement of students in group-oriented research projects at UTEP which require frequent oral and written reports has been proven beneficial at promoting communication skills of students. Because an estimated 60% of UTEP's students are first-generation college students, many are often uncertain graduate education.

PACES UNDERGRADUATE INTERN PROGRAM

The PACES Center has the goal of preparing well qualified young people to enter careers and graduate programs in areas related to environmental, earth and computing sciences and engineering. In an effort to influence students along these lines, the PACES Center initiated an undergraduate intern program during the summer of 1996. The goals of the program are to: (1) introduce student participants to technologies of interest to NASA in particular those of remote sensing and geographical information systems, (2) to develop research skills among student participants through their involvement in a group-oriented research project, (3) to prepare students

to enter a career in an aerospace related field and (4) to encourage student participants to consider graduate school as an option after completion of their baccalaureate studies.

In light of these goals, ten undergraduate students drawn from engineering and science were selected to form the initial cohort of PACES undergraduate research interns. The students were recruited through an application process based in part upon grades but also on the basis of recommendations from faculty and personal statements written by the students relating to their future plans, including interest in graduate studies. In order to expand the pool of applicants, formal linkages were made with the Alliance for Minority Participation (AMP) for the University of Texas System. Whereas PACES has formal collaborative ties with the University of Texas at San Antonio, one of the selected students was from that institution with the rest from UTEP. All students which were selected were Hispanic. For their participation in the program, the students are rewarded with a monthly stipend, which was paid through funds provided with our grant from NASA.

The underlying technologies of NASA's Mission to Planet Earth of primary interest to the PACES Center are remote sensing and geographical information systems (GIS). The use of remote sensing as a tool for analyses of environmental, cultural, and natural resource management characteristics is well documented [3]. A natural companion to remote sensing as a tool for solving problems associated with land-based processes is the geographical information system (GIS). In addition to representing landscape features, a GIS can be used in management to predict the consequences of a contemplated action, evaluate the results of actions that have been taken, and compare alternative actions. In most basic terms, a GIS is a computerized mapping system for capture, storage, management, analysis and display of spatial and descriptive data.

During the summer, the student interns were provided with a series of lectures on different aspects of remote sensing and geographical information systems. The lectures were held daily in the PACES Center over an eight week period. The textbook by Sabens, [3], and its accompanying laboratory manual were used for instruction. Additionally, the students were provided with instruction in the use of the image processing software package, PCI and a geographical information software system, SPANS Explorer,

The PACES Center provides summer support for eight science and engineering faculty at UTEP who are involved in projects relating to the PACES research mission. Each of these faculty gave an afternoon-long seminar on the research that they were performing and how it related to NASA's MTPE. At these seminars, students were able to recognize how remote sensing could be applied to solve down to earth problems. Additionally, they were able to ask questions and were 'able to observe what a future appointment as a graduate student might be like.

AFRICANIZED HONEY BEE INVESTIGATION

In 1956, the African honey bee was introduced into Brazil. The hope was to create a strain of honey bee which was better suited for the tropical environment of South America and to improve honey production. In 1957, 26 colonies escaped and began interbreeding with the native bees. These new Africanized Honey Bees (AHB's) have a greater tendency to swarm and abscond than domesticated European honey bees. The AHB's have been spreading at a rate of 80 to 500 kilometers annually. At the present time, the AHB has successfully colonized much South and Central America. At the present time, there appears to be no known obstacle that will prevent its colonizing the warmer areas of the United States [4]. In the path of their northward migration, they have reduced honey production and negatively impacted crop pollination, livestock production, tourism and public health. The migration of the AHB's reached the United States in October, 1990 near Hidalgo, Texas in the lower Rio Grande valley. At the present time, AHB sightings have occurred in parts of south and west Texas, southern New Mexico, southern Arizona, the central valley of California.

The impact of AHB's on local economies has been significant. Based on 1981 prices [5], the U. S. beekeeping industry may experience annual losses in the range of $26-$58 million if the AHB

700

colonizes the Southern and Southwestern U.S. and causes the same types of problems it has caused in South and Central America. In some areas, beekeeping and honey production declined because as many as 80% of the amateur beekeepers abandoned their colonies, up to 20% of the commercial beekeepers quit beekeeping, and hone y production by the remaining colonies declined. Although the AHB is implicated in changes in honey production, other factors including weather, destruction of forests and increased pesticide use (especially on cotton) may have contributed to reduced honey production.

At the Spring Advisory Board meeting for the PACES Center, research personnel from the Center for Health Applications of Aerospace and Related Technologies at NASA Ames Research Center suggested that it would be interesting to investigate the northward migration of Africanized Honey Bees (AHB's) using remote sensing and geographical information systems as tools. From this recommendation came the centerpiece group research project for the PACES undergraduate interns. As a consequence, the summer interns were organized into a research team with the goal to develop a GIS to track the northward migration of the AHB and to better understand the interaction of climatic, ecological and environmental factors influencing their movement.

The PACES Center acquired a software package for GIS development, SPANS Explorer, which is distributed by TYDAC Technologies, Inc. The SPANS Explorer software package has several formats for data layers and methods for analysis well suited for the AHB migration study. As background, at the core of any GIS is a base map. Information can then be added to complement the base map by overlaying data layers.

The attribute data that is being used in the development of the AHB migration GIS can be grouped into the categories of climatic, land usage and bee sighting data. The data in each of these categories are incorporated into the GIS as data layers. The first category, climatic data, consists of the number of frost free days, the average monthly temperature and amount of precipitation. This data is compiled on a county-wide basis. All three of these factors have been reported as important factors influencing the migration of AHB's [5]. The climatic data was acquired form the National Weather Service and the National Climate Data Center. The second category of data, land usage, is being assembled on the basis of information being acquired from State Departments of Agriculture and Commerce. The third category of data, bee sightings, provides the most important information of likely bee migration.

Information regarding the characteristics and spatial distribution of the Earth's land cover is critical to understanding AHB migration. During the past decade, substantial progress has been made in using National Oceanic and Atmospheric Administration (NOAA) Advanced Very High Resolution Radiometer (AVHRR) data for land cover characterization [6]. AVHRR data have only moderate spatial resolution (1 km) when compared, for example, to Landsat's 30 m resolution for thematic mapper or SPOT's 20 m for multispectral and 10 m for panchromatic data. However, the AVHRR data is collected more frequently with virtually entire global coverage twice each day. The high frequency of coverage enhances the likelihood that cloud-free observations can be obtained for specific temporal window, and makes it possible to monitor change in land cover conditions, over short periods, such as a growing season.

At the present time, remote sensing data obtained from the AVHRR sensor is also being incorporated into the GIS through a data layer which stores vegetation greenness. Greenness is most often quantified using a vegetation index, commonly the Normalized Difference Vegetation Index (NDVI) [7] which can be calculated using the AVHRR sensor suite

In our investigation of AHB migration, AVHRR data is being used to characterize land cover in our study area which includes much of the southern border region of the United States with Mexico. To date, we have imported hi-weekly NDVI calculations back to the year 1989. We are using time series of NDVI readings to stratify regions of vegetated land cover from barren land. We next intend to perform an unsupervised learning procedure to extract clusters of the various land cover types in our study region.

SUMMARY AND FUTURE WORK

The progress made by the PACES Undergraduate Interns during the summer period was impressive, The group was able to develop a rudimentary GIS with attribute data relating to climate and bee sightings. At the end of the summer, PACES sponsored a trip to NASA Ames Research Center to enable the students to present their research results. Two group presentations were made: one stressing the biological characterization of the AHB's and the other emphasizing the software aspects of developing the GIS. While at Ames, the interns were able to interact with numerous scientists and engineers as well as to visit numerous research facilities. In addition, the students were able to gather information about graduate education opportunities in the San Francisco area.

Following the summer, all interns continue to work on various aspects of the project as undergraduate research assistants. At the present time, correlation studies which are based on observations of the standard deviation of NDVI measurements from the AVHRR data are being conducted. As an adjunct to the project, the interns have accepted the challenge of community service by developing plans for the construction of a bee observatory. The bee observatory will house actual bee colonies and will include information on the habits and behavior of bees. Plans call for the building of two bee observatories. One will be located on the grounds of the Chamizal National Monument located on the international border in El Paso and the other will be sited on the UTEP campus. It is hoped that the bee observatories will serve to educate the public on bees and their value to our society and the economy. They will also be utilized in a variety of science outreach programs directed at young students.

At the present time, we envision a series of student publications to result from this program [8]-[10]. Also, one student will soon complete a senior Honors Thesis on work completed through the program. The experience gained from the preparation and presentation of research papers at professional meetings and to groups of professionals has had a very beneficial impact on all student participants.

ACKNOWLEDGEMENTS

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