

Integrative and Interactive Teaching and Learning about Sustaining the Natural Resources in a Changing Climate

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Abstract

To increase the number of students prepared for employment and/or graduate school in diverse technical fields relevant to global climate change and sustainable natural resources, the Urban Forestry Program at Southern University has implemented the projects to enhance the urban forestry curricular through the integration of global climate change into urban forestry and natural resources education. The project is being accomplished through an ecosystem modeling approach focusing on how climate change affects urban ecosystems and their major components such as forests, wetlands, and water, and how to mitigate the effects thereof. In teaching and learning, we have utilized many state-of-the-art models, such as the urban forest ecosystem service assessment model I-Tree Eco, Educational Global Circulation Model that simulate global climate change, and the water resource model Hydrological Simulation Program – FORTRAN. The project team has created a new course titled “Sustainable Urban Forests in a Changing Climate” and its accompany student workbook/learning resource book. We have implemented an annual climate change and urban ecosystem symposium to enhance student-scientist interaction and scientific exchange. To foster students’ critical thinking, we have established an annual student forum. The integrative and interactive teaching and learning enabled students to gain knowledge about natural resources in a changing climate and to learn strategies to address the complexities of the urban ecosystems, and to better able to apply learned knowledge to related fields for increasing their competitiveness. The projects strengthened education capabilities, enhanced students’ marketability and workforce preparedness, and developed sustainable partnerships.

Keywords: global climate change, ecosystem, modeling approach, natural resource, urban forestry

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Introduction

The multidisciplinary and rapidly evolving nature of climate change causes, consequences, and solutions presents a challenge to us as we seek to educate our students on critical contemporary issues. Students need to learn not only the causes of climate change, but also how to mitigate and adapt to changes already beginning.

Natural resources sustainability and ecosystem benefits are highly dependent on an environment that is changing globally. Previous studies have indicated that the Gulf of Mexico (GoM) coastal region, including Texas, Louisiana, Mississippi, Alabama, and Florida, has, and will, continue to experience increases in temperature, precipitation, and extreme climatic events such as hurricanes in the next 50 years (USGCRP, 2009; IPCC, 2007; Mellilo *et al.*, 2000; Burkett *et al.*, 2001; Ning *et al.*, 2010, 2003, and 1999; Abdollahi *et al.*, 2000). Climate change will bring acceleration in sea level rise and thus storm surge damage. Seventy-one percent of the coastal land in the U.S. between 0 and 3.5 m above mean sea level is in Florida, Texas, Mississippi, Alabama, and thirty-three percent is in Louisiana. Twenty-three percent of Louisiana's land area is in the path of a hurricane. New Orleans is located seaward of the upland edge of this vulnerable zone. The combination of hurricane frequency and strength, geographical position, and the elevation gradient creates a potential impact zone that is the highest anywhere in the US. Vulnerability to ecological catastrophe is likely to increase, as will the broad social consequences, as climate change proceeds.

Our knowledge in understanding climate change is essential if there is to be a solution to the daunting climate change challenge (PCGCC, 2009). Global climate change education and research are urgently needed so that we will possess the knowledge and skills to contribute to both the mitigation and adaptation strategies. The challenge that the climate scientists face is how to communicate the existing knowledge and future research findings to the public. The university professors, school teachers, and other educators, who have the most direct contact with the public in the realm of science education, need to take more immediate ownership of the climate change issue (Gentile, 2010).

Therefore, Southern University has implemented the climate change education projects. Funded by NASA and USDA NIFA, The projects focus on climate change education, research, mitigation, and adaptation in the GoM coastal zone. It is important to focus on this area because of the region's population size and density. Thirty-two percent of the populations in the GoM region live in the coastal zones that comprise twenty-three percent of the region's total land area. Louisiana also has a majority of its population in coastal counties, of which, about thirty-eight percent are minorities, as defined by the U.S. Census Bureau.

Integrating Climate Change Science and Ecosystem Sustainability into the Curriculum

To integrate climate change science and ecosystem sustainability into the curriculum, we have created new courses both at undergraduate and graduate levels, such as Sustainable Natural Resources in a Changing Climate (undergraduate level), Tree Biomechanics (M.S. level), Sustainable Urban Forest Management in Urban - Rural Interface (Ph.D. level), and Urban Phytoremediation (Ph.D. level). By using the best

available teaching tools and the most appropriate pedagogical methods, these newly created courses have enabled students to tackle complex problems. The integration of climate change, water resources, and sustainability, issues of critical importance to the world, to the curricular at SU is a significant effort in enhancing the curriculum both at undergraduate and graduate levels. The enhanced curricula have enabled students to be educated with most current national and international initiatives, and have prepared students for the workforce in a changing world.

Interactive Ecosystem Modeling

We use innovative approaches in course delivery through the use of Web-based interactive teaching tools, such as computer models, 3D and virtual learning, and e-learning to promote students' learning interest, imagination, and creativity. For example, for the newly created Sustainable Urban Forests in a Changing Climate course, we collaborated with Columbia University to bring the most up-to-date Educational Global Circulation Model (EdGCM), into teaching and learning. The model stimulated students' learning desire and enhanced their understanding through vibrant visual simulation and climate change predictions under different scenarios.

Using SU campus and the surrounding communities in Scotlandville and city of Baron Rouge - where students live, study, and play - as a teaching and learning laboratory, we collaborated with the USDA Forest Service Northern Research Station and Southern Research Station in teaching students how to use i-Tree Eco model to quantify urban forest ecosystem services such as CO₂ sequestration, carbon storage, building energy saving, and pollution removal. The modeling results demonstrated to students how urban forests can improve the quality of their lives. The students therefore become more eager to learn the subject matter and more determined to be the future managers of the urban forests in the nation.

To improve teaching and learning about water resources, we have organized faculty and student training workshops on Hydrological Simulation Program – FORTRAN (HSPF) in collaboration with Louisiana State University. Participants learned the utility of HSPF, modeling results of climate and land-use change impact on water resources, and water resource management strategies.

Experiential Learning

To combine classroom lectures with experiential learning, we take students to field trips to convey scientific information in a more interesting and appealing way. For example, when teaching sea level rise and its effects on coastal wetlands and forests, we took students to the coastal barrier islands in collaboration with Dr. R.E. Turner of Louisiana State University and Dr. Nancy Rabalais of Louisiana University for Marine Consortium. The field trips provide hands-on learning opportunities for students on ecological issues, such as identification and characterization of Gulf habitats affected by sea level rise, wetland and coastal forest conservation and restoration, etc. The field studies challenged students to envision the consequences of sea level rise at specific places over various time periods thereby addressed the chronic and catastrophic aspects and the need for developing management tools. The participating students became the catalyzing agents of change, attract others, for adaptation in the classroom and afterwards.

Each summer we send a group of students to study at our partners' research sites such as USDA Forest Service, North Carolina State University, East Carolina University, etc. The experiential learning opportunities provide students with a strengthened awareness of the inter-relationships among natural resources and the ecosystems, allow students to interact with the scientists, develop relationships, and prepare for future employment.

Foster Critical Thinking Skills and Communication Skills

To foster critical thinking skills, we demand students to conduct literature review of the subject matter and write papers to critic the literatures that they reviewed. We have created first time at SU the end of semester Student Ecosystem Forum that lead to student engagement in current topics, scientific debates, and professional discussion. The learning outcome surpassed what a final exam could only achieve.

To enhance scientific exchange and improve teaching and learning, we implemented an annual climate change and ecosystem sustainability symposium to introduce most current science and to bring together nationally and internationally renowned research leaders and educators. The symposium increased the level of scientific competency of faculty and students and served as a vehicle for partnership building and networking.

To enhance oral communication skills, we host training workshop on How to Communicate Science in a Story-Telling Style in collaboration with Randy Olson, a biologist and an educational film maker. When communicating science to the public, the most common and most difficult question that the communicators face is "why should we care"? The workshop taught students how to construct scientific topics into concise and powerful stories that even the disconnected audiences can be made to care about and take an interest in the topics. An advantage of the workshop is that students learn about the culture of science, while learning how to be interlocutors for positive societal learning. The students take ownership of the scientific knowledge on their own terms and become a window into the community.

Conclusion

The integrative and interactive teaching and learning enabled students to gain knowledge about natural resources in a changing climate and to learn strategies to address the complexities of the urban ecosystems, and to better able to apply learned knowledge to related fields for increasing their competitiveness. The projects strengthened education capabilities, enhanced students' marketability and workforce preparedness, and developed sustainable partnerships. The project team have enhanced at least eight existing courses with most up-to-date materials, and developed 4 new courses. Products also include internships, short courses, field trips, workshops, symposia, student forums, seminars, conference presentations, journal publications, and K-12 outreach, etc. The project team provided valuable information on climate change impacts on ecosystems and mitigation strategies to educators, students, and community members; and benefited the stakeholders and the society in economic, environmental, and social aspects.

The project team contributed to GoM regional recovery and post hurricane and storm restoration. The projects led to a multiple research outputs from participating faculty and students. The projects also increased awareness and competence on campus. The projects fostered collaborations across disciplines and strengthen the ties with our partners. The projects helped the University developing competitive education and research programs in climate change. The enhanced programs attracted more students into careers in STEM related fields.

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