SUMMARY REPORT

STATE UNIVERSITY SYSTEM CLIMATE CHANGE TASK FORCE WORKSHOP

MARCH 18, 2011
FLORIDA ATLANTIC UNIVERSITY
BOCA RATON, FL

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Table of Contents

EXECUTIVE SUMMARY 3
INTRODUCTION 4
WORKING GROUP BREAK-OUT SESSION SUMMARIES 4
Assessment of Climate Change Scenarios 5
Biodiversity and Land Use 6
Coastal County Adaptation 7
Education and Training 8
Water Management 9
ONGOING WORK 10
APPENDICES 11
APPENDIX A. WORKSHOP AGENDA 11
APPENDIX B. BREAKOUT SESSION QUESTIONS 12
APPENDIX C. WORKING GROUP SUMMARY NOTES 14
Assessment of Climate Scenarios Working Group 14
Biodiversity and Land Use Change Working Group 16
Education and Training Working Group 19
Coastal County Adaptation Working Group 24
Water Management Working Group 26
APPENDIX D. RESEARCH GAPS BY TOPIC 29
APPENDIX E. UNIVERSITY CLIMATE CHANGE INSTITUTES, CENTERS & INITIATIVES 31
APPENDIX F. KEY STATE AND FEDERAL AGENCIES 32
APPENDIX G. LIST OF ACRONYMS AND INITIALISMS 33
APPENDIX H. PRE-WORKSHOP QUESTIONNAIRES RESULTS INCLUDING RESEARCH & COURSES 34

EXECUTIVE SUMMARY

This workshop was an activity of a recently awarded State University Research Commercialization Assistance Grant New Florida 2010 Clustering Award. This project focuses on identifying current State University climate change expertise, research and curricula; enhancing cooperation with State and Federal agencies to bring science into climate change-related decision making; and developing a climate change information system and portal that will connect State University System (SUS) assets with these agencies and other groups to facilitate communication.

During this one-day workshop, the lead representatives from Florida Atlantic University (FAU), Florida State University (FSU), and University of Florida (UF) set the stage with a discussion about the project and its goals. This was followed by concurrent breakout sessions covering five climate change topic areas: 1) assessment of climate change scenarios; 2) biodiversity and land use / land cover change; 3) coastal county adaptation; 4) education and training; and 5) water resources management. The workshop outcomes described in this summary report are intended to guide the development of white papers on each topic area as part of the final project deliverables.

Among the ongoing tasks identified were:

- Creation of a web portal to share climate change information within the SUS and with cooperating agencies;
- Downscale global climate projections to be more relevant to Florida;
- Identify the effects of land use changes due to climate-generated population resettlement and biodiversity, and assess the impact of climate change on Florida's vital agriculture;
- Examine the current and potential impact of climate change on Florida's coastal resources, economy and job creation;
- Create a source of centralized, integrated data to help the entire system of water management;
- Develop a cross-university certificate program in climate issues to provide opportunities for any student without having to duplicate courses across SUS campuses.
- Work with state and federal agencies to target their priority needs as work progresses.

The workshop served as a good vehicle to expand the team working on the project. These teams will be further expanded as we move forward. It was gratifying to see the level of involvement by all the universities present. Preliminary results of the generated white papers and other project products will be presented at the fall conference set for November 14-15, 2011 in Gainesville at the University of Florida.

INTRODUCTION

The SUS Climate Change Task Force Workshop was the initial effort to reach out beyond the three-university project team and involve other State universities in the work to:

- Confirm priority climate change topics;
- Initiate working groups for high priority topics;
- Provide information for a State-wide data system;
- Identify existing climate change courses and curricula and determine unmet needs;
- Identify universities interested in joining the Florida Climate Institute or developing an SUS consortium to facilitate greater cooperation on climate change research, education and outreach.

Florida Atlantic University had the prime responsibility of organizing the initial workshop, which was held on the Boca Raton campus. Telephone conference calls among the project teams at FAU, FSU, and UF were used to plan the workshop and to develop a questionnaire for gathering research and curriculum information from each of the invited participants from across the SUS universities. A compilation of this information is provided in the Appendices, with more detailed workshop participation summaries, lists of identified research gaps and key agencies to involve.

Thirty-nine registered attendees representing seven SUS universities participated in the workshop: FAU, FSU, UF, Florida Agricultural & Mechanical University (FAMU), Florida International University (FIU), University of Central Florida (UCF), and University of South Florida (USF). Two faculty members from the University of Miami (UM), who are actively involved in research on climate change, also attended the workshop and are interested in contributing to this effort. After the initial presentations, attendees broke into five working groups, based on the priority climate change topics. Through a series of seven questions developed by the project team members, each group provided information for use in developing the white papers, which will be major products of the project. Groups identified other individuals and agencies that should participate in the ongoing work. The working group summaries shared in the closing plenary provided detailed information on each topic which will guide the white papers and which begins the ongoing collaboration for the remaining tasks.

WORKING GROUP BREAK-OUT SESSION SUMMARIES

Below are brief summaries of the discussions conducted during the working group break-out sessions, highlighting the key points, issues, vulnerabilities and research gaps. The questions that guided discussion for each group can be found in Appendix B. The expanded notes for each working group are in Appendix C; research gaps are listed in Appendix D. A list of acronyms and initialisms is provided in Appendix H. Climate change institutes, centers and initiatives and agencies and other contacts that were recommended for involvement in this effort are shown in Appendices E and F, respectively. Appendix G provides research and coursework information from the pre-workshop questionnaires from the workshop program. In order to represent the whole SUS, this section was expanded to include similar information from Florida Gulf Coast University, University of North Florida and University of West Florida.

Assessment of Climate Change Scenarios

The moderator for this group was Eric Chassignet, FSU. The session started with a general discussion on how we project ourselves in the next five years as part of a joint SUS-wide center.

There is a growing consensus that sea level rise (SLR) and temperature change are the climate change effects most relevant to Florida. Although coupled feedbacks are an integral part of the Earth system, the physical climate system of ocean-land-atmosphere can provide boundary conditions (scenarios) for application in other fields. So far in the 21th century, the SLR of the Southeast US is commensurate with global SLR.

Climate change challenges will become more acute in the future, exacerbated by high population density projections in Florida, with needs to engage private funding regarding climate change, e.g., insurance and utility companies. Engaging private donors and interdisciplinary skill sets will make proposals very competitive. There is an NSF general call for Science and Technology Center (STC) proposals to build a Center of Excellence. Proposals need a clear goal and must show economic impacts. The Southeast Florida Regional Climate Change Compact is a collaborative effort, a joint commitment of 4 counties (Palm Beach, Broward, Miami-Dade, Monroe) to partner in mitigating the causes and adapting to the consequences of climate change.

Climate models are deficient, with a need for cryosphere models that include ice dynamics to obtain realistic sea level rise estimates. Forcing functions are needed on future climate for greenhouse gases, temperature and sea level rise. An important question: will Probability Density Functions (PDFs) shift?

The Intergovernmental Panel on Climate Change (IPCC) provides the most thorough SLR estimates, but it does not include the melting of ice. The IPCC projection for sea level rise is far too conservative and should be scaled up by 20%, to 1 m by 2100. GRACE satellites provide direct information on how the mass of Earth's ice is changing. This research has already invalidated IPCC projections. They should have a more accurate estimate within the next 10 years.

The availability and exchange of data (boundary conditions) between models is important. There should be PDFs for each variable. The IPCC central repository for model-generated datasets (100 year simulations) are hosted by the Program for Climate Model Diagnosis and Intercomparison (PCMDI). Data are also available through the Earth System Grid web portal. Some downscaled data are available.

Remote changes can have extreme local impacts: the IPCC projects that drought over the Caribbean islands will cause climate refugees to migrate to south Florida. Recent research on the study of local changes in hurricane intensity due to climate change has suggested that there will be a lower frequency of storms, but they will be more intense. The methodology and results of this study are now considered questionable.

Anthropogenic influence of irrigation and urbanization on local climate of Florida and the North American and Atlantic Decadal Oscillations (NAO/AMO) impact on Florida are significant. AMO is controversial and may not exist. A coherent 5 cm decadal signal along the entire western boundary (Atlantic coastline) could mask or enhance SLR variations. A long time averaging scheme is needed to avoid aliasing/ misinterpreting this signal. Climate data for Florida are available at USF, National Climatic Data Center (NCDC), National Hurricane Center (NHC), FSU and U.S. Geological Survey (USGS).

There is a need for downscaling global projections, and how to consolidate projections from a variety of models. Quantitative estimates will be helpful in planning. Other identified gaps are: a comprehensive regional reanalysis for the physical climate system of Florida; a regional earth system model for Florida; an understanding of remote impacts of climate on the southeastern US / Florida. "Downscaling" needs to be defined so it is clear to the general public what this refers to.

Biodiversity and Land Use

The moderator for this working group was Susan Cameron Devitt, UF.

The group identified sea level rise (SLR) as the issue that potentially will have the biggest impact to biodiversity and loss of habitat, with drivers such as temperature and precipitation variability. If SLR is slow its impacts can be ameliorated by the hydraulic strategy of raising fresh water flow, but at some point this strategy will fall short. SLR will lead to changes in the water table which impacts both coastal and inland fresh water resources.

Wildlife habitat and food web biodiversity are vulnerable to an increase in climate variability, and will likely lead to an increase in disease and invasive species and a change in the distribution of species. Land use is expected to change due to increased population growth and inland migration. Current agricultural practices will also need to adapt to natural resource limitations (e.g., water) and temperature variability. Regional agricultural products will change as the frost line moves. Sustainable agricultural practices will alter the viability of species.

Research related to climate change within the Florida SUS includes

- Down-scaling climate models for Florida
- Seasonal weather pattern data of plant blooming cycles Niche and spatial modeling of SLR that includes evolutionary and phenotypic plasticity
- Paul Zwick continues to work on regional scale models
- Specific SLR adaptation assessment to gather information on a multi-county scale

Other noted research outside the SUS are

- Florida Regional Planning Council to look at population stressors / growth in the area north of Okeechobee (SLR-exacerbated human population increase)
- USFWS / MIT – collected Lidar data and created future SLR / land use scenarios
- Archbold workshop

The group discussed the value and challenges of the "Outreach, Training and Research" approach of land grant institutions. There are various programs and groups interested in biodiversity. It was suggested that it is important to put literature in public places to start dialog.

The lack of consensus on climate models and scenarios creates a lack of precision in SLR estimates and impacts in Florida. More monitoring is needed to update and validate models. Existing models need to incorporate interactions between incremental and episodic climate-driven events; include multiple climate scenarios; and differentiate climate impacts from sea level rise.

Additional research needs and gaps exist to: perform additional species and natural community assessments; identify potential land use changes due to increasing human population and re-settlement; determine how to accommodate a growing population while not negatively affecting biodiversity; update weather data to ensure that data are accurate and credible; research the potential negative impacts of adopting biofuels; examine the connectivity between the drivers that

affect climate. The group recommends adopting the 2060 Planning Horizon document to address statewide planning gaps and for general issues.

The Florida Fish and Wildlife Commission (FWC) is currently revising their State Action Plan to include climate change. The Landscape Conservation Cooperatives (LCC) structure divided the country into zones to coordinate climate variability, research and conservation across political boundaries. Counties are required to do comprehensive plans and have land use maps, which vary in accuracy and thoroughness. These should also address climate change. The effects of legislative changes are uncertain. Key decision makers, interdisciplinary and collaborative programs, and communication needs and existing programs are described more fully in the expanded notes for this group in Appendix C.

White papers should seek to connect Florida issues and findings to similar data or climate effects occurring elsewhere. Think beyond the state level when applying the principles of conservation and land use.

Coastal County Adaptation

The moderators for this group were Thomas Ruppert, Florida Sea Grant UF, and Jaap Vos, FAU. The group began by defining the topic and desired outcomes of the workshop. The scope of this topic is very large and the need for more people at the table was voiced. Coursework related to climate change needs to be identified, but will be covered by the Education and Training Working Group.

What is "adaptation"? It includes adapting to SLR, the changing of society to future trends, and adapting to changes in temperature, rainfall, and other weather-related items. A better understanding of mitigation is needed and how it relates to greenhouse gases, etc.

Given the breadth of potential scenarios related to this topic, the general consensus of this working group was to focus primarily on the urban system regarding coastal adaptation. Meeting outcomes that would be helpful for the white paper include developing an understanding of:

- Local/state/government attitudes and perceptions, and the appropriate level of government to address
- Steps policy makers can take in response to climate change issues
- The current and potential role and collaboration of educational institutions regarding climate change, SLR, and issues that relate to adaptation
- The gaps in science and the institutional capacity of the SUS to address them
- What people are doing; what planners can do
- The actual scope and bias of issues that relate to adapting our coasts

Other items on the working group wish list were a web portal with "Wiki"-style resources, and to modify the scope and terminology of the charge for this working group.

The main vulnerabilities and impacts in coastal areas relate to increased rainfall, increased storm intensity and SLR, plus related insurance and health issues. In addition to lack of funding for appropriate research, there is significant difficulty in cross-disciplinary research.

There are many quality of life issues. They cover the full spectrum of people issues, beach erosion, housing and coastal infrastructure, energy needs, the economy, tourism, agriculture, water issues, natural systems and recreation. Regarding the general population, there are varied economic groups, varied economic resources and gaps, and varied societal capital resources. There are also the disenfranchised groups, such as the environmental social justice advocates.

Within the broad white paper outline, the group recommended setting up a matrix of institutions and agencies/counties, to identify who is doing what, research gaps, institutional capacity, existing and potential connections, coursework, and county actions (short and long term). Population models and identified vulnerabilities should be included. An interdisciplinary approach can determine what research is needed to get action from policy makers. It is important to consider the target audience.

Education and Training

The moderator for this group was Jim Jones, UF. The session started by discussing the courses known to be offered at the various universities. Other courses likely exist.

There are specific efforts regarding development of climate studies coursework at FSU and FAU. FSU's focus is to develop an understanding of the basic science that governs our climate through its EOS and Meteorology departments. FAU has categorized their courses by differing levels of climate change focus. The group discussed creating a matrix using these categories that could be available to prospective students within the SUS. The matrix could be divided by: department, college level, and degree or certificate programs. Courses and programs outside the SUS, (Columbia University, (National Center for Atmospheric Research (NCAR), Cooperative Program for Operational Meterology, Education and Training (COMET), could serve as models for this matrix.

FSU and UM were identified as the strongest universities for identifying educational opportunities in the SUS regarding climate change or related areas of study. A web page was proposed for all SUS courses with links to appropriate programs. Key faculty and programs, and potential guest speakers need to be identified. Information regarding public communication is available on the University Corporation for Atmospheric Research (UCAR) web site.
FAU staff researched the mechanism by which a student can take courses from other universities. The Transient Student Form (see below) is available. Difficulties with course equivalency and the number of out-of-college credits that someone could take (perhaps six credit hours) need follow-up. Gaps in undergraduate and graduate climate change-related education programs were identified, including the integration of climate change education with other sciences, translating the science for the broader student community, and funding for course development.

Challenges include the generation of student credit hours and courses that can be transferable. There is a lack of interdisciplinary emphasis in courses. A change in behavior is needed at the university level, which is the driver for getting these courses offered. One suggestion is for climate change courses to be part of the main curriculum so that it is widely offered.

Continuing education and outreach programs include: the UM program "Enabling Capable Climate Communicators" by Dr. Hal Wanless, the Office of Sustainability at UM; EXPLORES at FSU, teacher training at USF and FAU funded by NASA's Global Climate Change Education. There are other programs with a broader focus through IFAS, Sea Grant and Land Grant. Few programs are specifically focused on climate change; others, if they exist, need to be identified. It was recommended to check with Water Management Districts, USDA – NRCS, and the Office of Emergency Preparedness to determine if they include climate change for staff development or in outreach programs.

A Climate Change Certificate across the whole SUS was proposed to advance climate change learning and improve communication between universities. This could be implemented through distance learning across the SUS. Suggestions for this certificate are for it to be coordinated by one agency, consist of four to five courses, include Social Sciences, and reflect an ongoing

assessment of curriculum needs. Nationally funded climate change SUS projects were identified at USF, UF, and FSU.

During a discussion about key decision-makers involved in climate change issues (including interdisciplinary and collaborative programs or working groups), various contacts and their research programs were identified. These include educational institutions and state and local agencies, including emergency management. More people are needed at the table.

Water Management

The moderator for this working group was Dr. Len Berry, FAU.

The group began with a discussion of the key vulnerabilities and impacts from climate change. The primary area of reference and concern at this time is from Lake Okeechobee southward. Information from this locale may be useful to other at risk low elevation / high risk SLR areas of the state, such as Big Bend, St. John's River, Tampa Bay and Apalachicola. Intense precipitation, SLR, the low number of reservoirs, inland flooding all relate to the issue of "too much water." Topics relating to the impacts of SLR on groundwater are extreme weather events, shifts in seasonal rainfall and drought, water quality degradation and a change in the use of the surficial aquifer. Stormwater topics include system design and infrastructure, gravity flow and groundwater de-watering, soil characteristics, and watershed issues. Demand management will be important for efficient water use. Energy demands associated with SLR were discussed. Once the gravity-driven system is affected, more energy will be needed for pumping, etc. There will an increased demand for nuclear power and solar power as the population grows.

The discussion on current research and outreach within the SUS was separated by what was being done by Florida's universities and research being done by outside agencies. Water-related topics being researched within the SUS include downscaling global models and drivers, the water/energy nexus, adaptive systems for urban use (e.g., decentralized systems), transition issues (infrastructure), extreme events and assessments for the future. SWITCH is a global water research project funded by the European Union and conducted through the Patel Center for Global Solutions at USF, to develop solutions for sustainable and effective water management of a city in the future (2050). There was some discussion if and how that could be applied to urban and rural areas in Florida. Another major topic of discussion related to the household level of water use, including people's perceptions and interpretations of what they hear.

Outside the university system, water quality and other monitoring data are being collected by Water Management Districts, utilities, Broward and other counties, and USGS.

Among the major research gaps identified, data sharing was foremost. A consistent and accessible centralized data location is needed, as well as communication to reduce data duplication. Other gaps are: the management of water demand using semi-centralized water use areas (the Patel Institute model); relating water management issues to the vulnerabilities identified for surface and groundwater resources; the potential use of the Everglades for water storage; information on the location of monitoring wells used by various agencies; cost and regulatory hurdles; effects of water on natural systems; and a means to measure agricultural water use.

The key decision-makers with the biggest roles in climate change issues for water management are the Water Management Districts, county and local governments, and utilities, plus regulatory and planning agencies, the U.S. Departments of Defense, Interior and Homeland Security, land developers, grass roots groups, and the National Flood Insurance Agency.

Interdisciplinary and collaborative programs and working groups were identified, both within the university system and externally. Key external groups include the Public Water Utilities Working Group, the Four County Compact, and Resilient Tampa Bay. Various innovative communication needs, existing and potential methods and innovative opportunities were identified.

Suggested topics for the Water Management Working Group White Paper were identified. The group suggested that part of the output of the white paper could be to identify three or four regions as potential case studies, with details describing where the deficiencies are and possibly including demonstration areas and monitoring information.

ONGOING WORK

Working groups based at the lead universities are actively reviewing the working group findings and recommendations and other information collected at the workshop as they begin to develop the white papers. The universities with prime responsibilities for these works are based on topic: FAU – Water Management and Coastal Adaptation; FSU – Assessment of Climate Change Scenarios; UF – Biodiversity and land use change; UF, FAU, and FSU – Education and Training. Communication between and among the white paper groups will be done via a web portal developed by FSU.

Collaborations with other groups relevant to these white papers will provide an opportunity to exchange and share information as papers develop. The following is a partial list of current collaborations. Information generated from the Water Management working group will be shared with the Florida Water Utilities Working Group. The second Sea Level Rise Workshop, sponsored by USGS, Sea Grant and FAU's Center of Environmental Studies, was held April 5-7, 2011 in Boca Raton and provided information relevant to several of the white papers. Teamwork between the SUS Education and Training working group and Jeff Ryan, Geology Department Chair at USF, and principal investigator of the Coastal Areas Climate Change Education Partnership may be beneficial to both groups. USF has secured this NSF climate change education grant to build networks and advance understanding of climate science in the Florida and Caribbean region. Key contacts at state and other agencies have offered to review the SUS white papers and provide input.

The Principal Investigators continue meet regularly by conference call to keep the project on task. White papers will be presented at the November workshop in Gainesville, which will have an expanded list of invitees to include outside agencies and other contacts.

APPENDICES

APPENDIX A. WORKSHOP AGENDA

SUS Climate Change Task Force Workshop, March 18, 2011
Florida Atlantic University, Boca Raton, FL

8:00-8:30am	Registration/Check-In
8:30-8:45am	Welcoming Remarks and Workshop Overview
8:45-9:30am	Presentation by the 3 PIs: Project description and goals, including Q and A • Leonard Berry, FAU • Eric Chassignet, FSU • James Jones, UF
9:30-10:15am	Participant Introductions (one minute)
10:15-10:30am	Breakout Group Overview & Charge
10:30-11:00am	Break
11:00-12:30pm	Breakout Groups: Discussion of white papers – content, organization and participation • Assessment of climate change scenarios *Moderated by: Eric Chassignet, FSU* • Biodiversity and land use change *Moderated by: Susan Cameron Devitt* • Coastal county adaptation *Moderated by: Thomas Ruppert, UF and Jaap Vos, FAU* • Education and training *Moderated by: Jim Jones* • Water management *Moderated by: Len Berry, FAU*
12:30-1:30pm	Lunch
1:30-3:00pm	Breakout Groups continued: Discussion of white papers – content, organization and participation • Assessment of climate change scenarios *Moderated by: Eric Chassignet, FSU* • Biodiversity and land use change *Moderated by: Susan Cameron Devitt* • Coastal county adaptation *Moderated by: Thomas Ruppert, UF and Jaap Vos, FAU* • Education and training *Moderated by: Jim Jones* • Water management *Moderated by: Len Berry, FAU*
3:00-3:30pm	Break
3:30-4:45pm	15 Minute Summary of Each Breakout Session (highlighting goals and outcomes)
4:45-5:00pm	Discussion of the Workshop Outputs, Conclusions and Next Steps

APPENDIX B. BREAKOUT SESSION QUESTIONS

Breakout Session Charge for all groups

The working group products will be incorporated into a white paper that will

1. Outline Florida's climate change related challenges and identify the key decision makers impacted by those challenges at state, regional and local community levels.
2. Identify ongoing and needed research and monitoring initiatives.
3. Explore ways to assist decision making at state, regional and local levels.

Questions to guide breakout group discussions - Assessment of Climate Scenarios

1. What historical data are available for users from climate and sea level changes in Florida, and are these data readily available? *approximately 20 minutes*
2. What is known about climate variability and climate forecasts for Florida, and how can these data be accessed? *approximately 20 minutes*
3. Are there readily available climate change scenario data sets based on IPCC climate model outputs? Have any of these been evaluated relative to their ability to hindcast Florida's climate? Where are the data? *approximately 30 minutes*
4. What climate change, climate variability, and sea level change research and outreach programs do our SUS universities have in place now? *approximately 30 minutes*
5. What are the major gaps in research that need to be filled? *approximately 15 minutes*
6. What interdisciplinary and collaborative programs or working groups (internal and external) exist? *approximately 20 minutes*
7. Discuss communication needs, methods and opportunities, including those that already exist and those that are needed. *approximately 30 minutes*

Questions to guide breakout group discussions – Biodiversity and Land Use, Coastal County Adaptation, and Water Management

1. What are the key vulnerabilities and impacts from climate change associated with each target area (water management, coastal counties, and Florida's biodiversity and land resources)? *approximately 30 minutes*
2. What research is being done in Florida now and by whom (universities, agencies, etc.)? *approximately 30 minutes*
3. What research and outreach programs do our SUS universities have in place now? *approximately 30 minutes*
4. What are the major gaps in research that need to be filled? *approximately 15 minutes*
5. Who are the key decision makers involved in climate change issues in each target area? *approximately 15 minutes*
6. What interdisciplinary and collaborative programs or working groups (internal and external) exist? *approximately 15 minutes*
7. Discuss communication needs, methods and opportunities, including those that already exist and those that are needed. *approximately 30 minutes*

Questions to guide breakout group discussions – Education and Training

1. What are the existing educational opportunities in the SUS regarding climate (climatology, meteorology, oceanography, etc.) and climate change in particular? *approximately 20 minutes*
2. What are existing educational opportunities in the SUS regarding interdisciplinary studies on climate change and societal responses? *approximately 20 minutes*

3. Are there gaps in undergraduate and graduate climate change related education programs that need to be filled? *approximately 30 minutes*
4. What mechanisms exist to allow any student in an SUS university to take courses that may exist in other universities, and how can this situation be improved? *approximately 20 minutes*
5. What SUS-organized continuing education and outreach programs currently exist? What sectors are being targeted (public, professional and business)? *approximately 15 minutes*
6. Are there opportunities to develop collaborative outreach and continuing education programs via a consortium of SUS universities? What programs or working groups currently exist? *approximately 30 minutes*
7. How might we improve communication between educational institutions to advance climate change learning? *approximately 30 minutes*

APPENDIX C. WORKING GROUP SUMMARY NOTES

Assessment of Climate Scenarios Working Group

The moderator for this group was Eric Chassignet, FSU. There were eight attendees representing four universities: FSU, UM, USF, and UF.

The session started with a general discussion on how we project ourselves in the next five years as part of a joint SUS-wide center. This working group began by discussing the need for organization within and among universities related to climate change. There was a suggestion to hold roundtable lunches within each university to see who is working on climate issues.

A web based forum for communication was proposed with multiple moderators to cater to the diverse fields of members. There was some discussion to have it restricted or allow limited connection with potential users. However, there were some organizations like Southeast FL compact which may find itself reluctant to air issues in such public forums. A proposal to NSF STC was discussed, but felt it could be non-competitive because the organization is distributed across many institutions and not centered in one location, which is preferable to NSF

Florida's climate change-related challenges and key decision makers impacted by those challenges at the state, regional and local community levels: There is a growing consensus that sea level rise (SLR) and temperature change are the most relevant to Florida. Although coupled feedbacks are an integral part of the Earth system, the physical climate system of ocean-land-atmosphere can provide boundary conditions (scenarios) for application in other fields, e.g., was the feasibility study for expansion of Eglin Air Force Base in the advent of SLR? The IPCC provides the most thorough SLR estimates, but do not include recent observations. So far in the 20th century, the SLR of the Southeast US is commensurate with global SLR.

Climate change challenges will become more acute in the future, one of them being the high projections of future population density in Florida. Another is how to access and engage private funding regarding climate change, for example, insurance companies, power/utility companies, etc. We need to get "all the pistons in the same engine." Engaging private donors and interdisciplinary skill sets will make proposals very competitive.

The Southeast Florida Regional Climate Change Compact is a collaborative effort, a joint commitment of 4 counties (Palm Beach, Broward, Miami-Dade, Monroe) to partner in mitigating the causes and adapting to the consequences of climate change: http://www.broward.org/NATURALRESOURCES/CLIMATECHANGE/Pages/SoutheastFloridaRegionalClimateCompact.aspx

Ongoing and needed research and monitoring initiatives; ways to assist decision making at state, regional and local levels: There is an NSF general call for STC proposals – $25 million over 5-6 years to build a Center of Excellence. Proposals need to have a clear goal and must show economic impacts.

Climate models are deficient – there is a need for cryosphere models that include ice dynamics to obtain realistic sea level rise estimates. Different ice melting processes occur at different vertical levels (over land, ocean mixed layer, thermocline, deep water) at different times.

Forcing functions [are needed] for future climate scenarios – probabilistic curves (PDFs, Cumulative Distribution Functions [CDFs]) for greenhouse gases, temperature and sea level rise. IPCC (vs. USACE or SFWMD) estimates are the most thorough. An important question: will PDFs shift? The IPCC projection for sea level rise (80 cm globally by 2100) is far too

conservative. It does not include the melting of ice, which may cause baroclinic ocean impacts and adjustments that take decades.

"NASA's Gravity Recovery and Climate Experiment (GRACE) satellites are giving us direct information on how the mass of Earth's ice is changing" http://climate.nasa.gov. The GRACE mission (gravity measurements) has already invalidated IPCC projections. The IPCC global projections should be scaled up by 20%, from 80 cm to 1 m by 2100. GRACE + ARGO + altimeter measurements of sea level rise are now underway. They should have an accurate estimate within next 10 years.

Available climate change scenario data sets: The availability and exchange of data (boundary conditions) between models is important (e.g., precipitation, temperature, evapotranspiration, winds for hydrology models), there should be PDFs for each variable.

The IPCC central repository for model-generated datasets (100 year simulations) are hosted by the PCMDI: http://www2-pcmdi.llnl.gov/esg_data_portal/dapserver/. Data are also available through the Earth System Grid web portal: https://esg.llnl.gov:8443/index.jsp. AR4 (IPCC 4th assessment report) model data: http://www2-pcmdi.llnl.gov/esg_data_portal has now been downscaled to 10 km by group at Columbia University, with the position of subtropical high (ridge axis) changes and the distribution of persistent sea breeze rainfall over Florida. The North American Regional Climate Change Assessment Program (NARCCAP) results are downscaled to a 50 km horizontal resolution. It is now available at the NCAR: http://www.narccap.ucar.edu/.

Remote changes can have extreme local impacts - sea level rise can cause outbreaks of cholera; the IPCC projects that drying over the Caribbean islands will cause climate refugees to migrate to south Florida.

Climate change, climate variability and sea level change research and outreach programs in place by SUS universities; interdisciplinary and collaborative programs or working groups: Recent research on the study of local changes in hurricane intensity due to climate change has suggested that there will be a lower frequency of storms, but they will be more intense (Category 4 and 5) http://www.gfdl.noaa.gov/global-warming-and-hurricanes. The methodology and results of this study are now considered questionable (unrealistic sea surface temperature (SST) distribution used in research; coupled regional climate models are problematic; persistent vertical wind shear and split Intertropical Convergence Zone (ITCZ) over the Caribbean damps hurricane formation). Are artificial increases in storm intensity by 10% justifiable?

The ENSO (El Nino, La Niña) impact on Florida in winter is the most prominent and very distinct wet/dry seasons can be defined over peninsular Florida. It has predictability to about six months. Anthropogenic influence of irrigation and urbanization on local climate of Florida and NAO/AMO (North American and Atlantic Decadal Oscillations) impact on Florida are significant. AMO is controversial, may not exist, unknown mechanism (same as SST?).

A coherent 5 cm decadal signal along the entire western boundary (Atlantic coastline) could mask or enhance SLR variations. A long time averaging scheme is needed to avoid aliasing/misinterpreting this signal. The local SLR trend in the southeast US is about 1meter and will be much larger if the regional distribution of ice and thermal expansion of seawater is extremely non-Gaussian. There is an irrigation signal over the southeastern US.

The 1993 winter "Storm of the Century" had a large impact – pressures were lower than hurricanes in Tallahassee, FL. Hurricane Wilma (2005) had some positive impacts: it transported rich, fertile sediment inland (despite extensive damage along the coastline), stabilized soil, and created new nesting areas.

The following are available climate data that will exhibit transparency in the method to generate data. Data for Florida:

- Gary Mitchum, USF, has corrected NOAA tide gauge data to obtain more realistic estimates of sea level rise and is willing to make this dataset available
- National Climate Data Center (NCDC) has meterological station, rawinsonde data, however there are quality control issues
- NCDC international best track data: http://www.ncdc.noaa.gov/oa/ibtracs/
- National Hurricane Center (NHC) tropical storm data and the best track data Jim Elsner (FSU) will provide high resolution best track data; downscaled data from IPCC AR4 models done in FSU's Center for Ocean-Atmospheric Prediction Studies (COAPS) will be made available.
- Altimeter data, warning: do not use Aviso gridded data – water vapor error near coastlines, multiple problems
- USGS has land cover data

Research gaps: There is a need for downscaling global projections, and how to consolidate projections from a variety of models. Quantitative estimates will be helpful in planning. Other identified gaps are: a comprehensive regional reanalysis for the physical climate system of Florida; a regional earth system model for the region; a good understanding of remote impact of climate on SE US/FL, for example, the effect of Sahel droughts, dust, Amazonian deforestation; cryospheric modeling to understand and better project SLR.

Communication Needs: "Downscaling" needs to be defined so it is clear to the general public what this refers to. Downscaling mechanisms and quantitative estimates will be helpful in planning. Sea level rise may be about 1 meter by 2100, but it will not be uniform in all places and this needs to be communicated.

Biodiversity and Land Use Change Working Group

The moderator for this working group was Susan Cameron Devitt, UF. There were eight attendees representing four universities: UF, FAMU, UCF FAU.

Key vulnerabilities and impacts of climate change on biodiversity and land use change:
The group discussed that sea level rise will potentially have the biggest impact to biodiversity and loss of habitat (with drivers such as temperature and precipitation variability). If SLR is slow its impacts can be ameliorated by the hydraulic strategy of raising fresh water flow, but at some point this strategy will fall short. SLR will lead to changes in the water table which impacts both coastal and inland fresh water resources.

Additionally, an increase in variability in climate will impact habitat and food web biodiversity, will likely lead to increases in disease and invasive species and a change in the distribution of species. Land use will change due to increased population growth and inland migration due to the changing ability of the coastline to house people.

Current agricultural practices will change due to natural resource (i.e. water) limitations and temperature variability. Regional agricultural products will change as the frost line moves. The degree to which more sustainable agricultural practices are adopted will make difference in viability of species.

Current research being done in Florida now and by whom (universities, agencies, etc.):

1. UF, down-scaling climate models for Florida

2. Dr. Betsy Von Holle's research includes weather data going back 35 to 108 years shows weather data patterns of colder winters and springs reflected in plant blooming times and warmer summers and fall – the exact opposite of what's been published
3. Grant Proposal for Research – Dr. Reed Noss with Kresge Foundation – spatially explicit niche modeling on SLR with evolutionary and phenotypic plasticity components
4. Archbold workshop
5. Paul Zwick continues to work on regional scale models
6. A project on 2060 led by Florida Regional Planning Council will start soon, looking at population stressors / growth in the area north of Okeechobee (What happens if we add 1 or 2 million people to the projection; conflict analysis to look at the conflict between land use / agro / conservation in area). This is the first project to include SLR-exacerbated human population increase.
7. USFWS / MIT – SLR, collected Lidar data, created future land use scenarios
8. UF - College of Design and Planning – a national estuarine reserve study involves a specific SLR adaptation assessment aiming to gather information at a multi-county scale

Outreach programs and their effectiveness: Land grant institutions use a three prong approach: outreach, training and research. This is a good model. Start in research, but bring it out to stakeholders, the value is in outreach. Translational research must reach stakeholders. Issues that have broader spatial aspects cannot be encompassed within the County level. Efforts to link Sea Grant to the county level have been unsuccessful, but we must continue trying.

Other major players include Audubon, which has a high concern about climate change issues, the SPICE program, students working with teachers, counties, public radio and TV (NEON network), and different citizen science groups. It is important to put literature in public places to start dialog.

Major Research Gaps: The lack of consensus on climate models and scenarios creates a lack of precision in SLR estimates and impacts in Florida. There is a need to increase the types and frequency of monitoring to determine thresholds that are useful for updating and validating models. Going forward, existing models need to:

- incorporate interactions between incremental and episodic climate-driven events, such as storm surge and the increase in droughts and freezes
- include multiple climate scenarios
- differentiate climate impacts from sea level rise

Additional research gaps exist in the following areas:

- Need to perform additional species and natural community assessments
- Identify potential land use changes due to increasing human population and re-settlement
- Determine how to accommodate a growing population without negatively affecting biodiversity
- Weather data needs to be updated to ensure that data are credible and accurate (location of weather stations may need to be changed)
- State-wide planning gaps exist and the working group recommended adopting the 2060 Planning Horizon document for general issues
- More knowledge is needed about the way people make decisions
- The impact of adopting biofuels needs to be researched to determine if alternative energy solutions exacerbate other problems (e.g. excessive water use for biofuel production, introduction of invasive species, or restoration of native flatwoods)
- Examine the connectivity between the different drivers (SLR, temperature and precipitation variability) affecting climate

Key decision makers involved in climate change issues: The Florida Fish and Wildlife Commission is currently revising their State Action Plan to include climate change. FWC is the Florida coordinator of LCC (Landscape Conservation Cooperatives). The LCC structure was established by the US Fish and Wildlife Service and divided the U. S. into zones (ecological / climatic / regions) to coordinate climate variability research and conservation across political boundaries. Counties are still required to do comprehensive plans and are required to have land use maps, which are done varying degrees of accuracy and thoroughness. These should address climate change. At the time of this workshop the effects of legislative changes related to comprehensive planning are uncertain.

Other key decision makers include:

- Municipalities
- County administrators / commissioners / planning staff - some counties have assembled climate adaptation strategies
- Regional Planning Councils, with varied roles across state, coordinate with MPO's, etc.
- Water Management Districts
- FDACS (Florida Dept. of Agriculture and Consumer Services) - Agricultural Commissioner and Agriculture Planning Groups - climate change, ranch land conservation and rural land use.
- DOD is important because they want to protect flight zones and their properties protect wildlife and serve as wildlife corridors
- FDOT – Florida Dept. of Transportation
- 1,000 Friends of Florida – actively looking to influence communities to smart growth management plans
- US Forest Service and private ranch lands provide ecosystem services including land for water storage and conservation
- US Army Corps of Engineers

What interdisciplinary and collaborative programs (internal and external) exist? SECC – Southeast Climate Consortium is mostly focused on agriculture (http://www.seclimate.org/). Florida Climate Institute; LCC – Landscape Conservation Cooperatives; FSU / UF – Energy Consortium; Dept of Interior's, Southeast Climate Science Center partners with LCC, Universities and NGO's; Florida Energy Systems Consortium (has 11 universities in Florida); NEON – will have a strong education and outreach component and a strong focus on climate issues (3 years out, but it will contribute).

Communication needs, methods and opportunities, existing or those that are needed:

- County outreach through extension agents
- National and Florida Phenological Network which uses internet and citizens input to update phenology of breeding and migration. http://www.usanpn.org/node/9415
- Facebook – directly related to adaptation and conservation of wildlife corridor
- TV spots and radio blips with climate focused emphasis
- Recommendations can be made at the state level by providing places to go to view information and see impacts
- People respond to forms of visualization (e.g., detailed maps. 3-D visualizations). Depict the range of SLR and display adaptive options based on future scenarios showing protection, management and restoration strategies
- Climate application that can be downloaded on phone or other personal device

Goals of White Paper: For all original research, consider a local scale, then find a gradient to larger scale outside the state of Florida. These climate drivers are going on all around the country. Think beyond the state level when applying principles of conservation and land use.

Education and Training Working Group

The moderator for this group was Jim Jones, UF. There were seven attendees from four universities: UF, FAU, FSU and UCF.

Educational opportunities that relate to climate change: The Education and Training Working Group started by discussing the courses known to be offered at the various universities, including those listed in the workshop program. Other courses likely exist.

Attendees described specific efforts regarding the development of climate studies coursework at FSU and FAU. FSU's focus is to develop an understanding of the basic science that governs our climate through its EOS and Meteorology departments and the environmental studies undergraduate program. FAU has performed a thorough search of their catalog to categorize courses by differing levels of climate change focus. These levels are:

- Level 1 = Climate Change is a main focus of Course;
- Level 2 = Climate Change is a major component of Course;
- Level 3 = Climate Change or Sustainability is a topic that is mentioned within the lectures, course materials &/or discussions;
- Level 4 = Subject area has the potential to illustrate an aspect of complexity, issues &/or component of climate change but from the course description, it is unclear whether Climate Change is mentioned in the course materials &/or discussion.

The group really liked these categories and discussed creating a matrix that could be available to prospective students within the SUS. The matrix could be divided by: Department (Physical Science, Biological Science, Social Science, Education, Interdisciplinary); College-Level (Undergraduate, Graduate); and Degree & Certificate Programs.

Other programs outside the SUS, that could be incorporated into this matrix and could serve as a model, include a graduate program offered by Columbia University, and courses taught out of NCAR. NCAR provides modules under COMET http://www.comet.ucar.edu/, a web-based distance learning program on basic atmospheric science. A parallel version is available in Spanish.

Future tasks that need to be defined relate to educational opportunities in the SUS on climate change in particular or within specific areas of study, including societal responses and interdisciplinary studies. FSU and UM were identified as the strongest universities for leading this effort. Both FSU and UM are members of NCAR – UCAR. Good information is available on the (University Corporation for Atmospheric Research) UCAR web site: http://www2.ucar.edu/. Key faculty and programs at other universities need to be identified. A web page was proposed that includes all SUS courses, with a link to appropriate programs. Another future task is to identify a list of guest speakers that can give outreach presentations.

General discussion included mention of the recent NASA Principal Investigators' meeting at which public communication was a major component. The University of Colorado has been creative, integrating art with climate change, e.g., rap on the CO_2 greenhouse effect, dance and

Native American pottery. The question was raised, "How do we educate about a topic that has such an ability to create a schism?"

Prior to the workshop, FAU staff researched the mechanism in which a student can take courses from other universities. The Transient Student Form shown below describes the existing system**.** One topic not discussed in the document was the number of out-of-college credits that someone could take. This may be limited to two courses or six credit hours. During the closing discussion, a graduate student mentioned difficulty using the Transient Student Form if the courses were not equivalent between universities. These two uncertainties need follow-up.

Gaps in undergraduate and graduate climate change-related education programs: The following gaps were identified: the need to integrate climate change education with other sciences, such as the social sciences; the need to translate the science (physical models, etc.) for the broader student community; the need for funding for course development time; the need for Earth Science teacher preparation; the need for courses offered in summer and faculty to teach them; and the need for a coherent set of courses.

Challenges include the generation of student credit hours and courses that can be transferable. There is a lack of interdisciplinary emphasis in courses. A change in behavior is needed at the university level, which is the driver for getting these courses offered.

Potential road blocks were identified. Student credit hours fund the university, so climate change courses need to be part of the standard core curriculum for them to be widely offered. In addition, universities are hoping to direct students into various other departments because the Biology and Psychology departments are typically over capacity.

Continuing education and outreach programs: University programs include the UM program "Enabling Capable Climate Communicators" by Dr. Hal Wanless, the Office of Sustainability at UF, EXPLORES at FSU, and teacher training at USF and FAU funded by NASA's Global Climate Change Education. Other programs with a broader focus are available through UF IFAS (Institute for Food and Agricultural Sciences), Sea Grant and Land Grant, all of which target managers, homeowners, extension agents and farmers. Other programs are in professional development for extension agencies, policymakers, engineering firms, other decision makers (county/city managers). Programs that focus specifically on climate change need to be identified.

There are **opportunities to develop collaborative outreach and continuing education programs** through IFAS Cooperative Extension Service, the Extension Climate Focus Group, the State Climatologists office at FSU, and links to other SUS products. A follow-up with the following state agencies was recommended: Water Management Districts, USDA – NRCS (Natural Resource Conservation Service) education and outreach, and the Office of Emergency Preparedness.

To **improve communication between educational institutions** and advance climate change learning, a Climate Change Certificate was proposed that would extend across the whole SUS. This could be implemented through distance learning. The working group suggested that this

certificate be coordinated by one agency, consist of four to five courses, include Social Sciences, and reflect an ongoing assessment of curriculum needs.

The following nationally-funded, SUS climate change projects were identified: USF – from NSF; Jane Southworth – UF; Tracy Irani –UF; Linda Jones – UF; Paul Ruscher – FSU; USF person – NSF. This link shows the NASA funded projects: https://gcce.larc.nasa.gov/ The national Global Learning and Observations to Benefit the Environment (GLOBE) project is used by NCAR in a campaign for climate change education and can be incorporated into university coursework.

Taking Courses across the Florida State University System (SUS)

How can a student enrolled in one university take a course in another university within the Florida SUS? This question has been raised regarding climate change issues and courses offered by various universities throughout the state.

The process already exists and is actually fairly simple. Here are the basic steps:

A. Students active in a state university, e.g., Florida Atlantic University (FAU). Note: this information is based on policies currently in effect at FAU and may vary at other institutions.
    1. Complete a "Transient Student Form" for your university (see color coded sample form on page 2)
        - The student completes the lines highlighted in yellow, i.e., Section A with their information, signature and date and the course information in Section B
        - The student then takes it to their academic advisor who can check on FAU equivalency, verify that the course would count toward the students' degree and signs the form (green highlights) – a critical point. Sometimes there is no course equivalent (often the reason to take a course at a different university that may have different specialties, such as climate change).
        - It then gets sent to the Registrar's office, who will sign, date and stamp the form (pink). This typically takes two to three days, but may take up to a week during very busy time (such as the Drop-Add period). Timing may vary between campuses and universities.
    2. The student will be given the white and yellow copies of the multi-copy Transient Student Form. As stated at the bottom of the form, the student keeps the yellow form and provides the white copy to the Registrar of the receiving school.
    3. At this time (Spring 2011) there is no fee for the Transient Student Form at FAU, but this may vary from one university to another.
    4. Students should keep their copy with their permanent records, at least until it shows up on their permanent transcript.

B. Students enrolled in a private college or out-of-state college or university
    1. Students enrolled in a private or out-of-state college or university need to complete a Non-Degree Seeking Student Application Form.
        - There is a $30 application fee (e.g., FAU) but this is paid only once.
        - This is good for as long as the student is active in the university system, i.e., taking at least one course per year. If a student does not take a course for

three consecutive semesters, they will need to fill out a new application form with proof of residency, but should not need to pay a new fee (good to check).

2. Students would need to check with the academic advisor at their college or university to determine if they would receive credit for the transferred course upon completion.

C. Students enrolled at Florida's State Colleges

In general, students enrolled at a Florida State College would follow the steps using the Transient Student Form described above, however, they would need to check if they have the proper prerequisites or get permission to take the course.

TRANSIENT STUDENT FORM — FLORIDA ATLANTIC UNIVERSITY

This form enables you to transfer credits of pre-approved courses ONE TERM ONLY.

IMPORTANT INSTRUCTIONS:

1) Check (✔) the institution you will be attending as a Transient Student, known as the **Receiving School.** Then complete and sign section A.
2) Ask your Academic Advisor to complete and sign Section B. The pink copy of this form may then be retained by your advisor for departmental use.
3) Submit form to any FAU Registrar's Office for completion of Section C. To receive the completed form by mail, **staple** a self-addressed, stamped envelope to the form. You are responsible for submitting the white copy to the Registrar's Office at the Receiving School in accord with the Receiving School's procedures.
4) To complete a Transient Form online, go to *www.facts.org* and click on "College Students" Quick Links "Transient Student Form".

COMPLETION OF THIS FORM DOES NOT CONSTITUTE REGISTRATION

RECEIVING SCHOOL:

- ☐ Florida A & M University, Tallahassee, FL 32307
- ☐ Florida Gulf Coast University, Ft. Myers, FL 33908-4500
- ☐ Florida International University, Miami, FL 33199
- ☐ Florida State University, Tallahassee, FL 32306-1011
- ☐ University of Central Florida, Orlando, FL 32816-0114
- ☐ University of Florida, Gainesville, FL 32611
- ☐ University of North Florida, Jacksonville, FL 32216
- ☐ University of South Florida, Tampa, FL 33620-6900
- ☐ New College, Sarasota, FL 33580
- ☐ University of West Florida, Pensacola, FL 32514-5750
- ☐ _____

SECTION A: To be completed by the student applicant. Do not leave any questions blank. Print with a ballpoint pen.

1. _ _ _ _ _ _ _ _ _ Student I.D. 2. _____ Last Name _____ First Name _____ M.I.

3. Transient Term: Fall ____ Spring ____ Summer ____ / Session ____
4. Birthdate: ____ Mo. Day Year
5. Sex: ☐ M ☐ F
6. Nation of Citizenship: _____ Race: _____
7. Address during term of attendance as a transient student. Address _____ City _____ State ____ Zip ____ Telephone Number ( )

I understand that if I register for different courses not approved herein, I assume the full risk of transferability. I also understand that this application is for the **ONE TERM** specified and that a new form with approved courses must be submitted in order to continue my Transient Student status. I also understand that I must provide FAU with an official transcript from the Receiving School, and authorize the release of such records accordingly.

The FAU Forgiveness Policy cannot be used for courses taken at another Institution.

Signature of Student: _____ Date: _____

SECTION B: To be completed by Academic Advisor. Please print with a ballpoint pen.

COURSE APPROVAL: The above named student is hereby authorized to take the following course(s) during the term specified. Transfer credit for these courses will be acceptable upon receipt of an official transcript as per the regulations of FAU.

	PREFIX	COURSE#	HRS.	COURSE TITLE	FAU EQUIVALENCY
1.					
2.					
3.					
4.					

Signature of Academic Advisor: _____ Date: _____

_____ Credit hours of this approved transfer work will reduce the FAU undergraduate degree requirement of earning 60 hours at a baccalaureate granting institution.

_____
Signature, Academic Dean or Representative

SECTION C: To be completed by FAU Registrar's Office.

- ☐ Y ☐ N The above named student is regularly enrolled in a degree program and is eligible to re-enroll.
- ☐ Y ☐ N This student has a Student Health Form indicating she/he has the required measles and rubella immunities.
- ☐ Y ☐ N This student has a CLAST hold.

FAU Validation

This student has the required documentation on file with FAU to meet the legal classification of:
☐ Florida Resident ☐ Non-Florida Resident ☐ Resident Alien ☐ Documented Alien

Signature of Registrar: _____ Date: _____

Distribution: White - Registrar of Receiving School, Yellow - Student Copy, Pink - Academic Advisor/Departmental Copy, Gold - FAU Registrar 090883

Coastal County Adaptation Working Group

The moderators for this group were Thomas Ruppert, Florida Sea Grant UF and Jaap Vos, FAU. There were eleven attendees, representing five universities: UF, FAU, FIU, UCF, FAMU.

The group began by defining the topic and the desired outcomes of the workshop. Recommended outcomes include developing a web portal; how to engage people in planning – action steps with a chain of responsibility; determining what other institutions are doing; establishing ground rules for the white paper; how natural and human systems can be maintained; drinking water supply concerns; long term ecological research and connecting to urban systems; determine if people are truly serious (challenging people about how they're going to adapt – both policy makers and influencing stakeholders); increased collaboration; where the adaptation is going to be; understanding who will take action (policy, government, and responsibilities); determining the key research issues needed to get action from policy makers; and what level of government will be addressed.

Working Group Title: The working group questioned the title, as the entire state, not just coastal counties, will be affected by climate change. They did agree that addressing the county level helps develop structure for the white paper. An alternative name was suggested: "Florida County Adaptation." (Project note: Coastal Counties were selected as the focus for this white paper, as time and finances were not sufficient to adequately cover the topic for the entire state.)

General Issues and Scope: Participants wanted to note that most of them worked with the built environment rather than natural systems. What is "Adaptation"? It includes adapting to SLR, the changing of society to future trends, and adapting to changes in temperature, rainfall, and other weather-related items. What is mitigation? We need to better understand how this relates to greenhouse gases, etc.

This group would also like to identify courses that include climate change. Many courses were not developed for climate change, but have since included it into the syllabus. Coursework was not discussed. [Note: coursework is being addressed by the Education Working Group.]

The scope of this topic is very large. We need more people at the table!

Given the breadth of potential scenarios related to this topic, the general consensus was that this working group should focus primarily on the urban system regarding coastal adaptation. Outcomes of the meeting that would be helpful in developing the white paper include developing an understanding of:

- Local/state/government attitudes and perceptions
- What the educational institutions, such as the SUS, are doing regarding climate change and SLR, and how they can collaborate in complementary areas, particularly on issues that relate to adaptation
- The gaps in science and the institutional capacity of the SUS to address them
- What steps policy makers can take in response to climate change issues
- What people are doing
- What planners can do
- The level of government that will be addressed – county, state
- The actual scope and bias of issues that relate to adapting our coasts

Other items on the working group wish list were a web portal with "Wiki"-style resources and to modify the scope and terminology of materials for this working group.

Key vulnerabilities and impacts from climate change: The main vulnerabilities and impacts in coastal areas relate to increased rainfall, increased storm intensity and SLR. Insurance and health issues also come into play. In addition to lack of funding for appropriate research, there is significant difficulty in cross-disciplinary research.

There are many quality of life issues. They cover the full spectrum of people issues, beach erosion, the economy, tourism, natural systems and recreation. Regarding the general population, there are varied economic groups, varied economic resources and gaps, and varied societal capital resources. There are also the disenfranchised groups, such as the environmental social justice advocates.

Key issues and vulnerabilities include:

- Water issues, such as water quality (including potable water), saltwater intrusion, and altered water flow in estuary systems
- Food and agriculture related issues
- Impacts on existing infrastructure. Adaptations will be needed for water supply and drainage, transportation, housing and coastal infrastructure such as seawalls.
- Energy needed to power consumer use and to drive the infrastructure
- Existing and new housing, real estate and construction
- Impacts of sea level rise on our coasts, including erosion of our beaches and barrier islands
- Impacts on our natural ecosystems, including our reefs, marine and terrestrial plant communities
- Economic impacts, including insurance, fishing, tourism, reefs, and real estate
- Impacts on the fishing industry – both recreational and commercial
- Impacts on people – both residents and tourists, including housing, food, water quality and health
- Impacts on military bases and ports
- Interaction between public knowledge about adaptations to climate change, behavior and the political power structures and their role in the big picture
- The lack of adequate funding for appropriate research and the difficulty of interdisciplinary research

Broad White Paper Outline: Include collaboration in complementary areas. Include coastal waters, particularly the estuaries; for example, Florida relies on estuaries for seafood consumption. There also needs to be a greater understanding of local and state government issues and perceptions.

1. **Matrix**: Set up a matrix of institutions and agencies/counties, to identify who is doing what research and where, strengths and weaknesses. Use this matrix to identify gaps, institutional capacity, existing and potential connections, what the schools are teaching, and county actions (what they are doing).
2. **Stages of different counties**: Assess social science needs; define the target audience – both short term and long term
3. **Research gaps, NOT KNOWING WHAT EVERYONE IS DOING IS A MAJOR GAP**: Research examining shoreline movement rates related to SLR; cross-link ecosystem vulnerability with human behavior (interdisciplinary research capabilities to examine enviro/ human vulnerability needs, tradeoffs); better hydrologic models that account for future scenario changes based on SLR and climate change, effects on subsurface water and what to do with excess water; create an inter-model tool comparison, but not restricted to utilities, and fill through collaboration (a “Wiki”- research tool); and client needs are different and have different time frames.

4. **Integration, Awareness and Access**: Include interdisciplinary research, information on law, medical, health and economic aspects; educate policy-makers. Population models should include density representation (account for fixed empty space); address scale issues.
5. **Connections**: Describe institutional capacity; what counties are doing (Miami has a taskforce matrix showing vulnerabilities and adding actions and needs; Broward approved their plan (on website); do a needs assessment and look at stages of different counties; identify short term needs). Identify what the universities are teaching, i.e., sustainability, climate change.
6. **Recommendations**: Continue meetings with officials to determine what research is needed to get action from policy makers. Identify vulnerabilities, including current work and other options.
7. **Clients Topics**: Policy makers; client time frames e.g., months, one, five years, long term, etc. (varies by client). Universities tend to have long term focus that's not useful for counties. Inter-model tool comparison can be used to determine what works. Consider target audience.

Key decision makers involved in climate change issues, and interdisciplinary and collaborative programs or working groups: various contacts and their research programs were identified at different institutions. More people are needed at the table.

- Mike Ross, FIU, is a good contact for other FIU contacts. The National Science Foundation (NSF) is funding the FCE LTER (Florida Coastal Everglades Long Term Ecological Research Network); Ellen Gazer or Laura Ogden are the contacts. ULTRA is an NSF program that looks at the urban settings, S. FL is driven by global processes (Gail Hollander is the contact), and P.I. Tom Gustafson, Department of Civil and Environmental Engineering, Director of Government and Transportation Policy.
- Nathaniel Plant, USF and USGS affiliate, is the Florida Integrated Science Center contact.
- UF recommended contacts: Paul Zwick (DURP), Karl Havens and Dr. Dawn Jourdan.
- Joe Donoghue, FSU, has a Department of Defense contract
- The Nature Conservancy has state university participants, funding university research.
- At UM, Kenneth Broad is the contact at the ABBS Center for Environmental Policy State Agencies:
- DEM, Department of Emergency Management – Emily Meyer, Community Assistance Consultant (emily.meyer@em.myflorida.com); (on a recent panel on Pet friendly Evacuation Sheltering)
- FDOT, Florida Department of Transportation – Cathleen Neil or Maria Cahill
- FWCC, Florida Wildlife and Conservation Commission – Nick Wiley
- DCA, Department of Community Affairs – Julie Dennis
- SFWMD, South Florida Water Management District
- ERTF, Everglades Restoration Task Force – Glen Landers

Water Management Working Group

The moderator for this working group was Dr. Len Berry, FAU. There were eight attendees representing three universities: FAU, UF, and University of South Florida USF.

Key vulnerabilities and impacts from climate change: The primary area of reference and concern at this time is from Lake Okeechobee and south. Information from this locale may be useful to other at risk low elevation areas of the state (high risk sea level rise (SLR) areas identified by CLIP (Critical Lands and Waters Identification Project) maps: Big Bend, St. John's River, Tampa Bay and Apalachicola). Regarding the issue of "too much water," intense

precipitation, sea level rise, the low number of reservoirs, inland flooding and salt water intrusion were mentioned. Groundwater topics included the impacts of SLR on groundwater, the frequency and magnitude of extreme weather events, shifts in seasonal rainfall and drought, their effects on groundwater, water quality degradation and a change in the use of the surficial aquifer. A discussion on gravity flow and groundwater de-watering led to the topics of: stormwater system design and infrastructure; soil characteristics (the effects of excess water and SLR will vary based on the soil type, for example, muck versus limestone base); Florida's low elevation and topography, particularly in southern Florida; and watershed issues, for example, those along the Kissimmee River and St. John's River. Demand management will be important regarding efficient water use and the lack thereof. There is EPA software to evaluate the vulnerability of urban/drinking water/ utilities from climate change.

Current research and outreach programs: Regarding current research and outreach within the state university system (SUS), discussion was separated by what was being done by Florida's universities and research being done by outside agencies. Water-related topics being researched within the SUS include downscaling global models and drivers, the water/energy nexus, adaptive systems for urban use (e.g., decentralized systems), transition – small versus large changes (e.g., new infrastructures), extreme events and assessments for the future. SWITCH is a global water research project funded by the European Union and conducted through the Patel Center for Global Solutions at USF, to develop scientific, technological and socio-economic solutions for sustainable and effective water management of a city in the future (2050). There was some discussion if and how that could be applied to urban and rural areas in Florida. Another major topic of discussion related to the household level of water use, including people's perceptions and interpretations of what they hear, particularly regarding water restrictions (using more water on specified days than they previously had used and a difference in understanding of well versus public water supply).

Outside the university system, water quality and other monitoring data are being collected by Water Management Districts, utilities, Broward and other counties, and USGS. The National Flood Insurance agency seems to have a lot of data, but it was unclear where that originates.

Research gaps: The following were identified as major gaps in research:

- A need for a centralized data location that is accessible by others and consistent (same data standards).
- A need for communication and long term data (some may be available); currently there is data duplication.
- Information on the location of monitoring wells used by various agencies.
- Data sharing issues – funding, willingness to share, proprietary information
- Management of water demand (include info from Patel Institute), for example, semi-centralized water use areas (may work best for small populations); a closed loop system
- Cost and regulatory hurdles; consider regional systems for cost and water quality
- The Everglades as a potential place for water storage
- Effects of water on natural systems
- Relate water management issues to the vulnerabilities identified for surface and groundwater resources, natural resources and agriculture; include info from CLIP
- Agriculture and social dynamics: citrus and other agriculture areas use more water when cold snaps threaten crops. How much does agriculture use in general? There are no meters, but some water is recycled thru Best Management Practices.

Key decision-makers: The key decision-makers with the biggest roles in climate change issues for water management are the Water Management Districts (for flows and levels, drainage) and

counties. Others include: utilities, Florida Department of Environmental Protection, Regional Planning Councils, Local Governments, grass roots groups, Environmental Protection Agency (EPA), Home Owners Associations, National Flood Insurance Agency, land developers (Unified Land Development Code), National Parks and Wildlife Refuges including Biscayne and Everglades National Parks, military installations and the U.S. Department Homeland Security.

Interdisciplinary and collaborative programs and working groups were identified. Within the university system, there is the School of Global Sustainability (USF, including the Patel Institute), the Water Institute / Florida Climate Institute (UF/FSU), CHAMPS (UCF) and ICCE – Integrative Collaborative on Climate and Energy (FAU). External groups include the Public Water Utilities Working Group, the Four County Compact with Palm Beach, Broward, Miami-Dade and Monroe counties; and Resilient Tampa Bay.

Energy Demands associated with SLR were discussed. Once the gravity driven system is affected, more energy will be needed for pumping, etc. There will an increased demand for nuclear power and an increased demand for solar power. Regarding infrastructure demands, as the population grows, demand increases. There is also a high demand for water associated with the production of kilowatt energy.

Communication: The following communication needs, methods and opportunities were identified.

- Briefing notes are helpful – Something simple that lay audiences find easy to interpret.
- Visualization (a picture is worth a thousand words), but something easy to interpret.
- Serious Gaming (e.g., Decision Theatre, etc.) using real scenarios.
- Climate change atlas (may cost about $2 million to develop).
- Dutch Dialogues.
- Agency discussions vs. public perception; e.g., “water restrictions” does not mean you must water on those days if you do not already do so or do not need to.
- Risk Communication Strategy – not all areas need to be treated equally, e.g., should areas with normal rainfall be subject to the same watering restrictions as drought stricken areas?
- Recognize vulnerable communities and public health issues

Water Management Working Group White Paper: The suggested length is about 25-35 pages with Appendices. Suggested topics include: a state-of-the-art literature review; sea level rise; river flows; changes in demands and migration; decentralized water management; costs, reliability and sustainability related to energy and transition; green jobs; balance of water supply between natural systems, agriculture, power and MFL; Total Water Management; water waste, e.g., drain to tide and evapo-transpiration; economic cost benefit to maintain South Florida (and other low elevation areas throughout the state?). The group suggested that part of the output of the white paper could be to identify three or four regions as potential case studies, with details describing where the deficiencies are and possibly including demonstration areas and monitoring information.

APPENDIX D. RESEARCH GAPS BY TOPIC

Assessment of Climate Scenarios

Research gaps: There is a need for downscaling global projections, and how to consolidate projections from a variety of models. Quantitative estimates will be helpful in planning. Other identified gaps are: a comprehensive regional reanalysis for the physical climate system of Florida; a regional earth system model for the region; a good understanding of remote impact of climate on SE US/FL, for example, the effect of Sahel droughts, dust, Amazonian deforestation; cryospheric modeling to understand and better project SLR.

Biodiversity and Land Use

Major Research Gaps: The lack of consensus on climate models and scenarios creates a lack of precision in SLR estimates and impacts in Florida. There is a need to increase the types and frequency of monitoring to determine thresholds that are useful for updating and validating models. Going forward, existing models need to:

- incorporate interactions between incremental and episodic climate-driven events, such as storm surge and the increase in droughts and freezes
- include multiple climate scenarios
- differentiate climate impacts from sea level rise

Additional research gaps exist in the following areas:

- Need to perform additional species and natural community assessments
- Identify potential land use changes due to increasing human population and re-settlement
- Determine how to accommodate a growing population without negatively affecting biodiversity
- Weather data needs to be updated to ensure that data are credible and accurate (location of weather stations may need to be changed)
- State-wide planning gaps exist and the working group recommended adopting the 2060 Planning Horizon document for general issues
- More knowledge is needed about the way people make decisions
- The impact of adopting biofuels needs to be researched to determine if alternative energy solutions exacerbate other problems (e.g. excessive water use for biofuel production, introduction of invasive species, or restoration of native flatwoods)
- Examine the connectivity between the different drivers (SLR, temperature and precipitation variability) affecting climate

Coastal Adaptation

Research gaps: NOT KNOWING WHAT EVERYONE IS DOING IS A MAJOR GAP: Research examining shoreline movement rates related to SLR; cross-link ecosystem vulnerability with human behavior (interdisciplinary research capabilities to examine enviro/ human vulnerability needs, tradeoffs); better hydrologic models that account for future scenario changes based on SLR and climate change, effects on subsurface water and what to do with excess water; create an inter-model tool comparison, but not restricted to utilities, and fill through collaboration (a “Wiki”- research tool); and client needs are different and have different time frames.

Education and Training

Gaps in undergraduate and graduate climate change-related education programs: The following gaps were identified: the need to integrate climate change education with other sciences, such as the social sciences; the need to translate the science (physical models, etc.) for the broader student community; the need for funding for course development time; the need for Earth Science teacher preparation; the need for courses offered in summer and faculty to teach them; and the need for a coherent set of courses.

Challenges include the generation of student credit hours and courses that can be transferable. There is a lack of interdisciplinary emphasis in courses. A change in behavior is needed at the university level, which is the driver for getting these courses offered.

Potential road blocks were identified. Student credit hours fund the university, so climate change courses need to be part of the standard core curriculum for them to be widely offered. In addition, universities are hoping to direct students into various other departments because the Biology and Psychology departments are typically over capacity.

Water Management

Research gaps: The following were identified as major gaps in research:

- A need for a centralized data location that is accessible by others and consistent (same data standards).
- A need for communication and long term data (some may be available); currently there is data duplication.
- Information on the location of monitoring wells used by various agencies.
- Data sharing issues – funding, willingness to share, proprietary information
- Management of water demand (include info from Patel Institute), for example, semi-centralized water use areas (may work best for small populations); a closed loop system
- Cost and regulatory hurdles; consider regional systems for cost and water quality
- The Everglades as a potential place for water storage
- Effects of water on natural systems
- Relate water management issues to the vulnerabilities identified for surface and groundwater resources, natural resources and agriculture; include info from CLIP
- Agriculture and social dynamics: citrus and other agriculture areas use more water when cold snaps threaten crops. How much does agriculture use in general? There are no meters, but some water is recycled thru Best Management Practices.

APPENDIX E. UNIVERSITY CLIMATE CHANGE INSTITUTES, CENTERS & INITIATIVES

Institutes, Centers and Initiatives	Descriptions
FAU / CES / ICCE	FAU's Climate Change Research Priority Area, coordinated by ICCE (ICCE – Integrative Collaborative on Climate and Energy)
FIU	Florida coastal Everglades long term ecological research (FCE LTER - NSF), climate and disturbance working group (and many other climate change research activities in other parts of the FCE LTER).
FIU	Florida Keys Working Group on Climate Change and Sea-Level Rise
UF	Florida Climate Institute
USF	School of Global Sustainability and the Patel Center for Global Solutions
USF	Coastal Area Climate Change Education (CACCE) Partnership
UF	Office of Sustainability
UF/IFAS	University of Florida's Institute of Food and Agricultural Sciences
(NSF/ FIU) FCE LTER, Florida Coastal Everglades Long Term Everglades Research	FCE LTER Program. Florida Coastal Everglades Long Term Ecological Research Network est. by NSF. They run a program on Everglades Research based out of FIU. http://fce.lternet.edu/
FSU	Center for Ocean-Atmospheric Prediction Studies (COAPS)
USF	School of Global Sustainability (USF, including the Patel Institute)
UF / Public Water Supply Utilities Climate Impacts Working Group	http://waterinstitute.ufl.edu/

APPENDIX F. KEY STATE AND FEDERAL AGENCIES

Abbreviation	Agency Name
ABS	Archbold Biological Station
DCA	Florida Dept. of Community Affairs
DEM	Florida Department of Emergency Management
DOE	U.S. Dept of Energy
DOI	U.S. Dept of Interior, Southeast Climate Science Center
ERTF	Everglades Restoration Task Force
FDACS	Florida Dept. of Agriculture and Consumer Services
FDEP	Florida Dept. of Environmental Protection
FDOT	Florida Dept of Transportation
FEMA	Federal Emergency Management Agency
FWC	Florida Fish and Wildlife Conservation Commission
GRACE	NASA's Gravity Recovery and Climate Experiment
HOA	Homeowner Association
LCC	FWC coordinator: Landscape Conservation Cooperatives
NARCCAP	North American Regional Climate Change Assessment Program
NCDC	National Climatic Data Center
NCFRPC	North Central Florida Regional Planning Council
NOAA	National Oceanic and Atmospheric Administration
NRCS	USDA,National Resources Conservation Service
NWFWMD	Northwest Florida Water Management District
SFWMD	South Florida Water Management District
SJRWMD	St. John's River Water Management District
SRWMD	Suwannee River Water Management District
SWFRPC	Southwest Florida Regional Planning Council
SWFWMD	Southwest Florida Water Management District
TNC	The Nature Conservancy
UCAR	UCAR, University Corporation for Atmospheric Research
USACE	U.S. Army Corps of Engineers
USDA	U.S. Dept of Agriculture
USFS	US Forest Service
USFWS, FWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
	1,000 Friends of Florida
	Audubon Society
	Broward County
	Charlotte Harbor National Estuary Program
	Counties - South FL 4-County Compact, Resilient Tampa Bay, etc.
	Kresge Foundation
	Municipalities
	National & Florida Phenology Network
	National Center for Atmospheric Research
	Private ranch land owners

APPENDIX G. LIST OF ACRONYMS AND INITIALISMS

AMO	Atlantic Decadal Oscillation
AR4	IPCC Fourth Assessment Report
ARGO	http://www.argo.ucsd.edu (ocean temperature/salinity float data)
CDF	Cumulative Distribution Function
CLIP	Critical Lands and Waters Identification Project
COMET	Cooperative Program for Operational Meterology, Education and Training
ENSO	El Nino Southern Oscillation
GLOBE	Global Learning and Observations to Benefit the Environment
GRACE	Gravity Recovery and Climate Experiment
IPCC	Intergovernmental Panel on Climate Change
ITCZ	Intertropical Convergence Zone
LCC	Landscape Conservation Cooperatives
LTER	Long Term Ecological Research Network
NAO	North American Oscillation
NARCCAP	North American Regional Climate Change Assessment Program
NCAR	National Center for Atmospheric Research
NCDC	National Climatic Data Center
NEON	National Ecological Observatory Network
NHC	National Hurricane Center
PCMDI	Program Climate Model Diagnosis and Intercomparison
PDF	Probability Density Function
SLR	Sea Level Rise
SPICE	Standford Program on International and Cross-Cultural Education
SST	Sea Surface Temperature
STC	Science and Technology Center
UCAR	University Cooperative for Atmospheric Research
ULTRA	Urban Long Term Research Areas

APPENDIX H. PRE-WORKSHOP QUESTIONNAIRES RESULTS INCLUDING RESEARCH & COURSES

Florida Agricultural and Mechanical University
Tallahassee, Florida 32307

A. Respondent(s)

Dr. Odemari Mbuya, Professor, Center for Water and Air Quality, Email: Odemari.mbyua@famu.edu **Research Interests**: Watershed processes/management, irrigation, nutrient management, impact of land use/land cover change on climate.

B. Current University-Wide Climate Change Research

1) Enhancing NASA's COAST Online Application for Agricultural Best Management –Practices / Decision Support
2) Integrating Agricultural Best Management Practices into the HSPF Model for Improved Watershed Decision Making in the Caloosahatchee Watershed, SW Florida

C. Current Climate Change Courses Offered and/or University Contact Name

Dr. O.S. Mbuya; Dr. Cassel Gardner; Dr. Katherine Milla; Dr. Margaret Gitau

Florida Atlantic University
Boca Raton, Florida 33431

A. Respondent(s)

Dr. Leonard Berry, Director, Florida Center for Environmental Studies Coordinator, FAU Climate Change Initiative, Jupiter, FL 33458; Email: berry@fau.edu **Research Interests**: In the whole issue of adaptation to climate change in South Florida and globally with special emphasis on the tropics. I'm particularly interested in the impacts of sea level rise in the limestone environment of South Florida leading to salt water intrusion and with changes in precipitation patterns, various kinds of flooding impacts. Adaptation research involves interdisciplinary approaches and I am interested in ways in which different perspectives can be merged. Outreach and education is also an interest, particularly to non-professional audiences.

Dr. Frederick Bloetscher, Civil Engineering, Boca Raton Campus; Email: h2o_man@bellsouth.net **Research Interests**: In how sea level rise affects vital infrastructure (water, sewer, drainage and transportation) and the consequences for local communities, from a planning, funding, and an economic perspective. The long-term economic impact on communities is an under-developed but particularly significant issue. My area of expertise is the development, expansion and management of infrastructure systems. The strategies for adaptation to rising sea level in the long and short term are areas of current research. I was part of a project at FAU to evaluate the impacts of sea level rise on water utilities. We are currently working on a project with FDOT to evaluate their infrastructure needs. I have previously looked at the impact of sea level rise of groundwater in the US, and the impact that the needs to adapt to changing water quality and availability will have on power (ongoing).

Dr. Marguerite Koch, Professor, Biological Sciences; Boca Raton; Email: **mkoch@fau.edu**
Research Interests: Research interests are in nutrient cycling and primary production in tropical marine ecosystems and stressors that influence tropical plant communities. We are currently focused on climate change impacts including upper temperature and salinity limits of marine plant communities and changes in partial pressure of CO_2. We examine stress responses from the physiological and molecular scale, consider life history strategies of individual species and life-stage, as well as focus on ecosystem-level indicators of stress, such as hypoxia. In addition to direct plant responses to stress, we are also interested in biogeochemical changes at the ecosystem-scale that can destabilize plant communities and influence the sustainability of foundation plant communities that support marine ecosystems. The majority of our work is in shallow tropical carbonate environments of South Florida, The Bahamas and wider Caribbean. We typically take an experimental approach to examine several alternative hypotheses in mesocosms and under field settings.

Dr. Julie Lambert, Associate Professor of Science Education, Teaching and Learning, College of Education, Boca Campus; Email: jlambert@fau.edu **Research Interests**: In general, global climate change education (GCCE). Instructional strategies and students' understanding of basic science concepts. Students' attitudes and views on global climate change. Assessment and Survey Development on GCCE. Manuscript on Students' Understanding of GCC has been accepted with revisions to the International Journal of Science Education. PI on NASA GCCE grant to develop curriculum materials for high school and undergraduates on how to address misconceptions using scientific data or evidence.

Dr. Mantha Mehallis, Director and Professor, Management Programs, College of Business, Davie Campus; Email: mehallis@fau.edu **Research Interests**: My primary interest in climate change research is action research concerning the impacts of climate change on business. Much work has been done on the scientific aspects of climate change but it is only relatively recently that work has begun on economic and social aspects impacting the business world and the entire area of business continuity, adaptability, and sustainability.

This past month I presented a training session to cruise line executive environmental and safety officers with regard to the impact of climate change on the cruise industry. This pertains both to the shipping business and to tourism. Ship captains, officers, and engineers need to understand the concepts behind climate change, why it is occurring, what their role has been contributing to it, and, most importantly, what they can do to adapt and to create a sustainable business and a sustainable world.

Dr. Diana Mitsova, Assistant Professor, School of Urban & Regional Planning, Fort Lauderdale Campus; Email: dmitsova@fau.edu **Research Interests**: (1) Integrate concepts and techniques from geosciences, hazards research and statistics to improve the spatial accuracy of coastal vulnerability assessments and contribute to the understanding of vulnerability as an integrated spatial phenomenon. (2) Provide geospatial visualization of the impact of sea level rise on shoreline protection that can be used by agencies or communities to enhance resilience to hazards, facilitate adaptation to sea level rise and improve the health of marine ecosystems in highly urbanized areas.

Jim Murley, J.D., Director, Center for Urban and Environmental Solutions, Fort Lauderdale Campus; Email: jmurley@fau.edu **Research Interests:** My recent work has been in the field of applied research as Principal Investigator. Two reports were produced: "Southeast Florida's Resilient Water Resources: Adaptation to Sea Level Rise and Other Impacts of Climate Change"

and “Florida’s Resilient Coasts: A State Policy Framework for Adaptation to Climate Change.” These reports were funded by the National Commission on Energy Policy.

I continue to work with external agencies and working groups that are involved in parallel research on climate change and coordinate climate change research initiatives with the FAU Center for Environmental Studies. External collaboration includes membership on the National Academy of Public Administration’s Review Panel for NOAA’s Proposed Climate Service; serving on the Miami-Dade County Climate Change Action Team and the Broward County Climate Change Task Force; advising the Southeast Florida Regional Climate Change Compact; and Chair of the Florida Energy and Climate Commission.

Other roles include: the FAU team to study the impacts of sea level rise on transportation for FDOT.

Dr. Jorge Restrepo, Professor, Dept. of Geosciences, Boca Raton, Email: restrepo@fau.edu
Research Interests: My interest is in hydrologic studies as it relates to water resources. Past accomplishments include several groundwater models for SFWMD and directing the hydrologic study of a hydroelectric power plant project and inferred statistical information using a hydrologic regionalization technique to infer extreme flows, average flows, and correlation structure. As a member of the National Academy of Sciences National Research Council, we focus on the sustainable underground storage of recoverable water. Current research interests and studies:

- Evapotranspiration in southern Florida, modeling recharge, evapotranspiration and runoff.
- The development of a Wetland Simulation Model.
- Model conceptualization and a data compilation in GIS for a regional three-dimensional groundwater flow model.
- Modeling the groundwater and solute transport flow for landfill areas
- The development of an optimization model to support the planning of a regional ASR facility along a canal system.

Dr. Tara Root, Assistant Professor, Dept. of Geosciences, Boca Raton/Davie; Email: troot@fau.edu **Research Interests:** One of my primary research interests is water-rock interaction and the use of groundwater chemistry as a tool for delineating groundwater flow paths and characterizing surface water-groundwater interactions. A detailed understanding of surface water-groundwater interaction is necessary for developing models to predict how hydrologic systems will respond to climate change and planned municipal and regional water supply projects.

Another avenue of my research is sustainability of water resources. I am particularly interested in 1) water use science and developing robust tools for quantifying water use, 2) investigating human perceptions of water availability and developing educational materials to promote conservation, and 3) evaluating how regulations, such as watering restrictions, influence water consumption. This type of research will be useful to municipalities and regulatory agencies as they plan for meeting both human and ecosystem demands for water at a time when the hydrologic system is adjusting to climate change.

My current climate-change related activities include: (1) I am supervising a Ph.D. student who is in the early stages of developing a dissertation proposal related to water use and sustainability of

water resources. (2) I am supervising another Ph.D. student who is developing a dissertation proposal to develop modeling tools that can be used to help evaluate how S. Florida's hydrologic system will respond to predicted changes in precipation patterns and storm intensity. (3) I am in the early stages of setting up a water quality laboratory that will support a variety of water quality-related research – include projects focused on ecology, drinking water supplies, and climate change.

Dr. Ramesh S. V. Teegavarapu, Assistant Professor, Civil, Environmental and Geomatics Engineering, FAU, Boca Raton, Florida. Hydrosystems Research Laboratory (HRL); Email: rteegava@fau.edu , ramesh@civil.fau.edu **Research Interests**:
Interests in Climate Change Research

1. Development of methodologies for climate-change sensitive and sustainable management and operations policies for water and environmental systems
2. Water Resources modeling and Management under climate-change uncertainty, scenario generation, and climate change impact and adaptation
3. Extreme events under climate change scenarios, stationarity issues, climate teleconnections, use of teleconnections for improvement of seasonal or intra annual forecasts for management of water resource/evironmental systems
4. Development of downscaling methods for climatic variables (precipitation, temperature, etc.)
5. Hydrologic design for future

Current Research (funded by USGS, SFWMD, SWFWMD, FEMA, UNESCO, FDOT and others)

1. Climate Change-sensitive Water Resources Management: Use of optimization and Soft Computing Methods for addressing climate change model uncertainty
2. Sustainable hydrologic design under climate change uncertainty
3. Extreme Events (especially precipitation events), trends over the last century (historical climatology) and assessments for future
4. Teleconnections: Atlantic Multi-Decadal Oscillations, ENSO, Elnino and Lanina, PDO and others. Impacts of teleconnections on regional and local climate and extreme events
5. Spatial and Temporal assessments of Extreme events. Evaluation of Global precipitation and Temperature re-analysis data sets
6. Evaluation of statistical and dynamically downscaled future projections of climatic variables and development of methodologies for climate-change models for regional and local use.
7. Uncertainty assessments from downscaled projects and dynamic simulation models for impact and risk assessments for water and environmental systems
8. Impact of Sea-level rise on infrastructure in coastal areas

Dr. Jaap Vos, Associate Professor and Director of the School of Urban & Regional Planning, Fort Lauderdale Campus; Email: jvos@fau.edu. **Research Interests**: My main interests are environmental planning, environmental justice, sustainable development and climate adaptation. Research interests include: the interaction between built, natural and social environment, equity and representation, sustainable cities and regions, and climate adaptation. Current research is focused on the relationship between Everglades restoration and urban development in southeast Florida, water scarcity and policy responses to water scarcity. Other research interests include seasonal variability in urban runoff in subtropical areas and coastal adaptation and planning responses to sea level rise.

Recent publications include:
"The Everglades: Where Will All the Water Go?"
"The Comprehensive Everglades Restoration Plan: The Missing Link With Land-Use"
"Seasonal Variability in PAH Concentrations in Urban Runoff Discharged to Biscayne National Park and Aquatic Preserve" (with Diana Mitsova)
"USA Florida Everglades: Policy Arrangement for Water Shortage" (with Yexsie Schomberg)

B. Current University-Wide Climate Change Research

1) HUMAN SYSTEM PROBLEM ASSESSMENT AND SUSTAINABILITY- RE-ENGINEERING AND ADAPTATION

Topic 1: Integrated Hydrological Model Development for Risk Assessment of Climate Change
Topic 2: Water Resources, Utilities and Flood Protection/Supply under a Changing Climate
Topic 3: Adaptation for Transportation Infrastructure
Topic 4: Coastal Urban Societal Response and Adaptation to Climate Change
Topic 5: Adaptation through Coastal and Marine Spatial Planning

2) NATURAL SYSTEM ASSESSMENT AND TECHNOLOGY DEVELOPMENT

Topic 1: Carbon Cycling and Sea Level Rise in Peatlands and Coastal Stability
Topic 2: Coastal and Ocean Ecosystem Responses to Increased pCO_2 (Ocean Acidification: OA)
Topic 3: Coastal Monitoring and Ocean Technology Development
Topic 4: Climate Change and Critical Mega-fauna Profiling and Tracking
Topic 5: Coastal Ecosystem Research, Management and Conservation under Climate Change

3) CLIMATE CHANGE COORDINATION, EDUCATION (K-GRADUATE) AND OUTREACH

Topic 1 Climate Change Education through Gaming and Visualization
Topic 2: Climate Change Education K- University
Topic 3: Focus on Decision Makers and Outreach

C. Current Climate Change Courses Offered and/or University Contact Name

1) ARC 6598 Sustainability and Tropical Architecture
2) BSC 6936 Climate Change: Ecosystems To Human Health
3) CGN 4930 Dynamic Hydrology
4) EDG 5931 Climate Change Education
5) EGN 4070 Sustainability Leadership for Engineers
6) ESC 2070 The Blue Planet
7) ESC 3704 Environmental Issues in Earth and Atmospheric Sciences
8) EVR 2017 Environment and Society
9) GEA 4275 Human Environmental Interactions
10) GEOC 4280 Water Resources
11) GLY 4241 Environmental Geochemistry
12) GLY 6746 Global Environmental Change
13) MET 2010 Weather and Climate
14) URP 4430 Sustainable Cities
15) URP 4930/ URP 6930 Seminar in Cities and Climate Change Adaptation
16) WST 4349 Green Consciousness

Florida Gulf Coast University

10501 FGCU Blvd, South, Fort Myers, FL 33965-6565

A. Respondent(s)

Dr. Michael Savarese, Department Chair, Marine and Ecological Sciences; Professor of Marine Science, Email: msavares@fgcu.edu. **Research interests**: My interests span the field of geobiology, combining disciplines from biology and geology to interpret the history of environmental change, including the history of coastal environment and its change in response to SLR, and the change in geomorphology of wetlands and estuarine environments. My focus is from the mid-Holocene to the present along the Gulf Coast in the area northwest of Cape Sable to the Caloosahatchee River.

Current research programs include the history and paleoecology of reef development, the effects of environmental change on oyster reef ecology, a study in the Bahamas on Holocene sea level history and influences on the coastal environment; the implication of sea level rise on restoration for the Greater Everglades system in Southwest Florida.

B. Current University-Wide Climate Change Research

1. Wetland vegetative response to SLR in marsh and mangrove communities, including the physiological response of plants, ecosystem dynamics and landscape mapping changes.
2. Precipitation influence on upland forest structure, changes in large scale disturbance, such as tropical storms and wild fires, and their effects on ecosystem dynamics
3. The historical patterns of monsoonal climates, such as Indonesia. A paleoclimatologist will start in Fall 2011 who has studied history as recorded in peat deposition and deep sea cores.

C. Current Climate Change Courses Offered and/or University Contact Name

A climate change minor has been proposed for undergraduates. It could be attached to a variety of programs. There is currently a minor in Earth and Space Science, for which a bachelor's degree program proposal has been submitted for Fall 2012. It partly treats Earth as a system and how climate affects that system.

There are other courses that include the impacts of climate change.

Florida International University

Modesto A. Maidique Campus: Miami, Florida 33174
Biscayne Bay Campus: North Miami, FL 33181

A. Respondent(s)

Dr. Hugh Gladwin, Program Director, Institute for Public Opinion Research; Assoc Professor, Dept of Global & Sociocultural Studies, 394A AC1, BBC Campus, Email: gladwin@fiu.edu
Research Interests: Urban growth patterns in South Florida and resultant environmental/social justice implications given requirement for sea level rise planning. Public opinion about climate change. Public understanding of probabilistic climate and weather forecasts. Economic, social, and health impacts of climate change and SLR in Miami-Dade County (work as member of County Climate Change Advisory Task Force). Climate change alteration of hurricane risk mitigation requirements (steering committee work on county local mitigation strategy).

Dr. Palab Mozumber, Assistant Professor, Department of Environmental Studies, University of New Mexico, Email: mozumder@fiu.edu **Research Interests**: Socio-economic Impacts of Climate Change. Adaptation Behavior and Decision-making. Economic Analysis of Climate Change Mitigation Options.

B. Current University-Wide Climate Change Research

1) NSF Urban Long-Term Research--Exploratory (ULTRA--Ex) project focused on interaction of globalization and climate change affecting human system and ecosystem functioning/services in South Florida.
2) Florida coastal Everglades long term ecological research (FCE LTER - NSF), climate and disturbance working group (and many other climate change research activities in other parts of the FCE LTER).
3) FIU - Florida Keys Working Group on Climate Change and Sea-Level Rise
4) Socio-economic Aspects of Adaptation behavior.
5) Inundation Mapping using LIDAR.
6) Ecological Impacts of Climate Change and Sea-Level Rise.

C. Current Climate Change Courses Offered and/or University Contact Name

1) Our Coastal Environment from the Bay to the World
2) Global Climate Change: Science, Society and Solutions
3) New Courses in the works

Florida State University

Tallahassee, Florida 32306

A. Respondent(s)

Dr. Eric Chassignet, COAPS Director, FCI Co-Director, Professor, Department of Earth Ocean Atmospheric Science; Email: echassignet@coaps.fsu.edu **Research Interests**: Climate change research involves the role of the ocean in climate variability from the complementary perspectives of coupled ocean-atmosphere modeling and observations. Research emphasis is on the study of the thermohaline circulation, western boundary currents, associated eddies and their impact on the world ocean circulation and on the validation of the HYbrid Coordinate Ocean Model (HYCOM) with data assimilation capabilities.

Dr. James Elsner, Professor, Geography; Email: jelsner@fsu.edu **Research Interests:** How tropical cyclone activity is regulated by climate variability and climate change.

Dr. Vasu Misra, Asst. Prof., Dept. of Earth, Ocean and Atmospheric Science, COAPS, FCI; Email: vmisra@fsu.edu **Research Interests**: We are looking at impact of increased greenhouse gas concentration, urbanization and irrigation on southeast US mean climate and its variability. We are also examining low frequency variations on Florida sea breeze from possibly AMO, and PDO. I am also interested in Asian monsoon climate variability, and changes in the trade wind regime in a changing climate.

B. Current University-Wide Climate Change Research

1) Hurricanes in a changing climate: Tim LaRow, L. Stefanova, Jim Elsner

2) Extra-tropical transition of tropical cyclones in a warming climate: Bob Hart
3) Sea Level Rise: Joe Donoghue
4) Permafrost changes: Jeff Chanton

C. Current Climate Change Courses Offered and/or University Contact Name

1) MET 5533 Tropical Meteorology I
2) MET2101: Introduction to physical climatology
3) Others in the Geography Dept

University of Central Florida

Orlando, Florida 32809

A. Respondent(s)

Dr. Scott Hagen, Associate Professor; Civil, Environmental & Construction Engineering; Email: scott.hagen@ucf.edu **Research Interests**: Coastal dynamics (ecosystem and the human infrastructure) of climate change. Late last year, I received a five-year, $3M grant from the NOAA / NOS / CSCOR Ecological Effects of Sea Level Rise Research Program (NOAA Award Number NA10NOS4780146) that is focused on the northern Gulf of Mexico. My team includes biologists (landscape ecologist, marine scientist, marsh ecologist, as well as a staff biologist at NWFWMD), civil engineers (hydrologist with downscaling expertise, deterministic overland flow and transport modeling, & coastal hydroscience), coastal engineers (tide & storm surge modeling, 3D circulation & transport modeling, and coastal morphology), and last, but not least, a social scientist.

Dr. Reed Noss, Professor, Dept. of Biology, Email: Reed.Noss@ucf.edu **Research Interests:** I am most interested in the biological impacts of sea level rise in Florida and in devising strategies to mitigate those impacts (i.e., adaptation strategies). I have conducted preliminary research on these topics, with a focus on species and natural communities of high conservation concern. I organized and led a symposium on sea level rise in Florida, held at Archbold Biological Station in January, 2010. I am guest-editing a special issue of *Climatic Change* on this issue, which contains some papers from this symposium and a couple new papers. I have no current research, as I am awaiting news on the status of several grants for which I have applied.

B. Current University-Wide Climate Change Research

1) EESLR: Integrated Modeling for the Assessment of Ecological Impacts of Sea Level Rise, Scientific PI: Scott C. Hagen

C. Current Climate Change Courses Offered and/or University Contact Name

1) Water Resources in a Changing Environment, taught by Dr. Dingbao Wang, who is one of two faculty we have hired with expertise in climate change research. The objectives include: To increase the students' knowledge and awareness of the potential impact of climate change and human activities (such as land use change, groundwater and surface water withdrawal etc.) on hydrology and water resources systems at various spatial and temporal scales; For students to understand how to identify research questions of the anthropogenic and climate induced hydrologic change correctly and how to separate and quantify the attribution of human and climate induced change.
2) Conservation biology course, Dr. Noss
3) Others in Process

University of Florida

Gainesville, Florida 32611

A. Respondent(s)

Dr. Susan E. Cameron Devitt, Assistant Professor, Dept. Wildlife Ecology and Conservation, UF, Gainesville, FL, Florida Climate Institute, School of Natural Resources and the Environment; Email: scameron@ufl.edu **Research Interests:** I study how climate change affects biodiversity (mostly animals). My main focus is developing predictions of how changing climate affects where species can live. I am interested in how species have responded to climate change in the past (on the scale of decades to thousands of years) and developing estimates of future change. I am also interested in conservation and management implications of climate change, particularly as it relates to sea level rise in Florida.

Dr. Wendy Graham, Director, University of Florida Water Institute, Gainesville Florida; Email: wgraham@ufl.edu **Research Interests:** Climate variability and change have the potential to dramatically affect the amount and quality of fresh water available at any given time. In addition to extreme events such as floods, droughts and tropical storms, cyclical climate patterns known to affect water resources in the Southeastern United States include the El Niño-Southern Oscillation (ENSO) and the Multi-decadal Oscillation (MDO). Predicted impacts of global climate change including changing weather patterns; higher surface air temperatures; longer, more frequent droughts; shorter, higher intensity rainy seasons; and sea-level rise which will cause salt water intrusion into freshwater aquifers and habitat destruction. Uncertainty about climate variability and climate change may increase competition among water users requiring that critical decisions be made to allocate sufficient water for agricultural use and consumption by cities, for maintaining water reservoirs and ensuring in-stream flows for aquatic ecosystems, and for industrial and energy production and recreational uses. The goal of this research area is to develop and improve predictive tools that allow us to simultaneously manage water resources for multiple uses under the certainties of climate variability, and the uncertainties of climate change. These tools include models that predict the hydrologic impacts of short-term (hourly to seasonal) climate variability and water management decisions, as well as long-term (years to decades) hydrologic impacts of the effects land and water planning decisions and climate change.

Dr. John Hayes, Professor and Department Chair, Wildlife Ecology and Conservation, and Director, Ordway-Swisher Biological Station; Email: hayesj@ufl.edu, **Research Interests**: Although my personal research program is limited, I serve as the UF lead for the National Ecological Observatory Network (NEON) and am interested in linking researchers from the region to NEON and our efforts at the Ordway-Swisher Biological Station.

Dr. Keith Ingram, Coordinator, Southeast Climate Consortium, Associate Research Scientist, Department of Agricultural and Biological Engineering; Email: ktingram@ufl.edu, **Research Interests**: Providing locally relevant information and scenarios to planners and decision makers. Assessing vulnerabilities, potential impacts, and adaptation strategies.

Current research: Assessing regional capacity for climate change research, information dissemination, and adaptive responses to anticipated climate changes, including:

1. Literature and web searches for assessment frameworks that have been successfully implemented in other regions and nations.

2. Social network analysis to identify key institutions, individuals, and communities based on results from literature and web searches.
3. Decision maker surveys to assess their perceived needs for climate change information and potential adaptive responses to perceived climate change threats.
4. Key stakeholder interviews: i) to identify priority issues and information needs for current and potential future climate sensitive decisions; ii) to ascertain how decision makers value climate information and their sources of climate information; iii) to investigate stakeholder perceptions of their vulnerability to climate change at different time scales; iv) to assess stakeholders' perceptions of the relative importance of climate information in their decision environment; v) to identify policy issues of concern to stakeholders; and vi) to identify the best methods for engaging stakeholders in research and assessment processes.

Dr. James Jones, Distinguished Professor, ABE, Director, Florida Climate Institute, Co-Leader of the Southeast Climate Consortium.; Email: jimj@ufl.edu **Research Interests:** Modeling dynamic crop, soil, climate, and management interactions; climate variability and climate change impacts on agricultural systems; research on climate change adaptation and mitigation management of soils and crops; decision support systems for climate risk management in agriculture and water resources; integration of crop and other models from molecular to field and broader scales; providing leadership in communities of agricultural systems modeling. Lead Developer of the Florida Climate Institute, a joint institute of the University of Florida and Florida State University for interdisciplinary research and education on societal responses to climate change. Co-developer /co-leader of the Southeast Climate Consortium, a NOAA Regional Integrated Science Assessment (RISA) Center of six universities in three SE states. This Center conducts research on climate change/variability for use in adaptive management of agriculture and natural resources and develops web-based decision support systems and outreach programs for engaging stakeholders. Developed dynamic models for important food crops that are now used worldwide for research on impacts of and adaptation to climate change and climate variability. Founding developer of an international consortium (www.ICASA.net) that developed data and interface protocols for integrating models of soil, climate, crops, and management for use in research on management of cropping systems and assessment of climate effects on production of crops. Organizer and teacher in many courses worldwide on concepts and applications of agricultural systems models for assessment of climate and management responses during the last twenty years.

Thomas Ruppert, ***JD*** Florida Sea Grant College Program, Coastal Planning Specialist; Email: truppert@ufl.edu, **Research Interests**: My research interests on climate change primarily relate directly to sea-level rise (SLR) and local government planning. This includes coordination with other Sea Grant programs, NOAA, non-profits, and state agencies in Florida and regionally, particularly in the Gulf of Mexico.

As an attorney, my focus is on legal issues with implementation strategies, particularly federal (constitutional) and state (statutory) takings law. Another focus, due to extensive statutory requirements, is the role of comprehensive planning in implementation of adaptation policy. Work with communications experts and stakeholders has indicated that with many communities, the best method to approach such work with communities not already explicitly addressing SLR is to begin with engagement in the area of hazard mitigation and coastal resilience. This has the benefit of being less politically charged and threatening than initial insistence on directly addressing SLR and takes advantage of federal requirements (such as the requirement that local governments develop a Local Mitigation Strategy) and state requirements (such as development of a Post-Disaster Recovery Plan and specified elements of the Coastal Management Element in local comprehensive plans).

Specific current projects include a cooperative project with other attorneys around the Gulf of Mexico examining the takings law impacts on adaptation options.

In addition, Florida Sea Grant is also facilitating the local government use of the Coastal Resilience Index to promote local government work on coastal resilience issues.

B. Current University-Wide Climate Change Research

Topics per Dr. Susan Cameron Devitt:
Wildlife management and climate change, invasive species and climate change, physiological and genetic adaptation to changing environments.

Funded Grants:

1) Agricultural Model Intercomparison and Improvement Project (AgMIP), Jones, James W
2) Assessing the Vulnerability of Florida Coastal Highways & Bridges to Hurricane Induced Storm Surge and Coastal Flooding Damage, Sheng, Yeayi P
3) Caribbean Food Systems Vulnerability to Global Environmental Change, Jones, James W
4) Climate Information System for Agriculture and Water Resource Management in the SE USA 2009, Jones, James W
5) Decision Support System for Reducing Agricultural Risks Caused by Climate Variability, Jones, James W
6) Decision Support Systems to Evaluate Global Environmental Change and Food Systems, Jones, James W
7) Development of a Prototype SURA-SCOOP Modeling Grid, Sheng, Yeayi P
8) Development of a Gene-Based Ecophysiology Model, Jones, James W Co-PI
9) Downscaling and Applying Climate Forecast in Agriculture, Jones, James W
10) Estuarine Response to Extreme Events-The GTMNERR Case Study, Sheng, Yeayi P
11) The Florida Climate Institute and NSF Science and Technology Center to understand and respond to climate, Jones, James W
12) Hurricane Suiter Simulation to Support FDEM's Hurricane Exercise, Sheng, Yeayi P
13) Iconic Agricultural Crops: Climate Change Impacts on Peanut, Cotton, and Corn in Georgia and Florida, Jones, James W
14) Integrated Crop Management Information System under Current and Future Climate Conditions, Jones, James W
15) Integration of NASA Models and Missions into Agricultural Decision Support, Jones, James W
16) Regional Applications of Enso-Based Climate Forecasts, Jones, James W
17) Risk Reduction for Specialty Crops in the Southeastern U.S.A., Jones, James W
18) State of Florida Hatch fund appropriation, Climate Center seed funding, Jones, James W
19) Understanding and Predicting the Impact of Climate Variability and Climate Change on Land Use and Land Cover Change via Socio-Economic Institutions in Southern Africa, Southworth, Jane
20) Use of Intra-seasonal and Seasonal Forecasts to Reduce Risk in Regional Public Water Supply Management, Martinez, Christopher J
21) Use of Seasonal to Multi-Decadal Climate Forecasts and Predictions for Public Water Supply Planning, Graham, Wendy Dimbero
22) Using Climate Forecasts to Improve Tomato Production , Jones, James W
23) Civil & Coastal Engineering: research on probable changes to storm surge extent under various SLR scenarios (Dr. Peter Sheng)

24) Florida Sea Grant: Assessments of coastal issues in Citrus and Wakulla counties, including issues related to climate change
25) Florida Sea Grant and Dept. of Urban & Reg'l Planning: Research linking property appraisers' database records with elevation data to establish statewide, regional, and county estimates of loss of property tax base revenues under various SLR scenarios; research currently very coarse; will be ongoing to make more precise and explore other ways of dissecting information already in the database. (Thomas Ruppert, Dr. Paul Zwick)
26) Florida Sea Grant and Dept. of Urban & Reg'l Planning - Proposal to Fla. Dept. of Community Affairs to conduct a feasibility analysis and benefit-cost analysis of different adaptation responses for climate change at the parcel level in Okaloosa and Martin counties; research would include analysis of Okaloosa and Martin county comprehensive plans and review of other comprehensive plans for models; web-based summary of project would be included. (Dr. Gene Boles, Dr. Dawn Jourdan, James Nicholas, Thomas Ruppert, Dr. Stanley Latimer)
27) UF Dept.of Urban & Reg'l Planning: Assessment of vulnerability and resilience of transportation infrastructure under SLR scenarios (Dr. Zhong-Ren Peng)
28) UF Law: Research on law and policy related to SLR consideration in siting and construction of Turkey Point Nuclear Reactor; past research on adaptive planning options

C. Current Climate Change Courses Offered and/or University Contact Name

Contact Name: Jim Jones, Director, Florida Climate Institute

1. **GEO 5809: Geography of World Agriculture (3)** World distribution of crops and livestock related to natural and cultural conditions. Agricultural problems related to products, economic organization, agricultural regions, and the significance of world affairs.
2. **GEO 5945C: Field Course in Geography (3)** Methods of geographical fieldwork. Observation, classification, interpretation, note-taking, traversing, and mapping of data. Aerial analysis; landforms, climate, vegetation, soils, resources, settlement patterns, and land use.
3. **GEO 6118: Contemporary Geographic Thought and Research (3)** *Prereq: admission to graduate program in geography.* Summary of major currents of intellectual thought and research orientations in contemporary geography.
4. **GEO6255: Climatology** - *Course taught by Dr. Corene J. Matyas*
5. **GEO 6375: Land Change Science Seminar (3)** Interdisciplinary study of land use and land cover change dynamics and their relationship with global environmental change.
6. **GEO 6495: Environment and Behavior (3)** *Prereq: graduate standing.* Theoretical and empirical analysis of how people perceive and interpret ordinary environments and their influence on well being.
7. **MET 5504: Weather and Forecasting (3)** *Prereq: familiarity with basic meteorology.* Skill development in predicting and discussing daily weather patterns using meteorological instruments to collect data and analyze weather events. *Course taught by Dr. Corene J. Matyas*
8. **MET 6530: Hurricanes (3)** *Prereq: familiarity with basic meteorology.* Meteorological and climatological concepts related to hurricanes. Forecasting current activity; researching past storms; and analyzing storm structure, damage, and future trends. *Course taught by Dr. Corene J. Matyas*
9. **MET 6752: Atmospheric Data Analysis (3)** *Prereq: MET5504 or MET6530, or consent of instructor.* How atmospheric data is collected and analyzed both for meteorologic and climatologic-scale research. Learn where to obtain various types of data and how to analyze data to answer specific research questions. *Course taught by Dr. Corene J. Matyas*

10. **GLY 5075: Global Climate Change: Past, Present, and Future** (3) Prereq: GLY 4552C. Evolution of the Earth's climate through geologic time, including discussion of modern climatology and methods of paleoclimate interpretations. *Course taught by Dr. Ellen Martin*
11. **GLY 6695: Topics in Paleoclimatology (4; max: 12)** *Prereq: undergraduate degree in geology or consent of instructor*. Studies of paleoclimates and interpretation of climate change from rock record.
12. **WIS6934:** in Species Distribution Modeling. Approximately 1/3 of this graduate level course focuses on developing models to predict climate impacts on species distributions. It is anticipated that this course will be offered every other spring. *Course taught by Dr. Susan Cameron Devitt*
13. **WISXXXX**:An undergraduate course on Case studies in Climate Change Ecology, will be offered every spring, starting 2012

Comment from Dr. Keith Ingram: If we are to be relevant, we need to also consider climate variability at seasonal and decadal time scales. If we focus exclusively on climate change at 50 to 100 years or longer time scales, we will not meet the needs of most decision makers. Similarly, courses on basic climate sciences that might include a section on climate change are probably more important for student education than courses that address only climate change.

University of Miami

Coral Gables, FL 33124
Rosenstiel School of Marine and Atmospheric Science, Miami, FL 33149

A. Respondent(s)

Dr. David Letson, Professor, RSMAS, Email: dletson@rsmas.miami.edu, **Research Interests**: Climate adaptation in agriculture and water resources.

Dr. Craig Mattocks, Atmospheric Research Scientist, RSMAS/ Division of Meteorology and Physical Oceanography, Email: cmattock@rsmas.miami.edu **Research Interests**: (1) Running high-resolution climate simulations with a icosahedral global climate model (OLAM) to investigate the impact of anthropomorphic changes to the landscape on the rainfall in Florida and the Caribbean. (2) Developing a climate-driven coastal flood modeling system to guide policy makers, planners and managers in making decisions that will help communities adapt to the risk of sea-level rise under current and future climate warming scenarios and build sustainable, hazard-resilient coastal communities?

B. Current University-Wide Climate Change Research

Climate: Research covers a wide range of topics, both global and regional. We study climate variations on time scales from sub-seasonal to interannual to decadal, as well as ancient (paleo) climates and future climate changes. Efforts include analysis of satellite data, field observations and global data products, and a large focus numerical climate modeling.
http://www.rsmas.miami.edu/academics/divisions/meteorology-physical-oceanography/research/
http://www.rsmas.miami.edu/groups/climate/
http://www.rsmas.miami.edu/people/tag/climate/

C. Current Climate Change Courses Offered and/or University Contact Name

1) **MSC 102 - Introduction to Atmospheric Science (3 cr)** Structure, physics, dynamics and thermodynamics of the atmosphere; weather phenomena weather forecasting, climate and

climate change. Contemporary topics covered in this class include global warming, the ozone hole, hurricanes and El Nino.

2) **MSC 220 - Climate and Global Change (3 cr)** The Earth's climate system and the role of natural and anthropogenic processes in shaping climate change.
3) **MSC 415 - Coral Reef Science and Management** The interdisciplinary nature of coral reef science and management: biological, environmental, ecological and socioeconomic aspects of coral reef science, coral reef management problems and approaches at local to global scales, and the implications of climate change for coral reef science and management.
4) **RSM 571 – Sustainability**
5) **MGG 676 – Paleoclimatology**

University of North Florida

1 UNF Drive, Jacksonville, FL 32224

A. Respondent(s)

Dr. Courtney Hackney, Biology Department Chair, Director of Coastal Biology, Email: c.hackney@unf.edu **Research Interests:** Two research interests have governed my work during the past 30 years. The first is the response of tidal wetlands to sea level rise and salt intrusion. Initially, my focus was on individual plant and animal species and their ecological role in tidal ecosystems, but increasingly my focus has shifted to the entire biotic community. Recent studies have focused on the community change associated with pulses of saline water into tidal swamps in the Southeastern U.S. Understanding this response is key to evaluating the impact humans will have on coastal water quality, fish and shrimp populations, and commercial fisheries as humans alter natural flows in rivers and tidal channels. My second research interest relates to coastal ecosystems, especially wetland communities, and the impact humans have and are having on those systems. This has led to service on a variety of state and federal regulatory and advisory boards. Most recently this interest has joined with my interest in sea level rise when dredging an estuary and port led to an upstream increase in tidal flooding. Current research began in 1999 and continues today. Summary reports are available at U.S. Army Corps of Engineers in Wilmington, NC website. Current research centers on the soil community in tidal swamps and carbon flux from these soils.

Dr. Dan Moon, Associate Professor, Assistant Chair, Biology Department; Email: dmoon@unf.edu **Research Interests**: Ecology of coastal communities, food web dynamics, insect ecology. Research in my lab centers on the ecology of coastal communities such as salt marshes, mangroves, and estuaries. I am primarily interested in how variation in environmental factors influences community dynamics such as plant and insect species diversity and abundance, food web structure and trophic dynamics.

A main focus of research in my lab has been investigating the influence of abiotic factors associated with climate change (primarily elevated CO_2 levels and fluctuating salinity levels) on the interactions among plants, herbivorous insects and their predators. Changes in these fundamentally important, but highly variable environmental factors influence both plants and animals in an astounding array of direct and indirect ways. For example, increasing levels of environmental stress resulting from salt water intrusion can have a negative direct effect on herbivores by decreasing food quality, but a positive indirect effect by decreasing frequency of attack by predators and parasites.

Dr. Cliff Ross, Associate Professor**,** Biology Department; Email: cliff.ross@unf.edu
Research Interests: My research merges a diverse array of biochemical, physiological, and ecological methodologies to examine the cellular mechanisms governing stress responses in micro/macro algae, cyanobacteria, seagrasses, and corals. Representative projects include:

Pathogen-Induced Defense Responses in Seagrasses: Several seagrass species are susceptible to periodic outbreaks of a "wasting disease" that can contribute to rapid population declines. Using seagrass (Turtle grass and Eelgrass) and *Labyrinthula* sp. as a model system, we are particularly interested in the structural and functional identification of elicitors, intracellular signal transduction components, and the transcriptional activation of defense proteins and secondary metabolites.

Effects of Environmental Stressors on Toxic Cyanobacteria: High quantities of toxic metabolites, including cyano-harmful algal blooms (cyanoHABs) not only affect human health but also have a direct impact on the wellbeing of coastal ecosystems. Our research interests are 1) to understand the environmental factors (both biotic and abiotic) that regulate bloom initiation (and demise) and 2) to elucidate the internal signaling events that lead to the upregulation/downregulation of cyanotoxin biosynthesis by using known inhibitors and promoters of cellular signaling processes.

Effects of Environmental Stressors on Scleractinian and Soft Corals: As coral reefs decline on a global scale, it is important to understand the stresses that influence the defense capabilities, adaptation and recruitment processes of different coral species. Our current research interests, within this broad area, are 1) to study the effects of environmental stressors and cellular regulatory processes that control coral settlement, 2) to understand the internal signaling events that may be involved in coral bleaching, and 3) to evaluate the effects of abiotic and biotic environmental stressors on secondary metabolite production.

B. Current University-Wide Climate Change Research

1) Sea level rise-induced phosphate release from tidal wetlands in the St. John's River
2) A study on peat degradation with the USACE is in the planning stage
3) Examining the effects of elevated CO2 levels on a scrub oak forest ecosystem, investigating food web structure and species diversity in constructed wetlands, and studying the interplay between environmental stress levels and intraguild predation in salt marsh communities.
4) Impacts of rising sea surface temperatures on coral larvae

C. Current Climate Change Courses Offered and/or University Contact Name

Climate change is included in various courses, such as Environmental Chemistry, Estuarine Ecology, General Ecology and Human Ecology. Three other courses that take climate change into serious consideration are Marine Biology, Marine Botany and Current Applications in Biology.

University of South Florida

Tampa, FL 33620

A. Respondent(s)

Dr. Gary Mitchum, Professor, College of Marine Science, Email**:** mitchum@marine.usf.edu
Research Interests: I work on estimates of total sea level change from tide gauges and satellite altimetry. An emphasis for me is whether the observed rates (not the sea level height, but rates of change of the height) are consistent or not with past observed changes at the decadal to centennial time scale.

I am also interested in the dynamics of decadal variations in regional to global scale sea level changes whether these changes are natural or anthropogenic. This interest includes decadal to centennial modulations in wintertime storminess, which I suspect might be very important for determining human vulnerability to climate change.

Dr. Joseph M. (Donny) Smoak, Associate Professor, Environmental Science, St. Petersburg; Email: smoak@mail.usf.edu, **Research Interests**: My research focuses on wetland carbon sequestration and the role wetlands play as potential positive or negative feedbacks in climate change. I examine freshwater wetlands and mangrove systems (coastal wetlands) to assess the wetlands current contribution to the global carbon budget (i.e., over last 100 years), and how the contribution may change as the climate warms and sea level rises. I use sediment cores and Pb-210 dating to make these assessments. I currently have projects at several sites in Brazil and in the Florida Everglades.

Dr. Mark Stewart, Professor, Geology Department, Univ. of South Florida-Tampa; Email: mark@usf.edu, **Research Interests**: (1) Mathematical modeling of geologic carbon sequestration (2) Determining the effects of climate change on stream flow and water resources in Florida (3) Carbon sequestration pilot project, Polk County, Florida.

Dr. Kalanithy Vairavamoorthy, Director School of Global Sustainability, Director Patel Center for Global Solutions (also Full Professor in Department of Civil Engineering); Email: vairavk@usf.edu, **Research Interests**: My research concerns the effects of global change on urban water management. My current research is looking into how to make urban water systems more flexible so they can respond to uncertainties associated with global change.

I am also the Scientific Director of research project called SWITCH (www.**switchurbanwater**.eu). SWITCH is one of the largest water research projects funded by the European Union. The project involves 32 partners from across the globe, including 17 from the EU and 12 from developing countries. The aim of SWITCH is to develop scientific, technological and socio-economic solutions for the sustainable and effective management of water in the city of the future (2050) - a city facing major global change pressures.

A focus of my research is how to design and manage urban water systems in an uncertain world (as external pressures like climate change show a great degree of uncertainties). Hence we have looked at how to best describe uncertainties, and developed frameworks to generate flexible water systems that are robust and adaptable to new, different, or changing requirements. For example, we have investigated the potential of small-scale decentralized storm-water options that provide internal degrees of freedom, allowing many different combinations to be considered (hence flexibility can be optimized over time). Such strategies could be important climate change adaptation strategies.

Another focus area has been on transitioning systems so that they can cope with climate change. The tendency has been to see urban form as fixed. However, if we want to develop more adaptable and robust systems that can cope with climate change, we need to develop effective transitional pathways that allow the system to function over time while moving it from its existing trajectory to an optimal trajectory. Transitioning is not only about infrastructure – we also need to know how to transition our institutional frameworks so that they are better suited to manage our resources in more intelligent and sustainable way.

B. Current University-Wide Climate Change Research

Research studying changes in the Earth's gravity field (i.e., water mass redistribution between the land and ocean), we have strengths in remote sensing of a variety of variables, and also have strengths in paleo-oceanography and climate modeling.

Research:
1. Carbon capture and sequestration
2. Effects of climate change on hydrologic systems
3. Effects of climate change on ecosystems
4. Clean energy research: solar, hydrogen fuel cells

Research at the School of Global Sustainability and the Patel Center for Global Solutions:

The Patel Center is coordinating the project 'Resilient Tampa Bay'. As Tampa Bay will become more vulnerable due to climate change (sea level rise, more extreme events etc.), this project is looking out how we can improve its resiliency. The project is demand driven, where an alliance of stakeholders are working with USF to establish a relevant and meaningful research programme. This includes looking at how urban planning can improve resiliency, how natural systems can improve defenses, and how greater integration between different agencies can lead to a more coherent approach to resiliency.

One of the main priorities of the Patel Center is to develop a training kit that will help coastal cities worldwide to improve their resiliency and reduce their vulnerability. This training program called 'Resilient Coastal Cities' will be tested in several coastal cities along the Gulf of Mexico in the next 12 months. The training kit will be launched on the Coastal City Summit in April 2012 in St. Petersburg.

USF is also part of the 'Coastal Area Climate Change Education' (CACCE) Partnership. The goal of this partnership is to develop a comprehensive climate education plan to educate K-12 and college students about the impacts of global climate change. It is expected, that these educational efforts will have broad impacts for adapting to and mitigating the socio-economic challenges that global climate change will impose upon coastal communities.

C. Current Climate Change Courses Offered and/or University Contact Name

Tampa Campus:
1. GLY 2073 Global Climate Change, Mark Stewart, Geology, USF mark@usf.edu
2. EVR 2217 Energy, Environment, and Sustainability, Yogi Goswami, Civil and Env Engineering
3. Global Warming: Science and Politics, Jeff Cunningham, Civil and Env Engineering
4. PSC 2515 Energy and Humanity, R. Criss, Physics

College of Marine Science:
A variety of courses in remote sensing,
A core curriculum in ocean, atmosphere dynamics,
A strong set of courses in statistics and data analysis methods,
A course covering the global hydrologic cycle,
Several courses in numerical modeling methods for the ocean and atmosphere, and
Courses in the physics of decadal to centennial ocean, atmosphere variations.

St. Petersburg Campus:
EVR 4934 / EVR 6934 Global Climate Change. Undergraduate and Graduate level every other year

Dr. Kalanithy Vairavamoorthy: It is not possible to provide a complete list of climate change related courses at USF. However, I list the following:

- Weather, Climate and Society (Prof. Jennifer Collins)
- Climatology (Prof. Jennifer Collins)
- Climate change and health (Prof. Connie Mizak)
- Paleoclimatology (Prof. Philip Edward van Beynen)
- Climate Change (Dept. of Geography, Environment and Planning)
- Global Climate Change: A Geoscience Perspective (Dept. of Geology)
- Global Climate Change: Past and Future (Prof Benjamin P. Flower)

Please note that there will be several other courses that I'm currently not aware of, and also many courses that include a strong element of climate change within them.

University of West Florida

11000 University Pkwy. | Pensacola, Florida 32514

A. Respondent(s)

Dr. Wade Jeffrey, Professor, Center for Environmental Diagnostics and Bioremediation, Email: wjeffrey@uwf.edu **Research Interests**: My primary interests relate to effects of ultraviolet radiation on marine microbes. Other interests include marine microbiology, DNA damage and repair in the environment, ozone depletion and microbial community structure and function.

Dr. Jason Ortegren, Assistant Professor, Dept of Environmental Studies, Email: jortegren@uwf.edu **Research Interests**: My research interests are principally in paleoclimatic change, specifically with regards to low-frequency (multidecadal) drought variability. I am working on a paper about subregional drought variability in the southeastern U.S. My research program is centered on climatology, specifically paleoclimate using dendrochronology (tree-ring science). In addition, I am working with a graduate student on a paper about temperature trends in urbanized and urbanizing areas of the Southeast.

B. Current University-Wide Climate Change Research

1) Latitudinal effects of ultraviolet radiation on marine microbial communities and molecular diversity of genes important in biogeochemical cycles
2) Investigation of molecular diversity of important functional genes in marine bacteria
3) UV effects on marine production by bacteria and phytoplankton: Assessing the impact of UVB
4) Interactive Effects of UV radiation and temperature on pelagic foodwebs
5) Trophic interaction of microbial organisms in response to oil
6) Bullock, A.K., and W.H. Jeffrey. 2010. Temperature and solar radiation interactions on ^{3}H-leucine incorporation by bacterioplankton in a subtropical estuary. *Photochem. Photobiol.* 86:593-599.

7) Ortegren, J.T., Knapp, P.A., Maxwell, J.T., Tyminski, W.P., and Soule, P.T. (2011). Ocean-atmosphere influences on low-frequency warm-season drought variability in the Gulf South and Southeastern U.S.A. In Press with *Journal of Applied Meteorology and Climatology.*
8) Maxwell, J.T., Soule, P.T., Ortegren, J.T., and Knapp, P.A. (2011). Droughtbusting Tropical Cyclones of the Southeastern Atlantic Coastal States, 1950-2008. In Press with *Annals of the Association of American Geographers.*
9) Ortegren, J.T., and Knapp, P.A. Tree-Ring Based Reconstruction of Multi-Year Summer Drought in Piedmont and Coastal Plain Climate Divisions of the Southeastern U.S.A., 1690-2006. MS in revision for *Quaternary Research.*
10) Ortegren, J.T., Liu, Z.J., and Lennartson, G.J. (2005). Spatio-Temporal Analysis of Temperature Trends in Urbanized and Urbanizing Areas of North Carolina. *North Carolina Geographer* (13): 31-45.

C. Current Climate Change Courses Offered and/or University Contact Name

GEO 3250 Weather and Climate, Dr. Jason Ortegren
OPC 4550 Global Climate Change (online course), Dr. Jeffrey

Dr. Ortegren is developing an Advanced Climatology course that will deal with climate change.
Climate change is also touched on in other courses and through guest lecturers.