Florida Atlantic University & U. S. Geological Survey Workshop

HYDROLOGY OF THE EVERGLADES IN THE CONTEXT OF CLIMATE CHANGE

Cover Photos
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EXECUTIVE SUMMARY

BACKGROUND

The Center for Environmental Studies (CES) at Florida Atlantic University (FAU) and the U.S. Geological Survey (USGS) held a workshop on March 29-30, 2012 at FAU in Davie, Florida. The purpose of this workshop was twofold:

- Assess the state of knowledge of the impacts of current and future climate change on the hydrological cycle in the Everglades including gaining a greater understanding of downscaled hydrologic global models for the Everglades.
- Examine each of the components of the cycle in the greater Everglades by identifying:
  - our understanding of potential changes in precipitation quantity and intensity, evapotranspiration, percolation to groundwater, runoff and drainage, and
  - critical knowledge gaps with respect to future patterns and their impact.

The plenary sessions opened with a series of presentations that set the stage by providing a common basis of information for the discussion groups to draw upon. The first group of speakers provided a "Big Picture Perspective" on the climate change implications for Florida, including the state of knowledge, downscaling global models and changes in hydrology. This was followed by a review of selected components of the hydrological cycle, including precipitation, temperature, evapotranspiration and groundwater and surface water flows. More importantly the idea of this workshop was to focus on the impact of global climate change on rainfall variability and hydrologic variations, and their consequent implications on Everglades restoration and water management in South Florida in the near term (10-30 years) and long term (end of century).

DOWNSCALING ISSUES

A series of discussions on the complexity of downscaling from global models to this peninsular region revealed significant problems with projections of future precipitation patterns but better predictions of temperature change. Decadal variations involving El Niño and the Southern Oscillation complicate the picture. Urbanization and change in land use are also important.

THE HYDROLOGIC CYLCLE

Research indicates that the hydrologic cycle will change in the future and water management must be modified to handle these changes. Current temperature projections show a rise of 1-2°C (1.8-3.6°F), precipitation change may be ±10% and evapotranspiration (ET) may increase 3-6 inches by 2050. North Florida will be warmer and South Florida, at the same latitude as the Sahara, will be drier.

Precipitation is the main driver of Everglades hydrology. The research priorities are:

- Understanding trends in extreme precipitation events, like tropically-driven heavy rainfall systems and droughts.
- Developing knowledge with spatial and temporal trends of precipitation.
- Understanding how spatial and temporal trends have changed throughout history and how they will evolve with a changing climate.
- Examining the relationship between precipitation trends of urban and natural systems.
- Developing models that incorporate future land use changes.
- Identifying current and future urban heat islands and the local effects they may induce on regional precipitation trends.

Evapotranspiration (ET) is the second most important component of the Everglades hydrology, but is the most poorly understood. We have begun to build a wealth of information over the past 5-7 years regarding ET. Progress has been made in gathering data that are used for the evaluation of climate models. There are several points that are crucial to the understanding of how present and future ET rates relate to the evolution of the South Florida landscape:

- Building a firm understanding of ET rates among urban, suburban, and agricultural areas.
- Understanding the related energy balance and effects on ET between urban and vegetative sites needs further investigation, as well as the effects of urban heat islands on non-stationarity in historic and present meteorological records.

The alteration of land use patterns and increased urbanization will far outweigh the potential impacts of climate change on ET in South Florida for many years. The two need to be jointly and thoroughly assessed to improve predicted ET rates in the future.

Groundwater and **sheetflow** are poorly understood components of the hydrology of the Everglades, especially regarding how they will be affected by climate change. The hydraulics of the Everglades is the only real world example of a genuine sheet flow system, which makes adaptive management and restoration an arduous and challenging task. Groundwater flow has undergone severe alteration as a result of the channelization and drainage of the Everglades, and several areas of research are needed:

- Practical modeling of sheet flow hydraulics to build a basis for future predications of sea level rise and climate change scenarios.
- Defining critical regions throughout the Everglades and begin to integrate models, information and people to acquire a more holistic approach to define where we are and where we should be going in terms of groundwater management.
- Examining the decomposition and subsidence of peat and marl throughout the Everglades as a result of groundwater alteration and its impact on flows.

PLENARY SESSIONS SUMMARIZED

Despite the dense data sets available for the Everglades there are substantial gaps and deficiencies in our understanding of Everglades hydrology. These become especially important as we attempt to assess the impact of climate change on components of the hydrological cycle. This workshop attempted to assess the state of knowledge of the hydrologic cycle, and on model projections of future change. In so doing, we identified critical knowledge gaps and made recommendations for future action.

DISCUSSION GROUPS

Attendees participated in discussion groups that concentrated on the three primary influences of hydrology of the Greater Everglades: evapotranspiration, groundwater and precipitation. The discussion groups' were given charges to:

- Describe and identify key gaps in the current state of knowledge,
- Describe the anticipated effects of climate change on research goals,
- Determine ways to increase our understanding of the hydrologic cycle in the Everglades, and
- Identify key steps to be taken to prepare South Florida and the Everglades for climate change events.

Discussion groups were composed of a wide variety of individuals including hydrologists, modelers, meteorologists and biologists. Discussion leaders guided the dialog to answer the above inquiries. Results were presented to the entire workshop to discover knowledge gaps and to discuss any potential items that may have been overlooked by the groups.

Each discussion groups produced a list of Data Needs and Research Priorities. These lists were combined and categorized under the following topics: Sheet Flow, Groundwater, Evapotransporation and Climate Change and Sea Level Rise (SLR). Additional recommendations for outreach were also determined. The Data Needs and Research Priorities as well as the Outreach Recommendations are listed in the table on the back of this publication.

DATA NEEDS AND RESEARCH PRIORITIES

Sheet Flow	• Understand the hydraulic dynamics of the Greater Everglades sheet flow system.
	• Examine the effects of restored sheet flow after the completion of the Tamiami Trail (US 41) project. This is vital to understanding the larger picture of restored sheet flow throughout the restored Everglades.
	• Use sulfur hexafluoride as a tracer deployed using airboats to remotely sense flow.
Groundwater	• Conduct studies that focus on the interaction between groundwater and surface flow.
	• Establish additional groundwater survey wells.
	• Continue to monitor groundwater for saltwater intrusion. This is critical for determining the impacts on the aquifer system as a result of SLR.
	• Determine the potential ecological impacts of a shifting saltwater/freshwater interface.
Evapotranspiration	• Examine stomatal response to elevated CO2 levels and determine how CO2 levels affect transpiration pathways.
	• Conduct isotopic studies of water that could help to distinguish between the rates of evaporation and transpiration leading to more accurate estimates of ET.
	• Build additional towers to measure ET rates in both urban and rural areas.
	• Understand the effects of seasonal variations and the physiological differences of plant species throughout the Everglades. This is imperative for understanding ET rates.
Climate Change and Sea Level Rise	• Conduct experiments to study the effects of SLR on peat collapse in the Everglades.
	• Learn how to best manage Lake Okeechobee under drier conditions, including dike management and inflows.
	• Understand the trends in extreme precipitation events, such as tropically driven systems and droughts.
	• Examine how permanent temperature changes will affect the hydrologic cycle. This has not yet been given research priority.
	• Integrate adaptive resource management strategies to cope with the uncertainties of future climate changes.
	• Integrate SLR into natural resource and regional planning efforts.
	• Create replicable, accurate models that define the minimal scales required for the regional downscaling needs of South Florida.
	• Produce realistic and robust "what if...?" scenarios that include models with different levels of annual rainfall, e.g., 30, 50 and 70 inches.
	• Implement practical modeling of sheet flow hydraulics, which is needed to build a basis for future predictions of sea level rise and climate change scenarios.

OUTREACH RECOMMENDATIONS

- Work to improve the communication between scientists and the public to create a dialogue on how climate change may impact their lives.
- Build better media relations with the scientific community to effectively communicate climate change issues.

For more information, a full report of the workshop proceedings and discussions is available in the Summary Report: HYDROLOGY OF THE EVERGLADES IN THE CONTEXT OF CLIMATE CHANGE March 29-30, 2012, Florida Atlantic University, Boca Raton, Florida
This report was developed in partnership with the USGS.
To obtain the report, please visit:
http://www.ces.fau.edu/climate_change/Hydrology_March2012

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