

# COASTAL ECOLOGICAL IMPACTS OF DROUGHT: NEEDS FOR A DROUGHT EARLY WARNING SYSTEM

Kirsten Lackstrom and Kirstin Dow

---

AUTHORS: Doctoral Candidate and Associate Professor, University of South Carolina,  
Department of Geography, Columbia, SC 29208

REFERENCE: Proceedings of the 2010 South Carolina Water Resources Conference, held October 13-14, 2010,  
at the Columbia Metropolitan Convention Center

---

**Abstract.** Both at a national level and in the Carolinas, experiences with drought over the past decade have led to new efforts to increase drought preparedness. Due to the severity of drought impacts in the Southeast, the US National Integrated Drought Information System has targeted the region for pilot project development of a drought early warning system. Such a system requires a regional approach to understanding drought monitoring and impact assessment needs, gaps in scientific understanding of drought processes, and development of communication strategies useful to the variety of groups involved in drought preparedness and response. This paper focuses on an initial effort to assess drought preparedness needs for the management of coastal ecosystems and presents highlights of workshop findings and interviews with coastal resource managers on needs in the areas of research and monitoring; planning and management; and education and outreach.

## INTRODUCTION

Recent droughts in the Carolinas have resulted in a broad array of impacts. While drought impacts on agriculture and water supplies are relatively well studied, several other critical areas are not yet as well understood. As the region considers how to increase drought preparedness, better understanding of drought impacts on coastal ecosystems is a vital area for advancing understanding.

Drought can have devastating impacts on aquatic as well as terrestrial environmental resources. Drought contributes to reduced streamflow, diminished water quantity and quality, which then impairs habitats and limits the resources available to wildlife. Human-induced changes in the environment (e.g. dams, flow regimes, development) may compound drought conditions, and its impacts. However, studies have indicated that "...environmental resources often receive inadequate attention during drought emergencies and in drought planning, not so much because of lack of concern but

because of lack of expertise in this arena, lack of adequate financial resources, and sometimes lack of awareness." (NDPC 2000, 29).

In order to advance our understanding of this area, the Carolinas Integrated Sciences and Assessment (CISA) group organized a workshop among South Carolina coastal management professionals with experience and responsibility for managing drought. The goal of this meeting was to assess the state of knowledge and issues to be addressed in three areas: research and monitoring; planning and management; and education and outreach.

## BACKGROUND

Carolinas Integrated Sciences and Assessments (CISA) is one of 9 Regional Integrated Sciences and Assessments (RISA) supported by the National Oceanic and Atmospheric Administration (NOAA). The RISA program addresses complex climate-related issues that are of concern at the regional level. CISA assesses the impacts of climate variability and change on natural and human systems in the Carolinas and develops information and tools to assist decision-makers. CISA research and projects encompass drought monitoring and assessment, watershed modeling, and coastal climate issues.

CISA has recently begun to work with the National Integrated Drought Information System (NIDIS), an interagency program that works to improve drought monitoring and management systems on the national level. A major goal of NIDIS is to create a "drought early warning system," a comprehensive approach to drought planning that provides accurate, timely and integrated information on drought conditions, as well as a management support system to facilitate proactive decisions aimed at minimizing the economic, social and ecosystem losses associated with drought. The temporal scale of monitoring and forecasting tools range from weekly (e.g. the U.S Drought Monitor) to seasonal (e.g. the U.S. Seasonal Drought Outlook).

The Southeast has been selected as one of the regions in which to pilot early warning systems. Efforts are underway in the Apalachicola/Chattahoochee/Flint River Basin and will begin in the Carolinas in the coming year. Development of an early warning system started earlier in the Upper Colorado River Basin, the location of the other pilot project.

The early warning systems will include a decision support and information portal (see the drought.gov website), with the data and technical tools used to monitor and forecast drought conditions (how long might a drought last, how severe) and to communicate the associated risks and possible impacts. The drought early warning system will also support communication networks, stakeholder partnerships, and education and outreach programs to enable information-sharing among different groups and the incorporation of drought early warning data and tools into drought response planning efforts. The NIDIS Implementation Plan (2007:1) emphasizes the importance of environmental impacts stating that "...effective coordination plans would evaluate drought programs to identify and address priority impacts on environmental services and, where possible, improve proactive mitigation of drought's impacts on the environment through training, incentives, technical assistance, research, and public education."

The need for greater attention to coastal ecological impacts of drought is reflected in the sparse research on the topic. Literature on drought and coastal resources in the Southeast is narrowly focused on the impacts of high-salinity on individual species and habitats, e.g. blue crabs (Lee and Frischer 2004), oysters (Power et al. 2006), and salt marsh die-off and associated vegetation changes (White and Alber 2009; Ogburn and Alber 2006; Visser et al. 2002).

## WORKSHOP DESIGN

Project activities began in October 2009 with the intent of conducting a stakeholder workshop in Spring 2010. The first tasks entailed identifying 1) significant issues and concerns for the Winyah Bay region and 2) individuals and organizations with experience and/or expertise with "on-the-ground" drought impacts and related management concerns. We conducted a literature review which broadly encompassed peer-reviewed research, technical reports, white papers, newspaper articles, and organization web pages. We also conducted scoping interviews with ten stakeholders to gather preliminary information about possible topics of interest and to gather suggestions for other stakeholders to invite to the workshop.

In February 2010 we sent workshop invitations to 67 people. We used Survey Monkey to send an online survey

to workshop registrants. The intent of the survey was to obtain background information about the participants and their drought-related work responsibilities; top concerns about drought; current use of drought-related information and tools; and the resources, tools, and information necessary to address their top concern.

The workshop was held on March 23, 2010, in Georgetown, South Carolina. The 29 participants included researchers from CISA and the National Drought Mitigation Center (located in Lincoln, Nebraska). Attendees included applied researchers, resource managers (e.g. wildlife, fisheries, forestry, water, land), and education and advocacy specialists. Individuals represented academic institutions, resource agencies, and NGOs engaged at the federal-, state-, and local levels.

The workshop had three central components. The first session included presentations by CISA and NDMC staff about national- and state-level activities to improve drought preparedness and monitoring. The purpose of this session was to bring participants up-to-date on national- and state-level drought efforts and to provide participants with a conceptual framework to begin thinking about drought-related impacts, stresses, information and management needs in coastal ecosystems. The second component was a large group session to have a more in-depth discussion of impacts and stresses of greatest concern. Participants were asked to categorize and rank impacts and to discuss the specific factors that created or contributed to impacts (e.g. length or duration of the drought, severity, human activities). Third, breakout sessions grouped participants according to their primary area of interest or expertise and asked them to discuss in more detail issues related to impacts research and monitoring, management and planning, and education and communication.

## DISCUSSION

The scoping interviews, online survey, and workshop discussions highlighted several broad themes regarding drought impacts, concerns, and vulnerabilities. Water quality concerns involve 1) salinity and saltwater intrusion issues and 2) reduced ability to flush or assimilate pollutants, exacerbating risks of impairment. Ecosystem impacts and concerns related to habitat loss or conversion and consequent impacts to species, such as affects on recruitment, distribution and migration patterns, and primary and secondary production. Third, participants cited the lack of knowledge and understanding about drought and its impacts on coastal resources as a major concern. Fourth, (and related to the limitations of current information and knowledge) participants voiced concerns about the ability of existing water management systems to consider and incorporate ecosystem needs into planning

**Table 1. Resources, Tools, and Techniques Necessary to Address Drought Concerns**

	High Importance	Medium Importance	Low Importance	Not Important
More data or basic research about drought, hydrology, climatology, or impacts	11	5	1	0
Monitoring tools	7	8	3	0
Science-based models, e.g. hydrology, ecological impacts, social-environmental carrying capacity	14	3	0	0
Decision-support and/or online tools to improve access to information	9	6	3	0
Coordination or partnerships with other agencies, organizations	10	6	2	0
Technical training	1	11	6	0
Formal plans to guide actions	8	7	3	0
Public education and outreach	9	7	2	0
Financial resources	8	7	2	0
Other: Connecting science to public policy decisions at the local, regional, and state levels to address drought-related impacts in our watershed.	1	1	0	0

and decision-making.

Table 1 displays survey results related to priorities for resources, tools, and techniques necessary to address drought-related concerns. Workshop participants elaborated on many of these needs during the small-group sessions. The group divided into three breakout groups according to work-related expertise and responsibilities, namely research and monitoring; planning and resource management; and, education and outreach.

### Research and Monitoring

The research and monitoring breakout group identified several areas requiring further research. The group identified a need for greater availability of appropriate drought data and information to manage coastal resources during drought. The current state of knowledge for this topic is seen as poor and minimal. Primary topics of interest are the impacts of low streamflows to estuarine and river habitats and species, water quality changes, groundwater-surface water interactions, and information to inform decisions on balancing environmental and human needs.

Participants observed that while some short-term impacts and impacts to particular organisms or species may be well-understood, the understanding of drought impacts at the ecosystem level is substantially less. The variability associated with ENSO has received some attention, but other types of climate information are sometimes difficult to obtain. Researchers highlighted the need for better long-term, fine resolution biological and ecological data, as well as models or tools which

incorporate human influences on ecological impacts. Basic research may be required to assess the quality and appropriateness of existing data networks and to identify which variables are most important to monitor and assess drought-impacted ecosystems (e.g. chemical, physical, or biological). With coastal areas experiencing increasing development and water demands, understanding and integrating social data (e.g. land use change, water allocation rules, and other socioeconomic processes) into water- and drought management decisions is also critical.

### Planning and Management

Participants expressed concern that drought management has been conducted as a “reactive” response to impacts or through “stop-gap” measures. In many cases, there are no drought management plans. Resource managers report a general lack of knowledge needed to consider such planning. Echoing the research group, they identified a need for drought-related data and information on potential conditions and impacts. Improved understanding of carrying capacities, changes to physical habitat, and connections among ecosystems during drought would be useful, as would better information on the ecosystem services affected.

Participants also noted that drought issues are not well integrated into other permitting and management processes. While drought influences water quality, habitat, forests, fisheries, reserves, and parks, cross-agency communication and coordination is limited.

## Education and Outreach

According to education providers, the public and local decision-makers often do not recognize the significance of drought issues until it is connected to other water and land use planning issues. The information and resource needs of this group focused on issues that would increase the public understanding of linkages to people's lives, interests, and employment. These included increased understanding of groundwater-surface water interactions, cones of depression associated with pumping, and public health considerations of water reuse strategies.

## RECOMMENDATIONS

The development of a Southeast early warning system pilot requires a regional approach to understanding drought monitoring and impact assessment needs, gaps in scientific understanding of drought processes, and development of communication strategies useful to the variety of groups involved in drought preparedness and response. This workshop was a significant first-step in identifying the greatest concerns for coastal Carolina ecosystems and the potential building blocks and priorities for the design of a drought management support system. This workshop was significant in that it convened stakeholders who do not necessarily interact to discuss a topic of common interest in an information-sharing forum.

CISA will continue to work with coastal ecosystem stakeholders and follow up on the workshop recommendations:

- The research and monitoring group recommended a state of knowledge report on coastal ecosystem drought impacts; a centralized source of drought studies and relevant data; and, an evaluation of monitoring and data collection practices for comparability and priority setting.
- The planning and management group suggested that the Office of the State Climatologist increase interactions with coastal resource managers and that ecosystem conditions and impacts be better integrated into state-level drought response management processes.
- The education and outreach group advised that local case studies of drought-related impacts and/or

adaptations (e.g. use of grey/recycled water systems or other water conservation strategies) would be most effective in transferring information to local planners and decision-makers.

## ACKNOWLEDGEMENTS

The authors thank NOAA's Climate Office and RISA Programs for their support; workshop attendees for their participation; and, CISA team members and Cody Knutson of the National Drought Mitigation Center for their assistance.

## LITERATURE CITED

- Lee, R.F. and M.E. Frischer, 2004. The Decline of the blue crab. *American Scientist* 92, November-December: 548-553.
- National Drought Policy Commission (NDPC). May 2000. *Preparing for Drought in the 21<sup>st</sup> Century*. US Department of Agriculture, Washington, D.C. 60 pages.
- NIDIS Program Implementation Team, NIDIS Program Office. *The National Integrated Drought Information System Implementation Plan: A Pathway for National Resilience*. June 2007. 34 pages.
- Ogburn, M.B. and M. Alber, 2006. An investigation of salt marsh dieback in Georgia using field transplants. *Estuaries and Coasts* 29 (1): 54-62.
- Power, A., B. McCrickard, M. Mitchell, E. Covington, M. Sweeney-Reeves, K. Payne, and R. Walker, 2006. *Perkinsus marinus* in coastal Georgia, USA, following a prolonged drought. *Diseases of Aquatic Organisms* 73: 151-158.
- Visser, J.M., C.E. Sasser, R.H. Chabreck, and R.G. Linscombe. 2002. The impact of a severe drought on the vegetation of a subtropical estuary. *Estuaries* 25(6A): 1184-1195.
- White, S.N. and M. Alber, 2009. Drought-associated Shifts in *Spartina Alterniflora* and *S. Cynosuroides* in the Altamaha River estuary. *Wetlands* 29(1): 215-224.