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National Environmental Change Information System Case Study Final Report

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November 2001

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LIST OF ACRONYMS

ACF	Apalachicola-Chattahoochee-Flint (river basins)
ACT	Alabama-Coosa-Tallapoosa (river basins)
AGNPS	agricultural nonpoint source
ASCII	American Standard Code for Information Interchange
BASINS	Better Assessment Science Integrating Point and Nonpoint Sources
CERES	Crop Environment Resource Synthesis
CGCM1	Canadian (Centre) General Circulation Model 1
COE	U.S. Army Corps of Engineers
DIWG	Data and Information Working Group
DSS	Decision Support System
DTN	Data Transmission Network
EPIC	erosion productivity impact calculator
FGDC	Federal Geographic Data Committee
GAEMN	Georgia Automated Environmental Monitoring Network
GCDIS	Global Change Data Information System
GCMD	Global Change Master Directory
GHCC	Global Hydrology and Climate Center
GIS	Geographic Information Systems

LIST OF ACRONYMS (Continued)

GLEAMS	Groundwater Loading Effects of Agricultural Management Systems
GPS	global positioning system
HADCM2	Hadley (Centre) Climate Model 2
HEC	Hydrologic Engineering Center
IFDC	International Fertilizer Development Center
IWR	Institute for Water Resources
M&I	municipal and industrial
MAP	mean areal precipitation
MSFC	Marshall Space Flight Center
NCDC	National Climatic Data Center
NECIS	National Environmental Change Information System
NEXRAD	next-generation weather radar
NGO	non-government organization
NOAA	National Oceanic and Atmospheric Administration
NRC	National Research Council
NSSTC	National Space Science and Technology Center
NWS	National Weather Service
QPF	qualitative precipitation forecasts
STELLA®	Systems Thinking In and Experimental Learning Lab with Animation

LIST OF ACRONYMS (Continued)

SWRRB	Simulator for Water Resources in Rural Basins
TM	Technical Memorandum
TOR	terms of reference
URL	An element used to link one document to other documents
USGCRP	United States Global Change Research Program
USGS	United States Geological Survey
USWRP	United States Weather Research Program
WES	Waterways Experiment Station

1. EXECUTIVE SUMMARY

Background: The Global Hydrology and Climate Center (GHCC), Huntsville, AL, and NASA Marshall Space Flight Center (MSFC), Marshall Space Flight Center, AL, conducted a fact-finding case study for the Data Management Working Group, now referred to as the Data and Information Working Group (DIWG), of the U.S. Global Change Research Program (USGCRP) to determine the feasibility of an interagency National Environmental Change Information System (NECIS). In order to better understand the data and information needs of policy and decision makers at the national, state, and local level, the DIWG asked the case study team to choose a regional water resources issue in the southeastern United States that had an impact on a diverse group of stakeholders. The southeastern United States was also of interest because the region experiences interannual climatic variations and impacts due to El Niño and La Niña. With input from the DIWG, a focus on future water resources planning in the Apalachicola-Chattahoochee-Flint (ACF) River basins of Alabama, Georgia, and Florida was selected. A tristate compact and water allocation formula is currently being negotiated between the states and the U.S. Army Corps of Engineers (COE) that will affect the availability of water among competing uses within the ACF River basin. All major reservoirs on the ACF are Federally owned and operated by the COE. A similar two-state negotiation is ongoing that addresses the water allocations in the adjacent Alabama-Coosa-Tallapoosa (ACT) River basin, which extends from northwest Georgia to Mobile Bay. The ACF and ACT basins are the subject of a comprehensive river basin study involving many stakeholders.

The objectives of this case study were to identify specific data and information needs of key stakeholders in the ACF region, to determine what capabilities are needed to provide the most practical response to these user requests, and to identify any limitations in the use of Federal data and information. The NECIS case study followed the terms of reference (TOR) developed by the interagency DIWG. The case study "lessons learned" and "key findings" offer guidelines and considerations to the DIWG for the development and implementation of a NECIS that would support the data and information needs of policy and decision makers at the national, state, and local level.

What is NECIS? The goal of the NECIS, as presented to the case study team,[1] is to provide its users with the best possible information for addressing the Nation's complex, often multidisciplinary environmental change issues. Such users will include decision makers in all three branches of the Federal Government, state and local governments, applied researchers, commercial entities, educators, librarians, non-Governmental organizations, and members of the public. Conceptually, NECIS will be a collaborative and multidisciplinary system consisting of many sets of distributed user information sources, collected and focused on particular problems by an interagency, transdisciplinary team. One set would more closely align to Federal issues and will address United States environmental changes that are of regional or larger extent. Another set would be information sources, based on state-Federal cooperative arrangements, for environmental changes that are of regional or local extent. Federal agencies would provide the expertise and capabilities for information resources relevant to their missions. For analyses of environmental change issues that cut across individual disciplines and agency

missions, there would be a coordinated interagency multidisciplinary analysis process that would include members of NECIS.

All NECIS information sources would be presented to the users as a coordinated information source, with easy access to assistance, and with the ability to have special information products and analyses produced. NECIS will coordinate and draw from existing capabilities and interagency programs to provide as many as possible information sources to the users in order to produce information relevant to environmental change impacting the United States.

1.1 Case Study Lessons Learned

1.1.1 No Show Stoppers

Federal and state agencies, commercial data providers, nonprofits, and stakeholders expressed interest in an environmental change data and information system where products can be located and accessed for use in assessments and decision systems. The next stage of NECIS formulation should allow for non-Federal participation in the advisory process.

Stakeholders expressed interest in the following:

- The models used for assessment and decision making need data products for input, not just information.
- Off-the-shelf data products did not satisfy the needs of stakeholders. Special data sets (e.g., consumptive water use, permitting withdrawals, unimpaired stream flow) and models (STELLA® "Shared Vision") were needed for the ACF basin assessment.
- Support services for data access and appropriate use are valuable to stakeholders.

1.1.2 Establish Open Communications

Trust of key data (55-yr unimpaired stream flow data set constructed by COE) and models (STELLA Shared Vision model developed at the University of Washington) used in the development of the three-state compact for the ACF were established early on because of frequent and open communications among stakeholders. All parties helped develop the model. There is little or no trust in "black boxes."

Comments by stakeholders were as follows:

- Data and models must be well documented, including heritage and modifications.
- Outreach and regional partnerships will be important. The assessments and decision making involve diverse groups of stakeholders including local, state, and Federal Government policy makers and regulatory agencies, and environmentalists.

- NECIS needs to be distributed to the regional, if not state, level to allow for frequent and easy interaction with the stakeholders. Personal contacts and relationships between NECIS staff and stakeholders will engender trust.

- Stakeholders are generally content with existing data sets and using climate norms. It will take proactive effort to establish the value of climate variations in policy and decision making. El Niño-Southern Oscillation has wintertime rainfall impact on coastal southeast United States, yet this impact was not considered in water resource planning. The 2000 drought was of greater concern to stakeholders.

- Some interest was expressed in climate variability products, but the forecast models are not deemed skillful nor of high enough spatial resolution to be valued by stakeholders at the local level. Consider the Canadian (Centre) General Circulation Model 1 (CGCM1) and the Hadley (Centre) General Circulation Model 2 (HADCM2) runs for the Southeast Regional Climate Assessment. The CGCM forecast a 20-percent decrease while HADCM2 forecast a 3-percent increase by 2030.[2] However, this result can be considered valuable if it leads to an appropriate understanding of the limitations and uncertainties in the model predictions that then allows the stakeholder to make an informed decision on the use and limitations of such information.

- The user needs to know the uncertainty in the models and data, and it must be easily communicated to stakeholders.

1.1.3 Data, Information, Special Products, Algorithms, and Models

Data, information, special products, algorithms, and models are obtained from sources outside the Federal Government.

Potential issues raised concerning proprietary algorithms and data products are as follows:

- Strong need for Government and private sector cooperation. Otherwise, expect possible Federal versus commercial data provider conflicts (e.g., issues being addressed between National Oceanic and Atmospheric Administration (NOAA), National Weather Service (NWS), and the private weather data providers—refer to the NWS policy and guidelines governing NWS and private sector roles (A–06) and the U.S. Weather Research Program Private Sector Workshop, Palm Springs, CA, November 29–December 1, 2000. Web addresses are in app. G).

- Government versus commercial data provider conflicts could be exacerbated as the Federal agencies produce more useful, higher resolution forecast models such as NWS' forthcoming weather research and forecasting model and point-specific products to meet stakeholder needs. This might be viewed as being in competition with the commercial data providers.

- Satellite data currently provided by the Federal Government are less useful to local and regional stakeholders owing to inadequate spatial and temporal resolution (e.g., land remote-

sensing satellite was not used in the ACF Comprehensive Study and the resolution is not as fine as what an individual farmer needs). However, this situation will change in the next 5 yr with the deployment of more Government and commercial satellites having the capability to produce high-resolution data products.

- Users desire interactivity with data sets allowing users to subset and analyze data sets as they see fit with their own data and tools. Increased use will be seen as Geographic Information Systems (GIS) and other analysis tools become more affordable.

1.2 Case Study Key Issues

1.2.1 Relationships Among Government, University, Commercial Data Providers, and Stakeholders

Cooperative relationships among Government (Federal, state, local), university, commercial data providers, and stakeholders will need to be developed. Areas of concern are as follows:

- Trust—How to develop trust of data providers, integrity of data products (especially downloads from the Web), climate models, or online decision support system. Determine the additional impediments holding users back from making broader use of climate variability/ environmental change products in decision making (high-speed connectivity, GIS tools, time).

- Responsibility—Who is responsible for data and product quality assurance, archive maintenance, digitizing useful data sets still in paper form, and cost recovery of data production and distribution?

- Cost—Who will assume the cost of producing valuable data sets desired by multiple stakeholders? More than $1M was spent by various stakeholders in producing specialized data sets for the ACF comprehensive study.

- Proprietary data and intellectual property rights—Government versus commercial. Some products provided to stakeholders may even originate as Federal data sets, but are not necessarily provided to stakeholders by the Federal Government, whether value added or not. This issue is of increasing concern to algorithm, model, and product developers.

- Market competitiveness—There is some concern by the individual stakeholder that some high-resolution data may provide a competitive advantage for one stakeholder over another.

1.2.2 Implementation of National Environmental Change Information System

The following services are already in place and will speed the implementation of NECIS:

- Distributed collection of data centers—Leverage existing centers in each state with augmented Federal (and state) funding for selected studies, sponsorship of topical workshops, production of specialized data sets, outreach to stakeholders at local-state-regional level, data center in reasonably close proximity to the individual stakeholders. The roles and responsibilities of the NECIS data centers need to be identified.

- Each state already has an extension service at the land grant universities with a mandate to disseminate the latest research results to Government agencies, non-Government organizations (NGOs), and private companies through permanent faculty fully funded by the U.S. Department of Agriculture. In addition to the faculty at these institutions, the land grants and extension services have county offices and outlying research stations that can serve as the basis for a network of standardized environ-mental data monitoring sites and would facilitate ongoing assessments.

- Each state has an office of the state climatologist, geologist, hydrologist, etc., with established relationships with the public (but not all are equally proactive).

- Each state is covered by an established NOAA/NWS forecast office.

- Various Federal agencies have a physical presence in many states, if not all (which ones, where?). Each state has a state university with close ties to various Federal agencies and laboratories as well as a ready supply of student assistants, but which combination of these institutions best serves the stakeholder? Is the "best arrangement" different in every state, and what will politics impose on the implementation?

1.2.3 Long-Term Sustainability of National Environmental Change Information System

In order to sustain the NECIS, the minimum requirements listed below must be met:

- Need sustainable level of funding—from both Federal and state sources? The state and regional partners should be motivated to participate in NECIS with matching funds for special projects.

- Outreach and development of partnerships within community, state, and region(s) with similar issues and problems is necessary.

- NECIS is more than a gateway to environmental data and information. Education and training of stakeholders, communications with stakeholders, and achievable goals and milestones are important for success. NECIS will need time to develop a track record of responsiveness to user requests.

TECHNICAL MEMORANDUM

NATIONAL ENVIRONMENTAL CHANGE INFORMATION SYSTEM CASE STUDY FINAL REPORT

1. INTRODUCTION

The Apalachicola-Chattahoochee-Flint (ACF) River basins of Alabama, Florida, and Georgia were selected as the case study regional area (fig. 1). The ACF extends 365 mi from northeastern Georgia to the Gulf of Mexico. The total drainage area of the basin is ≈20,000 mi^2. The system is used for recreation, water supply, power production, flood control, navigation, and supports diverse fish species and wildlife habitats. All major reservoirs on the ACF are Federally owned and operated by the U.S. Army Corps of Engineers (COE).

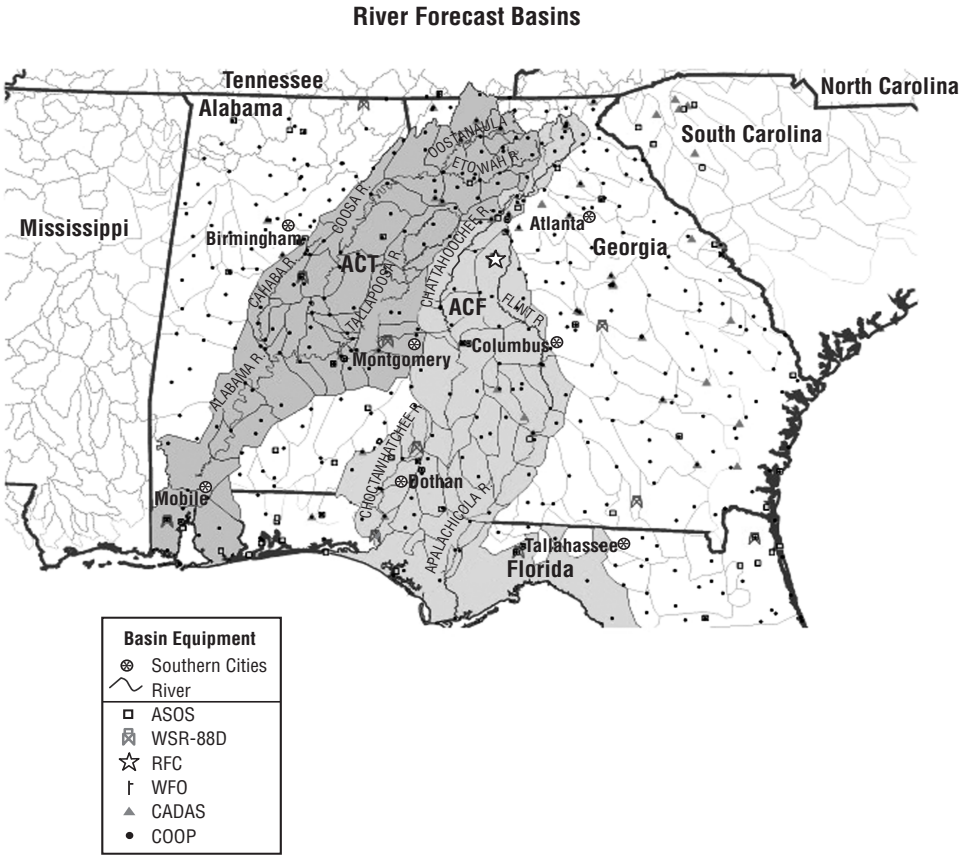

Figure 1. ACF-ACT River basins.

As part of a recent tristate water compact among the three states (Alabama, Florida, Georgia), a water allocation formula is currently being negotiated that will affect the availability of water among competing uses within the river basins. A basin-wide management study conducted by the COE examined whether or not there will be enough water to satisfy the competing interests and also determine if there was a better way to manage the water in the basin.[3] Accounts from published reports and personal contacts made during the conduct of the case study indicate there is enough water to satisfy the competing interests during periods of "normal" rainfall. Nevertheless, during extended periods of low flow, such as during prolonged droughts, there might not be enough water. In addition, nonclimatic effects such as demand growth (and population) are likely to equal or exceed the consequences of climate change in the ACF over the next several decades.[4] The impacts of reduced water availability are magnified during drought years, as have been widely reported in the media during the recent "Drought of 2000." In Alabama, with some areas having annual rainfall totals as much as 20 in. below normal, the drought was the top news story of the year.[5]

Section 2 of this Technical Memorandum (TM) presents the methodology used in the case study. Section 3 contains the summary and results of the two advisory group discussions held in Atlanta, GA, on June 7 and October 13, 2000. Presented here are additional interviews that helped to form the basis for the conclusions (lessons learned) and recommendations (key issues) in the Executive Summary. Appendix A lists additional contacts. Appendices B–G contain a case study chronology and milestone summary, the terms of reference (TOR), the agendas for the group meetings in Atlanta and responses to the National Environmental Change Information System (NECIS) questionnaire, the agenda of the National Research Council (NRC) meeting in Washington, DC, and Web sites consulted for information during the case study.

2. METHODOLOGY

The fact-finding study was conducted as a collaborative effort between the case study team at the Global Hydrology and Climate Center (GHCC), in Huntsville, AL, and the Data and Information Working Group (DIWG). A chronology of meetings and major milestones is given in appendix B. The DIWG developed the TOR, shown in appendix C, which was used as a guideline in the conduct of the case study.

The DIWG thought that the fact-finding process would be most effective if an actual regional policy issue were addressed rather than some hypothetical scenario. The case study team selected a competitive water resource issue affecting various stakeholders in the tristate region of Alabama, Georgia, and Florida. These states are developing a compact to address future water resource demands and allocations from a shared river basin.

In order to meet the case study objective, it was necessary to form an advisory group. Individuals were located who were both willing and able to participate. The advisory group was comprised of several key stakeholders involved in both the ACF comprehensive study and in the U.S. Global Change Research Program (USGCRP) southeast regional climate assessment.

The case study team developed a survey for the stakeholders that would help to identify and understand the possible data and information interests within the case study area. Some obvious data sets (e.g., streamflow, rainfall, temperature) were initially identified through the regional assessment process. These interests would then be communicated to the DIWG, and the DIWG would try to satisfy specific data and information requests from the stakeholders. The purpose of this task was to provide input to the first advisory group meeting described next and in appendix D.

The 1-day advisory group meeting in Atlanta, GA, on June 7, 2000, had the following three objectives: (1) Provide a clear articulation of the case study objectives and purpose; (2) present the specific agency data and information sources currently available, including how the Global Change Data Information System (GCDIS) can be productively used in the case study; and (3) identify specific data requirements of the meeting participants, including data format, resolution (temporal and spatial), and other requirements. The advisory group seeks specific information from the stakeholders about what they do, cannot do, or want to do but are limited by a lack of appropriate data or access to it. The meeting would also provide insights on the expectations for data management applications that would assist future users with similar or different foci and would assist data managers in providing data services that could be useful in many cases. The participants were queried on the availability and use of non-Federal data and policies, if any, restricting access to these data. Issues regarding data quality and the need for metadata to assist future users were also examined. Information about the hardware and software capabilities (i.e., Geographic Information Systems (GIS), PC/Mac/Linux-based, Internet access, central computing systems, etc.) of the participating organizations was obtained through the survey form.

A summary of the findings of the first advisory group meeting was presented to the DIWG members at their June 27, 2000, meeting in Washington, DC. This summary included a list of data and information needs, data format and resolution, data management-related barriers in conducting the case study, and feedback on the utility of the current GCDIS offerings. The presentation helped to clarify the findings of the first meeting of the advisory group and to organize a response to their specific data needs and requirements. Additional interviews were conducted by telephone over the next several months with the advisory group and focused on the input to the various ACF models used by stakeholders.

The case study team sought to understand the data and information needs of a potentially broad and diverse customer base for NECIS. Was NECIS primarily serving policy and decision makers, or was the public at large (individual stakeholders) expected to be a user? Since permitting, irrigation, crop fertilization and pesticide use, for example, extends down to individual stakeholders, the case study team thought it would be useful to also gain some insight into the perspective of an individual farmer. For this information, we interviewed the owners of a family farm, Glenn Acres, who currently collaborate with scientists at the GHCC and the Auburn Cooperative Extension Service on a precision agriculture project (sec 3.3). Key findings from these interviews are as follows:

- Access to proprietary information can be an issue at the local level.
- Private (e.g., commercial weather) data providers are an important source of information (whether adding value to Federal data or not).
- Individual stakeholders are concerned with long-lasting stewardship of the environment.
- GIS are becoming affordable for individual stakeholders.

A second meeting of the advisory group, with additional stakeholders in attendance, was held in Atlanta on October 13, 2000, in conjunction with the Upper Chattahoochee Riverkeeper and Georgia Water Resources Institute ACF River Basin Management Workshop. The workshop focused on models and data used by stakeholders in the ACT Comprehensive Study (app. E).

The case study team gained further insight into the attributes of two key components of the ACF Comprehensive Study: (1) The 55-yr (1939–1993) ACF unimpaired streamflow data set produced by the COE and (2) the STELLA® Shared Vision model developed by the University of Washington. The special data set and model development and their use by ACF stakeholders illustrate key findings of the case study—that Federal, state, and local data are used in regional decision and policy making, that important information is not available from existing Federal data bases (e.g., consumptive use and water permitting records), and that geophysical data and nongeophysical data alike are needed by decision makers.

Additional interviews were conducted outside of the advisory group with individuals having specialized knowledge of the data needs in the ACF basin or a useful contribution addressing the NECIS concept. Bill Werick of the COE Institute for Water Resources and Richard Palmer of the University of Washington Dept. of Civil Engineering were prominently involved in the Comprehensive ACF Basin

Study. They provided additional information and clarification on the types of data sets (existing and specially developed) and information used (sec. 3.4). Jim Block of Kavouras, a commercial data provider (to Glenn Acres Farm and other stakeholders) and a user of climate data in the commodities and futures markets, provided a private sector perspective on NECIS (sec. 3.5).

3. SUMMARY AND RESULTS

This final report documents the findings of the case study, including the nature of the data requirements identified in the selected study area, issues of availability and accessibility, the overall process employed, lessons learned, key issues for implementation, and applicability to other regions of the United States.

The TOR is addressed by considering the competing water resource issues of the ACF basin stakeholders that are impacted by short-term climate variations and decadal changes in demand growth. Ready access to the key stakeholders was possible because the southeast regional climate assessment was codirected by one of the case study principals, Ron Ritschard. These stakeholders include the Atlanta Regional Commission (urban development); Alabama and Georgia Power (hydropower); U.S. Army Corps of Engineers (navigation and recreation); Environmental Protection Agency (water quality); state regulatory and economic development agencies, Alabama Department of Environmental Management, Alabama Department of Economic and Community Affairs, and Georgia Department of Natural Resources; agricultural extension and farmers (irrigation); coastal fishermen (coastal resources in Apalachicola Bay); and the Northwest Florida Water Management District.

Prior to the Atlanta meeting, Steven Goodman, leader of the case study team; members of the DIWG; and Lola Olsen, representing GCDIS, identified likely GCDIS and other Federal data holdings that would be of interest to the NECIS advisory group. Nearly 800 URLs referring to the ACF basin were found through a GCDIS Web search. Likewise, the stakeholders were asked to provide a list of available model, data, and information sources used in their ACF basin studies; the format of those data; the accessibility, cost, and availability of the data; and their computation resources. In Atlanta, Thomas Mace, then chair of the DIWG, presented a vision for NECIS; Steven Goodman presented an overview of the NECIS case study; and Lola Olsen presented a synopsis of GCDIS data holdings and Web URLs of likely interest to the stakeholders.

GCDIS links to drought products were of immediate interest to James Hathorn, the representative from the COE Mobile district. Hathorn already uses the Global Change Master Directory (GCMD) (http://gcmd.gsfc.nasa.gov/) to search for available geospatial data within the Mobile district. They are currently developing a plan to perform a watershed study in which GIS is a key component. The GCMD provides the COE with a universal clearinghouse that they have used as a starting point in many cases. He finds the search method so efficient, that he only bookmarked a few sites to share with coworkers.

High-resolution, next-generation weather radar- (NEXRAD-) based rainfall maps were desired by a number of stakeholders. Many of the data needs were model driven. An introduction to the NECIS concept, the data and information needs survey conducted prior to the meeting, survey responses, models used, the meeting agenda, and the contact list for key stakeholders and participants in the meeting are provided in appendix C.

3.1 National Environmental Change Information System Kickoff Meeting in Atlanta, GA, on June 7, 2000

Fourteen participants attended the initial NECIS meeting in Atlanta, GA. The focus of this meeting was to identify data needs in as much detail as possible, and to identify the major water-related issues in the ACF.

Data needs were defined by data type, temporal resolution, spatial resolution, and usage. The major data needs focus on higher spatial resolution infrared and color remote sensing data, more frequent precipitation forecasts with greater accuracy, and a better inventory of waterway natural flows, both inputs and outputs. The major needs that better data will address include drought prediction and severity, identification of irrigated lands and systems, fluctuations between surface and groundwater sources, and environmental quality. Each category of data desired is discussed in detail in sections 3.1.1 and 3.1.2.

3.1.1 Remote Sensing Data

Infrared and color remote sensing data are desired at 1-m spatial resolution. During the summer, monthly data identifying irrigated lands and irrigation systems are desired. For land use and land cover classification, a multispatial resolution approach appears to offer the most potential. Data at 1-m or less spatial resolution is desired for a detailed land use classification. Data at a 1- to 30-m spatial resolution is needed for land cover classification, with higher resolution data needed for detailed classes that would include tree species, crop type, etc. A temporal resolution of 1–5 yr was suggested. One specific land cover need is the monitoring of impervious surfaces by establishing a baseline of the quantity and spatial distribution of these surfaces and subsequent data sets to monitor change. Land surface topographic data are desired at 1-m horizontal and vertical spatial resolution and 10-yr temporal resolution for input to hydrologic models and to monitor coastal erosion. In addition, 1-km data are needed on a daily basis in the Mobile and Apalachicola Bay areas to evaluate potentially harmful algae blooms.

NEXRAD precipitation data are suggested to fill gaps between rainfall gauge data. NEXRAD data at a 4-km spatial resolution collected daily are desired. Monthly data products and data collected on a rainfall event basis are desired for drought monitoring and to justify emergency assistance.

3.1.2 Other Data

Weekly precipitation forecasts 3–6 mo in advance, a better inventory of natural flows, and inputs and outputs by waterway are desired at the hydrologic unit category for reservoir management and water resources planning. Specifically needed are data on the net result of natural flows and usage between surface and ground water sources and better information on El Niño and La Niña patterns. Improved data on surface and vertical wind profiles would be helpful in monitoring algae blooms.

Major water-related issues in the ACF watershed that are driving the data needs described above are water availability, priority of water use, and water quality. The primary sources of data and products used within the ACF are:

- U.S. Geological Survey (USGS)
- Georgia Automated Environmental Monitoring Network (GAEMN)
- National Weather Service
- State climatologists
- National Climatic Data Center (NCDC)
- USGS stream gauge data
- Land remote-sensing satellite 30-m data
- Qualitative Precipitation Forecasts (QPF) 5 day and 6 mo.

Stakeholders described several deficiencies with the existing data sources. Generally, data are lacking on the areal extent of irrigated land, methods of irrigation, and the irrigation use patterns in varying climate scenarios. Better data are needed to monitor compliance within the three-state water compact. Real-time climate data are needed for hourly flood and weekly drought forecasts. The National Wetlands Inventory is out of date and not completely digitized. High cost prevents some organizations from using existing data sources.

Models in use by stakeholders in the ACF include hydrology and hydraulic, water quality, and crop models. Specific models include: Hydrologic Engineering Center (HEC 1, HEC 2, HEC 5, HEC RAS); Hydrodynamic and Water Quality Model (CE–QUAL–W2); TR–20; WSP2; RESOP; SITES; Erosion Productivity Impact Calculator (EPIC); Simulator for Water Resources In Rural Basins (SWRRB); Groundwater Loading Effects of Agricultural Management Systems (GLEAMS); Agricultural Nonpoint Source (AGNPS); DAMBRK; FLOWAV; UNET; Systems Thinking In and Experimental Learning Lab With Animation (STELLA); and Better Assessment Science Integrating Point and Nonpoint Sources (BASINS). The salient characteristics of some of these models have been summarized in appendix D.

Other potential stakeholder organizations are the Vice-President's Livability Pilot Project on the Chattahoochee River and the Southwest Georgia Water Resource Leaders focusing on the Flint watershed. The Chattahoochee group has three primary objectives: (l) Monitor water quality/quantity, (2) leverage Federal program dollars to protect a 500-ft buffer through conservation easements or outright purchase of property on both sides of the river from the head waters to Columbus (≈160 mi), and (3) develop a long-term strategy for managing the water resources in the Chattahoochee River basin. The Flint watershed group is developing a drought management plan for the regional watershed. They are researching inflow/outflow of surface water/underground aquifers, minimum flows for maintaining species diversity, and agricultural use of water resources. They use 10-m spot panchromatic imagery to determine center pivot locations and conduct county outreach meetings to talk with farmers about water use on their crops.

Finally, to successfully complete this case study and ultimately establish a national environmental change information system, local and regional political concerns must be considered. Two key organizations have not yet participated in this case study, possibly due to such political issues.

3.2 The Upper Chattahoochee Riverkeeper and Georgia Water Resources Institute Workshop in Atlanta, GA, on June 7, 2000

This workshop was held on October 13, 2000, to discuss models, data, and general issues concerning the ACF River basin. Key stakeholders (≈50) throughout the ACF basin attended. Models described at the meeting included the HEC 5, presented by James Hathorn of COE; STELLA, presented by Steve Leitman representing the Northwest Florida Water Management District; and ACF Decision Support System (DSS), presented by Aris Georgakakos of Georgia Tech. HEC 5 appears to be the standard among agencies interested in water allocation issues.

The HEC 5 program is designed to simulate the sequential operation of a reservoir/channel system with a branched network configuration. Any time interval from 1 min to a month can be used, and multiple time intervals can be used within a single simulation. Channel routing can be performed by any of seven hydrologic routing techniques. Reservoirs operate to (1) minimize downstream flooding, (2) evacuate flood control storage as quickly as possible, (3) provide for low flow requirements and diversions, and (4) meet hydropower requirements. Hydropower requirements can be defined for individual projects or for a system of projects. Pump storage operation can also be simulated. Sizing of conservation demands or storage can be automatically performed using the safe yield concept, and economic computations can be provided for hydropower benefits and flood damage evaluation. The primary input data needed for the HEC 5 model is daily streamflow data from 1939 to 1993 and evaporation rates.

STELLA ingests both daily and monthly streamflow data. Forecast data for precipitation, drought, and related climatological information is considered for planning purposes, but not used as model input data. The primary problem with forecast data, according to stakeholders, is that it is not accurate enough for more extensive use.

Other major issues discussed at the workshop included the problem of allocation formulas accurately measuring the impact of water usage on groundwater versus surface water resources.

Jerry Ziewitz of the U.S. Fish and Wildlife Service discussed major environmental concerns in the ACF basin. A primary concern is low- and high-flow conditions that cause stress on ecosystems, flora, and fauna. Data on flow magnitude, duration, frequency, seasonality, and rate of change are needed to evaluate potential environmental stress. Currently, monthly flow estimates are used, with the 25th percentile representing minimum flow conditions and the 75th percentile representing maximum flow. Using historical data, the flow between the 25th and 75th percentiles is considered a reasonable estimate of natural conditions.

The Georgia Tech PC-based model presented by Dr. Georgakakos focuses on streamflow forecasts, river and reservoir simulation, and reservoir management. The vector mean areal precipitation (MAP) dataset collected over the past 100 yr is used for land cover input. Better drought index data are desired.

Todd Hamill of the National Weather Service (NWS) Southeast River Forecast Center described data his office provides to the user community. Historical streamflow and precipitation data are being

processed to produce a MAP dataset. The Sacramento Model is being used for rainfall flow simulation. To produce 90-day streamflow forecasts, historical precipitation data from 1949 to 1989 are used. The NWS is beginning to shift its product focus from peak flows and floods to include more interest in droughts and low flows.

The following are conclusions from the meeting:

- Streamflow data are the primary data type currently being used for model input.
- Better drought index data are needed.
- Long-term forecasts are not used quantitatively because the user community does not consider the results reliable. For example, the Hadley (Centre) Climate Model 2 (HADCM2) and the Canadian (Centre) General Circulation Model (CGCM) have varying results that point toward contrasting conclusions.

Although the stakeholders do not currently make use of short-term climate forecasts (e.g., El Niño, La Niña), they expressed interest in someday using such information. The attendees requested that James Hathorn extend the unimpaired streamflow data set from 1993 to 2000 to include the recent El Niño and La Niña events. In a followup conversation with Hathorn in January 2001, he told the study team that the necessary state funding and staffing needed to collect the additional data required to develop the unimpaired streamflow data set has not yet been identified.

3.3 Glenn Acres Farm Site Visit

Glenn Acres Farm is a 1,200 acre, fifth-generation family farm in North Alabama (34.8 N. 87.1 W.) operated by Eugene Glenn and his two sons, Don and Brian. Their educational backgrounds include B.S. degrees in business and accounting, and computer programming classes. The Glenn Acres Farm is participating in a precision farming technology demonstration project with the Auburn Cooperative Extension Service and Doug Rickman of the National Space Science and Technology Center (NSSTC). They have good working familiarity with high-resolution (2 m) airborne multispectral imagery and awareness of satellite (EarthScan) remote sensing imagery (fig. 2). Precision farming allows the Glenn family to apply treatments to the field precisely where needed. Owners keep detailed historical records of yields by acre and they are very knowledgeable of efficient and nonefficient areas of the farm. Wheat, corn, and soybean are the primary crops. Three crop rotations every 2 yr is the normal operation procedure.

The farm recently purchased SSTool Box, a GIS package based on ArcView®, to perform yield, fertility, and soil profile mapping from their archived CD–ROM database. From those maps, they are compiling a database to use in applying variable rate fertilizer and lime, and making production decisions. This database allows them to determine several factors, such as performance of a particular seed variety on a particular soil type. They are in the process of creating variable rate nitrogen maps from which to apply nitrogen on corn. So far, these maps indicate the farm will be able to cut total nitrogen use on corn by 15 percent without cutting yield potential.

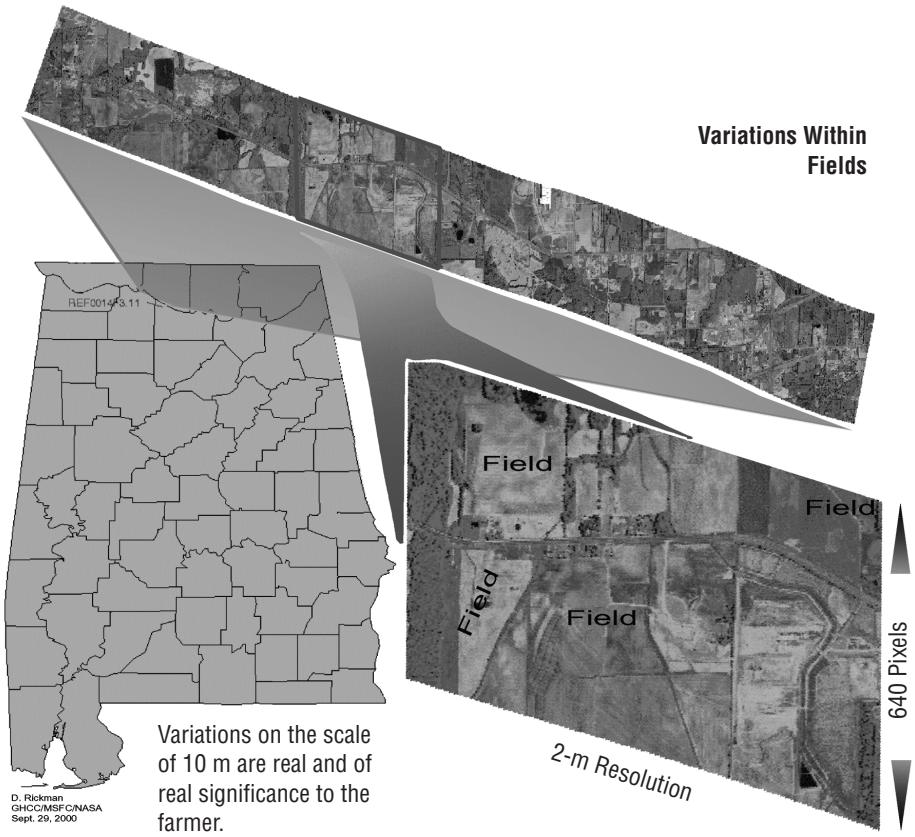

Figure 2. Airborne multispectral image of Glenn Acres Farm (courtesy of Doug Rickman, MSFC).

The farmers are aware of weather and climate services and weather forecast data, but do not consider forecasts 6–10 days and longer reliable enough to use in plant/no plant decisions. Historical climate averages for precipitation are used in crop rotation and plant/no plant decisions more than forecast data. Web sites with a variety of forecast data sources are consulted and considered in long-range planning (one season to the next season) and in market assessment.

The farm subscribes to Kavouras' Data Transmission Network (DTN), a commercial data provider of weather, commodity market, and agricultural data services such as AgDayta.com (http://www.agdayta.com). Much of the weather data provided by Kavouras are straight from National Oceanic and Atmospheric Administration (NOAA) standard products. The value added by Kavouras is not in the weather and climate products (no proprietary algorithms), but in the streamlined presentation and delivery of the data products and information to the end user. The farmers see this convenient access to weather data as valuable because they do not have the spare time to surf the Internet in search of data (although they do use the Internet occasionally and have bookmarked various NOAA URLs).

The site visit produced two subsequent inquiries about data availability, which were forwarded to the DIWG. The first request was for digital rainfall data at or close to the farm. The NWS office at Huntsville, AL, is considered too distant to provide rainfall measurements that are also representative of rainfall at the Glenn Acres Farm 35 km to the west. Archived, long-term (5-yr) NEXRAD rainfall

maps at 4-km spatial resolution over the farm are not available from the NCDC, although other private weather data providers, not contacted by the study team, may offer such a product. In any case, the accuracy of such products is unknown. Howard Diamond, NOAA DIWG member, identified two nearby (10–20 km) cooperative rain gauge sites: Falkville, AL, with data from 1948 to 1992; and Moulton, AL, with data from 1957 to 2000.

Regarding the offer of the cooperative observing network rainfall time series provided by Diamond of NOAA, the farmers say there are too many factors in the crop yield that make a historic time series of daily rainfall not very useful at the present time. However, the farmers left it open that with their 5-yr global positioning system (GPS)-derived crop database and the forthcoming availability of the GIS tool, they may eventually want to do their own analysis of precipitation data and study retrospective yield maps. When asked by the case study team if they would desire interactive Internet access to NEXRAD or in-site rainfall data, they responded that they would like interactive access where the user could control how the data are subsetted and examined.

The second inquiry was about digital aerial photography of the farm, located in Lawrence County near Hillsboro, AL, from 1998 or later. During the study team visit, we were shown recent aerial photography film imagery. The farmers have been trying to get some high-resolution digital aerial photography and were not able to find it via the Web, but thought it should exist. They have found it difficult to locate Federal data by using keyword searches for "topographic (topo) images" on the Internet. They attempted to locate digital aerial photography by grid number and zip code (for Hillsboro, AL), but they were unsuccessful. The farmers met with the Auburn Cooperative Extension staff in early February 2001 and learned that the aerial photography for Hillsboro had not been digitized yet, although such data exists for some parts of Alabama.

In response to the Glenn Acres Farm inquiry forwarded to the DIWG, Doug Nebert, of the Federal Geographic Data Committee (FGDC) Clearinghouse Search, has suggested that they locate the data by searching the Web site (http://clearinghouse1.fgdc.gov/servlet/FGDCServlet). All aerial photos in the national program are searchable, as are digital ortho quads from The USGS. The user chooses an area of interest, search words, and selects the national high-altitude aerial photo server. Metadata with data product handles will be returned to the user. Doug Nebert also suggested a search of the USGS National High-Altitude Photography Program and a database called APSRS on CD–ROM that can be searched on their behalf by calling: 1–888–ASK–USGS. The USGS will have several air photos existing over any one spot in the United States. John Faundeen of The EROS Data Center also responded to the request from Glenn Acres Farms and noted that customers can have the photography scanned, resulting in digital aerial photography.

Last, we asked the farmers to comment on the potential usefulness of interactive Web-based decision models by experimenting with the online, interactive crop model offered by Gerrit Hoogenboom at the University of Georgia (http://www.griffin.peachnet.edu/bae/). The crop simulation models allow a user to estimate crop growth and yield as a function of weather conditions and management scenarios. The decision models provide an answer for "if then" questions. In response to the experimentation with the online crop model, the farmer replied that the models are interesting but they do not consider different cultural practices such as no-till, which helps to preserve moisture. "For what I have looked at so far, his lows are lower than mine and my highs are higher. However, keeping this in mind, it does let you play with different planting dates and such. I can see where this would be useful."

In response to our inquiries about the data inputs to the Georgia crop models, Gerrit Hoogenboom replied, "We do not work with 'named' data sets, as each user obtains his own inputs to run the crop models. The data can come from various sources. We have an extensive data set for the major crops/crop models in collaboration with Florida, Michigan State, and the International Fertilizer Development Center (IFDC) in Muscle Shoals, In some cases, users share their data with us; sometimes they do not. This question is therefore difficult to answer. The models use American Standard Code for Information Interchange (ASCII) files as input and generate ASCII output files. We also have tried to define strict formats and file names, both for internal use as well as for data sharing with others. Some other crop modelers are now adapting these standards. The accuracy of the models depends to a certain extent on the quality of the input data as well as the type of application. We can predict to within 5 percent of observed (data) for plot measurements. However, taking it to farm level will introduce more variation. The crop models of course do not simulate all processes that are found in a cropping system. We are using the models at a field level to look at precision farming applications and decision making. The models have also been used at a regional (watershed-county-state-nation) scale to look at issues such as climate change, climate variability, etc. I am planning to use the models in a project that will look at total water use in the state of Georgia by agriculture, mainly irrigated crops."

At the NRC meeting in Washington, DC, a number of participants discussed the potential value of access to environmental data collected by statewide mesonetworks and monitoring stations. These stations could provide diagnostic sites for ongoing assessments and monitoring of socioeconomic change within and between different regions. Georgia also has an extensive network that Gerrit Hoogenboom helps to maintain, but not every county has a comprehensive monitoring station, such as in Oklahoma. The College of Agriculture and Environmental Sciences of the University of Georgia established the GAEMN in 1991. The objective of the GAEMN is to collect reliable weather information statewide for agricultural and environmental applications. Such data are also valuable for climate monitoring and decision making, as input to the crop models, for example. Each station monitors air temperature, relative humidity, rainfall, solar radiation, wind speed, wind direction, and soil temperature at 2-, 4-, and 8-in depths every second. Some stations have also begun recording barometric pressure and soil moisture. Total cost of hardware is approximately $6,000 per station. A useful input to the NECIS feasibility study would be to determine how widespread such comprehensive measurements are within each state.

Other concerns and needs at Glenn Acres Farm were the following:

- Automated or more efficient technology to determine soil characteristics. Currently, manual samples per acre are collected and sent to Auburn for analysis.

- Forecast data would be used more extensively if it were more accurate.

- Current bandwidth at the farm is limited to 26.4 kbs, so huge file downloads are not practical. They hope satellite Web access will come to their rural area in a few months; they may sign up.

- Proprietary data rights issues may be an increasing concern, especially regarding remote sensing imaging technology (1–2 m) that would give unilateral advantages and insight to others in the competitive marketplace. Of special note, the higher the spatial resolution of

multispectral imagery, the more useful it is and the greater the concern over proprietary rights to the data.

3.4 Interviews With William Werick—Institute for Water Resources

William Werick, COE Institute for Water Resources (IWR), played a key oversight role in the ACF Comprehensive Study. The IWR policy and planning division has been conducting water resource conflict studies in other river basins, including the following:

- The Green River (Tacoma, WA, water supply system)
- Boston, MA, water supply system
- Savanna River system
- Columbia River system
- Missouri River system.

William Werick provided detailed information on data sets developed or compiled for the ACF, which is documented in the following text:

Unimpaired flows were developed using the USGS stream gauges and reservoir elevations (used to calculate flows at the reservoir). Where there were no gauges, the flows were filled in by traditional methods, using similar, nearby, gauged watershed. More than $1M was spent developing the unimpaired flows and the Hydrologic Engineering Center (HEC) 5 model. Existing rainfall and evaporation data were used to calculate the change in reservoir volumes due to evaporation and direct rainfall.

USGS groundwater data, most of which was qualitative and based on previous USGS reports, were used in a simple base flow model to quantify groundwater to stream discharges in the Flint River. The model was developed specifically for the ACF study. A new population forecast was commissioned for the study area. Some census data were used; i.e., standard industrial classification employment, but a private contractor for the ACF basin study did population estimates for each county.

The agricultural forecast used some existing databases, such as number of acres per crop in each county, with new aggregation of existing studies to estimate, for example, the depth of water needed per month, per crop, per acre.

The only forecasting models used were the long-term forecasts of agricultural demand by crop, and municipal and industrial (M&I) water demand. The water balance was always based on 660 mo (55 yr) of unimpaired flows, less evaporation, and consumption. The river flows and reservoir volumes in each time step were calculated based on the rules-and-demand scenarios selected for the model run.

There was no rainfall runoff model, so rainfall was not needed except at the reservoirs. Gridded soil data were not generally needed, although the USGS probably used some in the Flint groundwater model.

Little of the information was taken off the shelf, but the basics are stated in sections 3.4.1 through 3.4.3.

3.4.1 Water Balance

Water balance was estimated using the following methodology:

- The physical characteristics of the reservoirs were obtained from official COE documents or from the power companies.

- Operating rules were taken from COE documents and then validated through interviews. This included all downstream target flows.

- A team including the Mobile district and the COE HEC calculated the unimpaired flows.

Withdrawals and returns were composed of M&I, agricultural, thermal power, and environmental; i.e., fisheries. These came mostly from new studies, but existing USGS studies were used for verification, especially current withdrawals. All these studies had two components—current and future (estimated) withdrawals, and all were carefully reviewed by all parties. In each case, the comprehensive basin study team had to identify the source of the withdrawal and return, so the basin study team can do a very detailed accounting. Future withdrawals were estimated through 2050. Returns were calculated based on the plumbing; i.e., where the wastewater treatment plants were, and the volumes based on the particular use; i.e., where there is little return from irrigation.

The Shared Vision model then calculated the volume of water in each reservoir, the flow in each river segment, and the flow in each withdrawal and return segment for every time-step for the 660-mo span of the unimpaired flows.

3.4.2 Water Depths

Water depths were calculated using the following techniques:

- Navigation depths versus flow: Relationships were calculated by the Mobile district at several points, and then the Shared Vision model used those relationships to calculate the depths at each time step. Alternative stage-discharge relationships were developed by Mobile for several structural alternatives that would focus flow in a narrower channel.

- Depths and flooded widths: These widths were also calculated for Mobile at several points for evaluations of riparian wetlands.

- Lake levels: Stage-volume curves had been developed for each reservoir during construction. The Shared Vision model calculated volume and then used these curves to calculate stage.

3.4.3 Effects

The number of people who would recreate at reservoirs at various reservoir depths was estimated by the COE Waterways Experiment Station (WES) based on COE surveys. Economic benefits were calculated based on three curves for each reservoir, relating visitation to willingness to pay local and regional tourism revenues. The curves were developed based on research original to this study.

IWR led studies to estimate the level of barge traffic (tonnage) in the future, depending on the ensured depths the shipping companies could be promised for the entire 660-mo simulation. This is because people are more willing to invest in landside development if they know they do not need a backup system for times when the river is too shallow to carry barges. IWR calculated the national benefit of transportation savings based on the tonnage of various commodities moved by barge each month. For example, if one 660-mo run showed that shippers could only be guaranteed 7-ft depths (they want 9 ft), the maximum monthly load would be selected from the guaranteed 7-ft channel table. Then the costs savings each month would be based on how many barges it took to carry that tonnage—more are needed at 7 ft than 9 ft, thus diluting the savings of using barges.

The model calculated the hydropower energy produced in each time step based on the flow, head, and turbine efficiency. These data were readily available. The COE Hydropower Analysis Center led a team that developed estimates of capacity based on the distribution of energy. This required elaborate dispatching model development and runs.

An IWR contractor developed estimates of M&I water conservation (costs and water use reductions). A consortium of universities developed similar estimates for irrigation, though much more simplistically.

WES and the Fish and Wildlife Service developed environmental indicators based on a statistical analysis of the 660 mo of flows developed from each model run; i.e., each alternative tested. The Nature Conservancy later developed a more sophisticated version of this approach.

The mode calculated a variety of performance measures, such as the reliability of water supply, suitable lake levels for recreation, success in meeting in-stream flow requirements, and success in meeting minimum energy production.

In conclusion, Werick thought too much time and money was spent developing data sets. Some were needed, but after a certain point and in certain areas, it has diminishing value. He recommends that data collection and the plan formulation and evaluation should be done iteratively. In addition, the key findings and issues for NECIS resulting from the ACF case study are probably applicable to the other river basins being studied by IWR.

3.5 Interview With Jim Block—Kavouras

Jim Block, Chief Meteorological Officer of Kavouras, was interviewed to get a commercial weather data provider perspective on the NECIS concept and to determine if there might be some potential conflict between public and private interests in providing environmental data and services. Glenn Acres Farm is a Kavouras client. Mr. Block supports the collection of various environmental

databases and a gateway to access them. He sees this as an opportunity for the private sector to create new value-added products. Despite the widespread availability of data and information via the Internet, he finds their customers want to avoid the sometimes exhaustive (and fruitless) searching for information. Further, their clients value the ability to go to a single source where data and information are presented in an easy-to-read, and often tailored, format.

Kavouras foresees a need to provide GIS capability to their customers in the near future. This would be an added tool provided with the Kavouras DTN terminal that each customer uses to access weather and agricultural data services.

One of the lessons learned in the ACF case study is that Government and non-Government data sources are needed to study complex environmental issues. In addition, stakeholders can share common objectives and find it advantageous to collaborate with one another (the Shared Vision ideal). It thus seems prudent that commercial weather data providers should participate in the formulation of NECIS.

APPENDIX A—ADDITIONAL CONTACTS

Listed below is the contact information for various sources described in this TM:

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APPENDIX B—CHRONOLOGY AND MILESTONES

Key events in the life of this case study are presented as follows:

- November 9, 1999, Steven Goodman presents draft of NECIS case study plan to DIWG, draft TOR discussed
- November 29, 1999, Ron Ritschard presents revised NECIS case study plan to DIWG agency principals
- November 30, 1999, Steven Goodman participates in DIWG meeting via telecon to review case study plan
- January 6, 2000, Steven Goodman participates in DIWG meeting via telecon to review case study plan
- January 24, 2000, NECIS case study team has kickoff meeting at the GHCC to discuss the formation of the advisory group
- February 10, 2000, DIWG endorses NECIS case study plan. The Co-Principal Investigators (Goodman and Ritschard) presented the case study implementation plan as revised to meet the DIWG's comments at its January meeting.
- March 15, 2000, Ron Ritschard presentation to DIWG and CGED chair Bretherton
- June 7, 2000, NECIS kickoff meeting in Atlanta with ACF stakeholders
- June 27, 2000, summarized NECIS kickoff meeting for DMWG
- July 2000, tabulation and analysis of data needs and models usage survey
- October 11, 2000, visit to Glenn Acres Farms to gain perspective of a family farmer
- October 13, 2000, second meeting with stakeholders at the Upper Chattahoochee Riverkeeper and Georgia Water Resources Institute ACF Management Workshop
- November 11, 2000, presented preliminary findings to the DIWG
- December 5, 2000, initial presentation of lessons learned and key findings of the NECIS case study at NRC meeting

- December 11, 2000, presentation of NECIS preliminary report at the DIWG meeting and summary of the NRC meeting

- February 19, 2001, Case study final report submitted to DIWG for comment

- March 2, 2001, Case study final report accepted by DIWG.

- March 29, 2001, Steven Goodman summarizes NECIS results at the DIWG meeting and presents agency representatives with CD containing the report and ancillary data and information

- May 2, 2001, Steven Goodman presents NECIS case study results at the "Gaining Knowledge From Environmental Data" workshop held in Ft. Collins, CO.

APPENDIX C—TERMS OF REFERENCE—NATIONAL ENVIRONMENTAL CHANGE INFORMATION SYSTEM CASE STUDY

The objective of the case study is to determine the issues involved and capabilities needed to provide the best practical response to a user request for help to the NECIS. To be fully successful, the case study should provide in its final report to the DMWG: (1) Enough information on the procedures used or recommended and the issues encountered to provide estimates of costs, schedule, and capabilities; and (2) the needed DMWG actions that can be taken to ensure the successful development of a proposal for a full NECIS.

To meet this objective, the case study will:

1. Chose an example of a focused user question that has a potential application in the southeastern region of the U.S. and is related to water availability.

2. Have a continuing advisory process composed of users potentially needing information or applications in the southeast region and included users who participated in the USGCRP's Southeast Regional Assessment.

3. Recommend to the DMWG what policy the case study should use relative to whether only federal or also other data and information will be used.

4. All NECIS and case study data and information will be fully and openly available.

5. All NECIS and case study data and information provided in response to user questions will have citations and a plan for its long-term availability.

6. With cooperation of the GCDIS subgroup, develop a plan for how GCDIS can be used most productively in the case study.

7. Be compatible with existing agency data and information management systems and build on their capabilities.

8. Include interagency participation and recommend to the DMWG how it can help the case study obtain the interagency cooperation needed.

9. Provide to each meeting of the DMWG a case study progress report; participate in a joint case study workshop with the DMWG.

10. Provide a case study final report, with lessons learned, by mid-2000 that could form the basis for a full NECIS implementation plan including performance, costs, and schedules.

11. Obtain DMWG approval if deviations from the TOR are needed.

APPENDIX D—NATIONAL ENVIRONMENTAL CHANGE INFORMATION SYSTEM KICKOFF MEETING JUNE 7, 2000, IN ATLANTA, GA

D.1 Agenda

May 23, 2000

To: NECIS Participants

From: Dr. Steve Goodman, Case Study Project Scientist, NASA

Subject: Meeting Announcement and Preliminary Agenda

The first National Environmental Change Information System (NECIS) meeting will be held on **June 7 from 9 a.m. to 3 p.m. in Atlanta**. Please complete the enclosed survey questions to assist us in planning the final agenda and follow-up discussion. Please return your responses to the survey by June 2nd to Maury Estes at maury.estes@msfc.nasa.gov. The meeting location will be at a Universities Space Research Association (USRA) facility adjacent to the Georgia Tech campus at 555 14th Street, N.W. Parking is available at the meeting site. Coffee and pastries will be provided in the morning and lunch catered. Our preliminary agenda is as follows:

Preliminary Agenda

8:30 - 9:00	Coffee and Pastries
9:00 - 9:30	Introductions and Opening Remarks, Dr. Goodman, Project Scientist, NASA/MSFC "NECIS Vision", Dr. Tom Mace, USGCRP Data Management Scientist, Working Group Chair, DMWG
9:30 - 10:00	"Locating Data of Interest for the ACF River Basin Study", Dr. Lola Olsen, NASA/GSFC
10:00 - 11:30	Summary of Survey Results and Brainstorming Session to Discuss and Identify Priority Climate Data Issues (All Participants)
11:30 - 12:30	Lunch
12:30 - 2:00	Small Group Discussions to Generate Ideas to Resolve Critical Data Issues (All Participants in Discussion Groups of 4-5)
2:00 - 2:30	Reports on Output from Small Group Discussions (Group Leader Reports)

2:30 - 3:00 Discussion of Future Plans

3:00 Adjourn

We look forward to your attendance and an interesting exchange of information. If you have any questions prior to the meeting, please contact Maury Estes at 256-922-5735.

Enclosures: NECIS Overview
Survey Questions
Directions to USRA Office
List of Participants

D.2 National Environmental Change Information System Initial Contact Questions

1. What climate data and information sources are you currently using? Such as precipitation, temperature, streamflow, etc. Annual, monthly, daily, etc. County, watershed, gauge point, etc.

   Data Types:

   Temporal Resolution:

   Spatial Resolution:

   Areal Extent:

2. How are you using these climate data and information sources? In Models? To apply to decision rules? Other?

   Models:

   Decision Rules:

   Other:

3. What is the format of the climate data sources you are currently using?

   Digital:

   Other:

4. Do you find climate data sources to be accessible and available when needed? **If yes**,

   Where do you get data?

   Is the data free or did you buy it?

   If you bought the data, was cost a constraint?

   If no,

   Please describe the limitations, proprietary data, wrong format, no data, etc.

   Spatial Resolution Limitations:

   Temporal Resolution Limitations:

   Cost Limitations:

5. How does your staff's technical capability impact your use of climate data and information?

6. What are your organization's hardware and software capabilities?

   PC/Sun/SGC CPU processing speed:
   RAM:
   Harddrive capacity:
   CD Drive:
   FTP:
   Internet access:
   Software:
   OS (Linus, Windows, Mac, UNIX, etc.)

   Models you are running:

7. What are the three major water resource issues in the ACF watershed in priority order?

   1.
   2.
   3.

8. Could you attend a meeting in Atlanta from about 9-3 p.m. on June 7?

   Yes No

D.3 Requested Action Items by Data and Information Working Group and Summary of June 7 Meeting

June 28, 2000

To: NECIS Working Group

From: Steve Goodman, Project Scientist

Subject: Requested Action Items by DMWG and Summary of June 7 Meeting

The Data Management Working Group (DMWG) has reviewed your survey responses and output from the June 7 Meeting. Before they can identify datasets that may be useful to you the following additional information is requested:

1. Review data used in models and provide specific information about each dataset, such as dataset name, version number, temporal and spatial resolution, and any other relevant information.
2. Survey available datasets from the websites of interest provided by Lola Olsen at the June 7 meeting and provide input on the utility to your organization. For example, will any of these datasets fill data gaps needed too more effectively run models? *Dr. Olsen's presentation slides, including suggested websites are enclosed.*
3. What kind of data services such as data analysis and visualization, data handling (subsetting, reformatting, compression etc.), mathematical or physical modeling, and education/outreach materials are the most valuable to you and why?

Please provide these responses by July 7 via email to maury.estes @msfc.nasa.gov.

Also, the tentative meeting for July 25 or 26 has been shifted to the mid-August timeframe. This will allow time for the DMWG to evaluate additional information from you as requested above and give us feedback before we meet again. If you have any questions, please contact Upton Hatch, Maury Estes, or me. Thank you very much for your assistance.

D.4 Summary of Meeting Invitees and Participation

NAME/ORG	PH/FAX	E-MAIL
Maury Estes (staff)# Universities Space Research Association	(256)-922-5735/5723	Maury.Estes@msfc.nasa.gov
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David Hawkins *# Georgia Department of Natural Resources	(404)-657-0017/5002	Dave_Hawkins@mail.dnr.state.ga.us
James Hathorn *# U.S. Army Corps of Engineers	(334)-690-2735/694-4058	james.e.hathorn.jr@sam.usace.army.mil
Daniel L. Thomas *# University of Georgia Biological and Agricultural Engineering	(912)-386-3377/3958	thomasdl@tifton.cpes.peachnet.edu
Rock G. Taber # U.S. EPA	(404)-562-8011/8053	taber.rock@epa.gov
Upton Hatch (staff)# Auburn University	(334)-844-5609/5639	uhatch@acesag.auburn.edu
H. Arlen Smith (staff)# Auburn University	(334)-844-3511/5639	arlens@acesag.auburn.edu
Lola Olsen (speaker)# NASA/GSFC	(301)-614-5361/5268	olsen@gcmd.nasa.gov

*Responded to Data Survey
#Attended Meeting

Thomas H. Mace (speaker)# U.S. EPA Chair, Data Management Working Group	(919)-541-0894	mace.tom@epa.gov
Rick Durbrow# U.S. EPA, Region 4	(404)-562-8286	DURBROW.RICK@EPA.GOV
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Jimmy Bramblett U.S. Department of Agriculture Natural Resources Conservation Service	(706)-546-2073	jimmy.bramblett@ga.usda.gov
Steve Goodman# (Project Scientist) NASA/MSFC	(256)-922-5891/5723	steven.goodman@msfc.nasa.gov
Dow Johnson Alabama Dept. of Economic and Community Affairs	(334)-242-5697	dowj@adeca.state.al.us
Steve Leitman * Northwest Florida Water Mgmt. District	(850)-539-3527	leitman@tds.net
Nick Tew Alabama Geologic Survey	(205)-349-2852	ntew@gsa.state.al.us
Doug Baughman/Steve Layman * CH2MHILL	(770)-604-9182 ext.510	dbaughma@ch2m.com
Paul Forgey SWGA Regional Development Center	(912)-522-3552	swgrdc@surfsouth.com
Dean Harless * Georgia Power	(404)-526-1618	l.d.harless@gpc.com

*Responded to Data Survey
#Attended Meeting

D.5 Models/Usage

Listed below are the models used by various organizations contacted during this study:

Models	Usage
HEC 5	NWFMD COE GA Power CH2M Hill/ARC
HEC RAS	COE GA Power CH2M Hill/ARC
AGNPS	UGA Tifton NRCS
GLEAMS	NRCS UGA Tifton
CERES	UGA Griffin
CROPGRO	UGA Griffin
SWRRB	NRCS
EPIC	NRCS
DAMBRK	GA Power
FLDWAV	GA Power
UNET	GA Power
TR-20	NRCS
WSP2	NRCS
RESOP	NRCS
SITES	NRCS
HEC HMS	COE

HEC 1	GA Power
HEC 2	CH2M Hill/ARC
STELLA (Shared Vision)	NWFMD
BASINS	CH2M Hill/ARC
SWMM	NWFMD
CE-QUAL-W2	CH2M Hill/ARC
HSPS	NWFMD
Princeton Ocean Model (adapted for Apal. Estuary)	NWFMD
USGS Groundwater of Dougherty Plain	NWFMD

D.6 Partial Summary of Models Used in the Apalachicola-Chattahoochee-Flint River Basin

This is a partial summary of models used in the ACF basin.

The HEC 5 computer program was developed at the Hydrologic Engineering Center (HEC). The initial version was written for flood control operation of a single flood control event. The program was then expanded to include operation for conservation purposes and for period-of-record routings. The program is used in planning studies for evaluating proposed reservoirs in a system and to assist in sizing the flood control and conservation storage requirements for each project recommended in the system. The program can be used for studies after the occurrence of a flood to evaluate preproject conditions and to show the effects of existing and/or proposed reservoirs on flows and damages in the system. The program is useful in selecting the proper reservoir releases throughout the system during flood emergencies in order to minimize flooding, while maintaining a balance of flood control storage among the reservoirs.

STELLA II® (Systems Thinking in an Experimental Learning Lab with Animation) is a tool for building models of dynamic systems and processes. Using a simple set of building block icons, users construct a map of a process or issue. The map automatically generates equations used for simulation. Output may be viewed as graphs, tables, diagram animation or QuickTime movies. Multirun sensitivity analysis allows exploration of a variety of "what if" scenarios. Mathematical connections between components may be defined that yield graphs and tables describing system behavior over time. Users may manipulate the model and watch the impact of their decisions.

The American Society of Civil Engineers' Water Resources Committee of the Water Resources Planning and Management Division is promoting the use of Shared Vision modeling, such as in the Alabama-Coosa-Tallapoosa (ACT)-ACF river basins, for conflict resolution in water resources planning. Shared Vision modeling brings together stakeholders, water managers, and water planners to incorporate planning objectives, performance measures into a framework that allows the generation and evaluation of alternatives in a manner that facilitates conflict resolution.

Groundwater Loading Effects of Agricultural Management Systems (GLEAMS) is a continuous simulation, field scale model, which was developed as an extension of the Chemicals, Runoff and Erosion from Agricultural Management Systems (CREAMS) model. GLEAMS assumes that a field has homogeneous land use, soils, and precipitation. It consists of four major components: hydrology, erosion/sediment yield, pesticide transport, and nutrients. GLEAMS was developed to evaluate the impact of management practices on potential pesticide and nutrient leaching within, through, and below the root zone. It also estimates surface runoff and sediment losses from the field. GLEAMS was not developed as an absolute predictor of pollutant loading. It is a tool for comparative analysis of complex pesticide chemistry, soil properties, and climate. GLEAMS can be used to assess the effect of farm level management decisions on water quality.

The Agricultural Nonpoint Source (AGNPS) model was developed for the analysis of nonpoint source pollution from agricultural fields. It estimates the quality of surface water runoff and compares it to the expected quality of other land management strategies. AGNPS is a single event-based model, though continuous simulated versions are under development. AGNPS uses a set of modified USLE equations in its erosion component.

APPENDIX E—THE UPPER CHATTAHOOCHEE RIVERKEEPER AND GEORGIA WATER RESOURCES INSTITUTE WORKSHOP

Following is the information sent to those who attended this workshop.

Upper Chattahoochee Riverkeeper & Georgia Water Resources Institute
Apalachicola-Chattahoochee-Flint River Basin
Management Workshop
October 13, 2000
Venue: iXL (room 292), 1600 Peachtree Rd NE, Atlanta

Thank you for agreeing to participate in this workshop. We have received a strong response from invitees, and look forward to a day of constructive dialogue about a number of important technical issues. Below are an agenda, directions, and lodging information.

Upper Chattahoochee Riverkeeper
1900 Emery St. Suite 450
Atlanta, GA 30318
(404) 352-9828 x.24
(404) 352-8676
bbriverkeeper@mindspring.com

Agenda

8:00 am	Coffee and Welcome
8:30 am	HEC-5 James Hathorn/U.S. Army Corps of Engineers
9:10 am	STELLA Steve Leitman/NW Florida Water Management District
9:50 am	Instream Flow Guidelines/Jerry Ziewitz/U.S. Fish and Wildlife Service
10:25 am	Break
10:45 am	ACF DSS/Dr. Aris Georgakakos of the GWRI
12:00 pm	Streamflow Prediction/Todd Hamill of the National Weather Service
12:30 pm	Lunch
1:00 pm	Panel Discussion
2:00 pm	Audience Q&A
3:00 pm	Adjourn

APPENDIX F—FINAL AGENDA OF THE NATIONAL RESEARCH COUNCIL'S WORKSHOP ON A NATIONAL ENVIRONMENTAL INFORMATION SYSTEM

F.1 Workshop on a National Environmental Information System

National Research Council, Green Building, Room 120, 2001 Wisconsin Avenue, Washington, DC, December 5, 2000

The U.S. Global Change Research Program is considering creating an environmental information service, which would provide global change research data in forms useful to policymakers, educators, the private sector, and the general public.

General questions:

- Given what we've learned so far about similar activities, what should we do next?
- What are the characteristics of a useful environmental information service?
- What are the possible initial foci for the system?

Issues for the NRC:

- Usefulness and scope of a possible NRC study

F.2 Draft Agenda

7:30 Continental breakfast available in meeting room

8:00 Overview of meeting goals *Minster*

8:15 USGCRP plans for an environmental information service *Ferrell*
- Scope, timetable, and budget

8:30 Panel discussion on lessons learned
- What relevant activity have you personally been involved in and what are the lessons learned? (*10 minutes each*)

  Climate services
  - Barron
  - Pielke

  National assessments
  - Yarnal
  - Wilbanks
  - Street

  Emergency services
  - Huh

  Applications
  - Turner
  - Glick

  Data issues
  - Bretherton

  DMWG pilot
  - Goodman
- Common threads in the lessons learned

12:00 Working lunch

1:00 Boundary and scope of the NECIS initiative *Panel*
- Essential characteristics of an environmental information service
- Additional desirable features
- Possible initial foci for an environmental information service

3:00 Conclusions of the meeting *Panel*
- Workshop summary
- Next steps for the NRC
- Possible NRC study(ies), including scope, form, and timetable

5:00 Meeting adjourns

APPENDIX G—WEB SITES CONSULTED

http://www.gcrio.org/
http://www.ncsa.uiuc.edu/edu/RSE/RSEindigo/stella.html
http://www.wrsc.usace.army.mil/iwr/ClimateChange/CVCW.htm
http://www.sam.usace.army.mil/pa/drought/samboatnews.htm
http://www.sam.usace.army.mil/op/rec/default.html
http://www.sam.usace.army.mil/pd/actacfeis/
http://www.griffin.peachnet.edu/bae/
http://www.gis.umn.edu/rsgisinfo/data.html
http://www.agdayta.com/
http://abe.www.ecn.purdue.edu/~wepphtml/wepp/wepptut/jhtml/agnps.html
http://www.nal.usda.gov/wqic/drought.html
http://www.wrc-hec.usace.army.mil/publications/pubs_distrib/hec-5/hec5user.pdf
http://www.wiz.uni-kassel.de/model_db/mdb/gleams.html
http://water.usgs.gov/realtime.html
http://water.usgs.gov/
http://clearinghouse1.fgdc.gov/servlet/FGDCServlet
http://fs1dgadrv.er.usgs.gov/gwrc/agenda.html
http://www.nwsserfc.noaa.gov/
http://sun6.dms.state.fl.us/nwfwmd/
http://www.nws.noaa.gov/im/a063.htm
http://box.mmm.ucar.edu/uswrp/recent_meetings/recent_meetings.html (USWRP Private Sector Workshop, Palm Springs, CA, November 29–December 1, 2000)

REFERENCES

1. Mace, T.: Private Communication, 2000.

2. Southeast Regional Assessment Team, 2001: "Preparing for a Changing Climate: The Potential Consequences of Climate Variability and Change, Southeast," Available from the U.S. Global Change Research Program Office, Washington, DC, in revision.

3. Werick, W.J.; Whipple, Jr., W.; and Lund, J.: "Basinwide Management of Water in the Alabama-Coosa-Tallapoosa and Apalachicola-Chattahoochee-Flint River Basins," Draft Report, August 1996.

4. Lettenmaier, D.P.; Wood, A.W.; and Palmer, R.N.: "Water Resources Implications of Global Warming: A U.S. Regional Perspective," Climate Change, Vol. 43, pp. 537–579, 1999.

5. *Huntsville Times*, "Alabama's Top 10 Stories of 2000," p. A11, December 31, 2000.

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13. ABSTRACT *(Maximum 200 words)*

The Global Hydrology and Climate Center and NASA's Marshall Space Flight Center conducted a fact-finding case study for the Data Management Working Group (DMWG), now referred to as the Data and Information Working Group (DIWG), of the U.S. Global Change Research Program (USGCRP) to determine the feasibility of an interagency National Environmental Change Information System (NECIS). In order to better understand the data and information needs of policy and decision makers at the national, state, and local level, the DIWG asked the case study team to choose a regional water resources issue in the southeastern United States that had an impact on a diverse group of stakeholders. The southeastern United States was also of interest because the region experiences interannual climatic variations and impacts due to El Niño and La Niña. Jointly, with input from the DIWG, a focus on future water resources planning in the Apalachicola-Chattahoochee-Flint (ACF) River basins of Alabama, Georgia, and Florida was selected. A tristate compact and water allocation formula is currently being negotiated between the states and U.S. Army Corps of Engineers (COE) that will affect the availability of water among competing uses within the ACF River basin. All major reservoirs on the ACF are federally owned and operated by the U.S. Army COE. A similar two-state negotiation is ongoing that addresses the water allocations in the adjacent Alabama-Coosa-Tallapoosa (ACT) River basin, which extends from northwest Georgia to Mobile Bay. The ACF and ACT basins are the subject of a comprehensive river basin study involving many stakeholders.

The key objectives of this case study were to identify specific data and information needs of key stakeholders in the ACF region, determine what capabilities are needed to provide the most practical response to these user requests, and to identify any limitations in the use of federal data and information. The NECIS case study followed the terms of reference developed by the interagency DIWG. The case study "lessons learned" and "key findings" offer guidelines and considerations to the DIWG for the development and implementation of a NECIS that would support the data and information needs of policy and decision makers at the national, state, and local level.

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