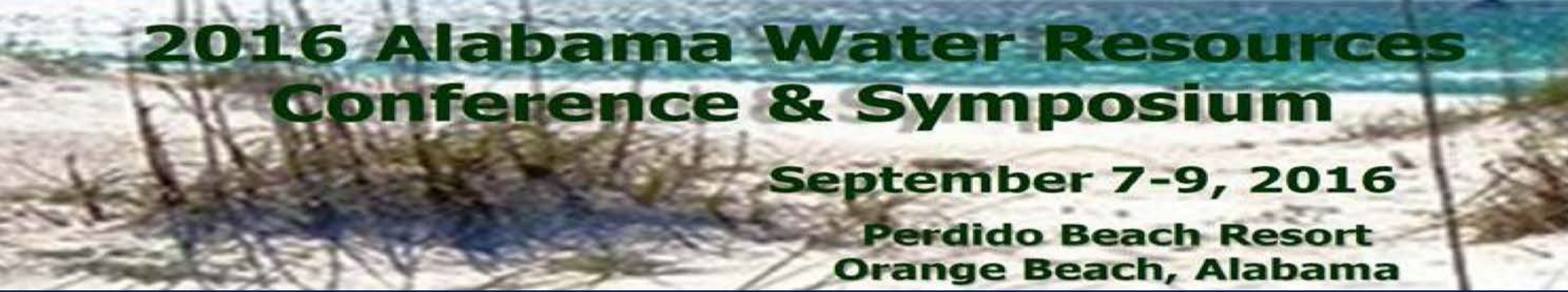


Food Grows Where Water Flows: Alabama Water Policy and the Food-Energy-Water (FEW) Nexus

The Food-Energy-Water Nexus

16th National Conference and Global Forum on Science, Policy and the Environment

January 19-21, 2016

Hyatt Regency Crystal City at the Washington, DC National Airport

Office of the Vice President for Research & Economic Development
Water Policy and Law Institute

Bennett L. Bearden, J.D., LL.M., J.S.D.
Director
Water Policy and Law Institute
The University of Alabama

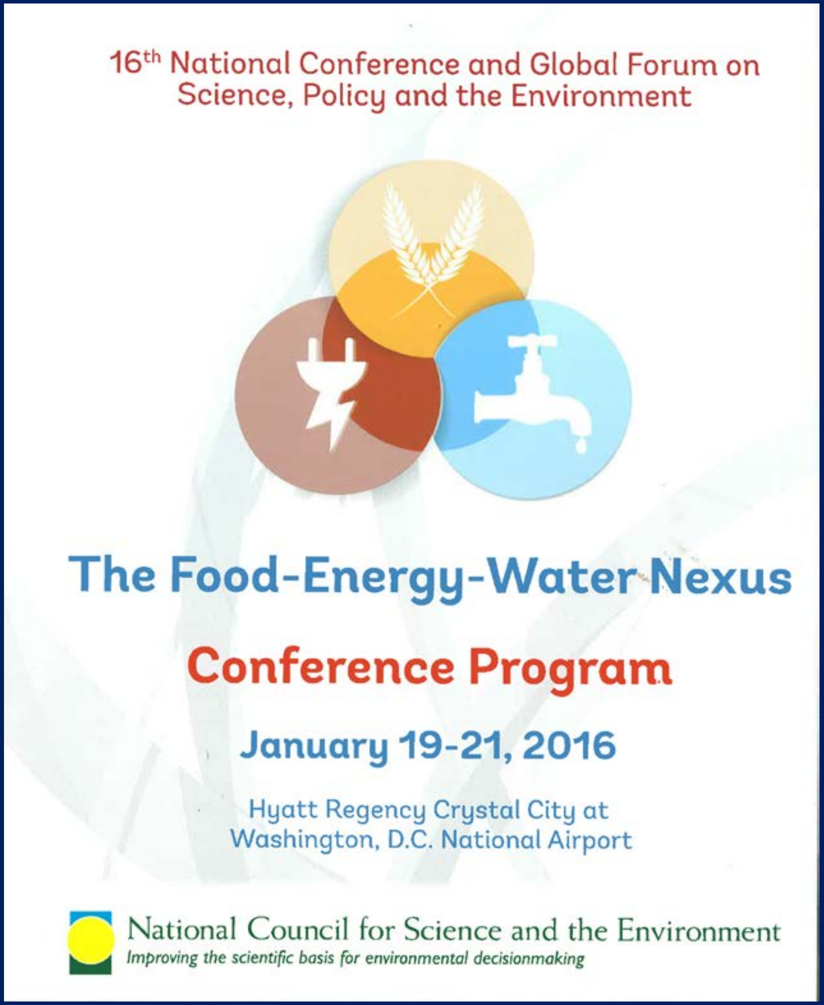
Office of the Vice President for Research & Economic Development
Water Policy and Law Institute

Symposium D4: Confluence of Government, Industry and Academic Research Activities Panel (January 21, 2016)

- Water Policy and Law Institute, The University of Alabama
- Peter Colohan, Senior Advisor to the Chief Scientist, NOAA, National Water Center
- Greg Koch, Senior Director, Global Water Stewardship, The Coca-Cola Company
- Ching-Hua Huang, Professor, Civil Engineering, Georgia Tech

Policy Context Analysis: Different Sectoral Goals of FEW Nexus Includes an Analysis of the Degree of Coordination and Coherence of Water Policy as Well as Extent of Regulations of Uses

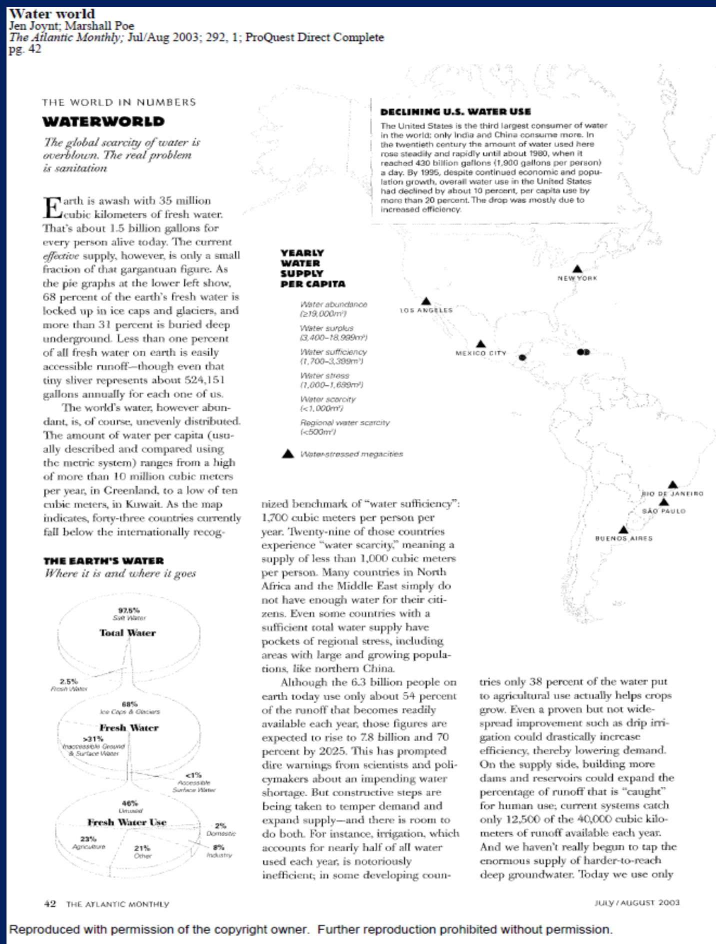
“Any realistic vision of a sustainable future requires us to understand, design, and model the interconnected FEW system. This is one of the greatest challenges facing humanity and it requires advances in science, engineering, economics, practice and *policy*.“



FEW Conference Policy Session Examined, *inter alia*:

- Not only lessening regulations but also limitations of current water law and policy where there are weak regulations and policies;
- Changes in water law and policy if we want to solve the water challenges in the FEW nexus (in Alabama maybe the FEW "perplexus");
- Why state agencies are too often structured around *regulations* rather than effective *policies*;
- Partnering with government and business to change policy;
- Scaling issues of access to water: scaling challenges nearly always come down to the same problem: the difficulty of spreading something good from those who have it, to those who don't or at least don't yet (Alabama Irrigation Initiative); and
- In the courts, "food law is the next great area for environmental litigation...environmental issues related to food production are...on the rise." (Richard Lazarus, Harvard Law School, *The Environmental Forum*, January/February issue 2016)

WaterWorld: 11.3 Billion People by the Year 2100…Sustaining a Global Appetite



Water world
Jen Joynt; Marshall Poe
The Atlantic Monthly; Jul/Aug 2003; 292, 1; ProQuest Direct Complete
pg. 42

THE WORLD IN NUMBERS

WATERWORLD

The global scarcity of water is overblown. The real problem is sanitation

Earth is awash with 35 million cubic kilometers of fresh water. That's about 1.5 billion gallons for every person alive today. The current *effective* supply, however, is only a small fraction of that gargantuan figure. As the pie graphs at the lower left show, 68 percent of the earth's fresh water is locked up in ice caps and glaciers, and more than 31 percent is buried deep underground. Less than one percent of all fresh water on earth is easily accessible runoff—though even that tiny sliver represents about 524,151 gallons annually for each one of us.

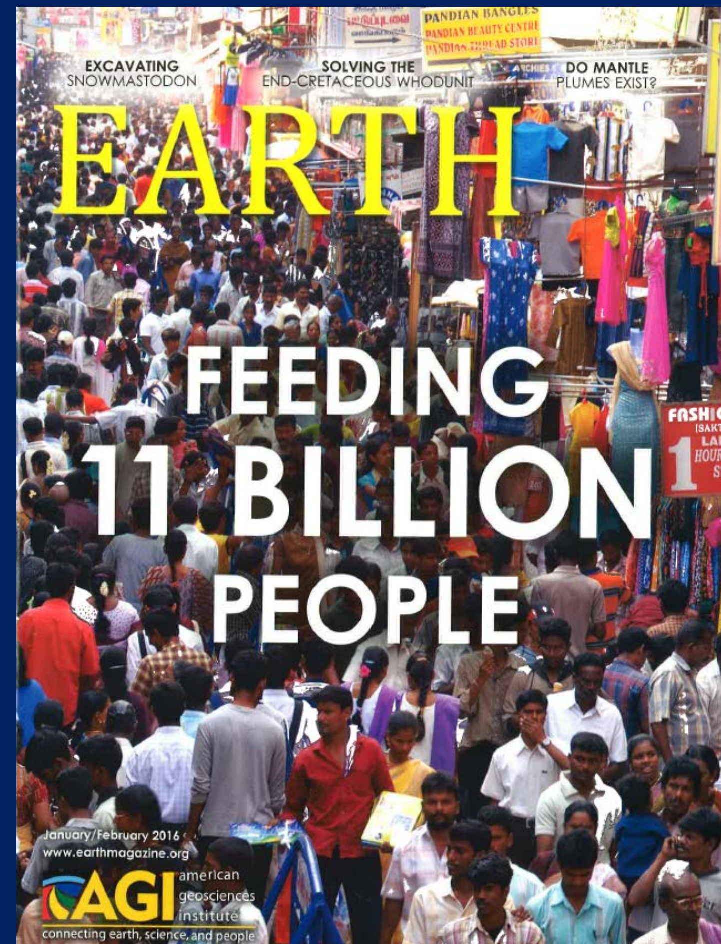
The world's water, however abundant, is, of course, unevenly distributed. The amount of water per capita (usually described and compared using the metric system) ranges from a high of more than 10 million cubic meters per year, in Greenland, to a low of ten cubic meters, in Kuwait. As the map indicates, forty-three countries currently fall below the internationally recognized benchmark of "water sufficiency": 1,700 cubic meters per person per year. Twenty-nine of those countries experience "water scarcity," meaning a supply of less than 1,000 cubic meters per person. Many countries in North Africa and the Middle East simply do not have enough water for their citizens. Even some countries with a sufficient total water supply have pockets of regional stress, including areas with large and growing populations, like northern China.

Although the 6.3 billion people on earth today use only about 54 percent of the runoff that becomes readily available each year, those figures are expected to rise to 7.8 billion and 70 percent by 2025. This has prompted dire warnings from scientists and policymakers about an impending water shortage. But constructive steps are being taken to temper demand and expand supply—and there is room to do both. For instance, irrigation, which accounts for nearly half of all water used each year, is notoriously inefficient; in some developing countries only 38 percent of the water put to agricultural use actually helps crops grow. Even a proven but not widespread improvement such as drip irrigation could drastically increase efficiency, thereby lowering demand. On the supply side, building more dams and reservoirs could expand the percentage of runoff that is "caught" for human use; current systems catch only 12,500 of the 40,000 cubic kilometers of runoff available each year. And we haven't really begun to tap the enormous supply of harder-to-reach deep groundwater. Today we use only

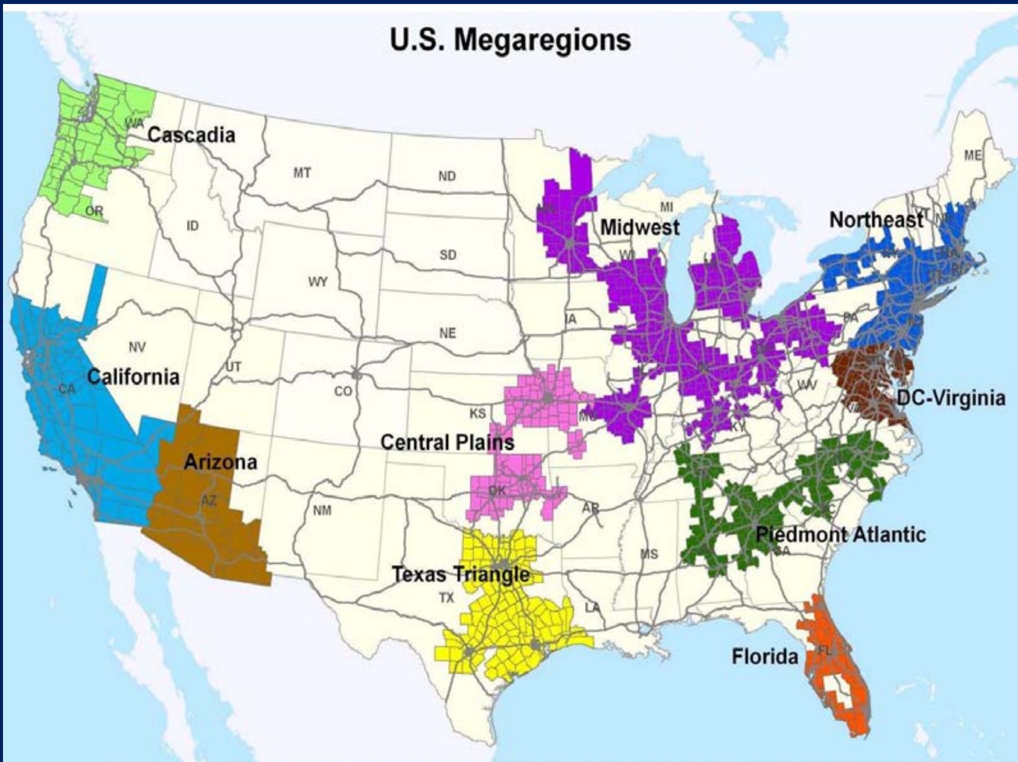
DECLINING U.S. WATER USE

The United States is the third largest consumer of water in the world: only India and China consume more. In the twentieth century the amount of water used here rose steadily and rapidly until about 1980, when it reached 430 billion gallons (1,900 gallons per person) a day. By 1995, despite continued economic and population growth, overall water use in the United States had declined by about 10 percent, per capita use by more than 20 percent. The drop was mostly due to increased efficiency.

THE EARTH'S WATER
Where it is and where it goes



USGS July 28, 2014: Urban Areas in the Southeastern U.S. Will *Double* in Size By 2060-Where Will We Get the Water?



Source: Center for Quality Growth and Regional Development (CQGRD), Georgia Institute of Technology, 2009

USGS
science for a changing world

News Release

July 28, 2014 | Adam Terando | 919-515-4448 | aterando@usgs.gov
| Christian Quintero | 813-498-5019 | cquintero@usgs.gov

Scientists Predict Massive Urban Growth, Creation of 'Megalopolis' in Southeast in Next 45 Years

RALEIGH, N.C.—Urban areas in the Southeastern United States will double in size by 2060 unless there are significant changes to land development, according to a new study by the Department of Interior's Southeast Climate Science Center and North Carolina State University.

The predicted growth would come at the expense of agricultural and forest lands, creating an urban "megalopolis" stretching from Raleigh to Atlanta, which also raises a number of ecological concerns.

"If we continue to develop urban areas in the Southeast the way we have for the past 60 years, we can expect natural areas will become increasingly fragmented," said Adam Terando, a research ecologist with the U.S. Geological Survey, adjunct assistant professor at NC State, and lead author of the study. "We could be looking at a seamless corridor of urban development running from Raleigh to Atlanta, and possibly as far as Birmingham, within the next 50 years."

To understand how urban and natural environments could change, the researchers used NC State's High Performance Computing services to simulate urban development between now and 2060 across the Southeastern United States.

Among the expected impacts of such expansive urban growth, the fragmentation of natural areas would significantly limit the mobility of wildlife, making it more difficult for them to find mates, raise young, find food and respond to environmental changes.

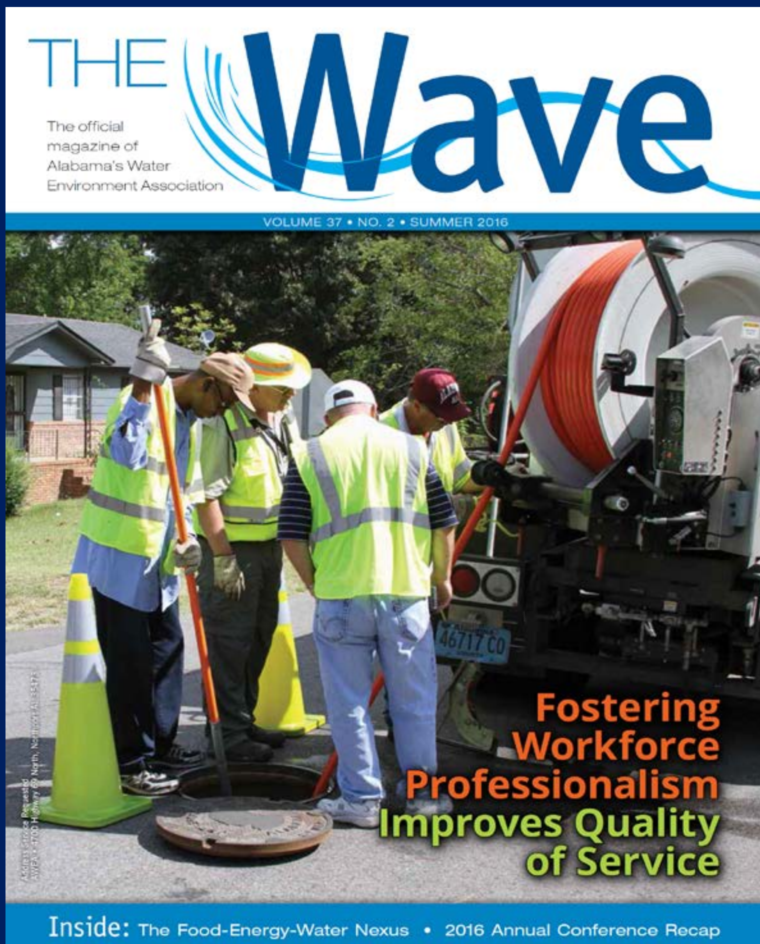
"This, in turn, increases the likelihood that we'll see more conflicts between people and wildlife, such as the increasing interactions with bears we're seeing in our suburban areas," Terando said.

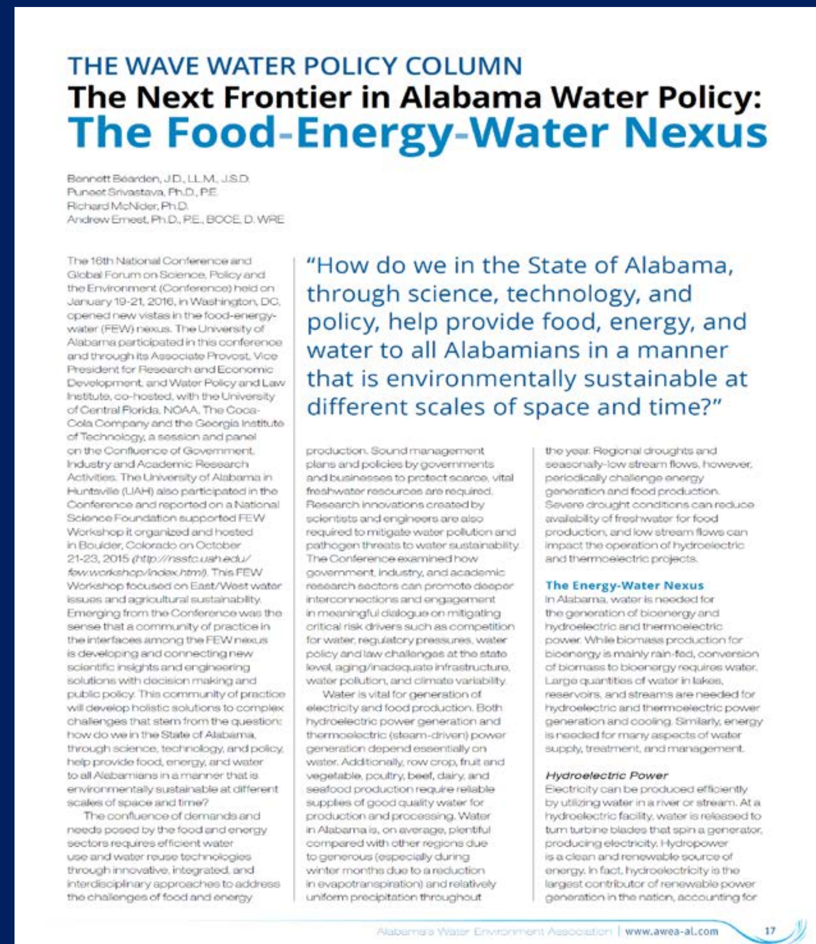
An increase in urbanization would also make urban heat islands—the warming of cities due to human activities and development—more common, favoring species that can take advantage of

Drought

The historically low river levels of 2005-2007 have demonstrated that the Southeastern United States is vulnerable to water shortages resulting from extended drought, overuse, and water policies and water management plans that are not adequate to accommodate future levels of population growth.

“How do we in the State of Alabama, through science, technology, and *policy,* help provide food, energy, and water to *all* Alabamians in a manner that is environmentally sustainable at different scales of space and time?”





THE WAVE WATER POLICY COLUMN

The Next Frontier in Alabama Water Policy: The Food-Energy-Water Nexus

Bennett Bearden, J.D., LL.M., J.S.D.
Puneet Srivastava, Ph.D., P.E.
Richard McNider, Ph.D.
Andrew Ernest, Ph.D., P.E., BCCE, D.WRE

“How do we in the State of Alabama, through science, technology, and policy, help provide food, energy, and water to all Alabamians in a manner that is environmentally sustainable at different scales of space and time?”

The 16th National Conference and Global Forum on Science, Policy and the Environment (Conference) held on January 19-21, 2016, in Washington, DC, opened new vistas in the food-energy-water (FEW) nexus. The University of Alabama participated in this conference and through its Associate Provost, Vice President for Research and Economic Development, and Water Policy and Law Institute, co-hosted, with the University of Central Florida, NOAA, The Coca-Cola Company and the Georgia Institute of Technology, a session and panel on the Confluence of Government, Industry and Academic Research Activities. The University of Alabama in Huntsville (UAH) also participated in the Conference and reported on a National Science Foundation supported FEW Workshop it organized and hosted in Boulder, Colorado on October 21-23, 2015 (*http://nsstc.uah.edu/fewworkshop/index.html*). This FEW Workshop focused on East/West water issues and agricultural sustainability. Emerging from the Conference was the sense that a community of practice in the interfaces among the FEW nexus is developing and connecting new scientific insights and engineering solutions with decision making and public policy. This community of practice will develop holistic solutions to complex challenges that stem from the question: how do we in the State of Alabama, through science, technology, and policy, help provide food, energy, and water to all Alabamians in a manner that is environmentally sustainable at different scales of space and time?

The confluence of demands and needs posed by the food and energy sectors requires efficient water use and water reuse technologies through innovative, integrated, and interdisciplinary approaches to address the challenges of food and energy production. Sound management plans and policies by governments and businesses to protect scarce, vital freshwater resources are required. Research innovations created by scientists and engineers are also required to mitigate water pollution and pathogen threats to water sustainability. The Conference examined how government, industry, and academic research sectors can promote deeper interconnections and engagement in meaningful dialogue on mitigating critical risk drivers such as competition for water, regulatory pressures, water policy and law challenges at the state level, aging/inadequate infrastructure, water pollution, and climate variability.

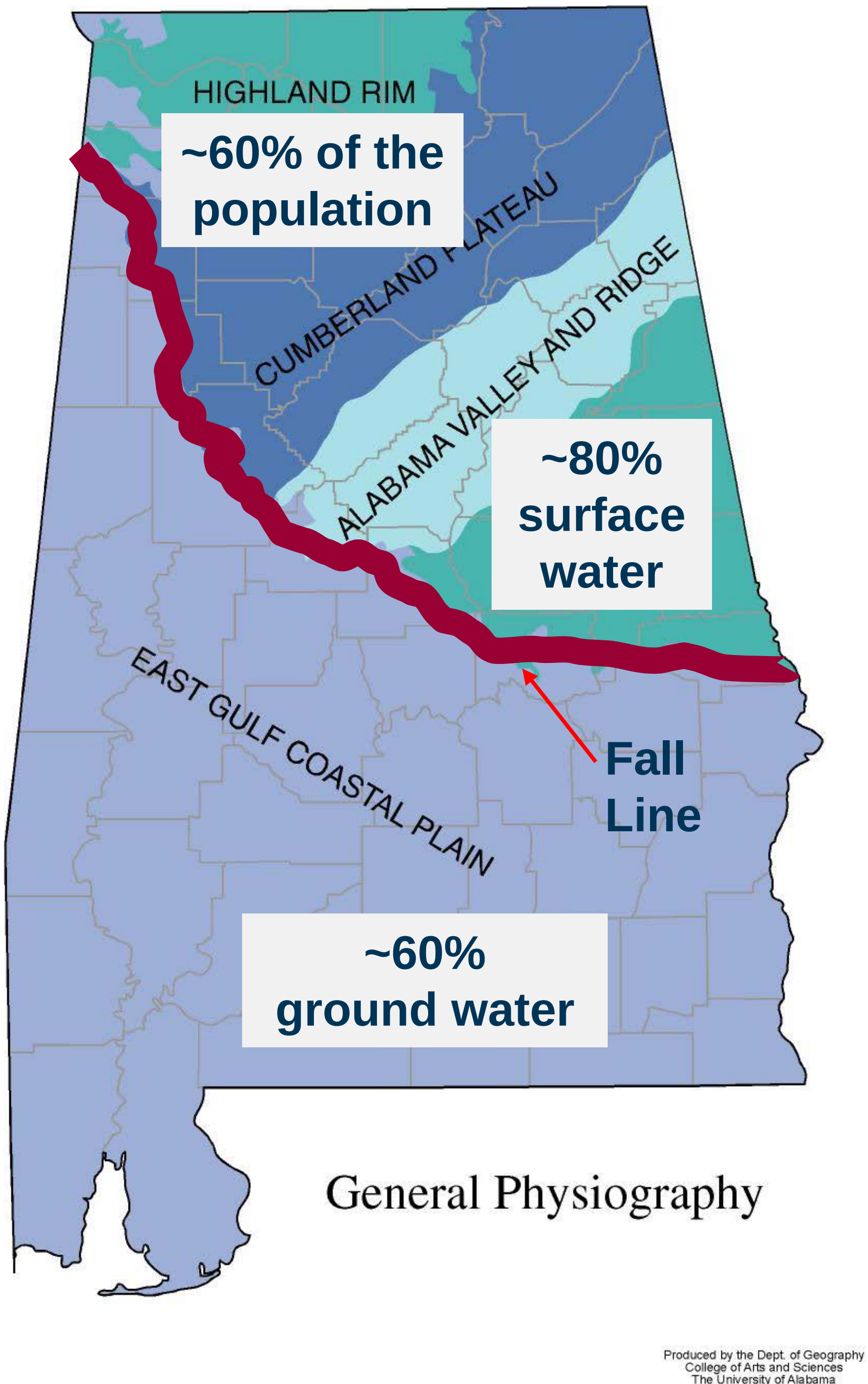
Water is vital for generation of electricity and food production. Both hydroelectric power generation and thermoelectric (steam-driven) power generation depend essentially on water. Additionally, row crop, fruit and vegetable, poultry, beef, dairy, and seafood production require reliable supplies of good quality water for production and processing. Water in Alabama is, on average, plentiful compared with other regions due to generous (especially during winter months due to a reduction in evapotranspiration) and relatively uniform precipitation throughout the year. Regional droughts and seasonally-low stream flows, however, periodically challenge energy generation and food production. Severe drought conditions can reduce availability of freshwater for food production, and low stream flows can impact the operation of hydroelectric and thermoelectric projects.

The Energy-Water Nexus

In Alabama, water is needed for the generation of bioenergy and hydroelectric and thermoelectric power. While biomass production for bioenergy is mainly rain-fed, conversion of biomass to bioenergy requires water. Large quantities of water in lakes, reservoirs, and streams are needed for hydroelectric and thermoelectric power generation and cooling. Similarly, energy is needed for many aspects of water supply, treatment, and management.

Hydroelectric Power

Electricity can be produced efficiently by utilizing water in a river or stream. At a hydroelectric facility, water is released to turn turbine blades that spin a generator, producing electricity. Hydropower is a clean and renewable source of energy. In fact, hydroelectricity is the largest contributor of renewable power generation in the nation, accounting for



Water Withdrawal Sources

- 60% of the population lives above the Fall Line
- Surface water is used by a margin of 4 to 1 compared to groundwater above the fall line
- Groundwater is the predominant source in the Coastal Plain

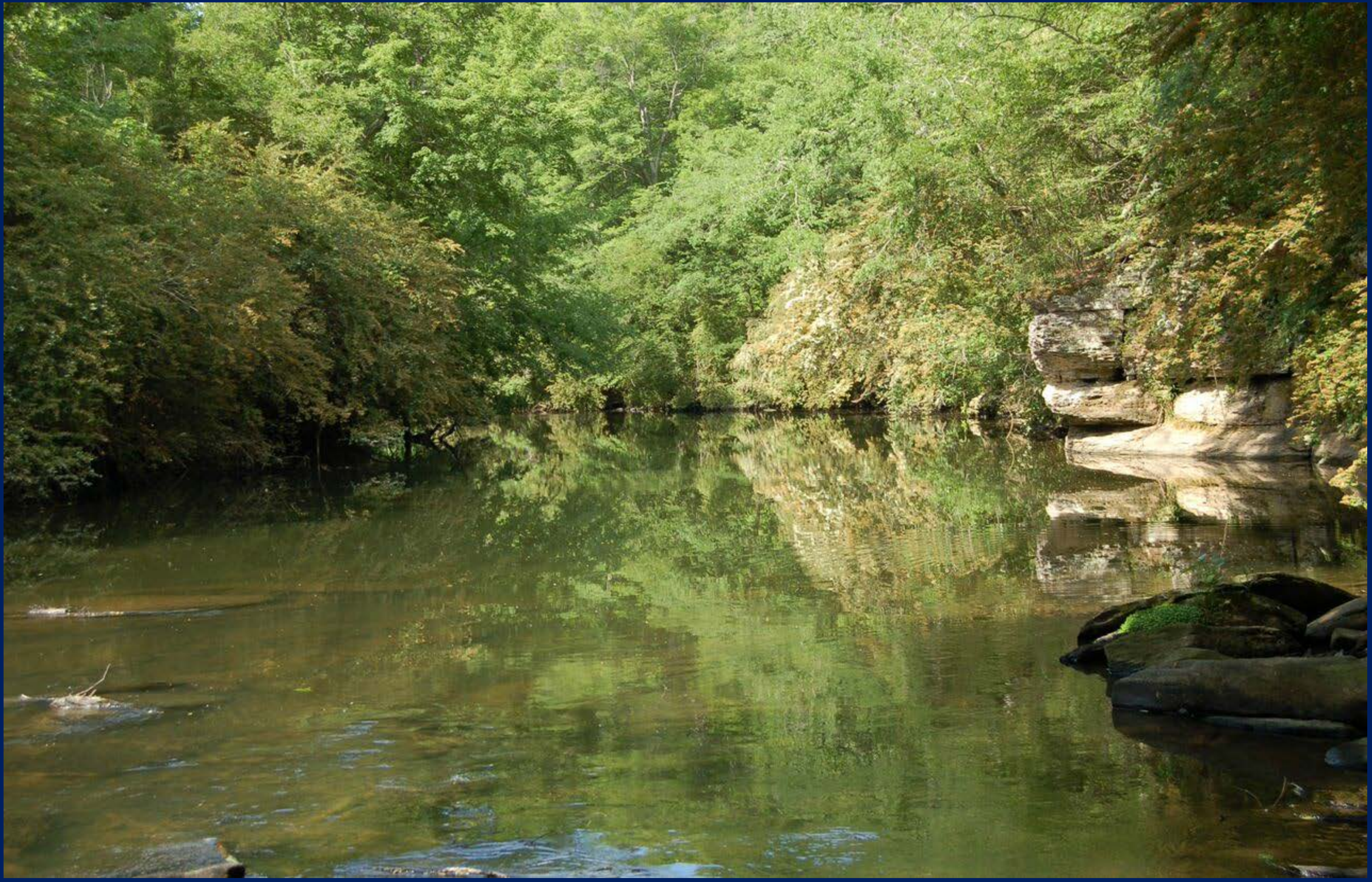
The Office of Water Resources
A Division of ADECA

Acres Under Irrigation-Southeastern US 2013*

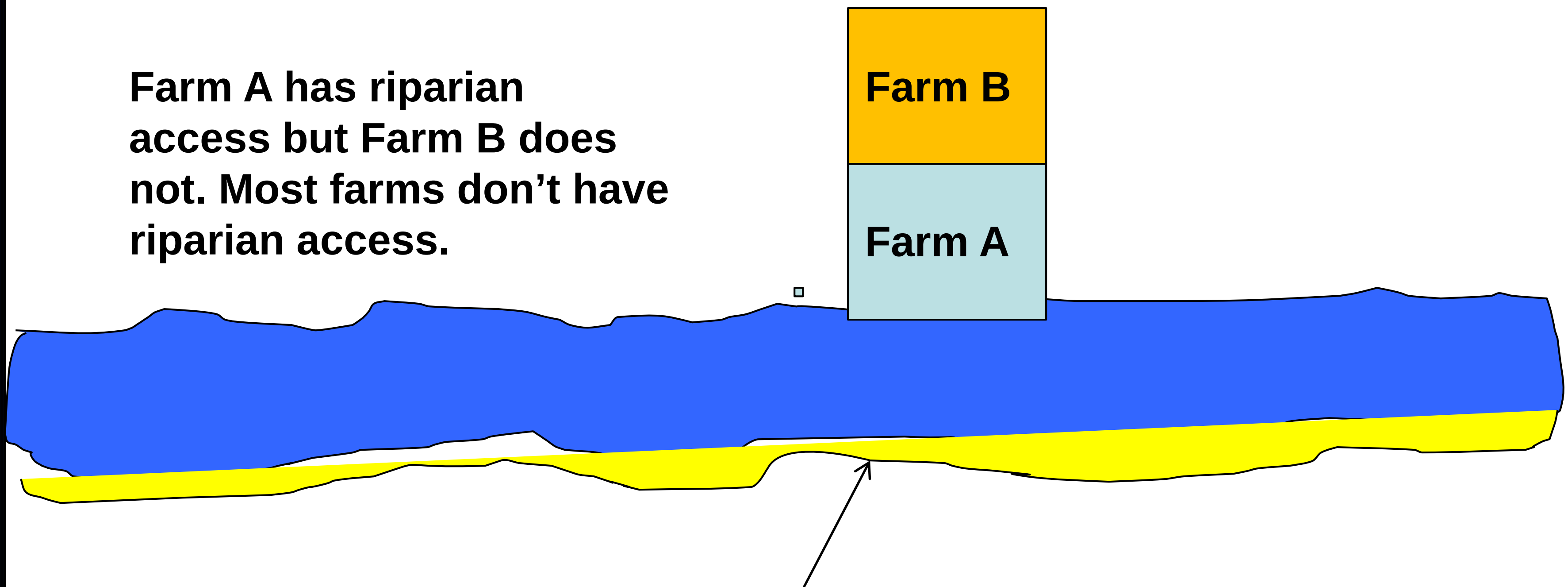
- Arkansas: 4,199,032
- Mississippi: 1,509,393
- Florida: 773,517
- Georgia: 976,400
- Tennessee: 123,153
- Alabama: 103,000-108,000

*Dick McNider, UAH, personal communication, January 13, 2016.

Alabama Water Law: Traditional Riparian Rights (Surface Water) and Reasonable Use (Groundwater) = Insecurity, Uncertainty, and Lack of Predictability



Farm A has riparian access but Farm B does not. Most farms don't have riparian access.



Reservoir operators often have easements along the reservoirs so no farms have riparian rights

AWAWG Report Containing Policy Options and Recommendations Delivered to Governor's Office on December 1, 2013

MAPPING THE FUTURE OF ALABAMA WATER RESOURCES MANAGEMENT:

Policy Options and Recommendations

A Report to
The Honorable Robert Bentley
Governor of Alabama
by the
Alabama Water Agencies Working Group

December 1, 2013

ALABAMA WATER AGENCIES WORKING GROUP

MEMBERSHIP

Bennett L. Bearden, Chair,
Alabama Water Agencies Working Group (AWAWG)
Special Counsel on Water Law and Policy

Brian Atkins
Tom Littlepage
Craig Kneisel

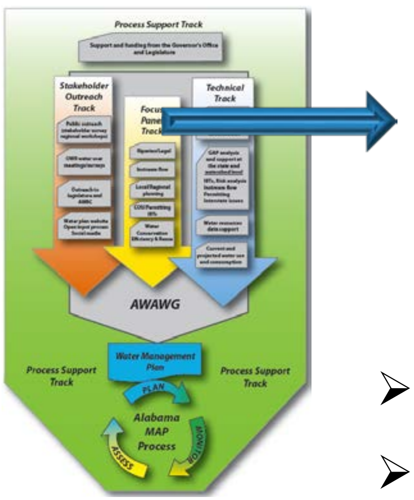
Berry H. (Nick) Tew, Jr.
Marlon Cook
Patrick O'Neil

Lance LeFleur
Marilyn Elliott
Vernon Barnett
Glenda Dean
Scott Hughes
Lynn Sisk
Vickie Hulcher

N. Gunter Guy, Jr.
Stan Cook
Chris Greene
Will Gunter

John McMillan
Glen Zorn
Brett Hall
Patrick Moody

Focus Area Panels (FAPs)



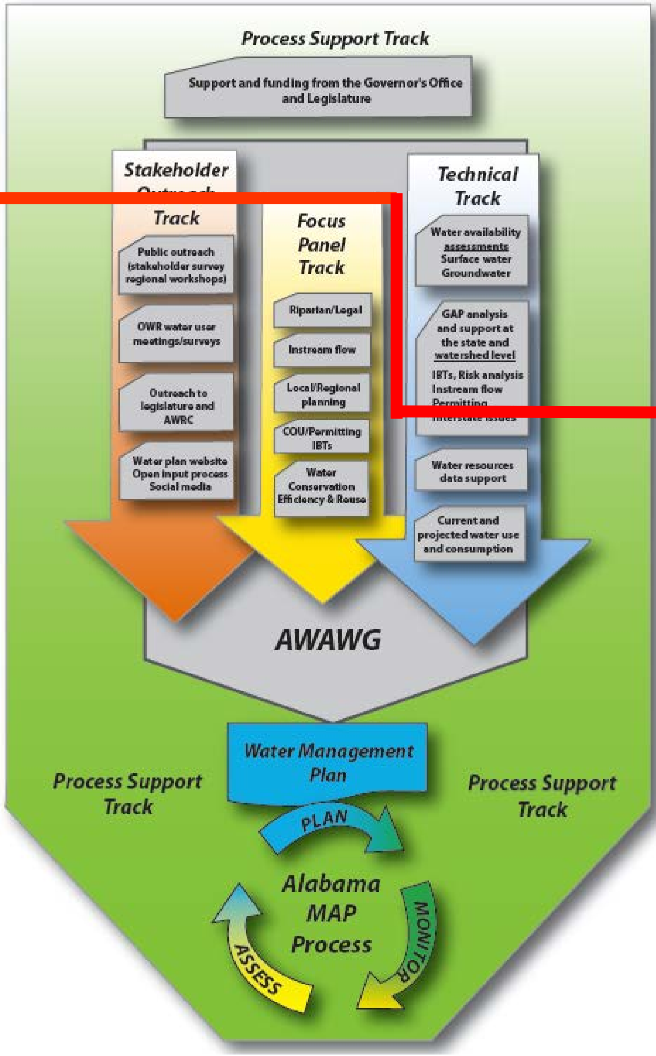
- Riparian and other legal issues
- Local/regional planning
- Water conservation, efficiency, and reuse
- Certificates of use, permitting and interbasin transfers
- Instream flows

Purpose of FAPs

- To bring partners together to discuss difficult issues.
- To develop written reports for the AWAWG addressing specific questions and issues.
- To meet within a short time frame (≈ 12 months).
- Process and partners approved through Governor's Office.

Where Are We Now ?

September 8, 2016



AWAWG Phase 2: FEW Nexus Issue Paper (forthcoming in next AWAWG Report)

Access to water for irrigation in the FEW nexus within the Alabama water resources spectrum might best be regarded as some sort of "plea for sanity" in the policy world.

FOOD-ENERGY-WATER NEXUS

Overview

Water is vital for generation of electricity and food production. Both hydroelectric power generation and thermoelectric (steam-driven) power generation depend essentially on water. Additionally, row crop, fruit and vegetable, poultry, beef, dairy, and seafood production require reliable supply of quality water for production and processing.

Water in Alabama, on average, is plentiful compared with other regions due to generous (especially during winter months) and relatively uniform precipitation throughout the year. Regional droughts and seasonally low stream flows, however, periodically challenge energy generation and food production. Severe drought conditions can reduce availability of freshwater for food production and low stream flows can impact the operation of hydroelectric and thermoelectric projects.

Energy-Water Nexus

In Alabama, water is needed for the generation of bioenergy and hydroelectric and thermoelectric power. While biomass production for bioenergy is mainly rain-fed, conversion of biomass to bioenergy requires water. Large quantities of water in lakes, reservoirs, and streams is needed for hydroelectric and thermoelectric power generation and cooling. Similarly, energy is needed for many aspects of water supply, treatment, and management.

Hydroelectric Power

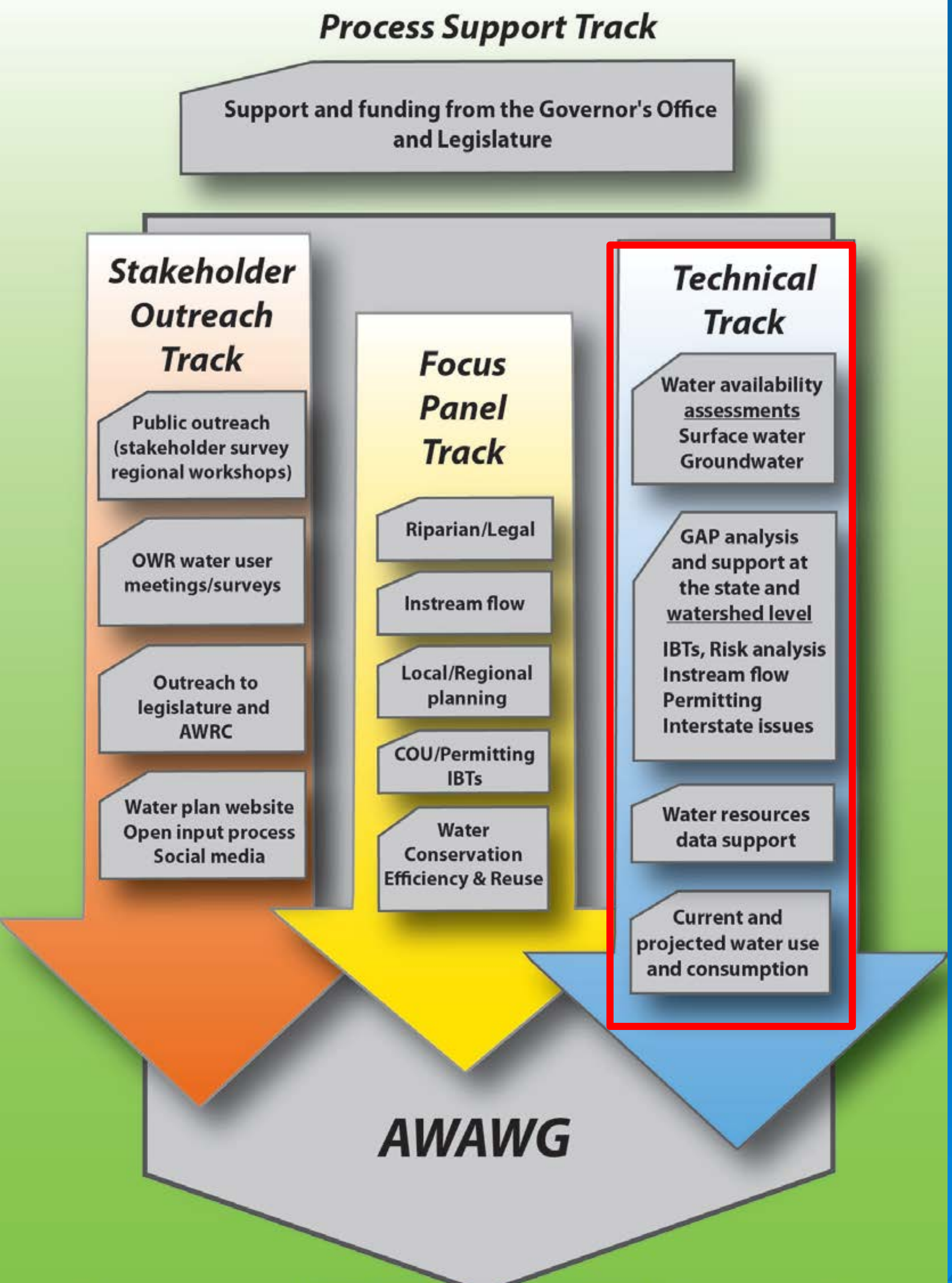
Electricity can be produced efficiently by utilizing water in a river or stream. At a hydroelectric facility, water is released to turn turbine blades that spin a generator, producing electricity.

Hydropower is a clean and renewable source of energy. In fact, hydroelectricity is the largest contributor of renewable power generation in the nation, accounting for 56 percent of U.S. renewable generation and 7 percent of total U.S. electricity generation.[1] Hydropower generation is highly efficient compared to other forms of power generation.[2] The use of hydropower also enhances the overall reliability of the greater electric generation system. In addition, reservoirs that provide renewable hydropower serve a number of additional purposes including flood control, navigational support, irrigation, drinking water, fish and wildlife habitats, and recreation.

Ample precipitation is essential for hydroelectric operations, but timing is also important. During spring, reservoirs in the region are replenished. If spring precipitation is well below normal, it becomes a challenge to fill and maintain reservoirs at levels that are necessary during the remainder of the year for power generation, recreation, navigation, and other needs.

[1] U.S. Department of Energy, The Water-Energy Nexus: Challenges and Opportunities at 42, 72 (June 2014).

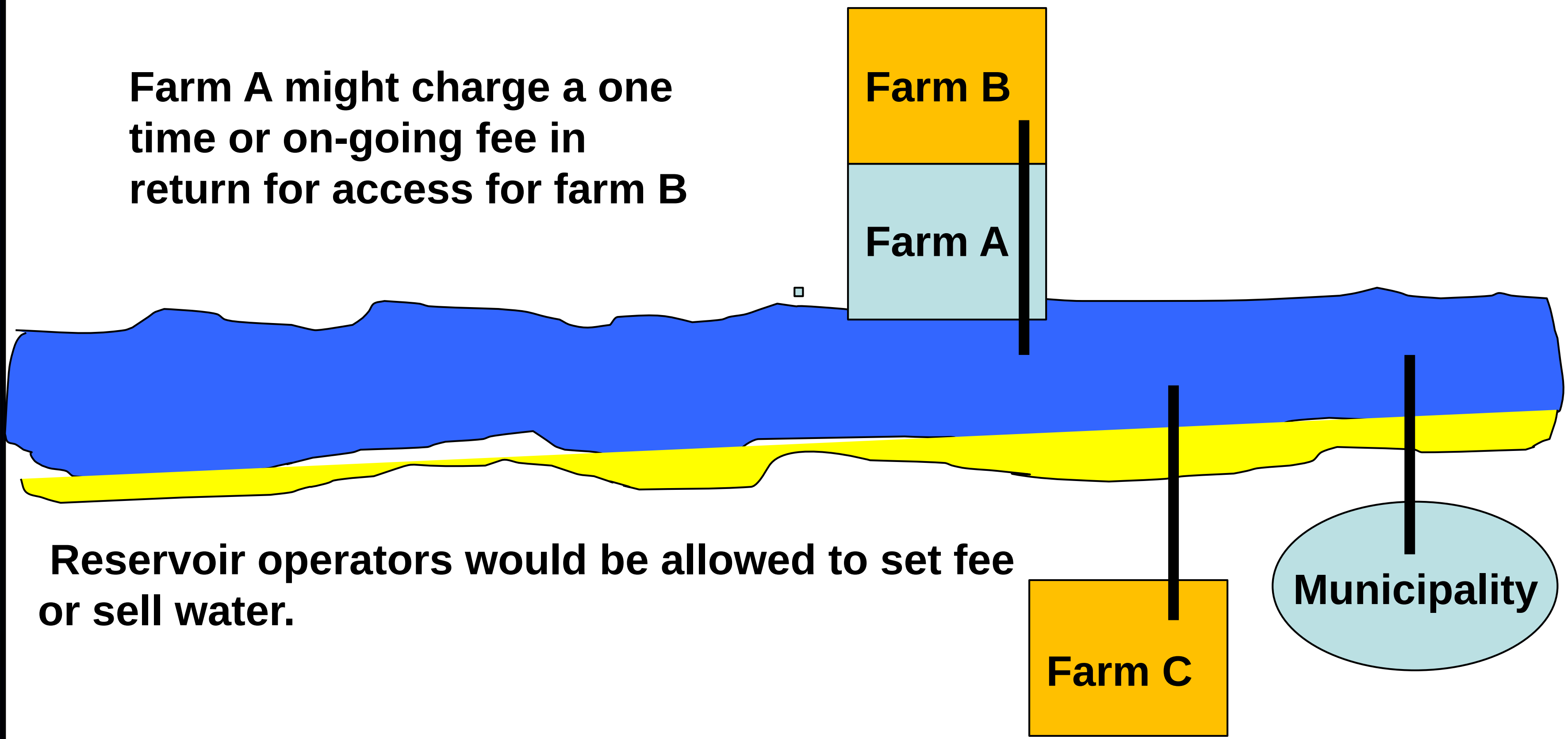
[2] *Id.* at 72.



Technical Track

Consists of science and engineering activities related to improving the understanding of Alabama water resources and their uses

Farm A might charge a one time or on-going fee in return for access for farm B



Reservoir operators would be allowed to set fee or sell water.

Proposed Riparian Relaxation

1. Allow legal use of water for non-riparian farmers/users

2. Riparian owners would still control access to water. Thus, the non-riparian may be required to pay a fee to the riparian owner for this access. We assume the market will work.

However , we must assure that the other part of the riparian doctrine – that down stream users must be protected - also be maintained.

3. New non-riparian users would be the first to give up use of water during extreme hydrologic droughts. Water insurance would be made available (similar to current crop insurance) to protect their investment. Models would be used to set actuarial.

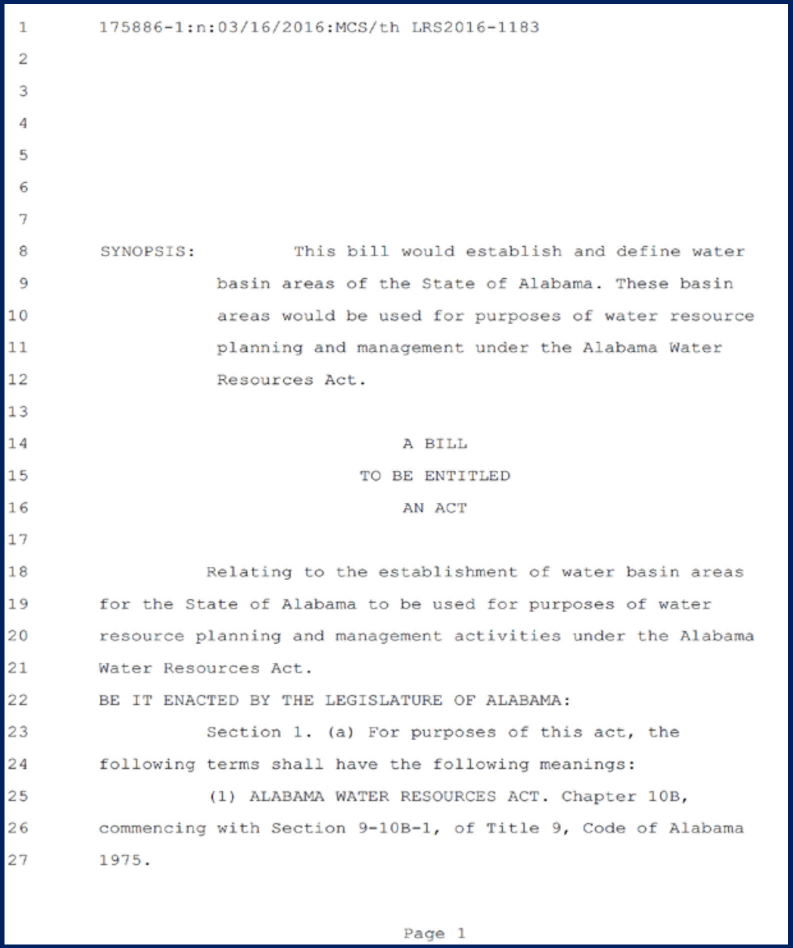
4. Limits would be placed on the total number of acres in a watershed for which non-riparian access would be allowed to (e.g. 20% of watershed).

Water Policy Implications: Alabama Irrigation Initiative

1. Perhaps the single greatest constraint to realization of goals of the Alabama Irrigation Initiative is the riparian rights doctrine governing water law and policy in the State.
2. Riparian rights doctrine in Alabama restricts the use of surface water to land owned next to watercourses.
3. The current water policy is an impediment to providing renewable water for expanded irrigation in Alabama and is possibly an impediment to relieving pressure on groundwater supplies.
4. Access to water for irrigation by non-riparians is one of the greatest emerging challenges in the Alabama water resources spectrum and its resolution will require advances in water policy (relaxation of riparian rights???).
5. Impacts of current policy on economic development in rural Alabama?
6. Sound state water management plan and water policy are needed to provide access to water for all Alabamians.

SB367 in 2016 Legislative Session

"[E]stablish and define water basins of the State…used for purposes of water resources planning and management under the Alabama Water Resources Act"



175886-1:n:03/16/2016:MCS/th LRS2016-1183

SYNOPSIS: This bill would establish and define water basin areas of the State of Alabama. These basin areas would be used for purposes of water resource planning and management under the Alabama Water Resources Act.

A BILL
TO BE ENTITLED
AN ACT

Relating to the establishment of water basin areas for the State of Alabama to be used for purposes of water resource planning and management activities under the Alabama Water Resources Act.

BE IT ENACTED BY THE LEGISLATURE OF ALABAMA:

Section 1. (a) For purposes of this act, the following terms shall have the following meanings:

(1) ALABAMA WATER RESOURCES ACT. Chapter 10B, commencing with Section 9-10B-1, of Title 9, Code of Alabama 1975.

March 15, 2016, Joint Legislative Committee on Water Policy and Management

Senator Arthur Orr (R-Decatur) announced he was working on legislation to define the watersheds in Alabama. The Senate Transportation and Energy Committee discussed, amended, and carried over SB367 in committee. Senator Orr said he introduced the Bill to get the process moving on elements of a larger water policy plan for the state.

The National Water Center

NOAA, USGS, USACOE, FEMA, and UCAR: Integrated Water Resources Science and Services (IWRSS)-a cross-cutting, multidisciplinary systems approach to addressing complex water problems collaboratively

National Water Center Linkage: Data-Driven Policy Making (Cyber Data)

The WAVE Water Policy Column

Data-Driven Policy Making

Bennett L. Bearden, J.D., LL.M., J.S.D.[1]
Andrew Ernest, Ph.D., P.E., BCEE, D.WRE,[2]
Edward Clark,[3] and
Lian Zhu[4]

[1]Director, Water Policy and Law Institute, The University of Alabama
[2]Director, Environmental Institute, The University of Alabama
[3]Director, Geo-Intelligence Division, Acting Director, Interdisciplinary Science and Engineering Division, National Water Center, NOAA National Weather Service
[4]Ph.D. Student, Civil, Construction & Environmental Engineering, The University of Alabama

This is the Information Age, a period in human history characterized by the ubiquity of information, accompanied by unassailable democratization of knowledge. Both public and private sector organizations have embraced the premise of Data Driven Decision Making (DDDM) [21] as core components of Total Quality Management (TQM) and other continuous improvement efforts. DDDM provides private sector organizations a structured mechanism for improving their competitive advantage, potentially improving productivity rates by as much as 4% and increasing profits by 6% [16]. Key to the successful implementation of DDDM is the reliance on verifiable, high quality data, and a rigorous analysis process.

There are key differences between policy development and decision making, with the scale of these differences tending to increase with the increasing size of the employing organization or scope of their application. Decision making, by definition, is the process by which an approach to achieving a particular goal is identified within a given set of constraints. Decision making can, somewhat arbitrarily, be categorized by the scope of its implementation (Figure 1).

An organization's mission is its overarching vision or purpose. In the context of a State, this is embodied in its Constitution, while for water or wastewater systems, this usually embodies basic premises of provision of clean water or protection of the environment. Policy and strategy can often be conflated, reflecting an overarching framework for operational or tactical decision making. Policy frameworks shape thinking and guide

Mission | Policy | Strategy | Tactics | Operations

Figure 1: Scope of Decision Making

long term decision-making, while strategy focuses more on the actions and resources needed to achieve specific long-term objectives. Tactics and operations can similarly be conflated, with differences related to the immediacy of the decision and the specificity of the desired outcome.

Examples of decision making can range in scope from identifying preferred policy frameworks that support an economic development goal, while satisfying stakeholder expectations, to selection of watershed management strategies to achieve a target water quality goal, or selection of a treatment train configuration to ensure compliance with regulated effluent standards.

Rather than being discrete elements, Figure 1 should be viewed as a continuous spectrum, with the scope of the goal getting broader and more inclusive to the left, and the specificity of the tools and constraints increasing towards the right. In a tactical or operational context, for example, selection of a treatment technology might only require civil or environmental engineering expertise, while watershed management might require the same technical expertise, but also need agricultural production, aquatic ecology, industrial processes and other expertise. As the scope of expertise required for decision making increases, so does the corresponding data and information needs, as does the necessity for brokered decision support to accommodate the increasing breadth of stakeholder expectations and constraints.

Because of the broad swath of stakeholder expectations and constraints, and the inter-dependence between the wide range of technical expertise required, water policy development is an increasingly complex and intertwined process. Traditional complex decision making processes have been conducted in a discrete but iteratively integrative fashion. For example, in Total Maximum Daily Loads (TMDL) development, impaired streams that do not meet the "fishable/swimmable" goal must undergo a Use Attainability Analysis (UAA) every 3 years to determine if new information has become available to support the achievement of the goal. A key component of TMDL development is stakeholder engagement that occurs in parallel to the scientific and technical investigations. These processes inform each other at discrete intervals with stakeholder engagement and the scientific assessment intersecting at pre-defined points in the decision process. Not unlike braided streams (Figure 2), this structured cyclic approach, leaves little room for dynamic exchange of information between parallel efforts, and can often introduce additional artifacts that may further complicate and elongate the time to convergence on a satisfactory decision.

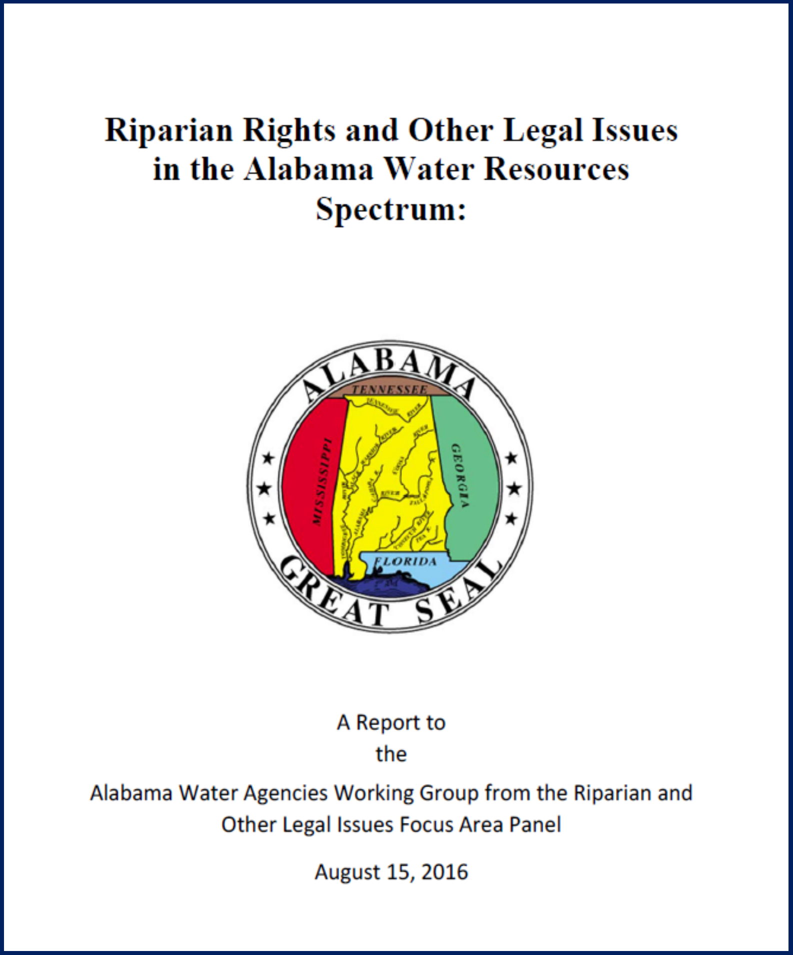
All strands in the braided decision making process described in Figure 2, are comprised themselves of individual, strand-specific micro-decisions, utilizing whatever information is available at the time. The ideal decision making process

NWC: Collaboration Opportunities

- As part of the IWRSS framework, the NWC will serve as a catalyst for federal partnerships.
- Just as important, the NWC will present opportunities for collaboration with academic and non-Federal partners.
- All of these partnerships will be vital to address national and global challenges associated with water.

Riparian and Other Legal Issues FAP Report (August 15, 2016)-Water Policy “Door Openers”

- **Non-riparian surface water and groundwater usage, particularly *access to water for irrigation* and public water supply providers;**
- **Groundwater well location and placement; and**
- **Local planning for droughts and periods of low flow.**


Riparian Rights and Other Legal Issues in the Alabama Water Resources Spectrum:

A Report to the Alabama Water Agencies Working Group from the Riparian and Other Legal Issues Focus Area Panel

August 15, 2016

Water Policy and Law Institute

Bennett L. Bearden, JD, LLM, JSD
Director

THE UNIVERSITY OF
ALABAMA
FOUNDED 1831

Walter Bryan Jones Hall-Room 118
P.O. Box 20276
Tuscaloosa, Alabama 35402-0276
OFFICE (205) 247-3683
FAX (205) 349-2861
bbearden@ua.edu