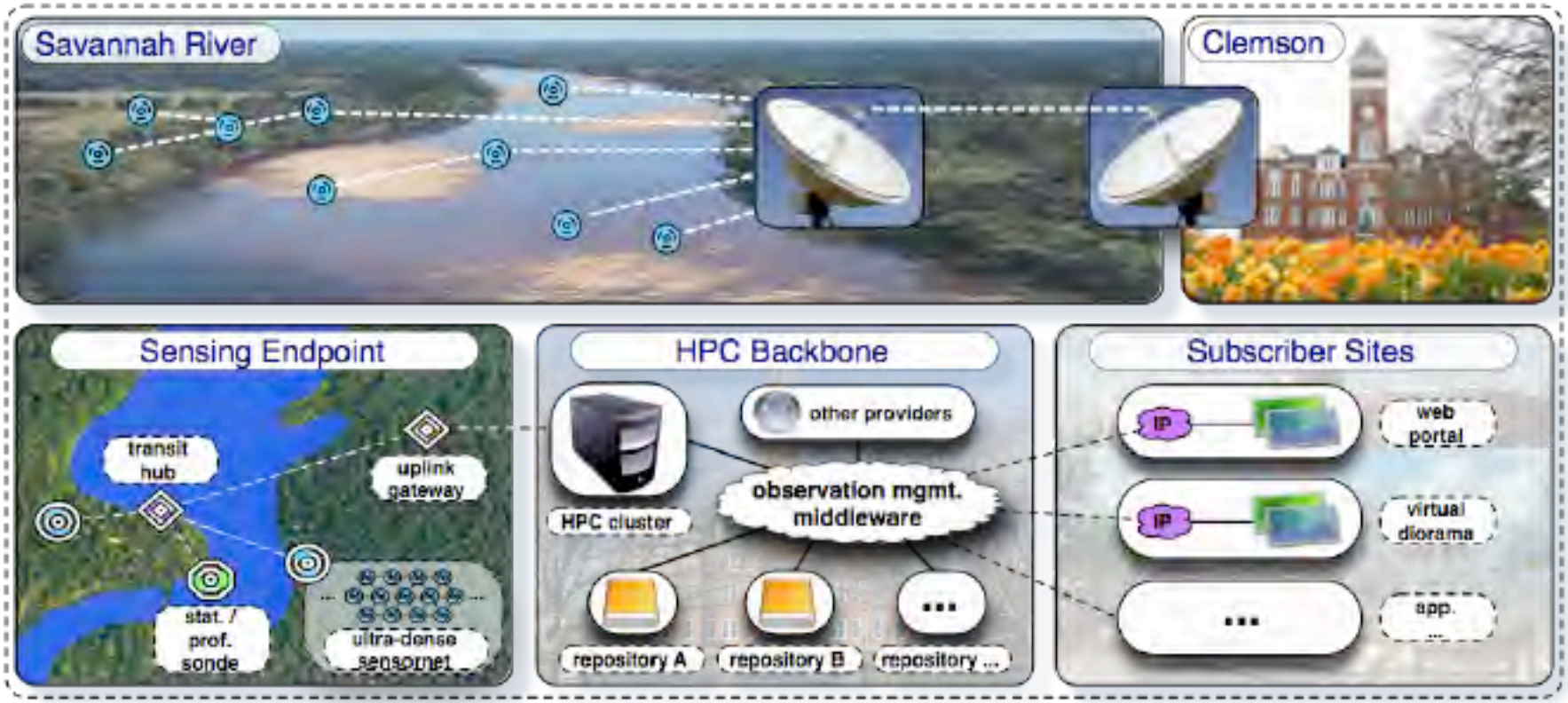
Intelligent River®

from observational to operational™

Cyberinfrastructure Technologies Enhancing Conservation for the 21st Century

….Advanced data acquisition, data integration, data storage, data management, data mining

….Environmental informatics –powerful social network



CLEMSON UNIVERSITY

Gene Eidson and Jason Hallstrom, Institute of Applied Ecology

Earth Monitoring: World-wide quest for solutions

... enabling a profound transformative shift in the science and business of managing natural resources ...

- **Real-time data**
- **Remote data acquisition systems**

Paradigm shift where computing is an essential partner in the worldwide quest to manage natural and built environments

Goals of Intelligent River® Research

- Engineer a long-lived, cost-effective, basin-scale earth monitoring fabric
- Engineer computational tools and systems designed to utilize and share the data derived from this fabric
- Embed the resulting technologies and data products into traditional ecological, forestry, & agricultural research methods, and
- Embed the technologies and data products into multiple sectors of the built environment.





Environmental Macroscope

Effective resource management requires fine-grained, landscape-scale datasets.

We build the tools that provide them.

Macroscope Design

Internet

Internet

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Case Studies

[charleston] VERTICAL FARM

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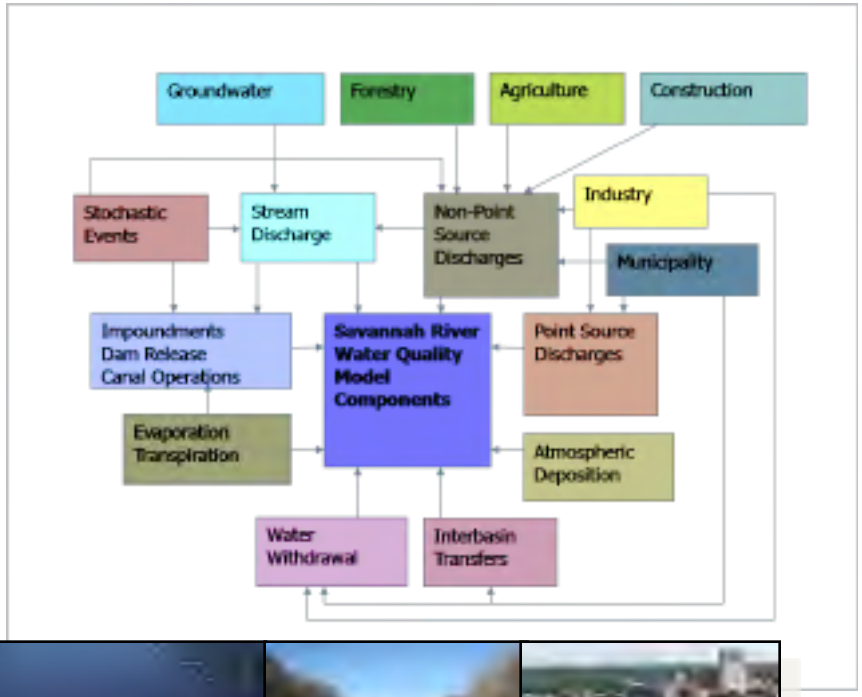
Bold Step: First Automated River

Development, analysis, and application of next-generation materials, hardware, software, and network systems designed to fill fundamental information technology gaps to enhance an understanding of environmental dynamics and policymakers ability to manage them.

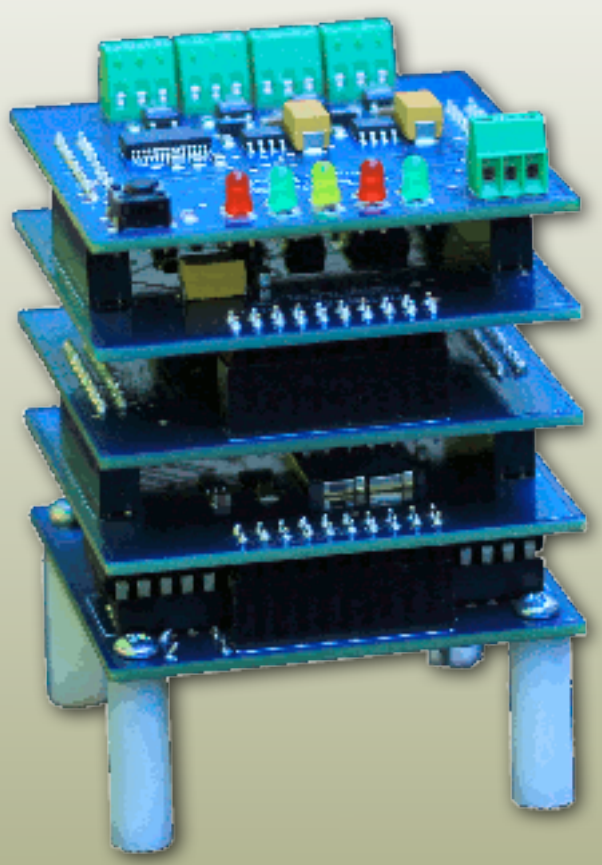


Agency Support

Colonel Edward Kertis
Commander, Savannah District COE "The technologies being developed will enable us to more **adaptively manage** the river by **optimizing water resource allocation** while **minimizing impacts** on the environment. We will be able to refine our releases in response to changes in water quality, ecosystem functionality, habitat availability, and anthropogenic effects. The new generation of data collection platforms could potentially be adopted by every Corps of Engineers Water Management office across the country".

Jim Giattina
Director, EPA Region 4 Water Protection Division
"The proposed watershed-scale monitoring instrument will directly **enhance our efforts to monitor water quality and manage watershed factors that impact water quality**... Real-time water quality monitoring at the watershed scale will allow the agency to **pursue informed pollutant allocation implementation** and water resources management in strong collaboration with our federal, state, and local partners."

Sensing Platform



Smaller.

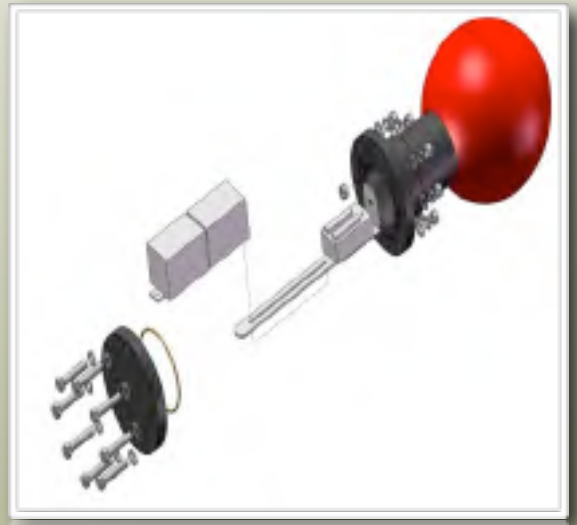
Cheaper.

Leaner.

The MoteStack (patent pending)

Platform Enclosure

Custom enclosures complete the package.

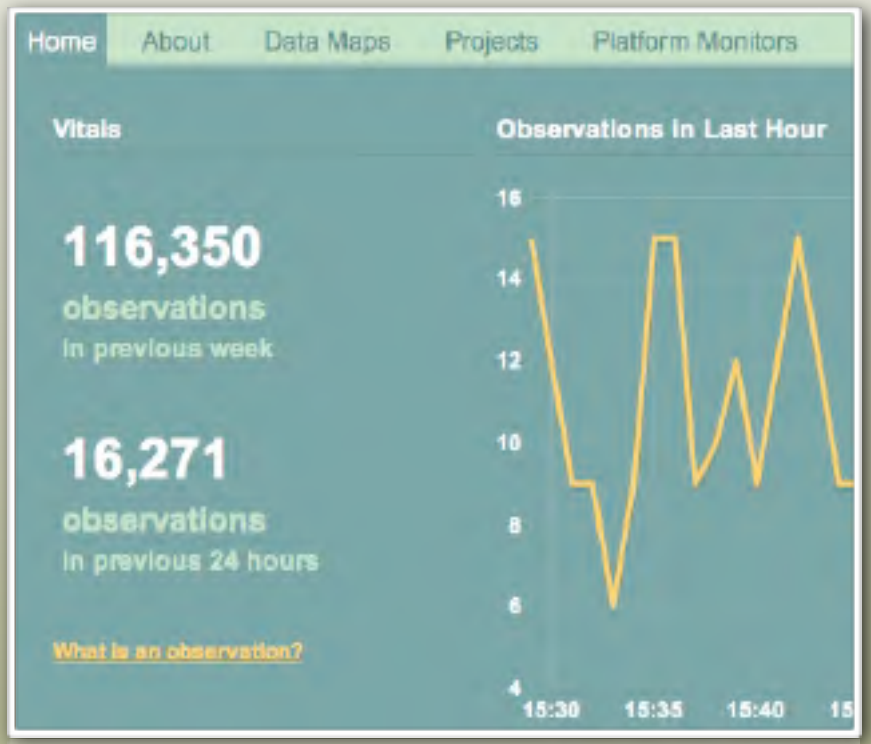


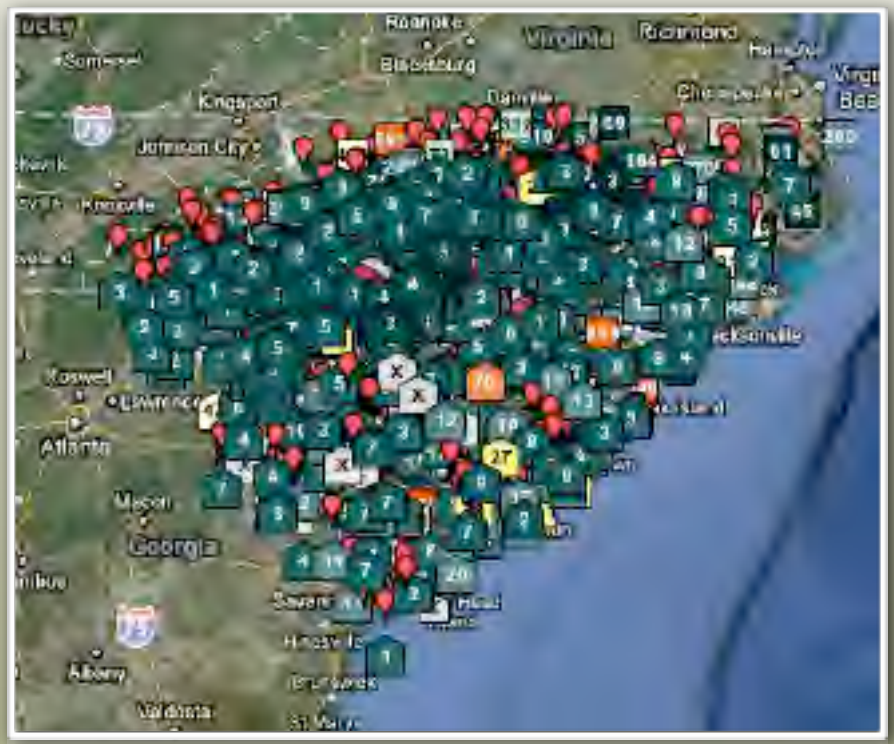
Telemetry Buoy (patent pending)

SOURCES: Buoy designed by B. Jones (Mechanical Engineering), C.J. Post (Forestry and Natural Resources), Clemson University.

Data Portal

From deployment to desktop...





...in seconds.

Intelligent River®

from observational to operational™

CNS-1126344

Team

- G. Eidson
- O.P. Flite
- R.M. Geist
- S. Goasguen
- J.O. Hallstrom
- A. Jayakaran
- C.J. Post
- J. Sharp
- J. Tessendorf
- K.-C. Wang
- D. White

MRI: Development of the Intelligent River, A Basin-Scale Monitoring Instrument

- Award Total: $3,039,173
- Match Total: $1,302,507

Focus:

The development of an environmental macroscope tailored for basin-scale water resource management

New technology for a thirsty world.

http://www.intelligentriver.org

Clemson University Institute of Applied Ecology

Linking land use, water, energy, and climate change

In announcing the MRI award, NSF officials made it clear there is a critical need for this research.

The grant announcement on the NSF website reads: “It is evident that the growing mismatch between water supply and demand impacts us all: USA watersheds are in peril! This project does something about it with support from EPA [U.S. Environmental Protection Agency] and USACE [U.S. Army Corps of Engineers]. Within the reach of environmental science, this work explores the connections among land use, energy production, climate effects, and water resources applying information and computing systems.”

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PUBLIC SERVICE ACTIVITIES

We make sense.

The Deployment

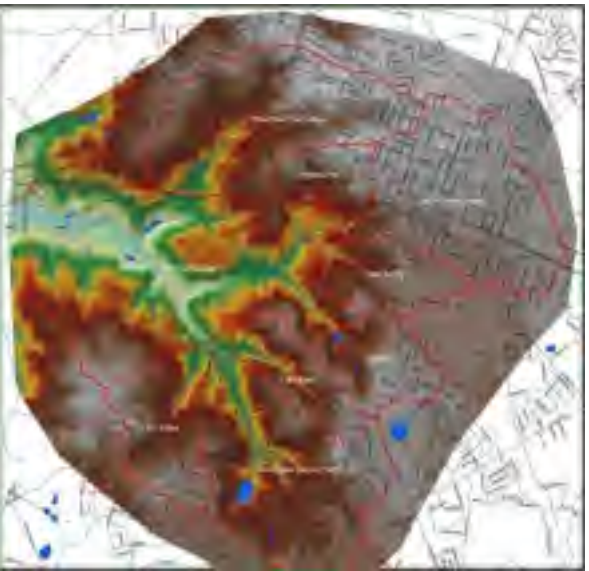
The Intelligent River® will be deployed along the 300-mile reach of the Savannah River, from the headwaters to the estuary.

Intelligent Stormwater Application

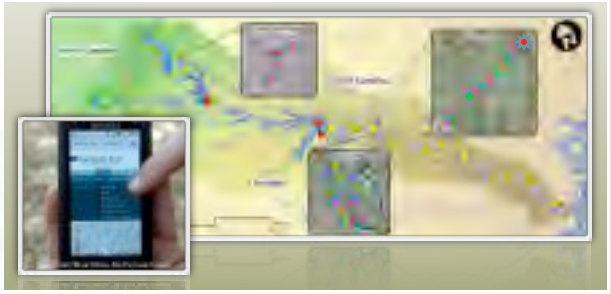
Sand River Headwaters Green Infrastructure Project

…an innovative approach to stormwater management
…linking green infrastructure with cyberinfrastructure
concept, design, construction and research

Gene Eidson, Ph.D. Principal Investigator
Drs. Cal Sawyer, Dan Hitchcock, Jason Hallstrom, Victoria Chanse, Chris Post,
Brad Putman, David White, Jon Calabria, Co-PIs
Sam Esswein and Ryan Shealy, Graduate Students; Chris Bellamy, Project Coordinator

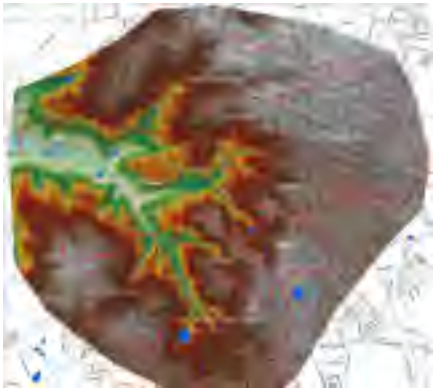


Savannah River Basin



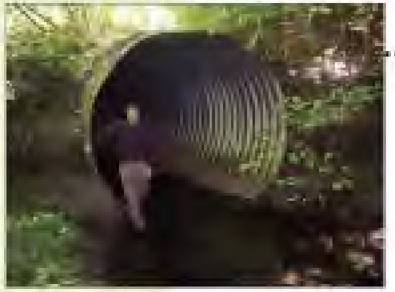
Horse Creek Watershed

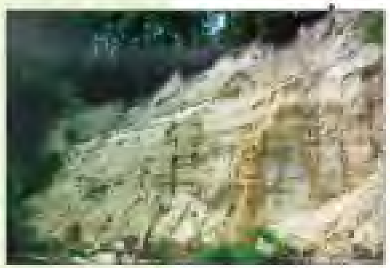
Sand River Watershed

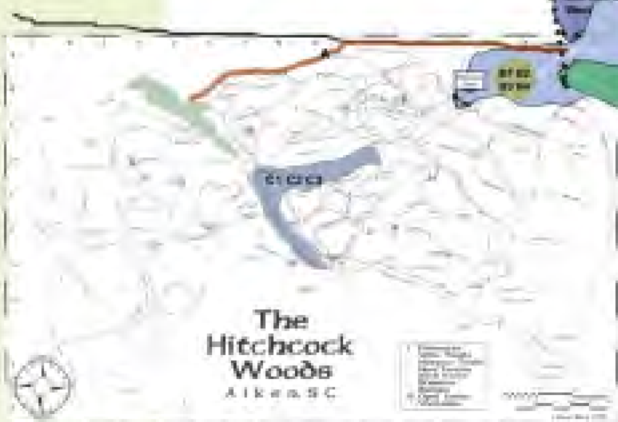


Aiken Green Infrastructure*

THE IMPORTANCE OF TREATING STORMWATER







RESEARCH OBJECTIVES

1. Quantify hydrologic flows in response to storm events (water quantity).
2. Quantify concentration and loading of identified stormwater pollutants (water quality).
3. Assess BMP design, construction, and maintenance to develop cost-effectiveness profiles.
4. Optimize site-level remote data acquisition capabilities and integrate associated collection, transmission, display, and archival facilities into the Intelligent River network.
5. Utilize graduate students in stormwater and green infrastructure design concepts, research design, implementation, and analysis.
6. Assess environmental knowledge and behavior to quantify how environmental perception of ecological processes, namely stormwater, may change.
7. Evaluate the city's changing stormwater management and design practices.
8. Disseminate results to the general public, as well as regional design engineers, site developers, municipal and county stormwater staff, state environmental agencies, landscape architecture academics and professionals, planning agencies, and peer-reviewed journals.

Clemson University Green Infrastructure Team:

Aiken Green Infrastructure

Monitoring Locations

NAD_1983_UTM_Zone_17N

Intelligent River.

Prepared by Sam Esswein.
September 6, 2011

1 cm = 25 Meters

1:2,500

0 50 100 200 Meters

Notes:

Roads from 2010 United States Census Data.
Imagery from Bing Maps. © 2010 Microsoft Corp.
Monitoring locations from Chris Bellamy. June 2011.

Intelligent River®

from observational to operational™

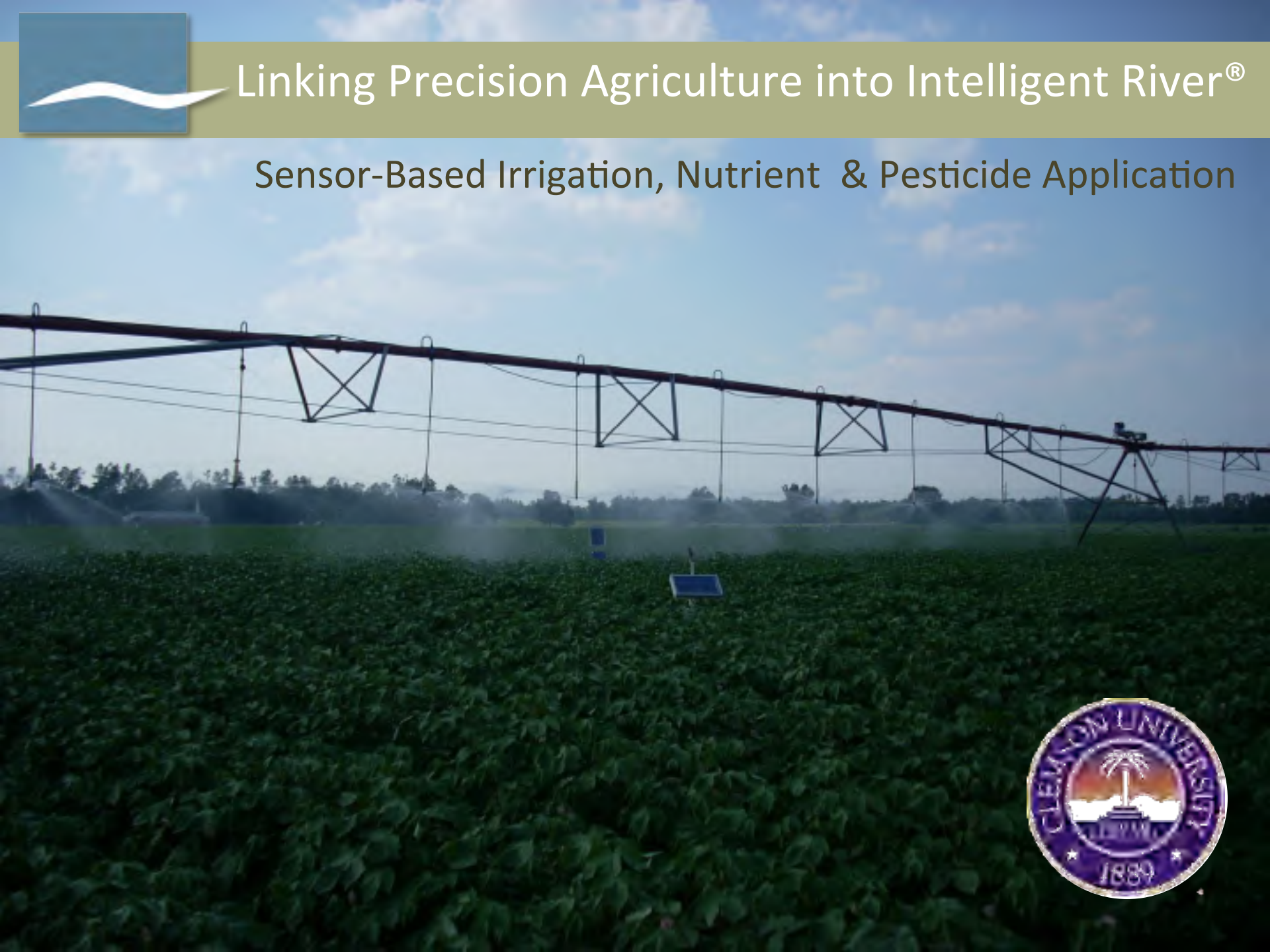
Intelligent Farm

Edisto Research and Education Facility

- Blackville, SC
- Founded 1937
- 2,354 Acres

Linking Precision Agriculture into Intelligent River®

Sensor-Based Irrigation, Nutrient & Pesticide Application



Linking Precision Agriculture into Intelligent River®

Precision agriculture on 2,300 contiguous acres of land typical of the Savannah Valley / Coastal Plains regions of SC

- Variable rate lateral irrigation systems
- Sensor-based, variable crop input applicator
- GreenSeeker technology
- Soil electrical conductivity
- GPS-GIS technology
- NSF funded 'last-mile' connectivity

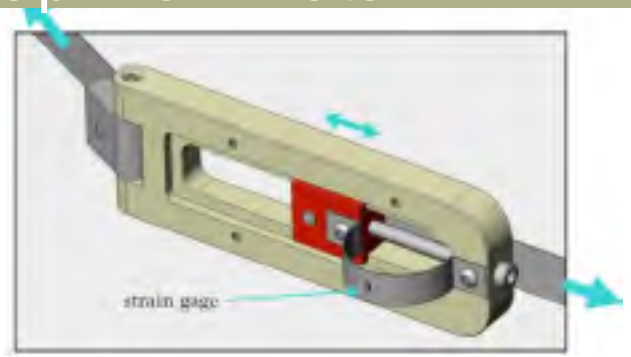
Farm Watershed Monitoring

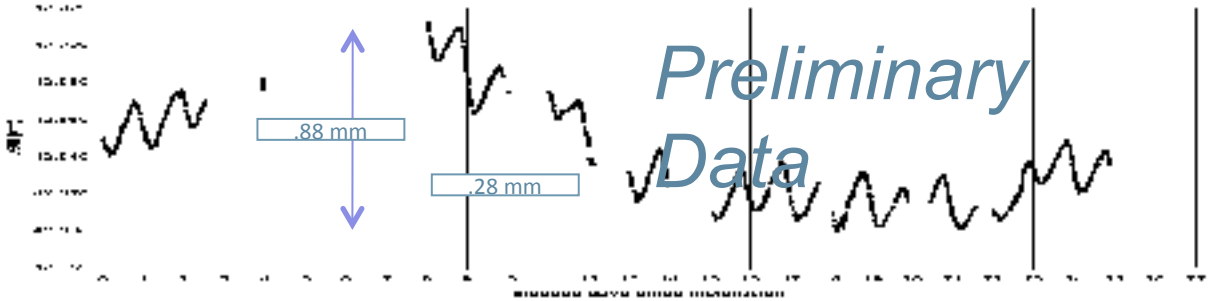
Intelligent Forest – Baruch Institute

Ultra-high precision tree monitoring

- Drought management
- Climate change
- Water balance

Forest Ecology: Tree Growth
Wireless Dendrometer and Sap Flow Data





Preliminary Data

[charleston] VERTICAL FARM
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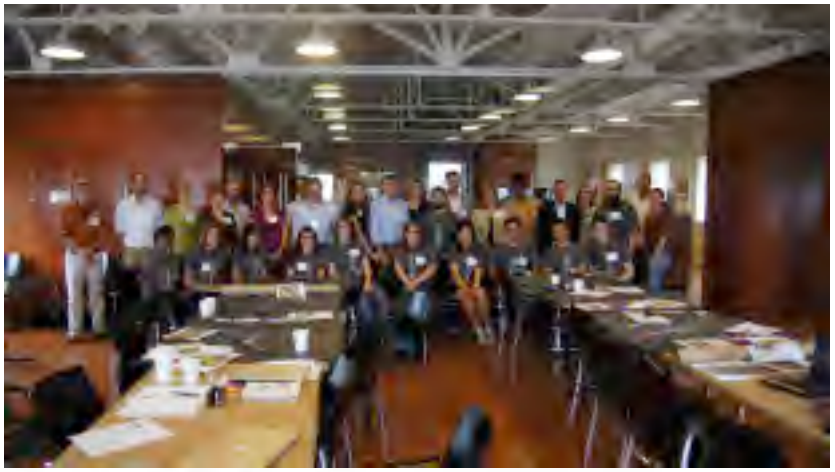
The Charleston Vertical Farm Design Feasbility Study was done in collaboration with Clemson University's Centers of Economic Excellence in Urban Ecology & Restoration and Sustainable Development and the City of Charleston. The study evaluated the repurposing of an existing building to house a vertical farm, powering it with solar and wind energy and using enhanced cyberinfrastructure and environmental informatics to monitor and operate the farm by incorporating the Intelligent River® cyberinfrastructure network that will provide real-time remote-data acquisition.



Food deserts

SOURCE: CITY OF NORTH CHARLESTON

[charleston] VERTICAL FARM

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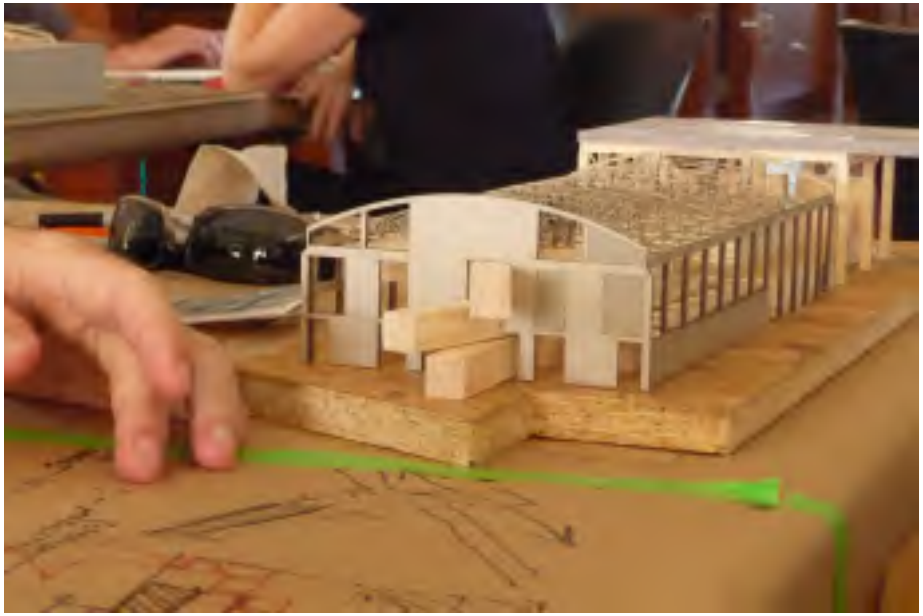

[charleston]
VERTICAL FARM
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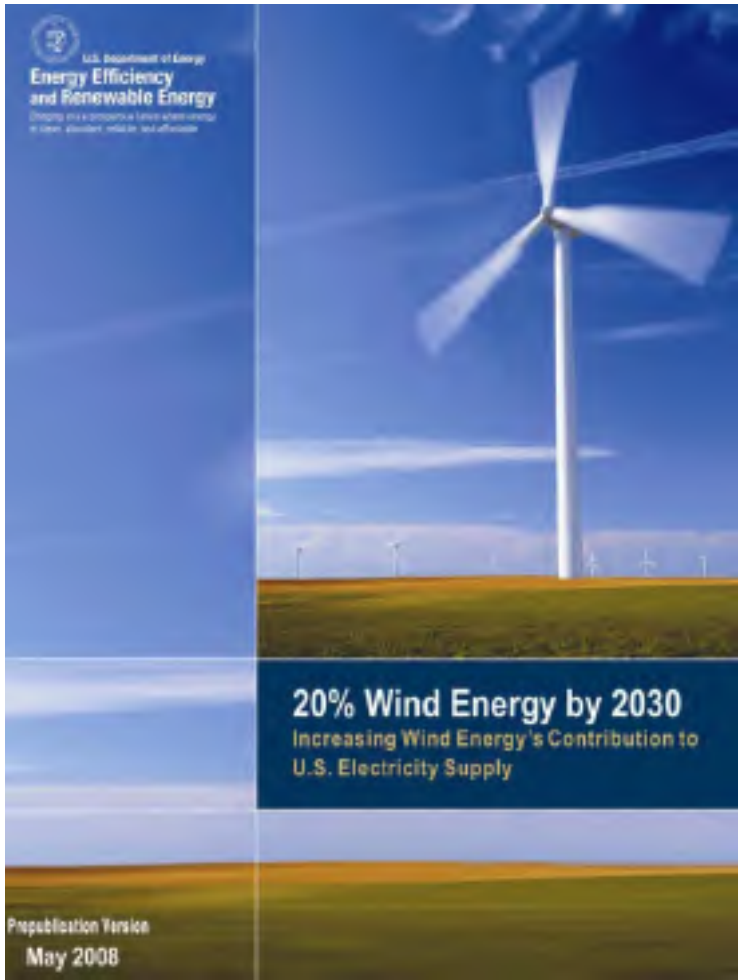
Tremendous Applications for Resource Management

Intelligent Wind Farm

- monitoring performance
- simulating real-world conditions in drivetrain test facility
- monitoring ecology

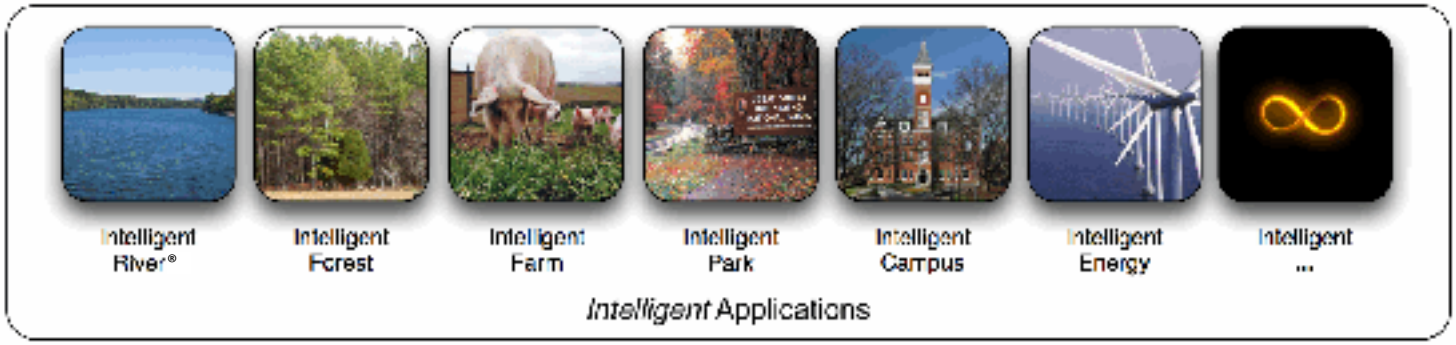
CURI Drivetrain Testing Facility



Basic and Applied Science
Grants
Contracts
Publications

Product Development
Patents
Licenses
Tech Transfer
Workforce Development

Economic Growth
New Companies
Job Creation



Integrative approach to research, IP development, and commercialization