Case Study: ARS Research on Water Quality and Watersheds

Assessing the Benefits of ARS R&D
within an Economic Framework

John King

ARS Research on Water Quality and Watersheds

- National Program 211
  - "Water Availability and Watershed Management"
- Formerly organized under NP 201
  - "Water Resource Management"

»INTRODUCTION AND FINDINGS

CASE STUDY SELECTION

RESEARCH ACTIVITIES

EVALUATION CONCEPTS

CONCLUSIONS

ARS water research combines several elements of our analysis

- Market failure paradigm
  - Problems in water quantity markets
  - Water quality is essentially nonmarket
- Mission paradigm
  - “Enhance the natural resource base and the environment”
  - “Sustain a competitive agricultural economy”
  - Research supports other USDA programs

Many water use/water quality decisions take place outside functioning markets

- Water quality actors do not transact directly
  - Environmental benefits, services not rewarded
  - Water quality impairments not penalized
- Primary users of some ARS research include other USDA, Federal, and state agencies
- Lack of economically significant prices, quantities a challenge for economic evaluation

Water research suggests opportunities for evaluation in programmatic review

- Definition of counterfactual scenarios
- Inferring research value from policy context
  - Conservation Effects Assessment Project (CEAP)
- Small-bore studies on specific areas of interest are possible
  - Focused studies for specific topics
  - Narrow spatial effects
- Internal evaluation

INTRODUCTION AND FINDINGS

» CASE STUDY SELECTION

RESEARCH ACTIVITIES

EVALUATION CONCEPTS

CONCLUSIONS

Why water quality and watersheds?

- Rounds out the scope of ARS research
  - Natural Resources and Sustainable Agricultural Systems
- Examines the “market failure” paradigm in an area of environmental externalities
- Illustrates interaction of science with policy; supports ARS mission areas

Physical, economic, and social properties of water present difficult issues

- Physical properties:
  - Universal solvent: problems are difficult to contain
  - Surface, subsurface, atmospheric channels
  - Nonpoint source: sources are difficult to establish
- As a commodity, barriers to market efficiency
  - Seasonal, regional correlation of supply and demand
  - Low total value to weight
  - Complex historical, legal allocation of property rights
- Universal necessity: Water used in every sphere of human activity
  - Each sector of use may have different, competing requirements
  - Multidisciplinary research
  - Multiple regulatory authorities

With such a broad topic, we tried to narrow the field somewhat

- Wanted to focus on water *quality* rather than water *quantity*/irrigation
  - Away from water-as-commodity
  - Towards market failure paradigm
- Difficult to separate water quality and quantity in practice

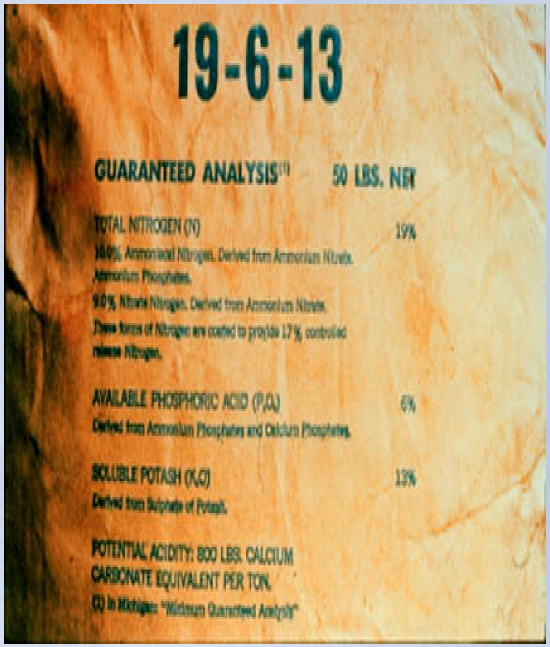
In the end, we focused on a few research activities with a water quality emphasis

- Biophysical models of water and pollutant processes
- Subsurface drainage
- Watershed studies

Water Quality Pollutants

Sediment

Water Quality Pollutants



Sediment **Nutrients**

Water Quality Pollutants

Sediment Nutrients **Pesticides**

Water Quality Pollutants

Sediment Nutrients Pesticides **Pathogens**

Water Quality Pollutants

Sediment Nutrients Pesticides Pathogens **Salts**

INTRODUCTION AND FINDINGS

CASE STUDY SELECTION

» RESEARCH ACTIVITIES

EVALUATION CONCEPTS

CONCLUSIONS

Current water quality emphasis evolved from historical USDA research

- Research on soil productivity and erosion date back to the creation of the USDA
  - Prevention of soil loss, erosion, salinity
  - Optimal application of nutrients
- “Tile drain” systems expanded rapidly after the Civil War
- All three areas have modern precursors dating from at least the 1950s
- Illustrates long research lags, changing paradigms

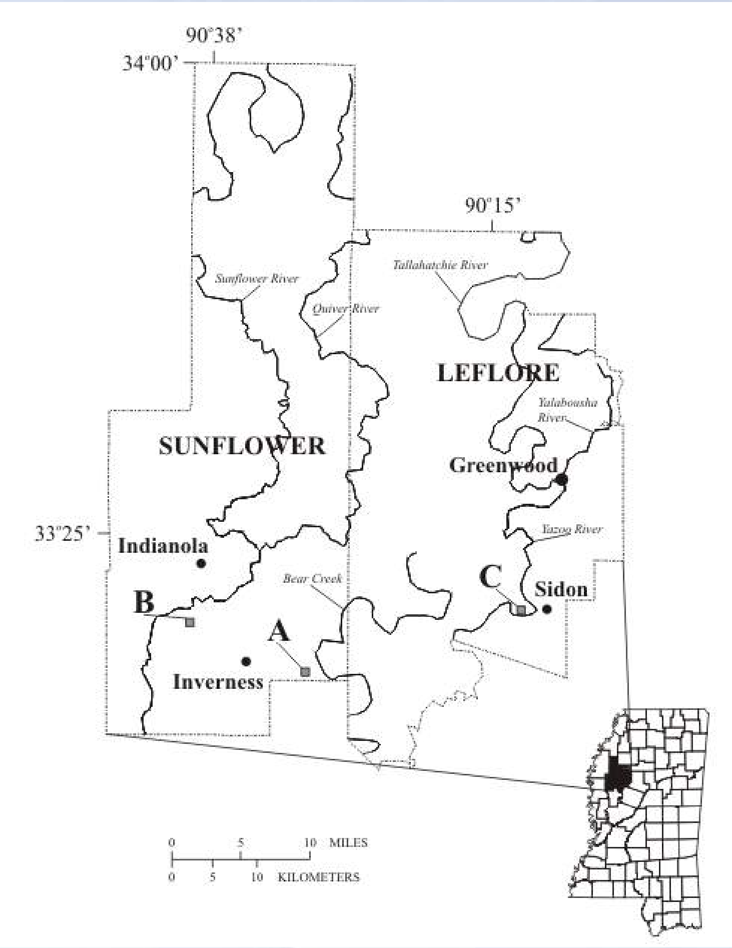
(1) Biophysical models are multidisciplinary efforts in widespread use

- Model the sources and effects of water quality pollutants
  - Rainfall, temperature, soil types, agricultural practices, physical and biological processes
- Models available free of charge
- Large networks of researchers improve, integrate, and customize models
  - Universities, other public agencies
  - Some secondary use: state environmental agencies, consultants, international users
- Often directed to other USDA agencies, but applied widely throughout Federal government

(2) Subsurface drainage

- Subsurface drains manage water tables for
  - Productivity
  - Runoff
  - Salinity
  - Irrigation
- Extensively used in large areas of US
- Represented in some biophysical models
  - RZWQM, DRAINMOD, …

(3) Watershed studies provide necessary spatial scale for ag water quality effects



Mississippi Delta MSEA

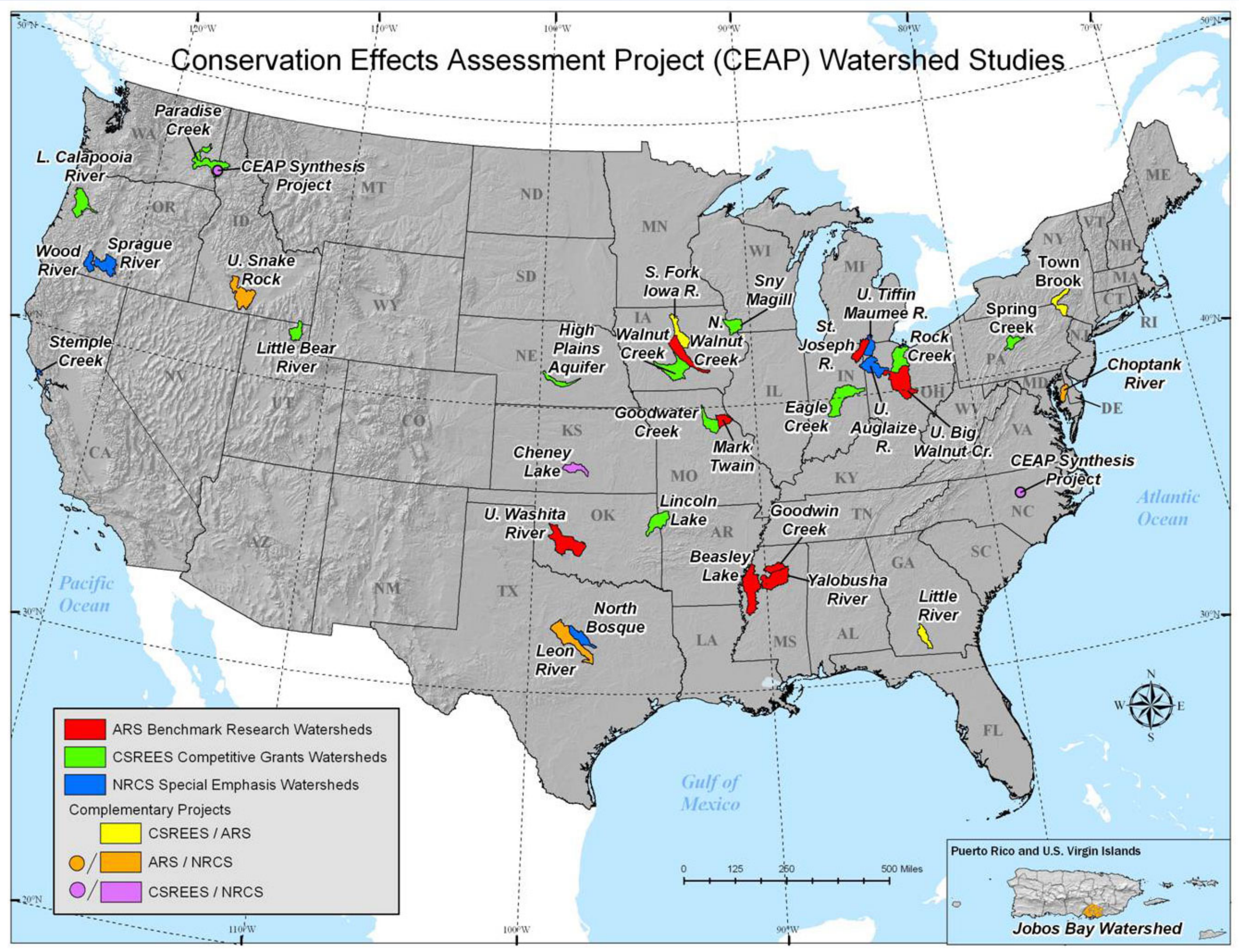
- Hydrologic, biologic processes occur over large areas
- Nonpoint sources and competing uses are regional
- Incorporates regional farming practices

1990 HUA: Hydrologic Unit Areas

1990 MSEA: Management Systems Evaluation Areas

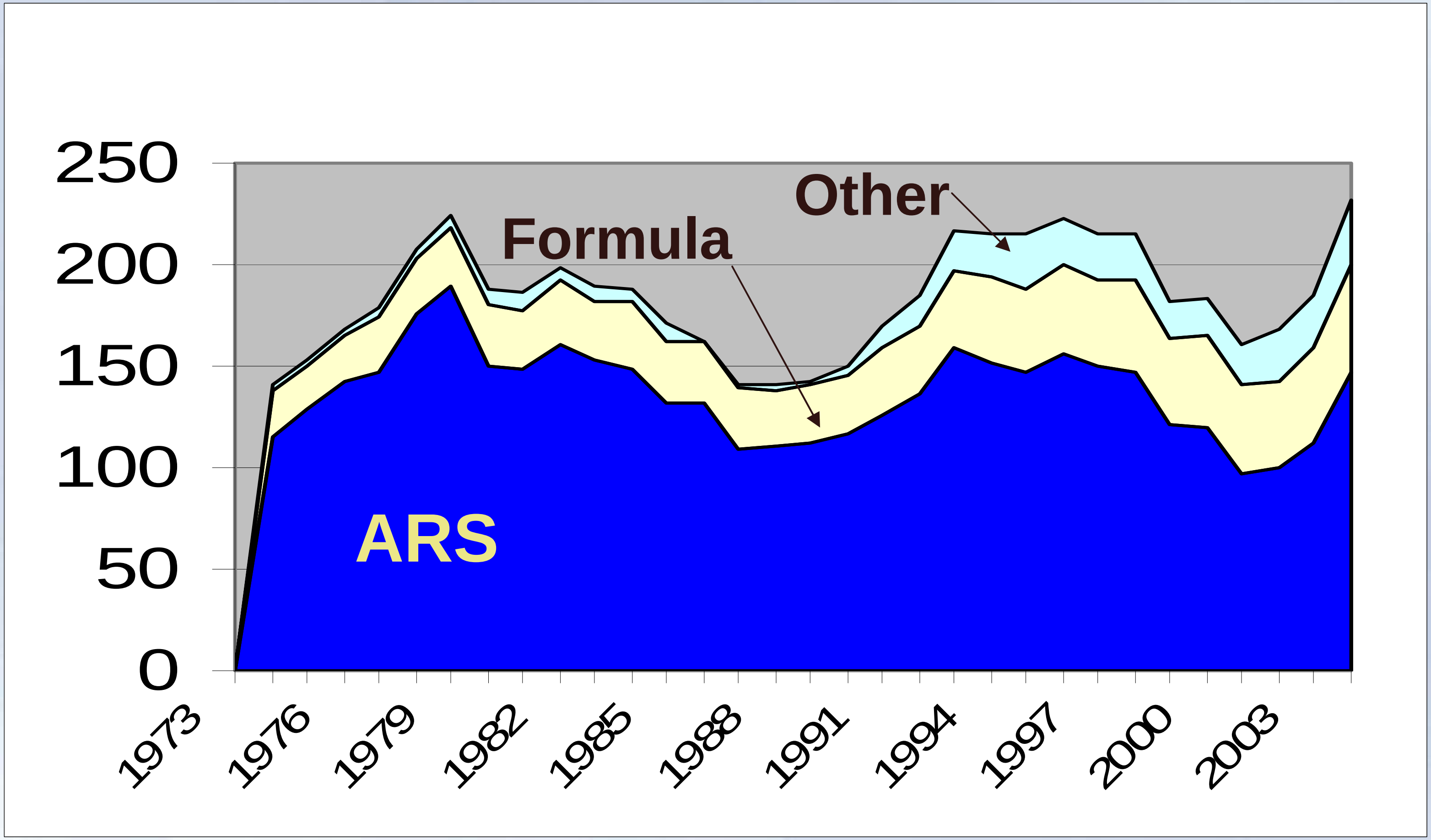
2003 CEAP: Conservation Effects Assessment Project watershed studies

Conservation Effects Assessment Project (CEAP)



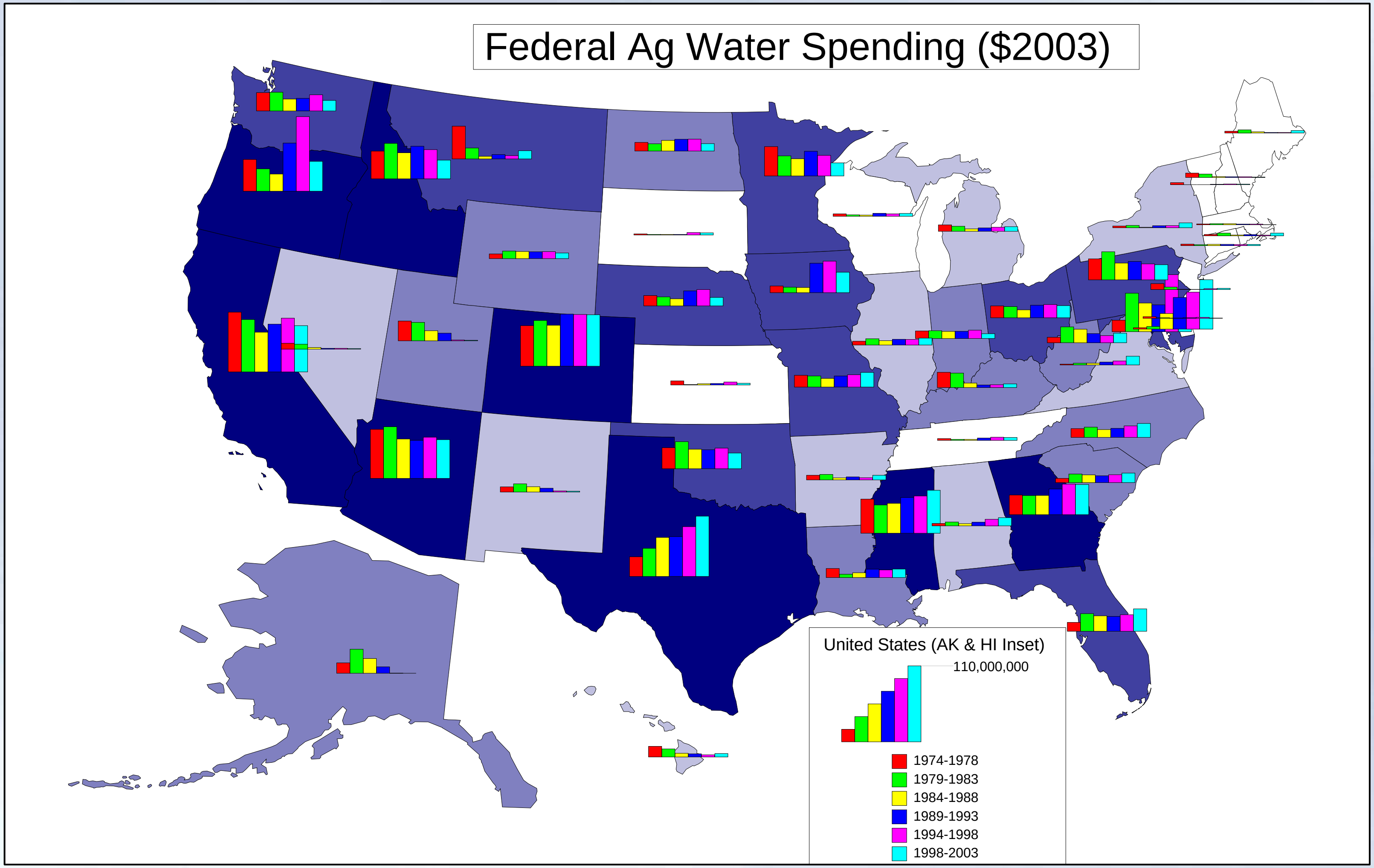
USDA water research spending 1973-2003

Millions $2003



Source: CRIS data, ERS

USDA Water Research Expenditures, 1973-2003



Source: CRIS data, ERS

ARS research funds fewer projects, in more research problem areas (RPA)

Funding Type	Projects	$2003/ Project	RPAs/ Project	RPA "span"
Formula Funds	17,769	$62,535	2.05	75%
ARS	8,245	$527,883	1.71	89%
Coop'ative Agreement	1,232	$116,888	1.64	47%
Comptitive Grant	1,078	$46,276	2.30	32%
Other	2,098	$91,088	2.19	51%

*"Span" := # of RPAs funded relative to 158 total RPAs addressed

Source: CRIS data, ERS

INTRODUCTION AND FINDINGS

CASE STUDY SELECTION

RESEARCH ACTIVITIES

» EVALUATION CONCEPTS

CONCLUSIONS

Biophysical models are important tools for identifying counterfactuals

- Biophysical models provide a baseline for evaluating new technologies and policies
  - Only one set of facts is observed, but many factors change simultaneously
- Important for “opportunity cost”:
  - What was the best alternative?
- How to evaluate an evaluation tool?

Environmental “targeting”: allocating program dollars for greater efficiency

- An application of models to achieve
  - Greater benefit per program dollar
  - Lower costs to achieve a desired performance
- Identifies physical impacts with greater economic significance (pos.or neg.)
  - Practices with cost-effective implementation
  - Sources that are particularly damaging
  - CRP, EQIP incorporate this approach to a limited extent
- At a minimum, research benefit is the difference “targeted” vs. untargeted policy

Inferring program benefits from policy context has attribution problems

- Incomplete attribution of benefits
  - Multidisciplinary, multisector problem
  - Basic vs applied, long lags
- Superattribution of benefits
  - Sum of marginal contributions can exceed total benefit
  - Occurs when multiple actors are indispensible:
    - ARS technology
    - CRP policy
    - Remote sensing data
    - Producer consent

How to value the marginal contributions?

Conservation Effects Assessment Project (CEAP)

- Simultaneous with 2002 Farm Bill expansion of conservation programs
- Representative spatial sample of croplands in grain, integrated analysis of farming practices
  - Rangeland, wetland components
- Watershed studies
- Literature review
  - Includes numerous smaller studies

Greater precision in benefits estimation narrows the scope of evaluation

- Spatial focus for more complete accounting
  - Market, non-market values vary spatially
  - GIS is a complementary tool
- Methodology for hard-to-measure effects has greater costs, data needs
  - Stated preference
    - Contingent valuation
  - Revealed preference
    - Travel cost, hedonic analysis
  - Economic experiments
- Do results generalize sufficiently for programmatic analysis?

Internal program evaluation is an area for application of economic analysis

- Research planning and management continue, whether external economic information is available or not
  - Reliance on peer review, achievement of milestones, other program planning tools
- Economic analysis can lend insight; examples from ARS programs:
  - Leveraging existing assets (human capital, experimental sites, etc.)
  - Reallocating marginal funds
  - "Sunk costs"

INTRODUCTION AND FINDINGS

CASE STUDY SELECTION

RESEARCH ACTIVITIES

EVALUATION CONCEPTS

» CONCLUSIONS

Conclusions

- Long lags, lack of market prices, and attribution errors create information deficiencies for program evaluation
- ARS plays a coordinating role for development of technologies that improve water quality and methodologies for measuring impact
  - Within USDA
  - Across Federal government

Conclusions

- In addition to research results and usable technologies, ARS provides analytical tools for program evaluation
  - Different levels of spatial scale, integration
- Program evaluation balances appropriate use of these tools and opportunities for finer-grained studies