The US Environmental Protection Agency's Regional Vulnerability Assessment Program (ReVA)

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ReVA: the Approach

ReVA's Integrated Assessment Framework Helps Organize Research Knowledge and Tools to Respond to Client Needs

- **Data acquisition / preparation (*existing* data)**
- **Extrapolation / interpolation**
- **Model development / forecasting (many *separate* models)**
- **Synthesis (many methods to address data issues and assessment questions)**
- **Scenario Analysis**
- **Visualization/Communication/Access to Information**

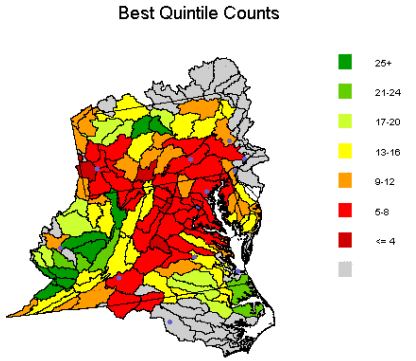
EDT

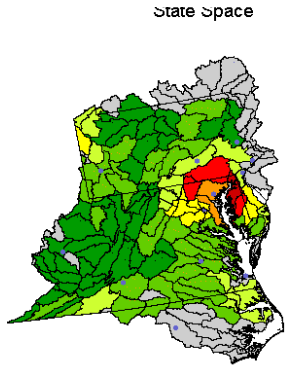
EDT = ReVA's web-based Environmental Decision Toolkit

Integration of Spatial Data: the Method Used Matters!

Is the method robust given the data being synthesized?

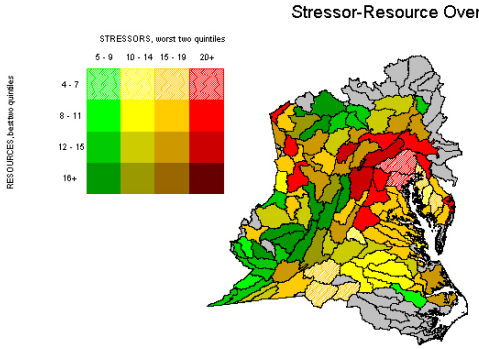
Method	Discontinuity	Skewness	Imbalance	Interdependency
Quantiles	Not sensitive	Not sensitive	Sensitive	Sensitive
Simple Sum	Not sensitive	Not sensitive	Sensitive	Sensitive
AHP	Not sensitive	Not sensitive	Not sensitive	Sensitive
PCA	Sensitive	Sensitive	Not sensitive	Not sensitive
State Space	Sensitive	Sensitive	Not sensitive	Not sensitive
Criticality	Not sensitive	Not sensitive	Sensitive	Sensitive
Overlay	Not sensitive	Not sensitive	Not sensitive	Not sensitive
Cluster	Not sensitive	Sensitive	Sensitive	Sensitive
SOM	Not sensitive	Sensitive	Sensitive	Sensitive

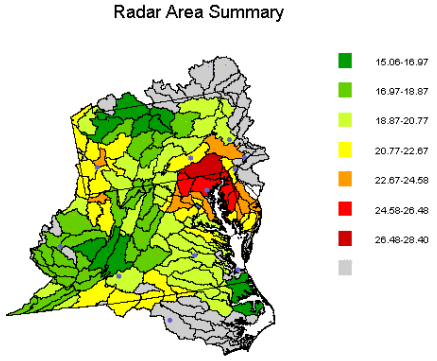




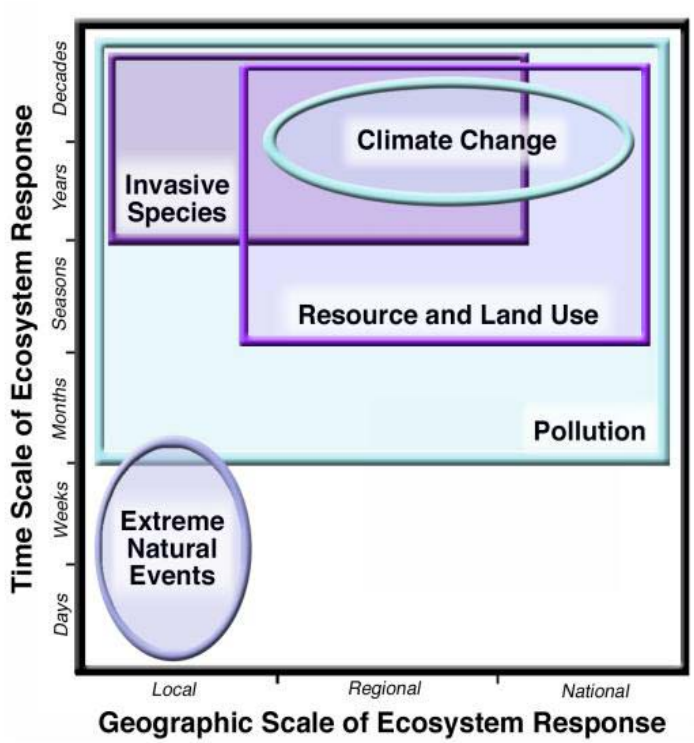
Is the method addressing the right question?

- **Ranking Methods *(Condition)***
  Quantiles, Sum of Ranks, AHP
- **Distance from Reference Point *(Sustainability)***
  PCA, State Space, Criticality
- **Overlay of stressors/resources *(Value, vulnerability)***
- **Grouping of Like Units *(Feasibility)***
  Cluster Analysis, Self-Organizing Maps





Future Scenarios: Projections of Major Drivers of Ecological Change (2020)



Despite compliance with environmental regulations, biological populations are declining.

Major drivers of change include:

- **Land use change**
- **Resource extractions**
- **Pollution and pollutants**
- **Exotic invasive species**
- **Climate change**

These drivers projected for the Mid-Atlantic Region

ReVA's Environmental Decision Toolkit (EDT)

- **Web-based, integration and visualization**
- **Statistical application (S-PLUS), with mapped output**
- **Linked to ArcServe version for finer-resolution analysis**
- **Results as *relative* rankings within larger region**
- **Addresses multiple assessment questions**
- **Integration of data in subgroups (e.g. water, air) or subregions**
- **Weighting to reflect different values, perspectives**
- **Scaleable (national to local)**
- **Data access, interoperable, webserviceable**

ReVA
Regional Vulnerability Assessment

ReVA Process

Descriptive Spatial Data

(Landscape metrics, census variables, species counts, etc.)

Spatial Model Output

(NPS estimates, air deposition estimates, invasive species, etc.)

Forecast Scenarios:

Drivers of Ecological Change (land use, exotic species, resource extraction, pollution and pollutants, climate change)

Alternative Management Scenarios (trade-off analyses)

Descriptive Spatial Data

(Landscape metrics, population/demo-graphic variables, etc.)

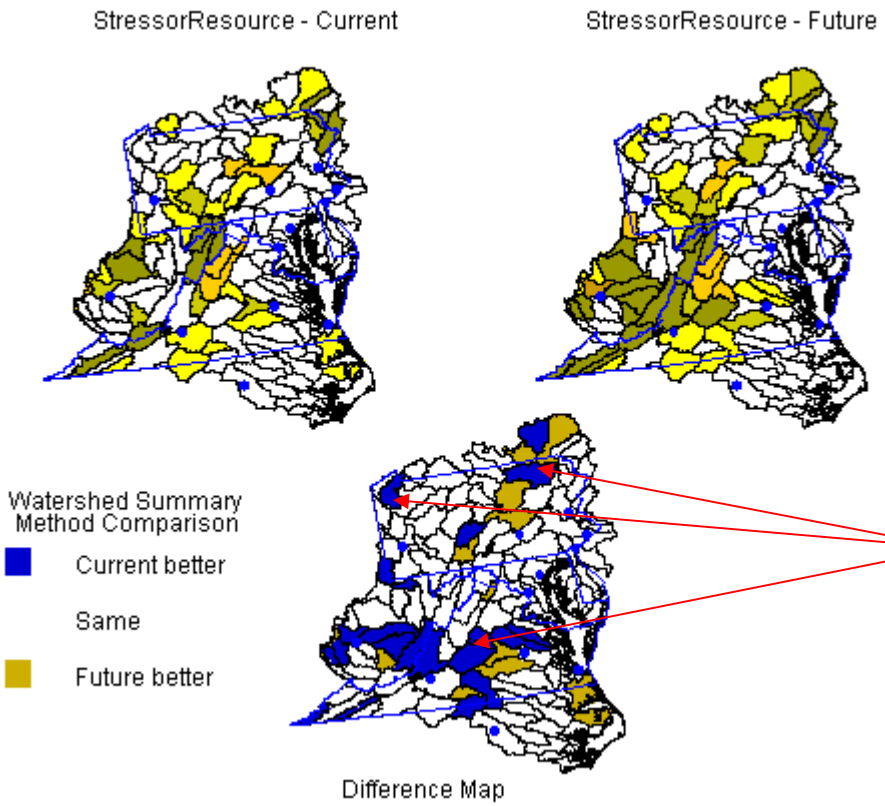
Spatial Model Output

(NPS estimates, air deposition estimates, invasive species, etc.)

Environmental Decision Toolkit

- Integration into Indices of Condition and Vulnerability
- Visualization from multiple perspectives
- Enabling Multiple Criteria Decision-Making
- Individual variables and Composite indices

Where will valued resources be subjected to additional stress?



Region 3 used the toolkit to prioritize the use of resources

Watersheds in blue - candidates for use of Region 3's discretionary funds for water monitoring, continuing existing projects, initiating new projects, partnerships with local communities for responsible development…..

Regional Growth Decision Tool

Sustainable Environment for Quality of Life (SEQL) study: 15-county area surrounding Charlotte, NC. Two alternative futures projected to 2030

About the RGDT | How can I use the RGDT? | Use the RGDT | What is SEQL? | What is ReVA?

Home Page > Levels of Detail > Executive Summary > SEQL Overview Map

View Scenario Maps

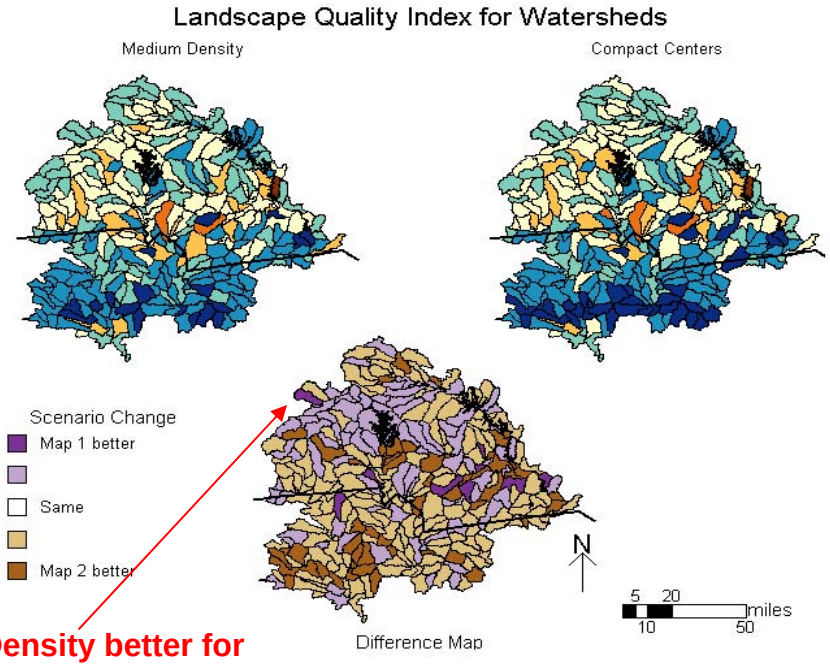
Select Layers to Display:
- ☐ County Lines
- ☐ Cities
- ☑ State Boundary
- ☐ Interstate Roads

<< Back | Redraw Map

Landscape Quality Index for Watersheds

Variables

- Percent any agricultural land
- Total agriculture land on steep slopes (9% slope)
- Percent barren landcover - natural
- Percent forest landcover
- Percent natural grass land cover
- Percentage of land that is edge forest class
- Road density
- Crop land cover along streams - 60 meters
- Forest land cover along streams - 60 meters
- Natural grass land cover along streams - 60 meters
- Percent shrub land cover
- Stream density
- Percent urban landcover
- Percent wetlands land cover



Trade-offs: Medium Density better for individual watershed; Compact Centers better for region

Print File

If you would like more detailed data, please go to the Management Summary page.

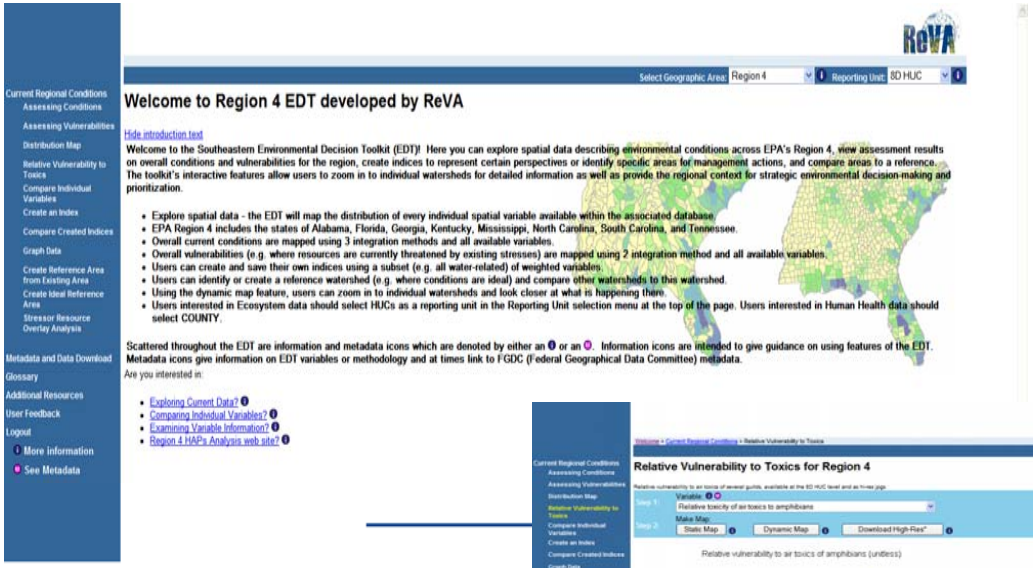
SEQL

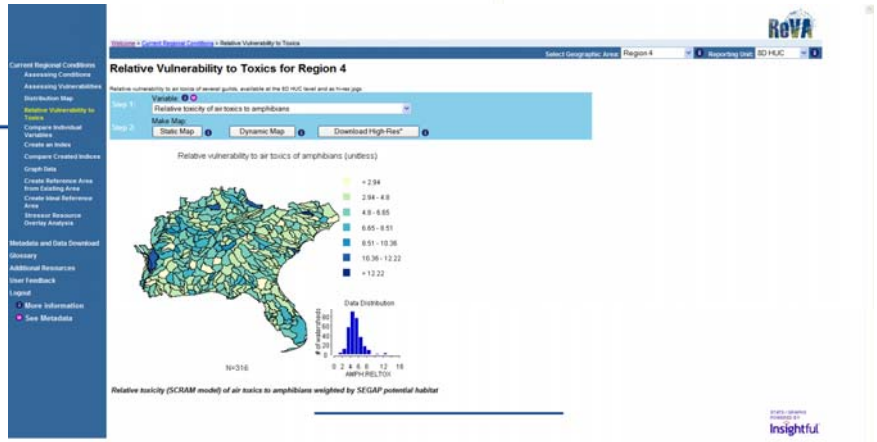
RGDT Home
SEQL | CCOG | CRCOG | UNC Charlotte Urban Institute |

ReVA

Done | Internet | 100%

SE Region – Air Toxics Policy Tool

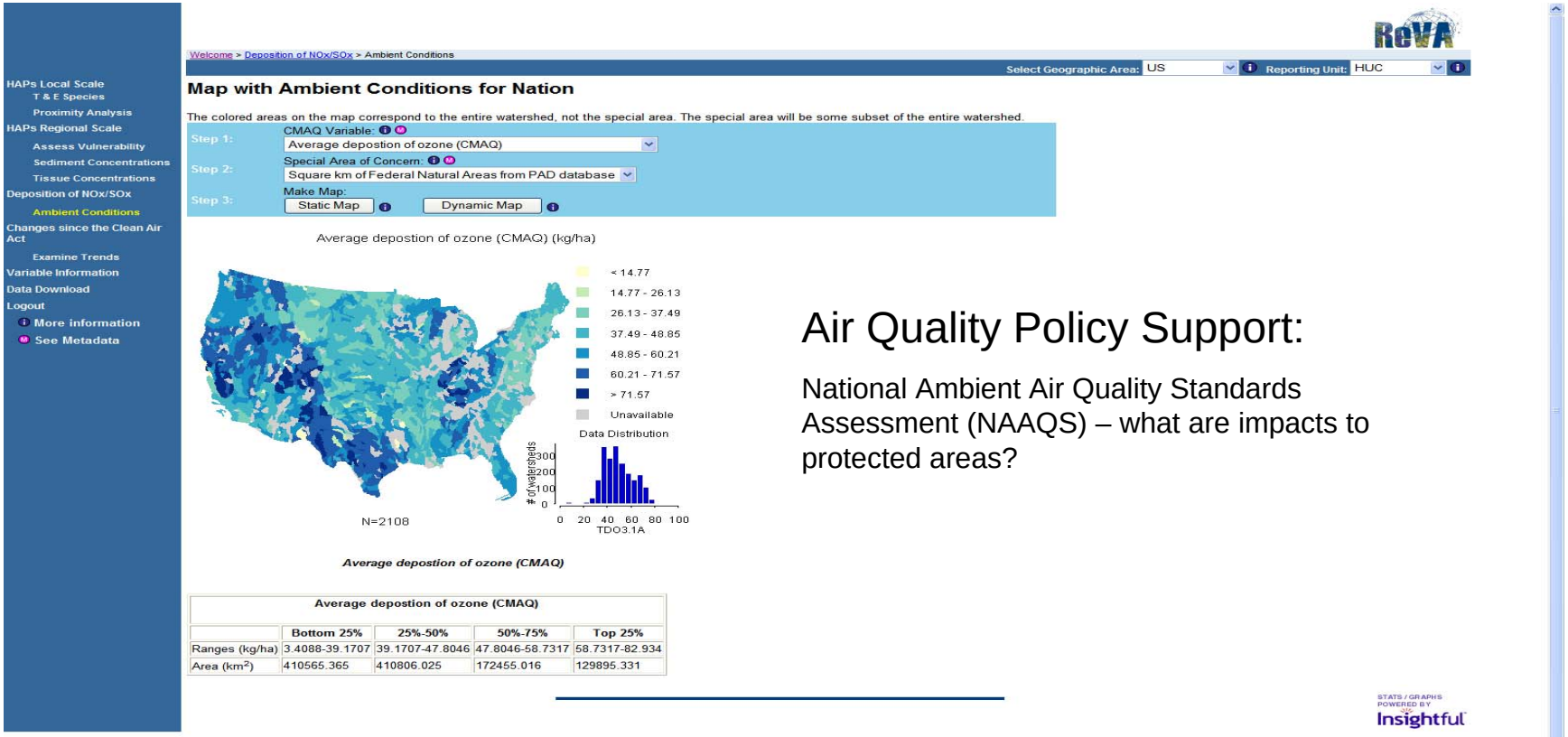




Residual Risk Assessment

EPA required to assess the residual risk after the maximum achievable clean-up of emissions under current technology (MACT) for air toxics. If risk to T&E species, migratory bird species, or human welfare is “high”, EPA Administrator has authority to regulate.

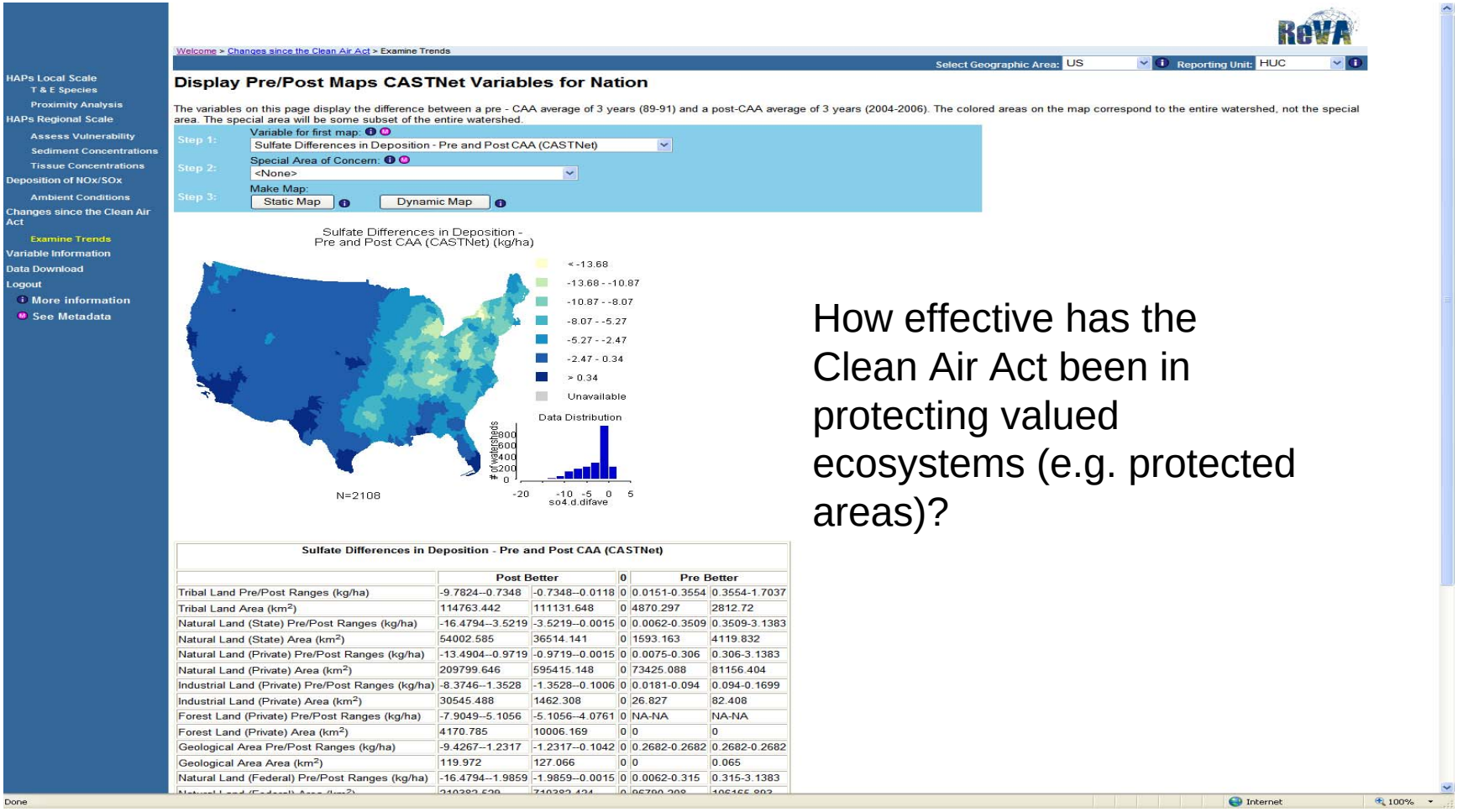
National Environmental Assessment Toolkit (NEAT)



Air Quality Policy Support:

National Ambient Air Quality Standards Assessment (NAAQS) – what are impacts to protected areas?

NEAT: Performance Measures



Sulfate Differences in Deposition - Pre and Post CAA (CASTNet)

	Post Better		0	Pre Better	
Tribal Land Pre/Post Ranges (kg/ha)	-9.7824--0.7348	-0.7348--0.0118	0	0.0151-0.3554	0.3554-1.7037
Tribal Land Area (km²)	114763.442	111131.648	0	4870.297	2812.72
Natural Land (State) Pre/Post Ranges (kg/ha)	-16.4794--3.5219	-3.5219--0.0015	0	0.0062-0.3509	0.3509-3.1383
Natural Land (State) Area (km²)	54002.585	36514.141	0	1593.163	4119.832
Natural Land (Private) Pre/Post Ranges (kg/ha)	-13.4904--0.9719	-0.9719--0.0015	0	0.0075-0.306	0.306-3.1383
Natural Land (Private) Area (km²)	209799.646	595415.148	0	73425.088	81156.404
Industrial Land (Private) Pre/Post Ranges (kg/ha)	-8.3746--1.3528	-1.3528--0.1006	0	0.0181-0.094	0.094-0.1699
Industrial Land (Private) Area (km²)	30545.488	1462.308	0	26.827	82.408
Forest Land (Private) Pre/Post Ranges (kg/ha)	-7.9049--5.1056	-5.1056--4.0761	0	NA-NA	NA-NA
Forest Land (Private) Area (km²)	4170.785	10006.169	0	0	0
Geological Area Pre/Post Ranges (kg/ha)	-9.4267--1.2317	-1.2317--0.1042	0	0.2682-0.2682	0.2682-0.2682
Geological Area Area (km²)	119.972	127.066	0	0	0.065
Natural Land (Federal) Pre/Post Ranges (kg/ha)	-16.4794--1.9859	-1.9859--0.0015	0	0.0062-0.315	0.315-3.1383

How effective has the Clean Air Act been in protecting valued ecosystems (e.g. protected areas)?

ORD Ecosystem Services Research
New Directions 2009-2014

- **Vision**

  A comprehensive theory and practice for quantifying ecosystem services, their value and their relationship to human well-being, is consistently incorporated into environmental decision making.

- **Goal**

  Transform the way we understand and respond to environmental issues by making clear how our management choices affect the type, quality and magnitude of the services we receive from ecosystems.

ESRP Major Research Questions

Pollutant-Based Ecosystem Services Research

How does a regulated pollutant—**nitrogen**—affect, positively and negatively, the bundle of ecosystem services at multiple scales?

Ecosystem-Based Ecosystem Services Research

How does the bundle of ecosystem services provided by selected ecosystem types—**wetlands and coral reefs**—change under alternative management options at multiple scales?

Place-Based Ecosystem Services Research

How does the bundle of ecosystem services for all ecosystems within an **"ecosystem service district"** change under alternative management options?

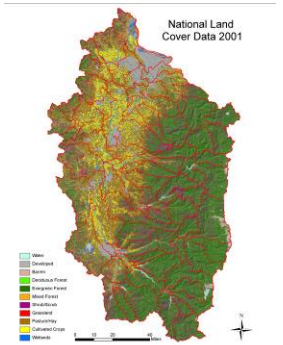
Place-based projects include…

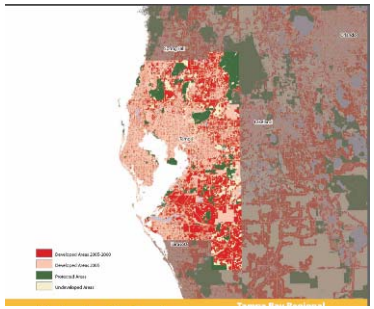
- ***Coastal Carolinas***
  Development, Sea Level Rise, agriculture, coastal storms, water quality, air quality

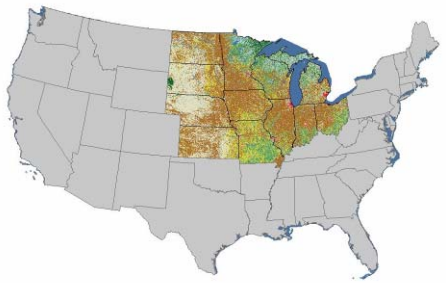
- ***Willamette Valley***
  Development, water quality, habitat, timber, agriculture, carbon

- ***Tampa Bay region***
  Population growth, development, water supply, habitat, climate change, sea level rise

- ***Future Midwestern Landscapes***
  Biofuels, agriculture, water quality, water supply, soil loss, habitat, carbon

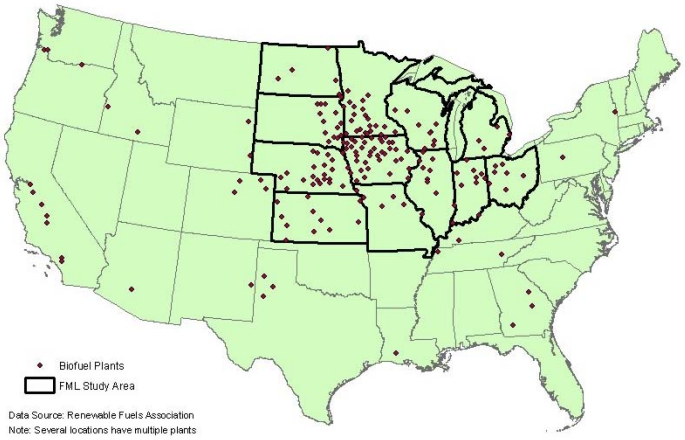




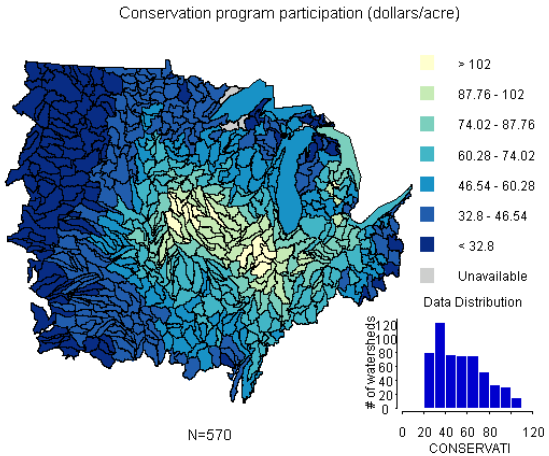


Change drivers of interest for Midwestern place-based study

- Biofuels
  - Potential for rapid, large-scale changes in land use or land management
  - Implicit trade-offs among ecosystem services
- Agricultural conservation practices
  - Existing area of large investment, uncertain benefit
  - Increasing interest in ecosystem service-based incentives and markets



Locations of ethanol biorefineries and FML boundary



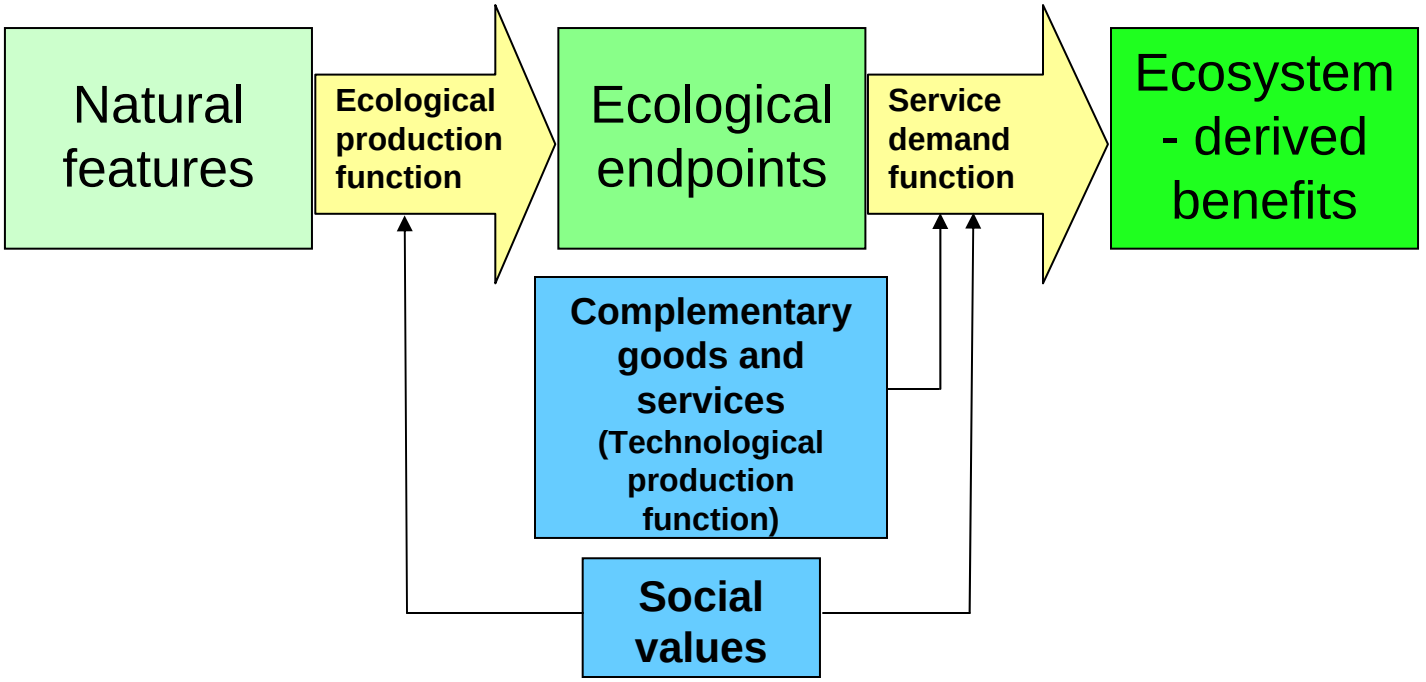
Problem statement

- How do structures, functions and processes of Midwestern ecosystems contribute to societal well-being?
- How can we quantify the ecological, technological, and service demand functions of the Midwest landscapes?
- How will today's land use decisions affect trade-offs of future ecosystem services? What land-use/land cover configurations afford the best combinations of ES based on society's values?
- What indicators of ecosystem service changes communicate the vulnerabilities and opportunities to decision-makers?
- How can we facilitate conservation and restoration of ecosystem services through existing or future market structures or policies?

Services of interest in FML Study
(examples)

- ***Carbon storage***
- ***Water supply***
- ***Flood moderation***
- ***Water quality***
- ***Biodiversity***
- ***Air quality***
- ***Food production***
- ***Biofuel feedstock production***

Ecosystem Services Framework



Wainger and Boyd

Quantifying production functions is long-term research

Short-term analysis of ecosystem service endpoints

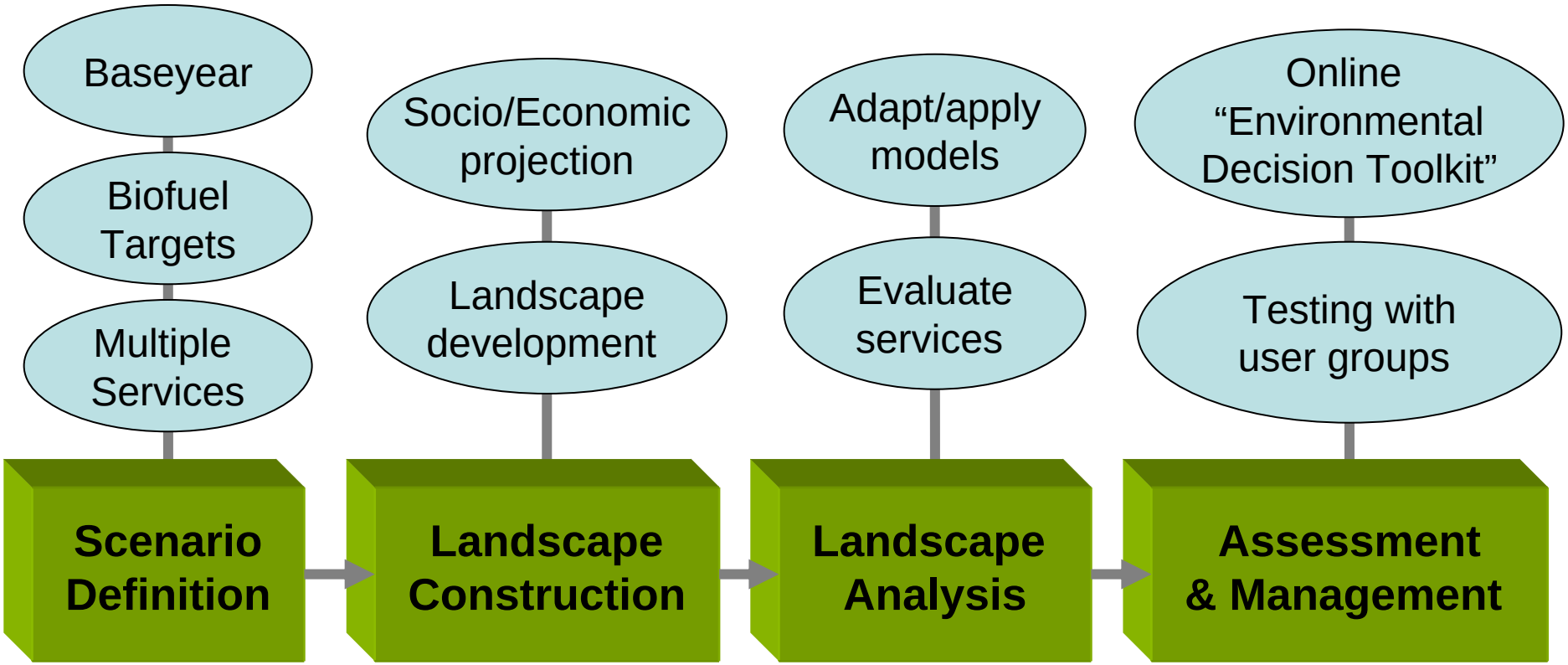
Supply and Demand Metrics

- Quality
- Quantity
- Vulnerability
  - Exposure
  - Ecological Resilience
  - Social Resilience

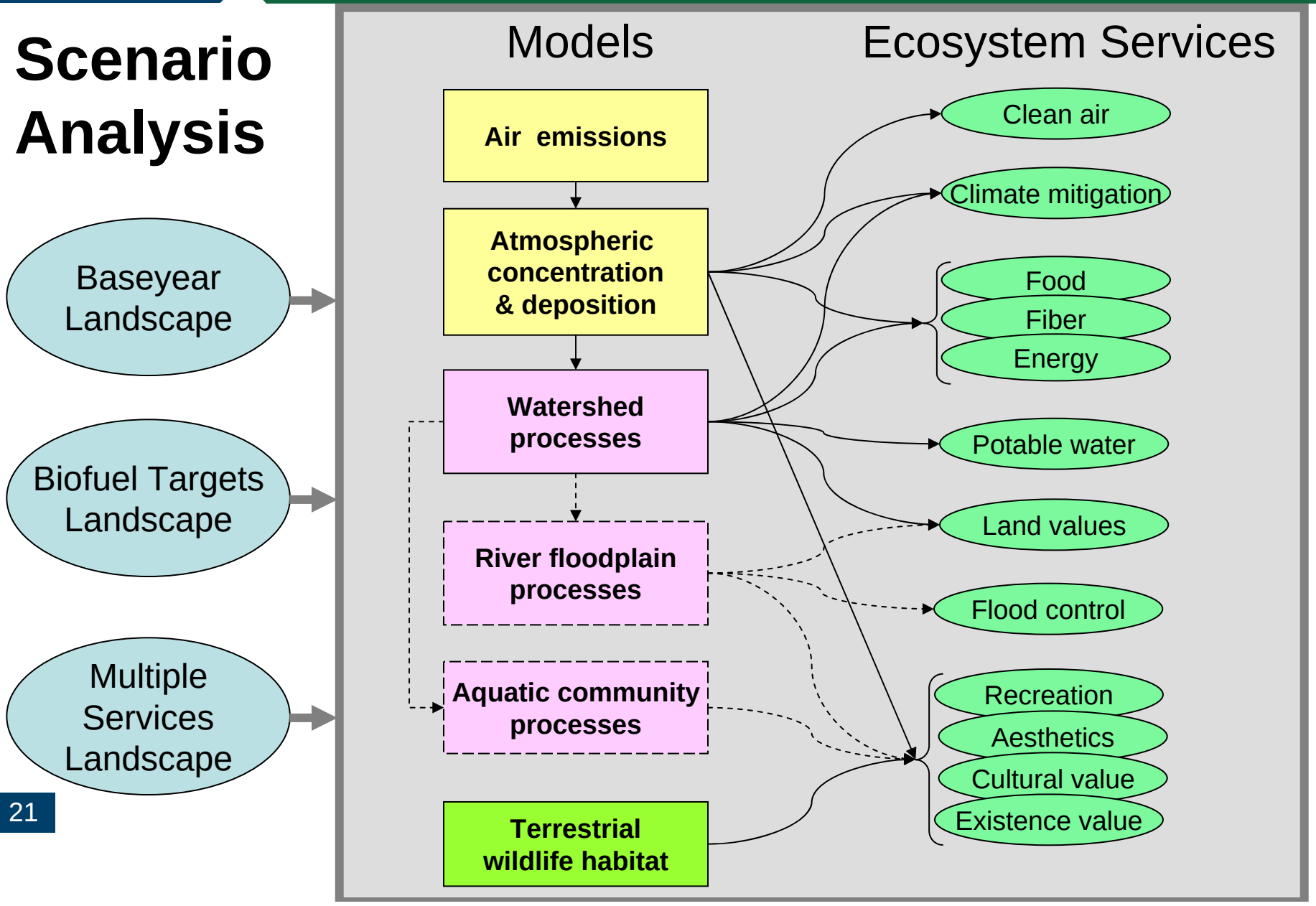
Interim Products:

- ***Acquire regionally consistent, available data***
- ***Clients (case studies) will help identify meaningful indicators through use of spatial data exploration tool (FML-EDT)***

Overview of alternative-futures research approach



Scenario Analysis



Biofuel Targets Scenario (2022)

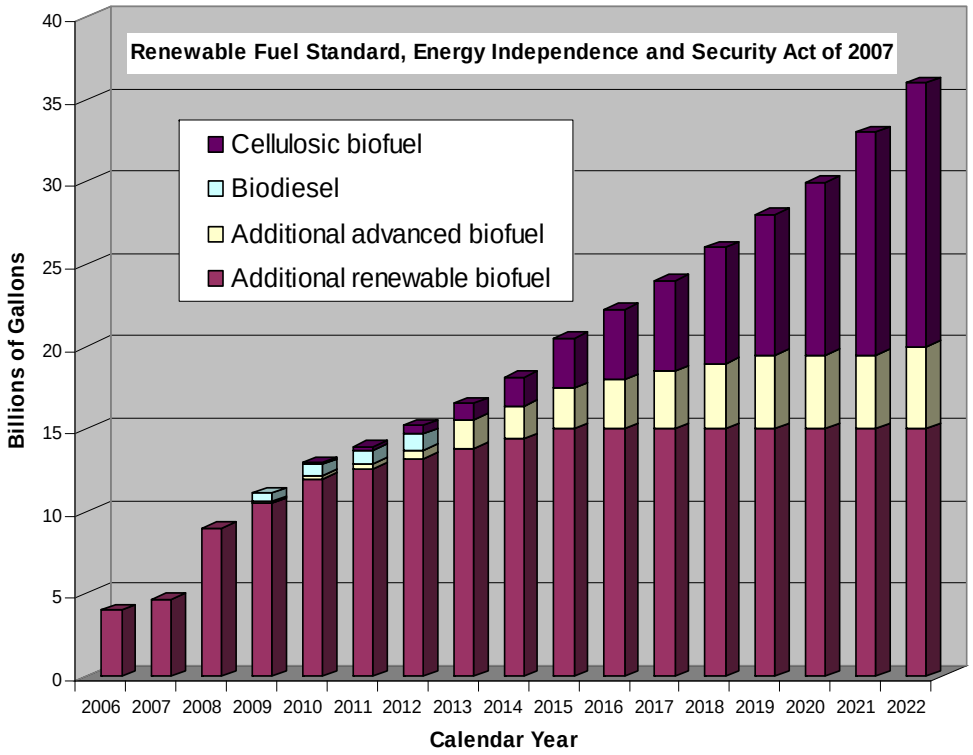
Market Allocation (MARKAL) econometric model (NRMRL)

- Energy supply and demand

Sets conditions for:

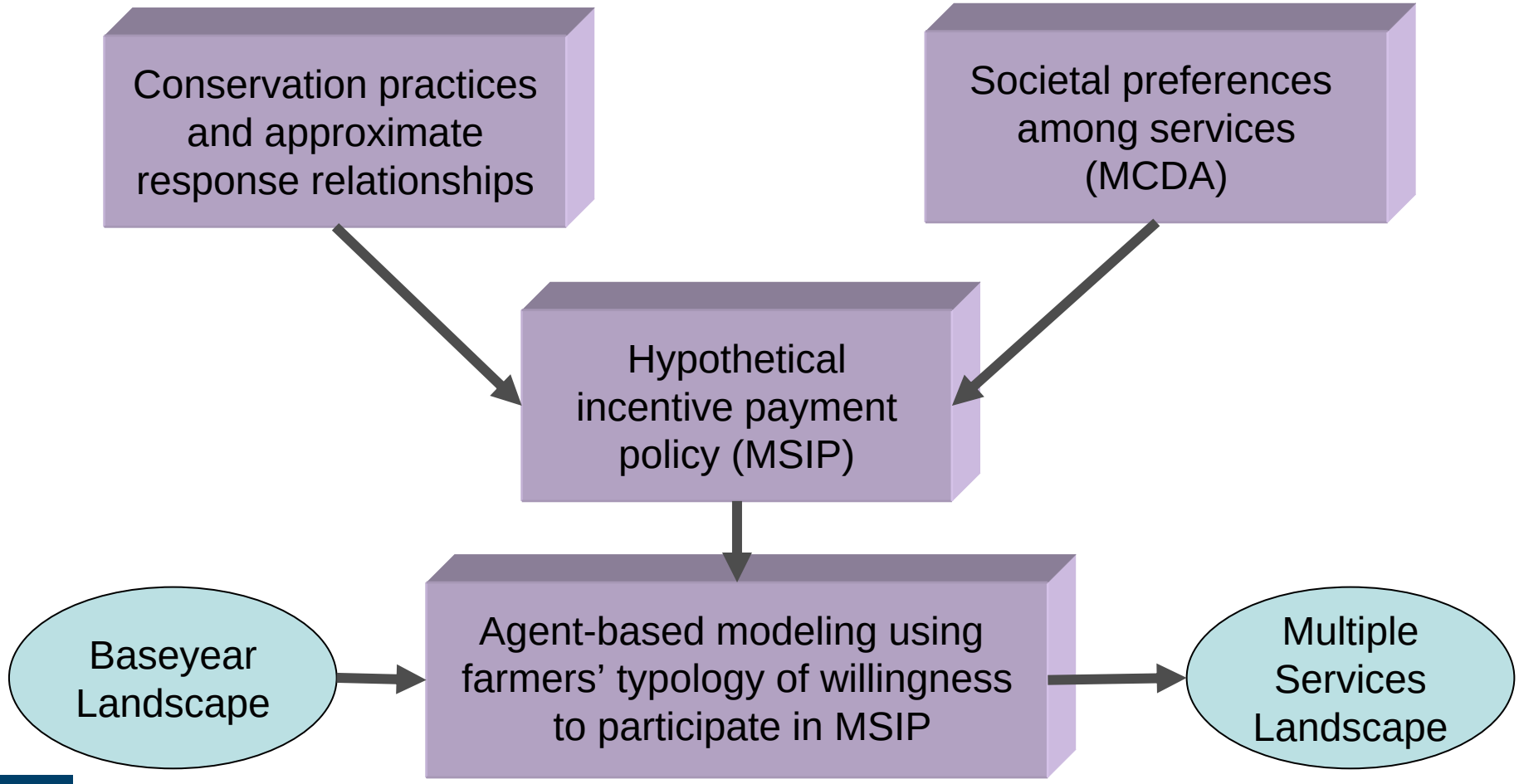
Food and Agricultural Policy Research Institute (FAPRI) econometric model (ISU/CARD)

- Net returns (profits – costs) drivers
- Number of acres / region

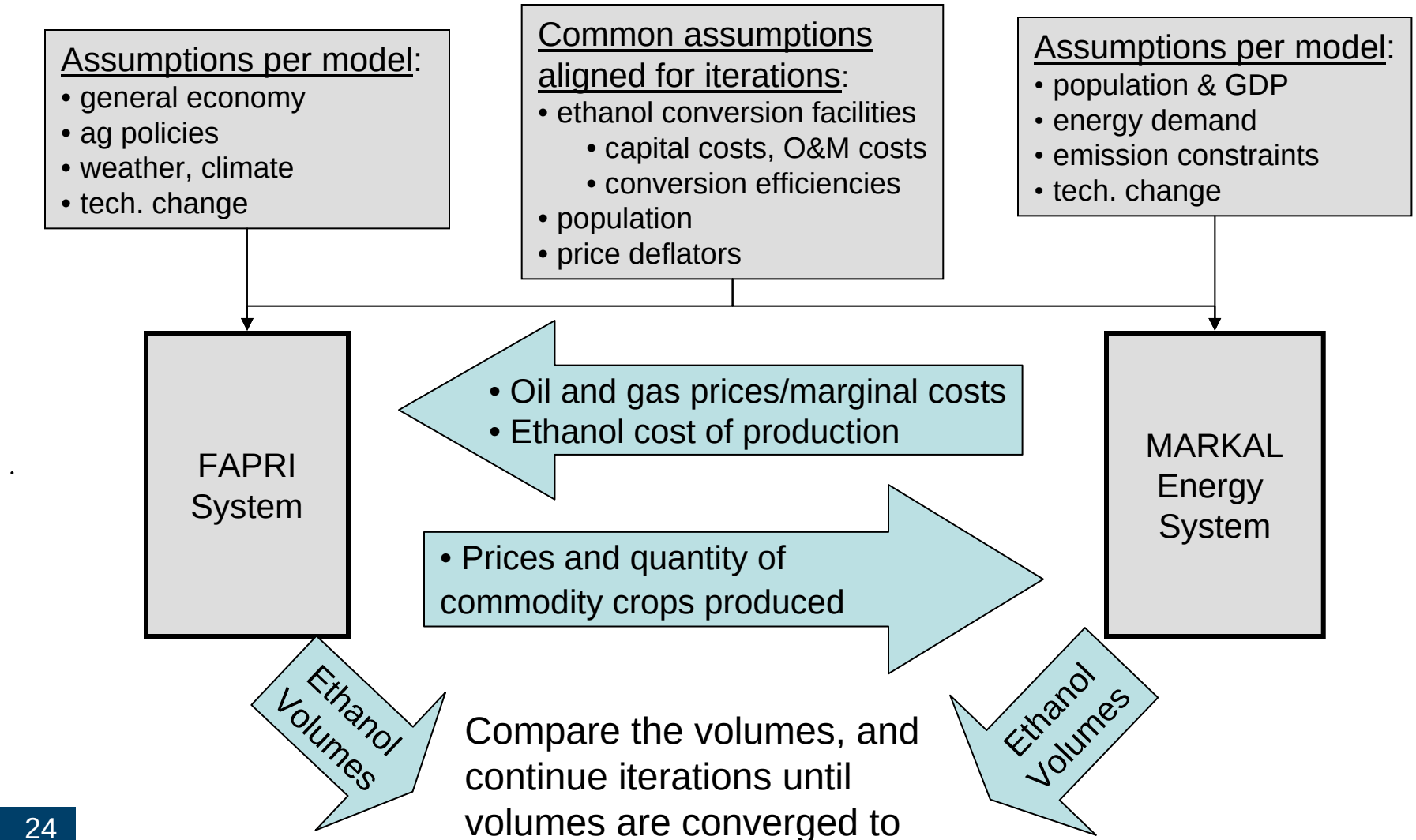


Results disaggregated using soils data, tillage practices, etc.

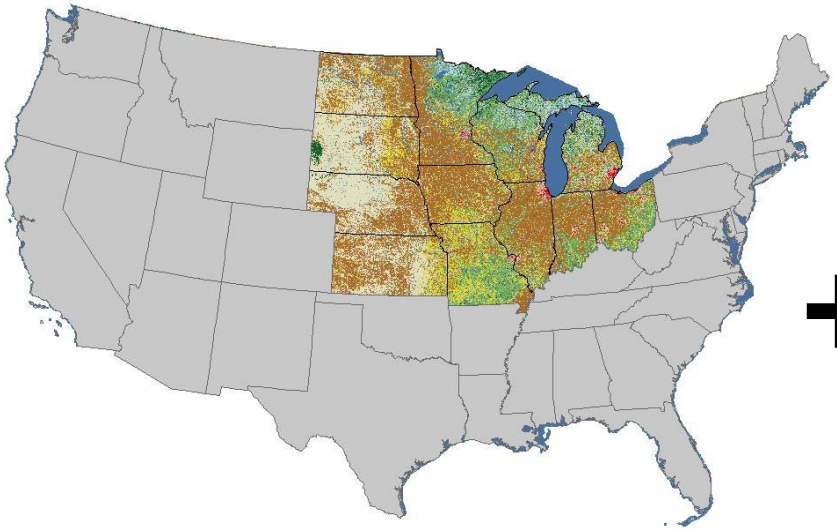
Multiple Services Scenario (2022)



Capturing Energy and Agriculture Market Dynamics through EPA and Iowa State/CARD Interaction



Base Year Scenario



NLCD 2001/2002

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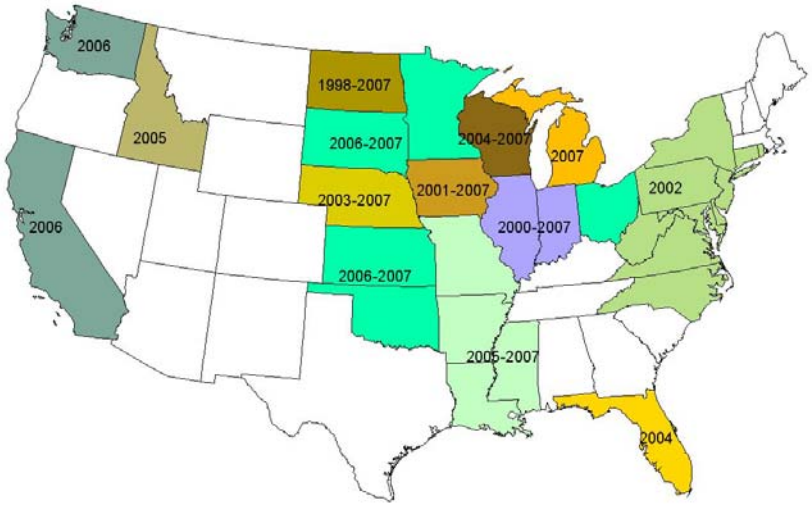
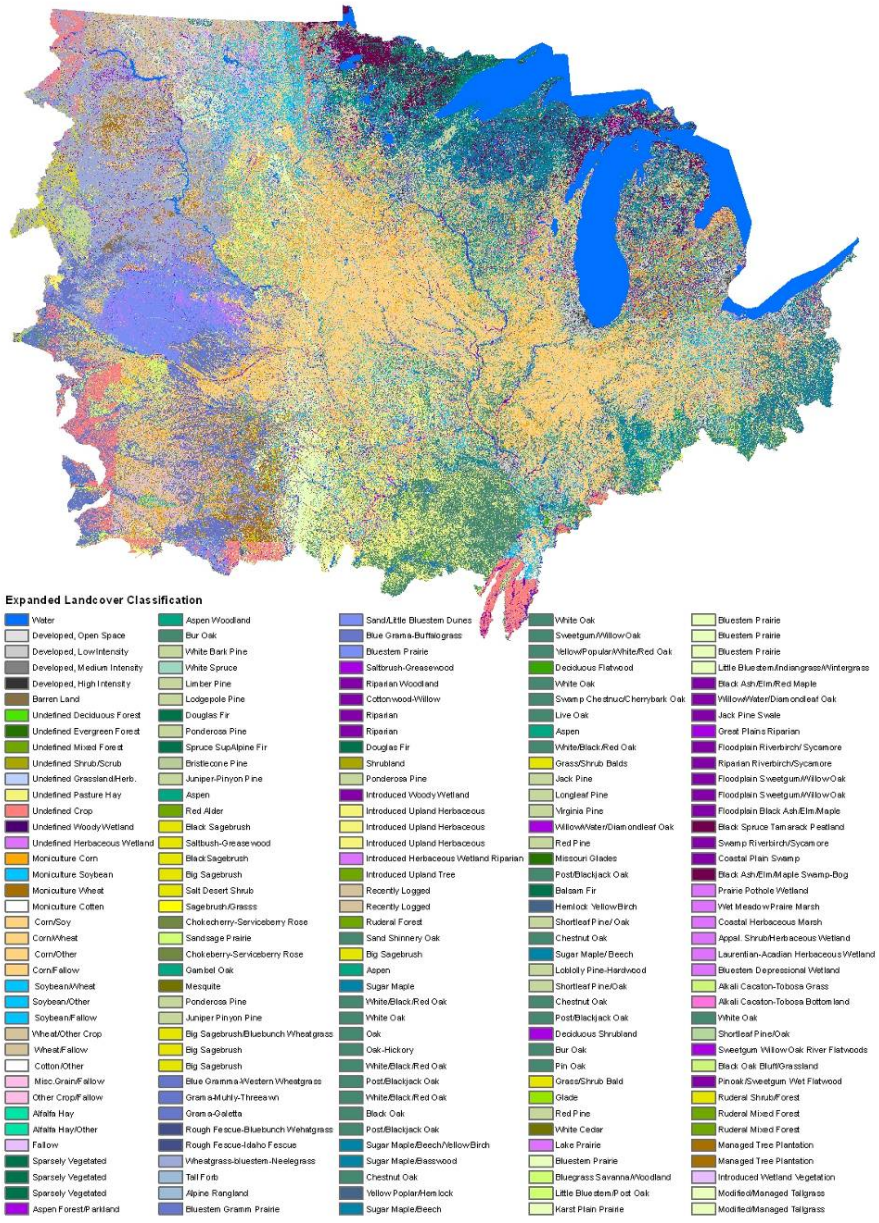


NASS Cropland Data Layers

ECOSYSTEM SERVICES RESEARCH PROGRAM



Enhanced Land Cover Data for FML– Combines the best of NLCD, NASS Crop Data Layer, and LANDFIRE using a set of rules

Includes crop type as well as rotation

Implications for better estimation of nutrients and pesticides loads/export

Better assessment of crop yields

Megan Mehaffey

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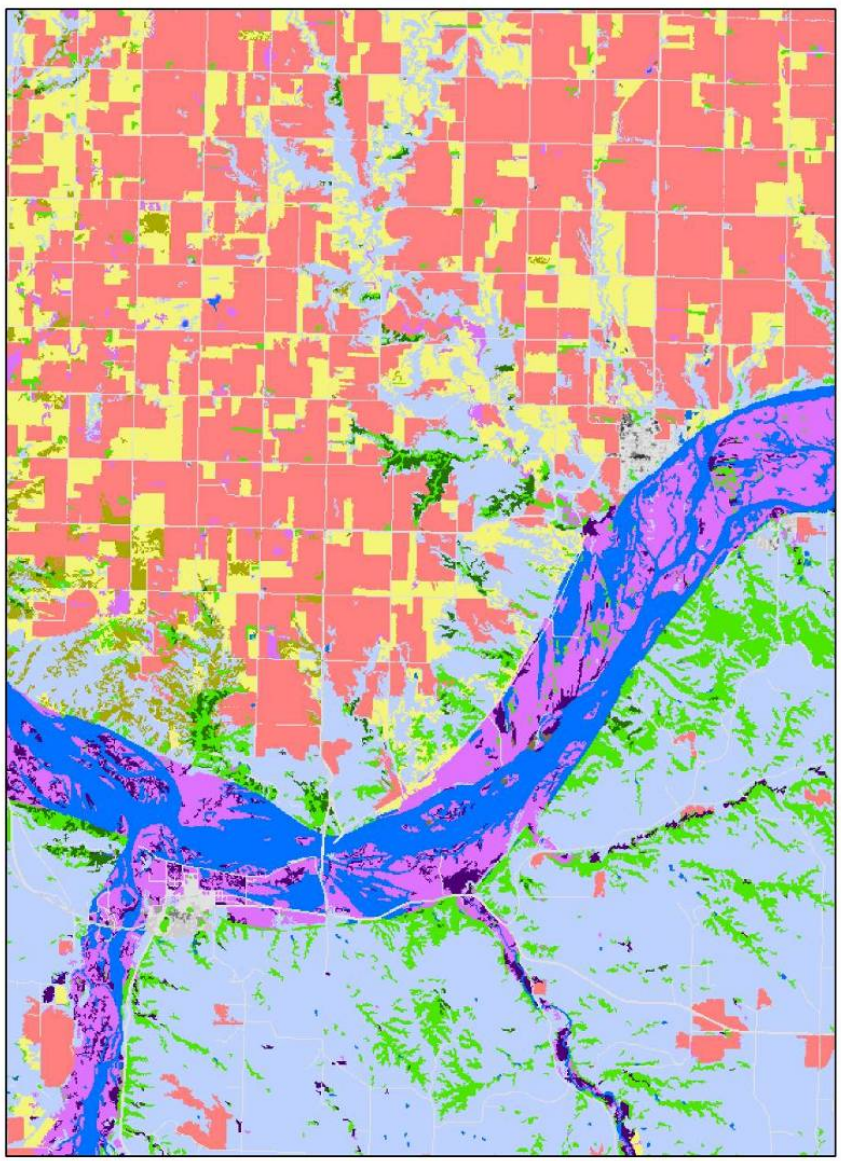
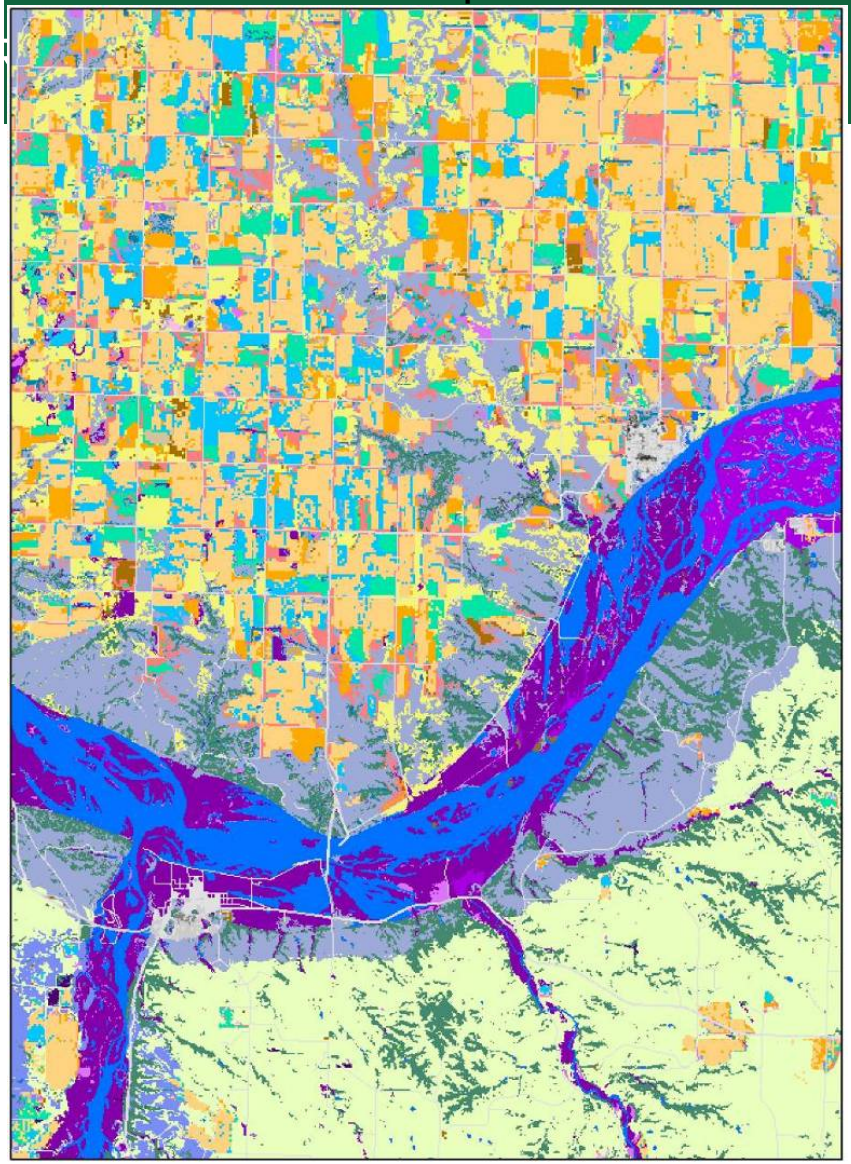
NLCD 2001

NLCD Expanded 2001





Pasture

Row crops

Corn monoculture

Pasture

Alfalfa/Hay

Soybean in rotation

Corn in rotation

Megan Mehaffey

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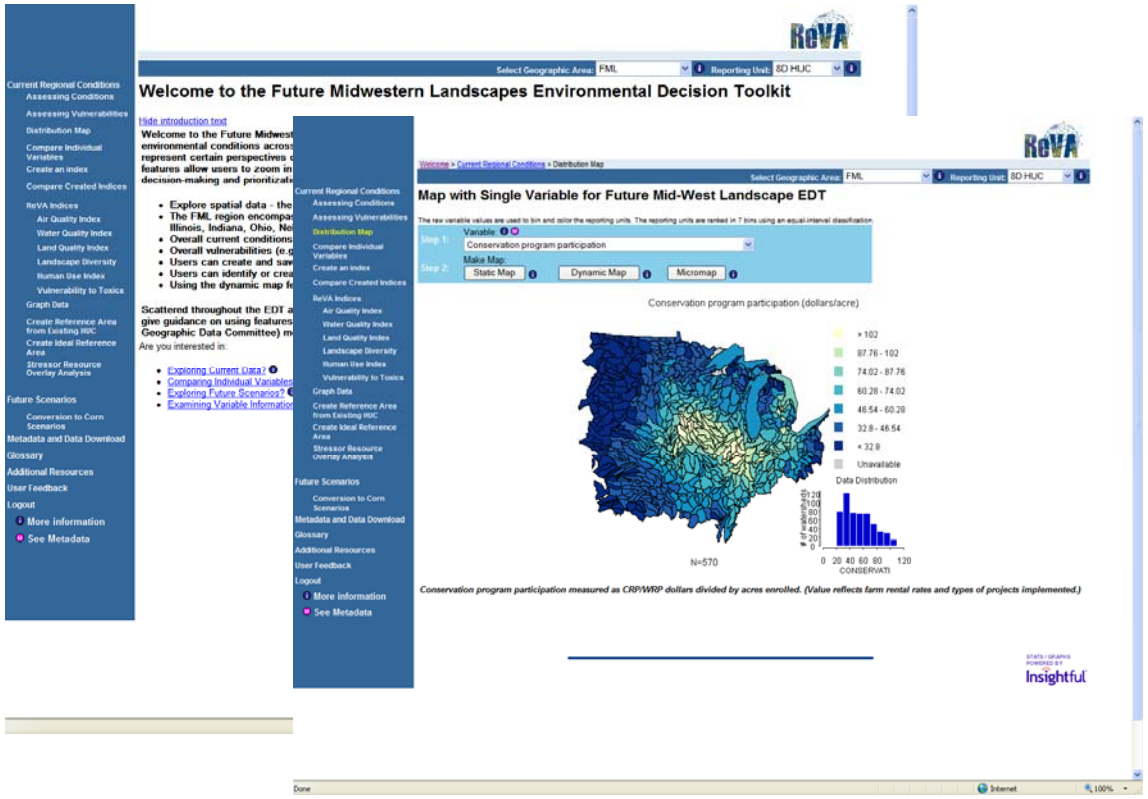
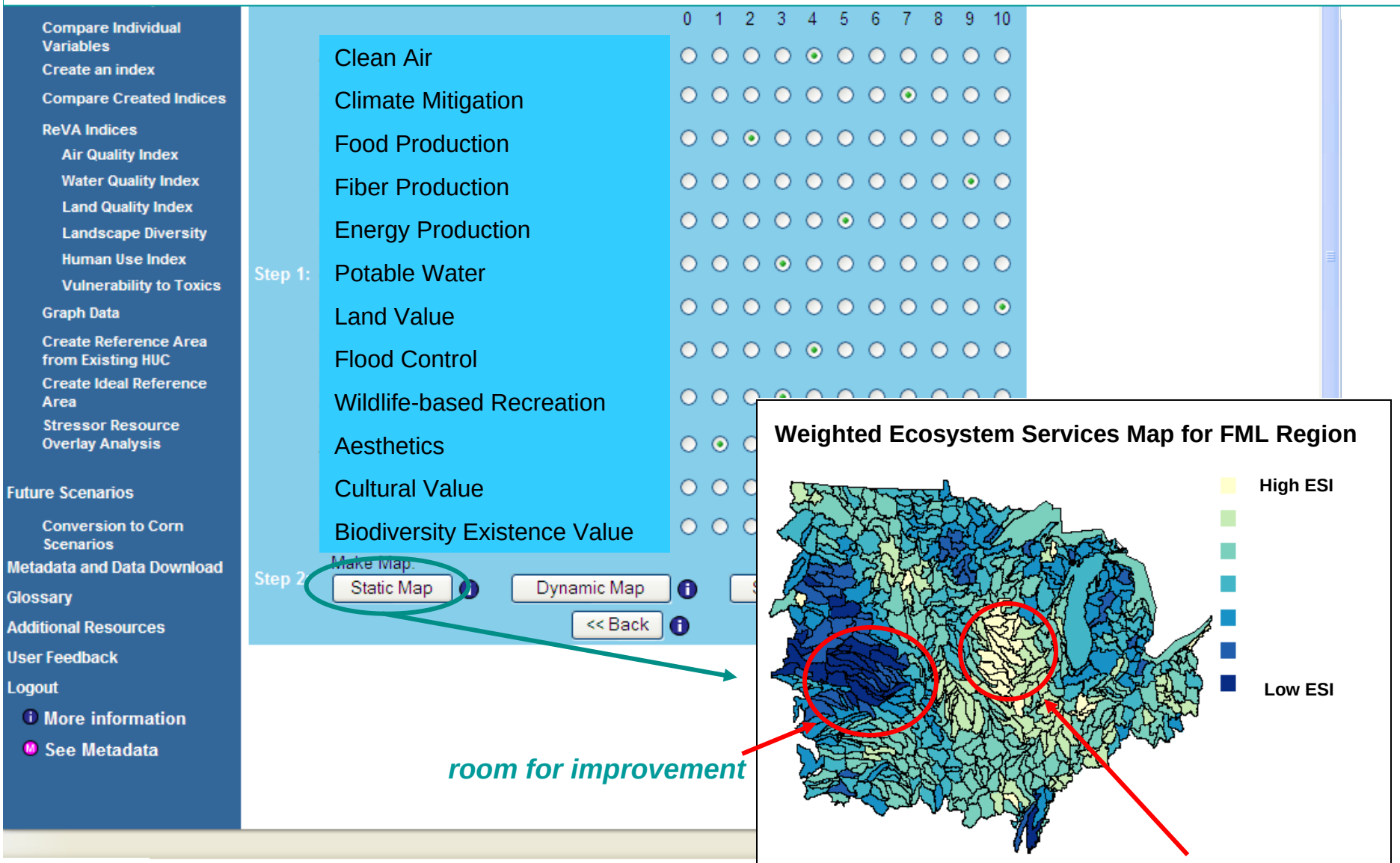
The Future Midwestern Landscapes Environmental Decision Toolkit (FML-EDT)



- User-friendly tool for decision-makers
- Structured around ES themes to promote problem solving
- Reduce complex information into useable performance metrics
- Promote understanding of cause/effects resulting from policy choices

http://www.waratah.com/fmledt revaguest/anonymous

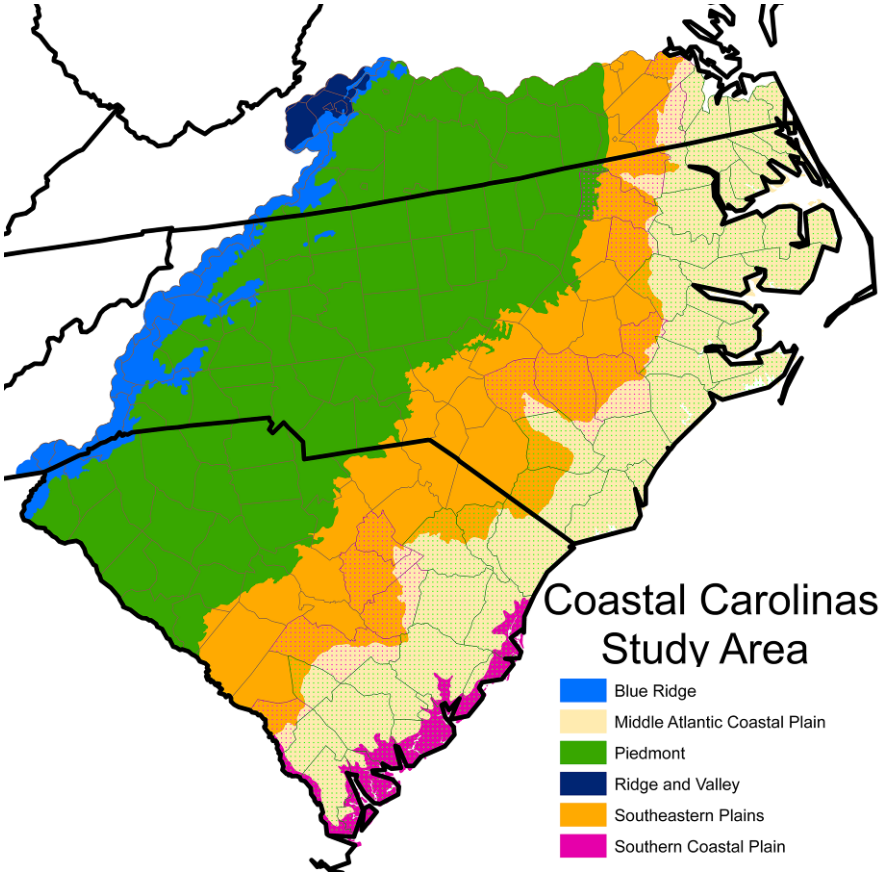
Future capability: Build an ecosystem service index (ESI) combining user-weighted values

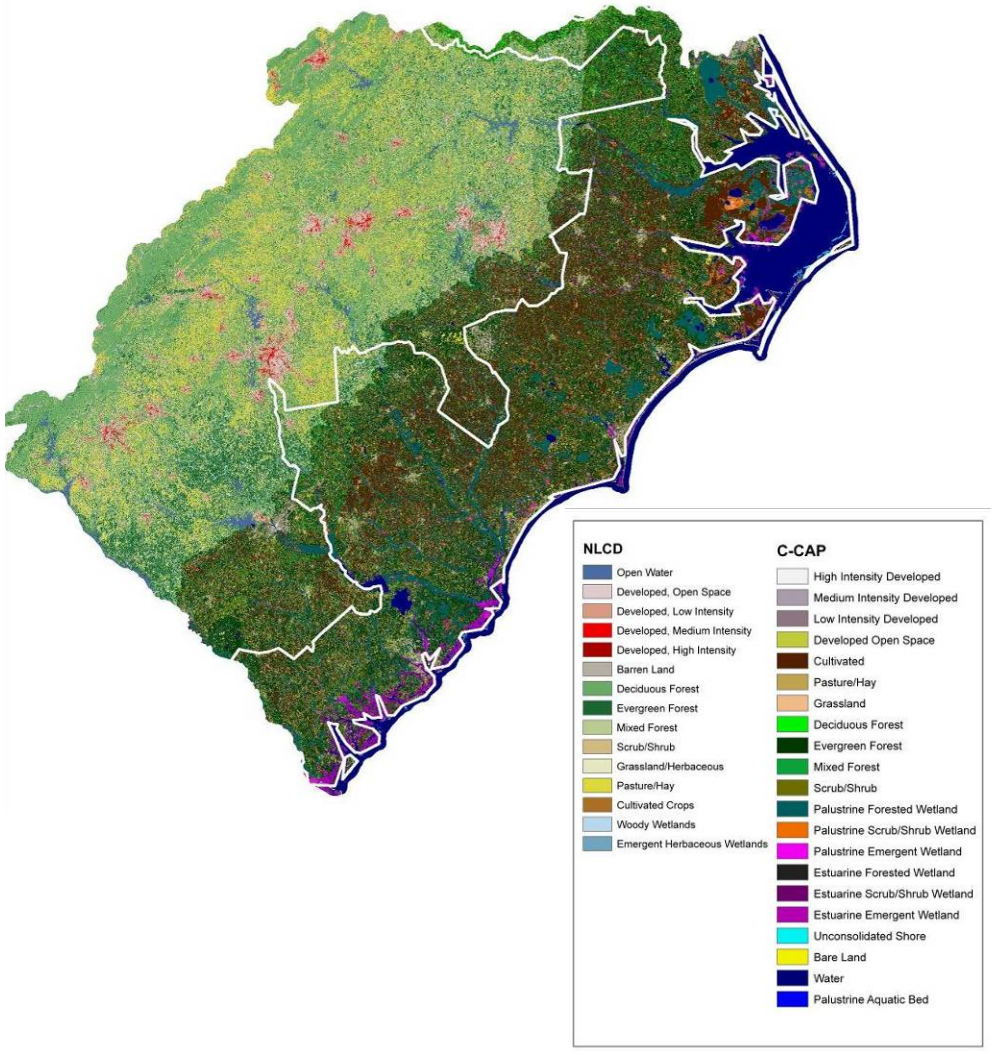


ECOSYSTEM SERVICES RESEARCH PROGRAM

Assessing Existing & Baseline Future Conditions	*Evaluating Opportunities for Action*	*Analysis Components*
Nutrients / GOM / Great Lakes		
Which watersheds are generating the most N and P to GOM?	Which watersheds are generating the most ***controllable*** N and P to GOM?	Establish model based on farm & landscape characteristics (e.g., areas with high fertilizer inputs, leaky soils/ geology, minimal conservation practices implemented)
Which watersheds are generating the most N and P to Great Lakes?	Which watersheds are generating the most ***controllable*** N and P to Great Lakes?	Establish model based on farm or urban & landscape characteristics
	How can conservation practices be targeted to cost-effectively reduce N, P exports to major waterbodies?	Identify leakiness factors by watershed or sub-watershed location , loadings, attenuation characteristics, existing BMPs
Which stream reaches have ecological components vulnerable to nutrient pollution?	How can conservation practices be targeted to cost-effectively reduce N, P exports to vulnerable streams?	Identify where functions have high likelihood of being restorable. (ie, moderately impacted with high opportunities for cost-effective BMPs)
Where are the biggest changes in stream chemistry likely to occur if biofuel production increases?	What level of nutrient export might be generated with alternative management aimed at fulfilling multiple services?	Scenario Analysis - nutrient export indices
Water Quality for Drinking		
Where are people exposed to health risks from nitrates in groundwater?	Where can practices be implemented to increase the safety of the groundwater supply?	Population exposed, % marginal farmland, restorable wetlands
Where are municipal surface water intakes (SWI) at risk for increased treatment requirements? (from development, nitrogen pollution, etc.)	Where could practices be targeted to protect SWIs?	% natural veg in surface water protection watershed (identify watersheds near thresholds?) vs. land conversion pressure
Recreational hunting		
Where are recreational hunting options the most scarce?	Where are opportunities to cost-effectively increase recreational hunting opportunities?	e.g., Green ratio vs. population
Existence Values - Terrestrial habitats		
Which habitats are vulnerable?	Which habitat patches are the most critical to preserve?	Documented, likely, and potential occurrences of rare species and natural communities combined with opportunities for green corridors, reduced fragmentation, etc. (e.g., something like FNAI)
Where are rare habitats experiencing the greatest stress?	Which areas are the most critical to restore to protect scarce habitat?	Land conversion potential; cumulative impacts of land conversion; x FNAI-like layer

The Coastal Carolinas Project





Coastal Carolinas

The Coastal Carolinas Ecosystem Services Initiative is being developed to address a variety of issues related to impacts from global change and coastal development. The initiative will focus on:

- **Mapping and quantifying coastal ecosystem services.**
- **Establishing the relationships between human land use, air, land, and aquatic processes, and coastal ecosystem services.**
- **Developing models and information to estimate how changing land use, sea level, and storm frequency and intensity may impact future coastal ecosystem services.**
- **Developing decision support tools which will help land use managers incorporate the full value of ecosystem services and the probable future impacts and costs of land use decisions.**

Hurricane Hugo

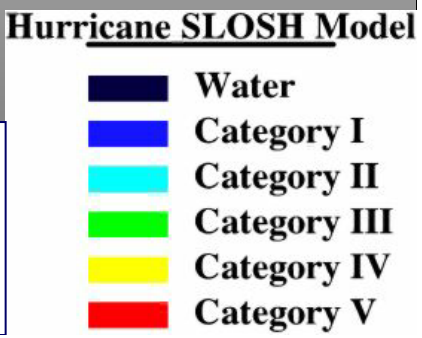
Coastal Carolinas Alternative Futures

Development Response:	***Sea Level Rise:*** Slow (current rate)	Medium (1 m by 2100)	Fast (3 m by 2100)
Business as Usual	✔	✔	✔
Adaptation in Place	✔	✔	✔
Flee the Coast	✔	✔	✔

Models of Climate Change Effects:

SLOSH?

SLAMM?



Charleston Harbor

Mount Pleasant

Isle of Palms

Folly Beach

Physical process models - National Weather Service's Sea, Lake, and Overland Surge from Hurricanes (SLOSH) model


Questions?