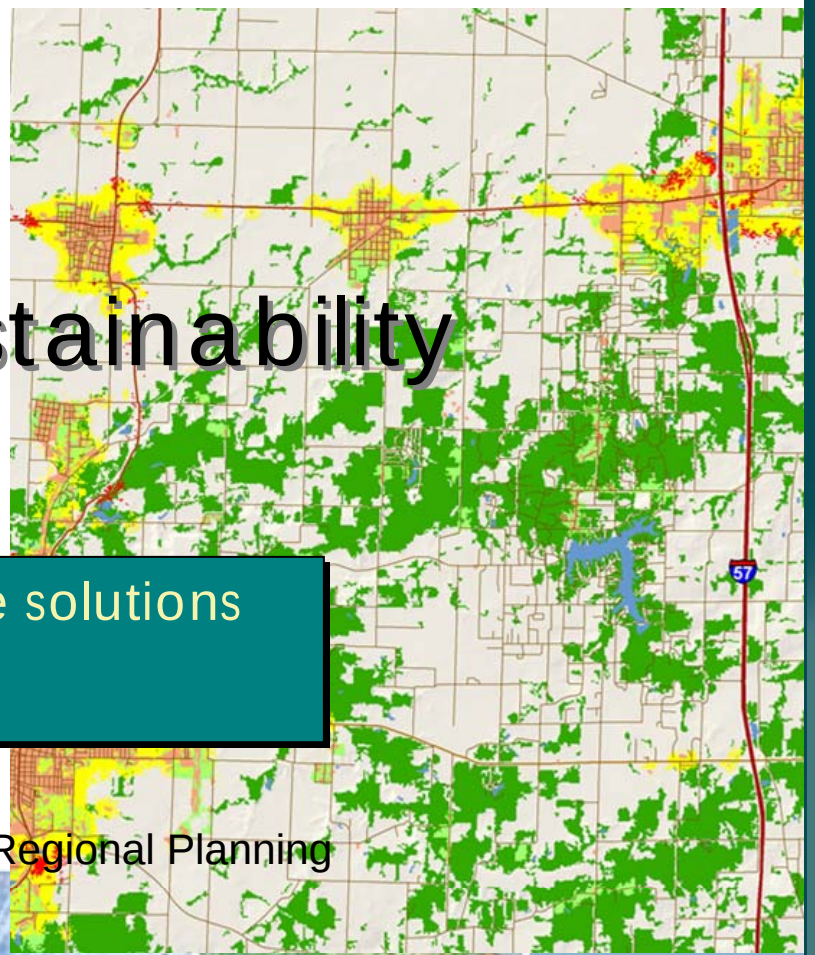
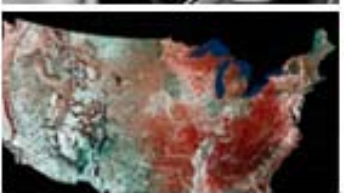
# Landuse and Sustainability



## Planning for more sustainable solutions

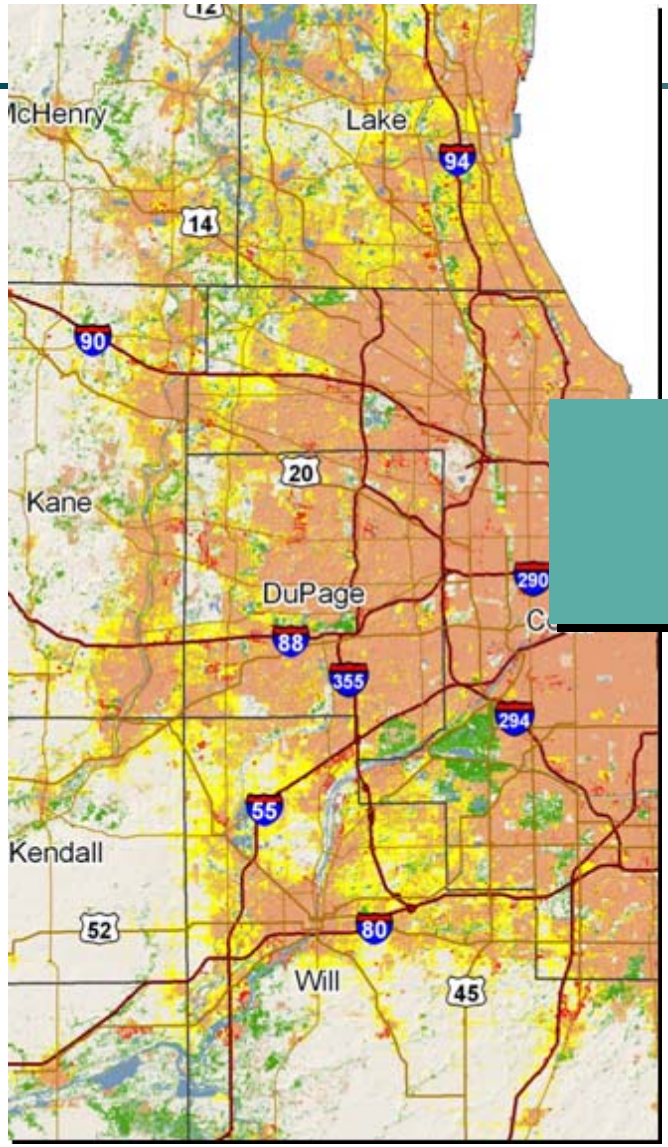
Brian Deal  Department of Urban and Regional Planning



landuse and impact assessment model evolution

# Overview

- Sustainability and planning
- Tools
- Approaches
- Lessons learned




## Sustainability is Important

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# Issues

Environmental Degradation

Poverty

Affluence

Ecosystems

Growth v. Development

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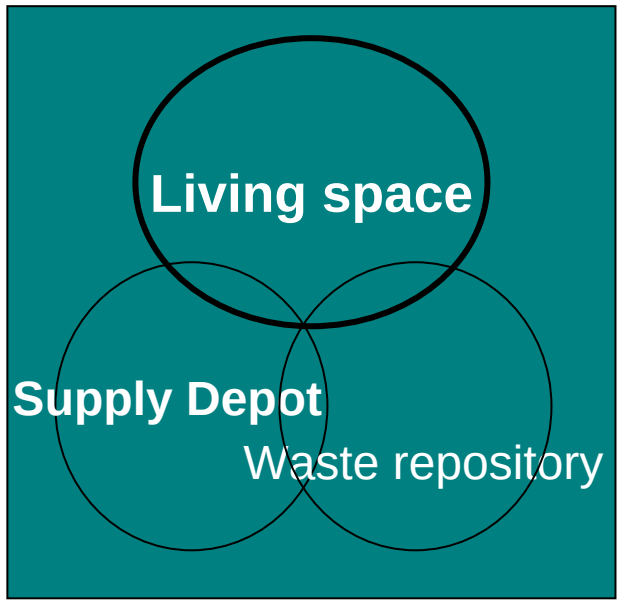
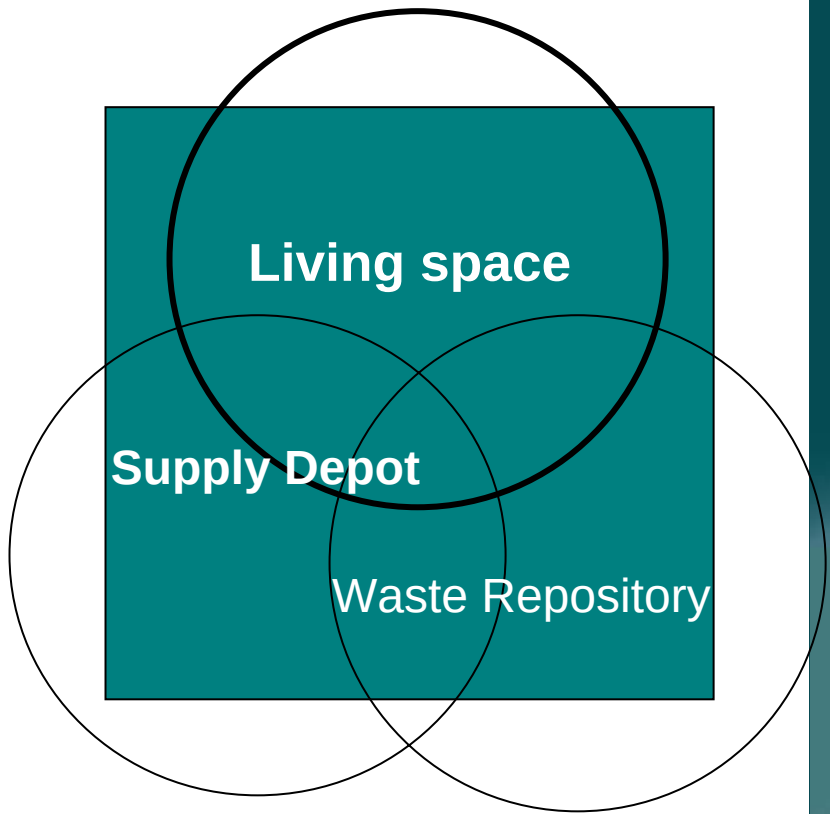
# ...living beyond our means ?

- Now

- Early 1900's




Global Carrying Capacity

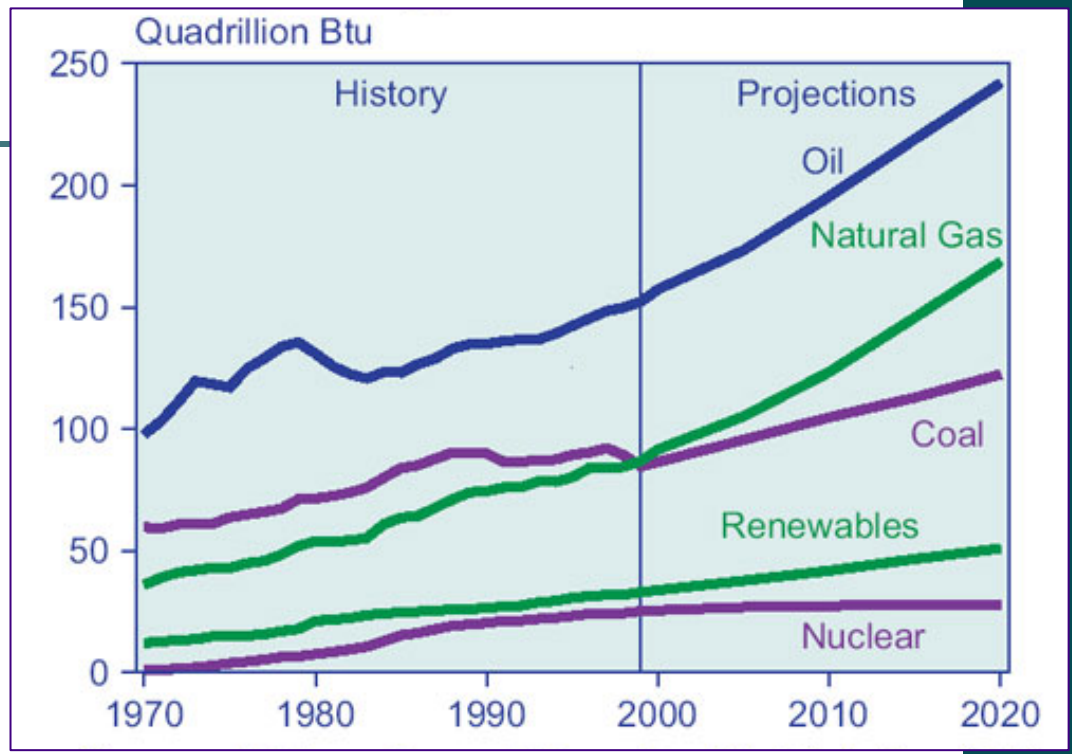



Dunlap, 1993

# Resource Depletion

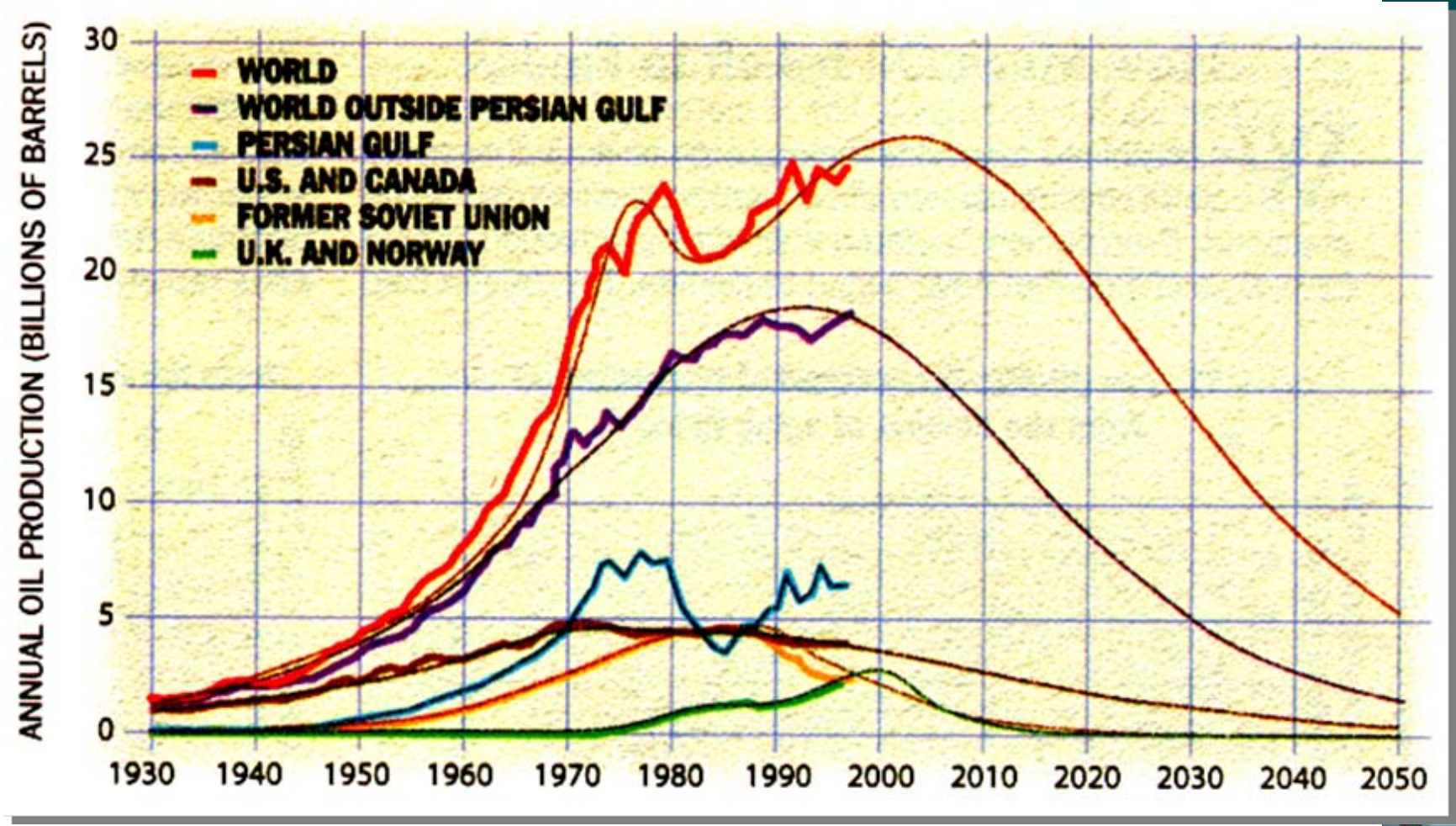
## Energy Example

World energy consumption projections



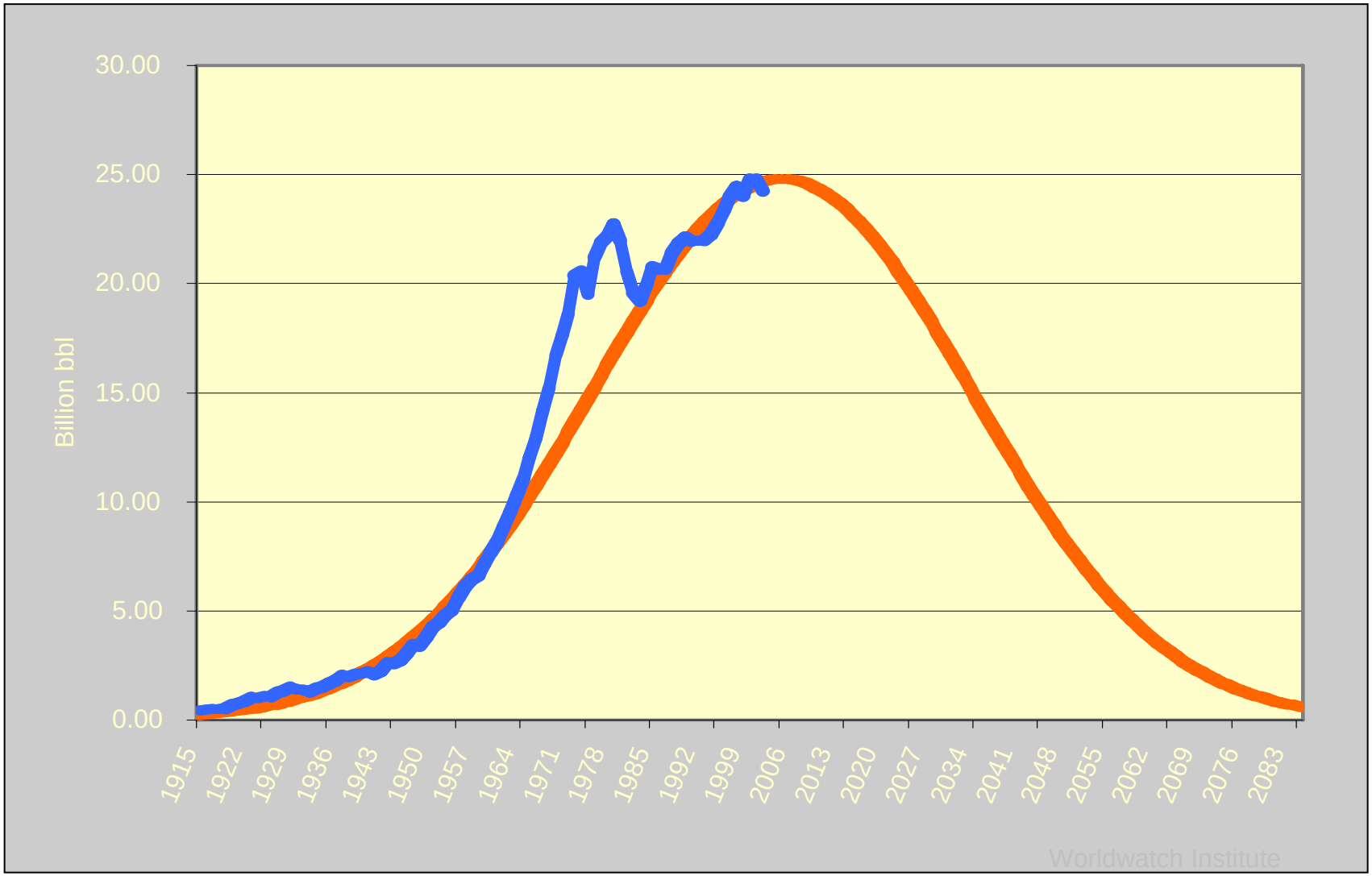

- World Energy Consumption
  - United States, Russia, China, Japan, and Germany consumed half of the world's energy in 1997.
  - United States, China, Russia, Japan, and India were responsible for half of the world's carbon dioxide emissions from the consumption of fossil fuels in 1997.
  - Asia recorded the largest absolute increase in consumption between 1988 and 1997, 33 quadrillion British thermal units (Btu). This was more than double the increase of 16 quadrillion Btu for North America, the second largest regional increase in consumption
  - Asia also had the largest absolute increase in energy production between 1988 and 1997, 22 quadrillion Btu. The Middle East had the second largest regional increase at 16 quadrillion Btu.

# World Oil Production

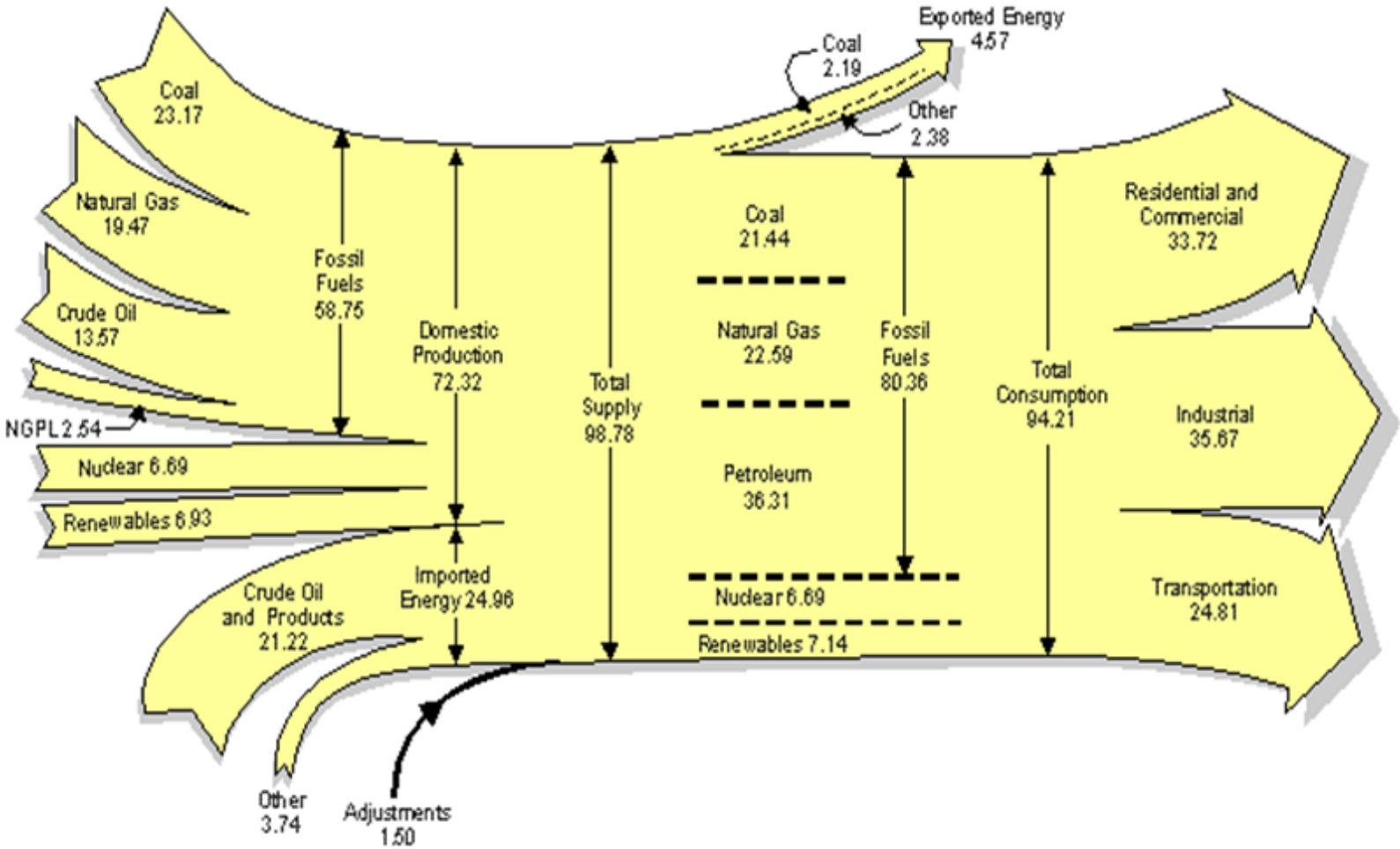



Scientific American, March 98 (Jean H. LeHerrere)

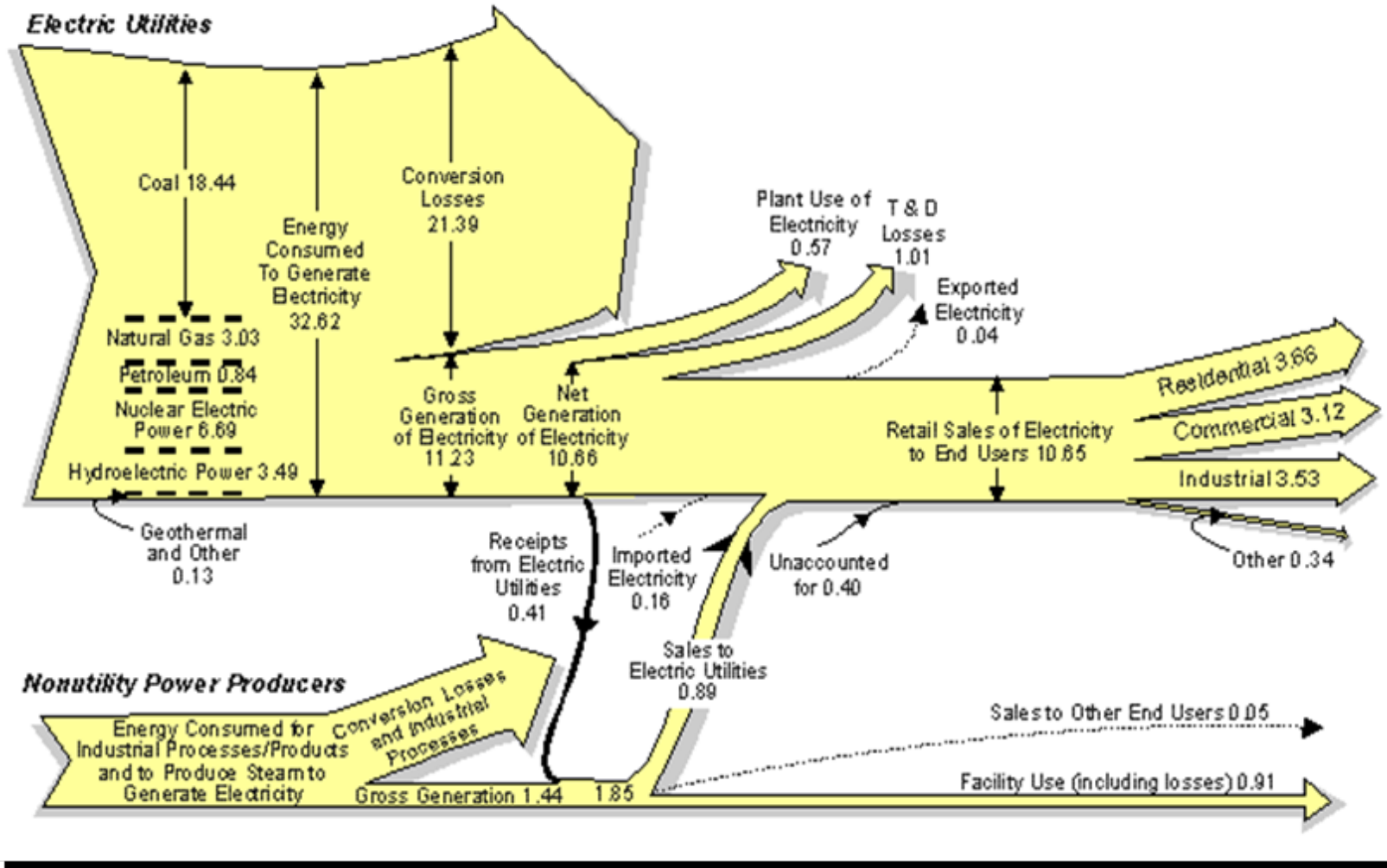
# World Oil Production



# U.S. Energy Flows 1997



# US Electrical Energy

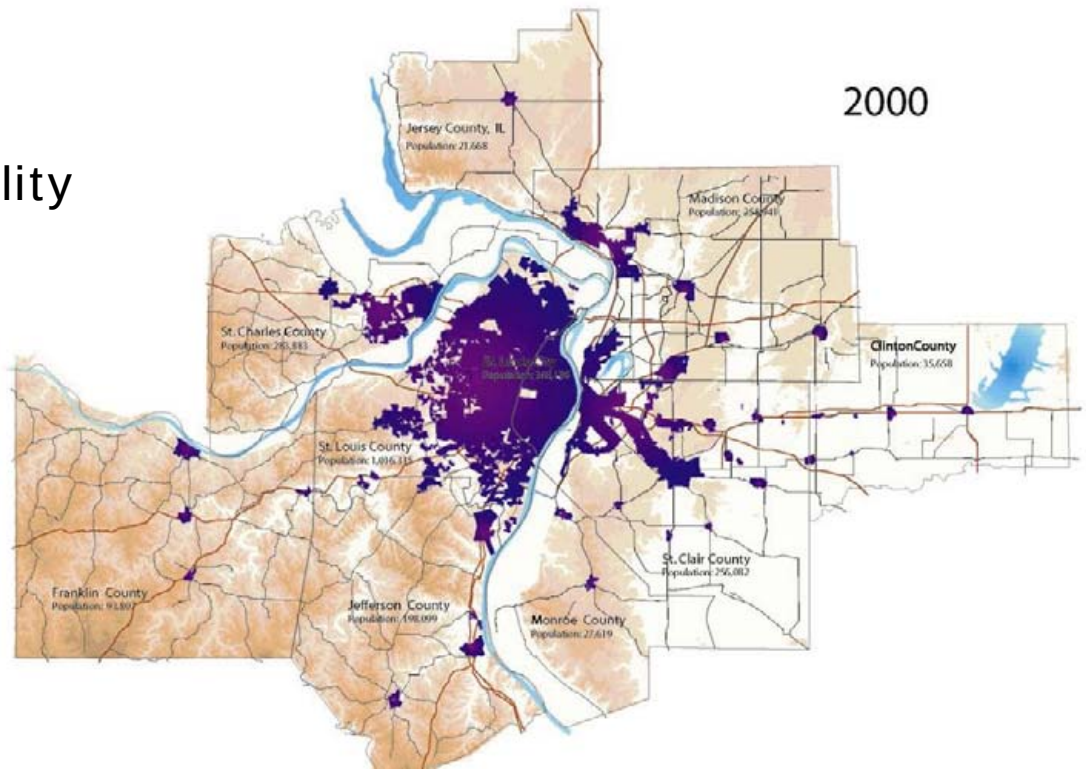


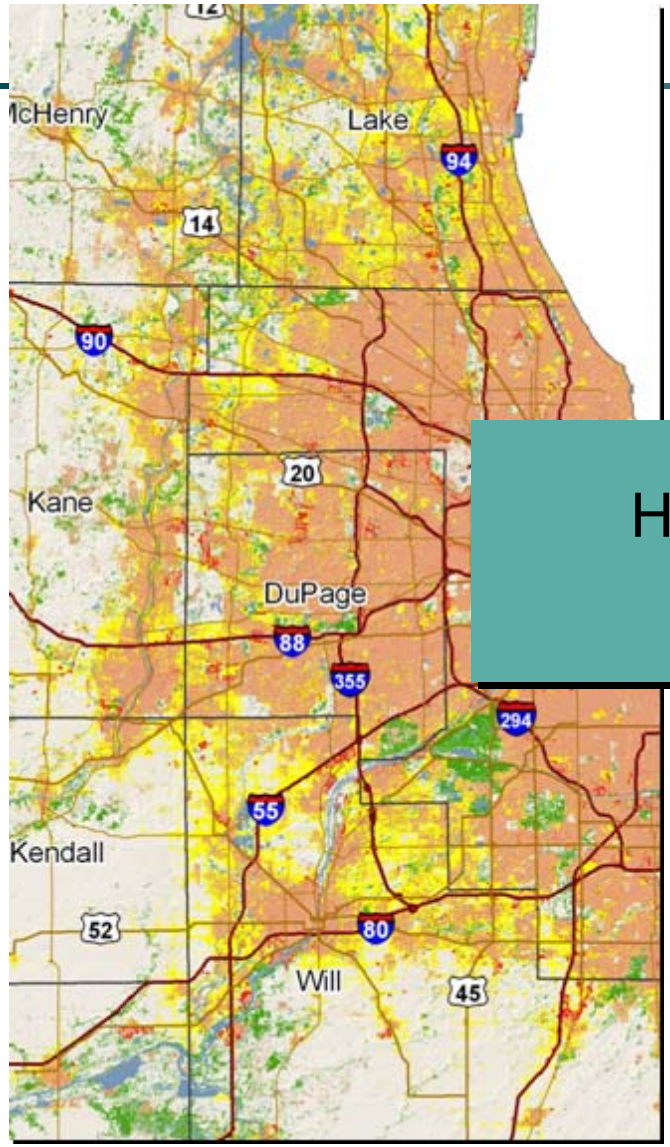
# Where can we find the answers?

# Sustainability is a Planning Issue

- Emissions
- Water quality and quantity
- Land use
- Transportation systems
- Energy use
- Green infrastructure
- Connections to buildings
  - Land around buildings
- Process based sustainability
  - Information
  - Dialogue
  - Communal consensus

St Louis Mo 1954-2000






How can we facilitate sustainable land use decisions?

Tools can inform the process and outcome

landuse evolution and impact assessment model

# Hypothesis

- We can facilitate more effective sustainable decisions by showing people the future consequences of current actions.
    - Communal goals vs personal aspirations
        - Personal vs Communal discounting
        - Economics
            - AC Pigou (welfare Economics)
            - Herman Daly (ecologic economics)
            - David Orr (sense of place)

# Questions for Engaging Sustainability

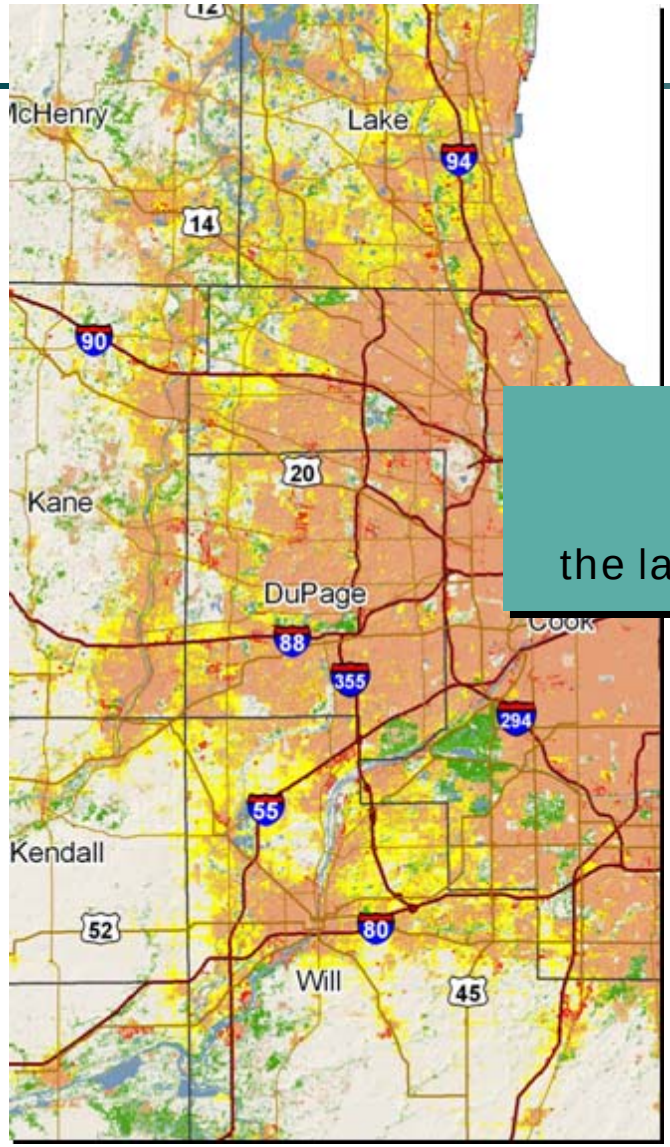
Three fundamental questions need to be considered:

- Where are we now?
  - Understanding the current state of the region provides a baseline to evaluate policy options and future impacts

- Where do we want to be?
  - Answering this question requires a vision and communal consensus about the future of the region

- How do we get there?
  - Planners and stakeholders need to be able to envision future alternatives and evaluate their potential consequences

☞ Requires planning tools!




# LEAM

the landuse evolution and impact assessment model

landuse evolution and impact assessment model

# LEAM

- What is LEAM?
  - LEAM is a land use decision support system that facilitates informed thinking about future land-use change and its consequences
    - Provides a basis for analysis and evaluation of options
    - Informs critical dialogue
    - Can help analyze potential outcomes and implications of decisions
- Why LEAM?
  - LEAM provides a rich, quantitative knowledge base
  - LEAM is a processed based modeling environment
    - Engages stakeholders
    - Improves quality and communal support
  - Open and transparent
- How does it work?
  - Through innovations in technology, but….
    - LEAM is a process and not merely a software package!

# The Value of Models to the Planning Process

- The model building process is as important as the end result
  - The process of modeling helps groups develop a shared understanding of key drivers affecting land use change in their region
  - Provides a common frame of reference that can be used to foster discussion among stakeholders

- Complex systems behave in unexpected and emergent ways
  - Feedbacks and lags are difficult to understand and predict without models
  - Uncertainty regarding variables can be tested with models

- Models provide quantifiable output
  - Models provide a basis for realizing community visions
    - Visioning becomes wishful thinking without reliable data and information
  - Dynamic land use models enable planners and stakeholders to make proactive land use change decisions

# LEAM Laboratory

- The LEAMlab is a multidisciplinary laboratory comprised of University of Illinois faculty, students, and full-time staff that specializes in analyzing complex real-world problems using the power of dynamic spatial models
- Support for developing LEAM has come from multiple local, state, and federal agencies
- LEAMlab provides ideas and approaches that enhance the traditional planning process
  - Economic Modeling
  - Spatial Data Manipulation
  - Dynamic Modeling
  - Data Visualization
  - Environmental Impacts
  - Community Engagement
  - Interactive Web Development

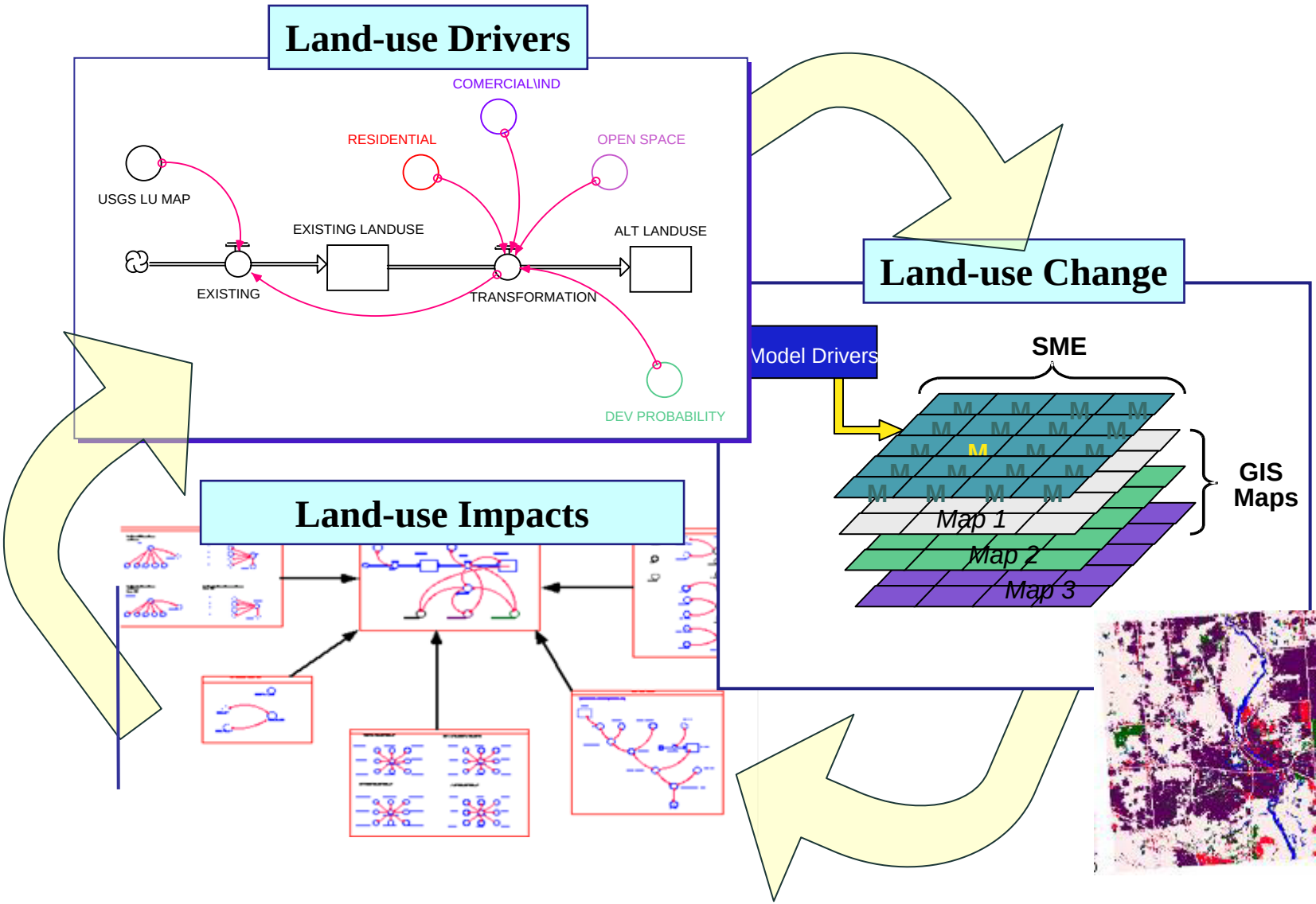
# LEAM Technology Innovation

- A 'Next-Generation' model
  - Incorporates the local causal mechanisms of change
    - Can be used to test 'What If?' scenarios
- Scales up and down
  - High-performance computing
  - Enables the modeling of very large regions at a very fine resolution
    - Large regions
      - Helps to discover unintended consequences of policies or investments
    - Fine resolution (30m x 30m)
      - Results can be aggregated to any geography for analyses
        - » School districts, Watersheds, …
- Open modular architecture
  - Can be limited or elaborate
    - Limited version produces early results to foster dialog
    - Elaborate versions incorporate local knowledge

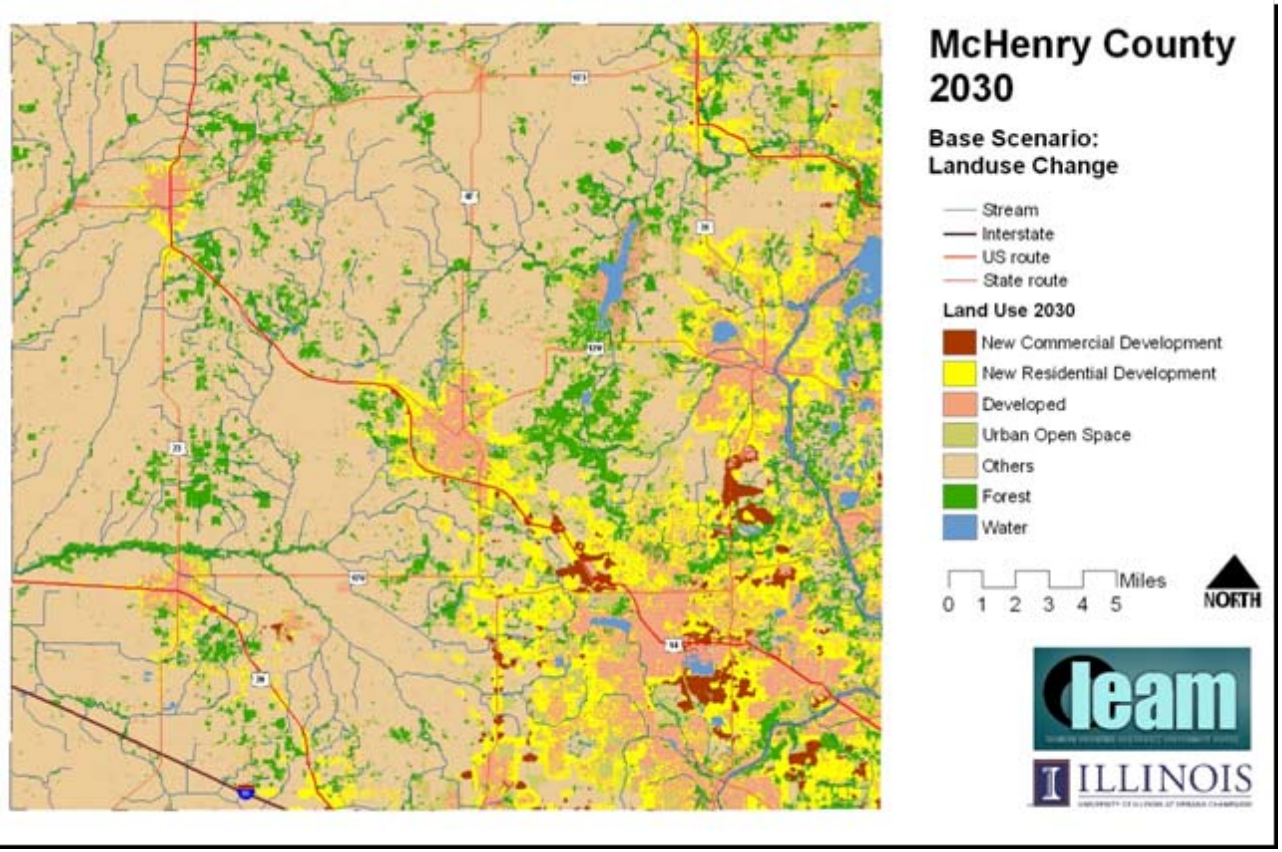
A Visualization Tool

- LEAM results include analysis of scenarios showing the transformation of the landscape as a product of policy-related inputs
- Dynamic visual outputs are critical for testing policy scenarios and raising concerns regarding the impacts of development

# LEAM Model Framework



# LEAM Land-use Simulations

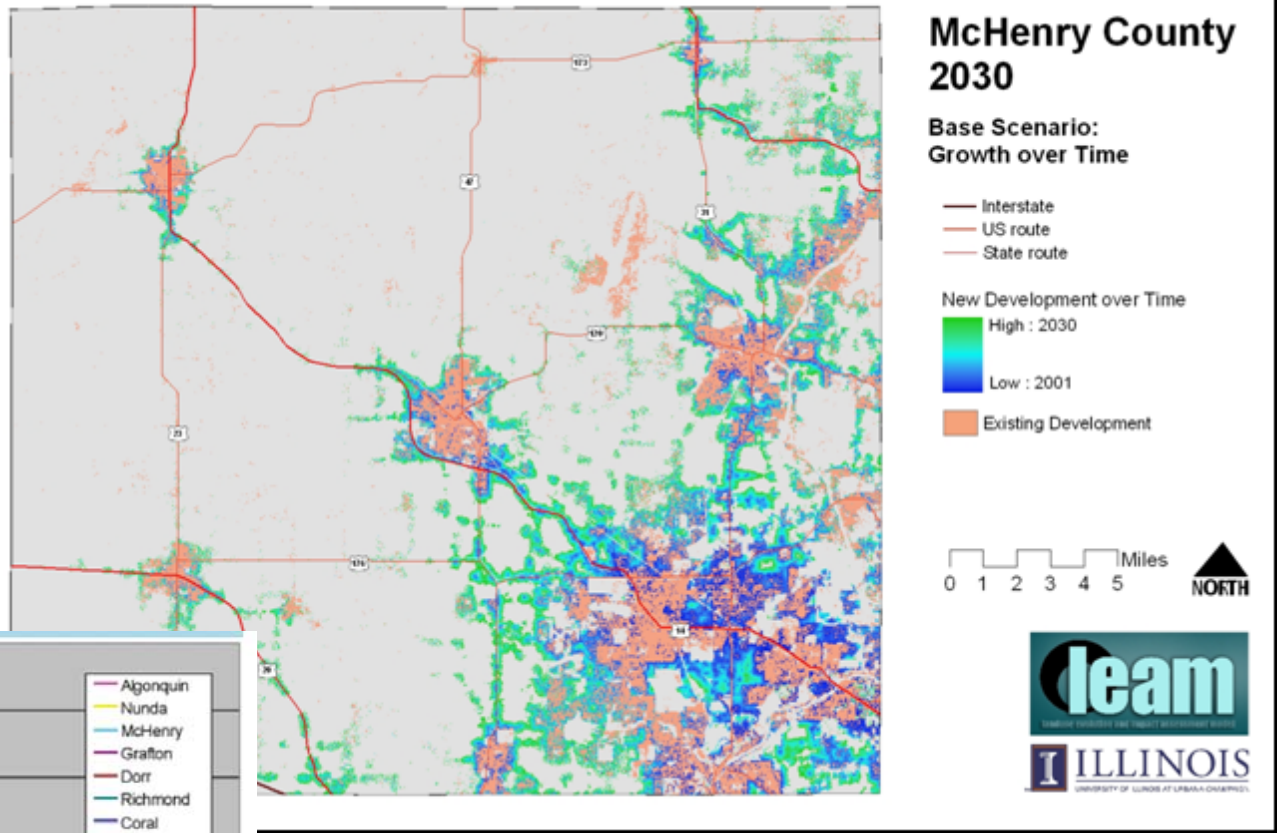


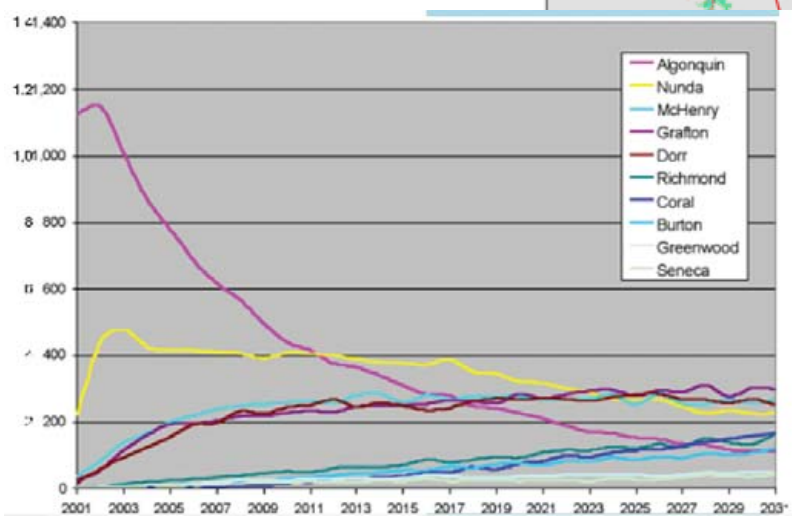

- Future regional demand for land is located based on a calculated probability of change for each cell or raster
- Based on growth 'Drivers'

- Locational drivers assess proximity to growth attractors
  - Jobs, shopping, health care, etc.
- Dynamic drivers change depending on local condition
  - Are utilities close by, etc.
- Causing different parts of the region grow differently

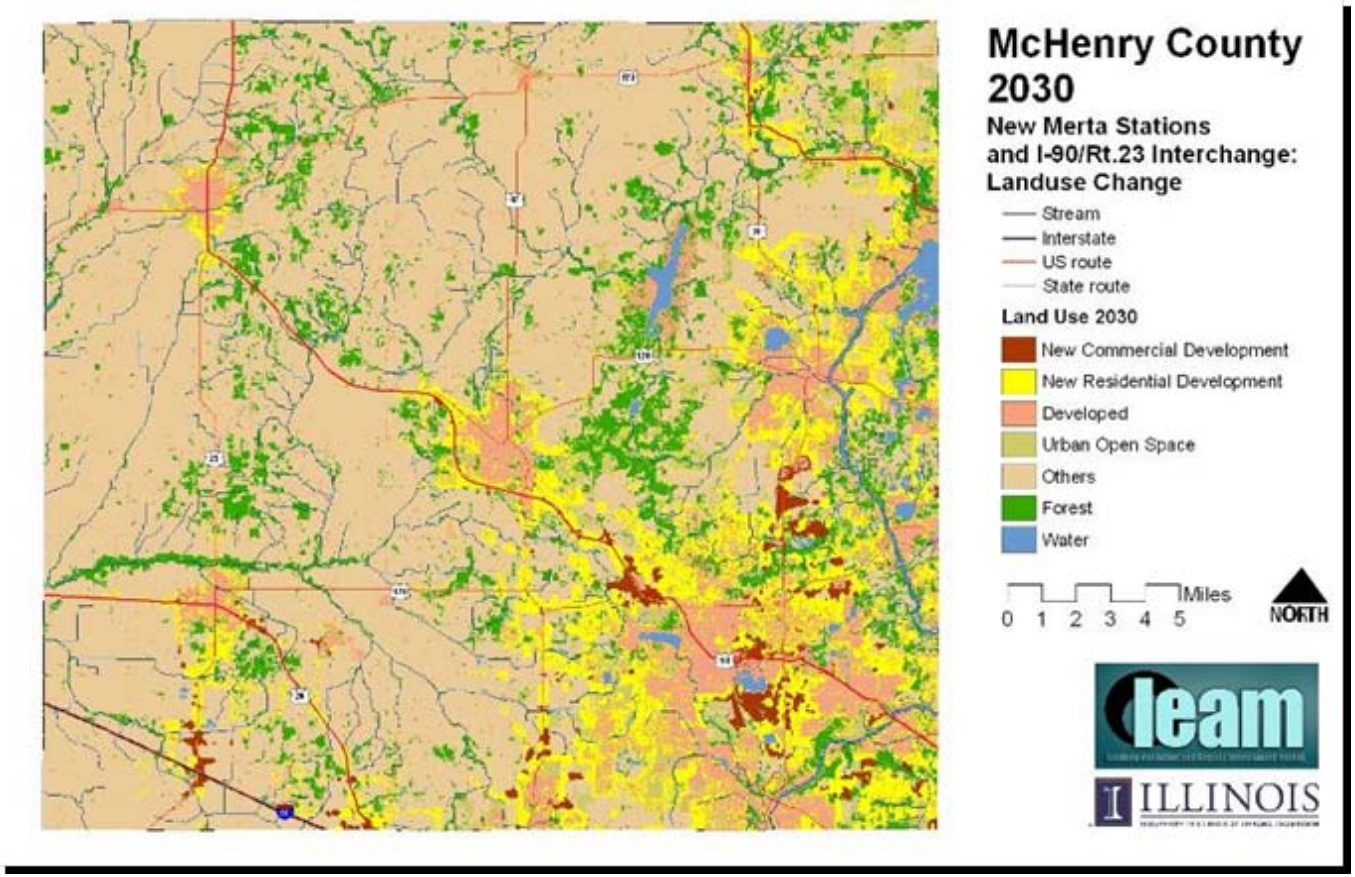
# Viewing Change Over Time

- LEAM simulates annual growth
- When viewed as a dynamic map or a graph the future is described in a much richer fashion



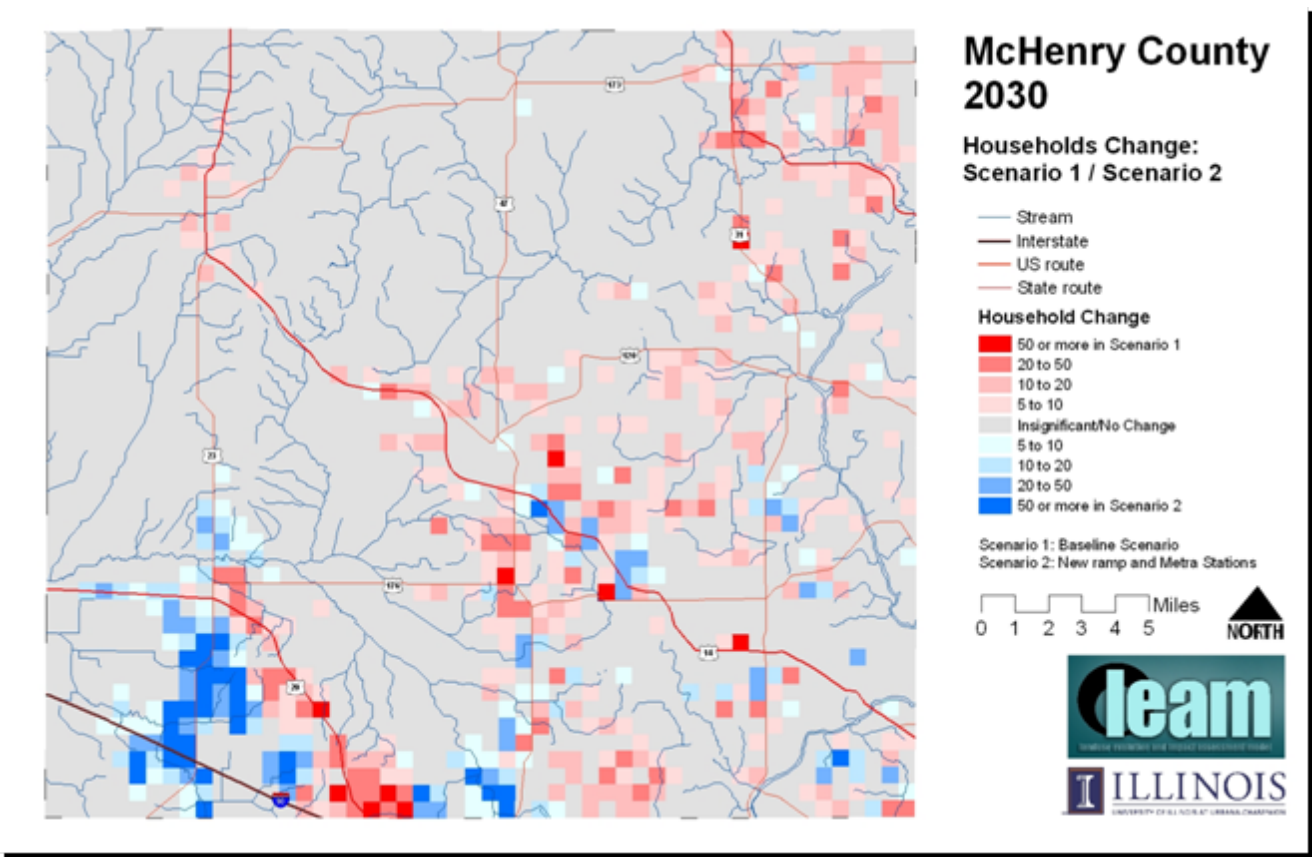



# Scenario Futures




The implications of transportation investment

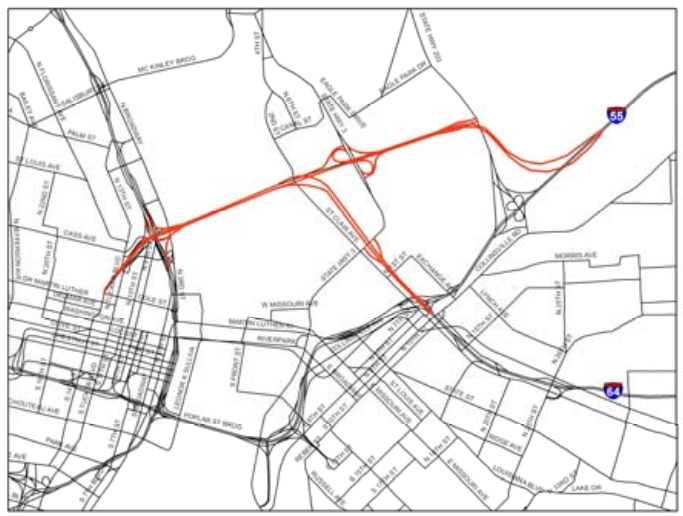
# Multiple Scenarios

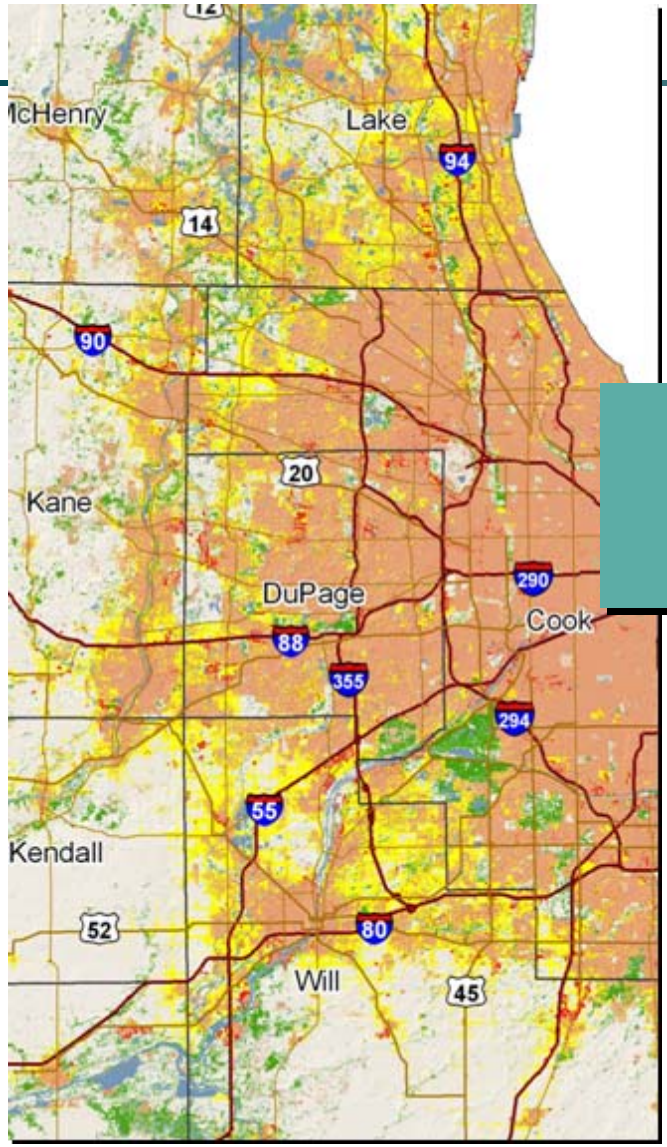



- Changing policies produces different scenarios
- Land-use change in different scenarios can be compared at different geographical scales
  - Quarter sections
  - Watersheds
  - School districts
  - Transportation zones
  - Sensitive natural areas
  - Municipal boundaries

# Types of Scenarios

- Typically look at implications of significant public investment or policies, or economic development project
  - Infrastructure:
    - New roads, interchanges, bridges
    - New passenger rail stations
    - New airport
    - Sewer/water facilities
  - Policy:
    - Resource protection
    - Stream buffer protection
    - Higher density development
  - Expansion of military base
  - Economic development
    - Expansion/New industry
    - Brownfield redevelopment
- Cannot model micro level issue






# Implications

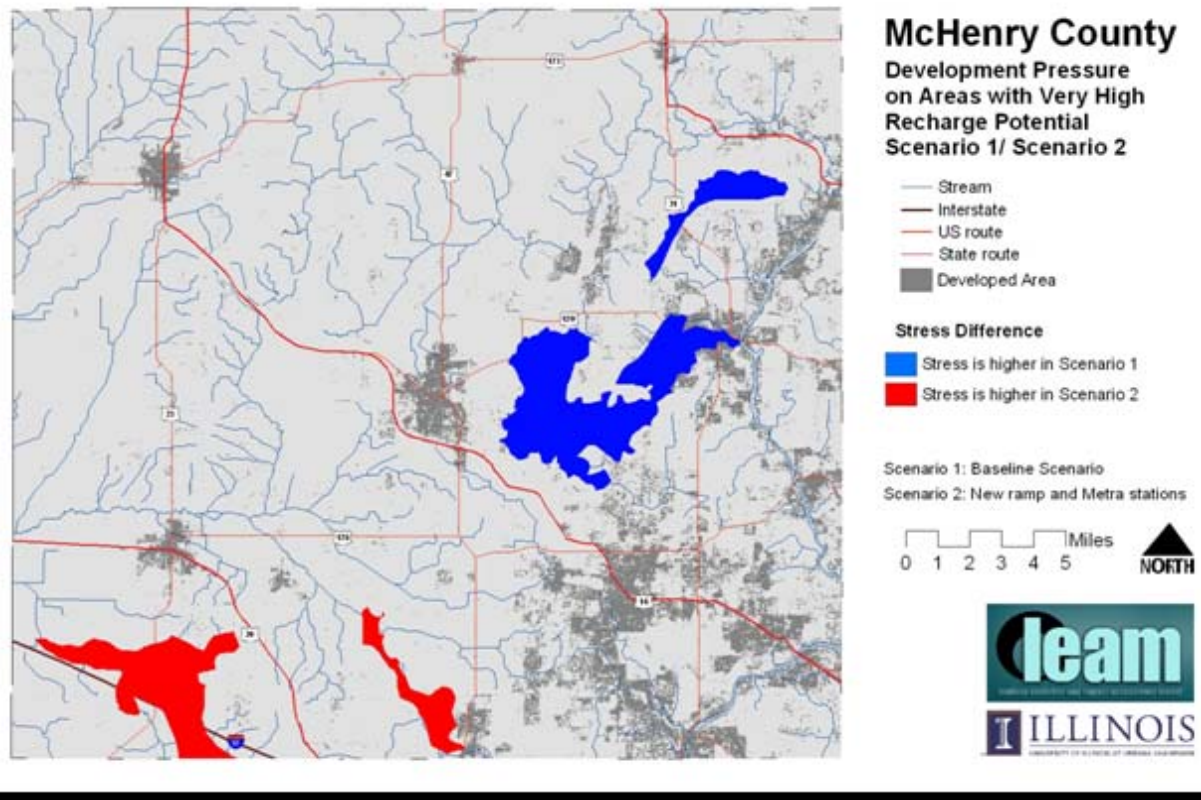
landuse evolution and impact assessment model

# Implications of Land-use Change

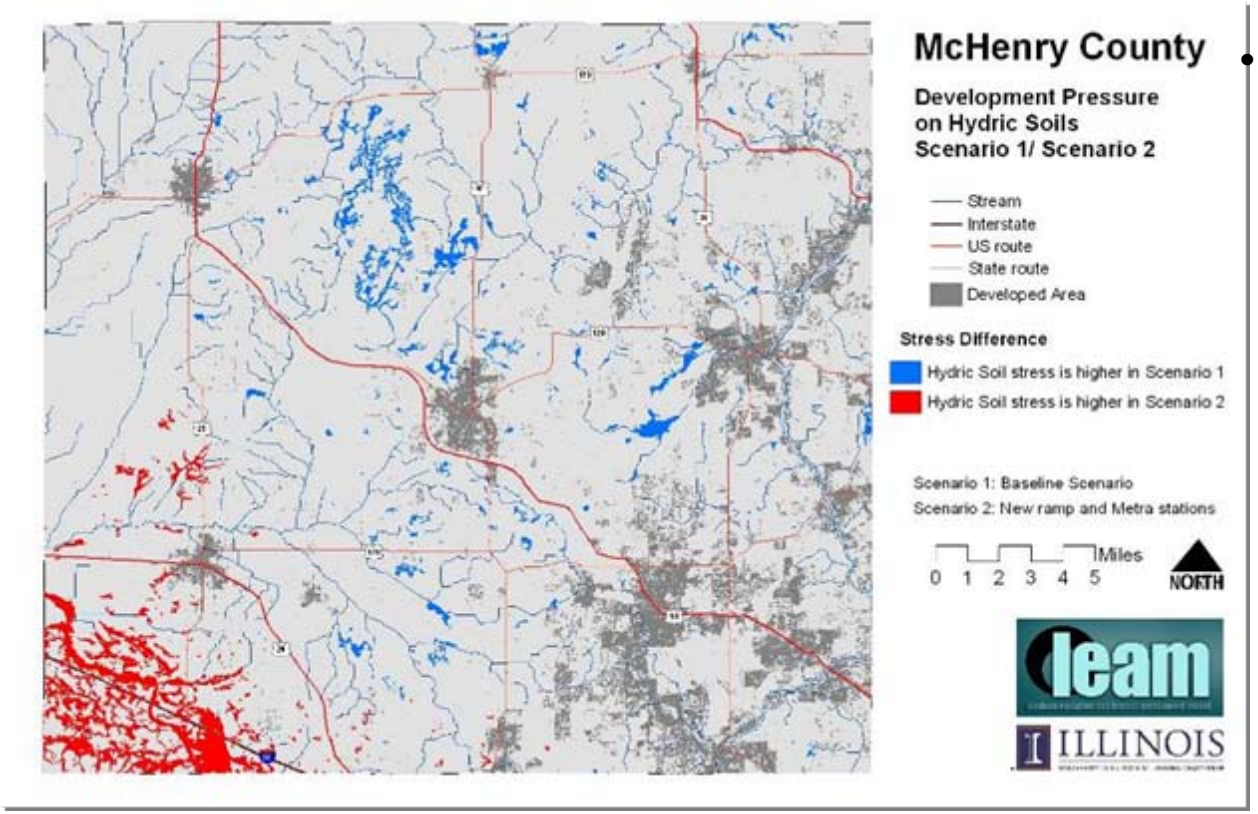
- More detailed comparisons among land-use futures can be made
  - What are environmental, social, and economic consequences?
  - How do they differ?
- Development probabilities indicate which areas are under most pressure for development
- LEAM data on land-use change is processed for input into other available models

# Developmental Stress Analysis

- A way of assessing the implications of planning decisions
- DSA is Based on
  - Spatial data
    - of the issue in question
  - LEAM probability results
    - for any given time
  - Compare across scenarios



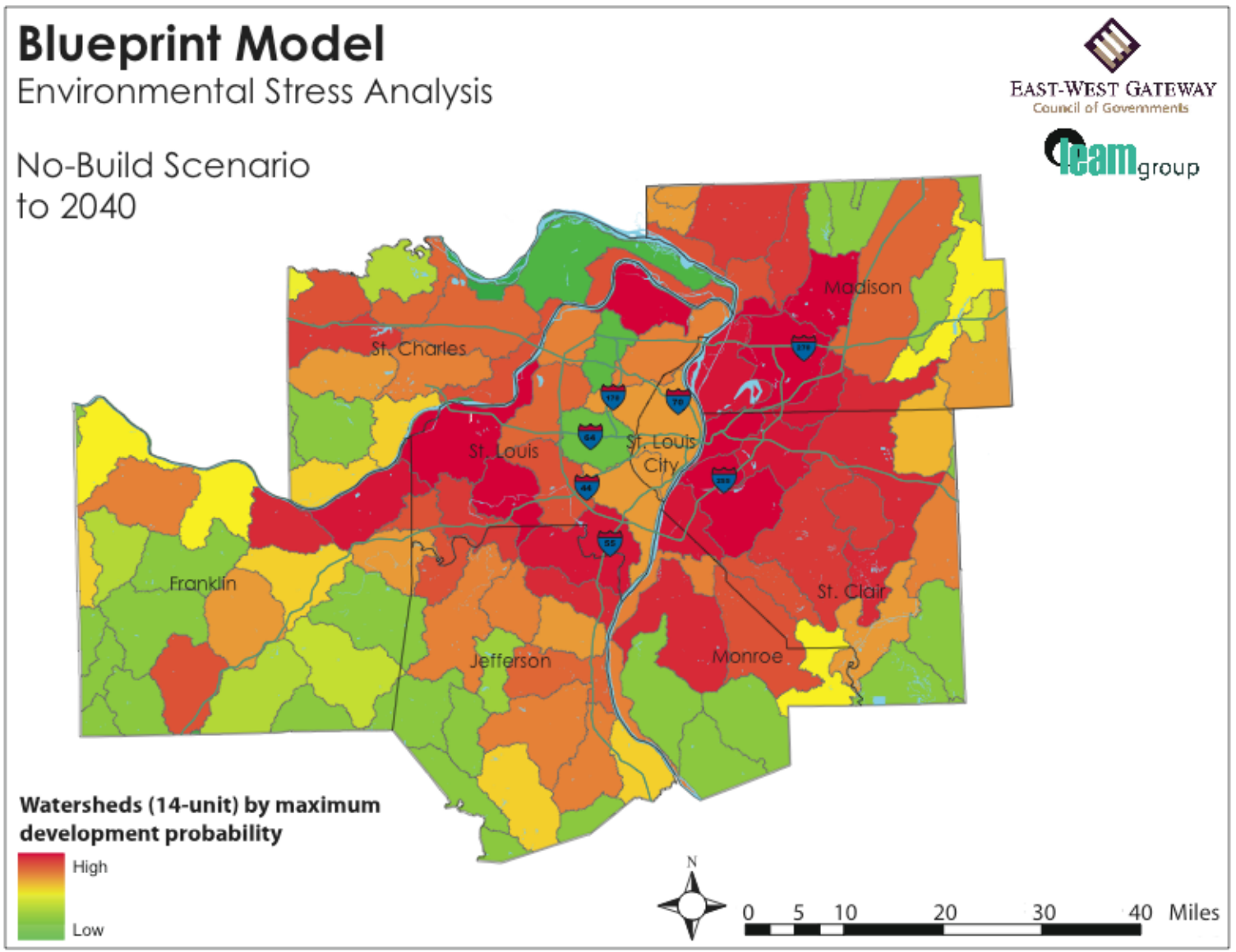
# Development Stress on Wetlands




- A good way of viewing information on the changes in stress across space and time due to development pressure
  - On resources
  - On social systems

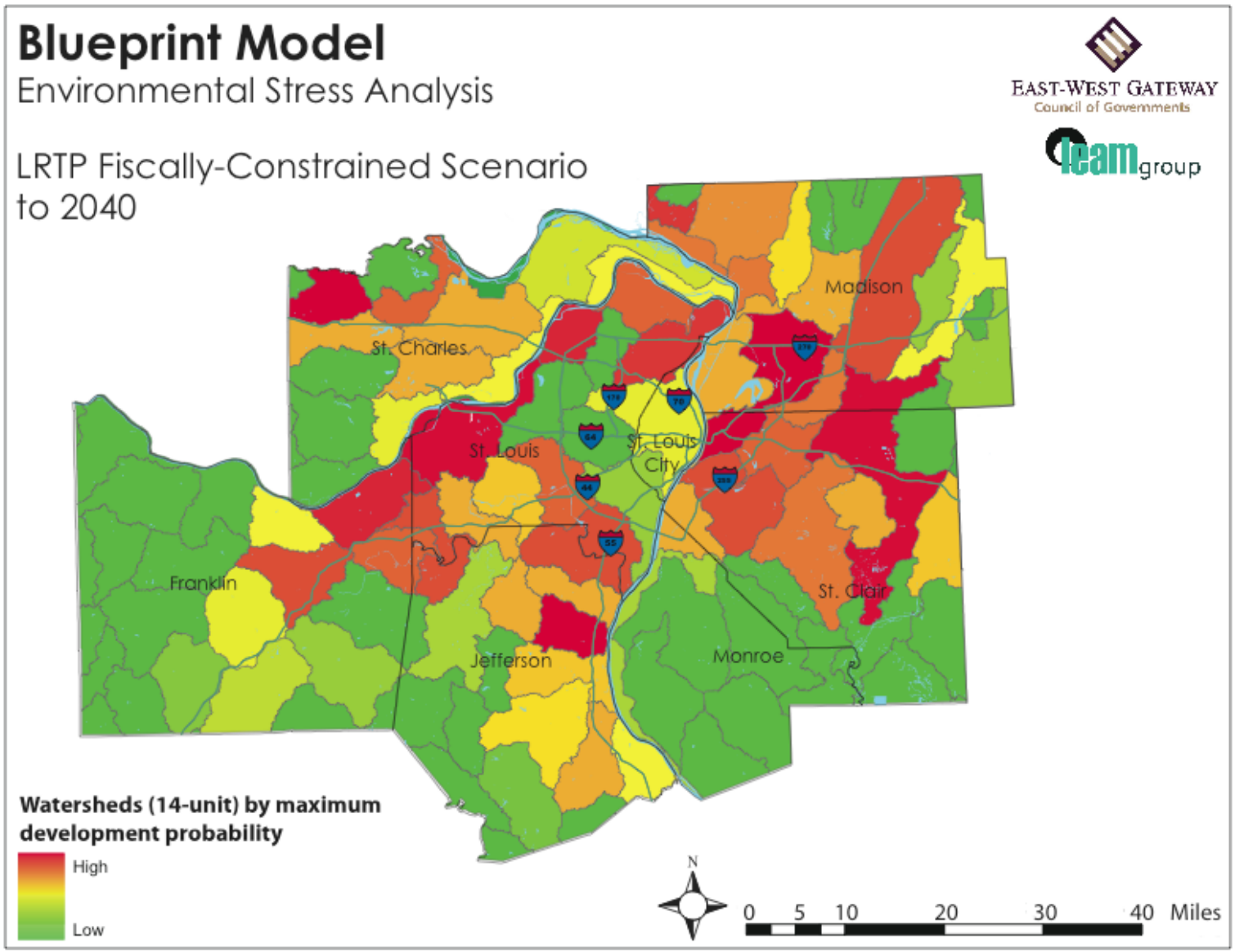
# Watershed Stress Analysis

Baseline



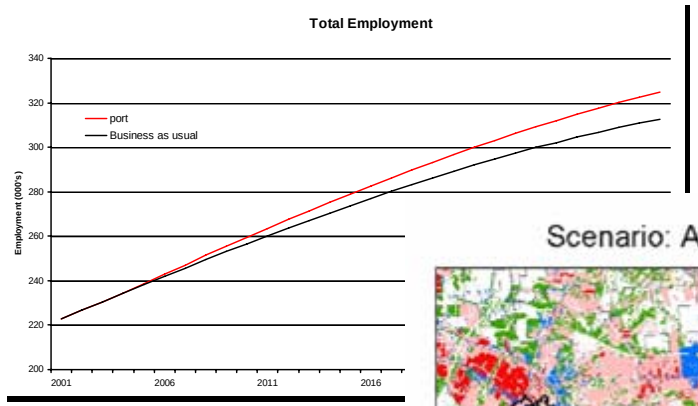
# Watershed Stress Analysis

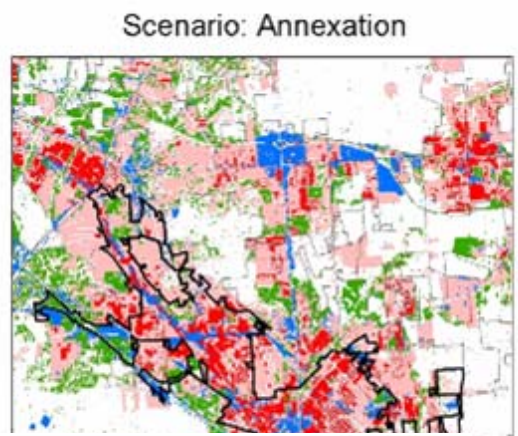
LRTP

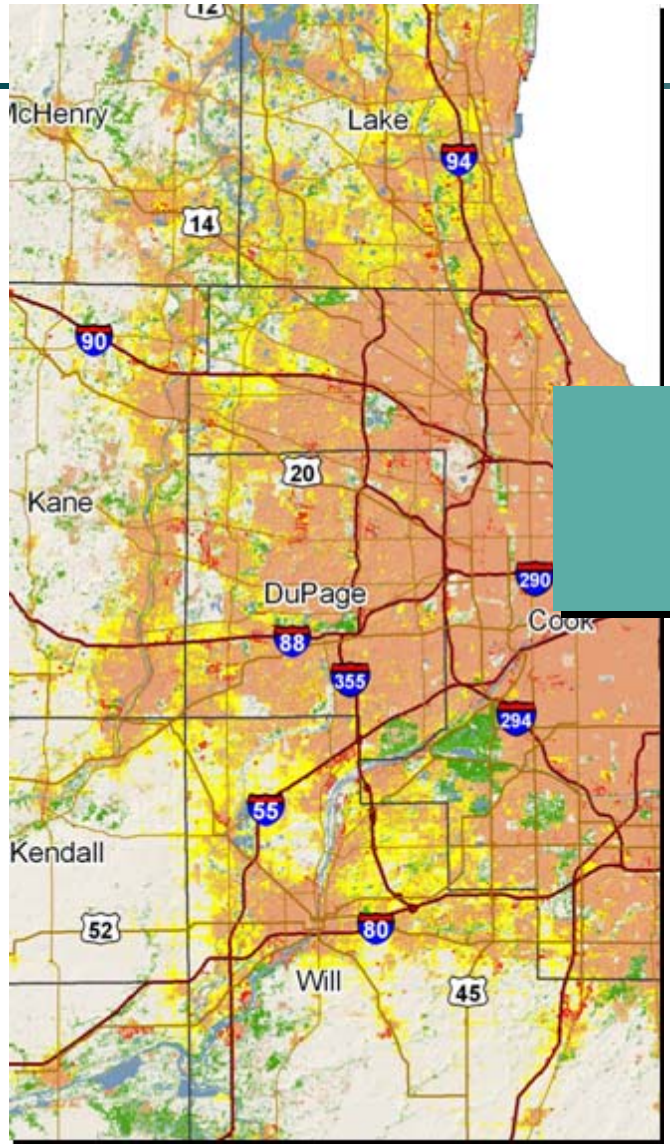


# Other Implications Modeled

- Traffic volume
- Fiscal impacts
- School costs
- Water quality and quantity
- Air quality impacts
- Economic impacts
- Habitat fragmentation
- Storm water and flooding
- Infrastructure costs
- Greenways
- Ground water
- Energy




# Democratization

# LEAM Process Innovation

- Model development and analysis in the public eye
  - Use limited model to produce preliminary results
  - Invite local stakeholders to repeatedly critique work
  - Use stakeholder insights to iteratively refine model and analysis
  - Stakeholders define scenarios

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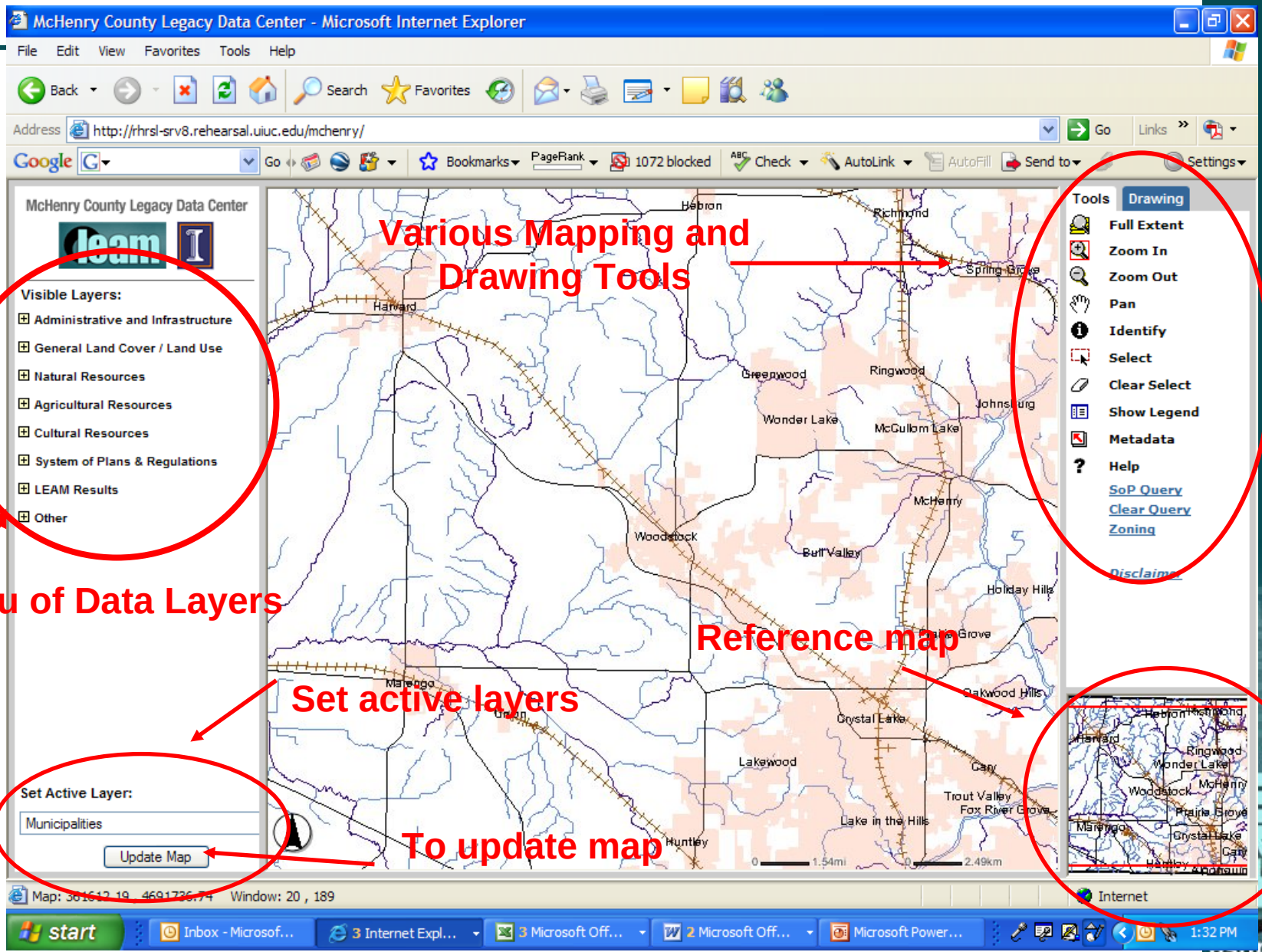
# Main page


McHenry County Legacy Data Center - Microsoft Internet Explorer
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Administrative and Infrastructure
General Land Cover / Land Use
Natural Resources
Agricultural Resources
Cultural Resources
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Select
Clear Select
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SoP Query
Clear Query
Zoning
Disclaimer
Menu of Data Layers
Reference map
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Set Active Layer:
Municipalities
Update Map
To update map
Hebron
Richmond
Spring Grove
Harvard
Greenwood
Ringwood
Johnsburg
Wonder Lake
McCullom Lake
McHenry
Woodstock
Bull Valley
Holiday Hills
Prairie Grove
Marengo
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Fox River Grove
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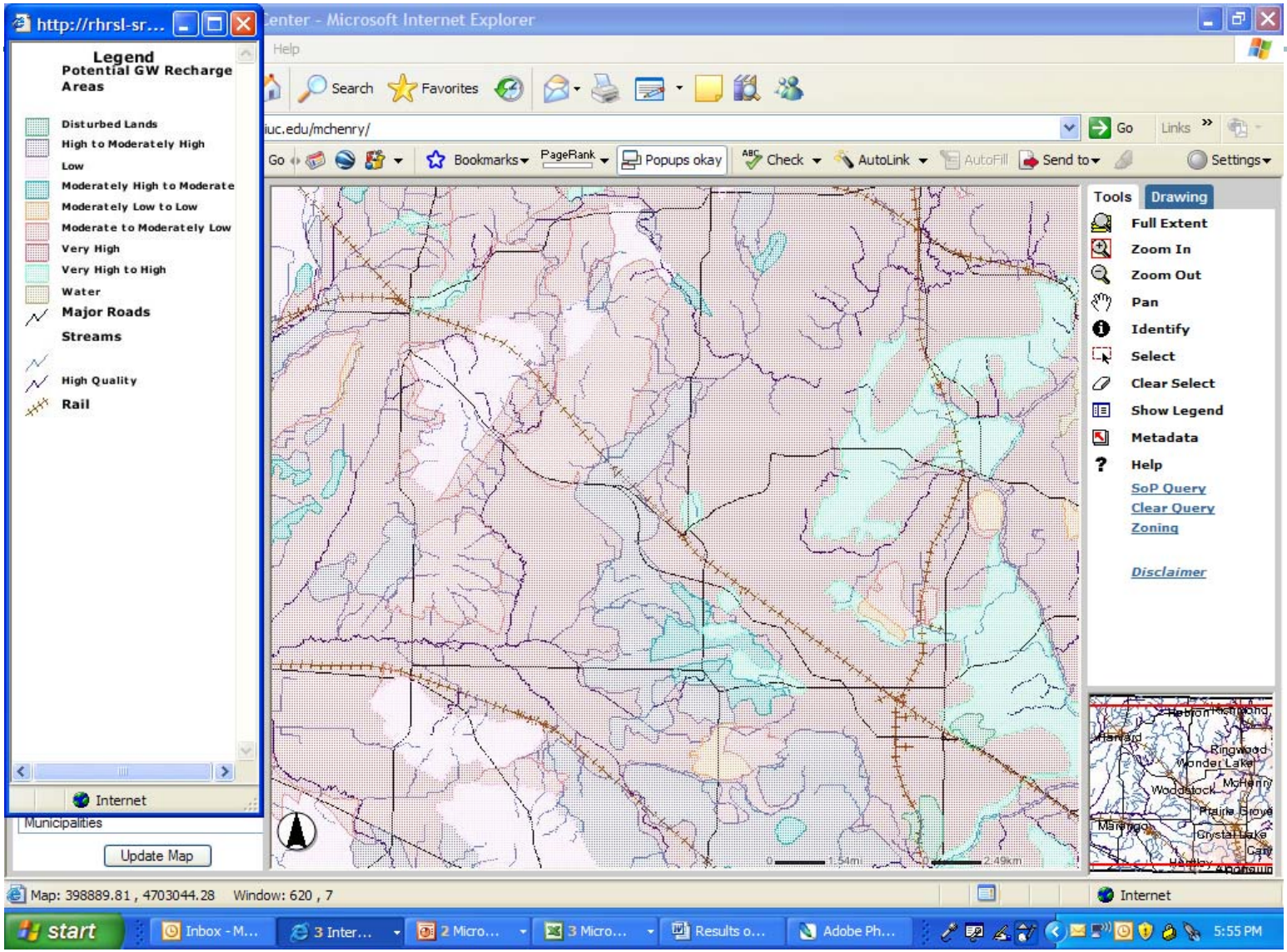
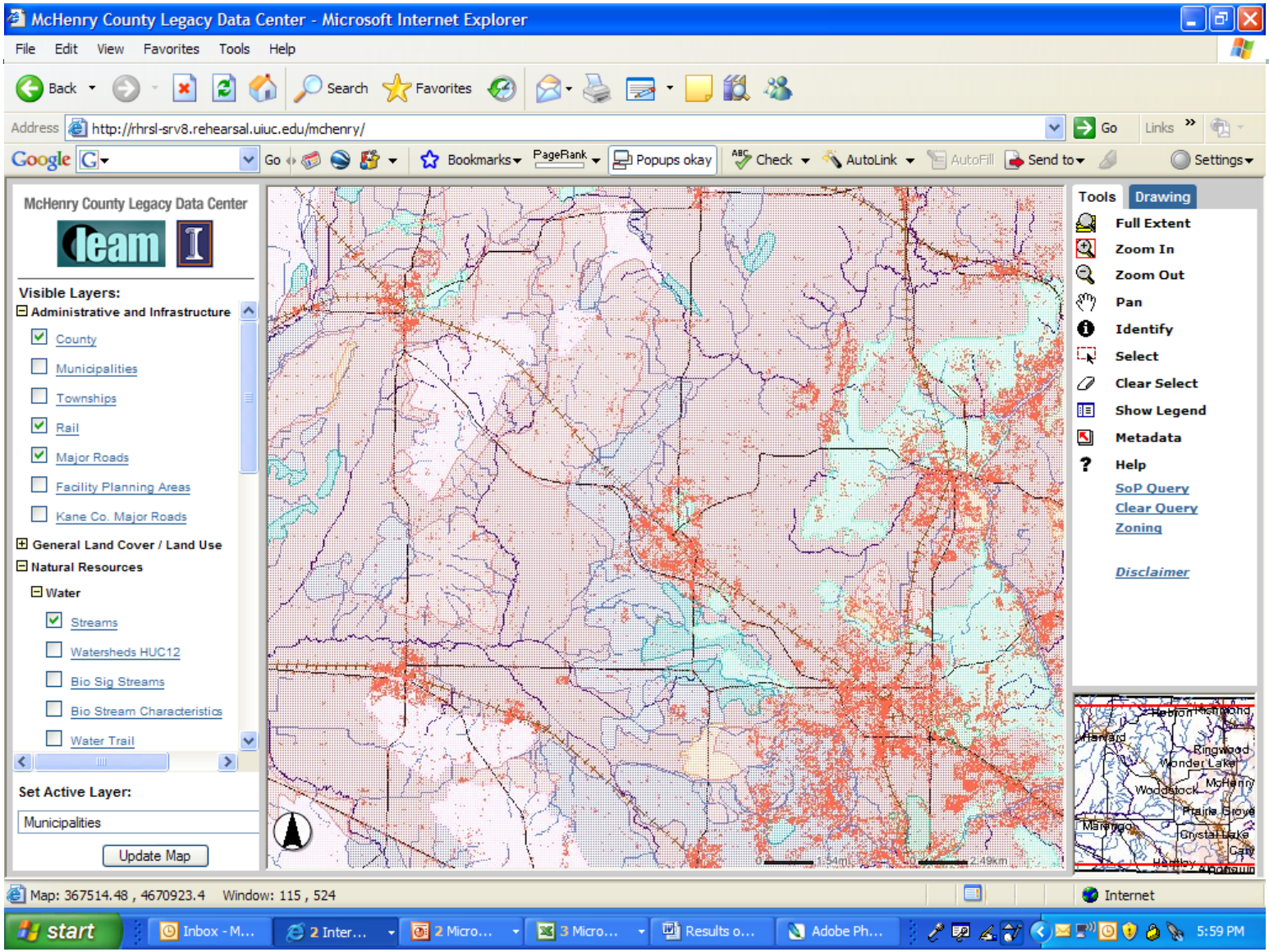
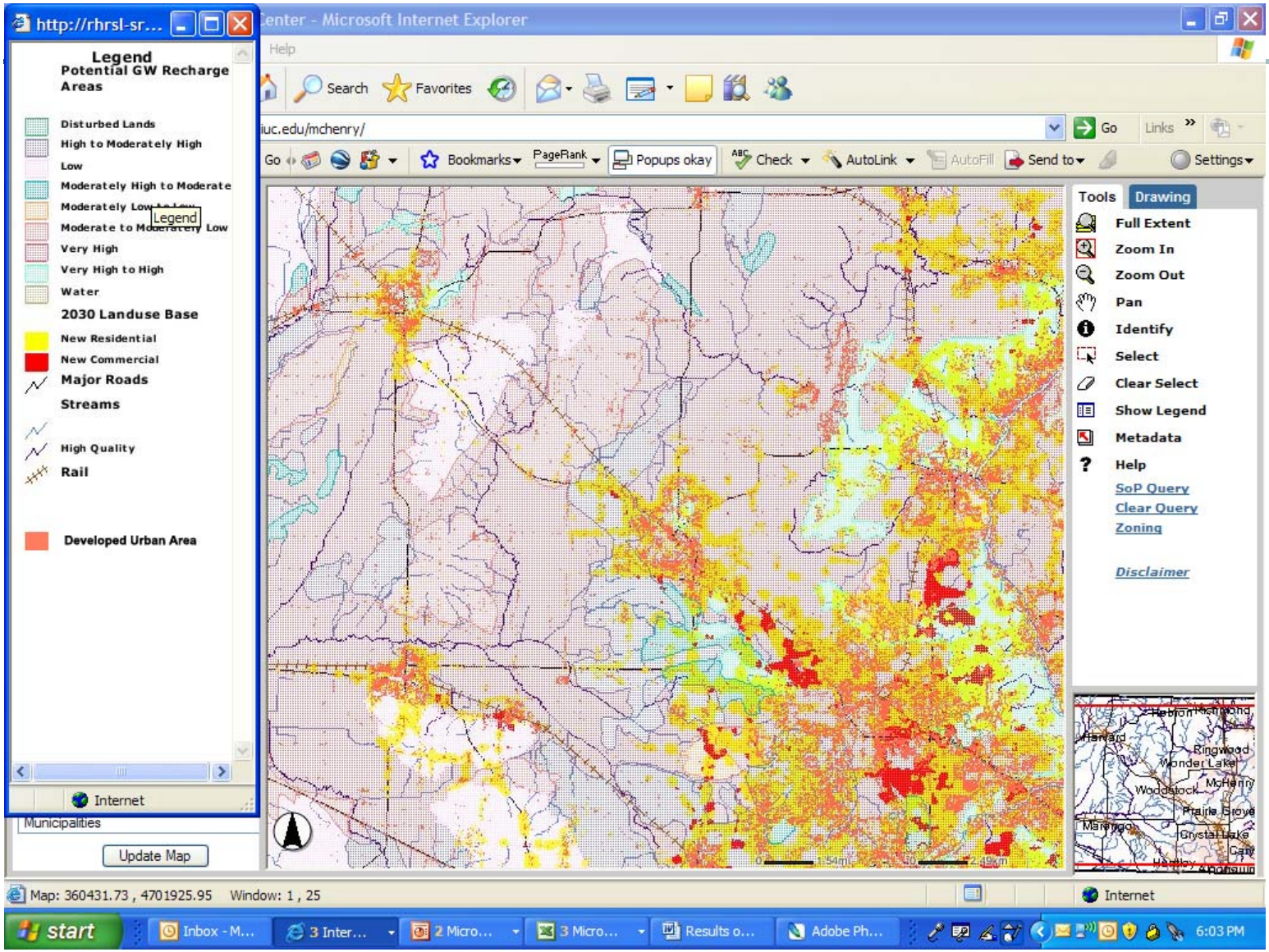
# Potential Groundwater Recharge Areas






- Existing urban landuse



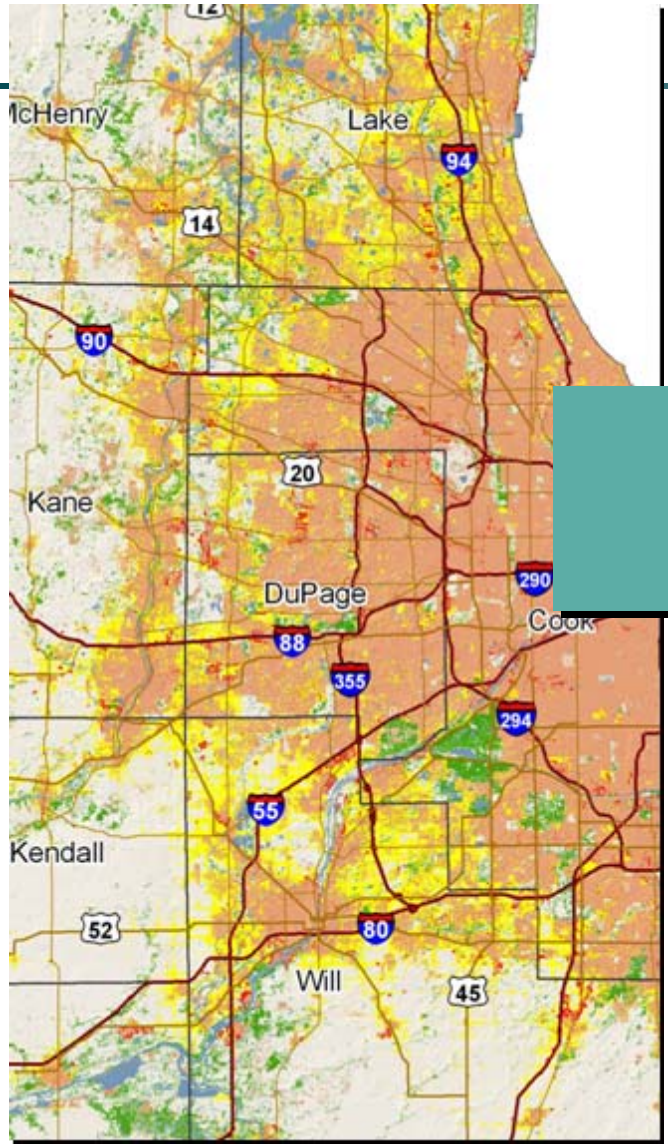

Existing urban areas and future growth

Business as usual scenari

# LEAM Applications

- Regional Planning
  - Chicago
  - St. Louis
  - Peoria
  - Traverse City, MI
  - Columbus, GA
- Travel demand modeling
  - St. Louis
  - Traverse City, MI
  - Chicago

- Environmental stress analysis
  - McHenry County, IL
  - Will County, IL
  - Peoria
  - St Louis
- Economic Development
  - Edwardsville, IL
  - Peoria, IL
- Watershed Analysis
  - Kishwaukee River Basin
    - Wisconsin, IL
- Urban encroachment on military bases
  - Ft. Benning
  - Ft. Bragg
  - Scott AFB
  - Camp Lejune
  - Camp Ripley
- International Planning
  - Ansung City. Korea
- Impacts Analysis
  - Metro St Louis
  - Peoria, IL
  - McHenry County
  - Ft Bragg, NC
- Factor Analysis
  - Belleville, IL
  - Peoria, IL
  - LaSalle County



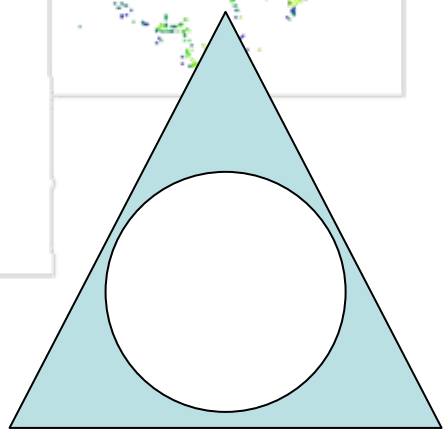

# Lessons Learned

landuse evolution and impact assessment model

# Some Lessons Learned

- Need faster feedback for deliberations
- The process of modeling can be more important than the model
- The need to link multiple scales
- Action Research promotes emergent research questions

- Learn by doing
  - Contribute to practical concerns of a constituent population
    - engage in the situation being studied
  - Costs
    - Integral to a process
    - Requires long-term relationships
    - Requires a programmatic infrastructure
  - Benefits
    - Real time critique of hypotheses and inferences
    - Practical solutions, sense of making a difference
    - Uncovers synergistic behaviors



# Feedback Matters

- Need better (faster) feedback for decisions
  - Steinitz - Scenario-Based Studies of Alternative Futures
    - "Alternative futures studies are also valuable in helping to manage uncertainty and risk. Because no one can tell what the actual future will be, investigating several options, which might encompass a spectrum of possibilities, can provide a useful step toward making sustainable decisions."
    - Process of observation to output and communal dialogue
      - How should the state of the landscape be described?
      - How does the landscape operate?
      - Is the current landscape functioning well?
      - How might the landscape be altered?
      - What predictable differences might the changes cause?
      - How should the landscape be changed?
    - Lacks feedback
    - Time (not viable for continuous dialogue)

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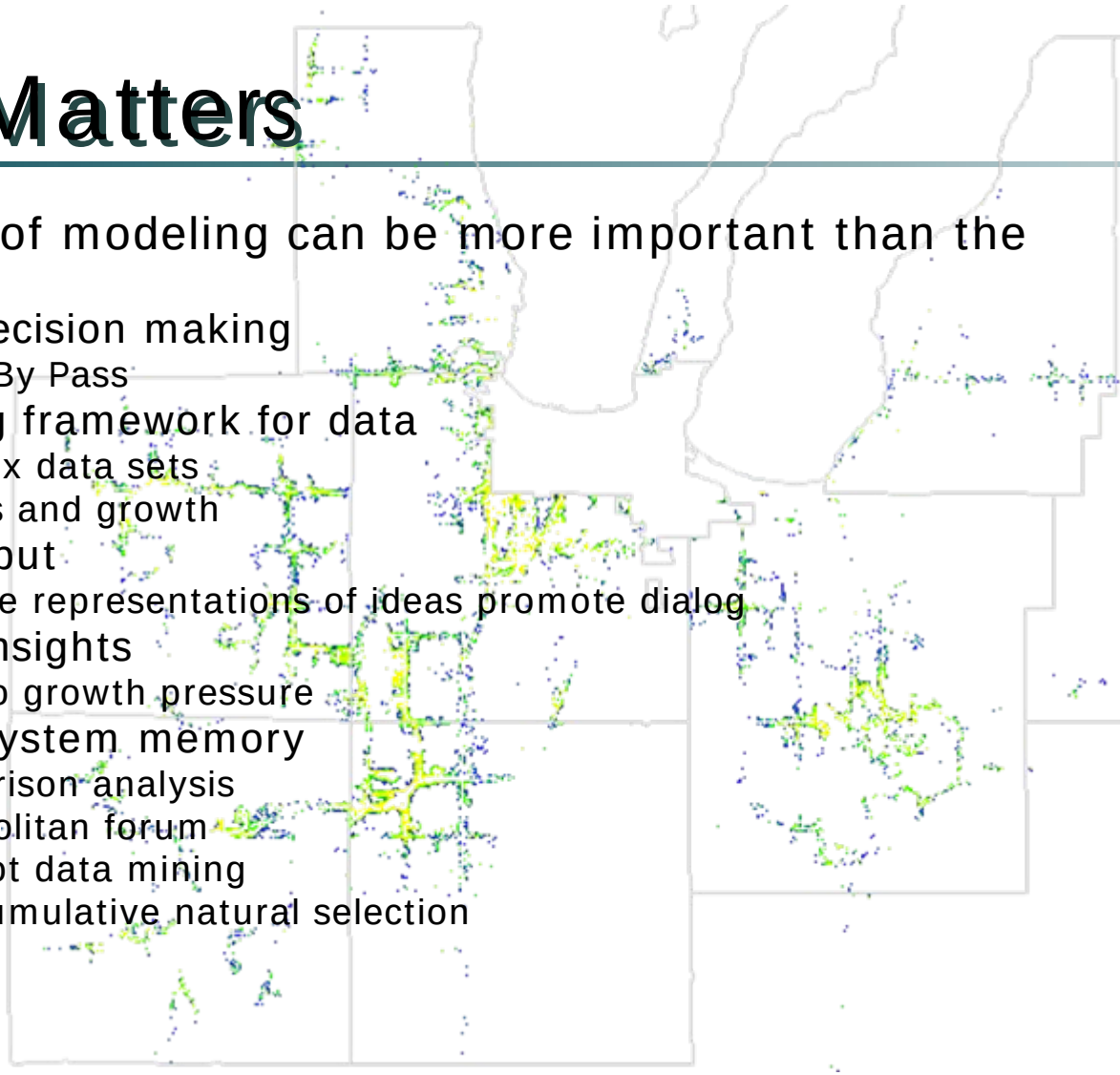
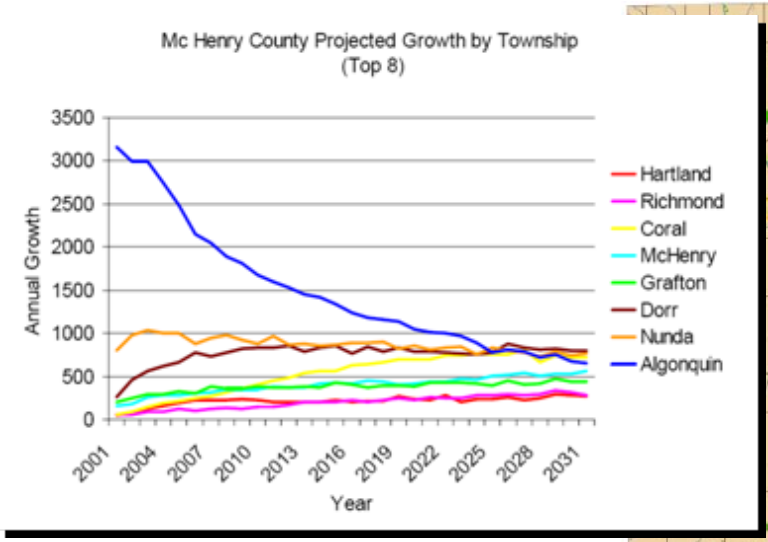
# Process Matters

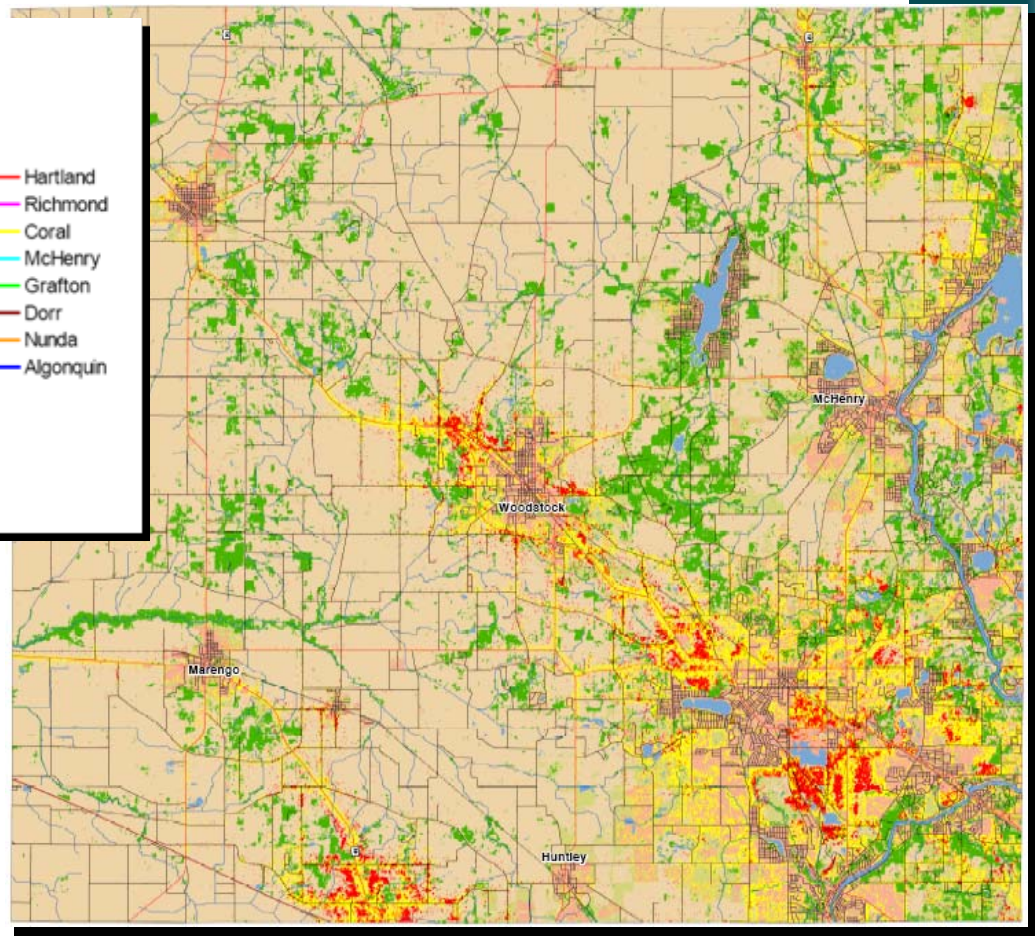
- The process of modeling can be more important than the model
  - Informs decision making
    - Peoria By Pass
  - Organizing framework for data
    - Complex data sets
    - Schools and growth
  - Visual output
    - Tangible representations of ideas promote dialog
  - Provides insights
    - Lake Co growth pressure
  - Provides system memory
    - Comparison analysis
    - Metropolitan forum
      - Not data mining
      - Cumulative natural selection



# The Importance of Visualization

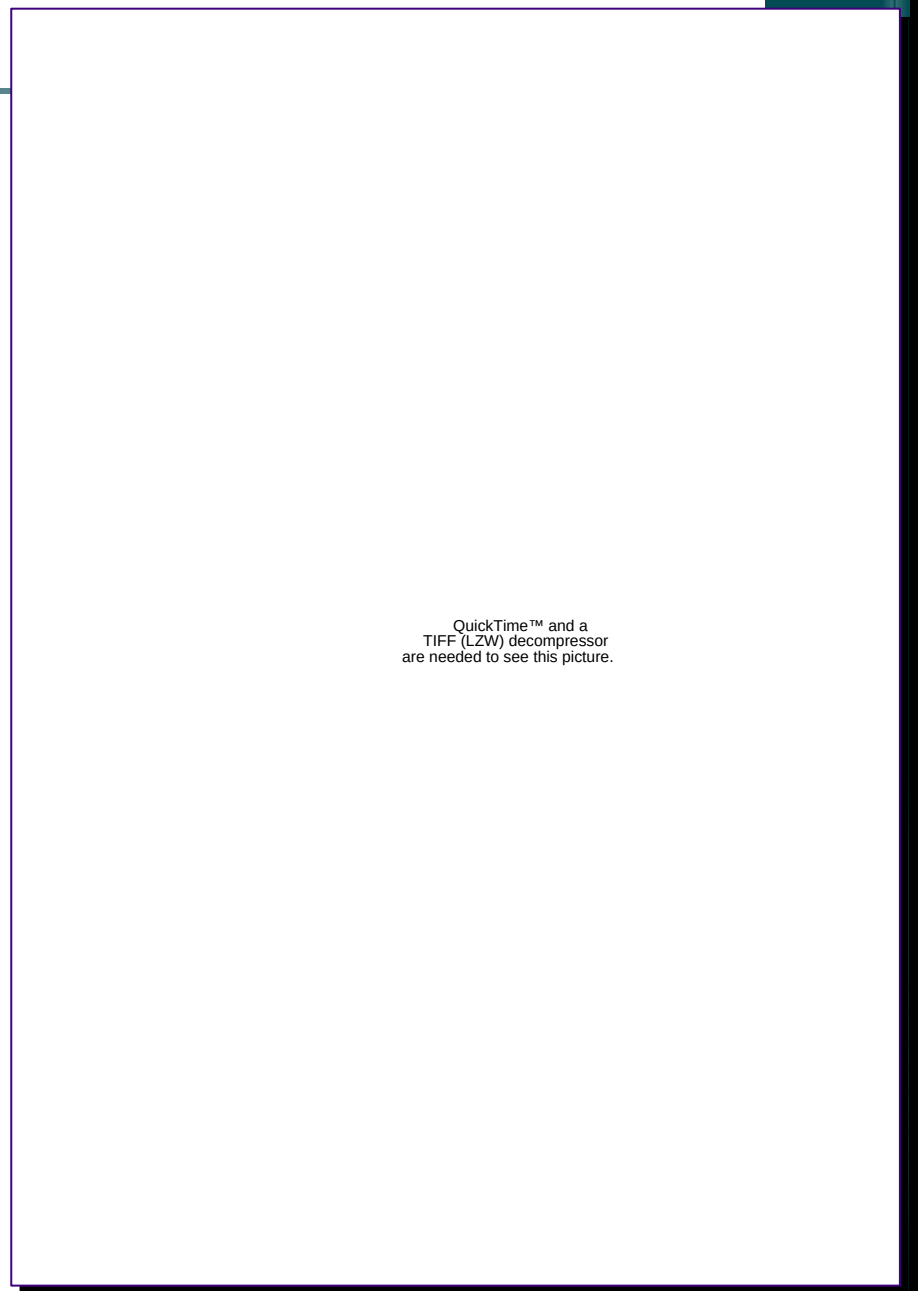



McHenry County
LEAM

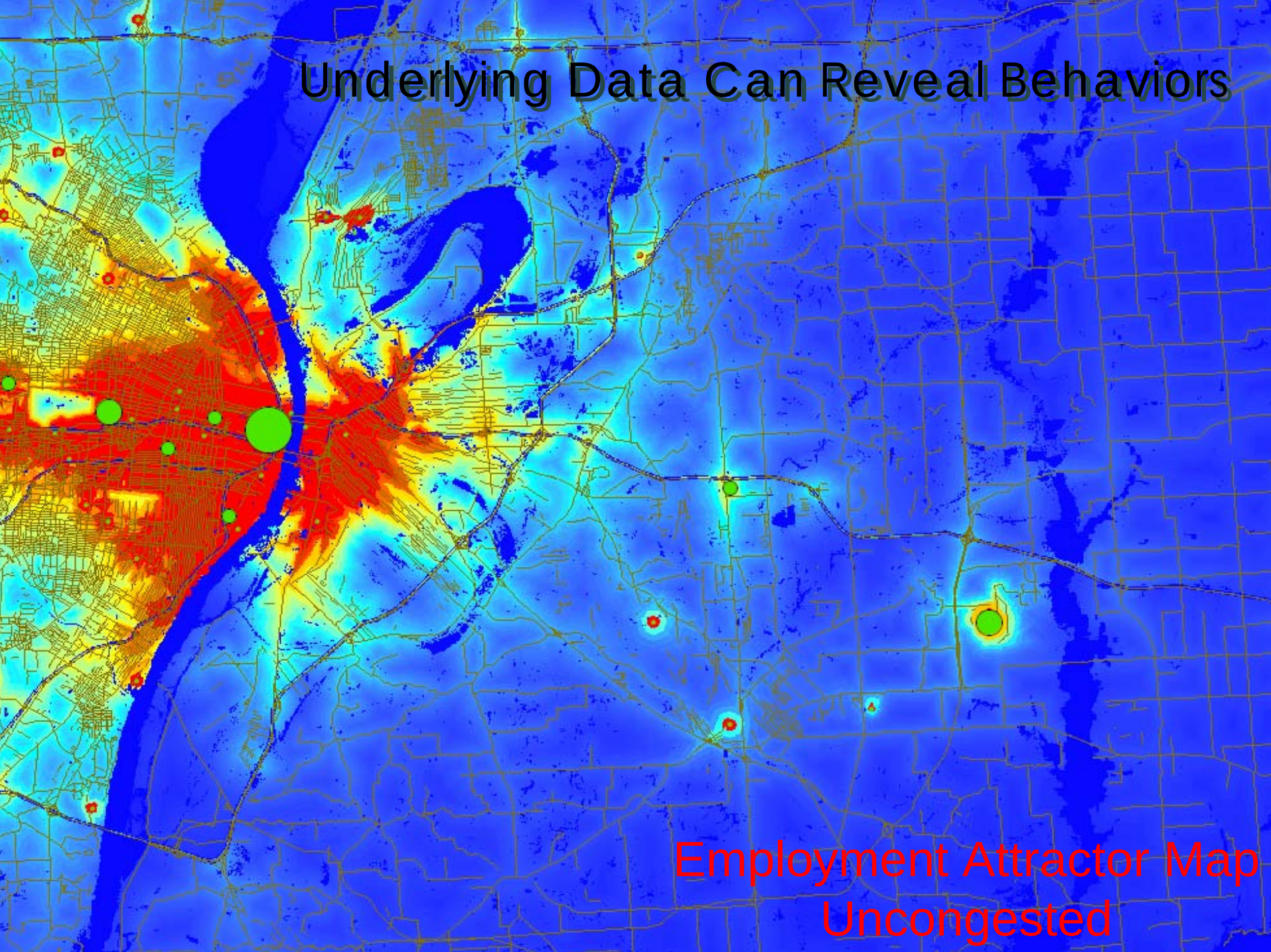


# Process Provides Insights

- Lake County pressure
  - What policies are needed to curtail growth in sensitive areas?
- Are planning tools available?
  - Zoning, policies and other planning tools
- How do investments alter outcomes?
  - New rail stations
  - Where do you get the most for the investment dollars?
    - Depends on what you are conserving
- How does downtown redevelopment affect the outcomes?
- The importance of areas of future growth for establishing current policy.



# Underlying Data Can Reveal Behaviors



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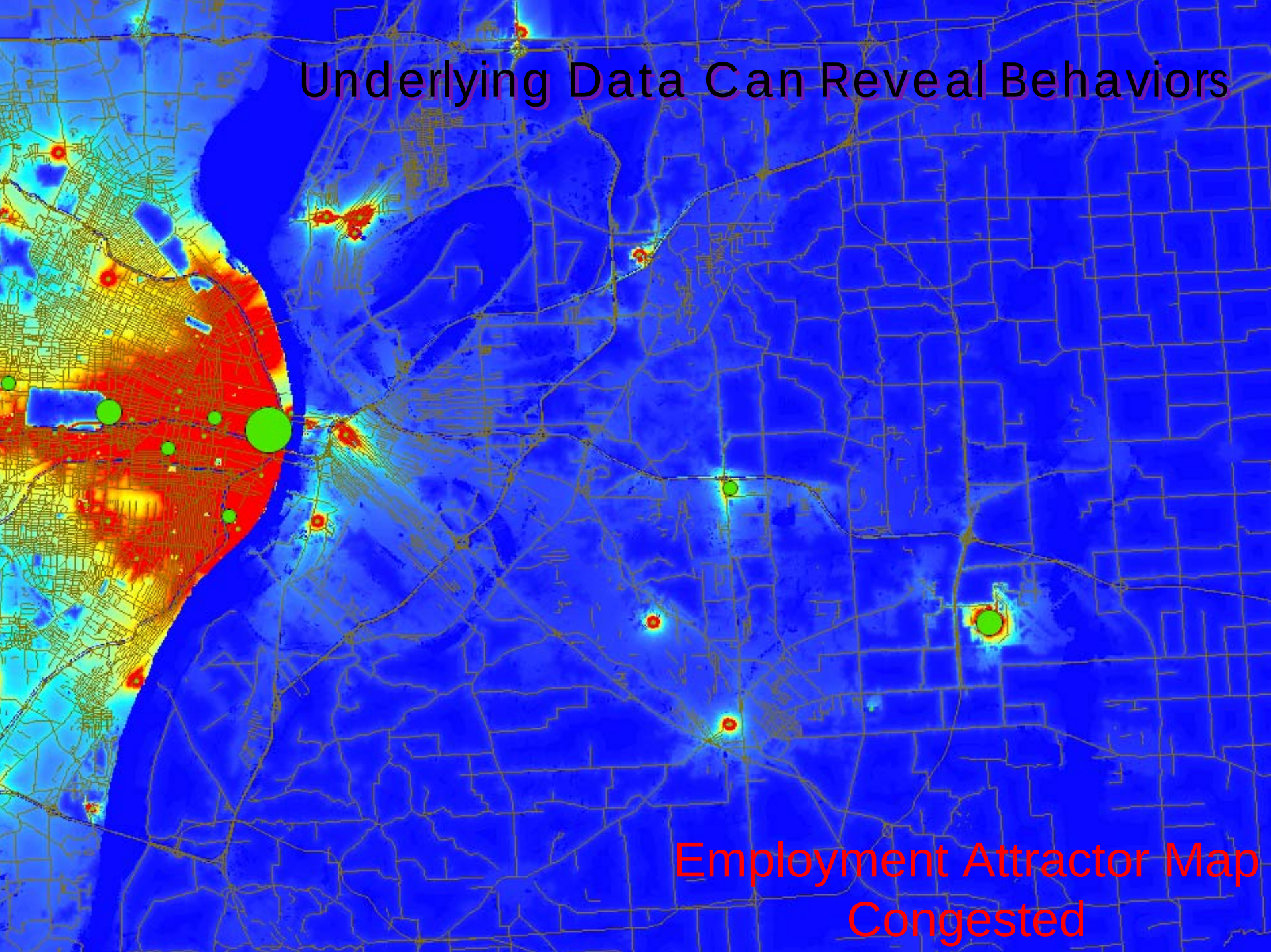
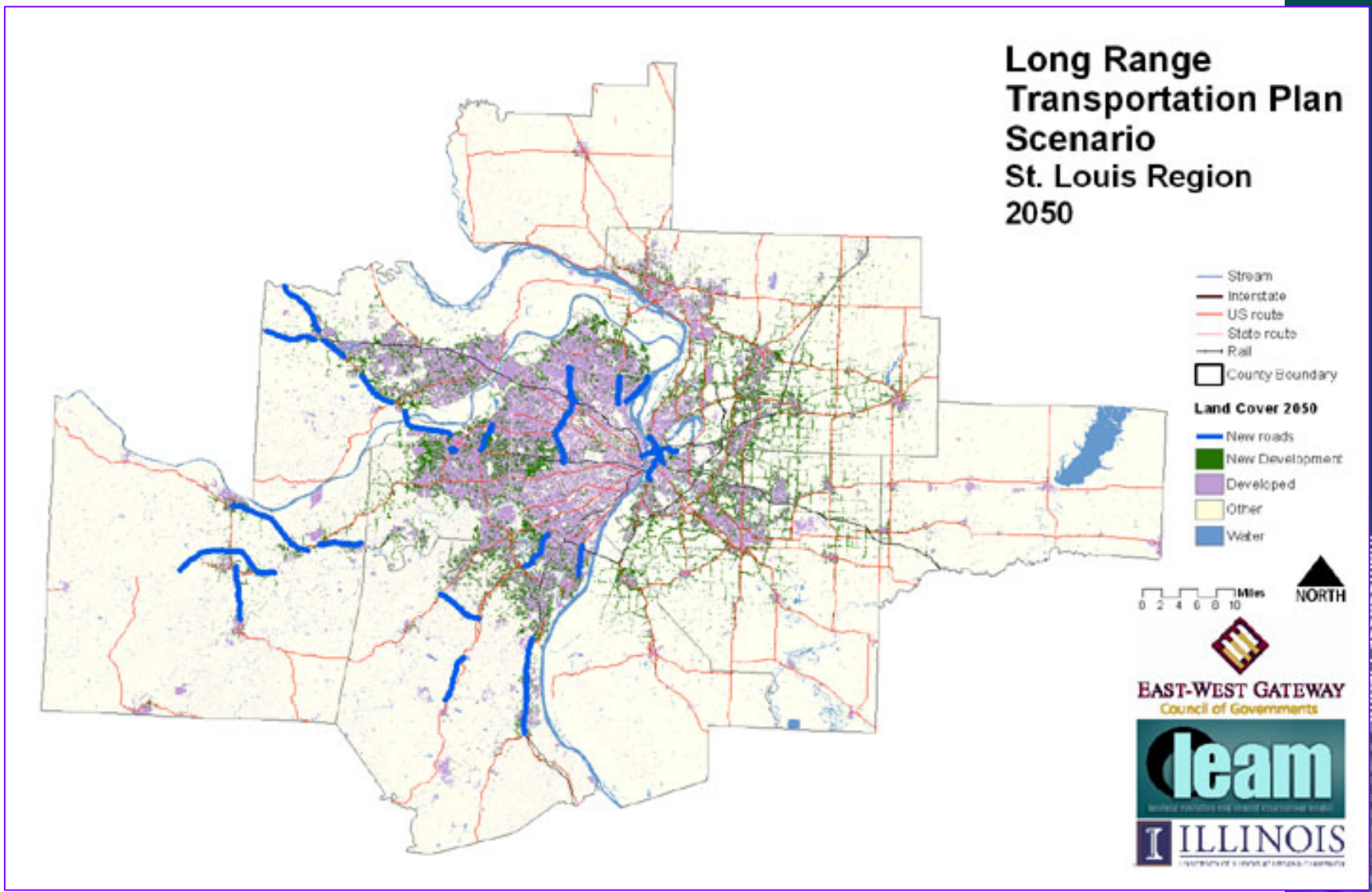


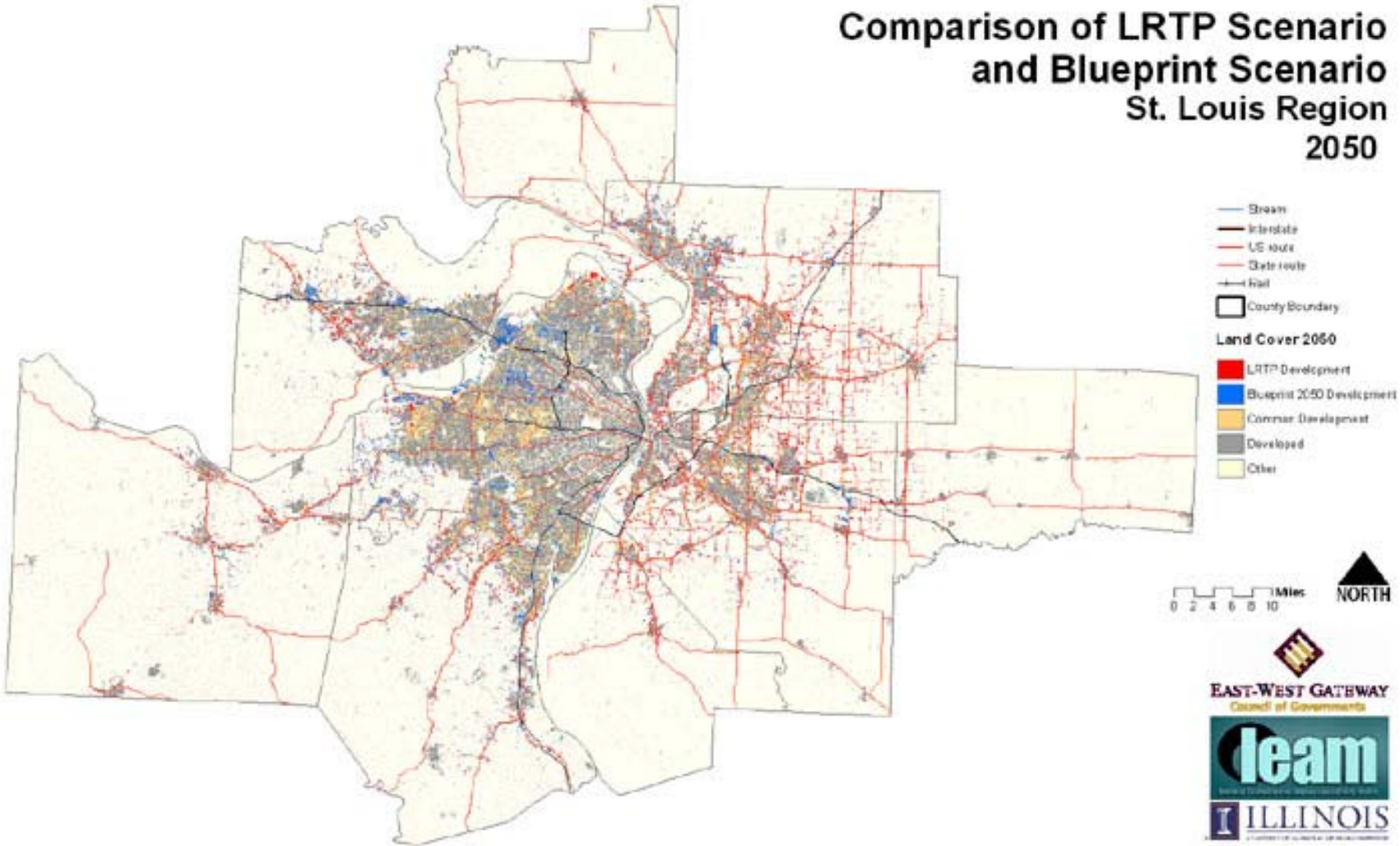
# Scenario Building

## Provides Systems Memory



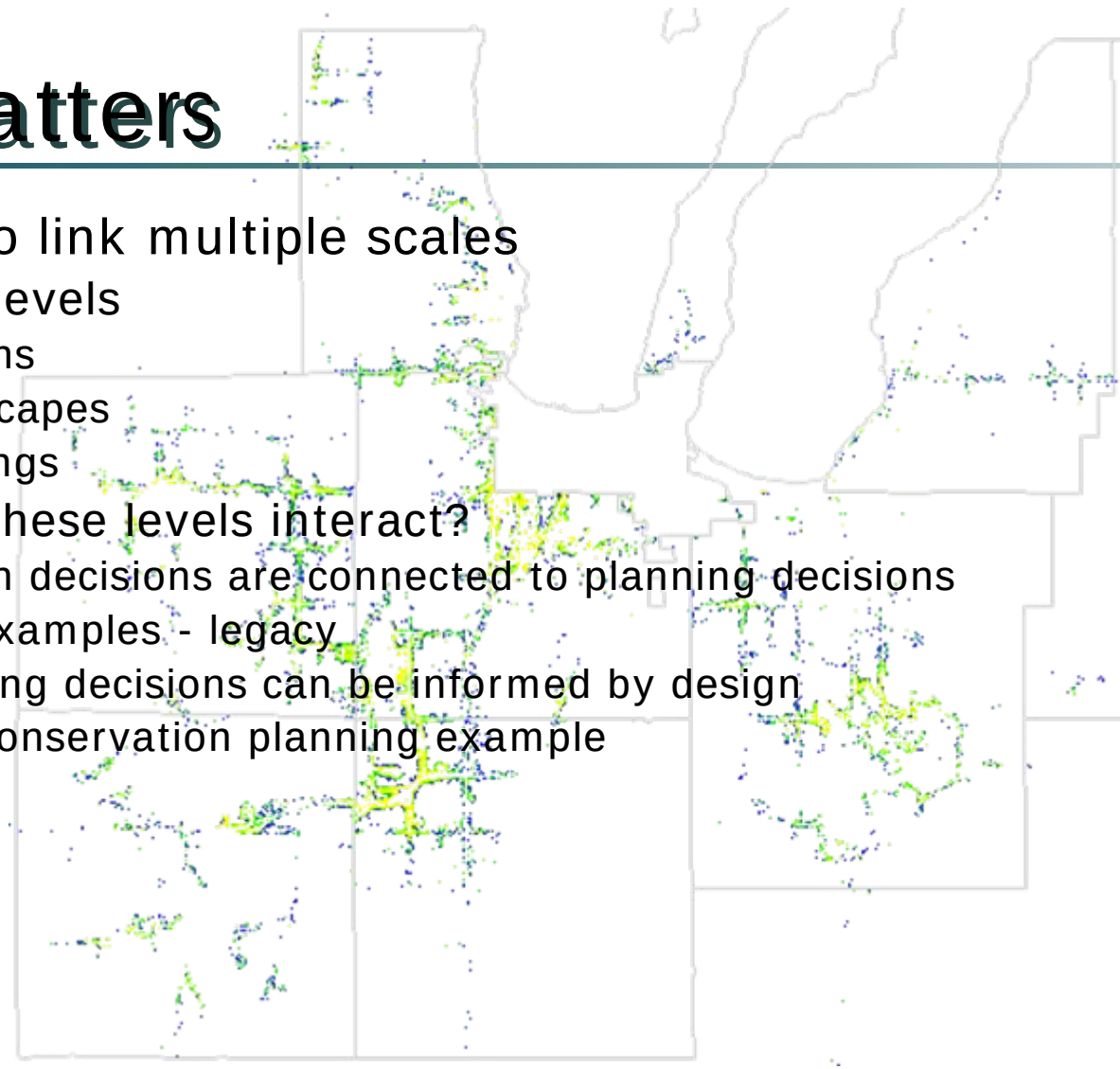
# Comparisons

## Scenario Building

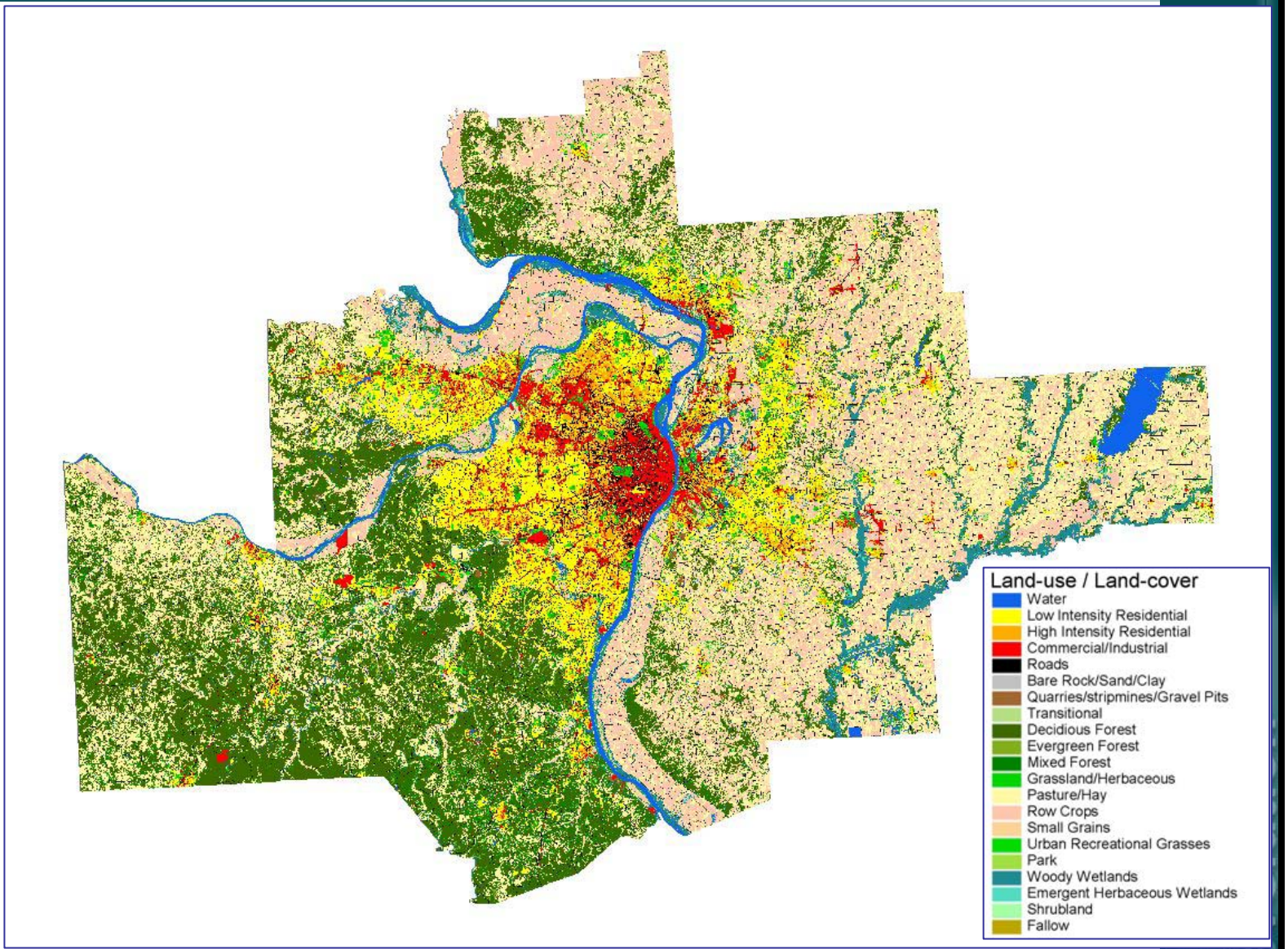


# Scale Matters

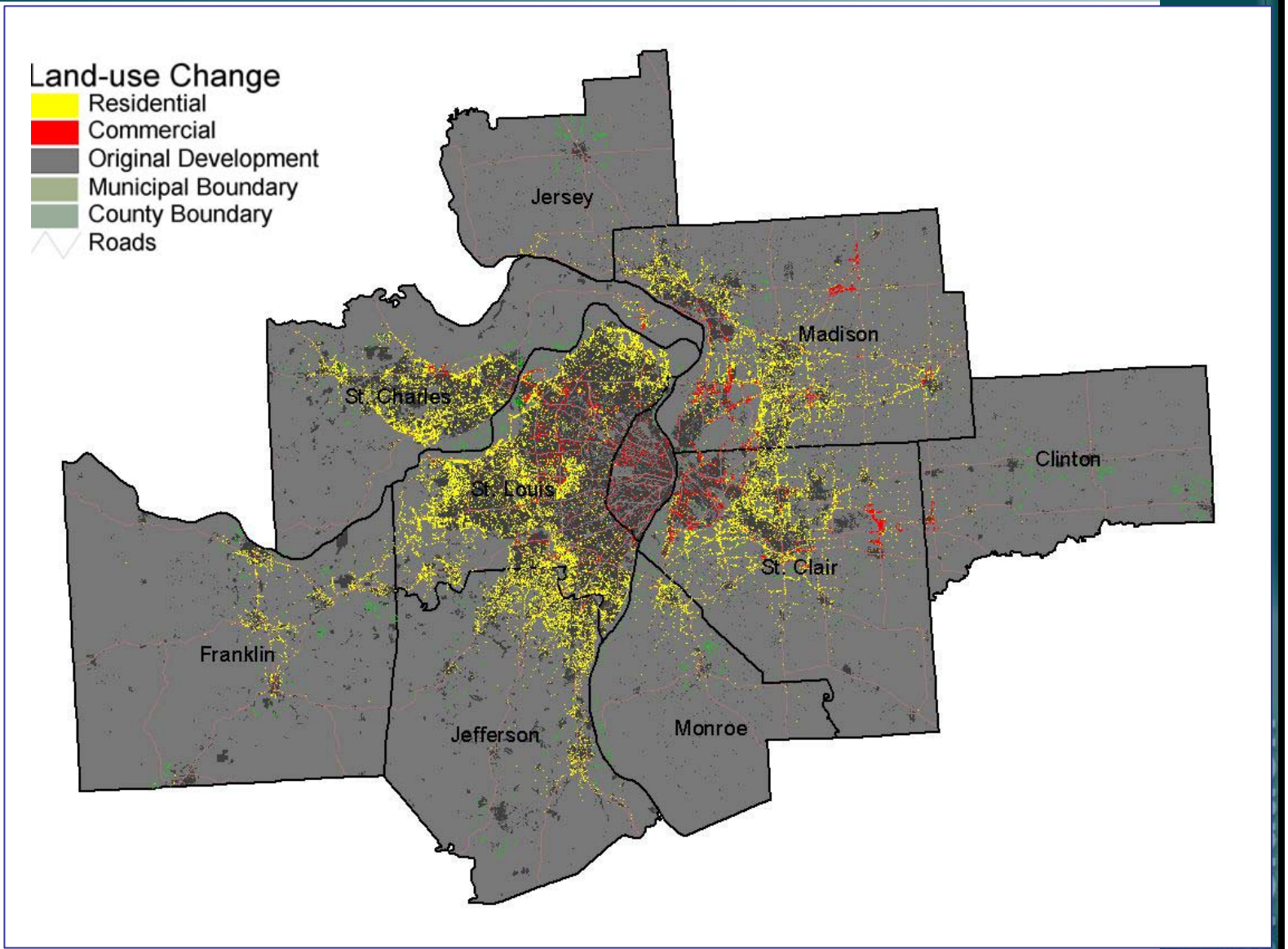
- The need to link multiple scales
  - Multiple levels
    - Regions
    - Landscapes
    - Buildings
  - How do these levels interact?
    - Design decisions are connected to planning decisions
      - Examples - legacy
    - Planning decisions can be informed by design
      - Conservation planning example



# Regional Scales



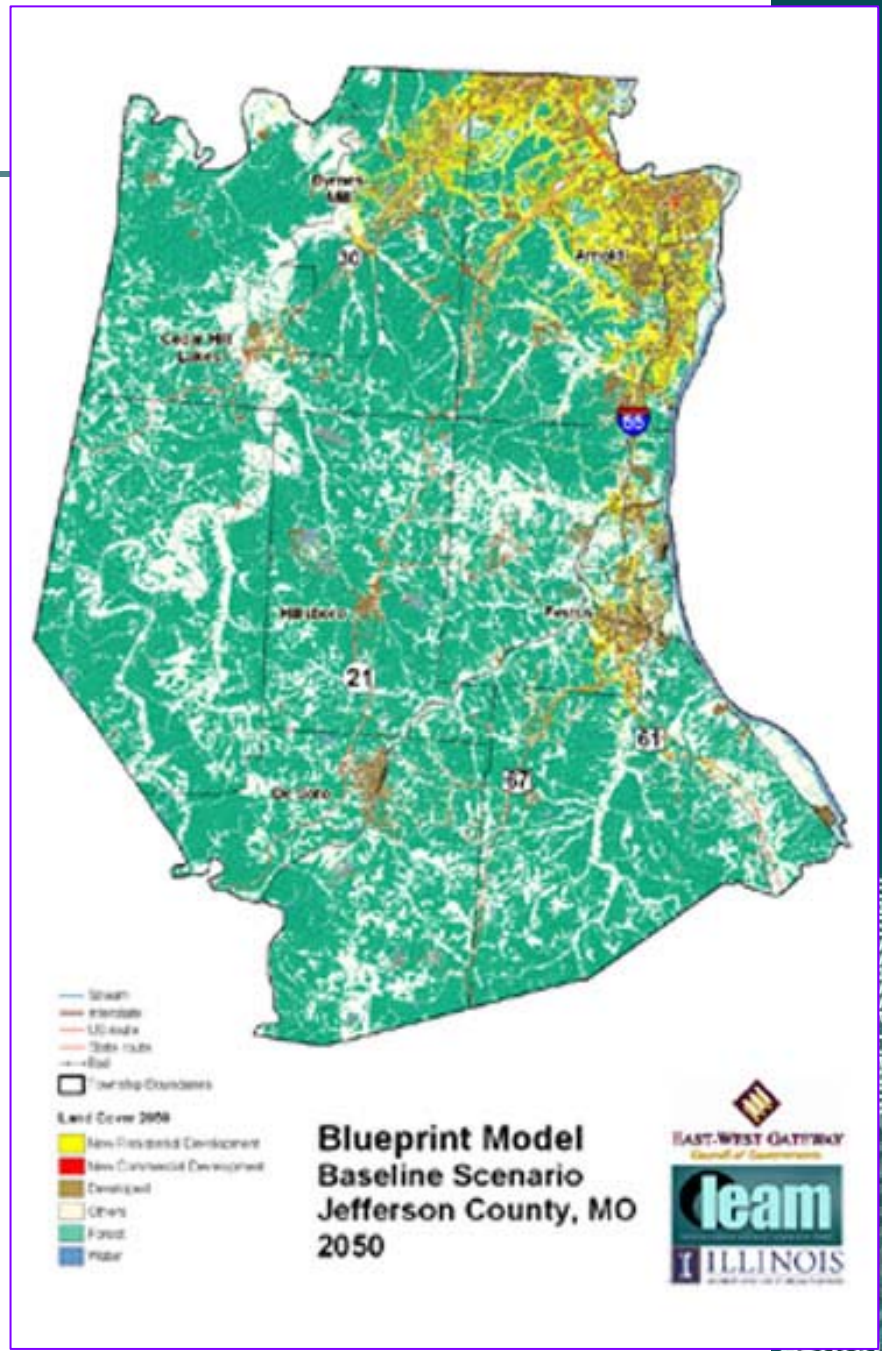
# Regional Analysis



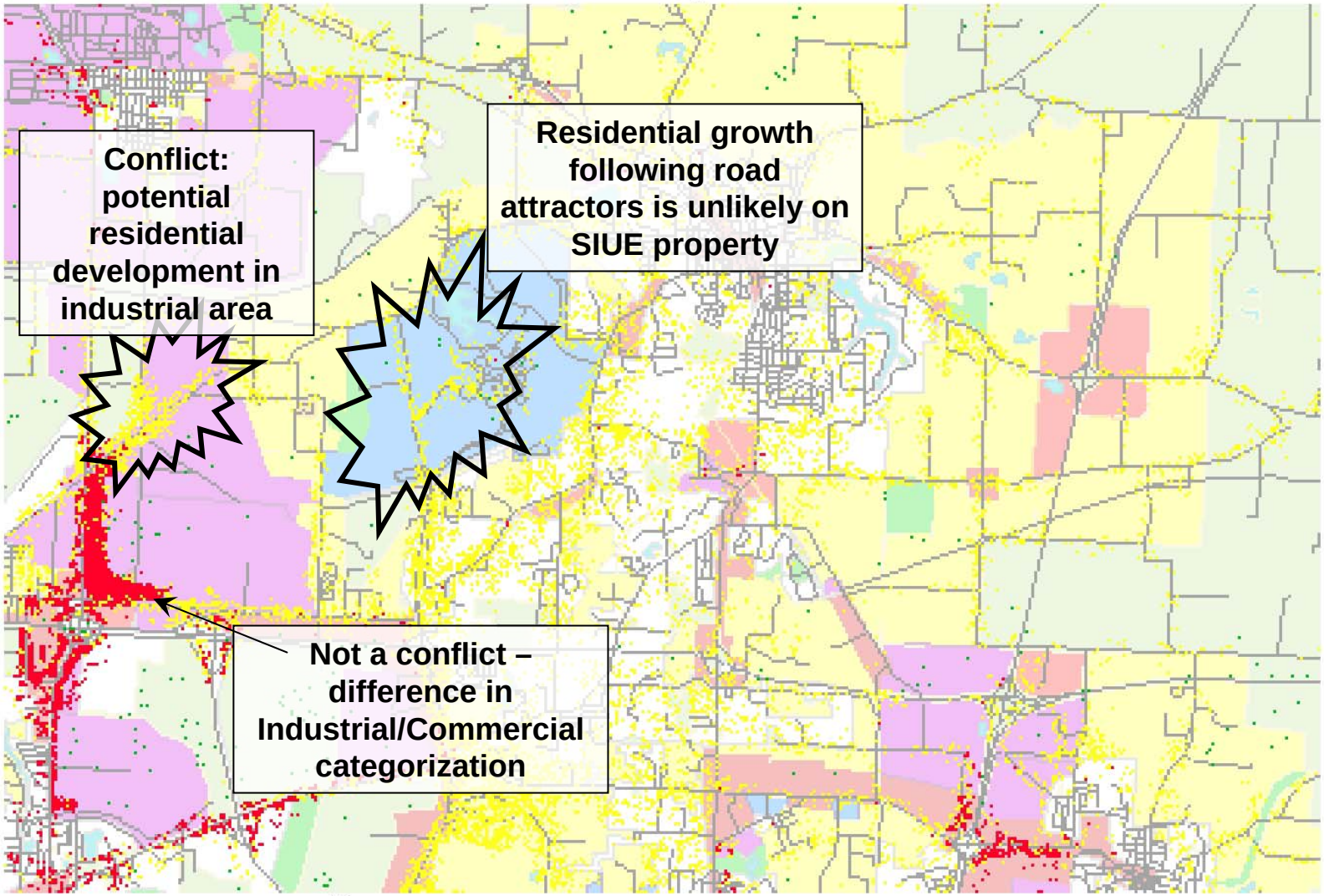
# County Level Analysis

Blueprint-LEAM

Jefferson County Landuse



# LEAM Blueprint 2030 and Madison County Plan 2020 - Edwardsville/Glen Carbon



# Summary

- Sustainability is a planning issue
- All communities want to be more sustainable
  - The question is how?
- New tools are available to help us make sense of the ‘how’ question
  - Provide multiple futures analysis
  - Assessing implications of current decisions on the future
  - Facilitating scenario-based planning

# Contact Information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