# Linking Science to Practice in Landscape Change

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# A persistent tension in science

- Pure science
  - acquiring knowledge to satisfy curiosity
- Applied science
  - acquiring knowledge to solve societal problems
- Pure and applied mathematics, engineering, geography
- Knowledge abstracted from space and time
  - knowledge of what is true everywhere and always is the most satisfying and the most valuable

# Putting science into practice

- The design disciplines
  - planning, architecture
- Intervention rather than investigation
  - action rather than study
- Landscape architecture as a case in point

# Can there be a science of intervention?

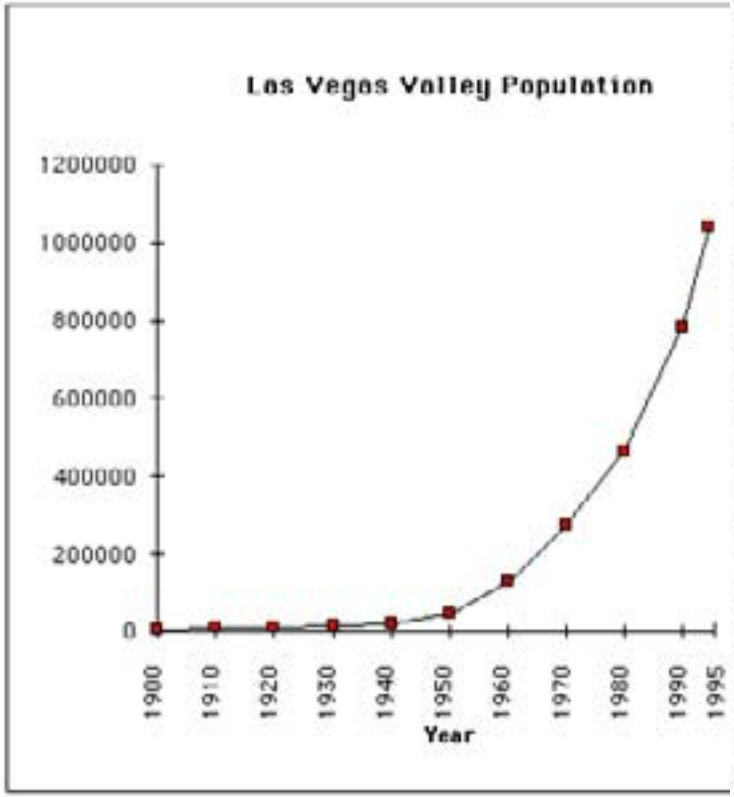
- NSF does not invest in the design disciplines
  - the design disciplines implement the scientific knowledge acquired by others
  - design is not *scientific*
- Can the process of intervention be scientific?
  - can one study the process scientifically, and reach generalizable conclusions?
  - can intervention be conducted scientifically?

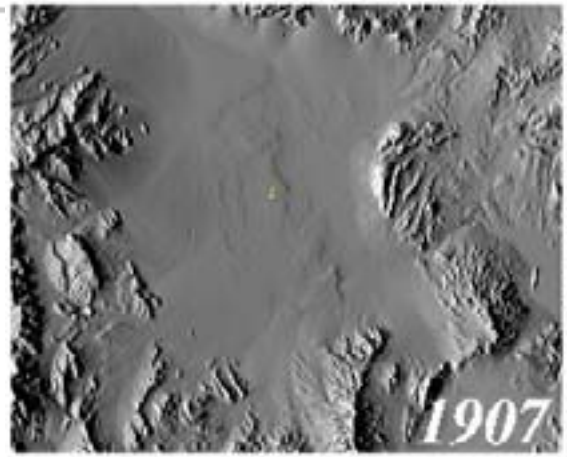
# What do philosophers of science say?

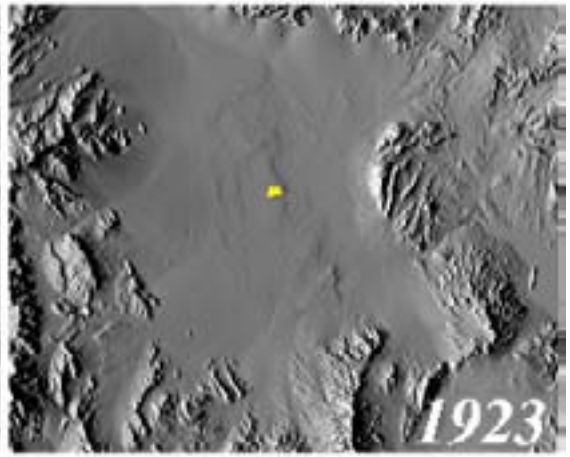
- For example, Laudan:
  - science is a process of problem-solving
  - it is irrelevant whether the problem is one of detached study, or engaged action
  - the normal apparatus of science applies in both cases
    - rigorous definitions
    - shared terminology
    - replicable results
    - generalizable conclusions
  - L. Laudan, *Beyond Positivism and Relativism* (Westview Press, 1996)

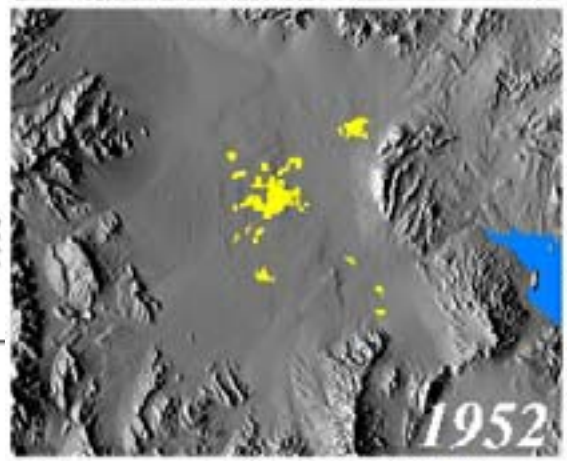
# Why landscape change?

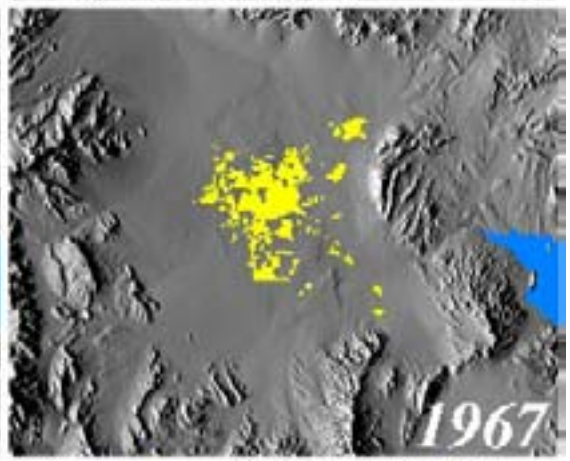
- Change is dramatic and problems are immediate
  - sprawl
  - climate change
  - land use transition
- Requires integrated science

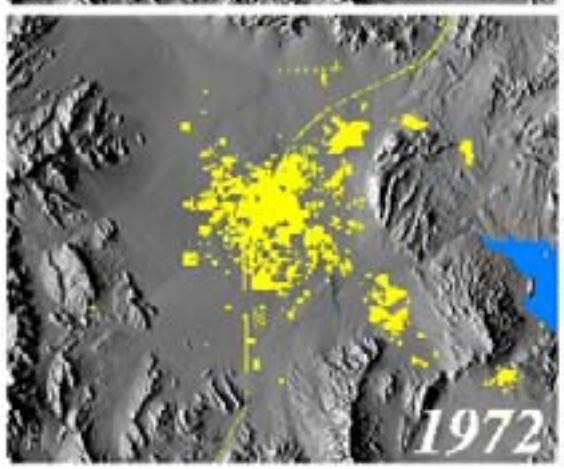

Las Vegas Valley Population
1200000
1000000
800000
600000
400000
200000
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
1995
Year

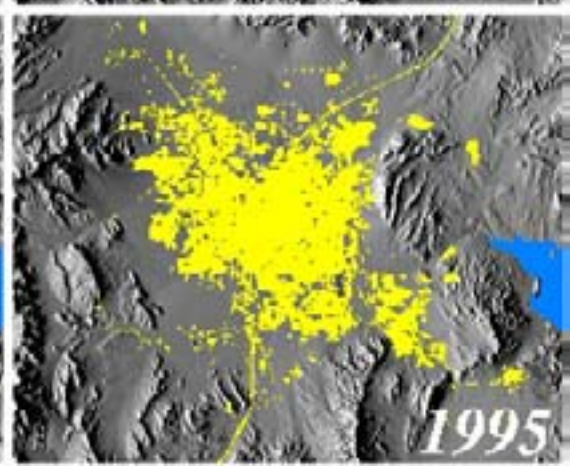

1907


1923


1952


1967


1972


1995

# A model for landscape architecture

- Ian McHarg's school at the University of Pennsylvania

Ian McHarg
1920-2001

Meteorology

Geology

Hydrology

Plant ecology

Animal ecology

Limnology

Computation

Remote sensing

"For the first time, a department of landscape architecture could recruit a faculty of distinguished natural scientists sharing the ecological view and determined to integrate their perceptions into a holistic discipline applied to the solution of contemporary problems."

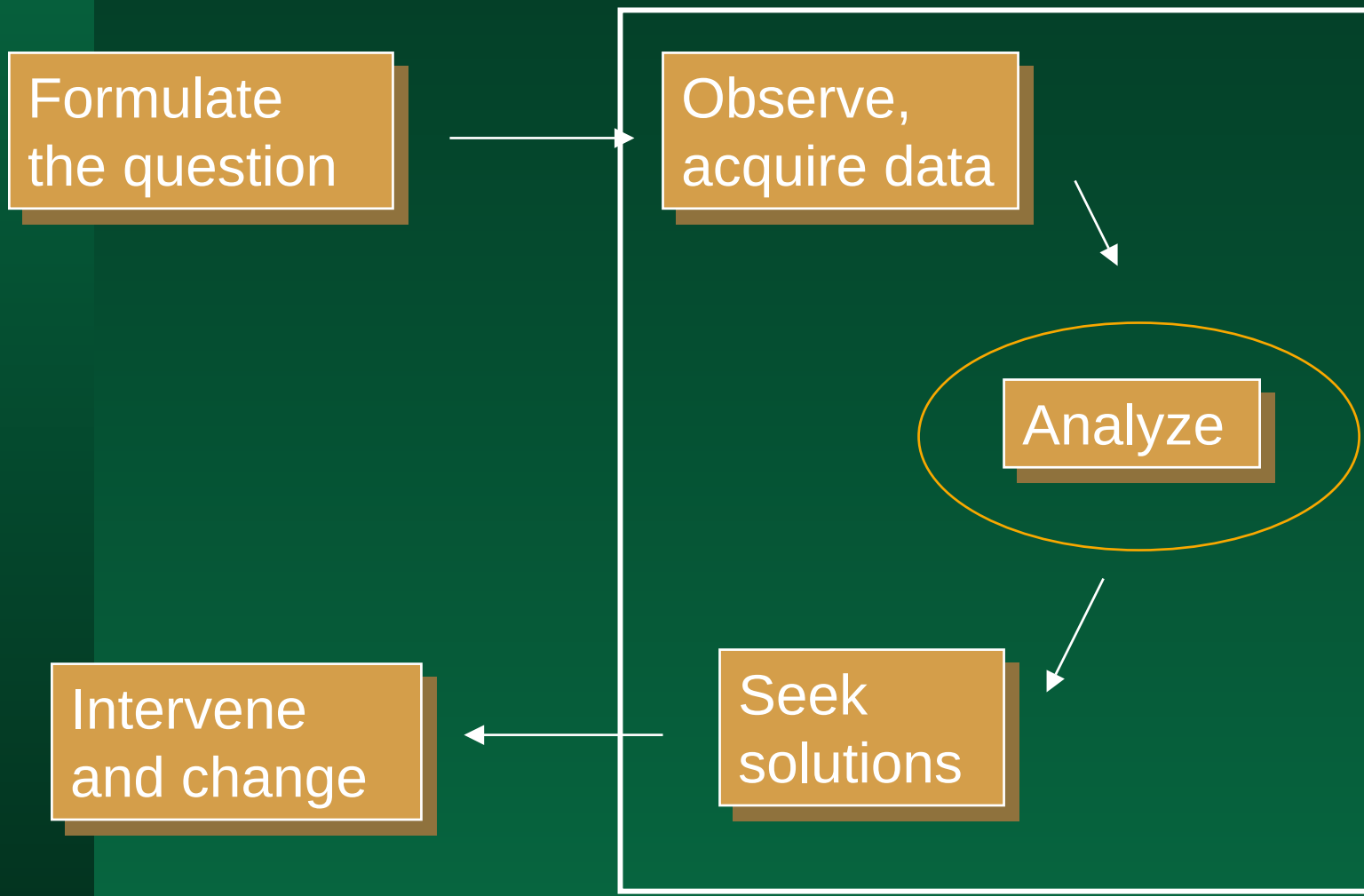
I.L. McHarg, *A Quest for Life* (Wiley, 1996, p. 192)

- Integration of science into action
- Frequently emulated as a model for environmental science
  - But with a weaker intervention component
- The social context is missing
- Computation and remote sensing do not fit the model

# The role of technology

- Computation and remote sensing
  - David Simonett and Waldo Tobler as advisors
  - Bruce MacDougall hired
    - an early proponent of geographic information systems (GIS)
- Technology as
  - a source of data
  - an engine for computation
  - a means of visualization
  - formal and replicable

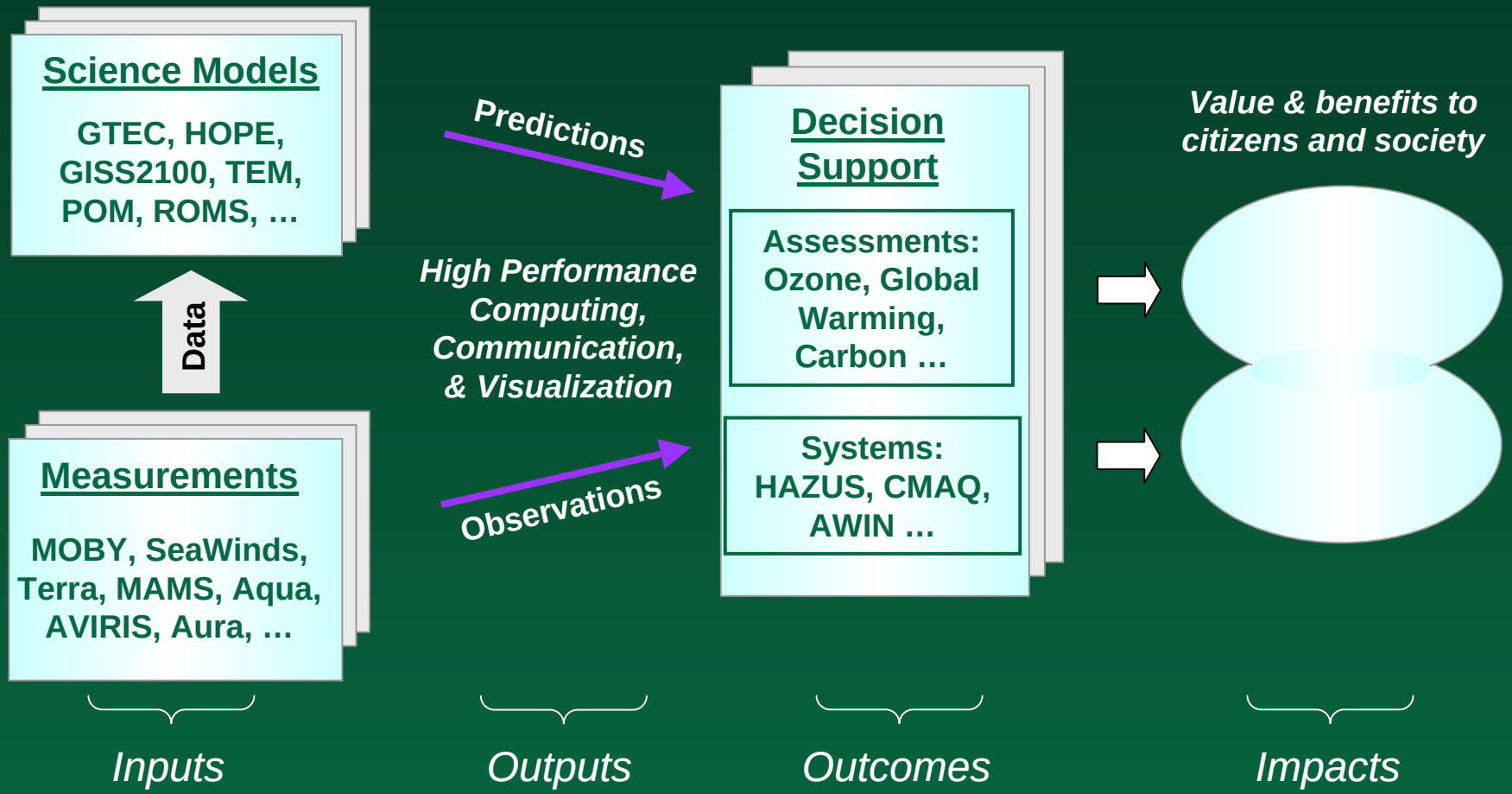
# Stages of problem solving



# 35 years later

- Has a science of intervention evolved?
- Is intervention more scientific?
- Has the role of technology advanced?
  - what are its components?
- How should we update the McHarg model?

# The NASA model



# Earth System Models

## LAND

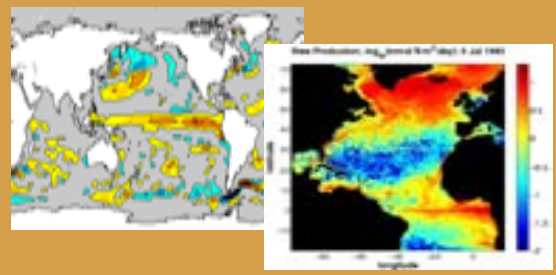
**GTEC**
*Terrestrial Ecosystem Carbon*

| | |
|---|---|
| **Mosaic** | *Energy, water fluxes* |
| **CENTURY** | *Land change/carbon* |
| **VolQuake** | *Seismicity* |
| **HSPF** | *Nutrient transport* |
| **ANIMO** | *Soil nitrogen cycle* |
| **PRMS** | *Precipitation run-off* |
| **MAESTRO** | *Canopy biomass* |

**Catchment LSM**
*Soil Moisture Transport*

## OCEANS/ICE

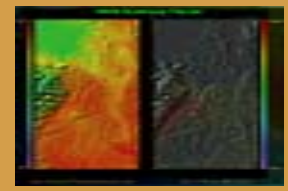
| | |
|---|---|
| **ROMS** | *Regional circulation* |
| **MOM3** | *Multi-scale ocean* |
| **CSIM4** | *Sea-ice* |
| **NWW3** | *Global/regional waves* |
| **BOM** | *Coastal & shelf seas* |
| **GOTM** | *Turbulence & mixing* |



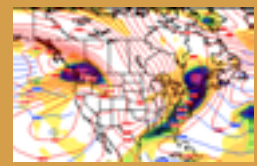
**Poseidon, HYCOM**
*Ocean GCM*

## ATMOSPHERE

**MM5**
*Mesoscale Meteorology*



| | |
|---|---|
| **CAM/CCM** | *Global climate* |
| **GISS GCM** | *Climate change* |
| **BEIS** | *Biogenic emissions* |
| **MSISE** | *Density, temperature* |
| **VAFTAD** | *Volcanic ash* |
| **PRECIS** | *Regional climate* |

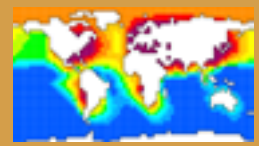


**Aries/GEOS**
*Atmos. GCM*

## COUPLED MODELS

**COUPMODEL**
*Soil-Plant-Atmosphere*

| | |
|---|---|
| **LOIS** | *Land-Ocean* |
| **HadCM3** | *Ocean-Atmosphere* |
| **COLA** | *Atmosphere-Land/Biosphere* |
| **ZEUS, CCSM** | *Land-Ocean-Ice-Atmosphere* |



**AOM**
*Atmosphere-Ocean*

# Decision support systems

- Combining space-time data with dynamic models of human and physical processes
- Built on a GIS platform
- Able to predict outcomes and evaluate alternative scenarios
- Dealing with uncertainty through sensitivity analysis, error propagation
  - accuracy assessment through hindcasting
- Designed for use by stakeholders

# UCIME Urban Change - Integrated Modeling Environment


Home

Scenario Chooser

**Scenarios:**

- **Scenario 1 - High Growth**
- Scenario 2 - Baseline
- Scenario 3 - ECP Principles
- Scenario 4 - No Growth

**Report Card:**

- **Main**
- Compare Differences
- 3-D Scenes
- Assumptions

Credits

How this site works


Last Updated on 9-26-2002

## Scenario 1 - High Growth Report Card

**Maps - Click on the map to enlarge**


Map of 1960

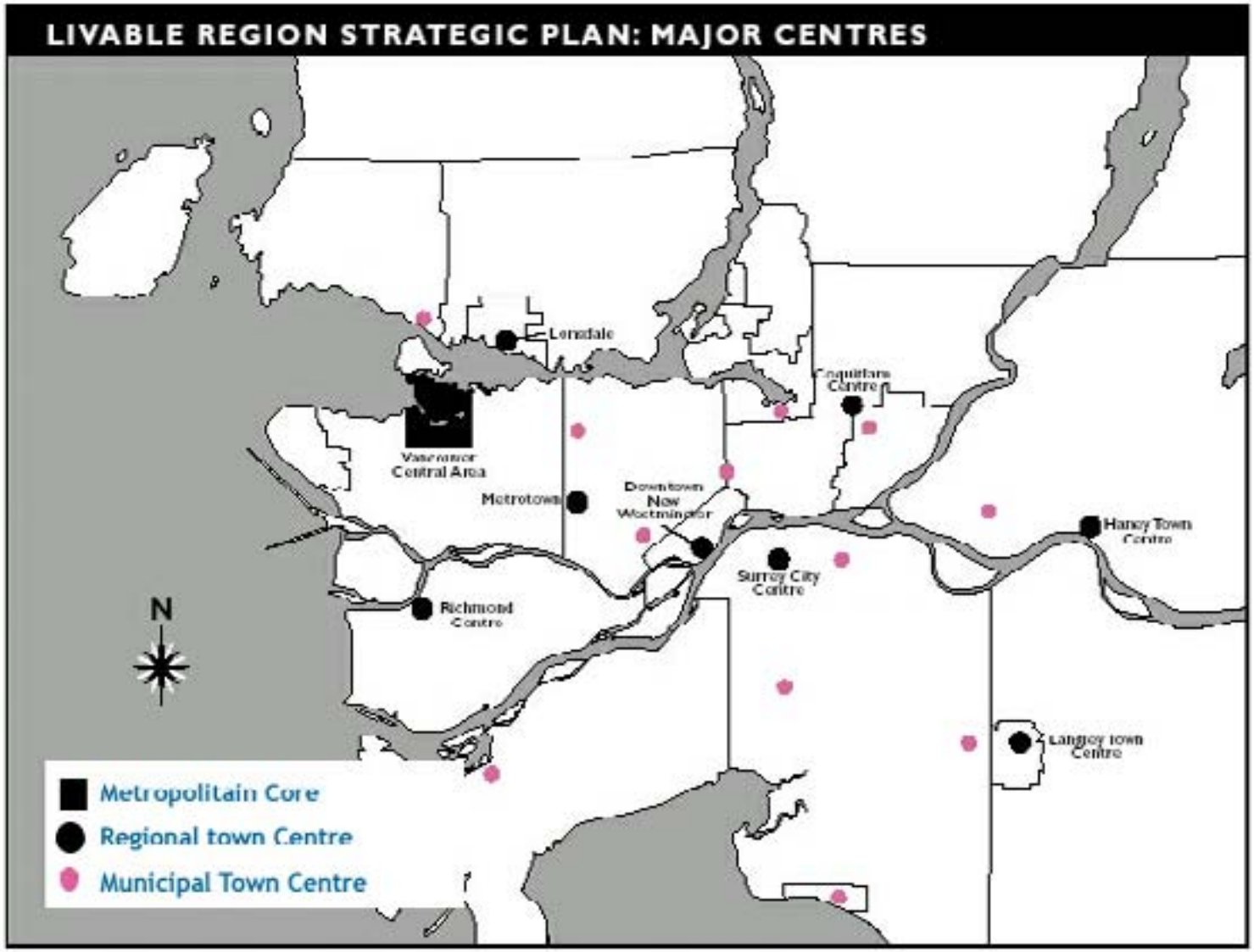

Map of 2000

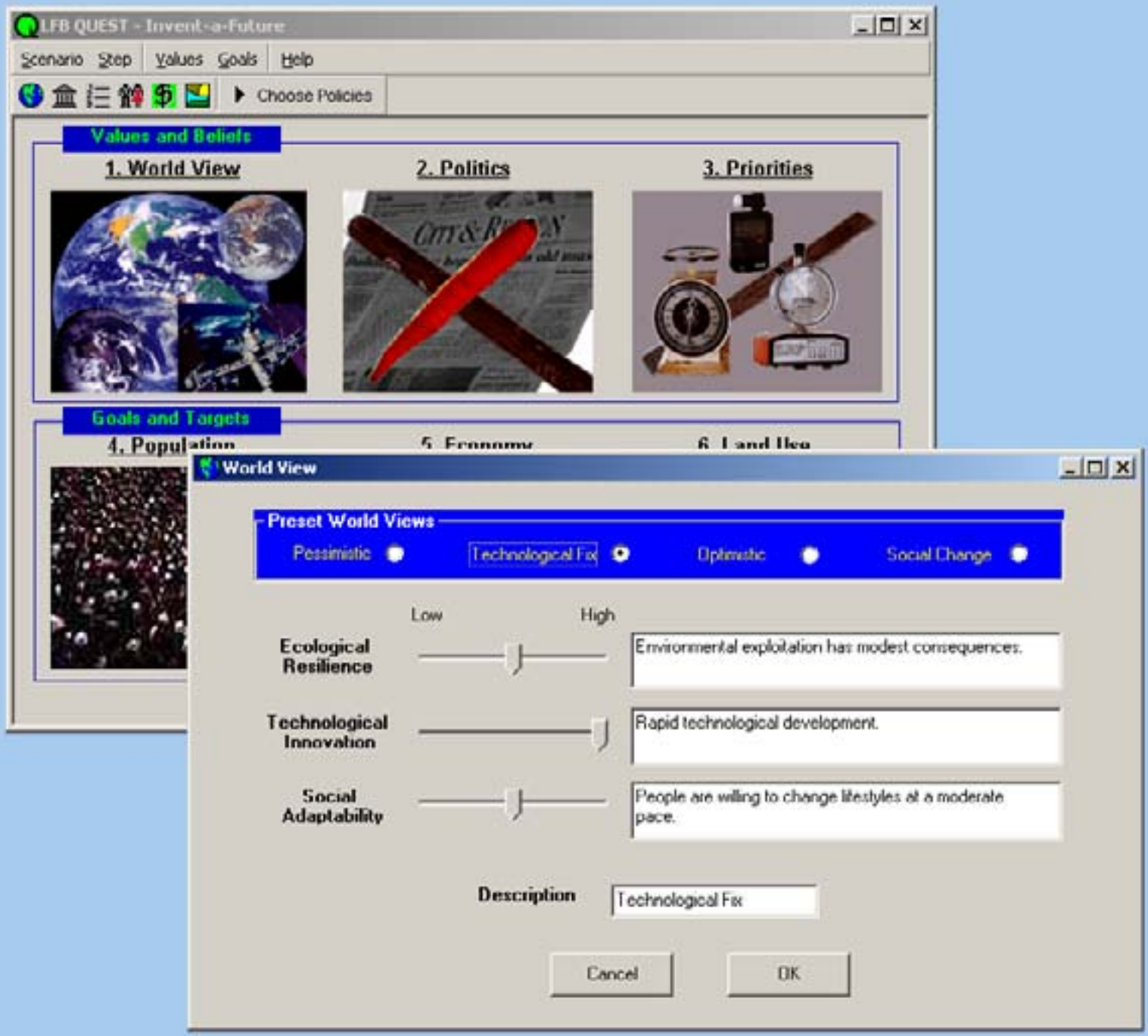

Map of 2020

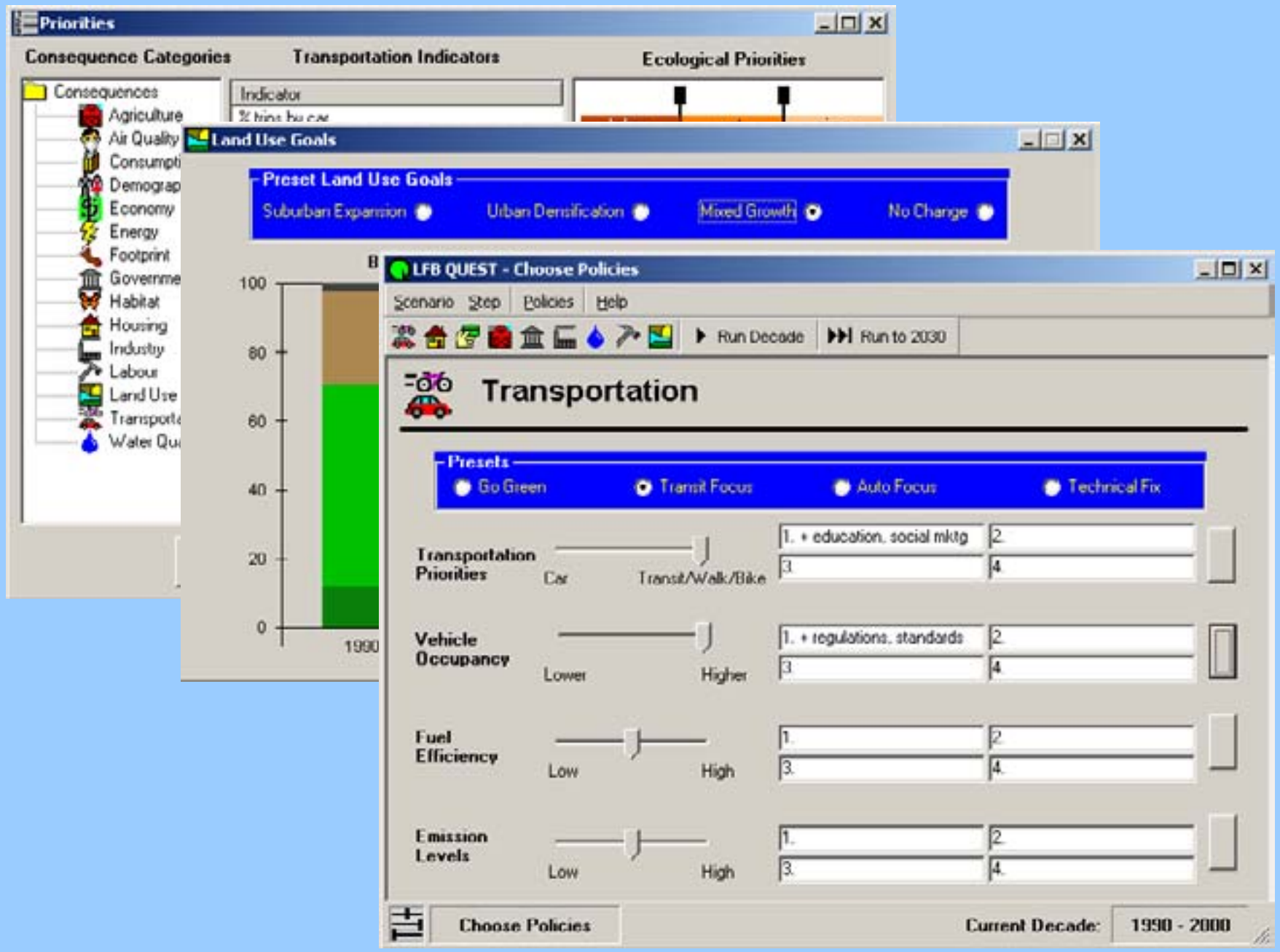

Map of 2040

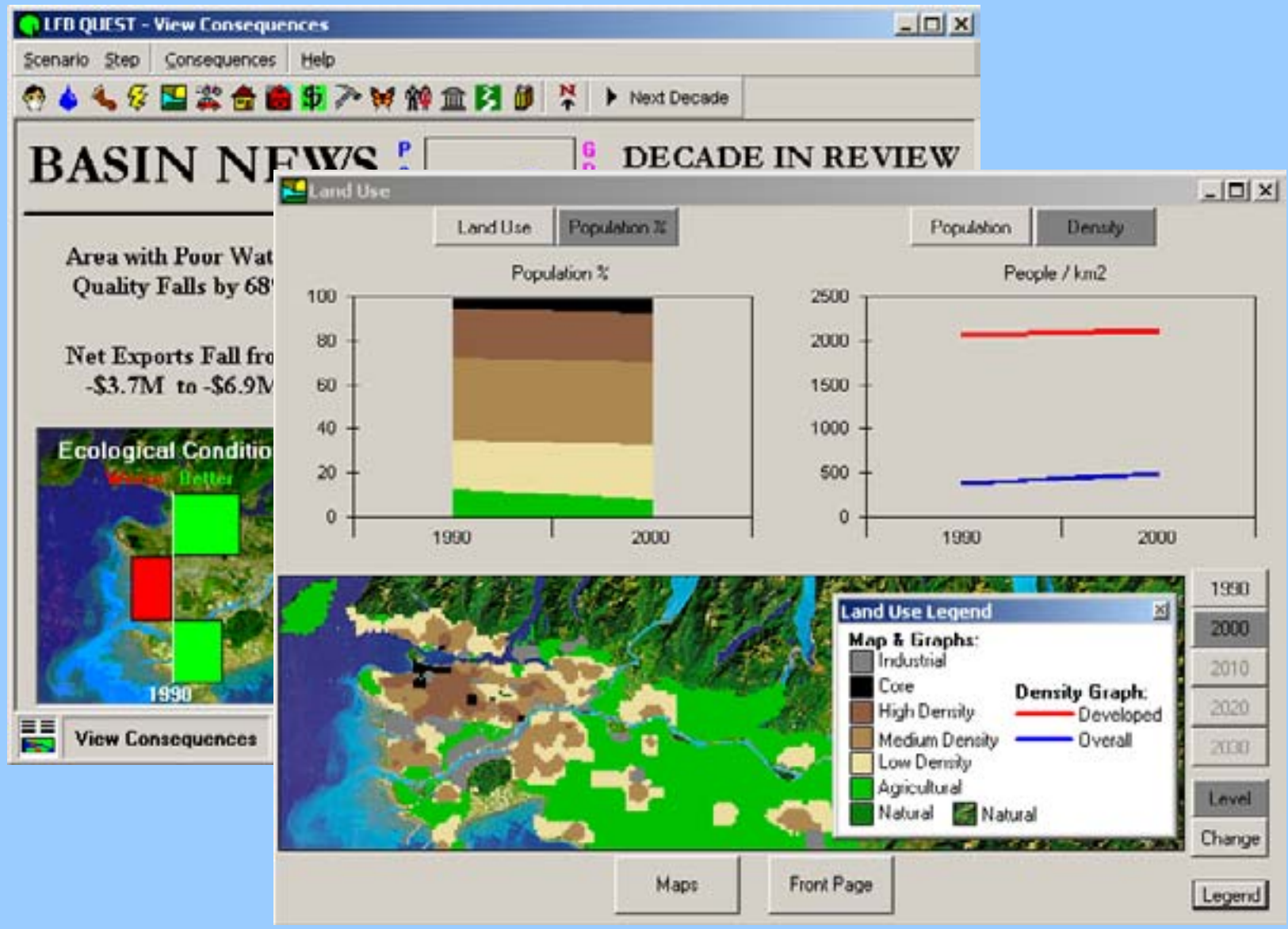
# LFBQuest

- Lower Fraser Basin SDSS
  - developed by Sustainable Development Research Institute, UBC
  - downloadable from http://www.sdri.ubc.ca/research_activities/tools.cfm


LIVABLE REGION STRATEGIC PLAN: MAJOR CENTRES
Lonsdale
Vancouver Central Area
Metrotown
Downtown New Westminster
Coquitlam Centre
Surrey City Centre
Haney Town Centre
Richmond Centre
Langley town Centre
N
Metropolitain Core
Regional town Centre
Municipal Town Centre

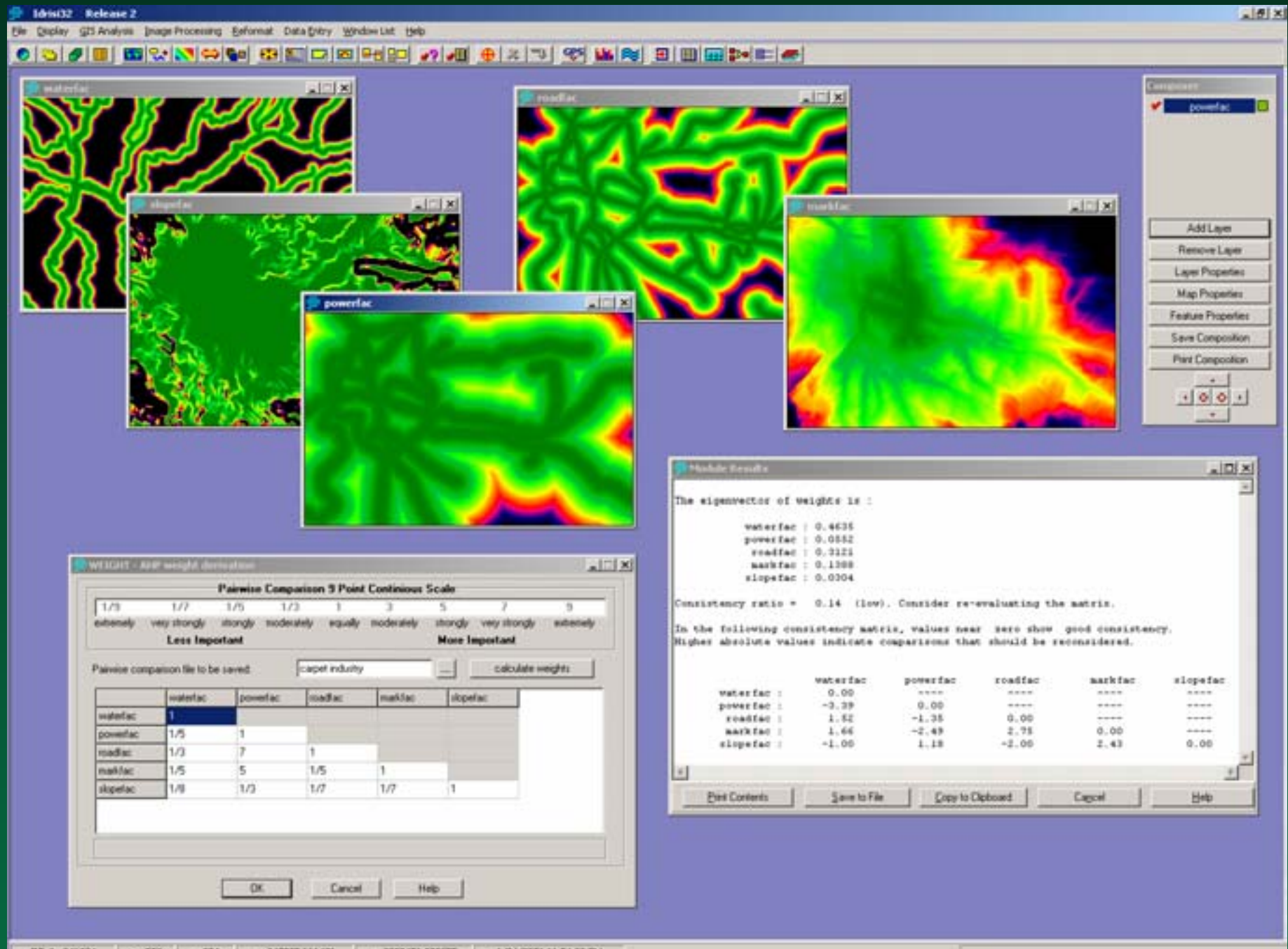

LFB QUEST - Invent-a-Future
Scenario Step Values Goals Help
Choose Policies
Values and Beliefs
1. World View
2. Politics
3. Priorities
Goals and Targets
4. Population
World View
Preset World Views
Pessimistic
Technological Fix
Optimistic
Social Change
Low
High
Ecological Resilience
Environmental exploitation has modest consequences.
Technological Innovation
Rapid technological development.
Social Adaptability
People are willing to change lifestyles at a moderate pace.
Description
Technological Fix
Cancel
OK


Priorities
Consequence Categories
Transportation Indicators
Ecological Priorities
Consequences
Agriculture
Air Quality
Economy
Energy
Footprint
Habitat
Housing
Industry
Labour
Land Use
Water Qu
Indicator
Land Use Goals
Preset Land Use Goals
Suburban Expansion
Urban Densification
Mixed Growth
No Change
100
80
60
40
20
0
1990
LFB QUEST - Choose Policies
Scenario
Step
Policies
Help
Run Decade
Run to 2030
Transportation
Presets
Go Green
Transit Focus
Auto Focus
Technical Fix
Transportation Priorities
Car
Transit/Walk/Bike
1. + education, social mktg
2.
3
4
Vehicle Occupancy
Lower
Higher
1. + regulations, standards
2.
3
4
Fuel Efficiency
Low
High
1.
2.
3.
4.
Emission Levels
Low
High
1.
2.
3.
4.
Choose Policies
Current Decade:
1990 - 2000


LFB QUEST - View Consequences
Scenario Step Consequences Help
Next Decade
BASIN NEWS
DECADE IN REVIEW
Area with Poor Wat
Quality Falls by 68
Net Exports Fall fro
-$3.7M to -$6.9M
Ecological Conditio
Better
1990
View Consequences
Land Use
Land Use
Population %
Population
Density
Population %
100
80
60
40
20
0
1990
2000
People / km2
2500
2000
1500
1000
500
0
1990
2000
Land Use Legend
Map & Graphs:
Industrial
Core
High Density
Medium Density
Low Density
Agricultural
Natural
Natural
Density Graph:
Developed
Overall
1990
2000
2010
2020
2030
Level
Change
Maps
Front Page
Legend

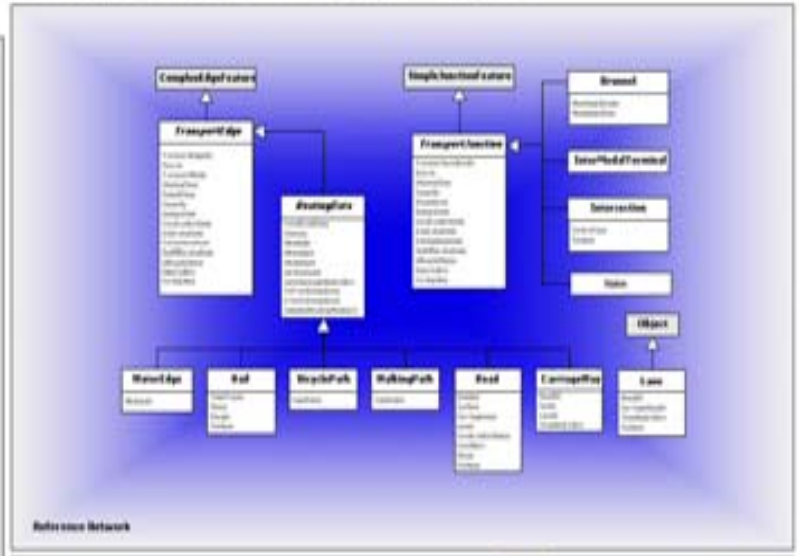
# The GIS model

- Data representing local conditions
- Algorithms, models representing general knowledge about processes
  - global climate models
  - agent-based models of human actions
  - coupled natural–human systems models
- Tools to support analysis, reporting, visualization
- Science abstracts general knowledge from space and time
  - GIS places it back in a space-time context, enabling intervention

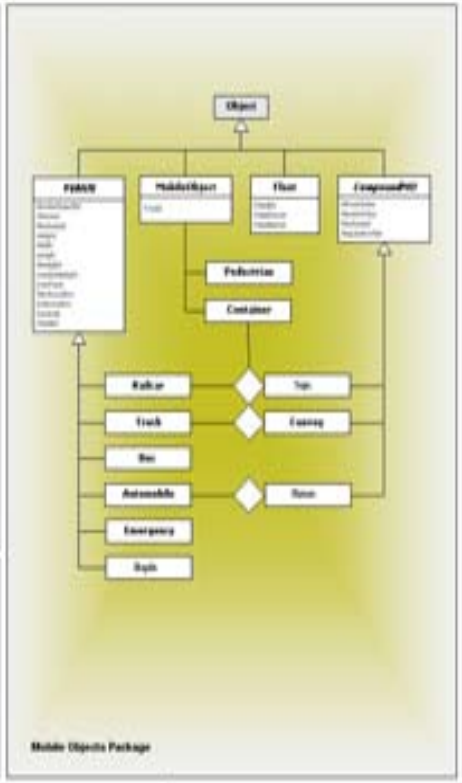

Idrisi32 Release 2
File Display GIS Analysis Image Processing Reformat Data Entry Window List Help
waterfac
slopefac
roadfac
powerfac
markfac
Add Layer
Remove Layer
Layer Properties
Map Properties
Feature Properties
Save Composition
Print Composition
Pairwise Comparison 9 Point Continious Scale
1/9 1/7 1/5 1/3 1 3 5 7 9
extremely very strongly strongly moderately equally moderately strongly very strongly extremely
Less Important
More Important
Pairwise comparison file to be saved:
carpet industry
calculate weights
waterfac powerfac roadfac markfac slopefac
waterfac 1
powerfac 1/5 1
roadfac 1/3 7 1
markfac 1/5 5 1/5 1
slopefac 1/8 1/3 1/7 1/7 1
OK
Cancel
Help
The eigenvector of Weights is :
waterfac : 0.4635
powerfac : 0.0552
roadfac : 0.3121
markfac : 0.1308
slopefac : 0.0304
Consistency ratio = 0.14 (low). Consider re-evaluating the matrix.
In the following consistency matrix, values near zero show good consistency.
Higher absolute values indicate comparisons that should be reconsidered.
waterfac powerfac roadfac markfac slopefac
waterfac : 0.00 ---- ---- ---- ----
powerfac : -3.39 0.00 ---- ---- ----
roadfac : 1.52 -1.35 0.00 ---- ----
markfac : 1.66 -2.49 2.75 0.00 ----
slopefac : -1.00 1.18 -2.00 2.43 0.00
Print Contents
Save to File
Copy to Clipboard
Cancel
Help
RF 1: 241024
c: 598
r: 224
x: 347085.111421
y: 3063451.939655
1/24/2001 11:54:03 PM

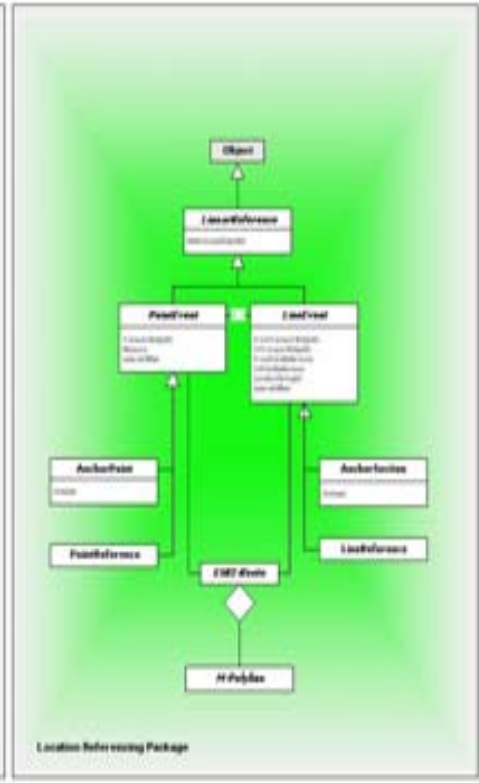
# ArcGIS Transportation Data Model

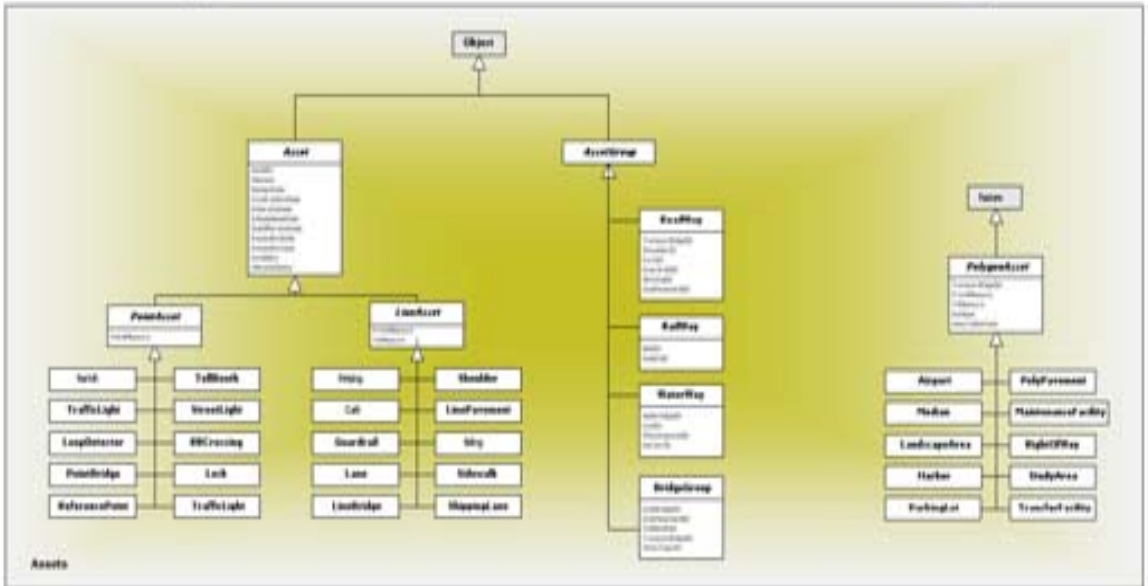
Feb. 21, 2001

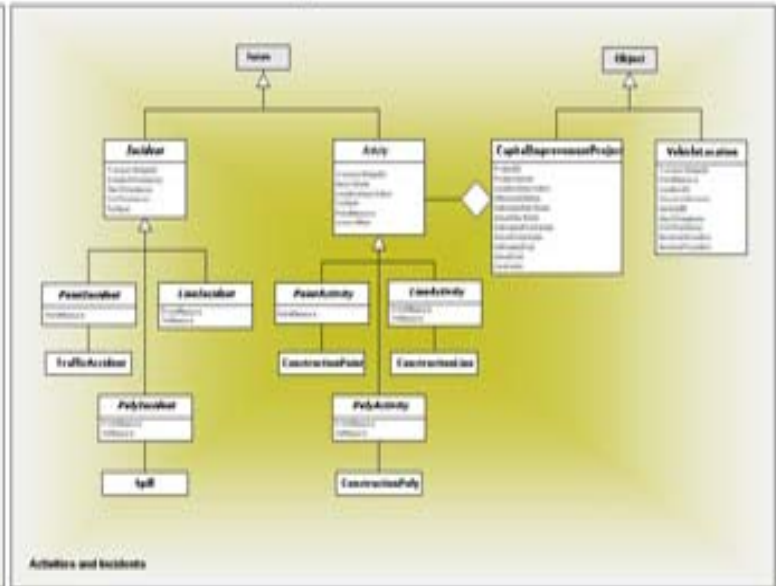







# Research in Metadata for Computer Models

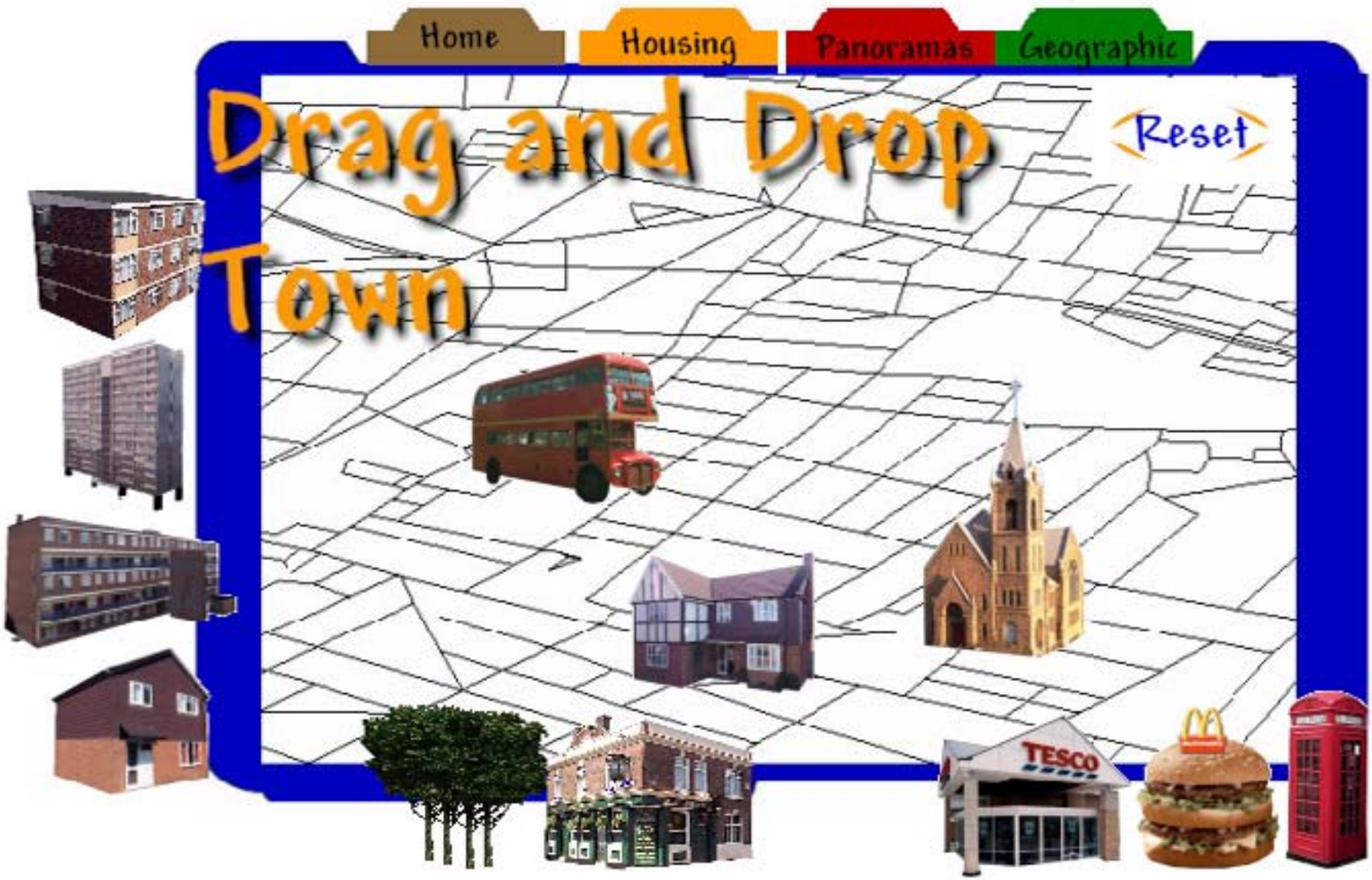
Models available over the Web
Model research and articles
Metadata & Cataloging: Examples, Ideas & Articles

Meetings
Interviews
Readings

Reporting Model 'Fitness of Use' or 'Validation' in Metadata
Comparison chart for Model Metadata
An Easier Method for Metadata Collection
Creating a Computer Model Metadata Standard

A Special thanks to the people at The National Science Foundation for their support of the Research Education for Undergraduates program

link to Geography 5, Fall 2000


Home
Housing
Panoramas
Geographic
Drag and Drop Town
Reset
TESCO

# The McHarg team of 2003

- Information scientists (GIScientists)
  - information integration
  - information management
  - semantic interoperability
  - visualization of scenarios
  - spatial decision support systems
  - public-participation GIS

# The social sciences

- Decision scientists
  - uncertainty, risk
- Cognitive scientists
  - human–computer interaction
  - IT enabling, not imposing
- Social psychologists
  - the process of group consensus
- At a different scale of intervention
  - environmental economists
  - political scientists

# Goals

- Research on the process of intervention
  - generalizable principles
- Education for intervention
- What structures would help achieve these goals?
  - virtual research community
  - center as an agent of change
  - department as a home for education programs

# A department focused on intervention

- Strong links to process-based science
  - internal if appropriate
- Incorporating IT, decision sciences
  - with strong links to discipline-focused departments
- Strong emphasis on collaboration
  - virtual and physical

# A scientist focused on intervention

- Familiar with the tools of intervention as well as investigation
  - GIS, data integration, SDSS
- Committed to teamwork
  - process sciences
  - information sciences
  - decision sciences
- Motivated by the need to solve practical problems