Computers, Urban Studies, and Urban Management

Jean-Claude Thill

Geography and Public Policy
Univ. of North Carolina at Charlotte
United States

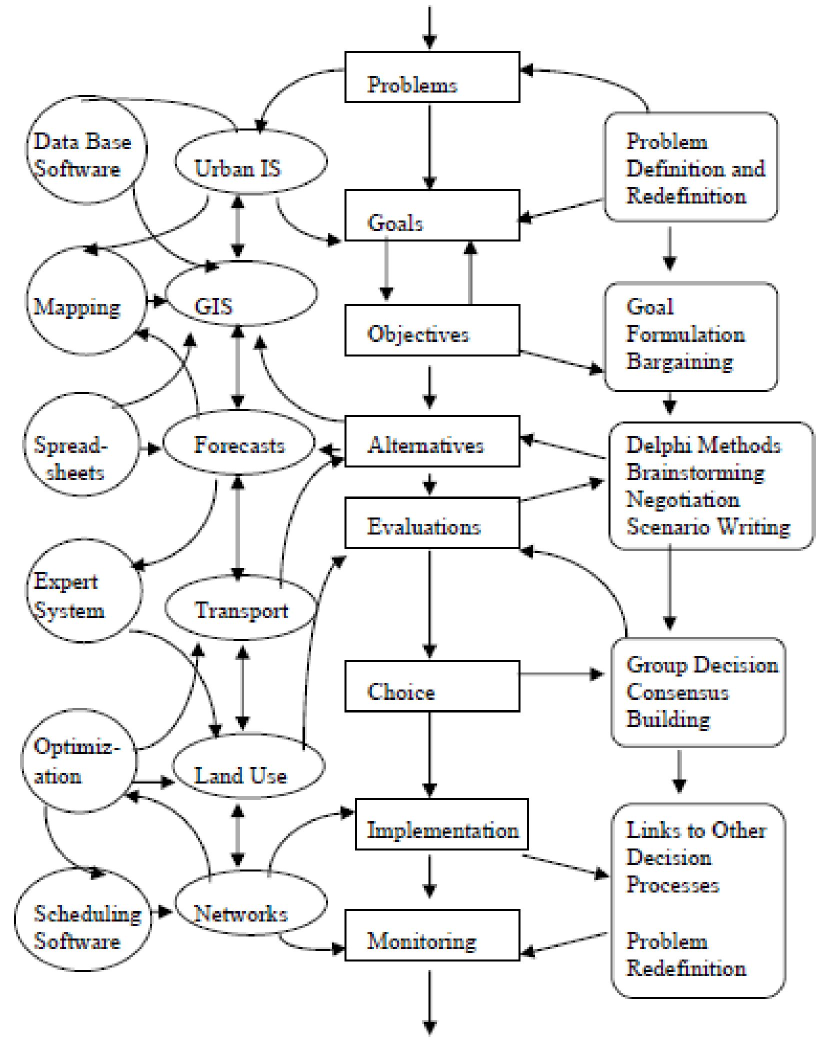
Computers in Urban Planning and Management

❖ The beginnings

- Computing devices used in public planning for 100 years
  - Transportation planning
  - Population and housing census
- Mainframe computers
- Hardware, software, and models were a bottleneck
  - Slow, not interactive (batch sessions)
  - Few variables
  - Coarse representation of the city region
  - “Fitting the reality to the model”

Computers in Urban Planning and Management

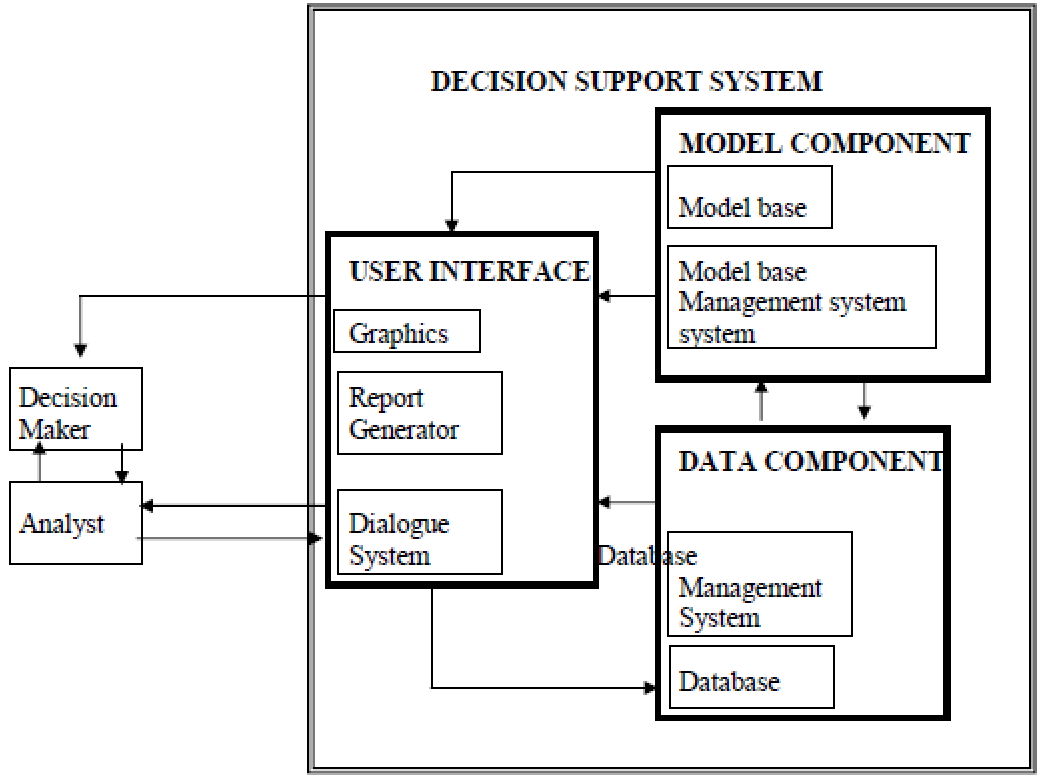
- ❖ The sequel
  - Data collection and data management
  - Data analysis and models
  - Communication and data visualization
    - From operational models (that grew out of theory or physical science models) to Planning Support Systems (Britton Harris)



The Planning Process as a sequence of computable methods enabling decision support (Batty & Densham, 1996)

Planning Support Systems (PSS)

- ❖ Many planning problems are semi-structured
- ❖ Planning problems are inter-related
  - Partial or holistic view
  - Modular structure
  - Common “language”, with shared data, shared vision, interoperable modeling tools
  - Collaborative environment to solve multifaceted problems (group DSS)

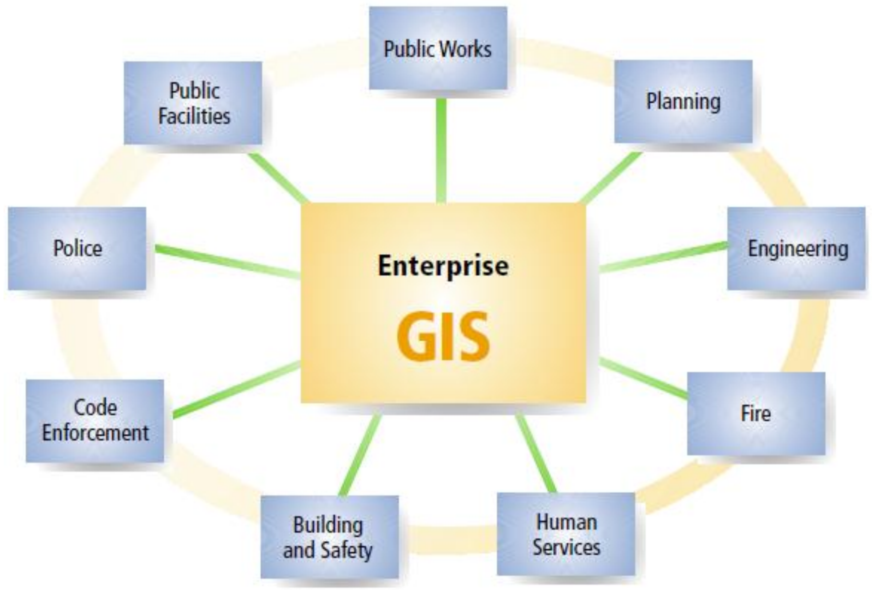


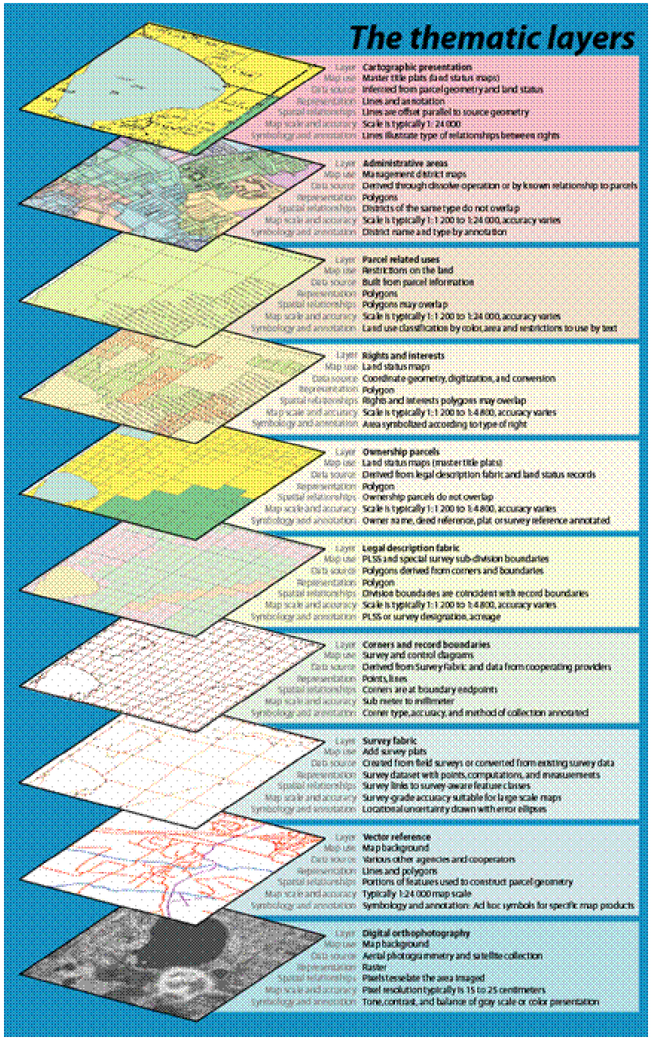
Sustainability
- Environmental
- Social
- Economic

(Lolonis, 1990)

Data Collection and Management

- ❖ Geographic Information Systems (GIS)
  - Computer-based information systems
  - Data is organized/referenced by their location
  - Started from need in Land Information Systems
  - Enterprise GIS: framework for integrated workflow

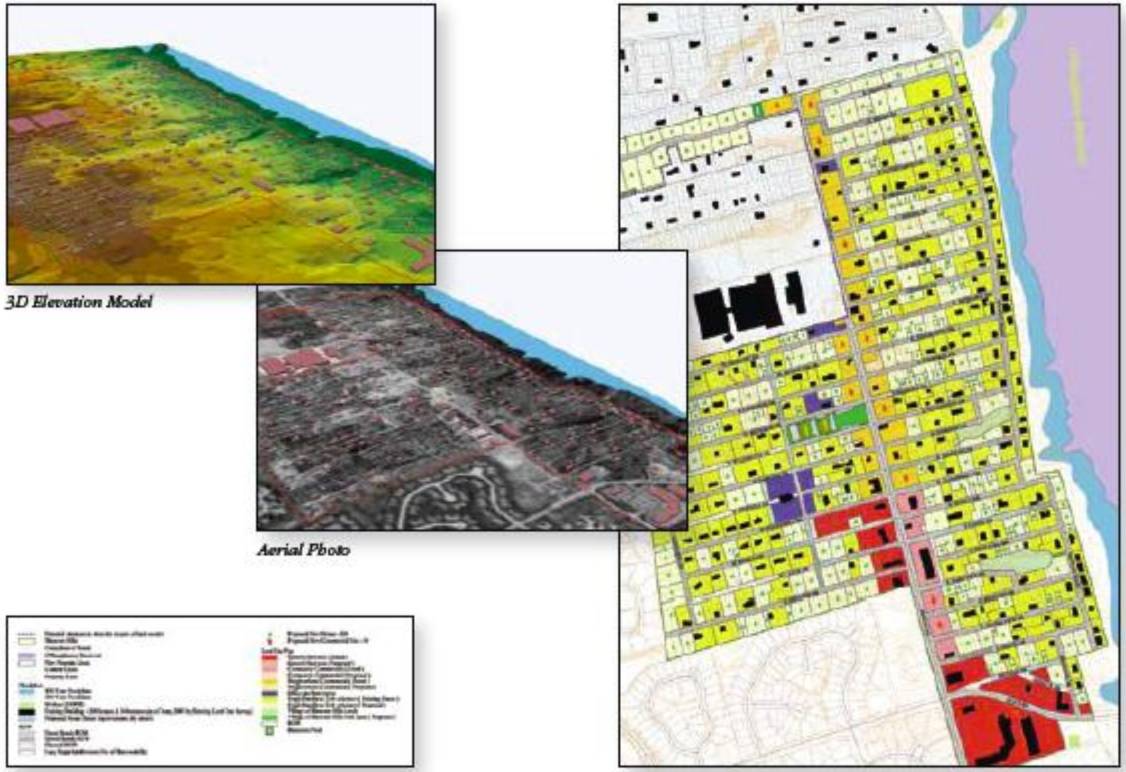




Data Collection and Management

❖ Geographic Information Systems (GIS)

- Data integration



Data Collection and Management

❖ Cadastral systems
- Parcels are a critical part of a modern GIS

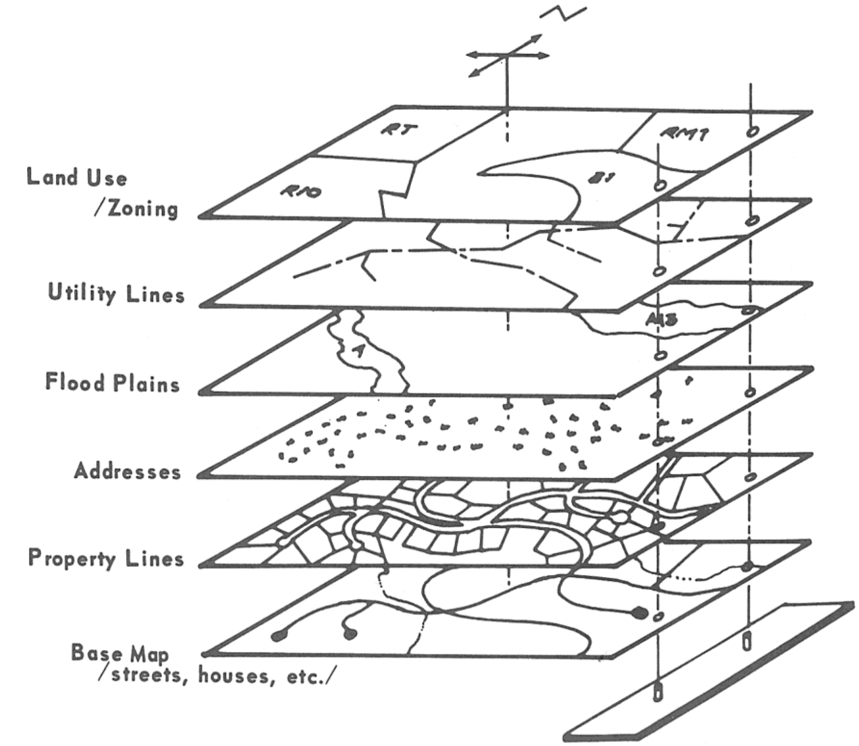


FIGURE 3.1 A registered overlay system.

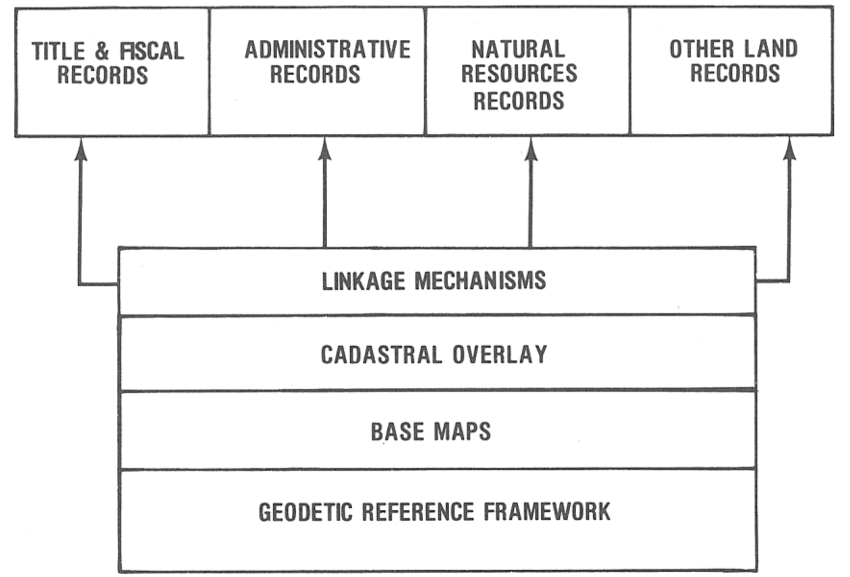


FIGURE 1.1 Components of a multipurpose cadastre.

Data Collection and Management

- Cadastral systems
  - Parcels are linked to many operations of government

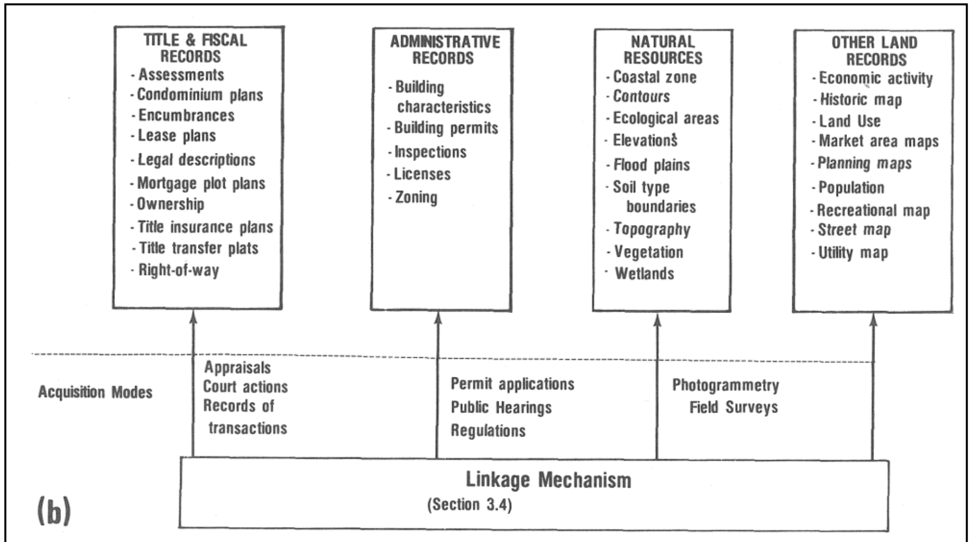


FIGURE 3.1 (a) and (b) Details of a multipurpose cadastre.

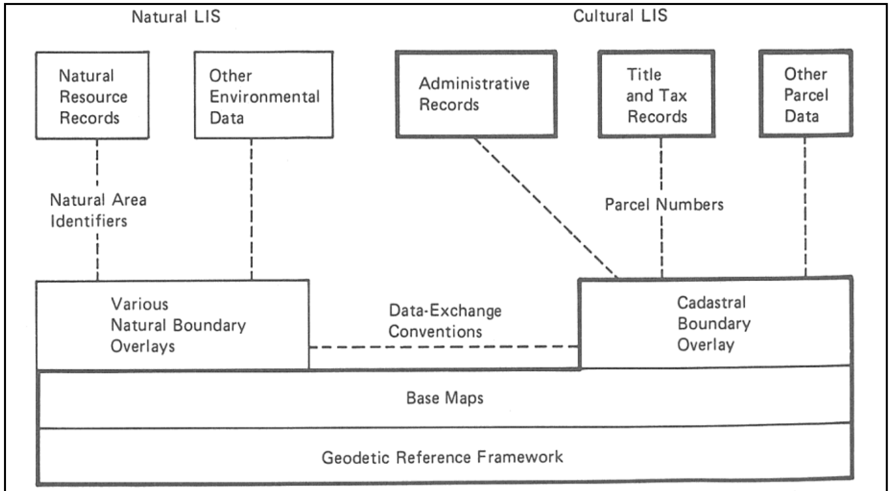


FIGURE 1.2 Components of a multipurpose cadastre (in heavy outline) as the foundation for Land-Information Systems (LIS's).

Data Collection and Management

- Cadastral systems

Potential Benefits to Local Government

Assures that the best available data are used in each public transaction
Avoids conflicts among land records of different public offices
Improves accuracy of real-property assessments
Provides base maps for local planning and preliminary engineering studies
Provides a standardized data base for neighborhood, municipal, county. or regional development plans
Avoids costs of maintaining separate map systems and land – data files
Encourages coordination among separate map systems and land –data files
Improves public attitudes toward administration of local government programs

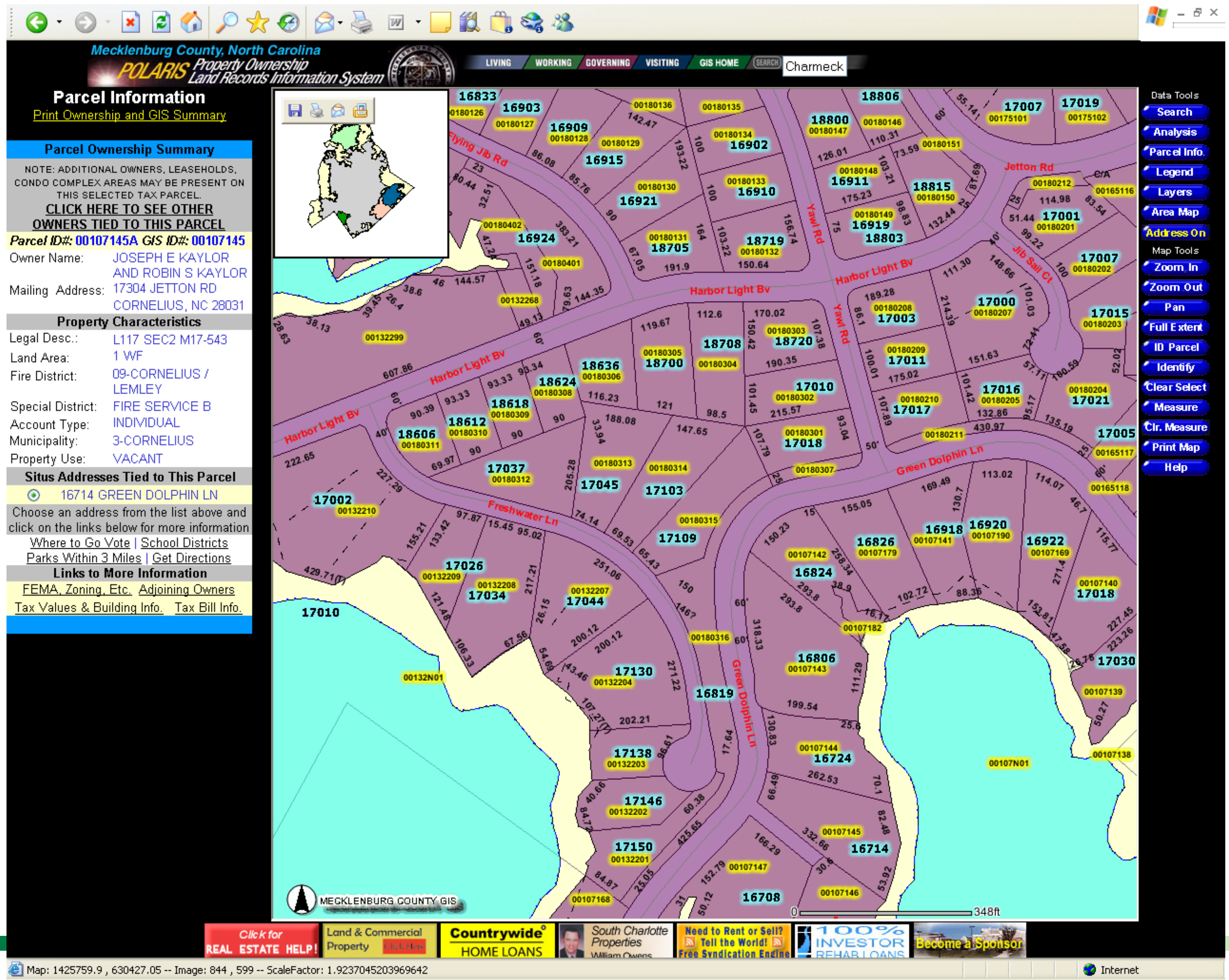
Potential Benefits to provincial & national governments

Provides accurate inventories of natural assets
Provides accurate locational references for administration of state regulations such as pollution controls
Accurately locate state ownership s of other interest in land
Provides a standardize data base for management of public lands
Provides large-scale base maps for siting studies
Simplifies coordination among province and local offices
Provides a data base for monitoring objects of national concern e.g. agricultural land use and foreign ownership of real estate
Provides standardized records for managing provincial/national assistance to local programs such as housing, community development and historic preservation

Potential Benefits to private firms and individuals

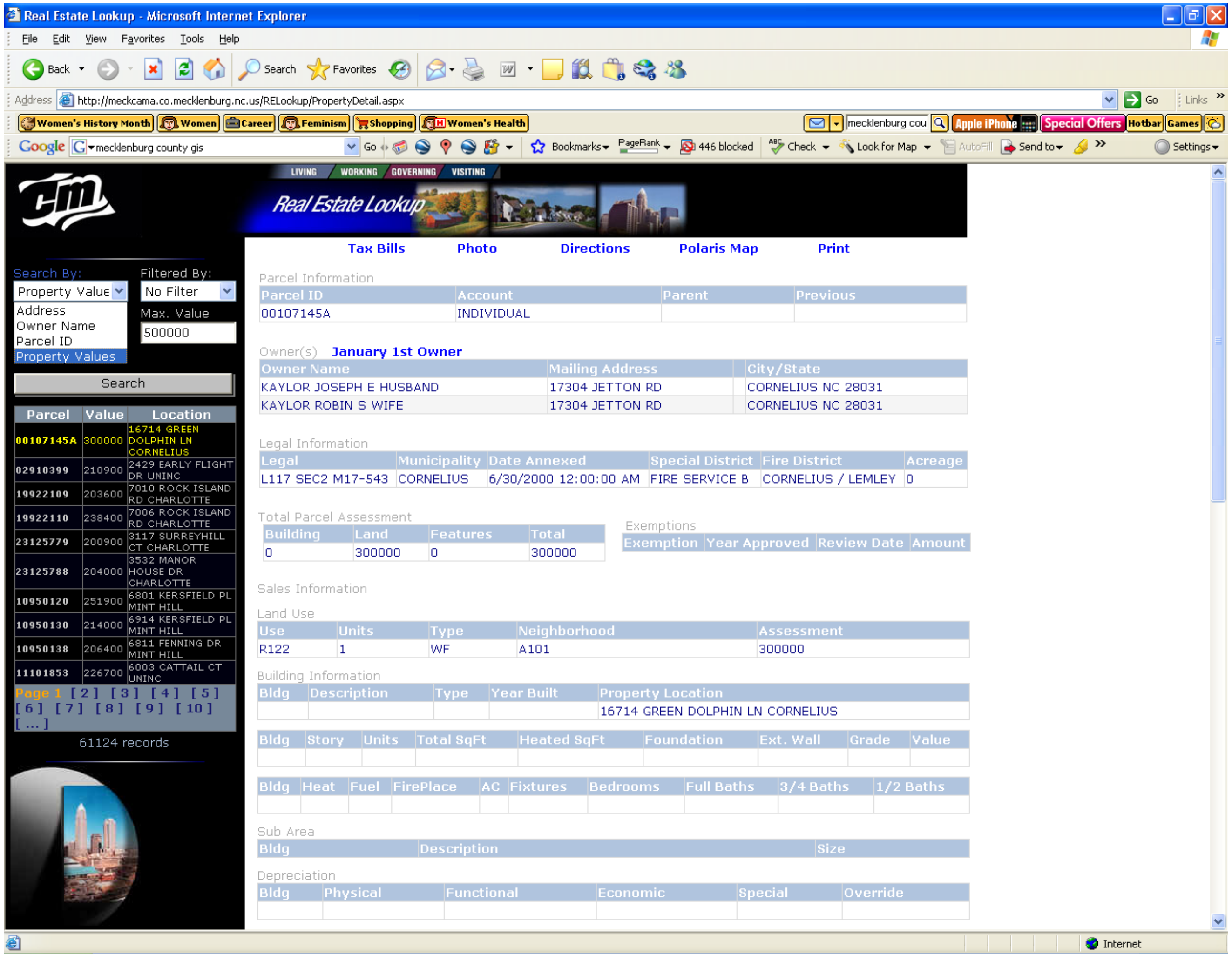
Data Collection and Management

Property Ownership Land Records Information System (POLARIS), Charlotte, North Carolina



Data Collection and Management

Charlotte-Mecklenburg Co – Property Records



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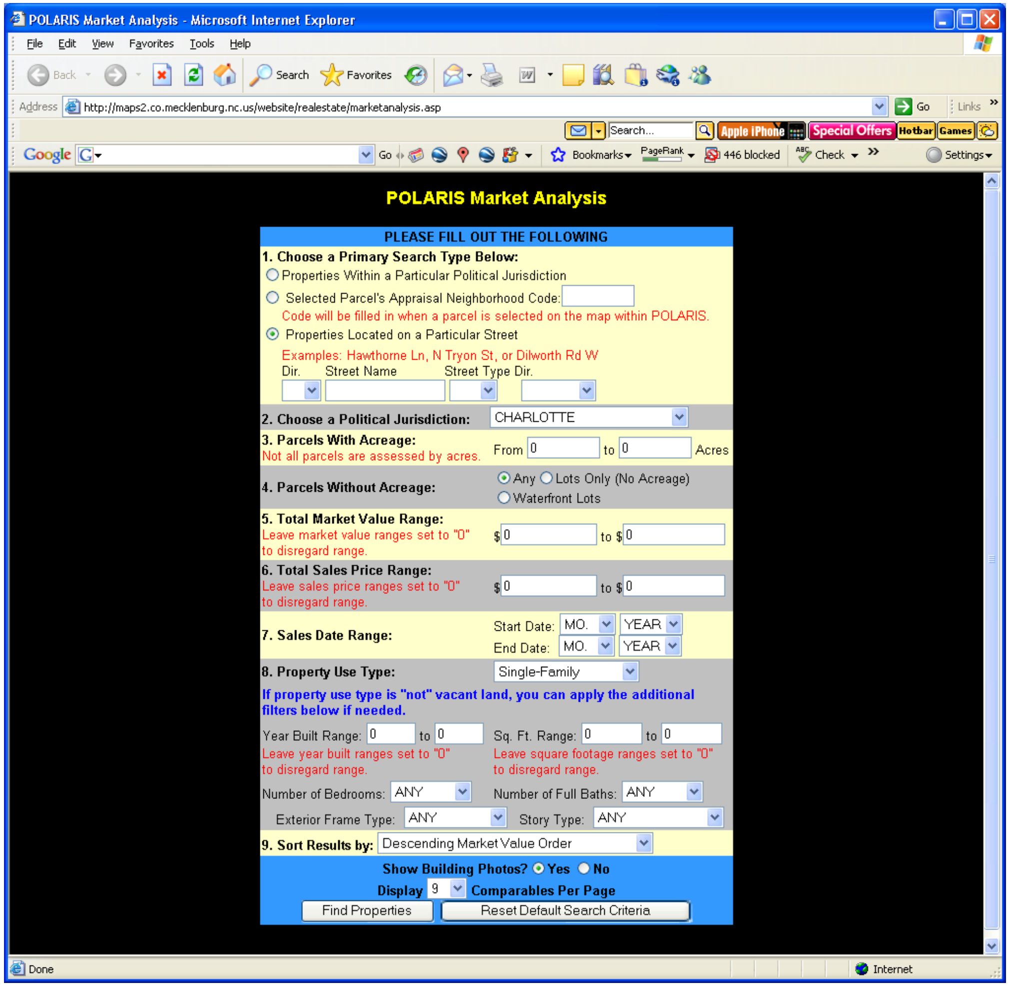
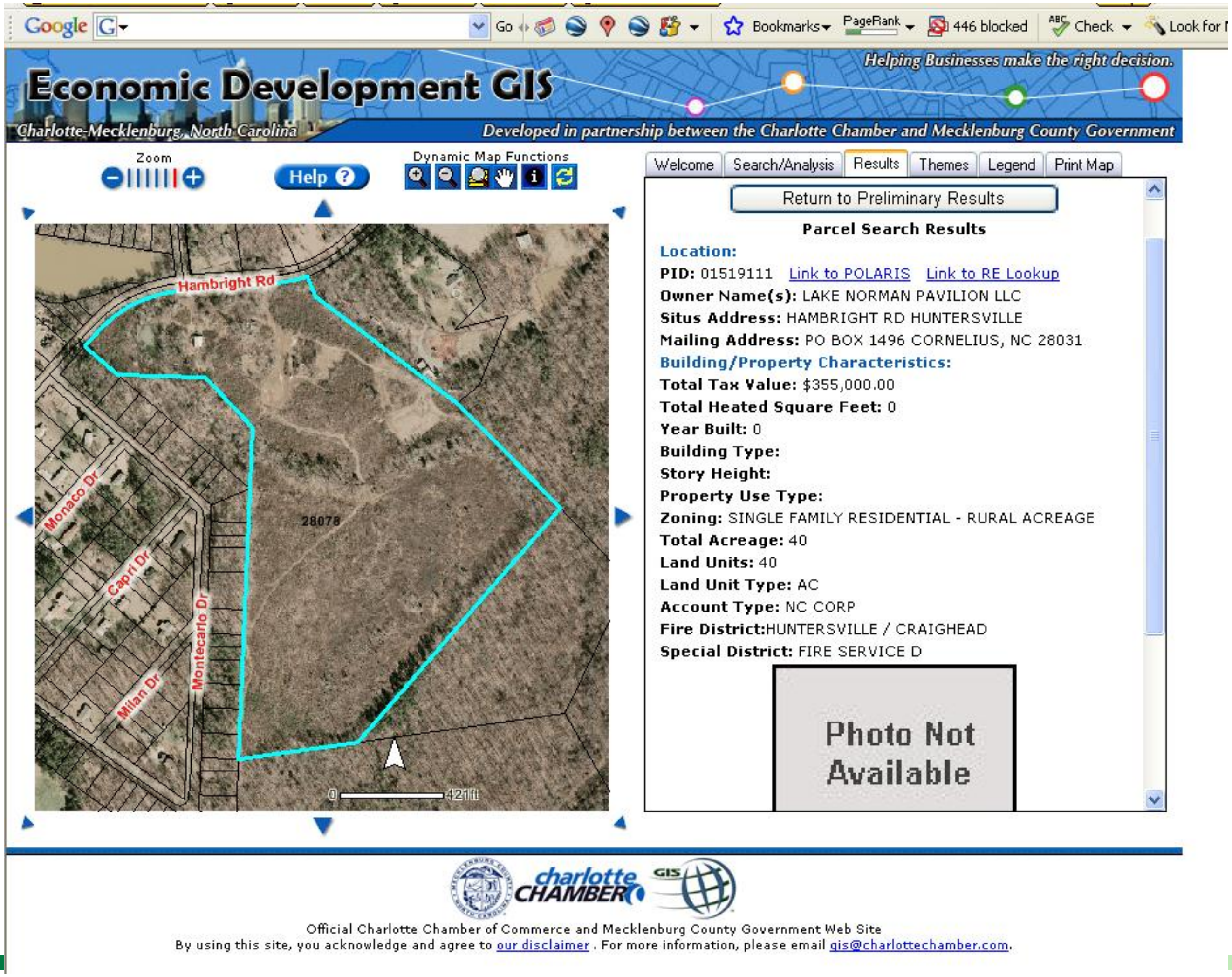
Data Collection and Management

POLARIS – Great Search



Economic Development



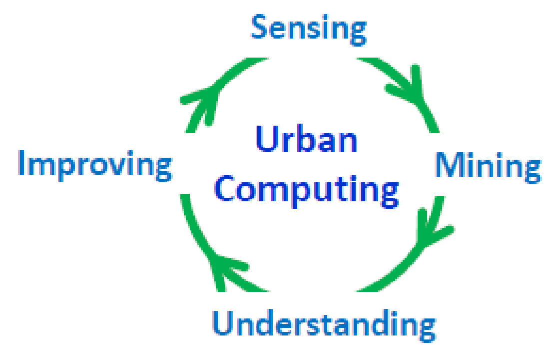
Data Analysis & Modeling

❖ Urban computing

- Emerging concept where every **sensor**, device, person, vehicle, building, and street in the urban areas can be used as a component to sense **city dynamics** to enable **city-wide computing** to tackle the challenges of urban areas (urban planning) so as to serve people and cities
- Using crowd-sourcing, volunteered geographic information to better under use and function of cities

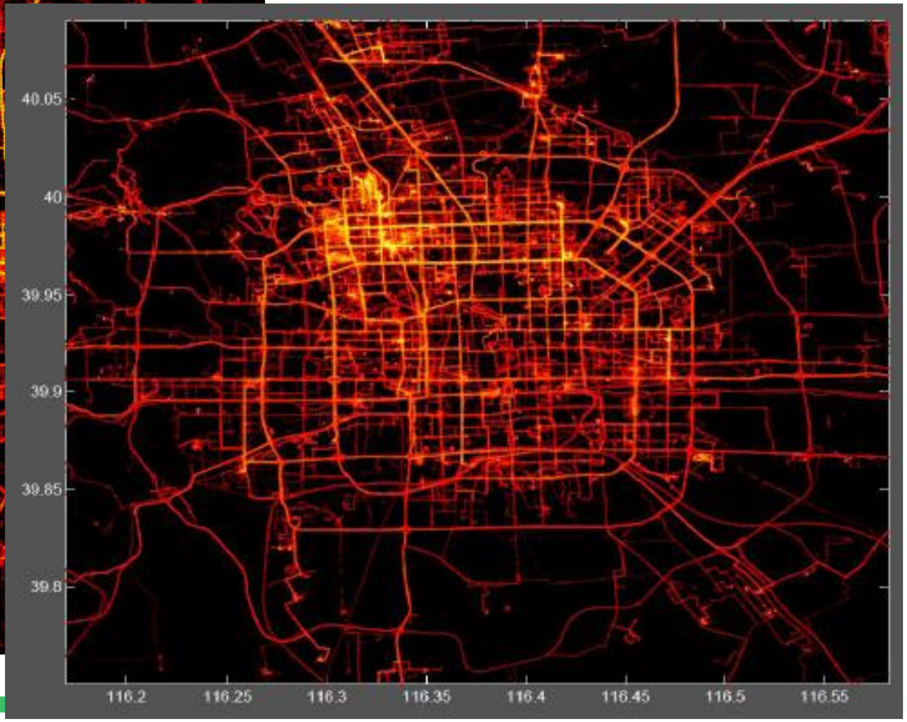
❖ Questions

- What's wrong with the city configuration?
- Does a carried out urban plan really work?



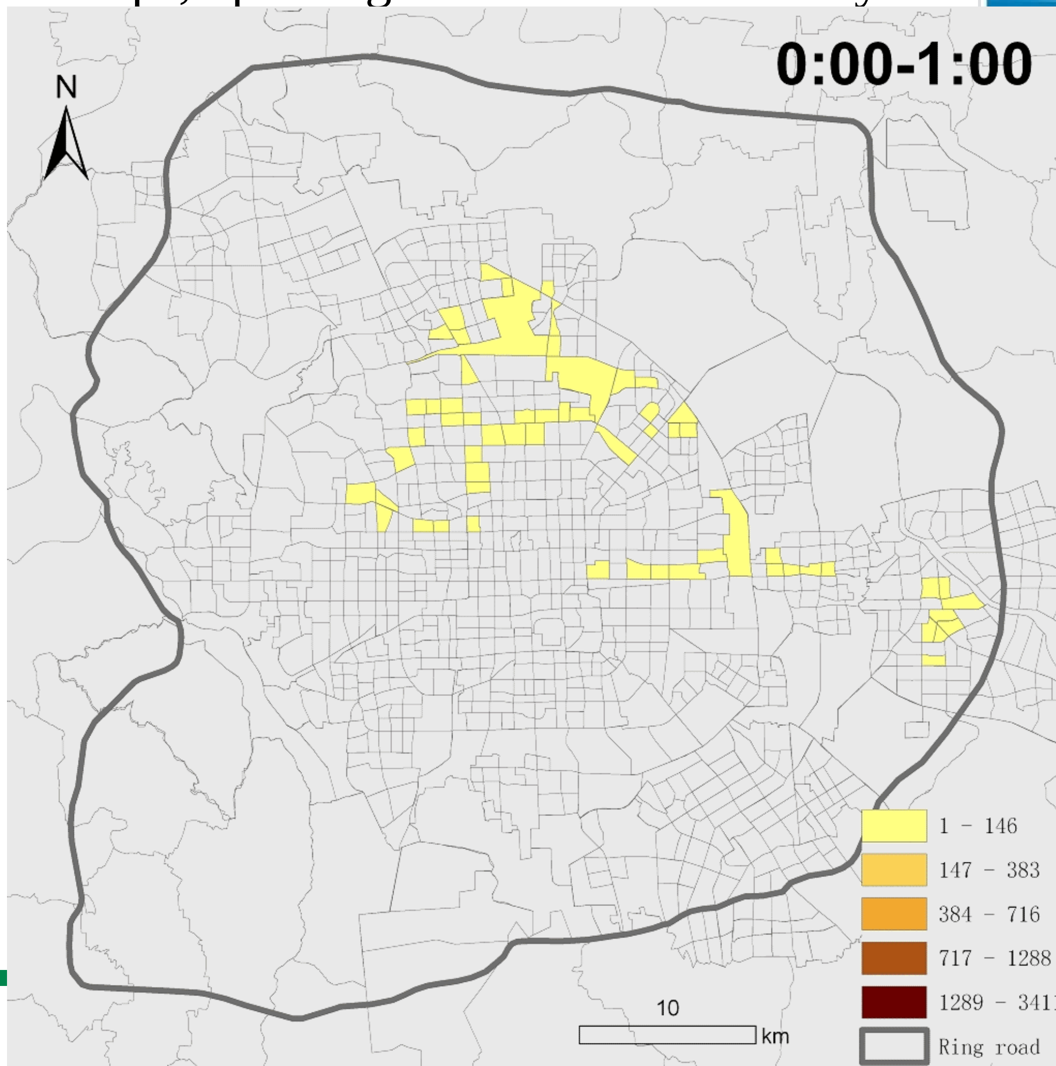
Data Analysis & Modeling

❖ Urban Computing
- Taxi trajectories in Beijing (67,000)
- Detection of traffic anomalies, functional regions, travel itinerary suggestions



Data Analysis & Modeling

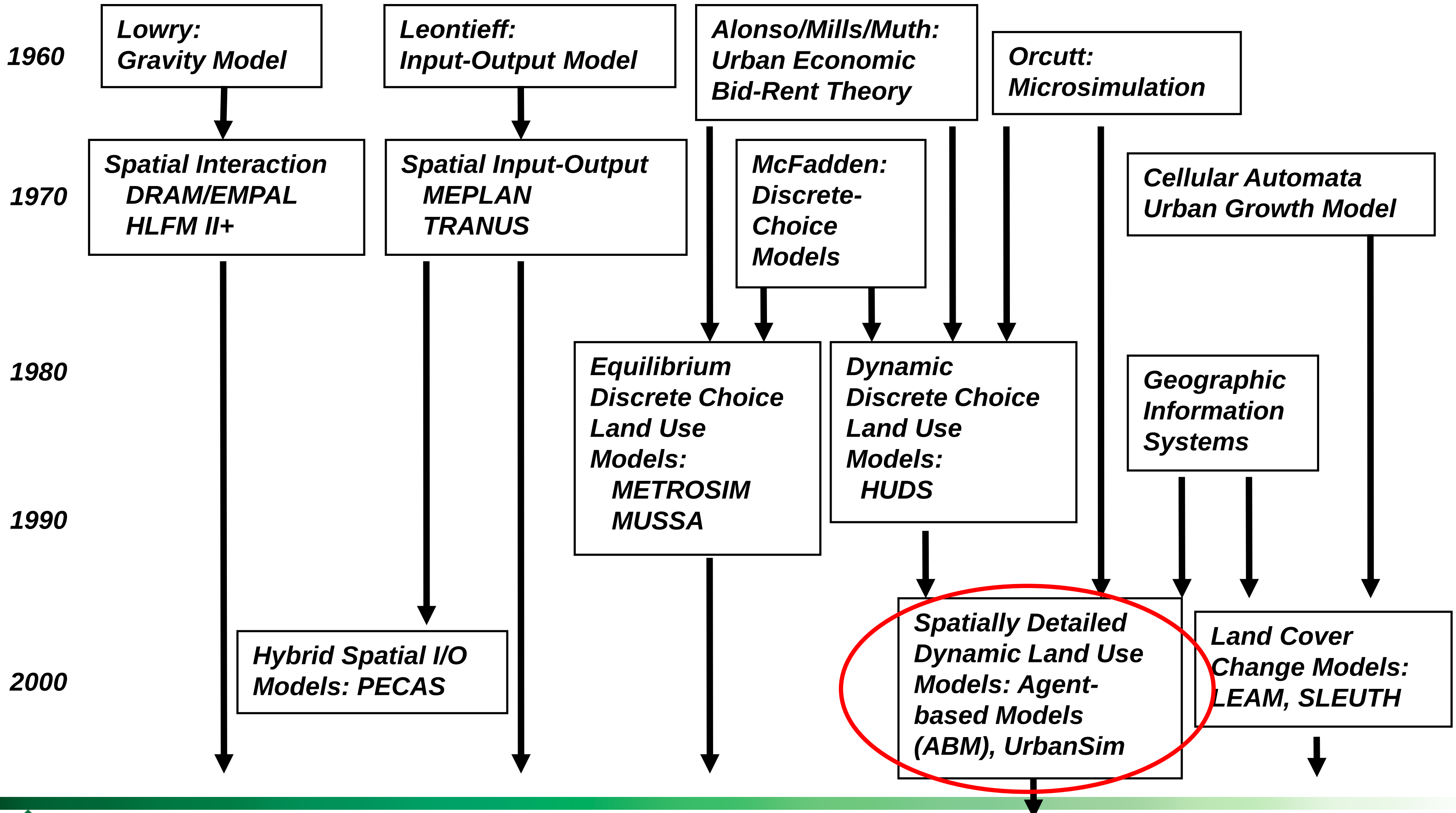
- ❖ Urban Computing
  - Bus Smart Card, Beijing
  - Commuter trips, updating travel behavior surveys



Data Analysis & Visualization

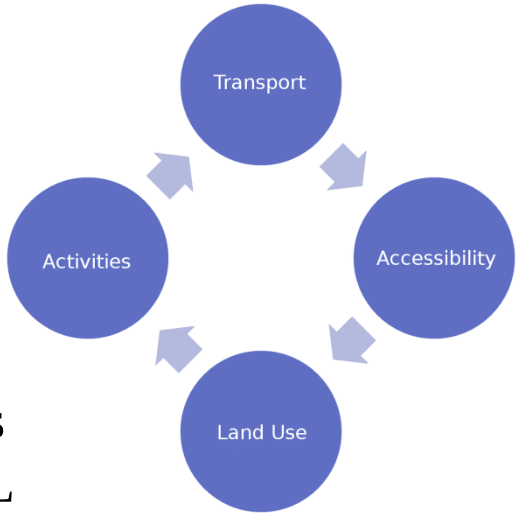
❖ Models of Urban Dynamics

- Evolution of Urban Models



Data Analysis & Visualization: Urban Dynamics

❖ Land use & Transportation



❖ How is ABM/CLUES different…

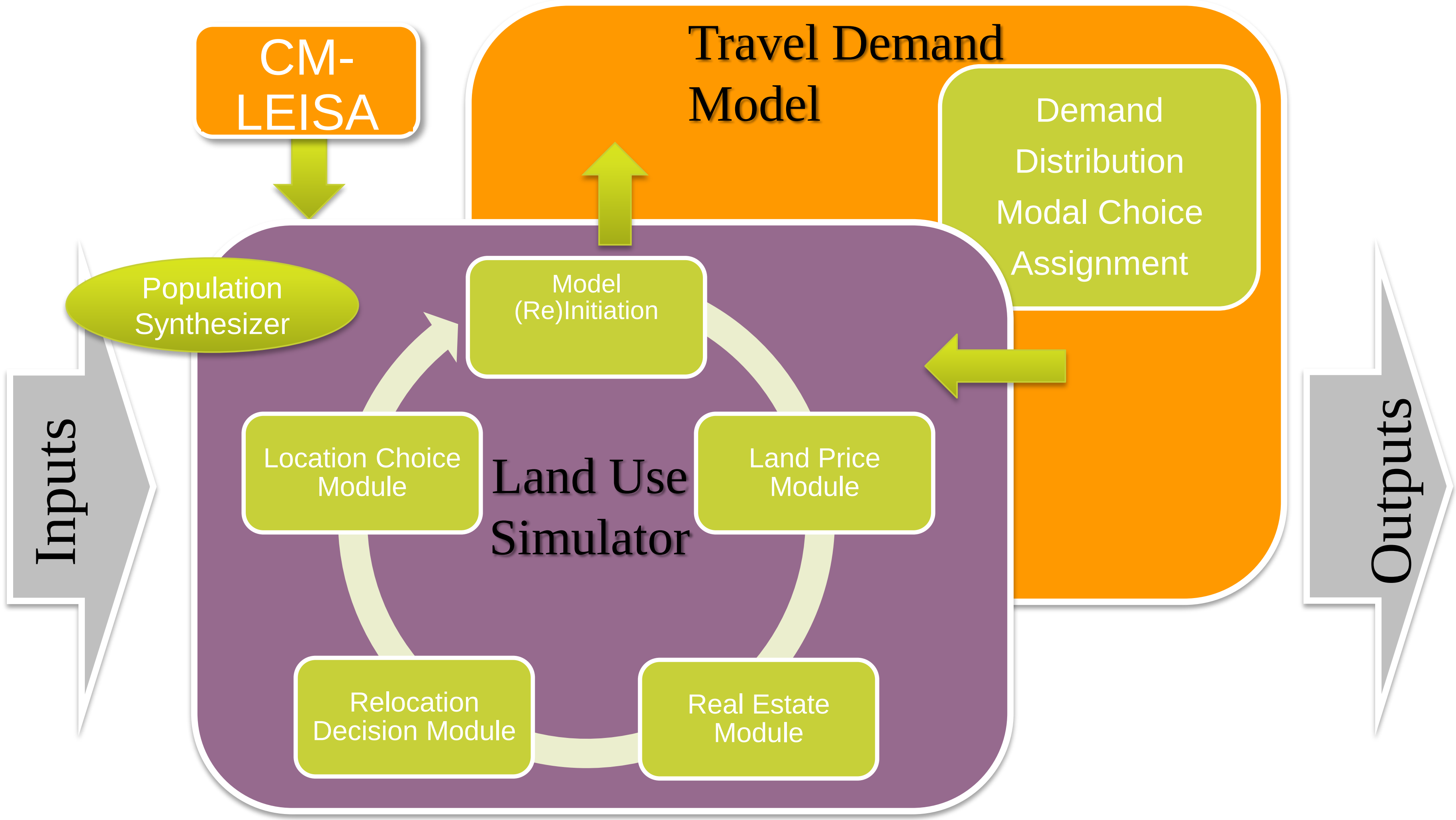
- Than Spatial I/O and Spatial Interaction Models
  - E.g. TRANUS, MEPLAN, DRAM/EMPAL
  - Dynamic, not cross-sectional equilibrium
  - Microsimulates agents and spaces, not aggregate
- Than Cellular Automata Models
  - Land Cover or Land Use Change Models
  - Agents and behaviors not based on cell transitions
  - Clearer accounting of agents, real estate, location
- Better for policy assessment and analysis

❖ How C.L.U.E.S. Works

- Process-based approach
- Behavioral simulations of individual agents
- Parcel level - allows for fine-grained analyses
- Integrates transportation and land use
- Models market interactions
- Dynamically simulates annual time steps
- Portable and open-source
- Customized version of UrbanSim

How C.L.U.E.S. Works

System Architecture



Data Analysis & Visualization: Urban Dynamics

❖ How C.L.U.E.S. Works

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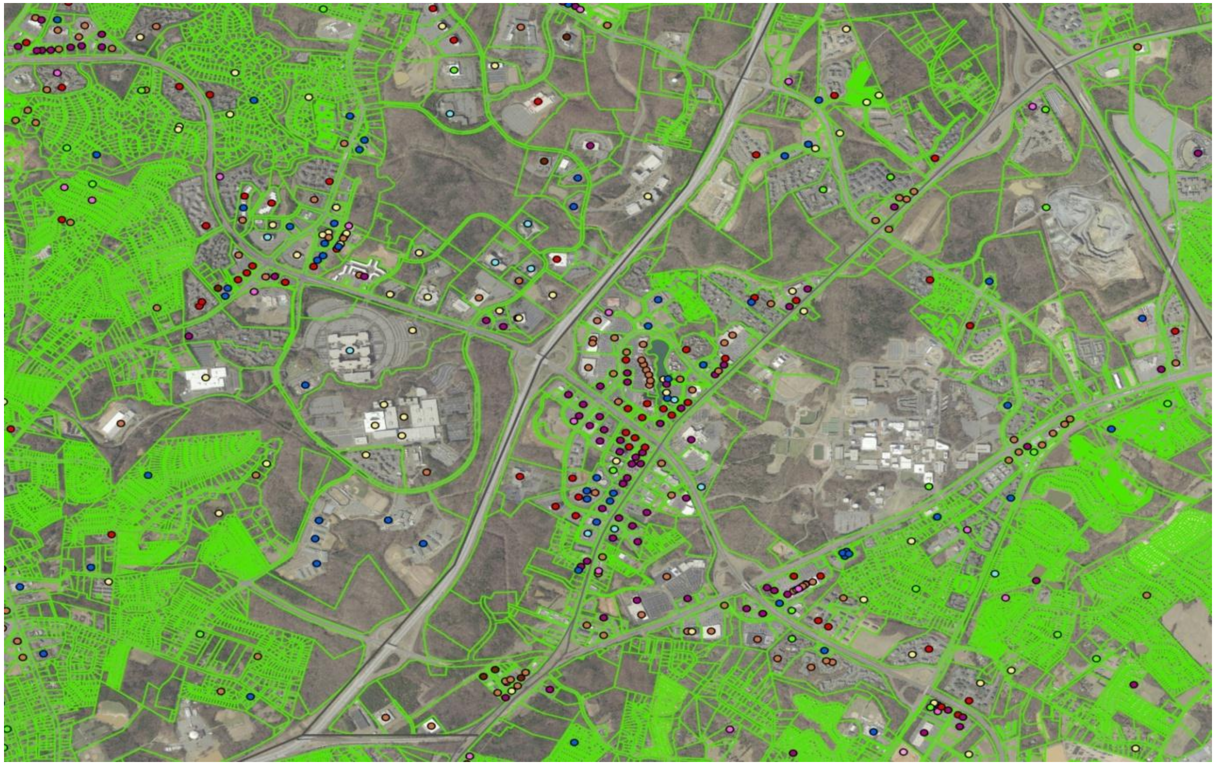
C.L.U.E.S. Inputs

Raw Data	Data Source	Derived Input Data
Parcel & Tax Data (2001-2009)	Mapping and Project Services in Mecklenburg County	Parcels & Buildings Development templates
PUMS (2008) STF3 (2000)	Census Bureau	Households Persons
Jobs & Businesses (2006, 2008, 2010)	Employment Security Commission ReferenceUSA Charlotte-Mecklenburg Planning Dept.	Jobs at place of work by NAICS code
Zoning ordinances	Charlotte-Mecklenburg Planning Dept. Planning Dept. of all the towns	Development constraints
Protected land	North Carolina Gap Analysis Project	Development constraints
FEMA	Mecklenburg County	Development constraints
Preliminary plans	Mecklenburg County	Development templates
Transport network	Metrolina/CDOT	Travel data

Data Analysis & Visualization: Urban Dynamics

Inputs

Businesses in Parcels, Mecklenburg County, 2008

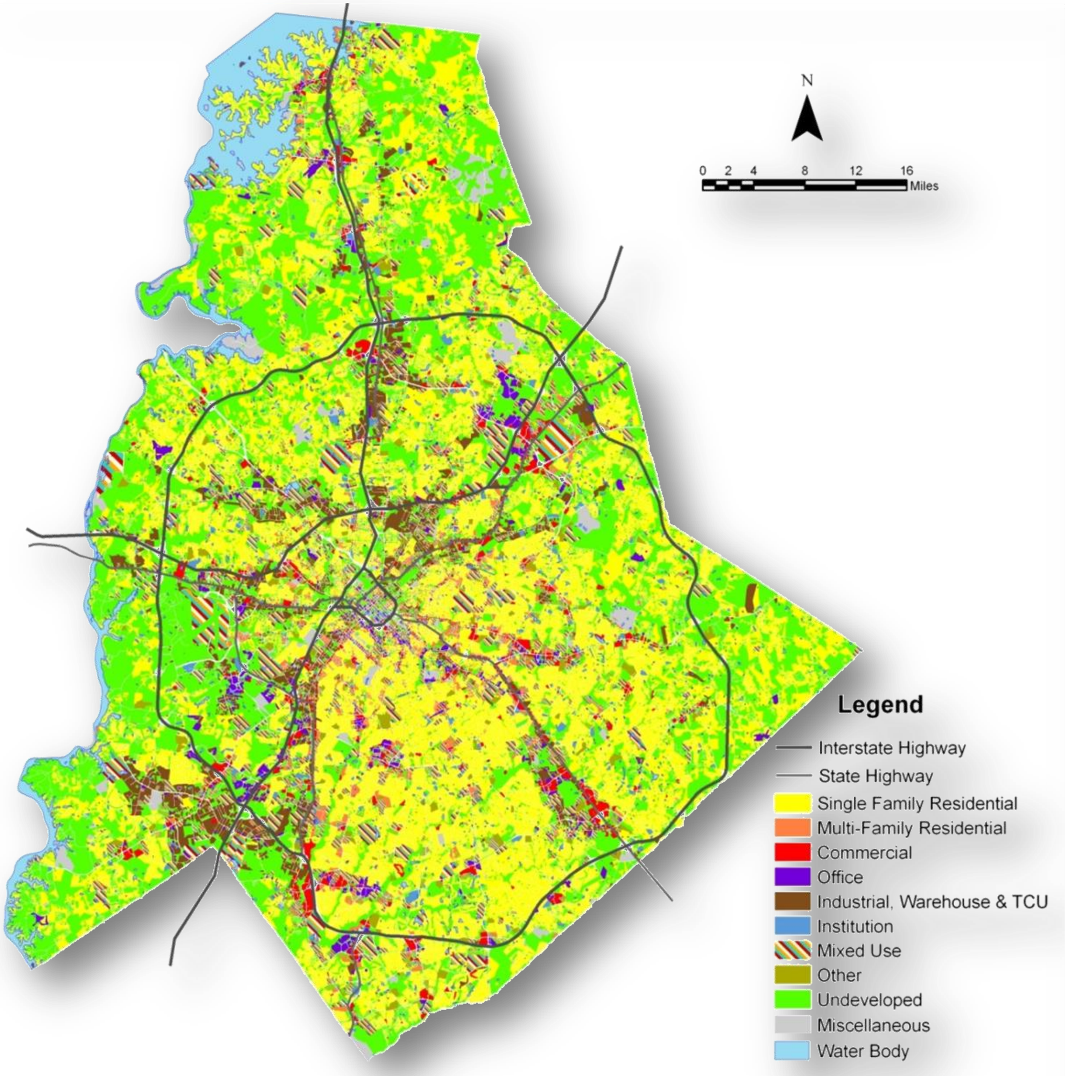


Economic Sectors

- Construction, Natural resources, Mining
- Manufacturing
- Transportation, Trade, Utilities
- Information
- Financial activities
- Professional & Business Services
- Education & Health Service
- Leisure & Hospitality
- Other services
- Government

Data Analysis & Visualization: Urban Dynamics

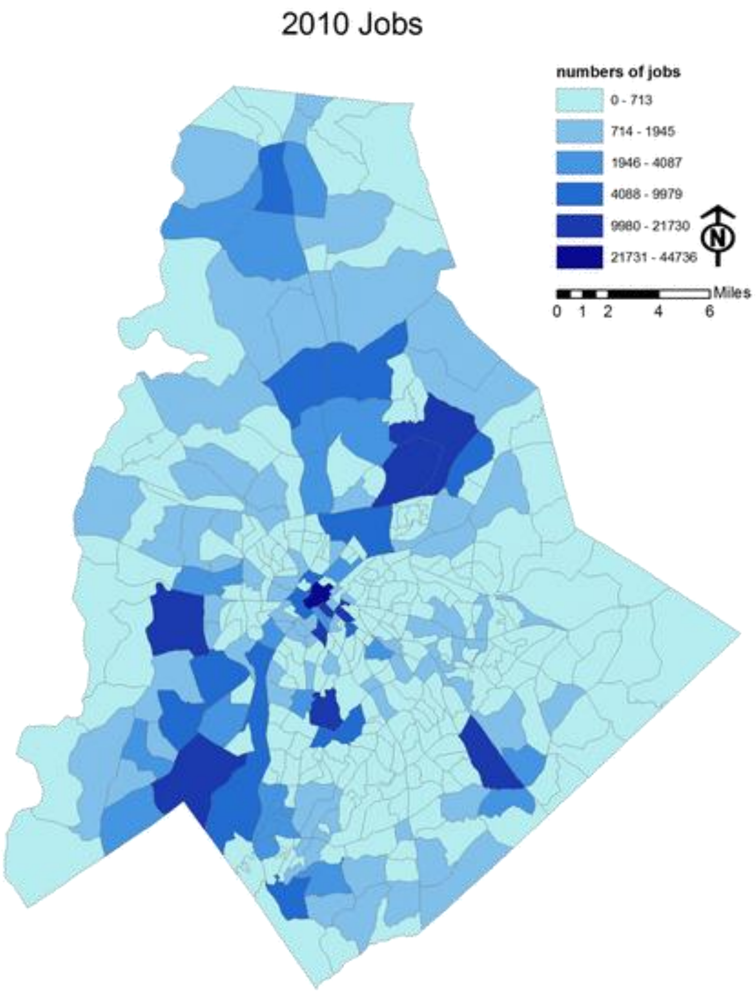
Inputs



Land Use Map, Mecklenburg County, 2008

Outputs

Jobs Projections Sample



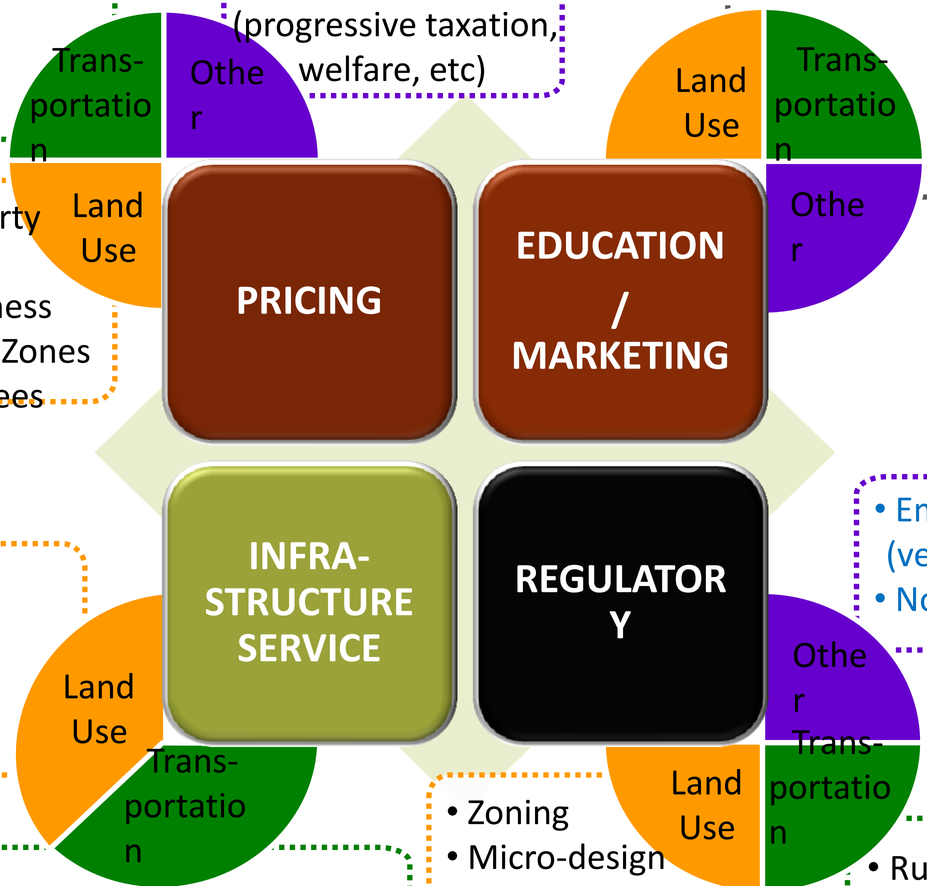
Policy Evaluation (what is testable?)

- Road tolls/congestion pricing
- Gas taxes
- Transit fares
- Parking pricing

- Income distribution (progressive taxation, welfare, etc)

Changing / how to change attitude and sensitivities (e.g. traveler 'value of time' as opposed to deeply held value)

- Taxation: property taxes
- Subsidies: Business Redevelopment Zones
- Development Fees



Blue text indicates 'implicit' policy capability

- Emission standards (vehicle-specific)
- Noise

- Public Housing
- Servicing land
- Government buildings/other institutions

- Build roads, HOV
- Build rail/dedicated transit ways
- Operate transit services

- Zoning
- Micro-design building/ neighborhood issues

- Rules of road (speed limit, on-street parking, HOV lanes, etc)

Reference: Hunt, Kriger, and Miller, 2005

Under Development: Google Earth platform to better communicate with the public on urban form

Data Analysis & Visualization: Facility Location Models

- Rapidly expanding urban areas are dynamic environments
  - Need to expand existing network of public facilities to meet anticipated increase or decrease in demand
    - **schools**, libraries, emergency services
- Closing existing facilities in areas characterized by population decline
- Location models are tools for regional and urban planners and decision makers
  - Each student must be assigned to a school
  - Budget determines number of schools (*p*-median)
  - School deemed essential can be kept in the system
- Public facility location models
  - Minimize total travel distance to the facility *j*
    - p-median - Hakimi (1964)

Formulation

- Objective Function

$$\min \qquad Z = \sum_{i \in I} \sum_{j \in J} a_i d_{ij} X_{ij}$$

Where Z is the total impedance
i is a demand node, *I* is the set of all demand nodes
j is a school site location, *J* is the collection of all school sites
a_i is the demand at location *i*
d_{ij} is the impedance between locations *i* and *j*
X_{ij} means the allocation between demand *i* and site *j*

Formulation

- Subject to (constraints)

$$\sum_{j \in J} X_{ij} = 1 \qquad \forall i \in I$$

$$X_{ij} \le Y_j \qquad \forall i \in I, \forall j \in J$$

$$\sum_{j \in J} Y_j = p$$

$$C_j^- \le \sum_{i \in I} a_i X_{ij} \qquad \forall j \in J$$

$$C_j^+ \ge \sum_{i \in I} a_i X_{ij} \qquad \forall j \in J$$

$$X_{ij} \in \{0,1\} \qquad \forall i \in I$$

$$Y_j \in \{0,1\} \qquad \forall j \in J$$

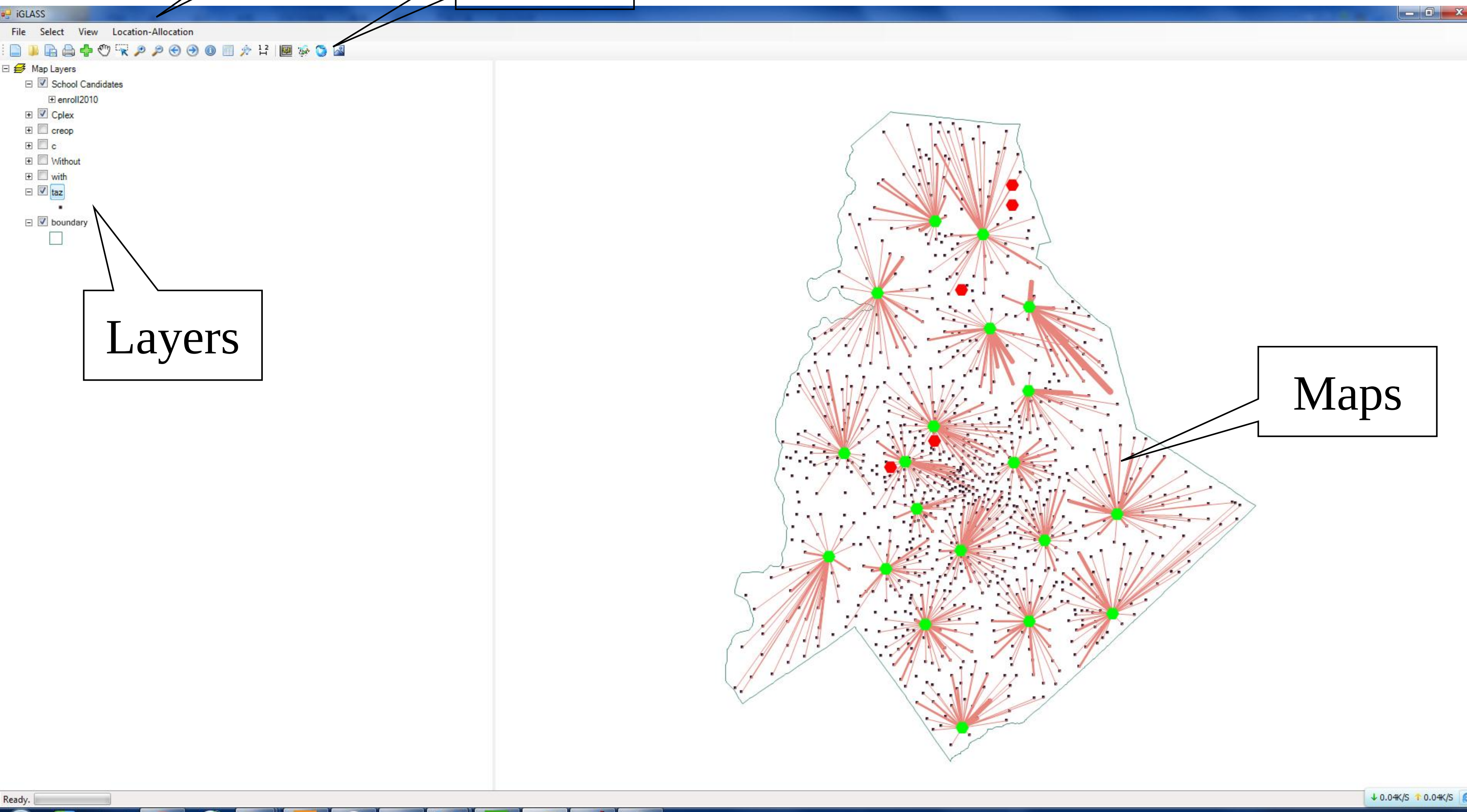
p is the total number of schools to open
C_j^- is minimum capacity of school site j
C_j^+ is maximum capacity of school site j
Y_j is the location decision variable

Data Analysis & Visualization: Facility Location Models

- iGLASS – a Planning Support System
  - Portable
  - Interactive
  - Scalable open source GIS platform
    - DotSpatial 1.3
    - C#
  - The model parameters and input data can be altered on the fly through the GUI (such as addition of school locations and modification of their capacities)
  - Visualization components pertain to children assignment to school and school utilization
  - Highlights demand allocated to a given school
  - The model allows for sensitivity analysis on capacity constraints and the fractional allocation of nodal demand to multiple schools
  - Complex computational algorithm (Tabu search and genetic algorithm)

Data Analysis & Visualization: Facility Location Models

iGLASS



Conclusions

- Urban studies have made major progress thanks to computers and information technologies, and so have urban planning and urban management

- Recent trends are from model-intensive to data-intensive

- The integration and coupling of data, modeling, and visualization leverage the strength of each component

- Spatial information technologies present great opportunities for spatial urban and regional planning in fast developing countries

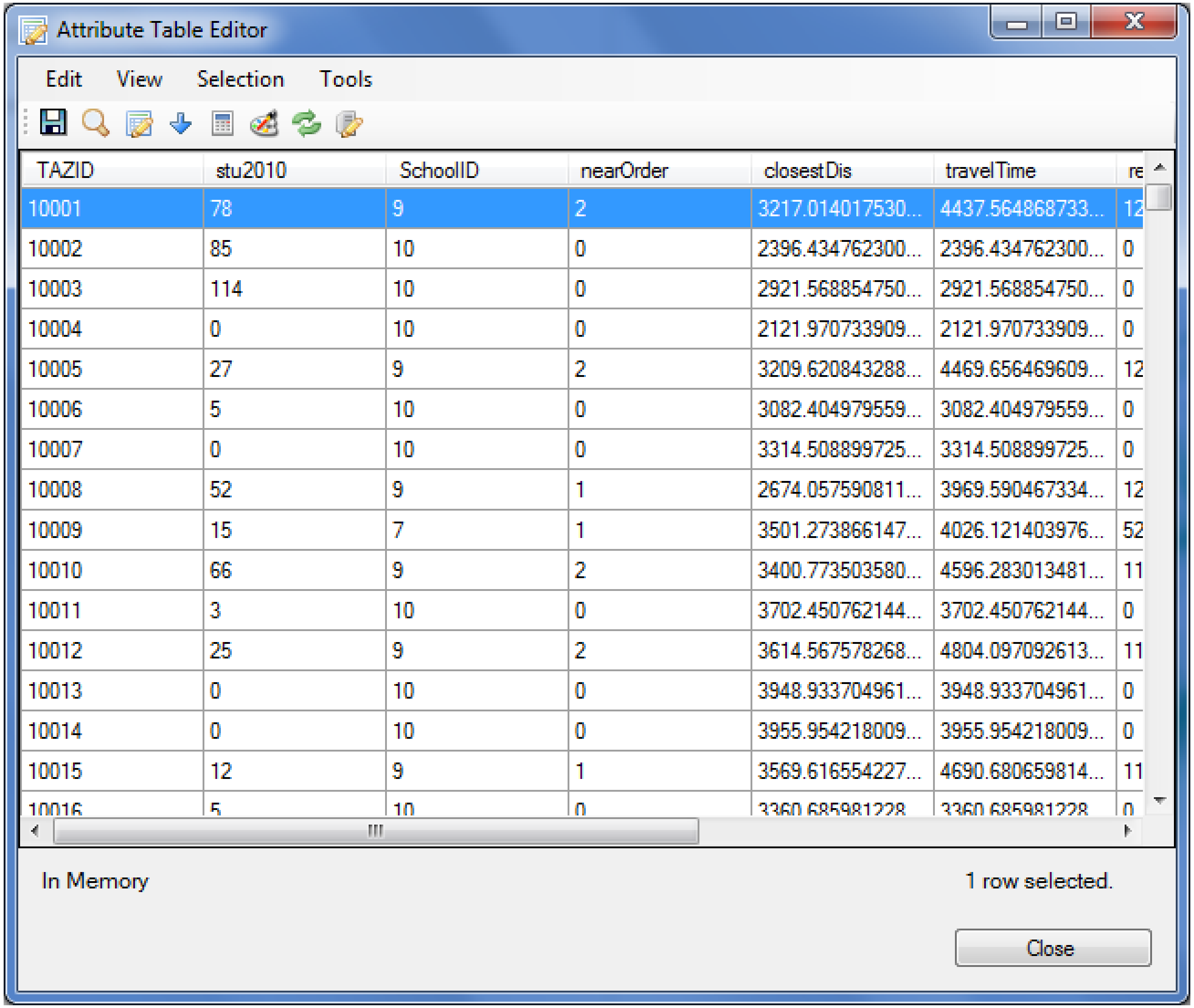
THE END

Thank you!

Jean-Claude Thill

Jean-Claude.Thill@uncc.edu

Editable attribute tables



TAZID	stu2010	SchoolID	nearOrder	closestDis	travelTime	re
10001	78	9	2	3217.014017530...	4437.564868733...	12
10002	85	10	0	2396.434762300...	2396.434762300...	0
10003	114	10	0	2921.568854750...	2921.568854750...	0
10004	0	10	0	2121.970733909...	2121.970733909...	0
10005	27	9	2	3209.620843288...	4469.656469609...	12
10006	5	10	0	3082.404979559...	3082.404979559...	0
10007	0	10	0	3314.508899725...	3314.508899725...	0
10008	52	9	1	2674.057590811...	3969.590467334...	12
10009	15	7	1	3501.273866147...	4026.121403976...	52
10010	66	9	2	3400.773503580...	4596.283013481...	11
10011	3	10	0	3702.450762144...	3702.450762144...	0
10012	25	9	2	3614.567578268...	4804.097092613...	11
10013	0	10	0	3948.933704961...	3948.933704961...	0
10014	0	10	0	3955.954218009...	3955.954218009...	0
10015	12	9	1	3569.616554227...	4690.680659814...	11
10016	5	10	0	3360.685981228	3360.685981228	0

Location-Allocation parameters configuration

Define the number of schools to open

Define the type of distance

Open-Close constraints on schools

Define tabu search parameters