A Guidebook for Best Practices on Integrated Land Use and Travel Demand Modeling

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Project Details

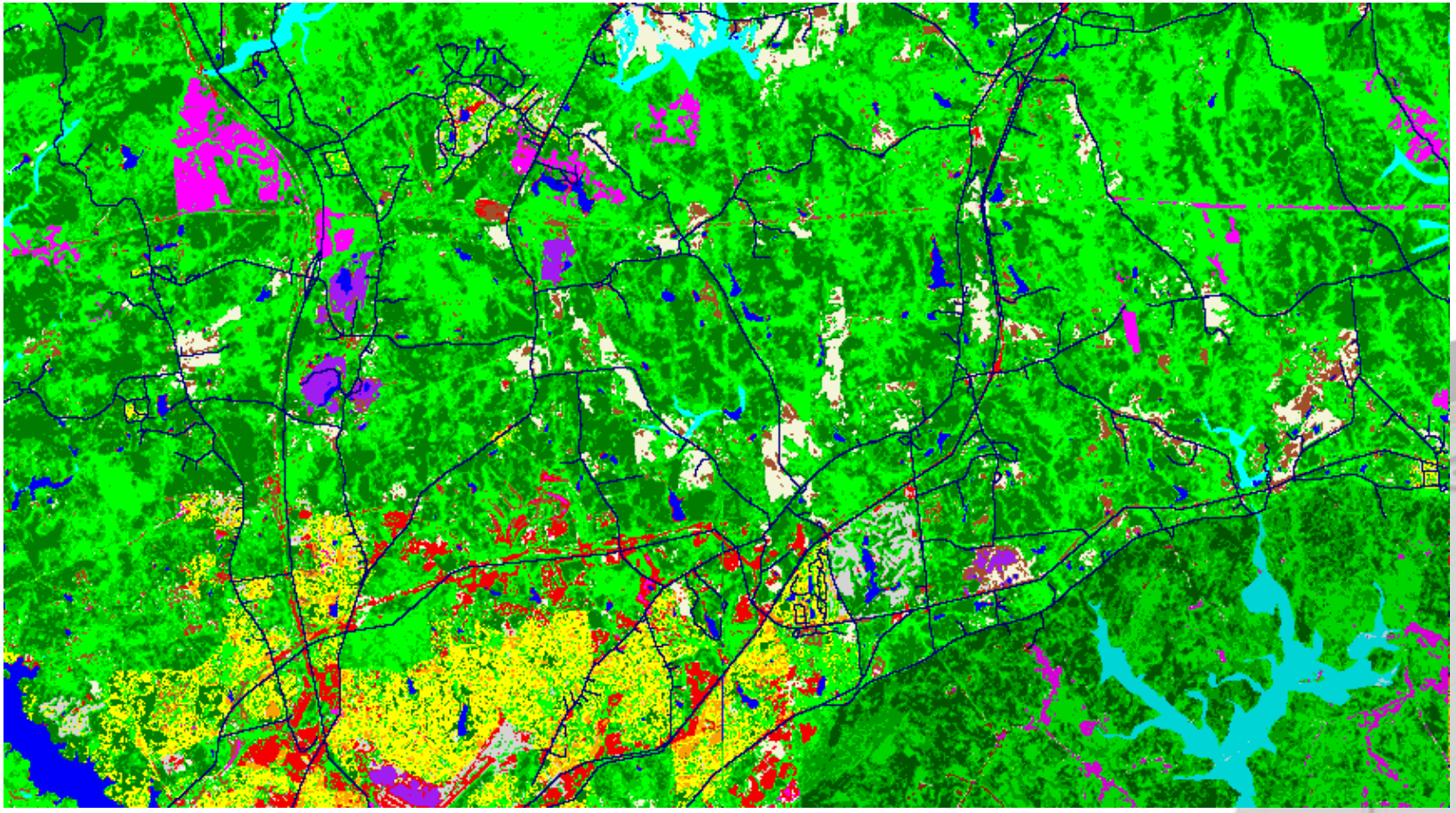
- Title: A guidebook for best practices on integrated land use and travel demand modeling
- People Involved: Golias M.M. (PI), Mishra S. (Co-PI), Psarros I.
- Sponsored by: Tennessee Department of Transportation
- Project Duration: Oct. 1st, 2013 – Sep 30th, 2014

Project Overview

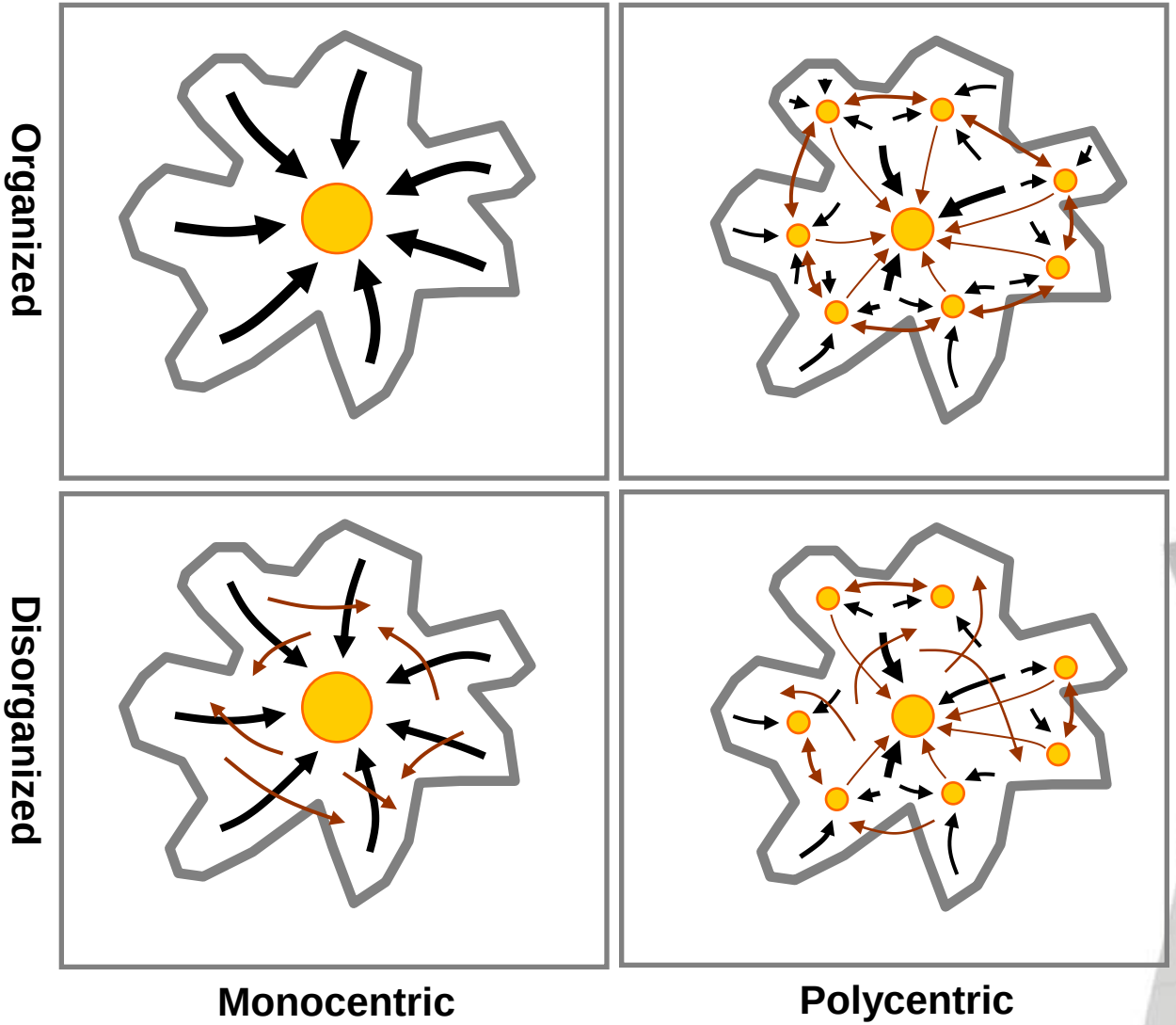
- This project analyzes the **interdependence** of **land use** and **travel demand**

- Anticipated results:
  - Develop a step by step guidebook with the best practices on integrated land use and transport models
  - Suggest the application of an integrated land use-transport model in a synthetic **case study**

Land Use and Evolution



Possible Spatial Patterns



Source: http://alain-bertaud.com/images/AB_Metropolis_Spatial_Organization.pdf

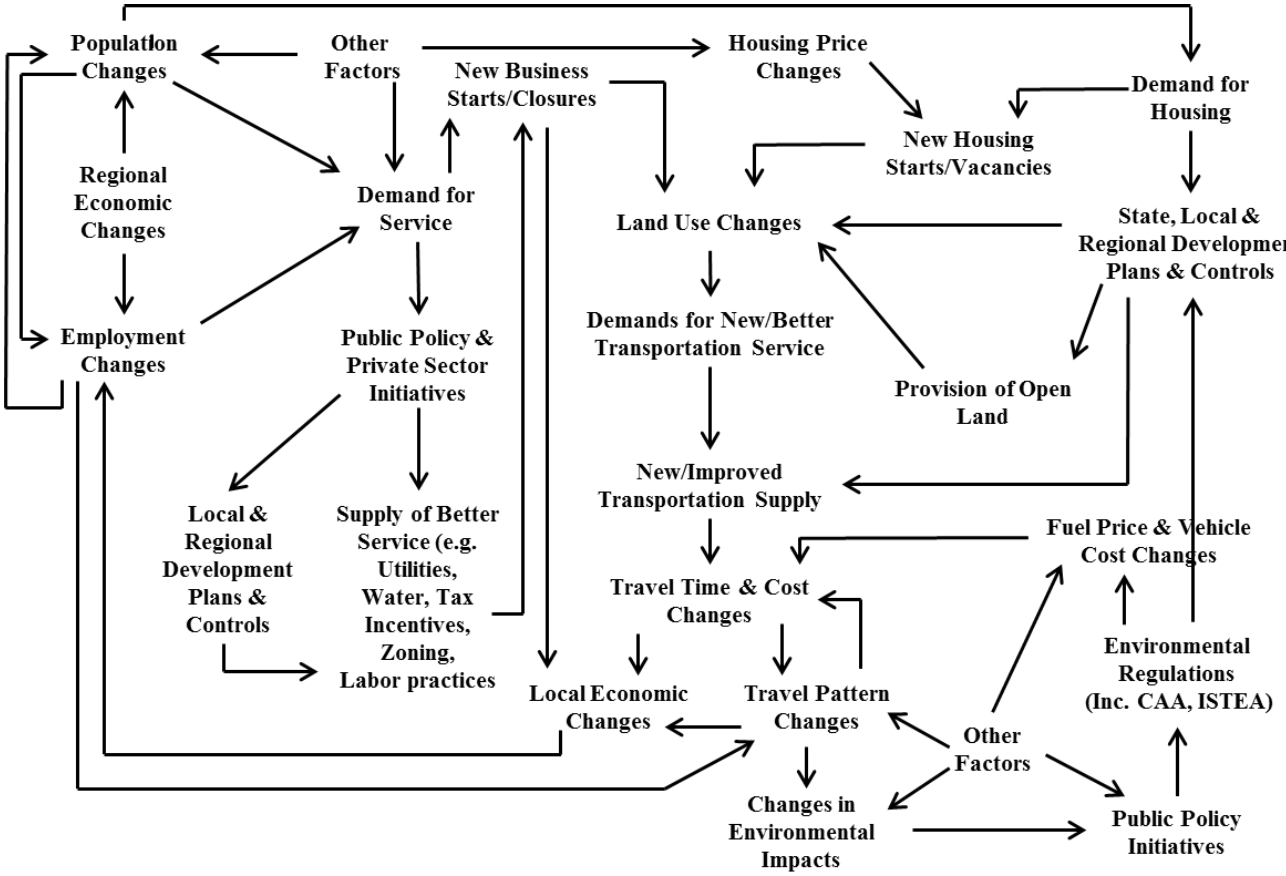
Land Use Modeling

- Use **economic theories** and **statistical methods** to estimate urban **land use patterns** (Peng, 2012)

- Describes methods to **predict changes** in land use, socioeconomic and demographic data

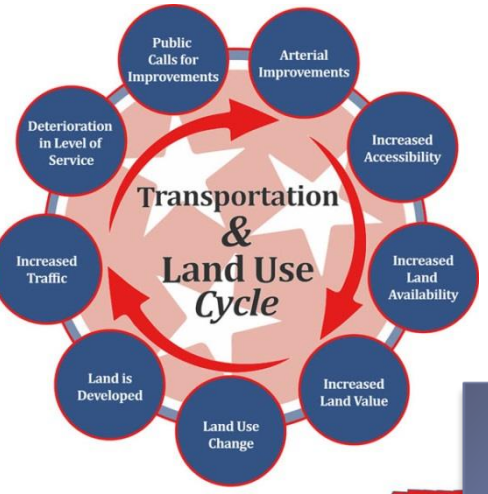
- Additional objectives
  - incorporation of land use changes in demand models
  - conduct policy analysis

Agent Interaction in Urban Systems

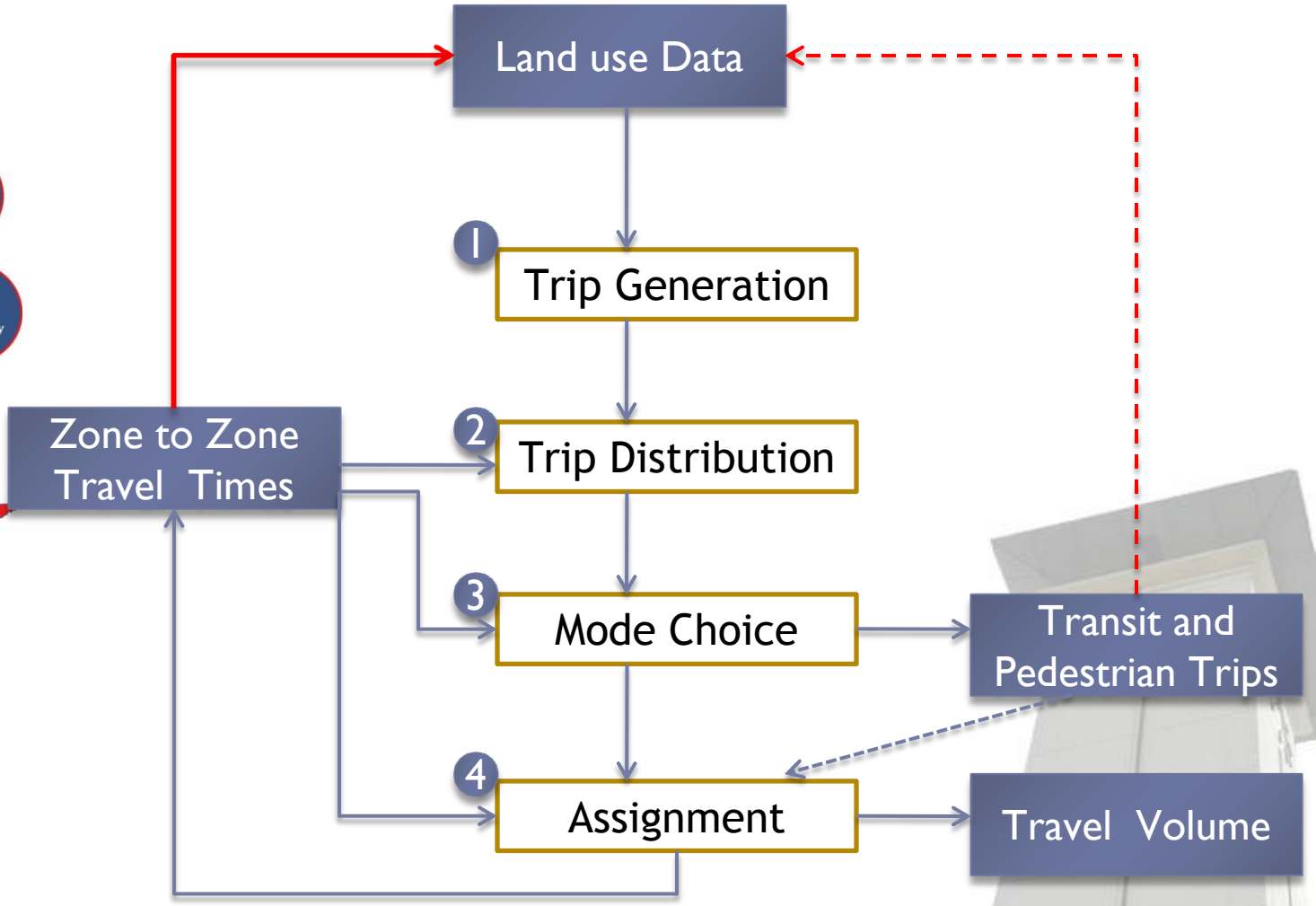


(Source: Southworth, 1995)

Integrated Models

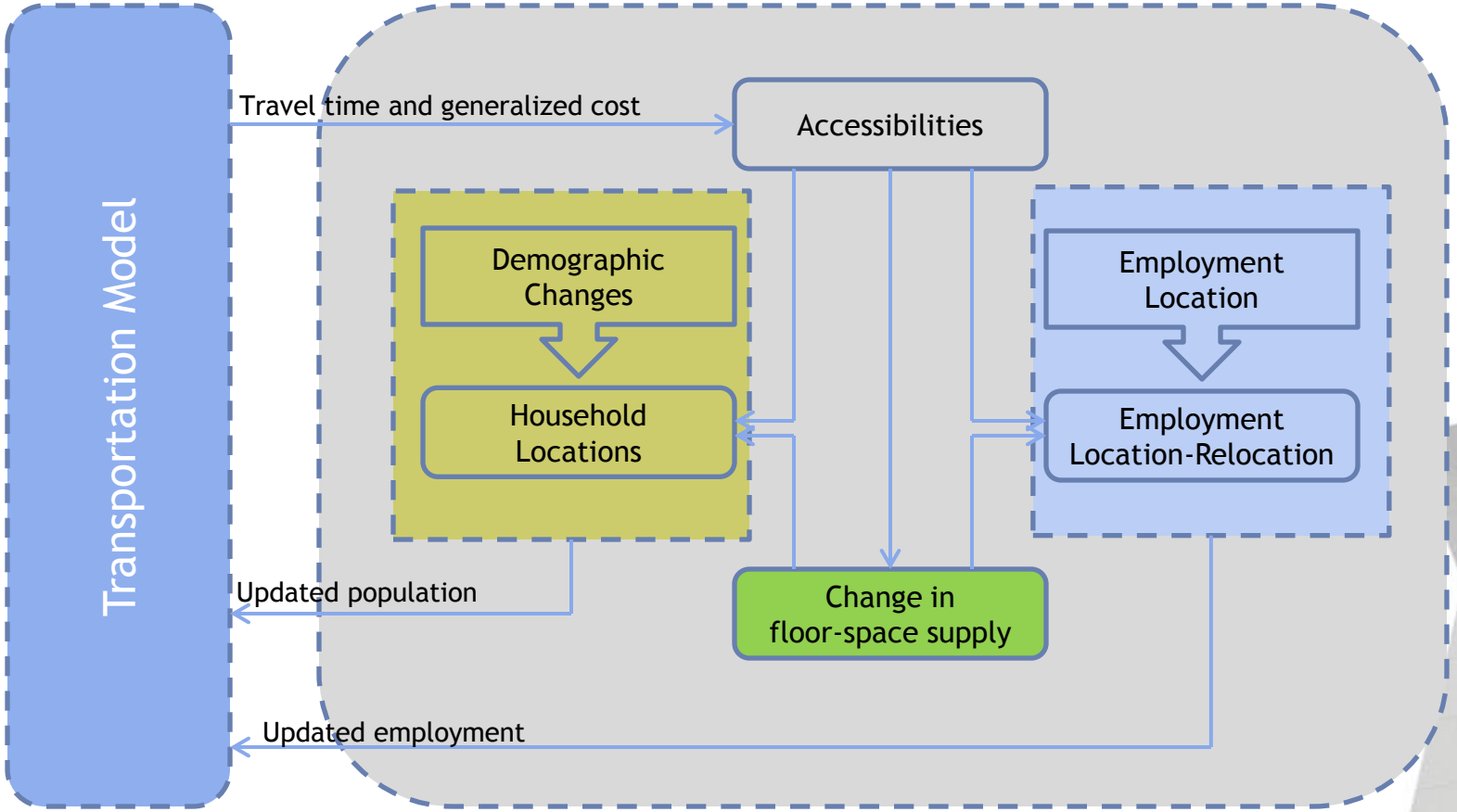


(Source: www.tdot.state.tn.us)

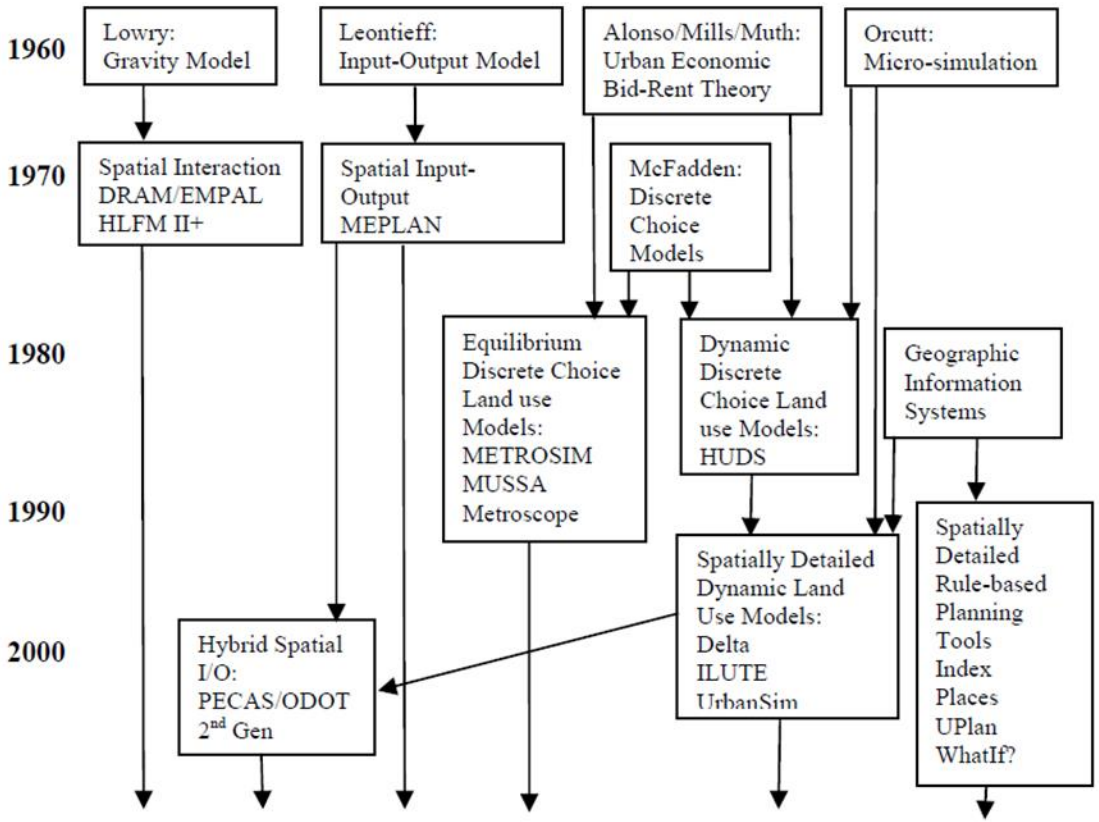


Need for Developing Integrated Land Use/Travel Demand Models

Interaction



Land Use Models Evolution

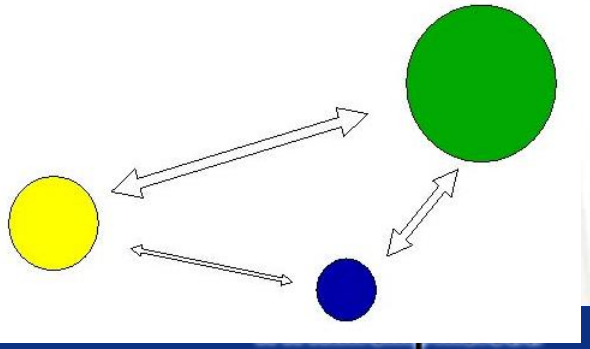


Land Use Models Evolution (Source: Wadell, 2005)

1st Generation of Land Use Models

- The first models were introduced around 1960s and were aggregate models of **spatial interaction** and gravity models (Iacono et al., 2008)

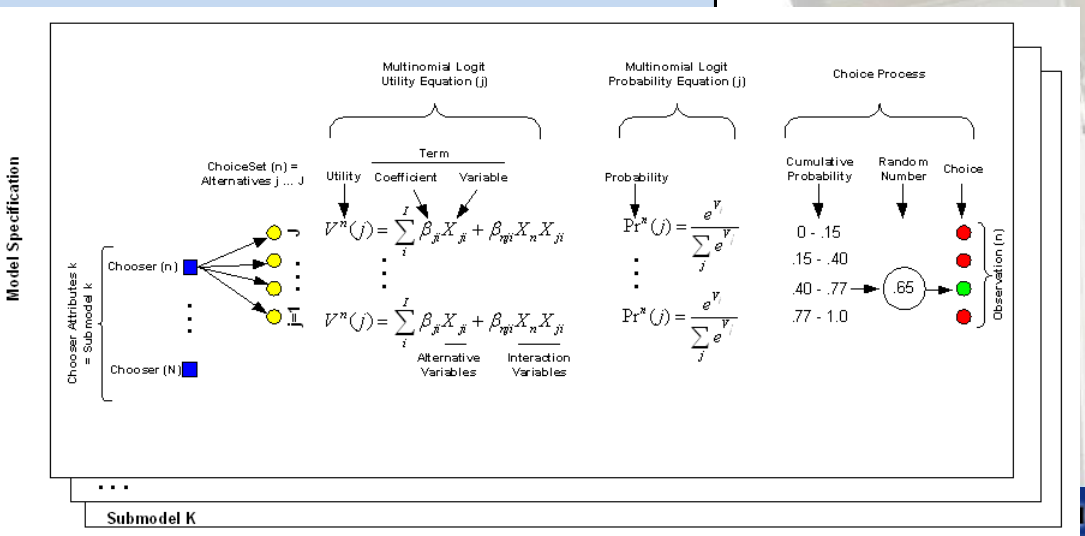
First Generation of Land Use Models			
1	Lowry Model	**6**	IRUPD
2	Lowry-Garin Model	**7**	LILT
3	TOMM	**8**	POLIS
4	PLUM	**9**	HLFM Model
5	TOPAZ/TOPMET	**10**	METROPILUS-DRAM/EMPAL



2nd Generation of Land Use Models

- A new approach in 1980s suggested the development of **econometric**, market models and discrete choice models based on utility theory (2nd generation)

Second Generation of Land Use Models			
1	HUDS	**8**	METROSIM
2	CATLAS	**9**	DELTA
3	TRANUS	**10**	NYMTC-LUM
4	RURBAN	**11**	IMREL
5	MEPLAN	**12**	METROSCOPE
6	MUSSA & ESTRAUS	**13**	PECAS
7	CUF	**14**	-



3rd Generation of Land Use Models

The 3rd generation (starting from late 1980s) included **micro-simulation** disaggregate systems, cellular automata models and rule based tools

Third Generation of Land Use Models			
1	SMART	**7**	U-Plan
2	SAMS & AMOS	**8**	PUMA
3	ILUTE	**9**	LEAM & SLEUTH
4	What if?	**10**	ILUMASS
5	RAMBLASS	**11**	LUSDR
6	UrbanSIM	**12**	LandSys

Land Use Planning Tools

Land Use Planning Tools			
1	CommunityViz	5	TRESIS
2	INDEX	6	I-PLACE3S
3	LUCAS	7	Envision Tomorrow
4	Smart Places	8	UrbanFootprint

Operational Models with Agencies

Operational Models with U.S. Agencies			
1	OREGON TLUMIP Model	4	PSRC Model
2	SACOG Model	5	CalSIM
3	LUCI Model	6	-

Other Models

Other Models			
1	LUTRIM	6	TELUM
2	ULAM	7	G-LUM
3	SAM/SAM-IM	8	Land Use Allocation Model for Florida Turnpike
4	LUAM	9	MARS
5	FLUAM	10	LUTSAM

Evaluation of Selected Models

✓	Well represented
⊘	Moderately represented

	Land Use Model	Efficient Geographical Coverage	Spatial Detail			Freight Transport	Travel Demand Model Integration		Multi-modality	Visualization
			Zone	Parcel	Cell		Trip Based	Activity Based		
1	*UrbanSIM*	Regional level	✓	✓	✓	⊘	✓	✓	✓	✓
2	*PECAS*	Regional level	✓	✓	✓	⊘	✓	✓	✓	✓
5	*ILUTE*	Regional level	✓	✓	✓	⊘	✓	✓	✓	✓
6	*What if*	Regional level	✓	✓	⊘	⊘	⊘	⊘	⊘	✓
8	*U-Plan*	Regional level	⊘	⊘	✓	⊘	✓	⊘	✓	✓
9	*PUMA*	Regional level	⊘	⊘	✓	⊘	⊘	✓	✓	✓
10	*LEAM*	Regional level	✓	✓	✓	⊘	✓	⊘	⊘	✓
11	*SLEUTH*	Regional level	⊘	⊘	✓	⊘	⊘	⊘	⊘	✓
12	*ILUMASS*	Regional level	⊘	✓	✓	⊘	⊘	✓	✓	✓
13	*LUSDR*	Regional level	✓	⊘	⊘	⊘	⊘	⊘	✓	✓
14	*LandSys*	Regional level	⊘	⊘	✓	⊘	✓	⊘	⊘	✓
15	*CommunityViz*	Regional level	✓	⊘	⊘	⊘	✓	⊘	✓	✓
16	*INDEX*	Regional level	✓	✓	⊘	⊘	⊘	⊘	✓	✓
18	*Smart Places*	Regional level	✓	✓	✓	⊘	⊘	⊘	⊘	✓
19	*TRESIS*	Regional level	✓	⊘	⊘	⊘	⊘	⊘	✓	⊘
20	*I-PLACE3S*	Regional level	✓	✓	⊘	⊘	✓	⊘	✓	✓
21	*Envision Tomorrow*	Regional level	✓	✓	✓	⊘	✓	⊘	✓	✓
22	*UrbanFootprint*	Regional level	✓	✓	✓	⊘	✓	⊘	✓	✓

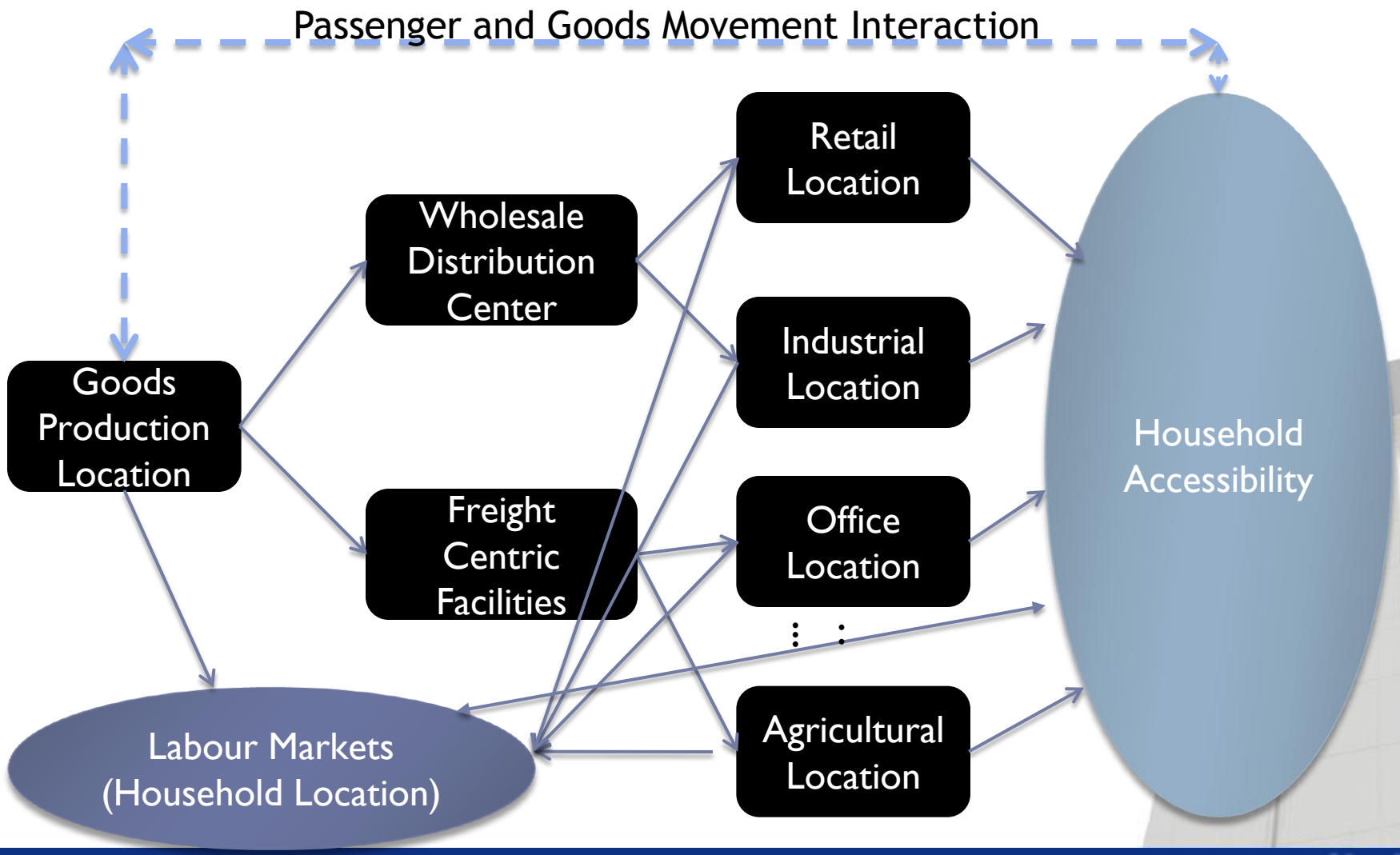
Land Use Modeling Challenges

- **Accuracy** of Land Use Models at Finer Geographic Level
- **Computational** Resources Requirement
- **Visual** Demonstrations versus **Computational** Complexity
- Evolving **Indicators** and **Linkages** to Transportation Models
- **Methodology** to Address **Freight** Movement Patterns
- **Uncertainty** in Future Policy and Growth
- Location Choice and **Evolution** of Freight Facilities

Direction of Land Use Research

- Limited evidence of “freight land use evolution”
- Freight evolution is complex to analyze
- More emphasis on parcel-based disaggregate models
- Evolution versus proportional fitting

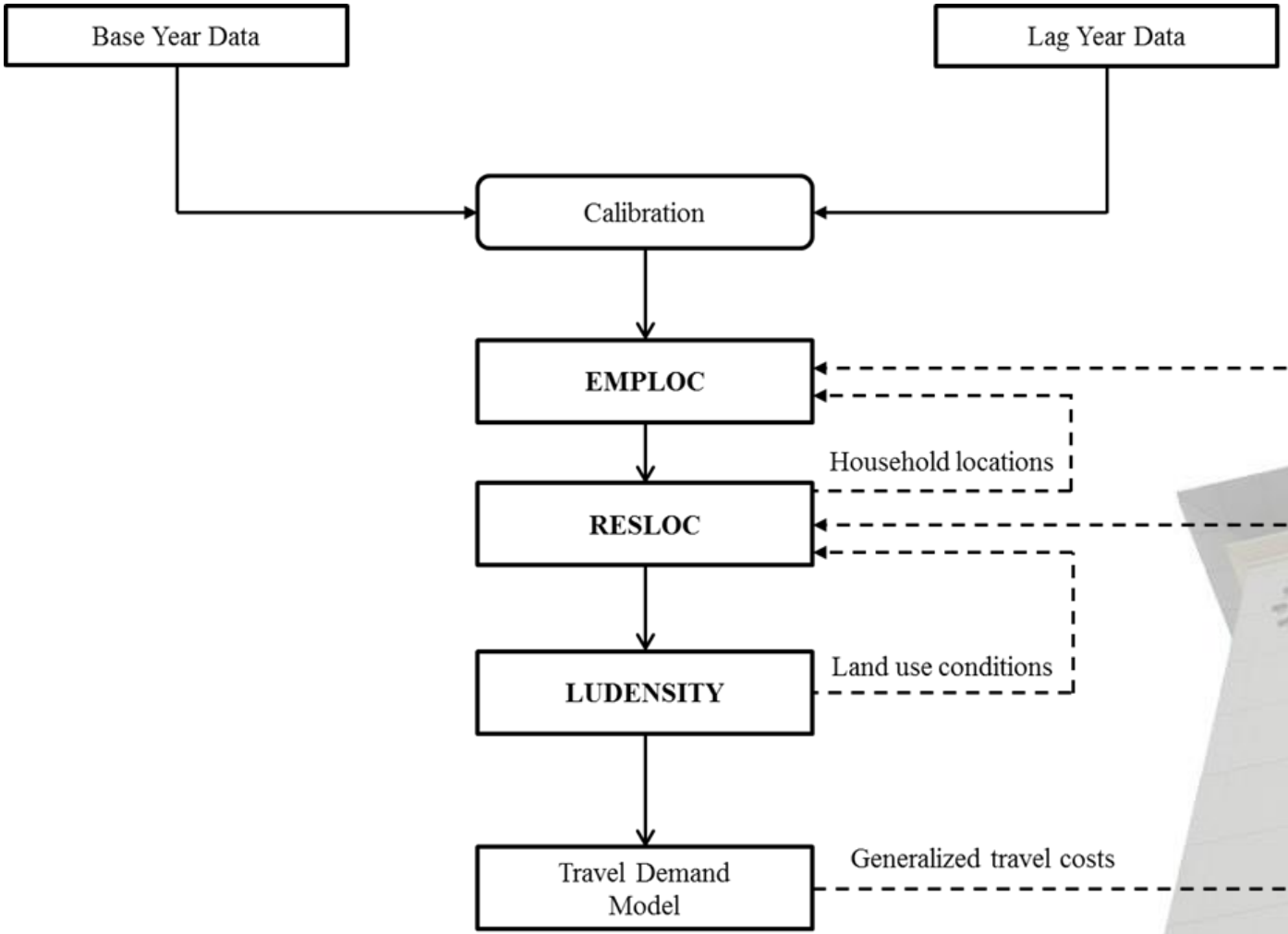
Freight and Spatial Structure



Application of a Land Use Model

- G-LUM model was selected for application at a synthetic case study
- Selected as it provides a faster and relatively straightforward model implementation
- Developed at the University of Texas at Austin, and modified in this project
- Land use and transport model based on the formulation of ITLUP (DRAM/EMPAL) package

G-LUM Structure



Source: http://http://www.caee.utexas.edu/prof/kockelman/G-LUM_Website/homepage.htm

Synthetic Case Study

- G-LUM was applied at a synthetic case study for demonstration purposes
- A case study area of approximately 161,310 acres with seventy-five different zones was analyzed
- Scenario was developed that considered 2005 as the lag year and 2010 as the base year of analysis.
- Forecasts of employment, household and land use change were provided for five year prediction periods up to 2035.
- A ten percent increase between the subsequent prediction periods for employment and household control totals was assumed

Data Requirements for G-LUM

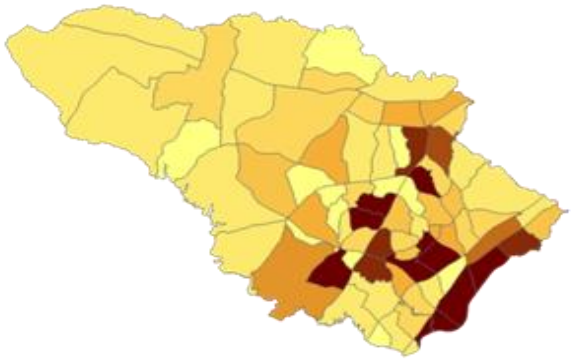
- Employment & Household for Lag and Base year
- Amount of land (acres) used for basic employment, non-basic or commercial employment
- Amount of acres:
  - undeveloped land (acres) that is available for future development
  - residential purposes, road network
  - cannot be further developed
- Travel times/costs between zones
- Zone size
- Control totals of Employment and Household change over the prediction period

Model Output

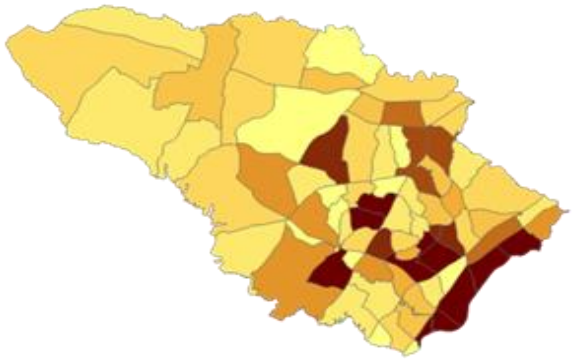
- G-LUM forecasts include:
  - Employment by type(Basic, Non-basic and Retail)
  - Households by income (Low, Medium, Medium-High and High)
  - Land use change by type (Land for Basic employment, Land for Non-basic employment and Land for Residential purposes)

Employment

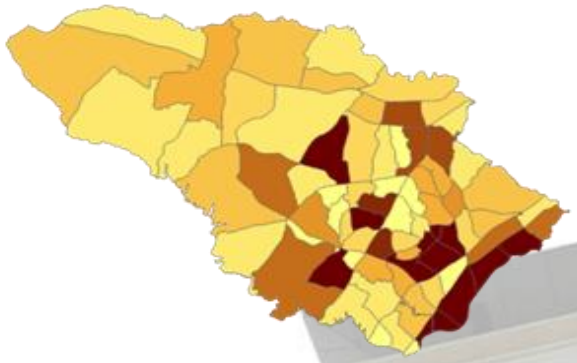
Employment - Base Year



Employment - 2020

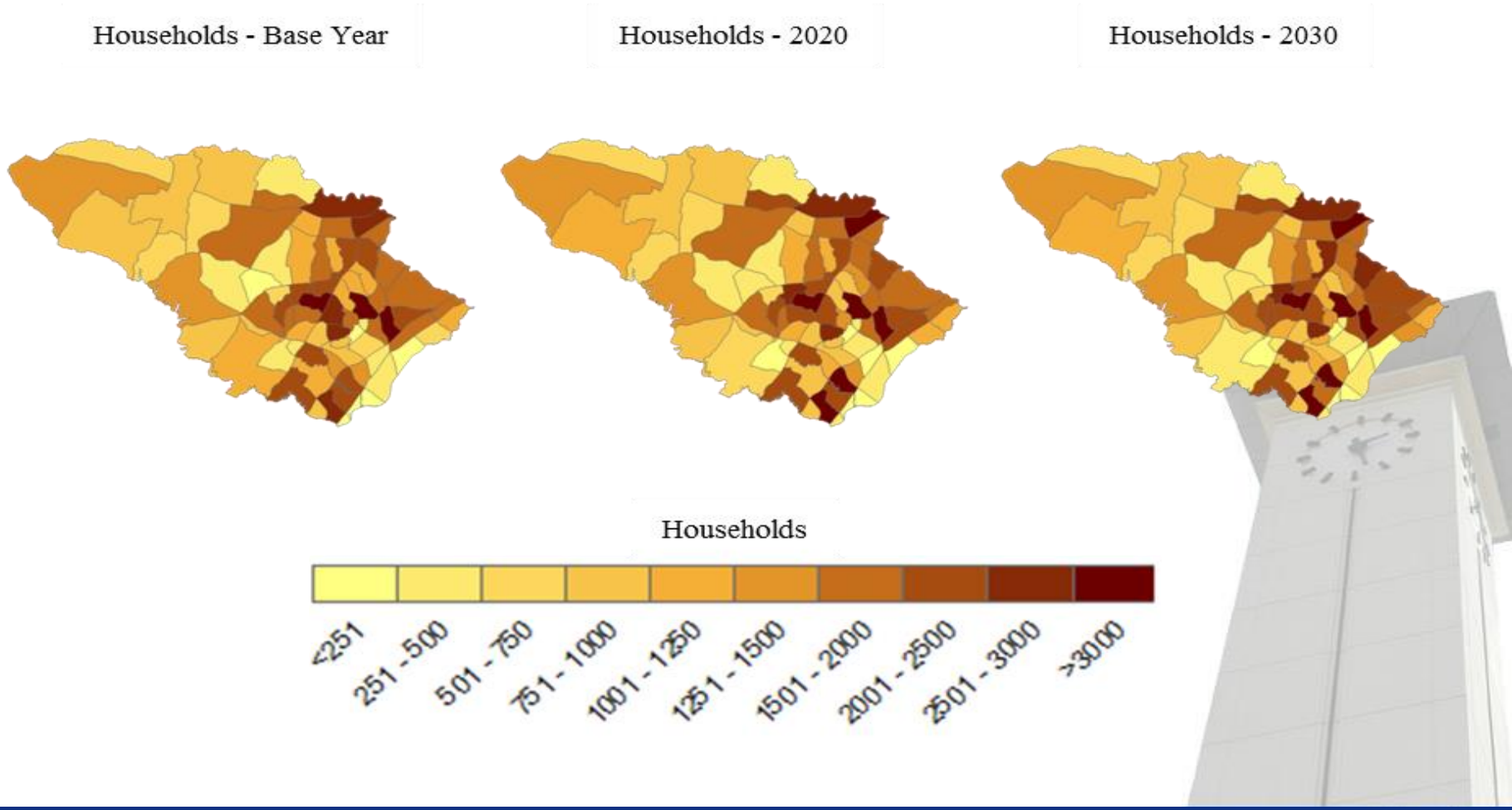


Employment - 2030

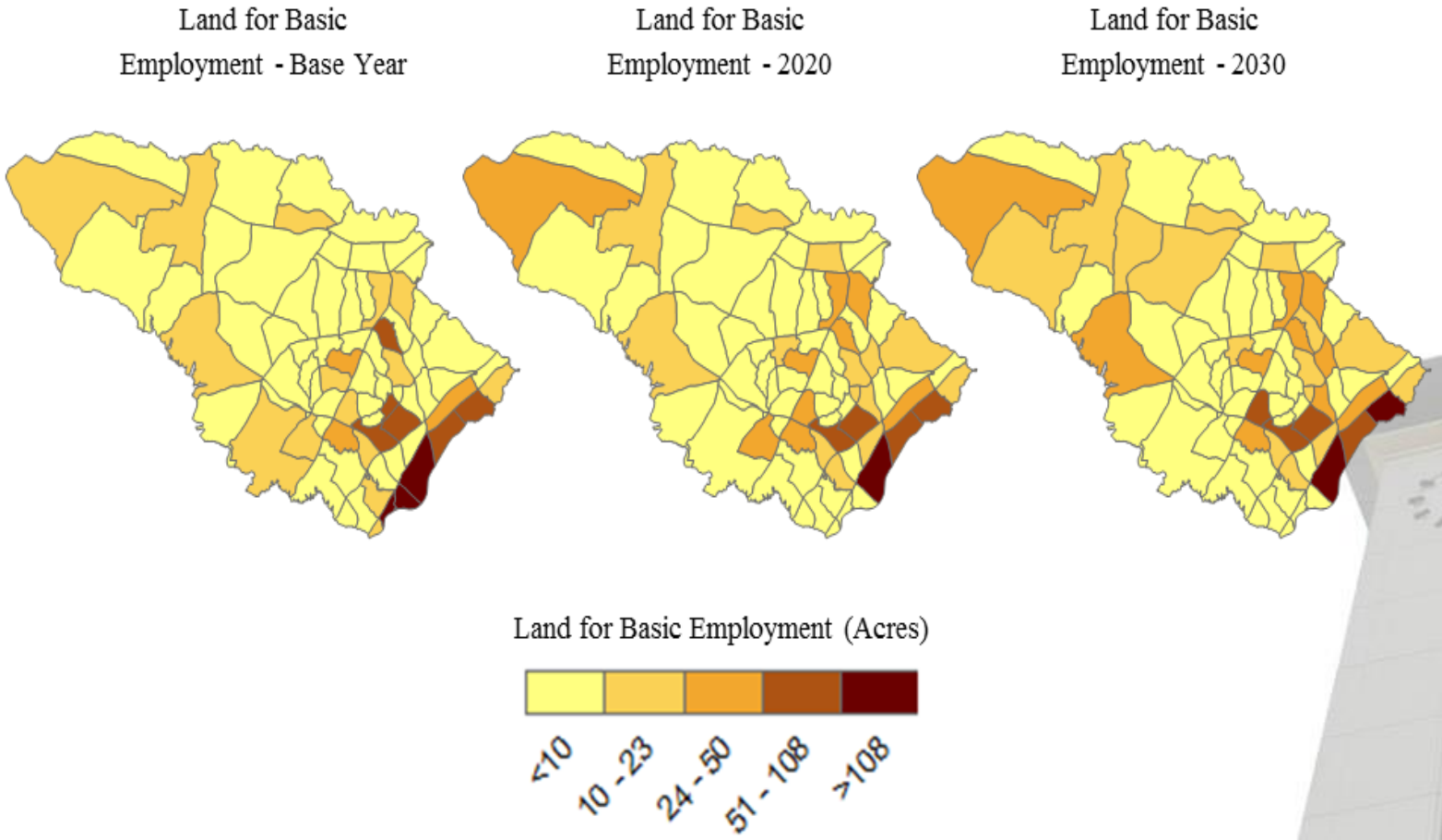


Employment

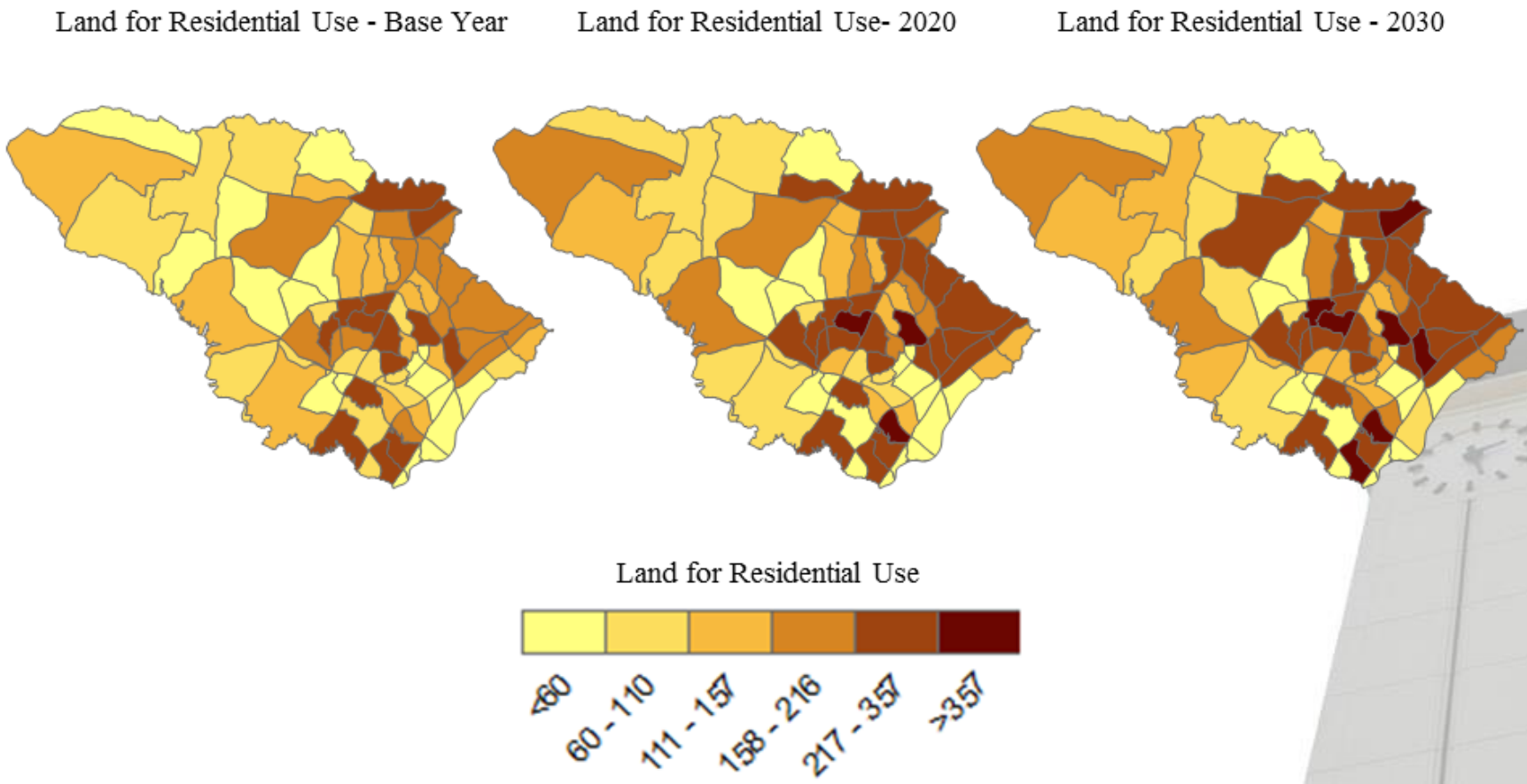
Household


Households - Base Year
Households - 2020
Households - 2030
Households
<251
251 - 500
501 - 750
751 - 1000
1001 - 1250
1251 - 1500
1501 - 2000
2001 - 2500
2501 - 3000
>3000

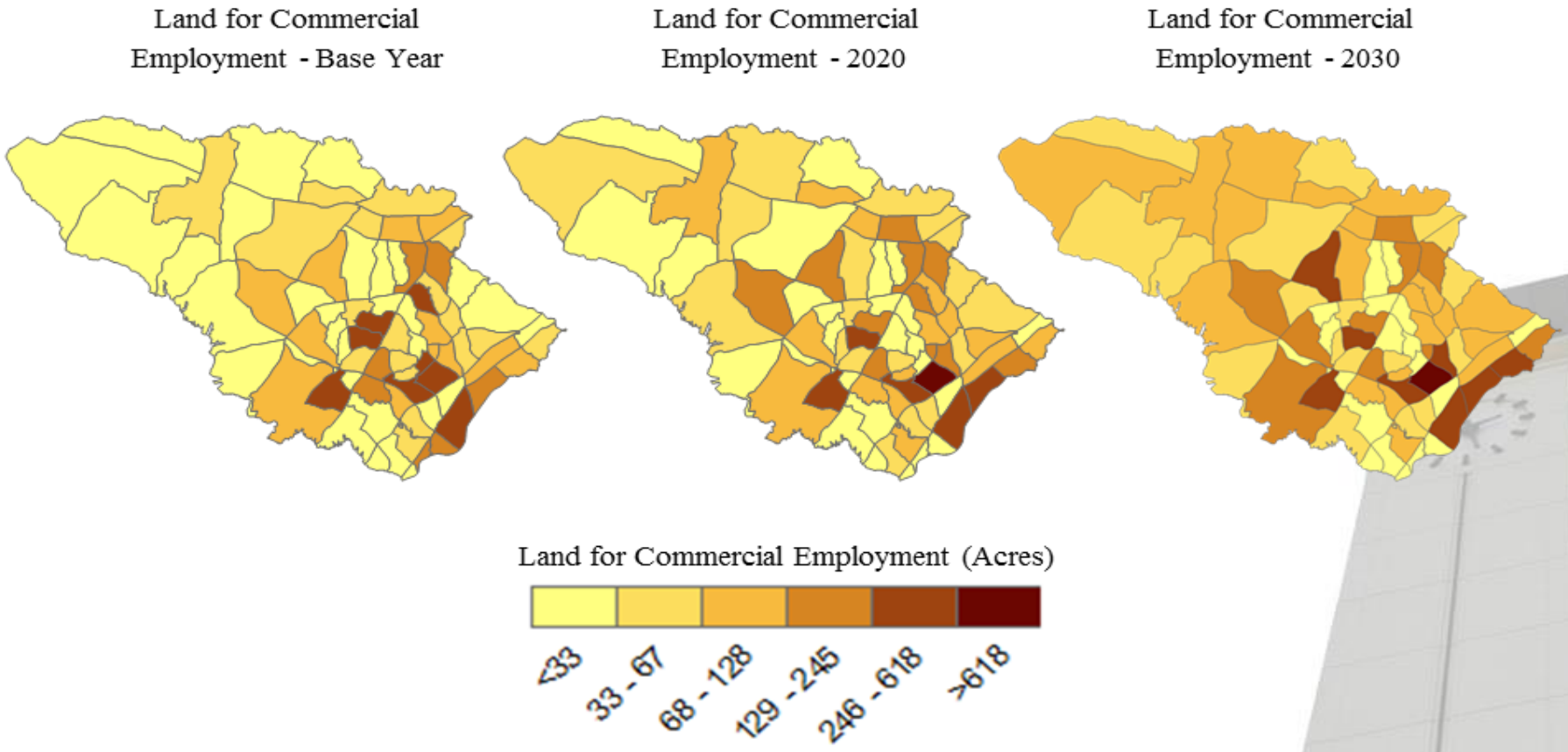
Land for Basic Employment



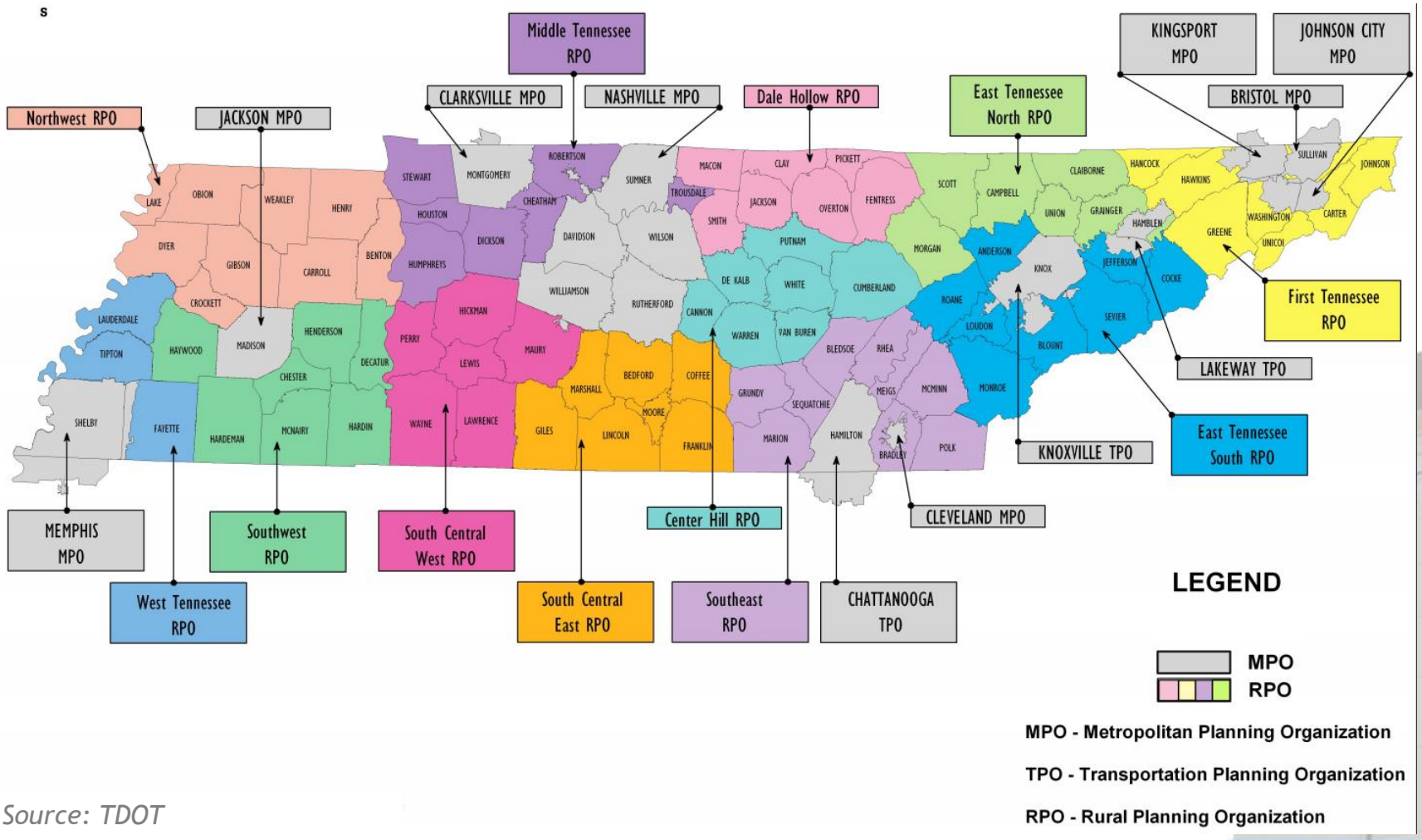
Land for Residential Use



Land for Commercial Employment



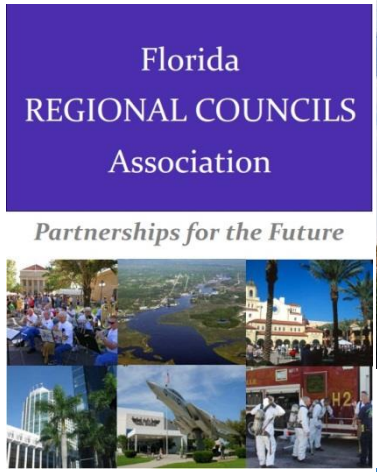
MPOs/RPOs in TN

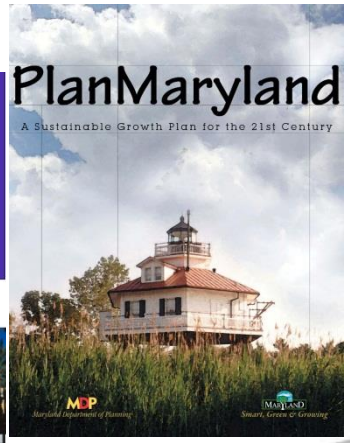


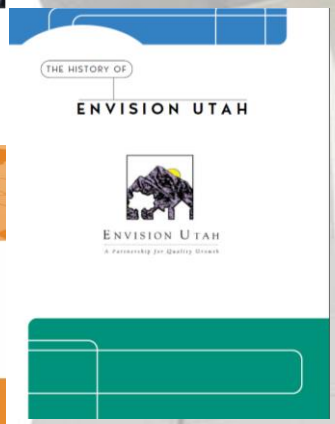
Source: TDOT

Current Efforts by States/Regions

- Envision Utah
- Plan Maryland
- Florida Regional Planning
- Portland 2040
- DVRPC comprehensive plan
- Visioning Sacramento
- Other metropolitan plans

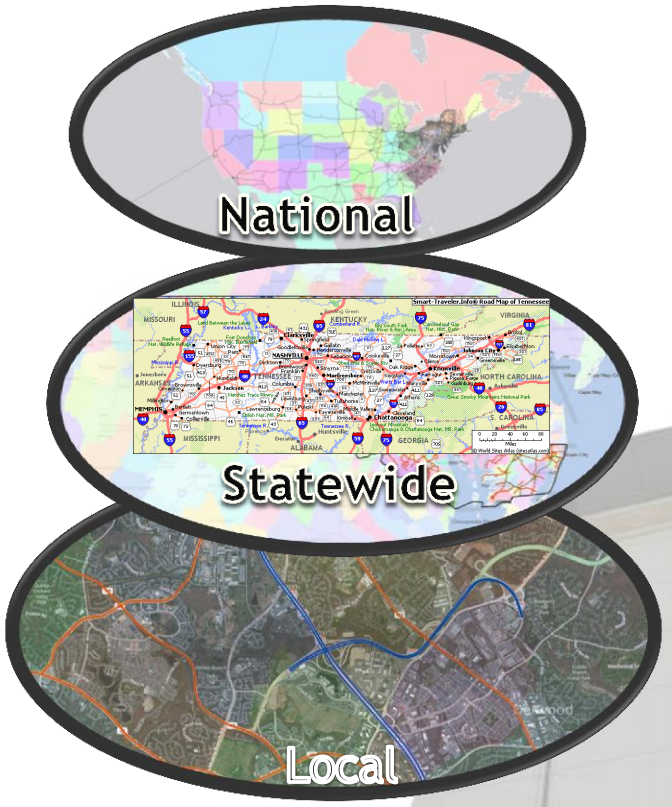




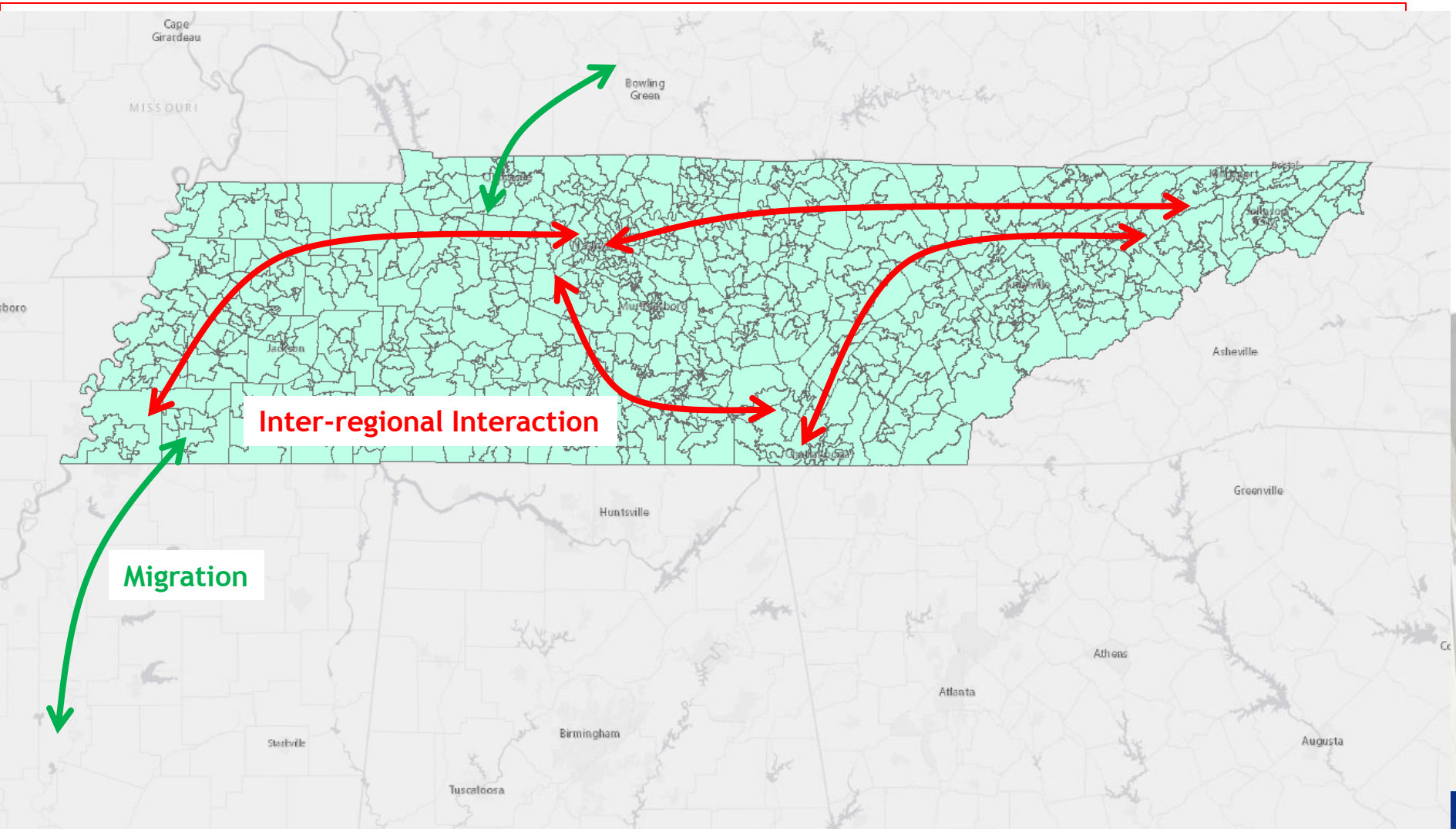


Multi-layered Approach

- **Multi-layer** lands use model working at *national*, *statewide* and *local levels* to **forecast and analyze** key measures of **transportation system performance.**



Inter-regional Interaction in Tennessee



LAND USE

Population

Households

Employment

Land Usage/Designation

TRAVEL DEMAND

Accessibility

Connectivity

Travel Schemes

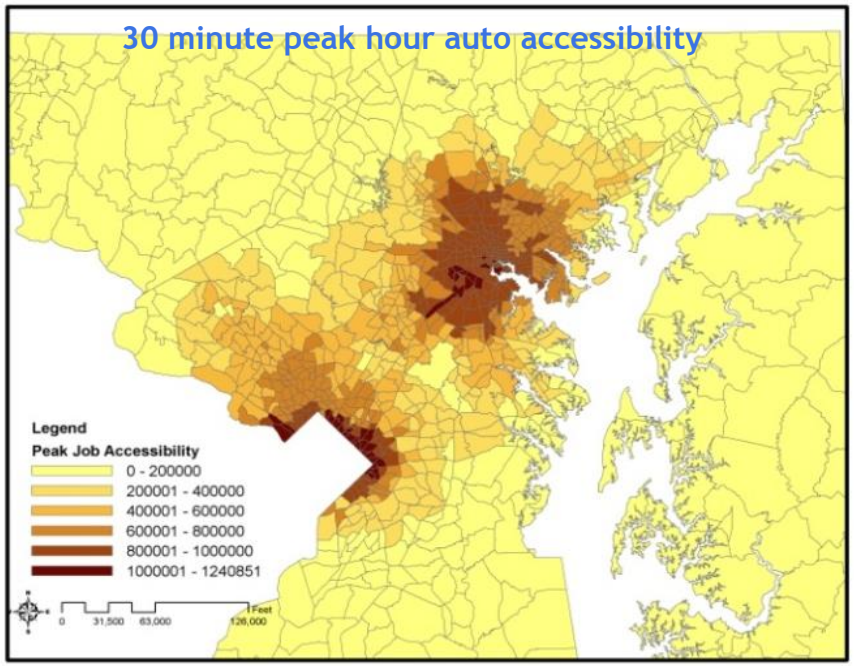
Flows

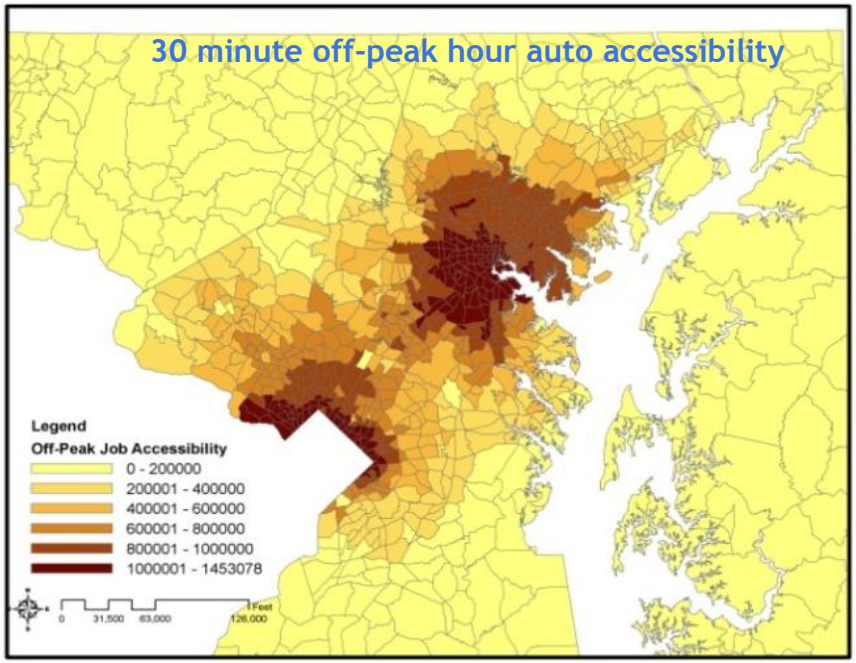
Multimodal-Intermodal Transportation Planning Effort

3 year work program

10 year strategic inv. plan

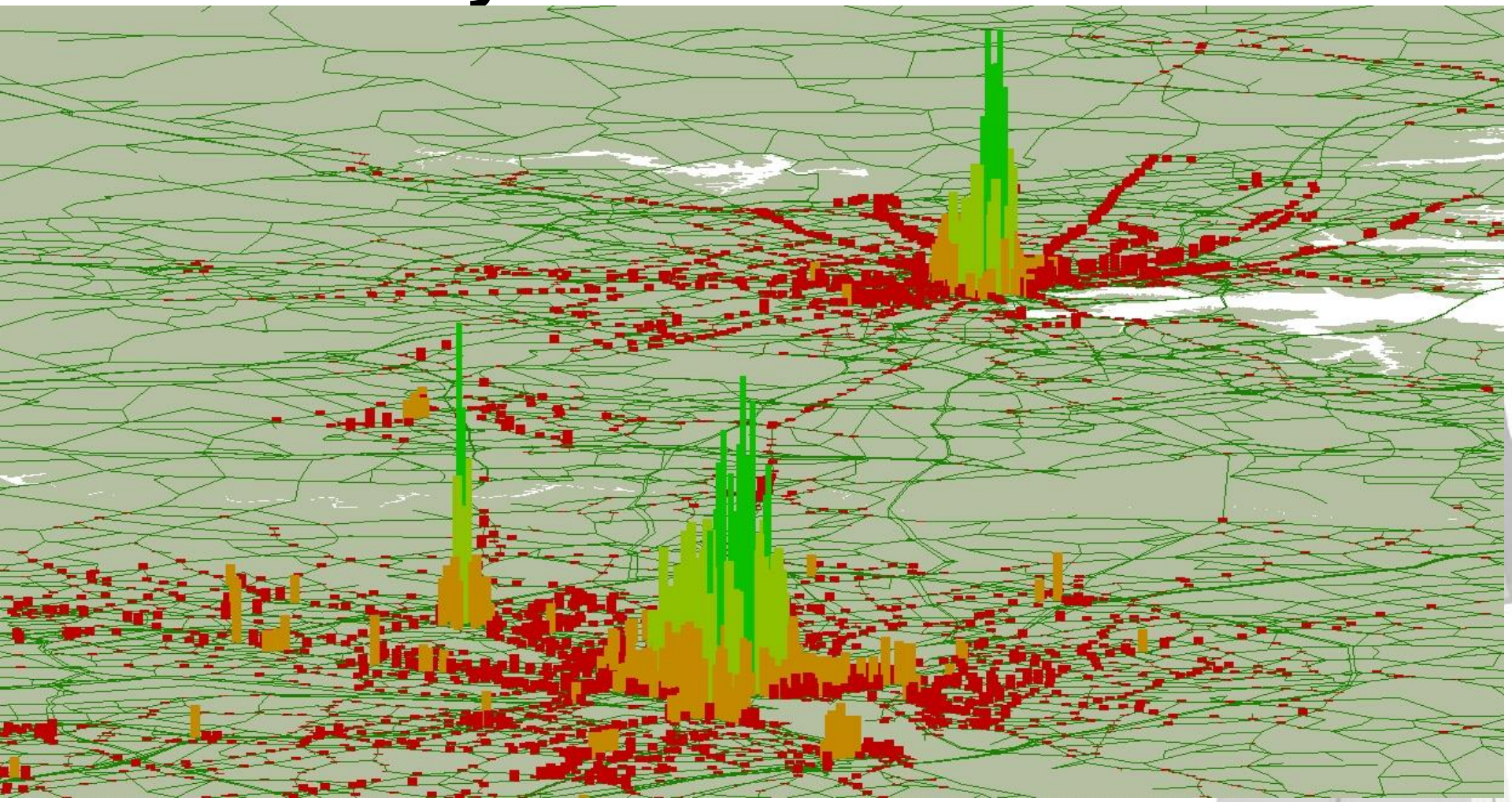
Accessibility





Mishra, S., Wang, Y, Erdogan, S, and Welch, T. (2012). An Integrated Travel Demand and Accessibility Model to Examine the Impact of New Infrastructures Using Travel Behavior Responses. 91st AM TRB

Connectivity



Sarker, A., Mishra, S., Welch, T., Golias, M., and Torrens, P. (2015) Model Framework for Analyzing Public Transit Connectivity and Its Application in a Large-Scale Multimodal Transit Network. 94th AM TRB

Summary and Conclusion

- The project prepared a guide book of best practices on land use/transportation models
- A number of suggestions are made for TN
- A synthetic case study is conducted as a proof of concept
- Future recommendation on how to expand the study results to be used for developing a TN statewide land use model.

Thank you
Q/A

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