LAND USE FORECASTING MODELS FOR SMALL AREAS IN NORTH CAROLINA: NCDOT RP 2012-03

NCAMPO Conference, Raleigh, NC
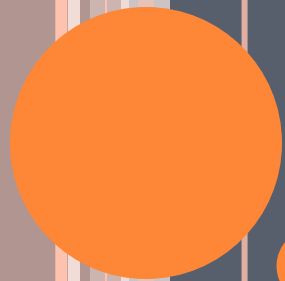**April 30, 2015**
Joseph Huegy
Brian Morton
Branislav Dimitrijevic

PRESENTERS AND PRIMARY RESEARCHERS

- Joe Huegy, AICP
  Director, Travel Behavior Modeling Group and P.I.
  Institute for Transportation Research and Educ.
  North Carolina State University
  - Adapted and ran transportation model for pilot study
- Brian J. Morton, Ph.D.
  Senior Research Associate
  Center for Urban and Regional Studies
  University of North Carolina – Chapel Hill
  - Prepared and ran land use model for pilot study and prepared tools for sending data between models

INTRODUCTION TO THE PRESENTATION

- Project's goals
- Land use models and current practice
- Pilot study
- Results: experience with model
  - TELUM would work well in NC

PROJECT'S GOALS

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Project's Goals

- Identify land use models available and used in practice, emphasizing models available for free
- Understand the tools used now in North Carolina
- Use a model to prepare socioeconomic inputs needed by NCDOT's Transportation Planning Branch for one of its small-area travel demand models

Land use models and current practice

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LAND USE MODELS

- Aim to capture interactions between transportation and land use
- Have been in development since 1950's
- Mostly implemented in large urban areas

CURRENT PRACTICE IN NORTH CAROLINA

- Web-based survey provided to RPOs October, 2011
- 16 out of 20 RPOs responded
- Majority reported experience with developing base year household and employment data
- Less than half report experience preparing forecasts of land use data
- Five responding RPOs reported they have used a land use forecasting model or GIS add-on tool such as Community Viz
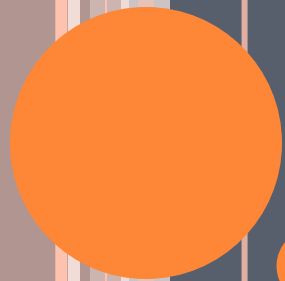
CRITERIA FOR SELECTING MODEL

- Minimize cost of operating model – cost to purchase and cost to maintain the inputs
- Easy to link to other planning tools used in local government planning
- Models recently developed and used in multiple locations
- Well-documented user's manual
- Reasonable learning curve for project's staff
- Easy to link to Transportation Planning Branch's travel demand models
- Reasonable learning curve for TPB's staff

MODELS MOST SERIOUSLY CONSIDERED

Development Scenario Design Tools		
Community Build-Out Analysis	CommunityViz	INDEX
I-PLACE^{3}S		
Legacy Models		
Kain	Lowry	Projective Land Use Model (PLUM)
Cellular Automata Models		
Land Use Evolution and Impact Assessment Model (LEAM)	Slope, Land Use, Exclusion, Urban, Transportation, Hill Shading (SLEUTH)	
Rule-Based Spatial Allocation Models and Spatial Interaction Models		
California Urban Futures 2	ITLUP, DRAM, EMPAL, METROPILUS	Gravity Land Use Model (G-LUM)
HLFM II+ (part of QRS II)	Land Use Scenario DevelopeR (LUSDR)	Simplified Land Allocation Model (SLAM)
Transportation Economic and Land Use Model (TELUM)	UPLAN	What if?
Integrated or Linked Land Use-Transportation Models Using Discrete Choice Sub models		
Integrated Land Use, Transportation, Environment (ILUTE)	MEPLAN	MetroSim
PECAS	TRANUS	UrbanSim
Other Models		
Cube Land	School-enrollment forecasting models	Subarea Allocation Model and Information Manager
Urban Dynamic Model	Urban Land Use Allocation Model (ULAM)	

USING TELUM TO DRIVE TRAVEL DEMAND MODEL
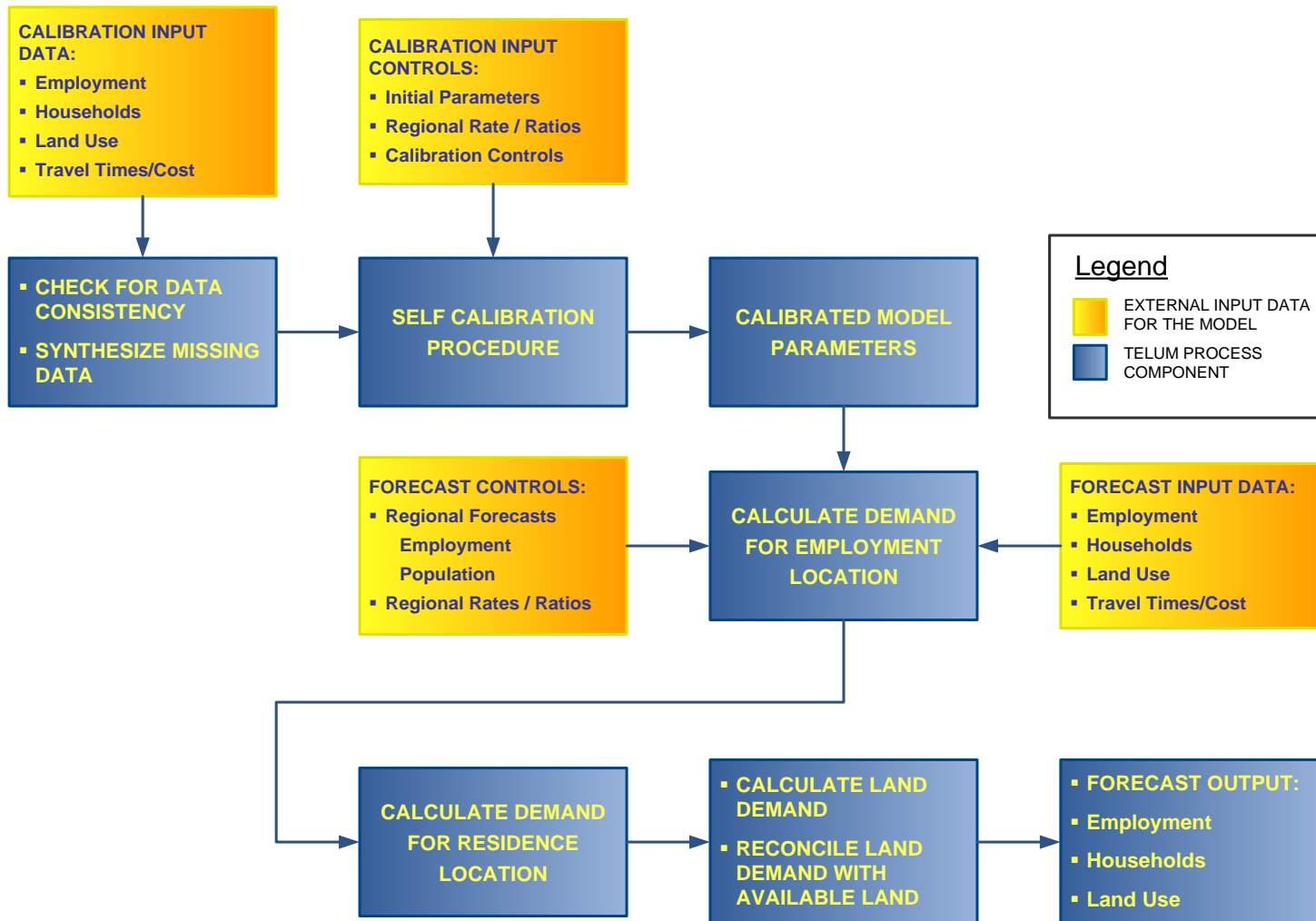
PILOT STUDY

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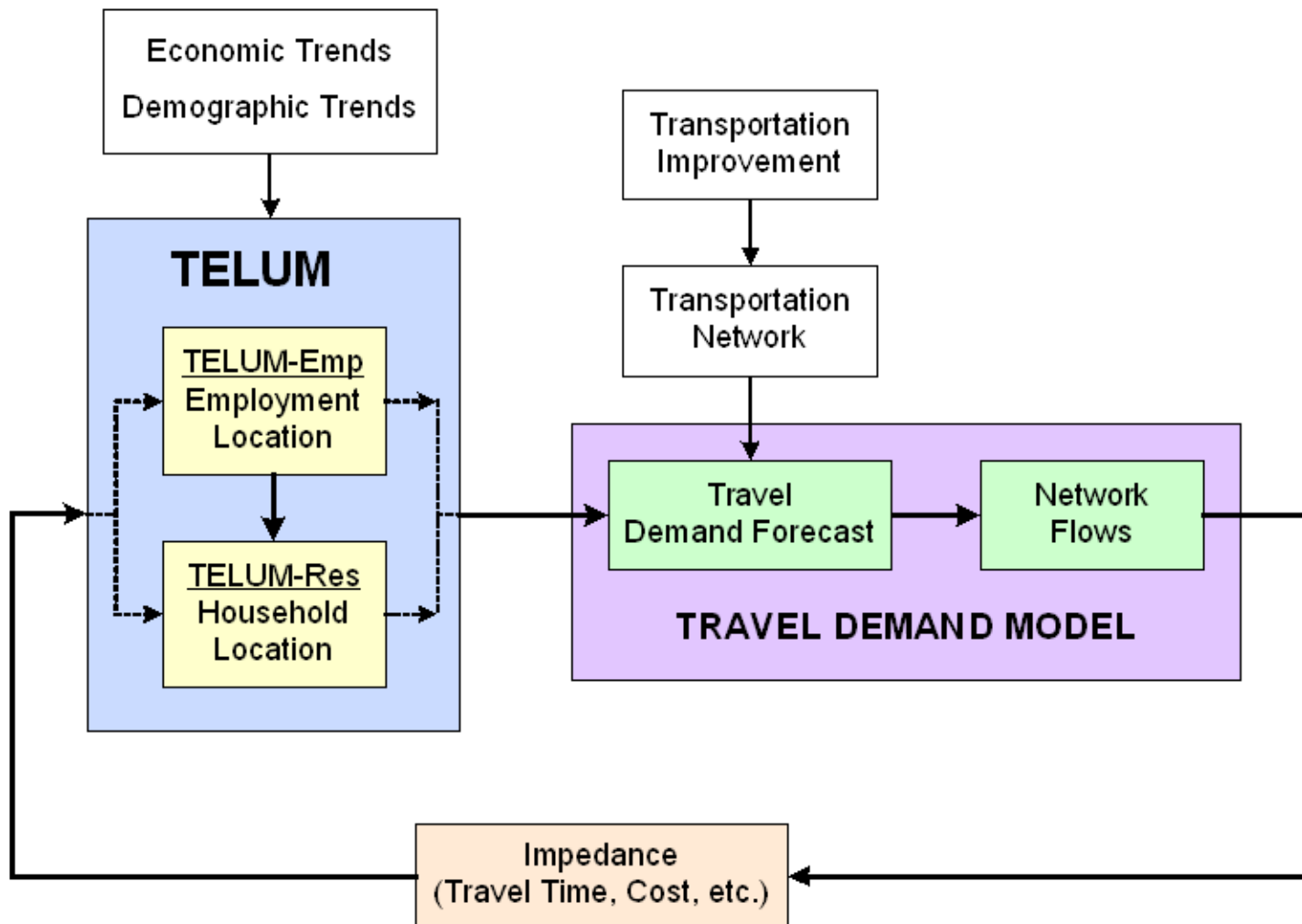
PILOT STUDY

- Statesville, North Carolina chosen
  - 25,000 households – appropriate small size
  - Transportation model available for 2009 and a 2040 forecast year
- Travel demand model is an NCDOT small area 4 step travel model
- Model area 179 square miles, 167 internal zones

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TELUM Model for Statesville

- Model developed using a current year (2009) and a lag year (2004) based on transportation model households and employment for 2009 and census households and employment for 2004

- Transportation model zones aggregated to 136 land use model zones

- Five household categories by size, and four employment categories (Industrial, Retail, Service, Office)

- Spreadsheet(s) developed to translate inputs and outputs between the models

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TELUM: Overview of Modeling Process

CALIBRATION INPUT DATA:
- Employment
- Households
- Land Use
- Travel Times/Cost

CALIBRATION INPUT CONTROLS:
- Initial Parameters
- Regional Rate / Ratios
- Calibration Controls

- **CHECK FOR DATA CONSISTENCY**
- **SYNTHESIZE MISSING DATA**

SELF CALIBRATION PROCEDURE

CALIBRATED MODEL PARAMETERS

Legend
- EXTERNAL INPUT DATA FOR THE MODEL
- TELUM PROCESS COMPONENT

FORECAST CONTROLS:
- Regional Forecasts
  - Employment
  - Population
- Regional Rates / Ratios

CALCULATE DEMAND FOR EMPLOYMENT LOCATION

FORECAST INPUT DATA:
- Employment
- Households
- Land Use
- Travel Times/Cost

CALCULATE DEMAND FOR RESIDENCE LOCATION

- **CALCULATE LAND DEMAND**
- **RECONCILE LAND DEMAND WITH AVAILABLE LAND**

- **FORECAST OUTPUT:**
- **Employment**
- **Households**
- **Land Use**

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TELUM's Data Requirements for Calibration

Datum	Source
Total population for lag year (by zone)	Census or American Community Survey
Total households for lag year (by zone)	Census or American Community Survey
Households for current year (by zone and sector)	Census or American Community Survey
Group quarters population for current year (by zone)	Census or American Community Survey
Total employed residents for current year (by zone, i.e., place of residence)	Census or American Community Survey
Employment for lag year and current year (by zone, i.e., place of work, and by sector)	Census or American Community Survey
Land occupied by residences for current year (by zone)	Local government's parcel data
Number of jobs per employee (for study area)	Local government or council of governments
Net commuting rate (for study area)	Census or American Community Survey
Unemployment rate (by sector for study area)	Employment Security Commission
Employees per household (by sector for study area)	National Household Travel Survey
Land occupied by industrial establishments for current year (by zone)	Local government's parcel data
Land occupied by commercial establishments for current year (by zone)	Local government's parcel data
Land devoted to transportation infrastructure for current year (by zone)	NC DOT
Vacant, developable land for current year (by zone)	Local government's parcel data
Unusable land for current year (by zone)	Local government's parcel data
Zone-to-zone travel times and/or costs for current year	Travel demand model

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TELUM's Data Requirements for Forecasting

Datum	Source
Total population (for study area)	Census or state demographer
Total employment (by sector for study area)	Woods & Poole Economics, Inc.
Unemployment rate (for study area)	Judgmental extrapolation from base year
Employees by household (by sector for study area)	Judgmental extrapolation from base year
Average income per employee (by sector for study area)	Judgmental extrapolation from base year
Jobs per employee (for study area)	Judgmental extrapolation from base year
Zone-to-zone travel times and/or costs for current year	Travel demand model
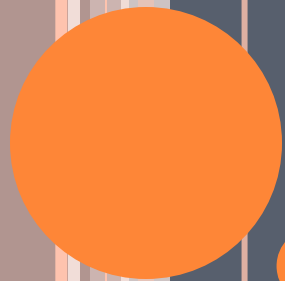
RESULTS

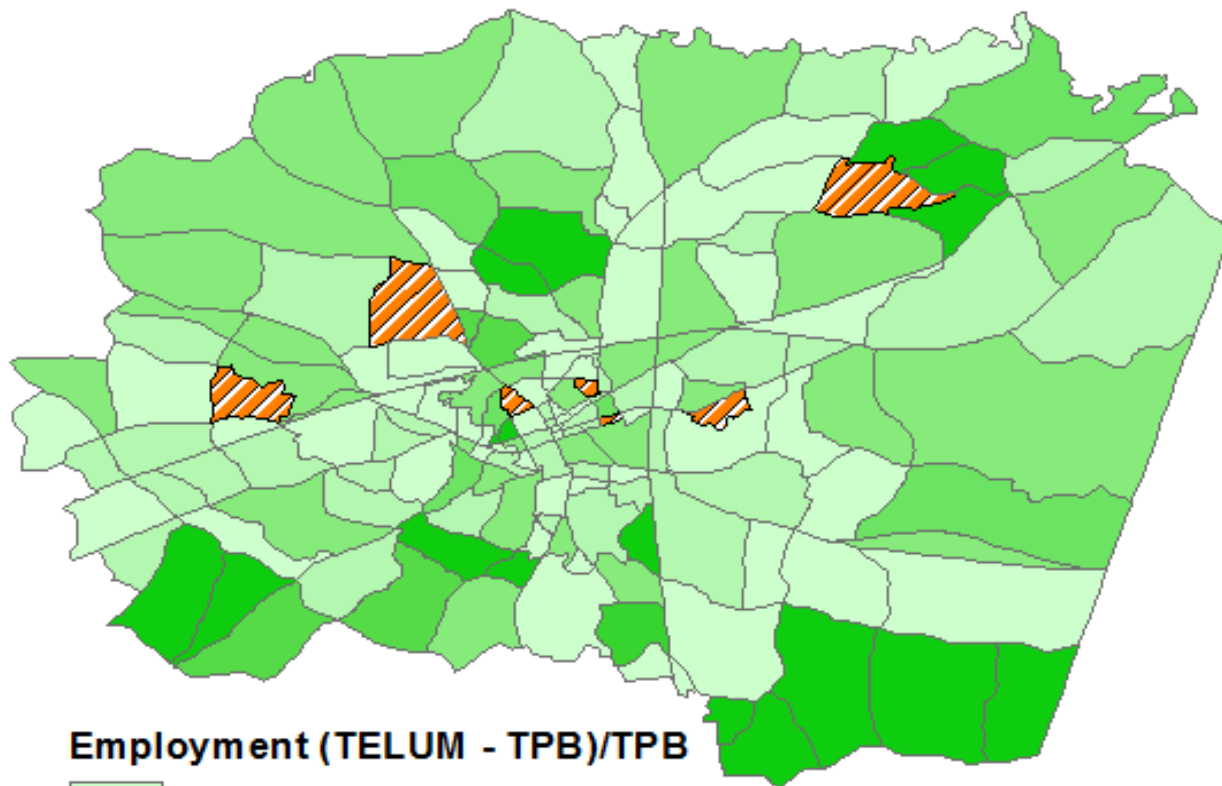**Experience with model and possible application**
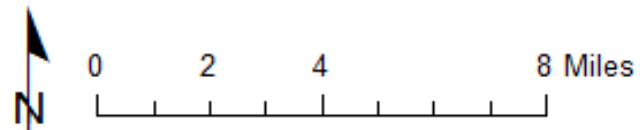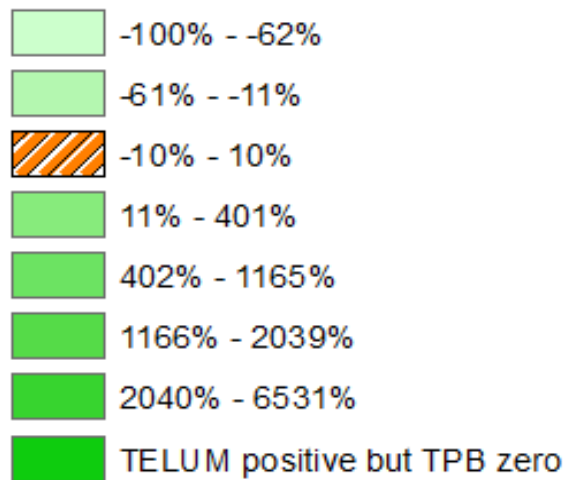
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RESULTS

- Simulations were run for five year intervals: 2014, 2019, 2024, 2029, 2034, 2040
- NCDOT 2040 forecast provided controls for households and employment
- Congested travel times for previous year become inputs for forecast: 2009 times used for 2014 forecast
- Results for 2040 TELUM forecast were compared to the NCDOT 2040 forecast
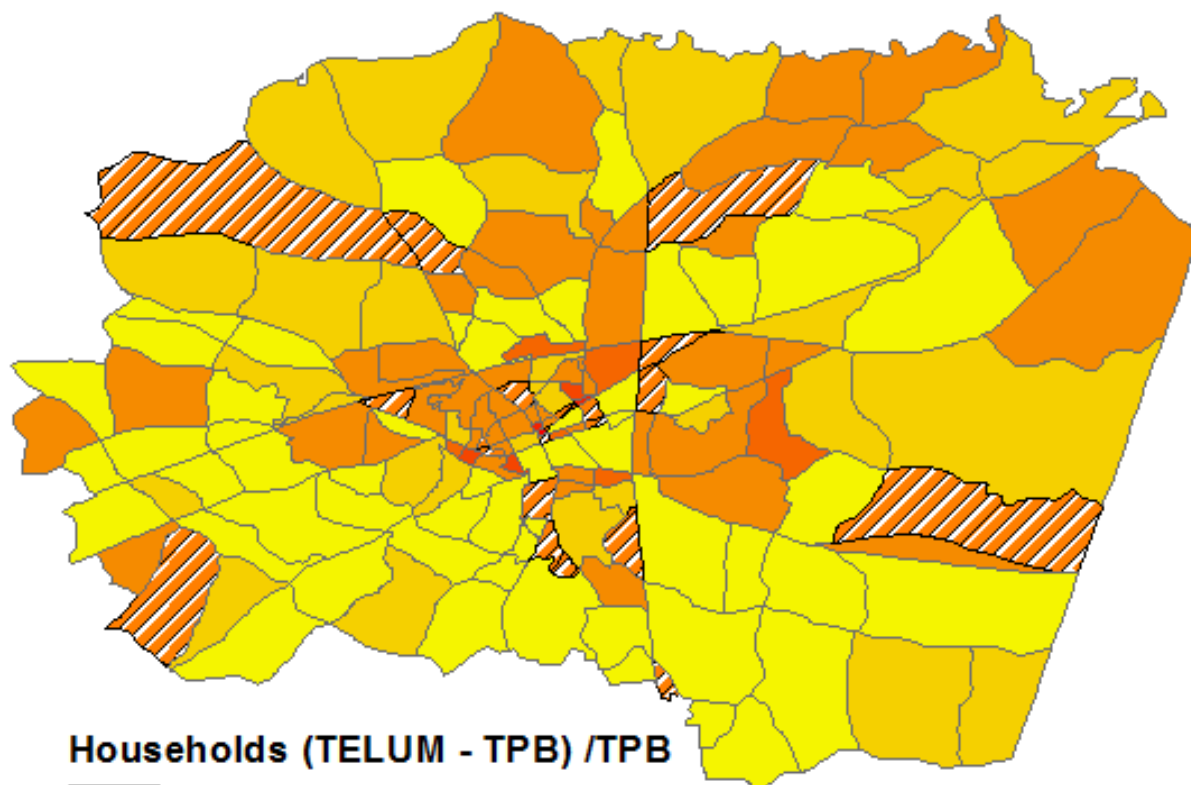
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RESULTS (2)

- Purpose for comparing two forecasts is to understand how the projections vary by method
- Projections differ by more than 10% in nearly all zones for both households and employment
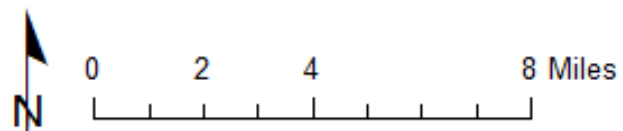
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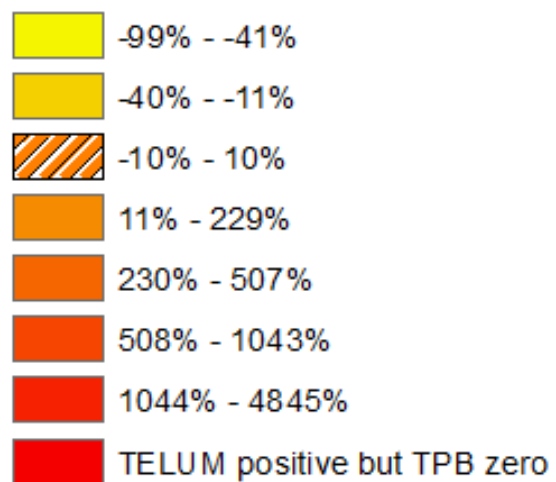**Employment (TELUM - TPB)/TPB**

	-100% - -62%
	-61% - -11%
(hatched)	-10% - 10%
	11% - 401%
	402% - 1165%
	1166% - 2039%
	2040% - 6531%
	TELUM positive but TPB zero

0   2   4   8 Miles

N

Households (TELUM - TPB) /TPB

- -99% - -41%
- -40% - -11%
- -10% - 10%
- 11% - 229%
- 230% - 507%
- 508% - 1043%
- 1044% - 4845%
- TELUM positive but TPB zero

0   2   4   8 Miles

N

FINDINGS

- TELUM is a mature, flexible, and capable model platform with modest demands for data
- All required data available at no cost
- Model platform requires reasonable effort & less than one year start to finish
- Software is easy to use and the model runs quickly
- NJ Institute of Technology provides quality tech support
- Provides another approach for preparing transportation model inputs – either alternative or complementary
- TELUM requires all assumptions to be made explicit: a prerequisite for best practice planning

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DELIVERABLES FOR PROJECT

1. Calibrated model

2. Method to estimate privately owned vehicles available to households

3. Detailed instructions for data sources, processing data, and post processing TELUM forecasts for use with travel demand model

4. Final report available from NCDOT Research and Development Unit: Mustan Kadibhai, or the researchers (https://curs.unc.edu/files/2015/03/Final_Report_RP2012-03.pdf)

QUESTIONS?