Development of a high-resolution statewide socio-demographic, land use and economic development framework for transportation planning

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UCF

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- Objectives
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Introduction

- The current project focuses on developing a standardized high resolution state-wide sociodemographic, land use and economic development model
- The research team will provide stakeholders with a framework analogous to the FSUTMS model
- The project will generate a universal template of variables that will be useful for the statewide framework
- For the universal template built, the research team will generate socio-economic, land use and economic development variables
- A workshop/webinar will provide a tutorial on using the data that will be saved and provided on research website and YouTube

Background

- From 2011 to 2015 the population of Florida increased by 1 million and is expected to increase by 7.4 million by 2045
- With population increase, new building permits issued have nearly quadrupled from 2011 through 2018
- Increased population has resulted in rapid revamp of land use and economic development patterns across the state
- Passenger and freight demand and its spatio-temporal patterns is a result of intricate interactions between:
  - Socio-demographics
  - Land use patterns
  - Transportation infrastructure
  - Economic development

Background

- Travel demand modeling approaches are augmented with socio-economic, land use modeling and economic development frameworks
- In Florida, FSUTMS provides a standardized travel demand modeling platform for transportation forecasting needs in the state
- The availability of a standardized model allows to either directly employ the standardized model or customize the model for local conditions
- However, there is no comparable standardized socio-economic, land use and economic development modules in the state

Objectives

- To establish a universal template of socio-demographic, land use and economic indicators
- To develop and validate an algorithm to generate socio-demographic, land use and economic indicators
- To employ the validated algorithm developed to generate future socio-demographic, land use and economic indicators in 5-year increments from 2025 through 2050
- To generate the variables for a spatial resolution that can be directly employed for local jurisdictions and statewide models

Literature Review and Initial Template Preparation

Initial Template Preparation

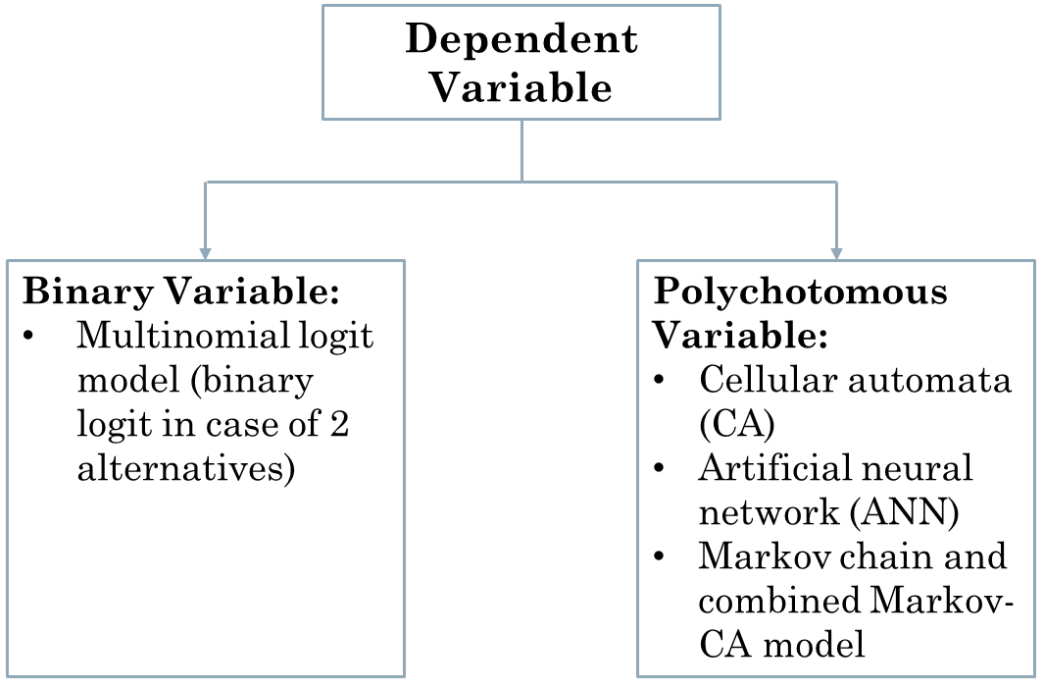
- The research team has prepared the initial pool of socio-demographic, land use and economic development variables
- The initial pool of variables are identified based on:
  - Travel demand model inputs
  - Recommended variables in the literature
- The variables are identified from travel demand model inputs across different jurisdictions in Florida and similar urban regions
- The research team has also investigated the various spatial resolutions employed for generating the data

Findings

- Spatial Resolutions:
  - Parcel resolution (finest resolution)
  - Grid/ Cell (the most common resolution)
  - TAZ (employed in FLUAM, LUSDR and G-LUM land use models)
- Dependent Variables:
  - Binary variables (such as land development, cell vacancy)
  - Polychotomous variables (more than 2 alternative categories)

Findings

- The most important LU model components found from literature:
  - Macroeconomic Model
  - Relocation Model
    - Household Relocation Model
    - Employment Relocation Model
  - Development Model
  - Transportation Planning Model



Mathematical Methods Employed in Land Use Models

Variables identified

Sociodemographic	Land Use	Economic Development
• Population • Number of households • Age distribution • Gender distribution • Race • Number of children • School enrollment • Educational Status • Vehicle ownership	• Land use diversity variable • Residential area • Business center density • Institutional area • Roadway density • Bike lane density • Sidewalk density • Bus station and network density • Number of hotel/motels	• Median income • Employment • Retail employment density • Average number of workers per household • Retail density • Shopping center density

Stakeholder Survey Design and Development

Survey feedback

- The research team designed a Qualtrics survey to obtain feedback on initial template
- The finalized survey instrument will be shared with FSUTM membership and MTF Model Advancement membership shortly to obtain your inputs
- Based on the survey feedback useful information for the development of the framework will be finalized

Work in Progress

Base Year

- We processed base year (2020) data from various publicly available sources
- The research team considered publicly accessible data sources such as:
  - U.S. Census Bureau
  - American Community Survey
  - Florida Department of Revenue
  - FDOT Roadway Characteristics Inventory
  - Florida Geographic Data Library
  - Florida Natural Areas Inventory

Base Year

- The research team has completed parcel data preparation for 2020 for all counties
- The processed parcel data was employed to identify the land use types for each individual parcels
- Moreover, we aggregated parcel level land use data at the block group level for the entire state for base year
- For other independent variables, we mainly considered the following resolutions:
  - Block group
  - Census tract
  - County

Data Sources

Data Sources	Variables
U.S. Census Bureau and American Community Survey	Population, number of households, gender distribution, age distribution, poverty, school enrollment, educational attainment, race, vehicle ownership level, median income, total number of business establishment, number of jobs
Florida Department of Revenue	Land use type, distance to the nearest road, percentage of different land use types, land use mix/land use diversity variable, number of hotel/motel, number of stores and supermarkets and number of shopping centers
FDOT Roadway Characteristics Inventory and Florida Geographic Data Library	Road density, sidewalk density, bike lane density, bus stop and bus route density

Spatial Resolutions

Spatial Resolutions	Variables
Parcel	Land use type, distance to the nearest road from a parcel
Block Group	*Sociodemographic:* Population, gender distribution, age distribution, poverty, school enrollment and race *Land use:* Percentage of different land use types, land use mix/land use diversity variable, road density, number of hotel/motel, sidewalk density, bike lane density, bus stop and bus route density *Economic development:* Number of stores and supermarkets and number of shopping centers
Census Tract	*Sociodemographic:* Number of households, educational attainment, and vehicle ownership level *Economic development:* Median income
County	*Economic development:* Total number of business establishment and number of jobs

Land Use Categories

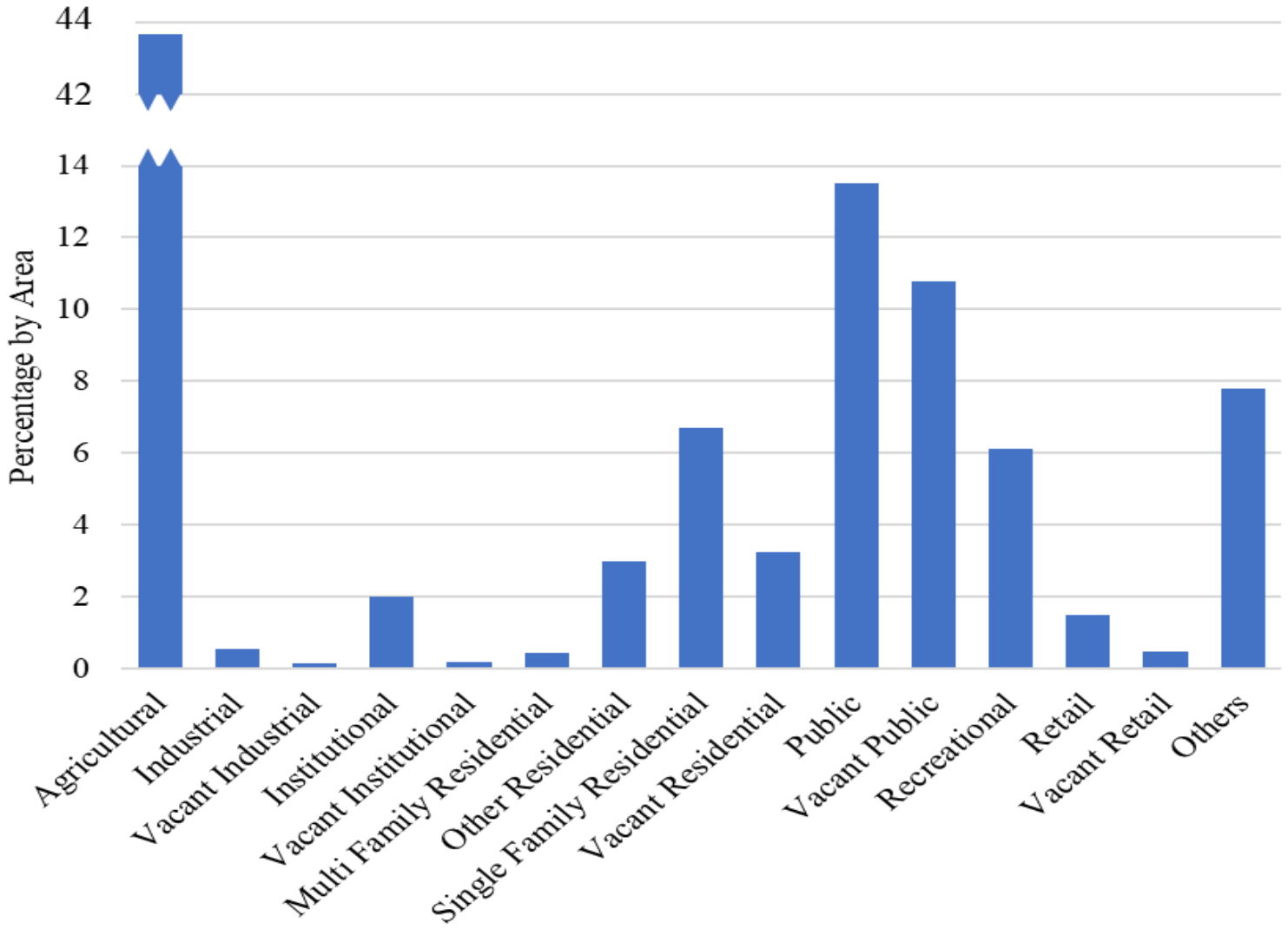
- The research team has considered 15 land use categories in this study

Land Use Type	DOR_UC Code	Examples
Agricultural	50-69	Improved agricultural, Cropland soil capability Class I, Poultry, bees, tropical fish, rabbits
Industrial	41-49	Light manufacturing, Heavy industrial, heavy equipment manufacturing, Packing plants, fruit and vegetable packing plants, meat packing plants
Vacant Industrial	40	Vacant Industrial -with/without extra features
Institutional	71-79, 81, 84	Churches, Private schools and colleges, Cultural organizations, facilities, Military
Vacant Institutional	70	Vacant Institutional, with or without extra features
Single-Family Residential	1	Single Family
Multi-Family Residential	3, 8	Multi-family - 10 units or more, Multi-family - fewer than 10 units

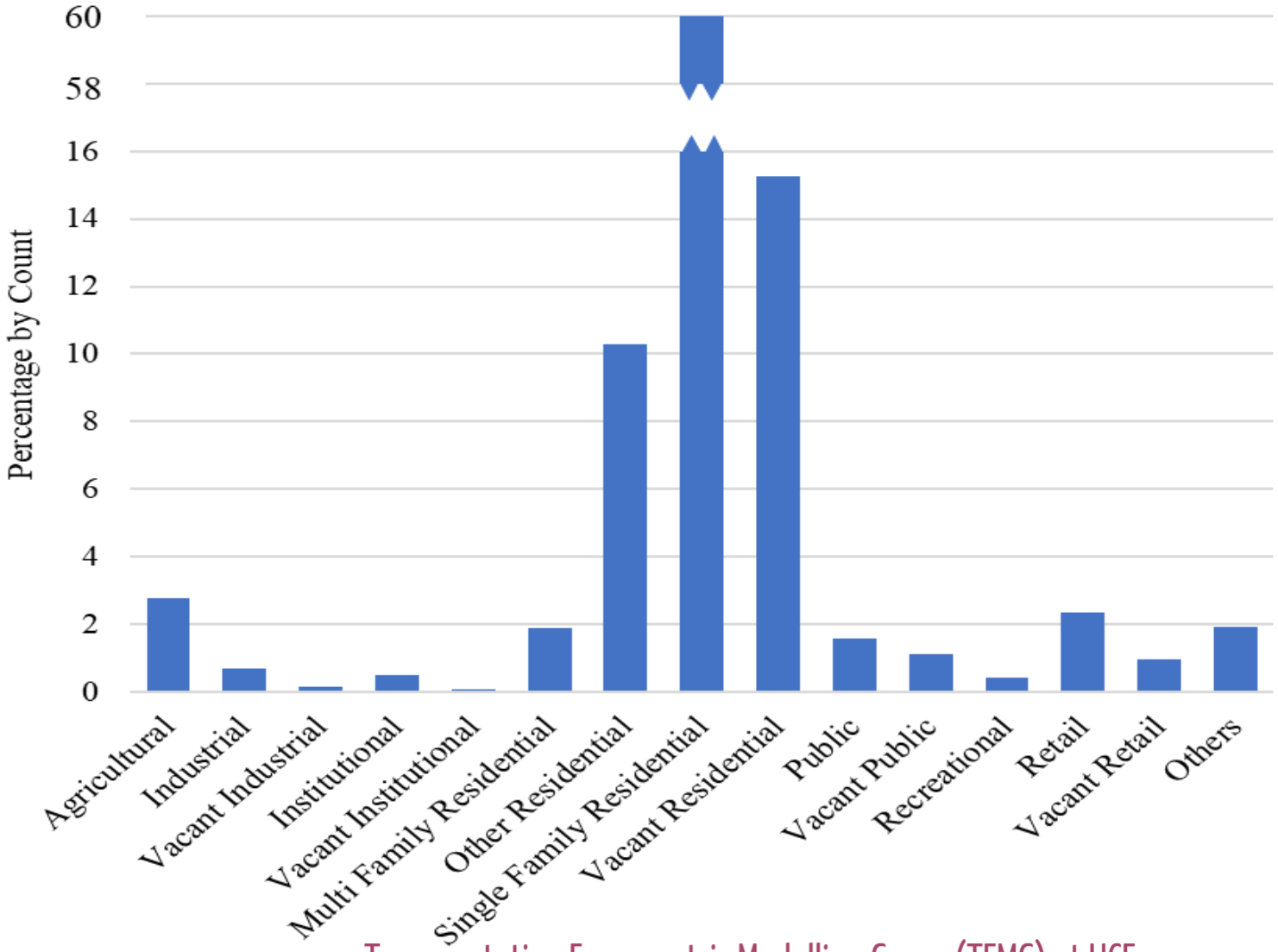
Land Use Categories

Land Use Type	DOR_UC Code	Examples
Other Residential	2, 4-7, 9	Mobile Homes, Condominiums, Cooperatives, Retirement Homes not eligible for exemption and Residential Common Elements/Areas
Vacant Residential	0	Vacant Residential – with/without extra features
Public	83, 85-91	Public county schools, Hospitals (non-private), Counties, State, Federal, Municipal
Vacant Public	80	Vacant Governmental - with/without extra features
Recreational	82, 97	Forest, parks, recreational areas and Outdoor recreational or parkland, or high-water recharge
Retail or office	11-39	Stores, Mixed use - store and office, Department Stores, Supermarkets, Office buildings, Airports, Restaurants, Cafeterias
Vacant Retail or office	10	Vacant Commercial - with/without extra features
Others	92-96, 98-100, 995, 999	Mining lands, petroleum lands, or gas lands, Right-of-way, streets, roads, irrigation channel, Rivers and lakes

Land Use Distribution

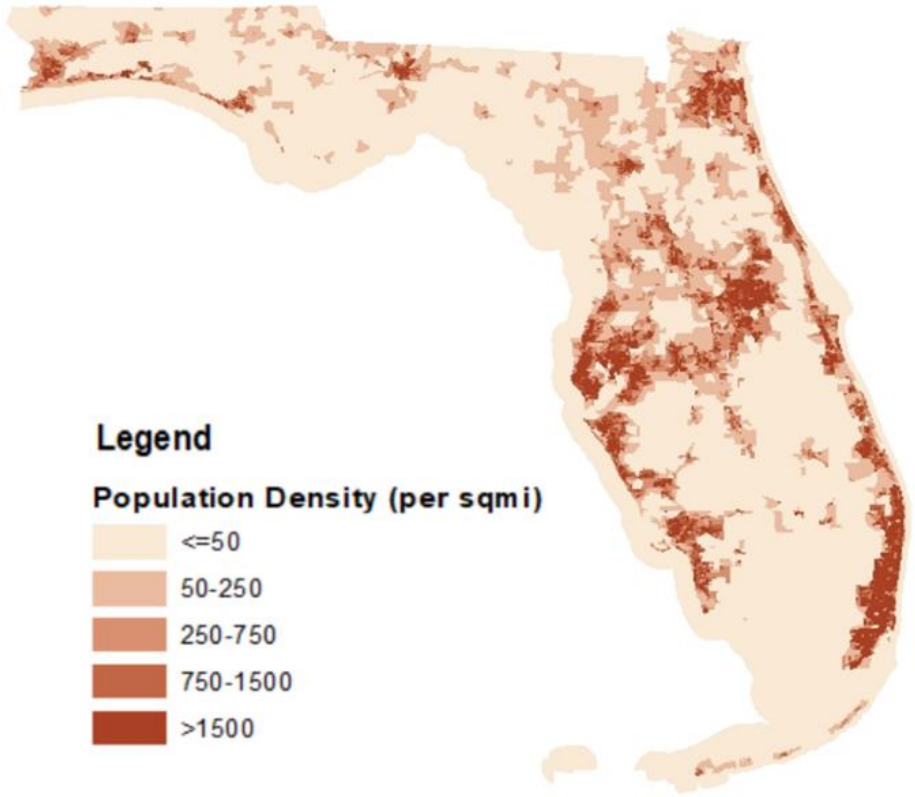


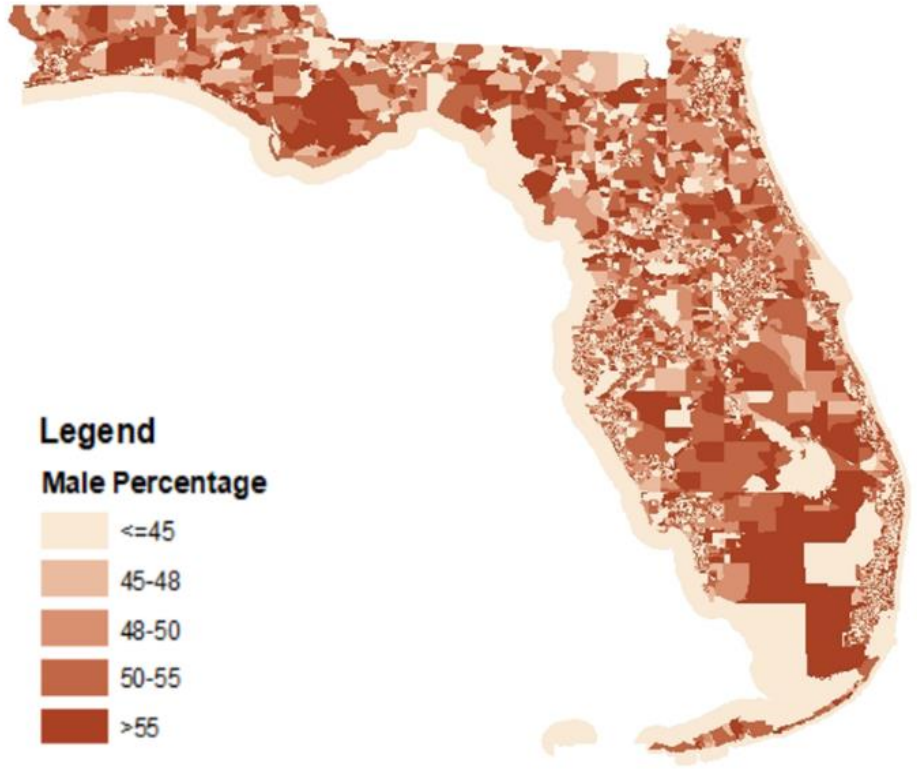
Land Use Distribution



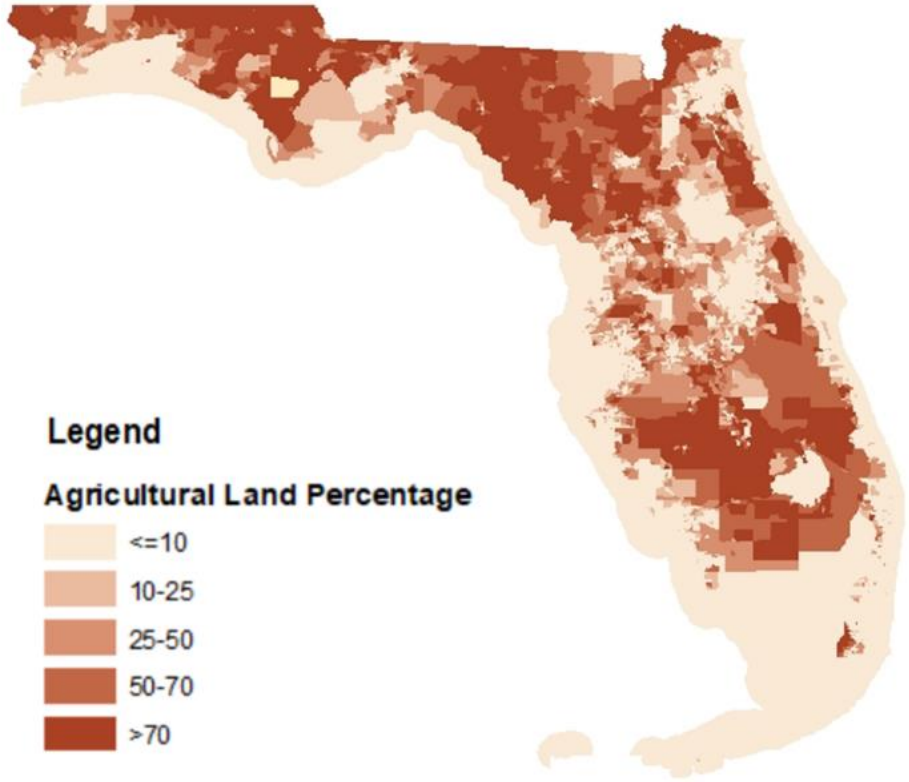
Transportation Econometric Modelling Group (TEMG) at UCF

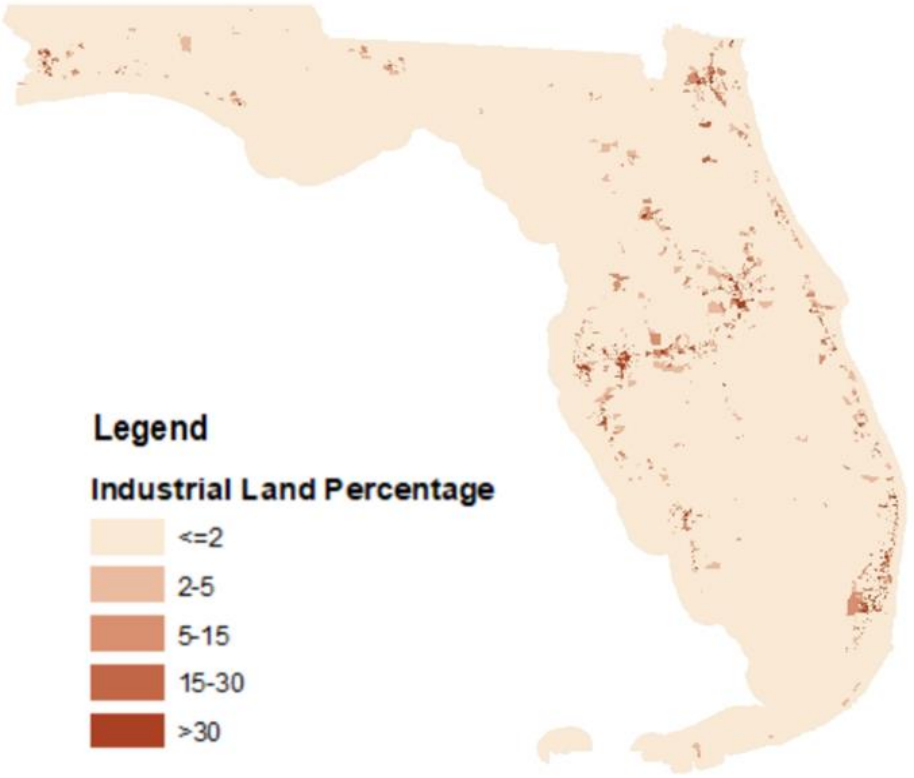
Findings


Legend
Population Density (per sqmi)
<=50
50-250
250-750
750-1500
>1500

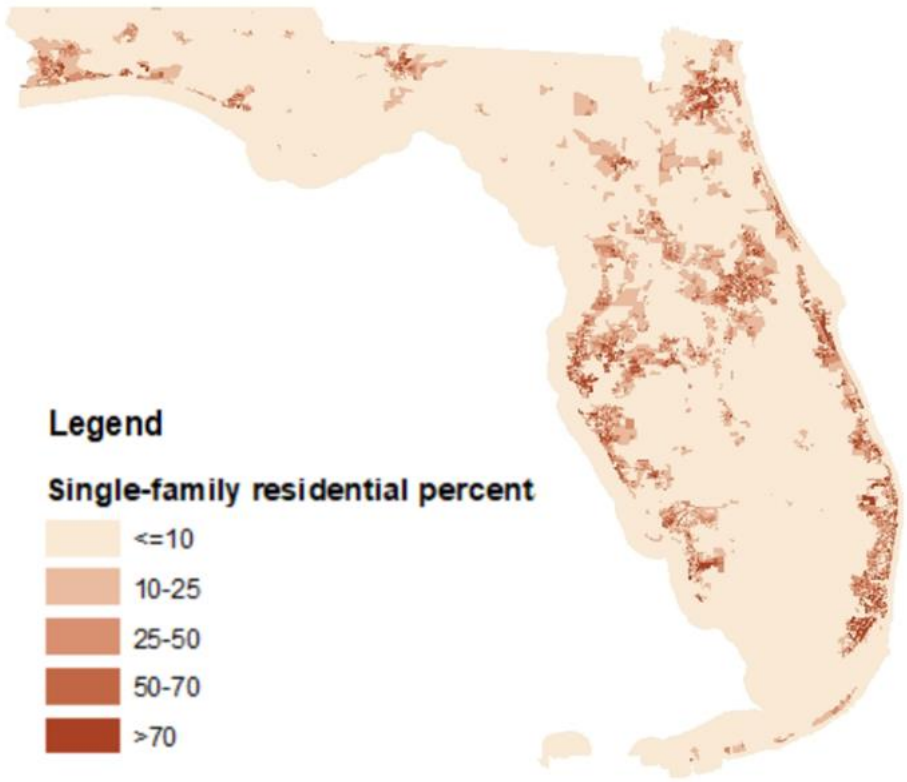

Legend
Male Percentage
<=45
45-48
48-50
50-55
>55

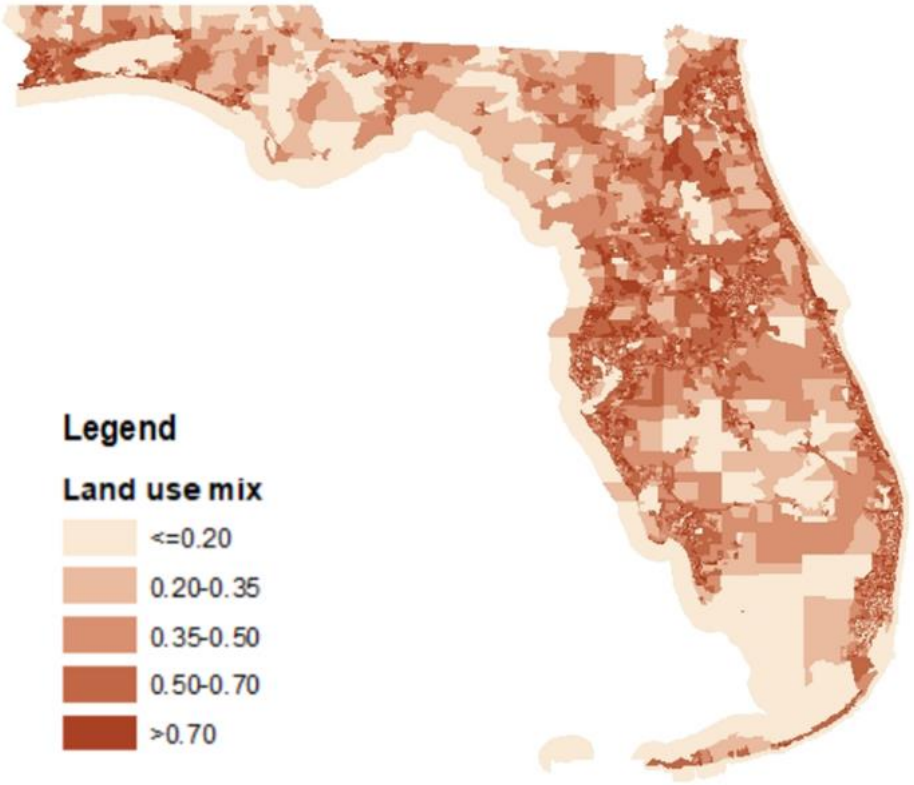
Findings


Legend
Agricultural Land Percentage
<=10
10-25
25-50
50-70
>70


Legend
Industrial Land Percentage
<=2
2-5
5-15
15-30
>30

Findings


Legend
Single-family residential percent
<=10
10-25
25-50
50-70
>70

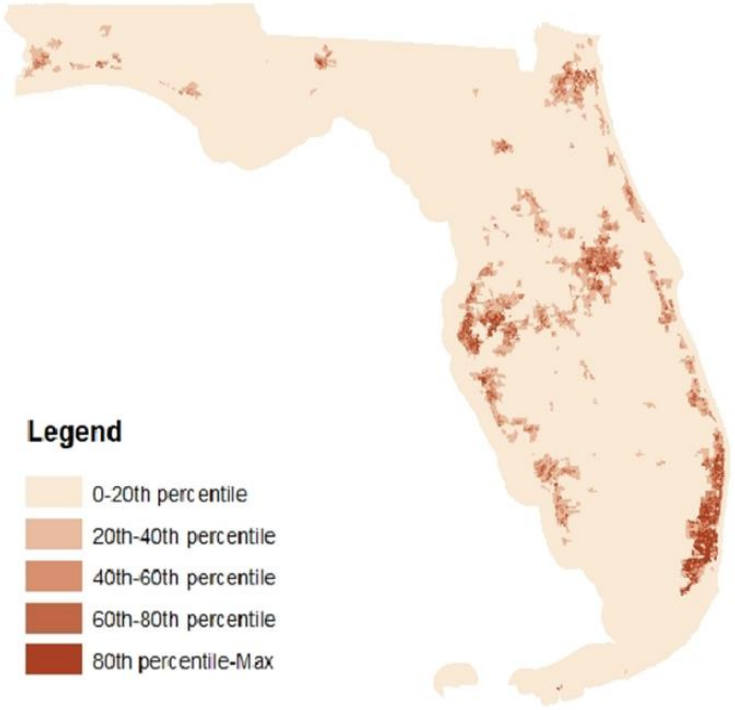

Legend
Land use mix
<=0.20
0.20-0.35
0.35-0.50
0.50-0.70
>0.70

Data Consistency Analysis

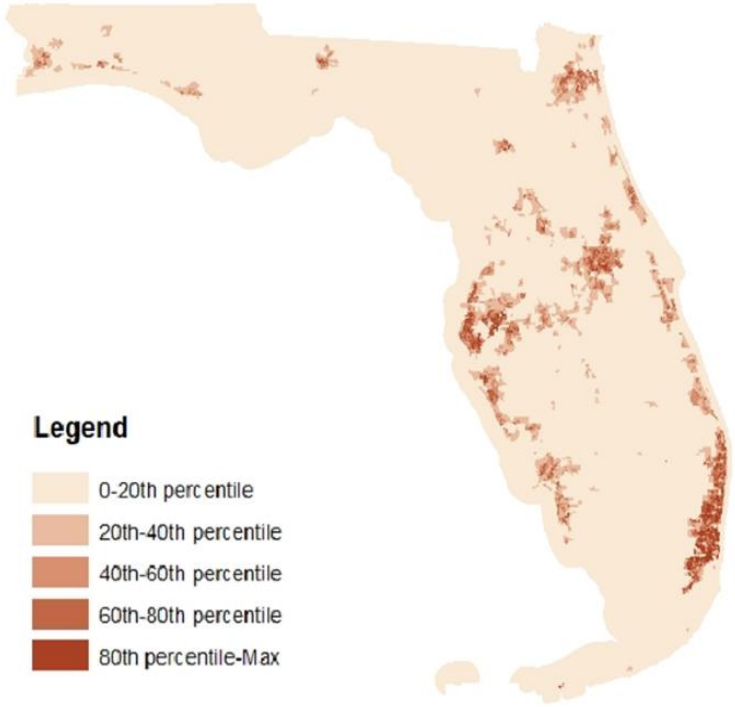
- After data preparation, we examine the consistency of the variables by comparing them at different spatial resolutions
- We undertook 3 comparisons analyses:
  - CT level – Population, HH and Residential Parcel Density
  - County Level – Population and Job Density
  - County Level – Agricultural Area and Agricultural Products

Variables	**Total Count (in million)**	**Per Household (Total HH = 7.93M)**
Population	21.22	2.68
Number of Jobs	6.62	0.83
Number of Residential Parcels (Single-family, Multi-family and Other Residential)	6.54	0.82

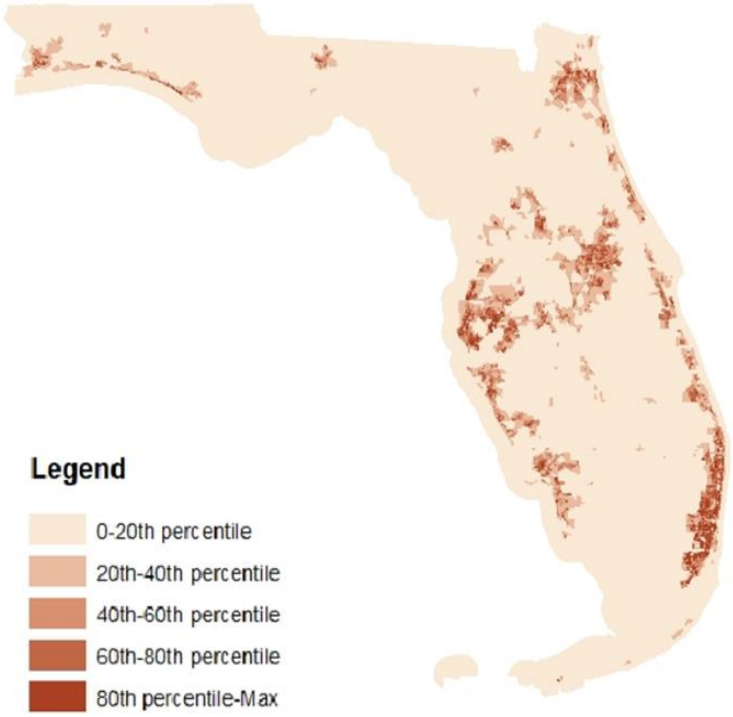
Data Consistency



CT – Population Density



CT – HH Density



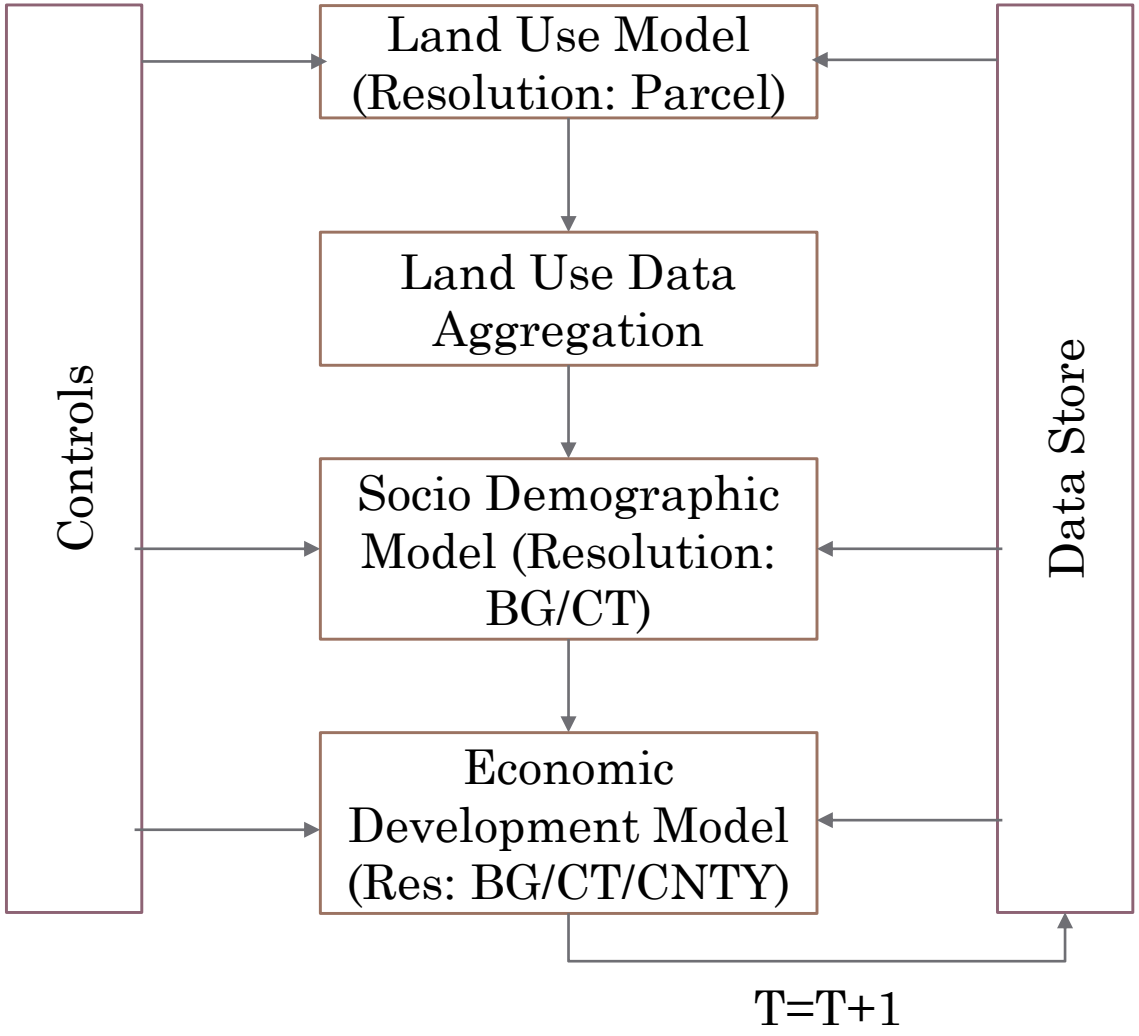
CT – Residential Parcel Density

Future Work

Algorithmic Procedures

- Based on the review of the existing land use models, we prefer to employ a microsimulation approach for land use modeling
- The research team is working on framework development for the land use, socio-demographic and economic development data generation
- In algorithm development, we first consider data availability of socio-demographic, economic development and land use variables in different resolutions
- Based on data availability matrix, we select the appropriate spatial resolution for our analysis
- For the chosen resolution, we propose an algorithm for variable forecast for future years

Model Framework



Land Use Model

- Land use model will be developed using high resolution parcel data sourced from Florida Department of Revenue
- Parcel level land use will be forecasted each year based on socio-demographic, economic development, transportation infrastructure and neighborhood characteristics at year, T-1
- The model will have two components: a binary logit model and a multinomial logit model
- Binary logit model will identify the probabilities of conversion of land use type from current to other at year, T
- Multinomial logit model will identify the probabilities of new land use types given the land use changes at year, T

Socio-Demographics and Aggregation

- We will predict socio-demographic variables using existing data for future demographic data
  - It is possible that we will have to disaggregate the future data for our model
- The land use, demographic and economic data generated will be appropriately aggregated for the land use model
- The resolutions for data aggregation will be guided by the data requirements from other model components
- This step may include aggregation at Statewide TAZ, Block Group and Census Tracts

Economic Development Model

- Similar to socio-demographic variables, we will predict economic development variables using this step
- Resolution of prediction exercise will depend on the data availability:
  - For example: business data are available at the county level
  - For median income, we can predict at the census tract level
- Predicted variable will be a linear function of temporal lag variable, land use variables at year T (number of commercial, industrial and retail parcels) and transportation infrastructure variables

Model Controls

- This component will control the outputs from individual model components
- For example, we can identify the changes from vacant residential to residential developed land use over the years (i.e., 2%) across the state
- In this case, we can restrict maximum change from residential vacant to residential developed to 2%
- For population, we can use external population forecast to calibrate population model outputs (i.e., county level population by Bureau of Economic and Business Research)
- In this case, we can calibrate the census block level population prediction so that county level results are close to external controls

Future Work

- The algorithm finalized will be used to generate the data for future years in 5-year increments from 2025 through 2050
  - The data will be generated for all spatial units in Florida
- The research team will conduct a webinar/workshop summarizing the research effort
- The final report will contain a summary of the research project including:
  - Literature review
  - Stakeholder survey
  - Base and future year data generation
  - Knowledge transfer activities

Summary

- The current project focuses on developing a standardized high resolution state-wide sociodemographic, land use and economic development model
- The availability of a standardized model allows to either directly employ the standardized model or customize the model for local conditions
- The research team has already completed literature review and survey preparation
- We have also completed base year data preparation and land use data was processed at the parcel level
- In the next step, we will develop an integrated model system for forecasting sociodemographic, land use and economic development variables

Project Benefits

- Qualitative Benefits:
  - *The research team will develop a standardized socio-economic, land use and economic development modules for the entire state*
  - *The research team will provide stakeholders with a framework analogous to the FSUTMS model*
- Quantitative Benefits:
  - *Urban metropolitan organizations can directly employ the standardized model or customize the model for local conditions*
  - *It will reduce the need for exhaustive financial and professional resources in these organizations for transportation planning exercises*

Questions