

# An Exploration of Quantitative Methods for Comparing Urban Development Scenarios

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# Research Objectives

1. Explore the interdependent relationship between space, urbanization, and quality of life
2. Use What If? to apply four different land use policy scenarios to Calgary, Alberta
3. Develop a methodology for comparing the spatial patterns produced by the different land use policy scenarios using spatial-quantitative techniques
4. Define connections between the spatial-quantitative techniques used and the urbanization process, as well as quality of life



New Urbanism



Urban Sprawl



Calgary



Ecological Design



Imagine Calgary

# Theory and Background

- Urbanization is a spatial-temporal process
  - Urban areas are always evolving and changing
  - Changes to the spatial structure of the city modify the movement patterns of people, goods, and capital
  - These changes inevitable impact quality of life by re-organizing the spatial relationship between consumers and goods/services, labour and employment, as well as capital and the market
  - It is useful to measure the spatial structure of the city because it provides a way to evaluate how spatial pattern impact the urbanization process and quality of life

# Urban Growth Models (UGMs)

## ■ Agent vs. Equation-Based Models

- Agent-based UGMs are disaggregate models, where household, government, business, developer, and land agents are generated
  - The various agents have methods and attributes (i.e. actions that they can perform and traits that define them)
  - The methods and attributes of agents encourage them to interact with one another
  - Agent interactions cause changes to the landscape, population, and economy of the study area
  - An example of this type of UGM is UrbanSim
- Equation-based UGMs tend to be aggregate models that are either stochastic or deterministic
  - Deterministic models use fixed equations to predict land use changes
  - Stochastic models include a random seed in their equations and leverage Monte Carlo simulation
    - Used to account for uncertainty
    - SLEUTH is a stochastic equation-based UGM

# What If?

- What If? is a deterministic equation-based UGM
  - Land use changes are based on demand and suitability functions
  - Demand is predicted using population growth trends and density levels
  - Suitability is defined by a variety of topographic and infrastructure features
  - What If? can be manipulated to simulate a wide variety of land use policy scenarios by manipulating suitability and demand variables
- Land use policy scenarios tested
  - Urban Sprawl
  - New Urbanism
  - Ecological Design
  - 'Imagine Calgary'

# Methods: Spatial-Quantitative Measurement Techniques

## ■ Land Use Intensity

- Land use intensity is measured using a modified density gradient and Local Indicators or Spatial Association (LISA)
- Density gradients are typically used to measure change in density vs. distance

## ■ 8 Landscape Metrics

- Number of patches (NP), mean patch size (MPS), and patch size standard deviation (PSSD) are used to explore the fragmentation of the landscape and are associated with the land use intensity measure to determine if the landscape is monocentric or polycentric
- Edge density (ED), class level Fractal Dimension (GFD), and mean nearest neighbor distance (MNND) are used to measure the shape, complexity, and level of fragmentation of the landscape
- Contagion (CONTAG) is used to measure the level of contiguity within each land use class
- Simpson's Evenness Index (SIEI) is used to measure the relative diversity of the landscape

## ■ Accessibility

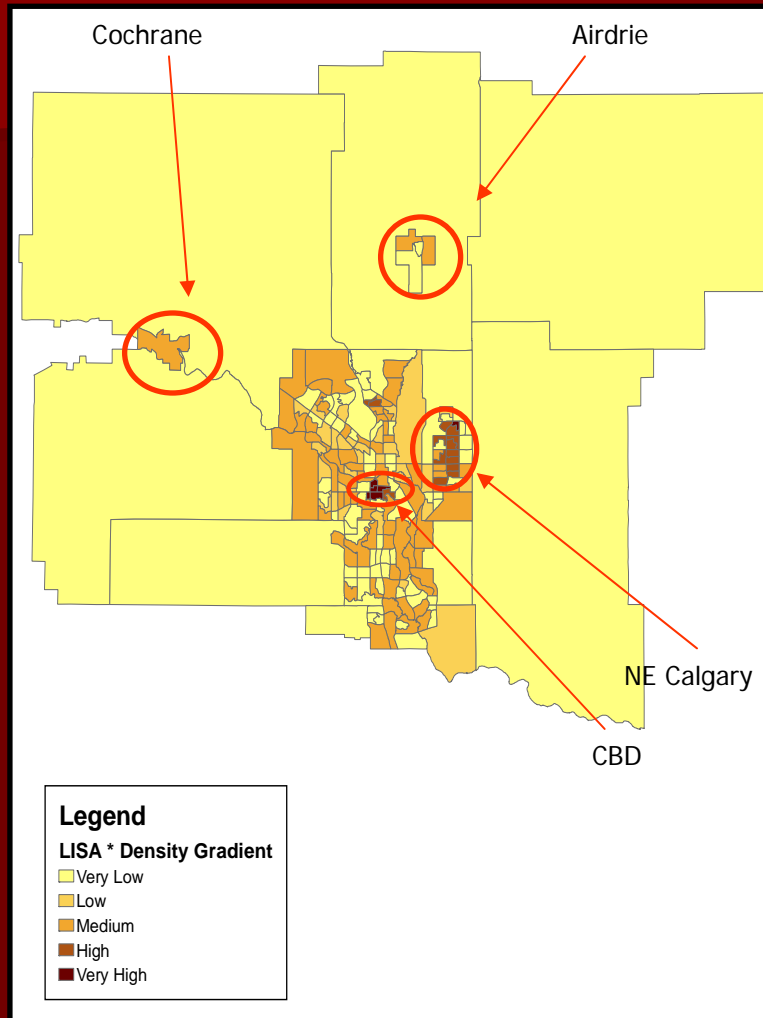
- An accessibility measurement tool was developed using ArcObjects to measure approximate accessibility to amenities such as parks and recreational facilities, commercial areas, and public transit stations
- The Euclidean distance is calculated for each residential feature to the closest amenity feature of each type considered and standardized by the total number of residential features

# Preliminary Findings

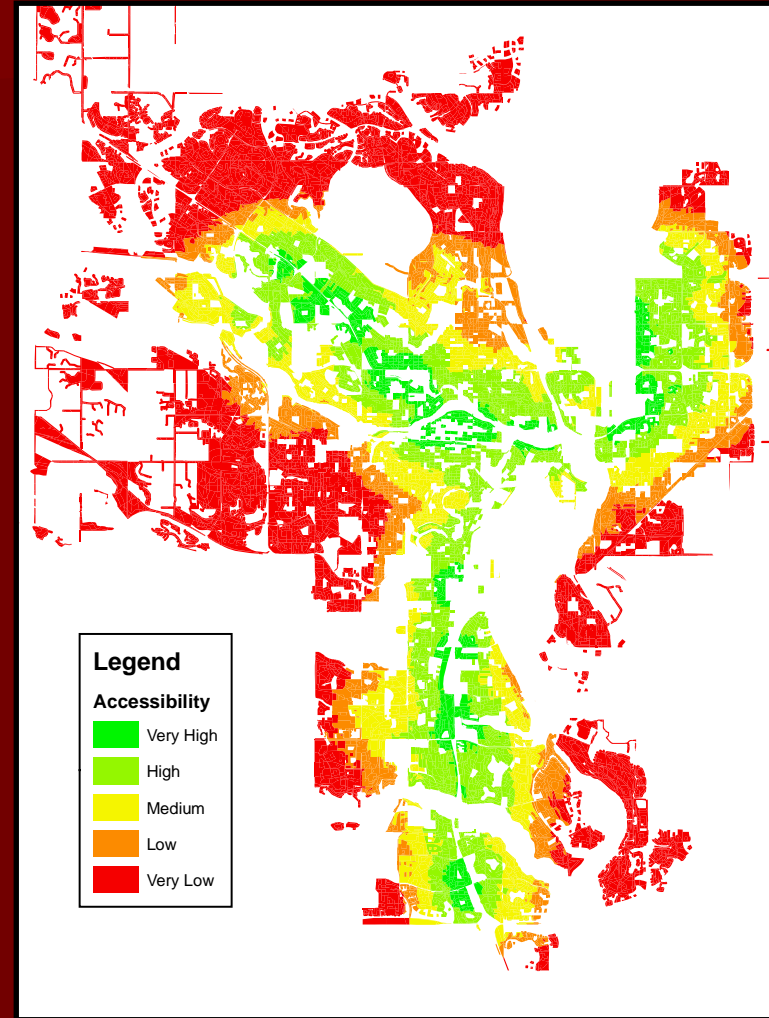
- Calgary, AB 2006
  - Land Use Intensity
    - Calgary is primarily monocentric
    - One primary and one secondary population center; the central business district (CBD) and NE Calgary
    - The CMA of Calgary has two additional minor population centers
      - Cochrane (NW of Calgary) and Airdrie (North of Calgary)
  - Landscape metrics
    - Residential land uses dominate the landscape (NP, MPS, PSSD)
    - Calgary land uses are relatively disperse with moderate fragmentation (ED, MNND, GFD)
    - Land uses appear to be discrete and the landscape is relatively homogeneous (Contagion = 85.2, SIEI = 0.0117)
  - Accessibility
    - The residential areas with the highest accessibility are located near the Calgary CBD and along light rail transit lines

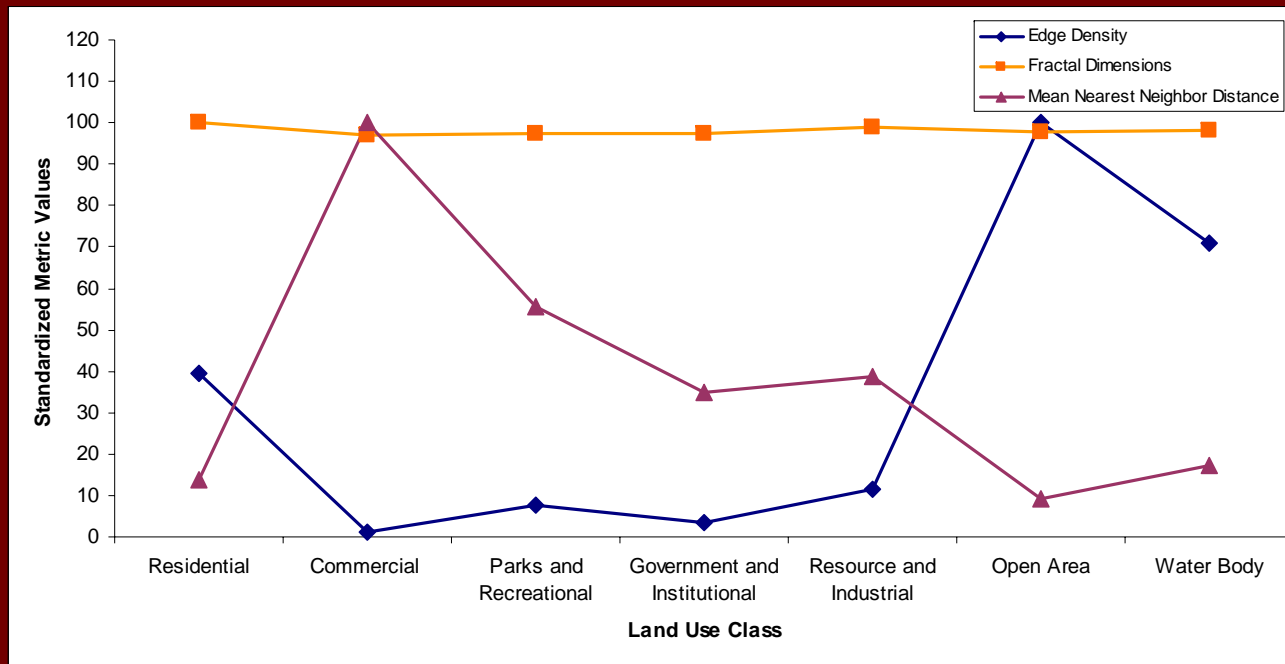
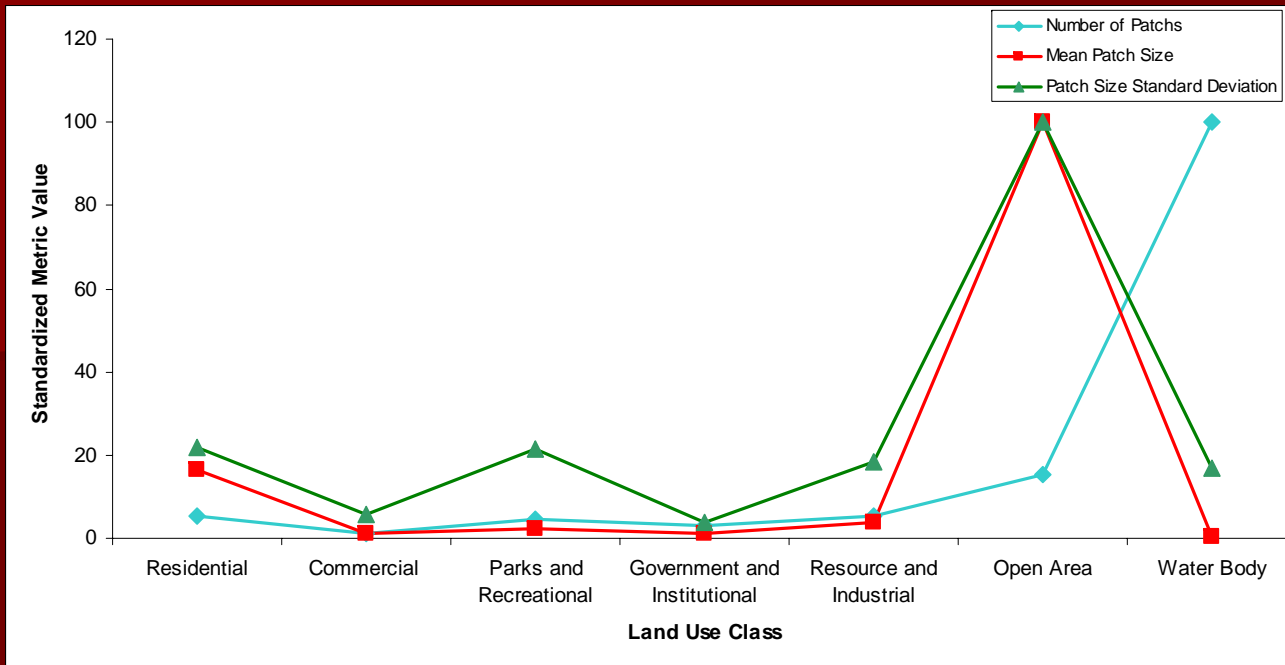


Land Use Intensity Map for Calgary, AB 2006. Dark brown values indicate high concentrations of population and light yellow values indicate low concentrations of population.



Accessibility map for Calgary, AB 2006.





# Expected Results

- Urban Sprawl
  - Produces landscapes that are dominated by low density residential housing, and limited public green space
  - Encourages private transportation
  - Discrete land uses with very minimal mixed use areas
- New Urbanism
  - Increased density levels and amount of public green space
  - Better balance of transportation options
  - Mixed land uses
- Ecological Design
  - Highest development densities and amount of public green space
  - Encourage public forms of transportation
  - Mixed land uses
- 'Imagine Calgary'
  - Moderate increase in density levels and public green space
  - increased balance between public and private transportation, but still dominated by private forms of transit
  - Moderate amount of mixed use development



New Urbanism



Urban Sprawl



Calgary



Ecological Design



Imagine Calgary

# Conclusions

- Calgary exhibits many of the characteristics of a region under an 'urban sprawl' land use policy
  - This is demonstrated by the preliminary results obtained
- The preliminary results suggest that the spatial-quantitative techniques used for this project successfully distinguish the spatial patterns of the landscape, provide insight about the type of development occurring, and can be associated with issues of quality of life
- It is expected that What If? will successfully simulate the four land use policy scenarios and that the spatial-quantitative techniques will distinguish the four scenarios

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