
Residential Development Threats in The Land Between

Tenley Conway & Namrata Shrestha
Department of Geography and Program in Planning
University of Toronto at Mississauga
June 07, 2007



Presentation Outline

- ❖ **Background on exurban development**
- ❖ **Outline of project objectives**
- ❖ **Work to date**

Land use change

- ❖ Land use change is occurring at unprecedented rates
- ❖ North America is increasingly seeing exurban development
- ❖ Exurban development is
 - Low density residential development
 - Outside existing urban centers
 - Often near high amenity areas



Rural



Exurban



Suburban



Urban



Interest in Exurban Development

❖ **Planning/Conservation**

- Factors driving exurban development
- Understanding relationship between areas with high development potential and critical biophysical features

❖ **Ecological Impacts**

- Local conversion of land cover
- Alteration of landscape-level processes

Potential Locating Variables

Accessibility to Urban/Employment Centre

Positive relationship in many urbanizing and suburbanizing areas

- Berry et al. 1996, Bockstael 1996, Schneider and Pointus 2001

Often negative relationship in exurban areas

- Theobald and Hobbs 1998; Thomlinson and Rivera 2000; LaGro 1994

Accessibility is still important...

1. Access to nearest road.
2. Access to regional transportation system.
3. Access to water body, marinas, etc.
4. Access to protected open space or other amenity features.

Potential Locating Variables

Site/Neighbourhood Level Characteristics

1. Starting land cover
2. Topography and soils
3. View of road/built structures/water/protected open space
4. Population density in municipality
5. Special planning/zoning designation

Research Goal

- ❖ **Assess development threats from land conversion or intensification in The Land Between.**
 - **Focus on exurban development using a variety of sources, including remotely sensed images and census data.**

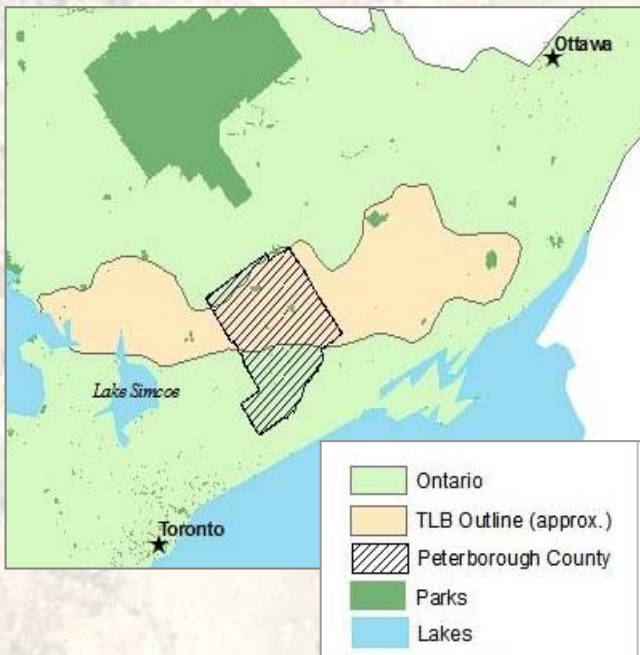
Research Objectives

1. Create spatial database of potential locating variables: accessibility to population centers, transportation corridors and natural amenity features; socio-economic conditions; biophysical characteristics
2. Determine the relationship between locating variables and existing exurban development
3. Identify protected open space and other constraints on exurban development
4. Map potential future development threat levels based on correlated locating variables and constraints

An aerial photograph of a suburban residential area. A prominent road runs diagonally from the top right towards the bottom center. The surrounding land is a mix of green grass, trees, and some buildings, typical of a residential development. The text is overlaid on this background.

**But First...where is
exurban development
in the Land Between?**

Exurban & TLB.....



❖ Sample Area

- Peterborough County = 4379 sq. km
- Representative of TLB
- Data availability

❖ Rapid exurban expansion

- Advances in IT – live & work from anywhere
- Changing demographics - affluent retiring communities
- Increasing affinity for rural settings / natural amenities

❖ *The Land Between*

- Rich in natural amenities - popular cottage country area
- Within close proximity to major urban centers as well as protected areas.
- Ideal exurban setting

Mapping exurban development

❖ Indirect Approach

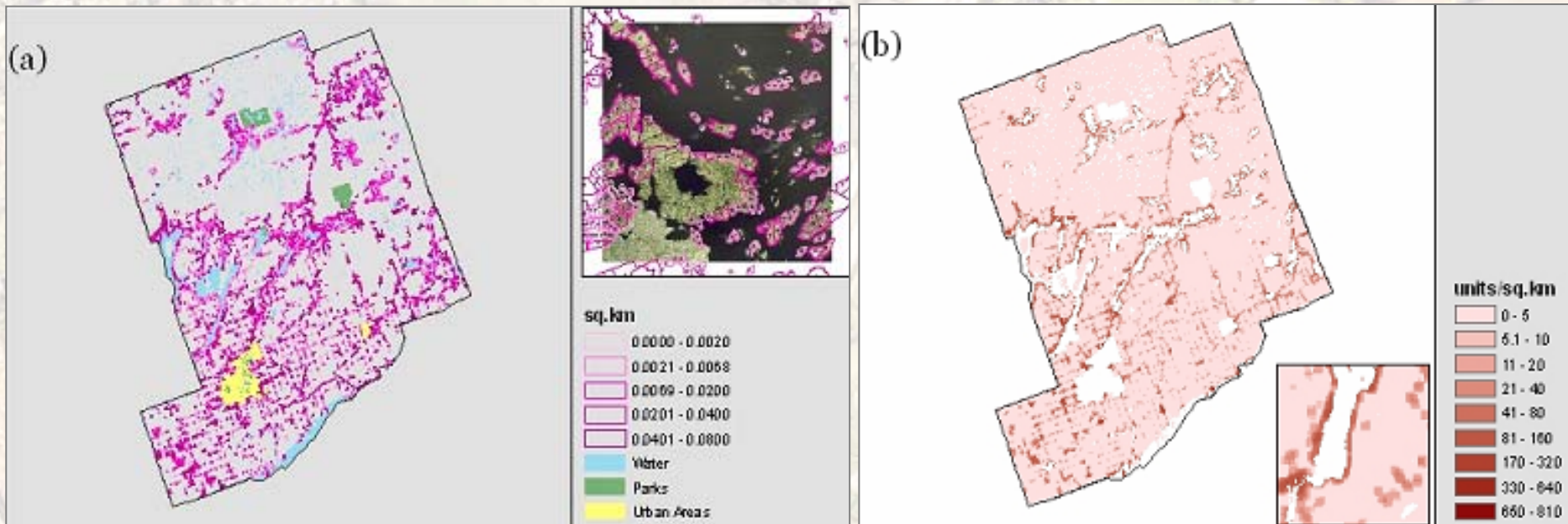
- Road density as the surrogate for development?
 - Compute road densities at various resolution and neighbourhood radii
 - Examine correlation between road densities and exurban parcel density
 - Data: Road data
- Dasymetric mapping
 - Disaggregate census dwelling count data (2001) over finer spatial unit (cells) using ancillary data.
 - Data: Road density raster, water, protected areas, and UA boundary layers

❖ Direct Approach

- Remote sensing (SPOT/HRVIR – 10m res.)
 - Supervised classification using training data
 - Normalized Difference Vegetation Index (NDVI) recoding
- Remote sensing with ancillary data
 - Using parcel data
 - Using distance from road and water bodies

Parcel data as reference

Exurban Parcel Polygons & Density

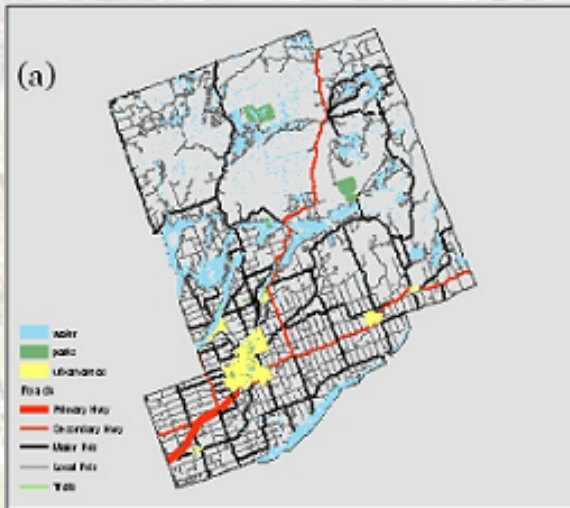


≤ 8 ha property parcels (a) were used to compute parcel density (500m NH shown here in fig. b) to be used as reference data in indirect mapping correlation analysis.

A mask was applied during all analyses to exclude the “non-exurban” areas from analysis (all incorporated urban areas, protected areas, and water bodies)

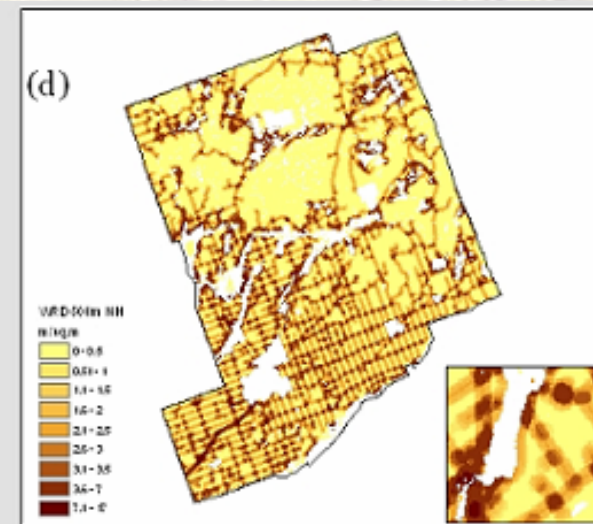
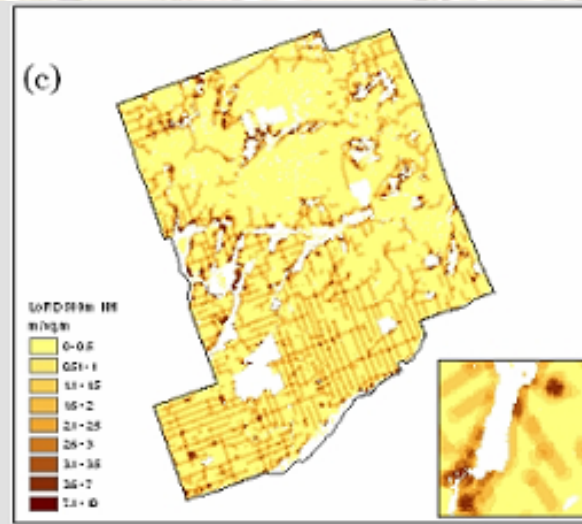
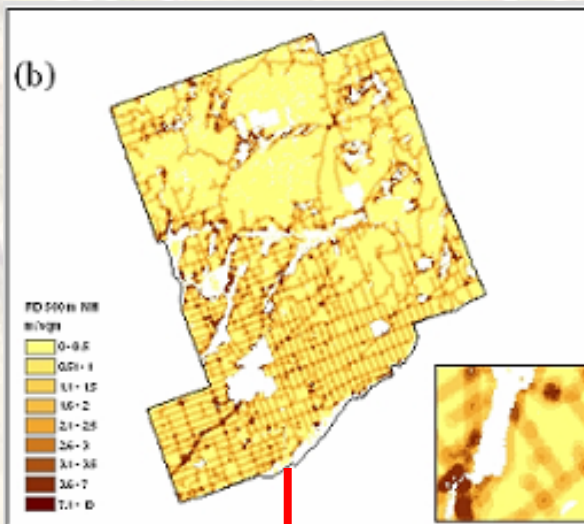
Indirect Approach

1. Road density as the surrogate



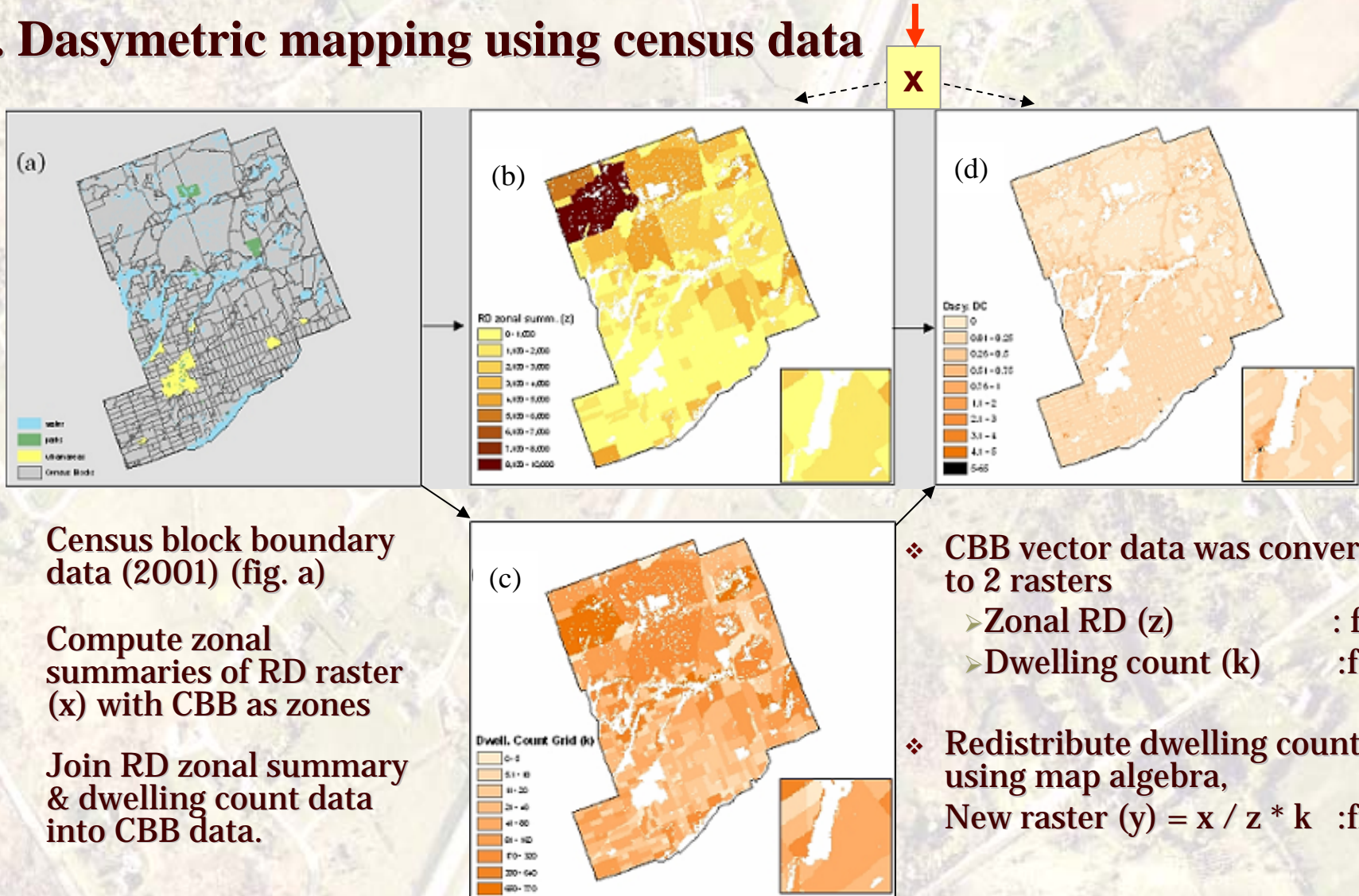
- ❖ Road vector data (a)
- ❖ Road densities computed using different neighbourhood (NH) radii including,
 - All road types (b),
 - Only local roads (c), and
 - All roads weighted by speed (d)

(500 m NH shown below)



Indirect Approach

2. Dasymetric mapping using census data



Indirect Approach

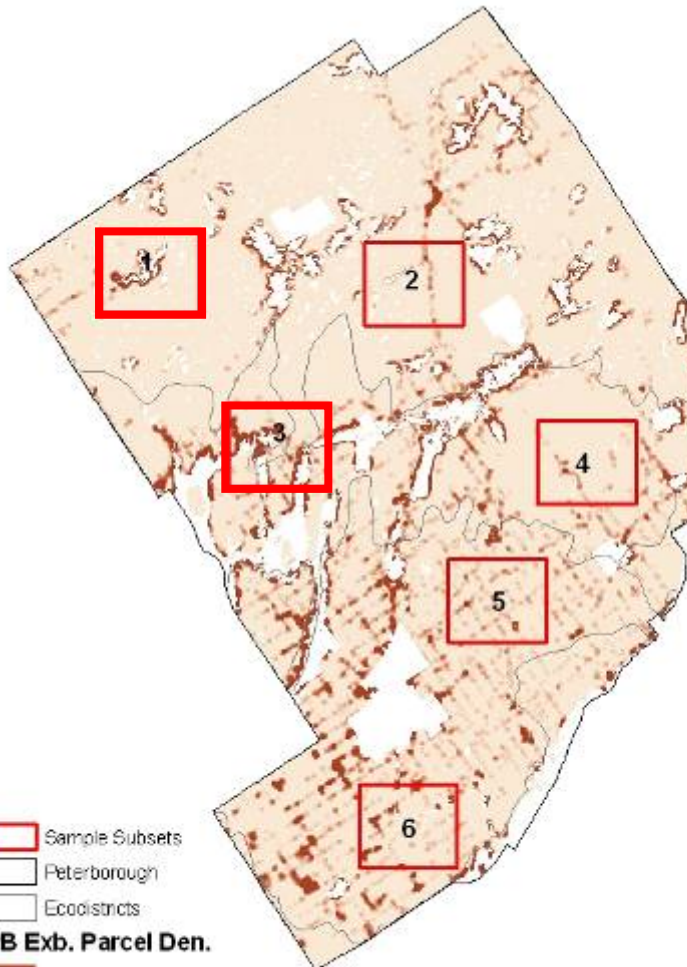
Correlation Analysis (against exurban parcel density)

500 m NH Radii		
	N	Spearman's rho
Road Density	153742	.558(**)
Local RD	153742	.075(**)
Weighted RD	153742	.100(**)
Dasymetric w RD	153246	.092(**)
Dasymetric w LoRD	153246	.083(**)
Dasymetric w WRD	153246	.089(**)
1500m NH Radii		
Road Density	153616	.298(**)
Local RD	153616	.247(**)
Weighted RD	153616	.296(**)
Dasymetric w RD	153068	.236(**)
Dasymetric w LoRD	153068	.243(**)
Dasymetric w WRD	153068	.236(**)

(**) Correlation is significant at the 0.01 level (2-tailed).

Indirect Approach

Correlation Analysis Results (at smaller spatial extents)

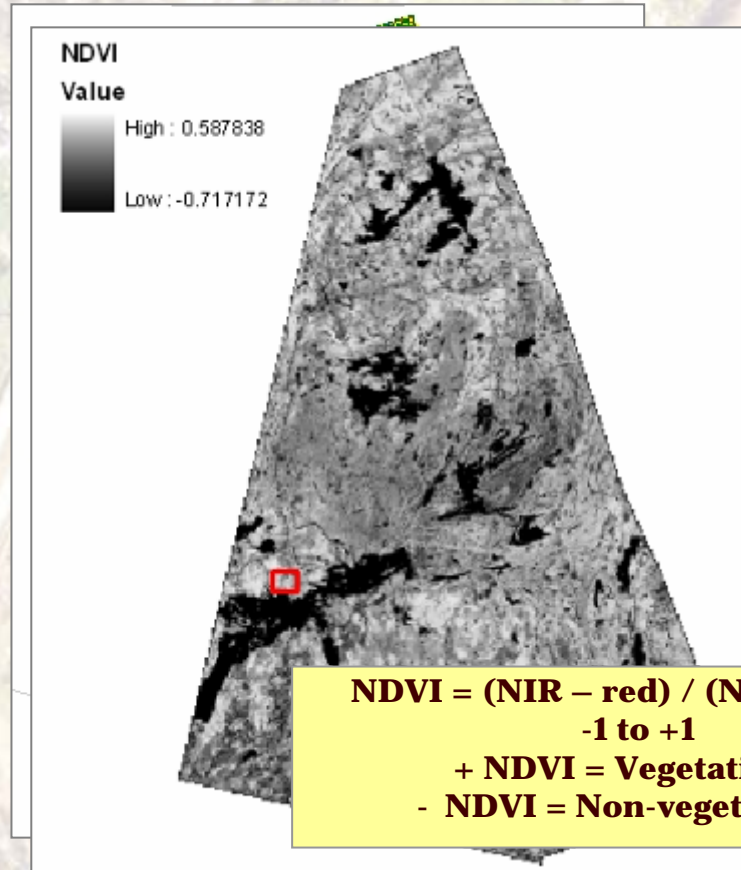
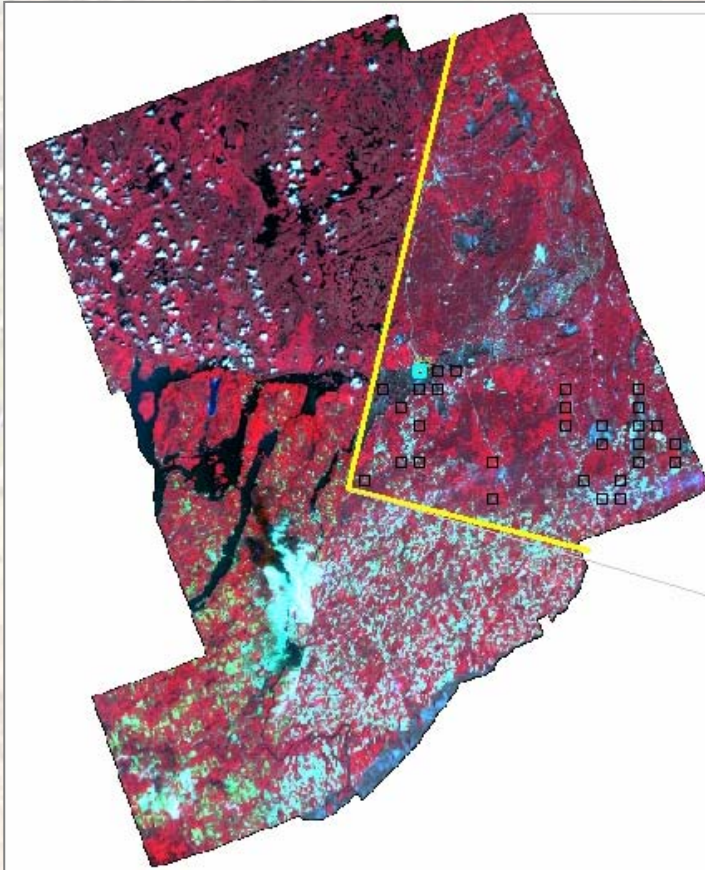


Geographic Extent		Road density*	Dasymetric**
Peterborough County		.558(**)	.092(**)
Ecodistricts	Shield (50%)	.516(**)	.052(**)
	Mid	.587(**)	.237(**)
	South	.542(**)	.097(**)
Sample Subsets	1	.575(**)	.575(**)
	2	.457(**)	.469(**)
	3	.688(**)	.614(**)
	4	.461(**)	.461(**)
	5	.530(**)	.495(**)
	6	.468(**)	.427(**)

Non-parametric CC (Spearman's Rho) at multiple spatial extents for road density and dasymetric map (including all roads; 500m NH)

Direct Approach

SPOT/HRVIR – 10m Resolution

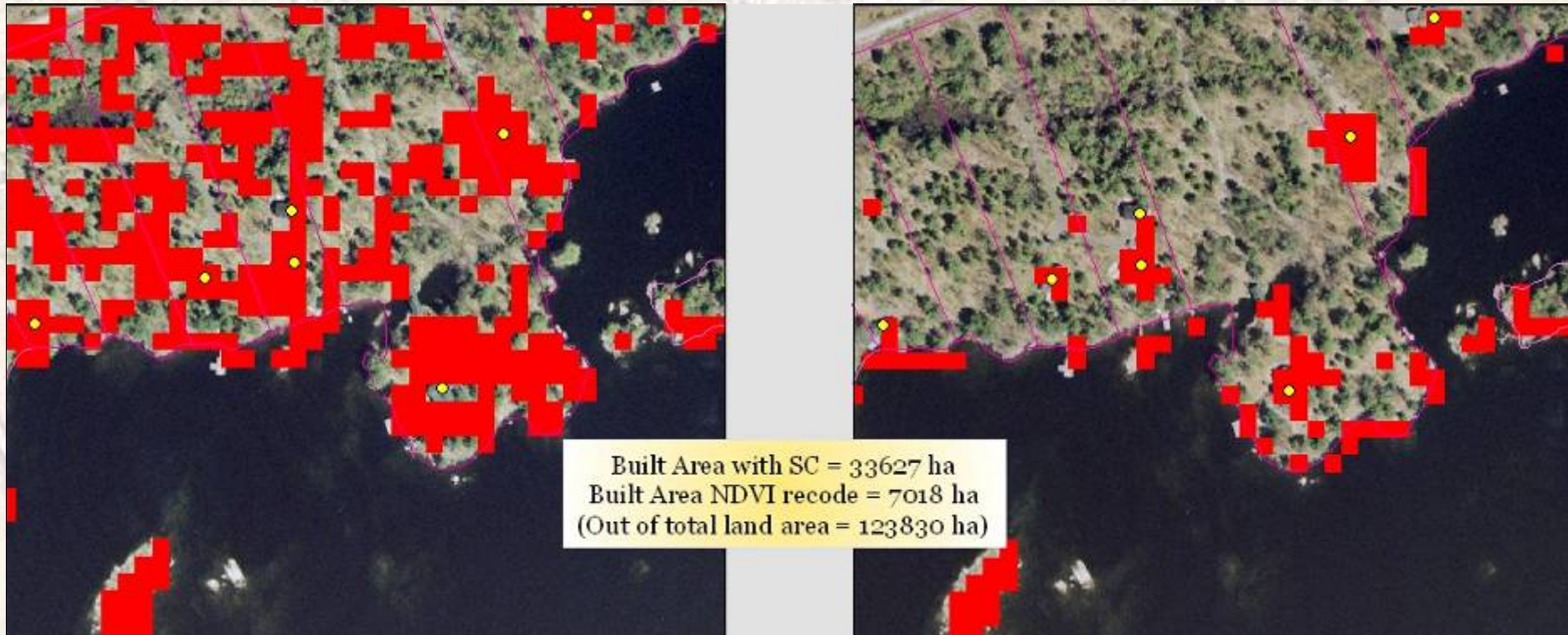


(a) SPOT Imagery – 5 scene mosaic; (b) Supervised Classification; (c) NDVI

Direct Approach

SPOT/HRVIR – 10m Resolution

Binary Recode of Built Areas



(a) Supervised classification binary recode

(b) NDVI binary recode (-ve = built; water masked out)

Direct Approach

Classification Accuracy Assessment

Using 100 Random Points (Equalized) in Classified Image

	Supervised Classification					NDVI Recoding				
	Ref.	Classifi	No.Corr	PA(%)	UA(%)	Ref.	Classifi	No.Corr.	PA(%)	UA(%)
Built	11	50	9	81.82	18	14	50	14	100	28
Non-Built	89	50	48	53.93	96	86	50	50	58.14	100
Totals	100	100	57			100	100	130		
OA (%)	57					68				

- ❖ NDVI recoding has higher overall accuracy.
 - lower omission error (high PA) and commission error (high UA)
- ❖ Commission error is below acceptable limits in both
 - mainly due to class confusion between built and bare rocks and fallow fields
- ❖ Further processing is needed to correct this problem
 - Using ancillary data → Structural attributes / contextual information to distinguish between uninhabited bare areas and habited built areas.

Findings so far...

- ❖ Indirect methods' applicability to map exurban areas is spatially dependent.
 - In some areas road network is not indicative of residential developments such as in southern regions of the study area (where historically roads were laid in grid pattern regardless of the level of development).
 - In other areas like mid region and areas around large lakes, roads are where the developments are so these approaches work well.
- ❖ RD computed using smaller NH radii including all road types seem to reflect built areas better than larger NH radii, and including only local or weighted roads.
- ❖ Direct methods using medium resolution remotely sensed image (SPOT/HRVIR) seemed to work well in capturing the built pixels, esp using simple NDVI recoding technique.
- ❖ Further processing using structural and contextual information is mandatory since spectral information alone is creating high commission error.

Future Work

- ❖ Refine the direct method using ancillary data to improve the user's accuracy (commission error).
- ❖ Identify various factors associated with exurban locations in the study area.
- ❖ Assess exurban conversion threat to the landscape and identify potential conflict areas between conservation and development interests.
- ❖ Quantify the impacts of exurban development in terms of landscape structure and function.

Thank You !!

Contact Info

Tenley Conway

Email: tconway@utoronto.ca

Web: <http://geog.utm.utoronto.ca/conway/>

Namrata Shrestha

Email: namrata.shrestha@utoronto.ca

Web: <http://eratos.erin.utoronto.ca/namrata/>