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# Carpet Inventory Estimates Using Building Characteristics Data: Opportunities and Obstacles

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**Presented by Matthew Realff and Ning Ai**

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# Overview

- Team Members and Research Background
- Methodology of Carpet Modeling
  - Carpet inventory estimates
  - Discarded carpet estimates
- Region Illustrations and Results
  - Atlanta metro
  - Seattle metro
- Next Steps and Obstacles

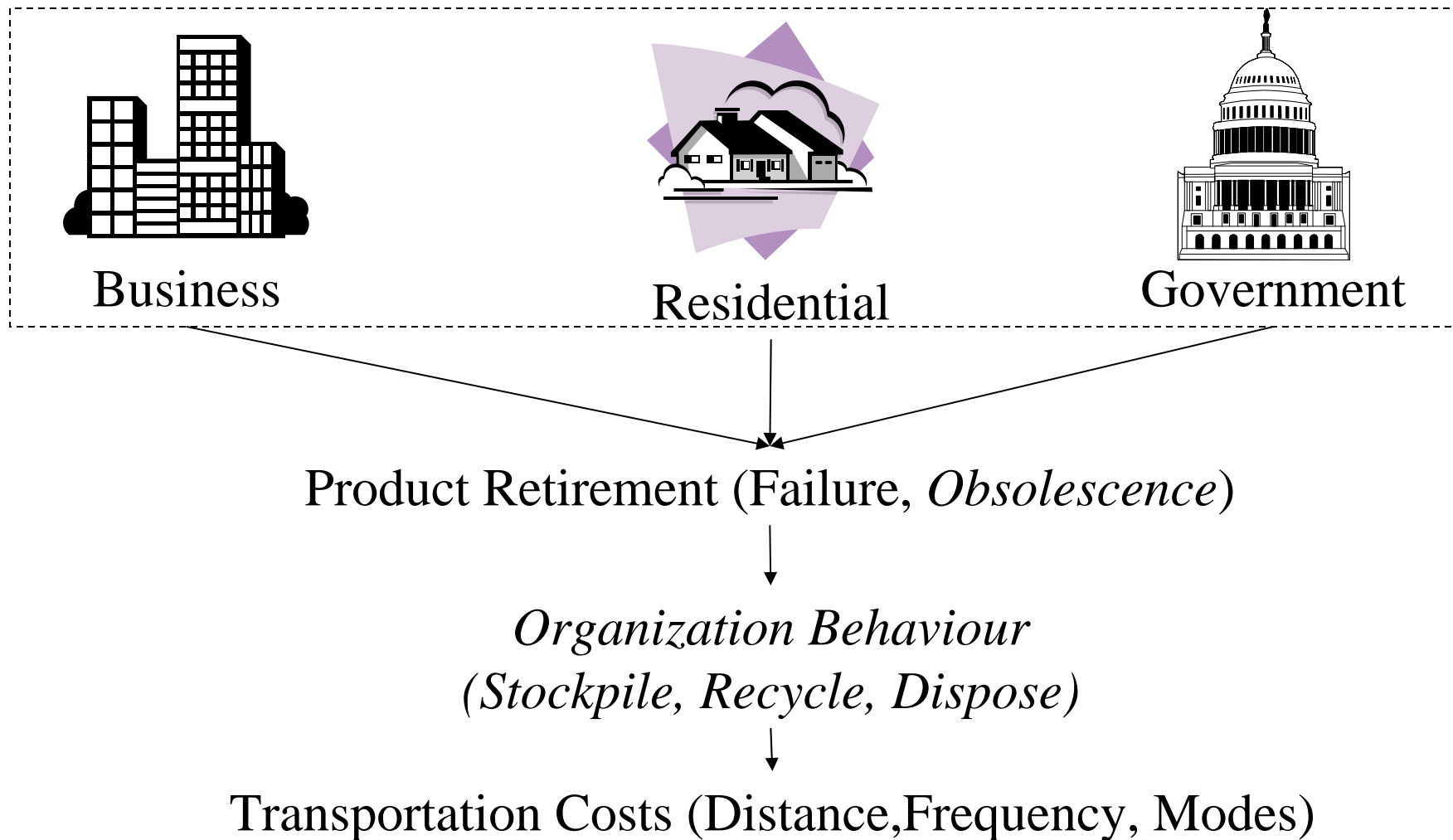
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# Multidisciplinary Research Team

- City and Regional Planning (Georgia Tech)
  - Dr. Nacey Green Leigh
  - Dr. Steven French
  - Taelim Choi
  - Ning Ai
- Mechanical Engineering (Georgia Tech and Univ. Washington)
  - Bert Bras (Georgia Tech)
  - Joyce Cooper (Univ. of Washington, Seattle)
  - Caroline Guidry
  - Seung-Jin Lee
- Chemical Engineering (Georgia Tech)
  - Dr Matthew J Realff
  - Dr. John Muzzy
  - Valli Subbiah
- Regional Economics and Geography (West Virginia Univ.)
  - Dr. Randy Jackson

# “Reservoir Engineering”

## *Product Stockpiles*



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# Ongoing Research

- Product Inventory Estimates (PIE) – current
  - Carpet
  - Computer CRTs
  - FPD TVs
- Product obsolescence estimates – current
- Transportation and environmental models
- Recycling center location analysis
- Socioeconomic impact analysis

Industrial Systems Sustainable Urban Systems

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# Approaches of Product Inventory Estimates and Data Requirements

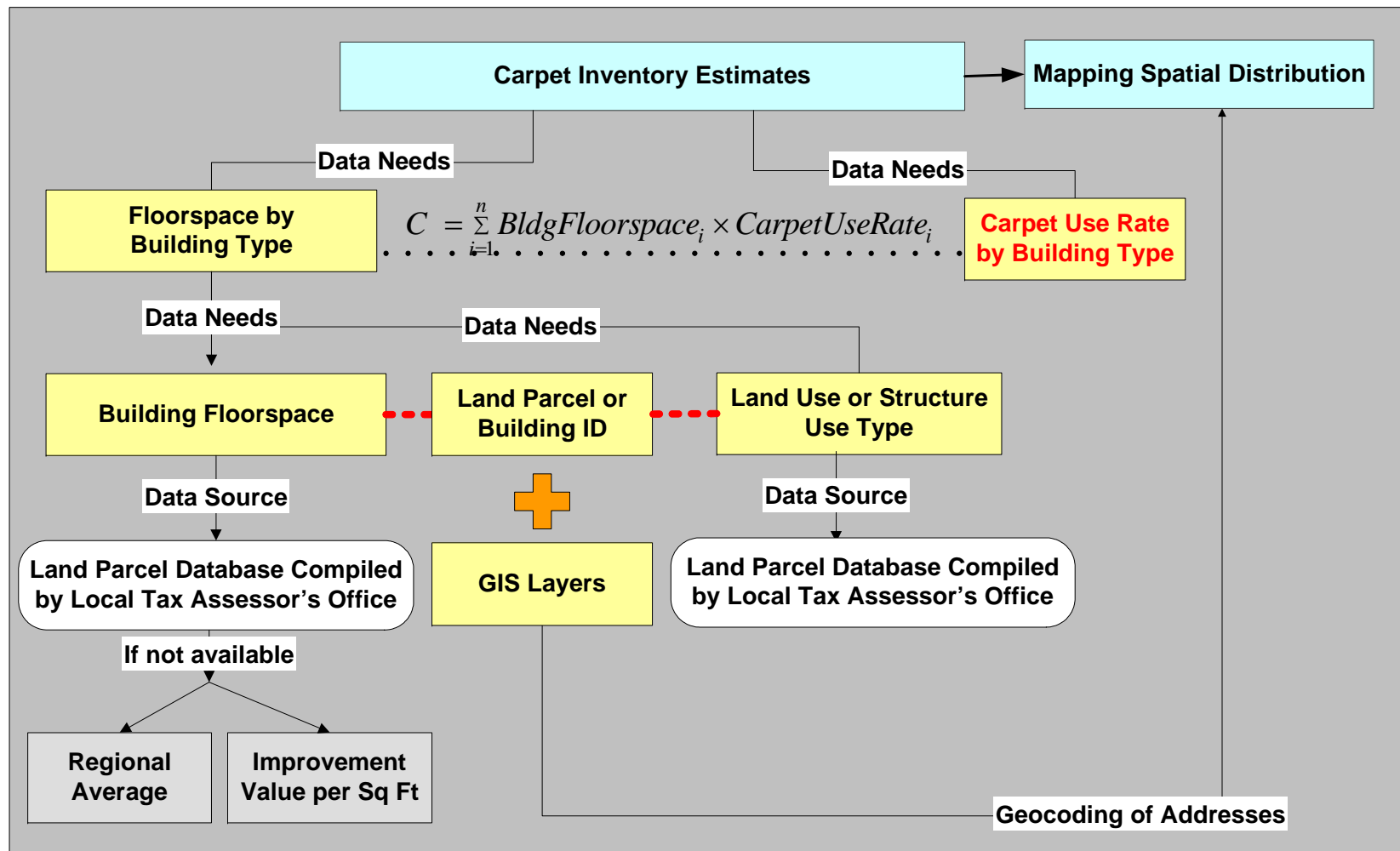
- General approaches of PIE
  - Focus on the beginning of product life cycle
    - Product sales & replacement rates
    - Ownership rates & demographic characteristics
  - Trace the end of product life cycle
    - Waste characterization study
- Data needed but unknown
  - Carpet sales
  - Carpet use rates
  - Distribution of carpet inventory

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# Data Availability at County Level

- Building characteristic data commonly provided by Tax Assessor's Office
  - Land use or building structure use type
  - Building sq ft or parcel size
  - Year built
  - Improvement value
  - Address

# Methodology Developed for Carpet Inventory Estimates



# Initial Estimate of Carpet Use Rate

<b>General Categorization of Building Use</b>	<b>Estimated Carpet Use (% floor space)</b>
Commercial	50
Industrial	10
Institutional	40
Multi-Family	90
Office	90
Single-Family	80

Please give us feedback!

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# Estimated Carpet Weight per Sq Yd

- Parameters for weight estimation:
    - Percent of broadloom carpet: 90%
    - Percent of carpet tile: 10%
    - weight/sq yd broadloom carpet: 4.5 lbs
    - weight/sq yd carpet tile: 9 lbs
- Assume uniform weight: 5lb/sq yd

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Note: Data estimation from a working document by Matthew Realff. The result is to be further refined for different building types.

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# Discarded Carpet Modeling

- Assumption of carpet life span

- Commercial use: 8-10 yrs
- Residential use: 10-15 yrs

- Two scenarios of carpet life span in general

- 10 yrs
- 15 yrs

- Yearly carpet discard rate

- 10-yr lifespan: 1/10 of carpet stock
- 15-yr lifespan: 1/15 of carpet stock

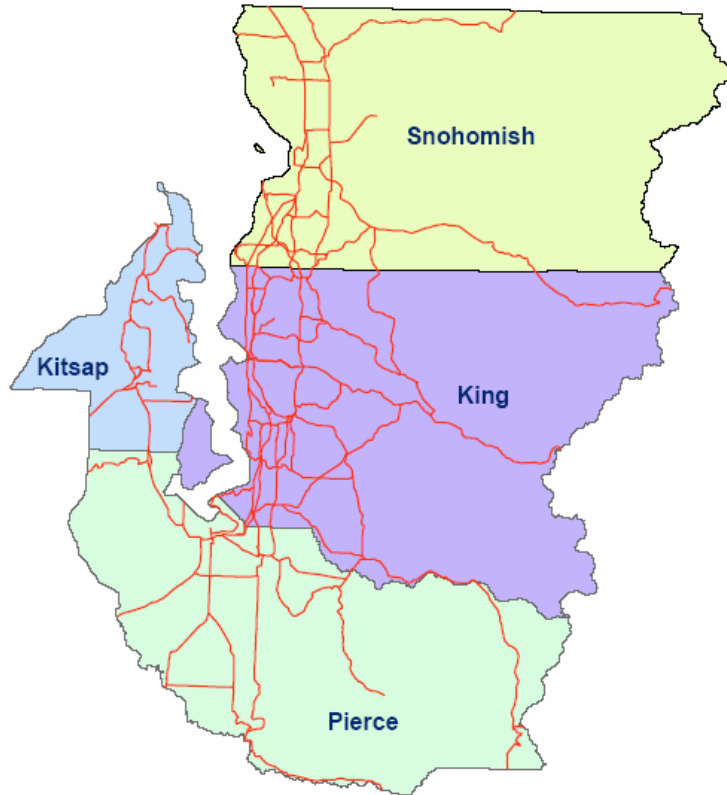
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Note: The life span information is provided by Dr. Matthew Realff.

# Selection of Case Study Regions

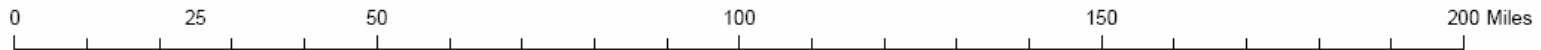
## Greater Seattle Area:

4-county of Central Puget Sound Region

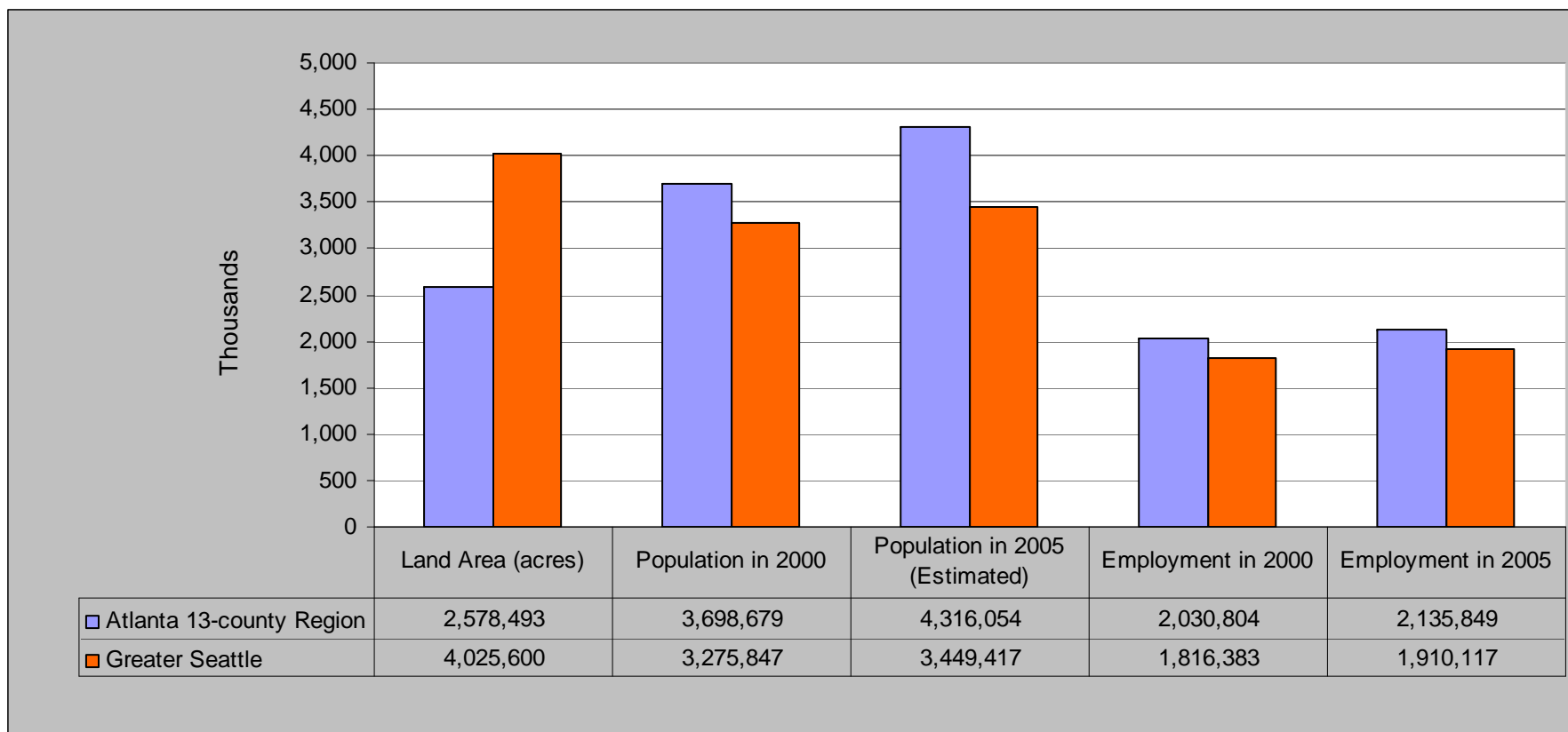


## Atlanta Metro Area:

13-county air quality non-attainment area

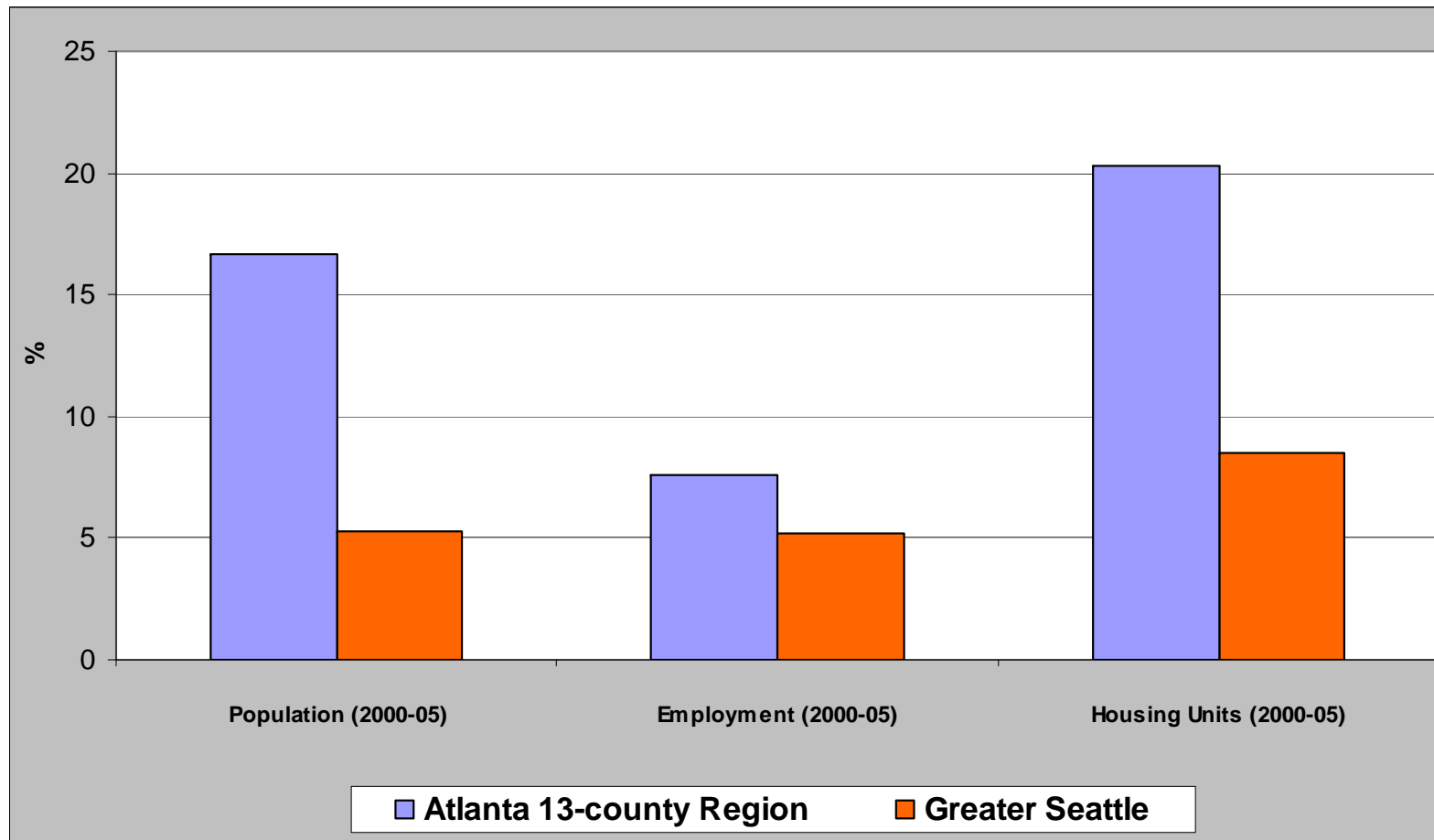


# Regional Comparison: Atlanta and Seattle



Data source: (a) Land area: ARC and PSRC; (b) Population: US Census 2000, 2005; (c) Employment: Average of 12-month total civilian employment data provided by State Department of Labor LAUS (Local Area Unemployment Statistics) program – reflecting the worker’s county of residence rather than place of work.

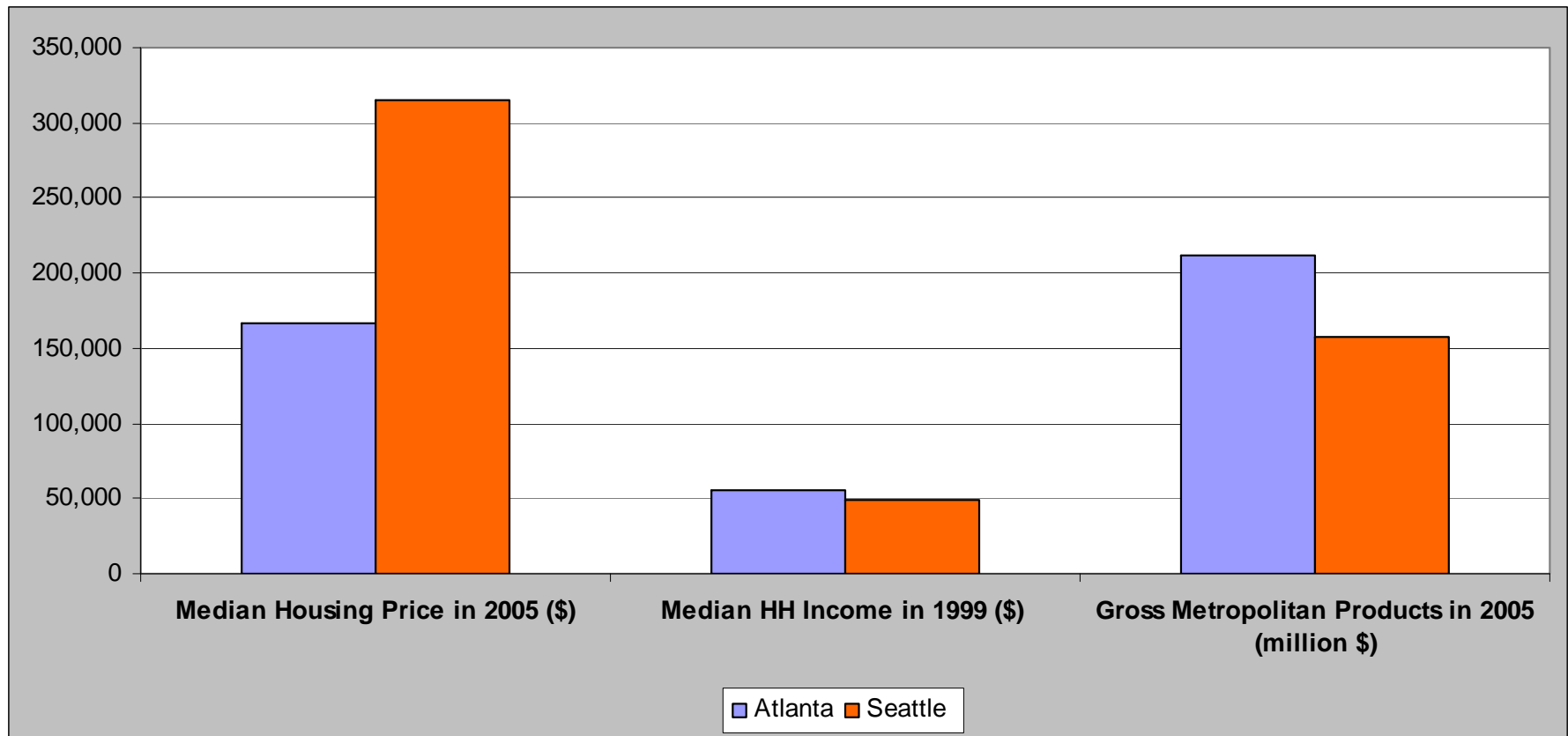
# Comparison of Regional Growth Rate



Data source: US Census and Department of Labor LAUS program, 2000; 2005.

Note: Data of population and housing units in 2005 are estimated by US Census.

# Comparison of Economic Indicators



Source: (1) National Association of Realtors; (2) US Census 2000; (3) US Conference of Mayors and the National Association of Counties.

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# Atlanta Data Illustration

- SMARTRAQ parcel-level database
  - Latest data available by Year 2004
  - Integrated data of 13 counties in one database
  - 1,329,627 parcels in Atlanta metro
  - Standardized by Center for GIS at Georgia Tech
  - Data processing method
    - Re-categorize 13 building uses standardized in SMARTRQ database into six general types for carpet estimates
    - Estimate building sq ft using the average sq ft by building type when sq ft data is not available (institutional, single-family, and multi-family residential)
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# Atlanta Land Use Categories

<b>Land Use Categories by CGIS</b>	<b>Definition</b>	<b>Re-Categorization for Carpet Estimation</b>
Agriculture	Property actively used in agriculture	NA
Cemetery/Park/Open Space	Public parks, cemeteries and open spaces	NA
Commercial	Wholesale and retail trade	Commercial
Industry	Manufacturing, light industry and warehousing	Industrial
Institutional	Government or other institutional uses	Institutional
Mobile Home	Single mobile home or mobile home park	Single-family
Multi-Family Residential	Apartment or other attached housing units	Multi-family
Office	High and low-rise offices	Office
Parking/TCU	Parking lot, structure or utility	NA
Recreation	Golf course or other recreation area	NA
Single-Family Residential	Owner occupied, detached housing unit	Single-family
Unknown	Use could not be determined	NA
Vacant	Undeveloped parcel	NA

# Atlanta 13-County Building Summary

Categorization for Carpet Estimates	Statistics of Building Sq Ft				Statistics of No. of Buildings	
	% of Total Bldg Sq	Recorded Bldg Sf	Estimated Bldg Sq Ft	Total Bldg sf	No. of Bldgs	% of Total Bldgs
Commercial	9.45	350,214,947	0	350,214,947	30,136	2.38
Industrial	10.04	371,800,262	0	371,800,262	9,836	0.78
Institutional	1.50	15,823,051	39,823,652	55,646,703	5,254	0.41
Multi-Family Res.	6.61	232,711,547	12,007,916	244,719,463	69,742	5.50
NA	6.94	257,262,017	0	257,262,017	145,464	11.47
Office	4.36	161,434,552	0	161,434,552	7,240	0.57
Single-Family Res.	61.10	2,042,354,436	221,064,371	2,263,418,807	1,000,285	78.89
<b>Total</b>	<b>100</b>	<b>3,431,600,812</b>	<b>272,895,939</b>	<b>3,704,496,751</b>	<b>1,267,957</b>	<b>100</b>

Note: (1) The category of “NA” includes land for agriculture, open space, parking, recreation, vacant, or unknown use. (2) The estimated bldg sq ft only includes estimations in this study; i.e., those estimated by SMARTRAQ study is considered as “recorded” for now. 18

# Atlanta Carpet Inventory Estimates

Categorization for Carpet Estimate	Bldg Sq Ft (Estimated)	Est. Carpet Use (% Floorspace)	Est Carpet Use		Est Carpet Weight	
			(Sq Ft)	(Sq yard)	(lbs)	(tons)
Commercial	350,214,947	50	175,107,474	19,456,386	97,281,930	48,641
Industrial	371,800,262	10	37,180,026	4,131,114	20,655,570	10,328
Institutional	55,646,703	40	22,258,681	2,473,187	12,365,934	6,183
Multi-Family Res.	244,719,463	90	220,247,517	24,471,946	122,359,732	61,180
NA	257,262,017	0	0	0	0	0
Office	161,434,552	90	145,291,097	16,143,455	80,717,276	40,359
Single-Family Res.	2,263,418,807	80	1,810,735,046	201,192,783	1,005,963,914	502,982
<b>Total</b>	<b>3,704,496,751</b>		<b>2,410,819,840</b>	<b>267,868,871</b>	<b>1,339,344,356</b>	<b>669,672</b>

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# Estimated Volume of Discarded Carpet in Atlanta

- Assumption 1: 10-yr life span of carpets
  - Each year in Atlanta metro area
    - In total:  $669,672 \text{ tons}/10\text{yrs} = 66,967 \text{ tons}$
    - $(310 \text{ lbs/person-yr})/10 \text{ yrs} = 31 \text{ lbs/person-yr}$
- Assumption 2: 15-yr life span of carpet
  - Each year:
    - In total:  $669,672 \text{ tons}/15\text{yrs} = 44,644 \text{ tons}$
    - $(310 \text{ lbs/person-yr})/15 \text{ yrs} = 21 \text{ lbs/person-yr}$

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# Greater Seattle Area Data Illustration

- Building data is collected from four counties and processed individually
- Data year: 2005 or 2006
- No. of records in each county
  - King: 596,467
  - Kitsap: 96,328
  - Pierce: 308,364
  - Snohomish: 214,517
- Data processing method
  - Match building use type with building sq ft via unique Parcel/Building ID across the tables
  - Re-categorize/standardize all building uses (approx. 100~ over 1,000 categories) into six general types for carpet estimates
  - Estimate building sq ft using the index of “improvement value per sq ft” when sq ft data is not available (in Snohomish County only)

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Note: The number of records is not necessarily equal to the number of buildings, because some parcels may not have any building structure and some parcels may have more than one buildings.

# Seattle Building Summary

Categorization for Carpet Estimates	Statistics of Building Sq Ft				Statistics of No. of Buildings	
	% of Total Bldg Sq	Recorded Bldg Sf	Estimated Bldg Sq Ft	Total Bldg sf	No. of Bldgs	% of Total Bldgs
Commercial	7.81	189,798,030	72,839,420	262,637,450	24,842	1.99
Industrial	12.39	301,792,716	115,027,981	416,820,697	23,198	1.86
Institutional	4.01	128,187,456	6,877,584	135,065,040	8,157	0.65
Multi-Family Res.	13.22	383,606,177	61,301,448	444,907,625	144,606	11.59
NA	1.37	45,156,558	1,092,719	46,249,277	61,669	4.94
Office	6.08	168,400,048	36,121,247	204,521,295	11,909	0.95
Single-Family Res.	55.12	1,854,524,371	0	1,854,524,371	973,021	78.00
<b>Total</b>	<b>100.00</b>	<b>3,071,465,356</b>	<b>293,260,400</b>	<b>3,364,725,756</b>	<b>1,247,402</b>	<b>100.00</b>

# Seattle Carpet Inventory Estimate

Building Categorization	Bldg Sq Ft	Est Carpet Rate (% floorspace)	Est Carpet Use		Est Carpet Weight	
			(Sq Ft)	(Sq yard)	(lbs)	(tons)
Commercial	262,637,450	50	131,318,725	14,590,969	72,954,847	36,477
Industrial	416,820,697	10	41,682,070	4,631,341	23,156,705	11,578
Institutional	135,065,040	40	54,026,016	6,002,891	30,014,453	15,007
Multi-Family Res.	444,907,625	90	400,416,863	44,490,763	222,453,813	111,227
NA	46,249,277	0	0	0	0	0
Office	204,521,295	90	184,069,166	20,452,130	102,260,648	51,130
Single-Family Res.	1,854,524,371	80	1,483,619,497	164,846,611	824,233,054	412,117
<b>Total</b>	<b>3,364,725,756</b>		<b>2,295,132,336</b>	<b>255,014,704</b>	<b>1,275,073,520</b>	<b>637,537</b>

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# Estimated Volume of Discarded Carpet in Seattle

- Assumption 1: 10-yr life span of carpets
  - Each year:
    - 63,754 tons/yr
    - 37 lbs/person-yr
- Assumption 2: 15-yr life span of carpet
  - Each year:
    - 42,502 tons/yr
    - 25 lbs/person-yr

# Summary Comparison: Atlanta vs. Seattle

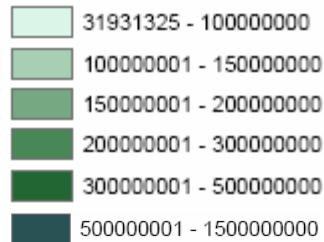
	Atlanta 13-County	Greater Seattle
<b>Population (2005)</b>	4,136,054	3,449,417
<b>Total No. of Buildings</b>	1,267,957	1,247,402
<b>Total Building Sq Ft</b>	3,704,496,751	3,364,725,756
<b>Estimated Carpet Stock (tons)</b>	669,672	637,537
<b>Estimated Discarded Carpet (tons/yr)</b>	44,644 - 66,967	42,502 - 63,754
<b>Estimated Discarded Carpet (lbs/person-yr)</b>	21 - 31	25 - 37

# Spatial Illustration by County

## Greater Seattle Area

## Atlanta Metro Area

CARPET\_SF



County Boundary

Interstate Rd

COM

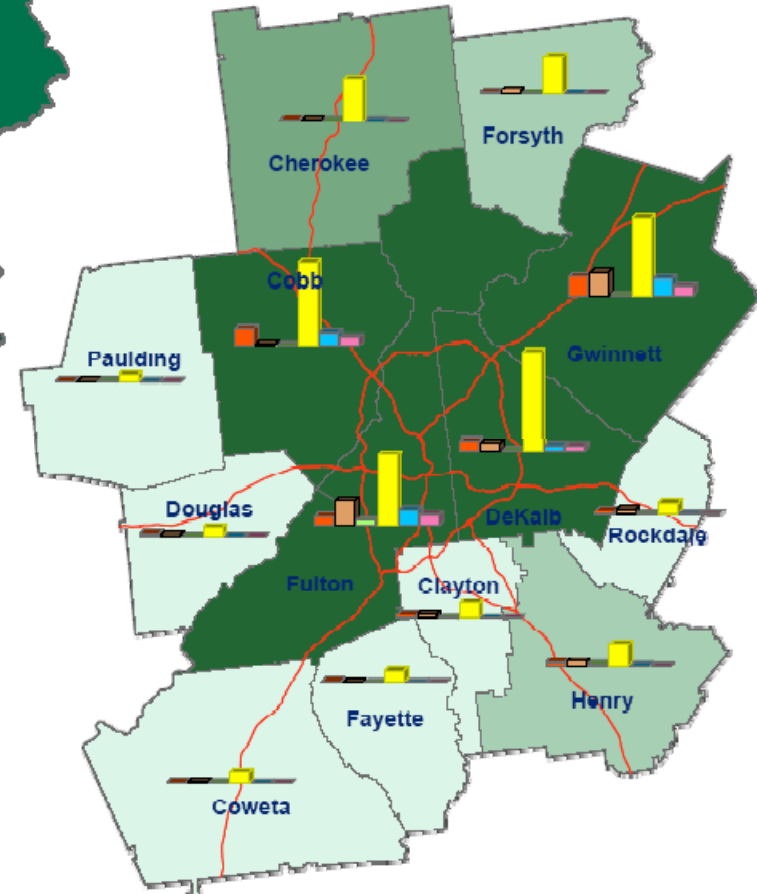
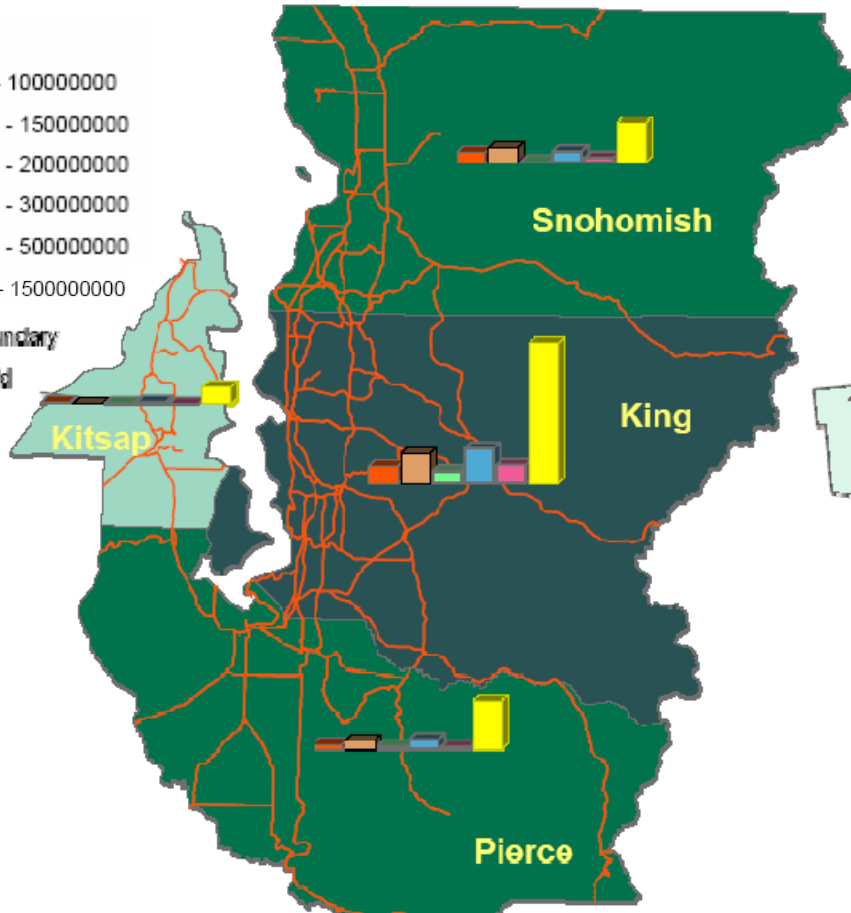
IND

INST

SF

MP

OFFICE



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# Crucial Data Needed to Refine the Results

- Percentage of buildings that are carpeted (by building type)
- Quality and type of carpet (by building types) for estimation of carpet fiber types and carpet weight
- Regional sales data (total and split among buyers)
- Life span of carpet in different buildings

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**We appreciate any relevant information and comments you could provide to enhance our research.**

**Thank you!**

