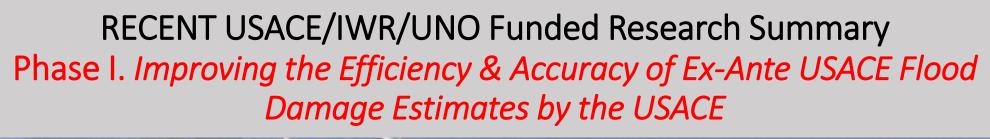
#### 2015 HAZUS-USERS Conference, Atlanta

### Improving the Reliability of HAZUS Building Inventory Data to Estimate Potential Economic Losses,

Steve Shultz, University of Nebraska at Omaha



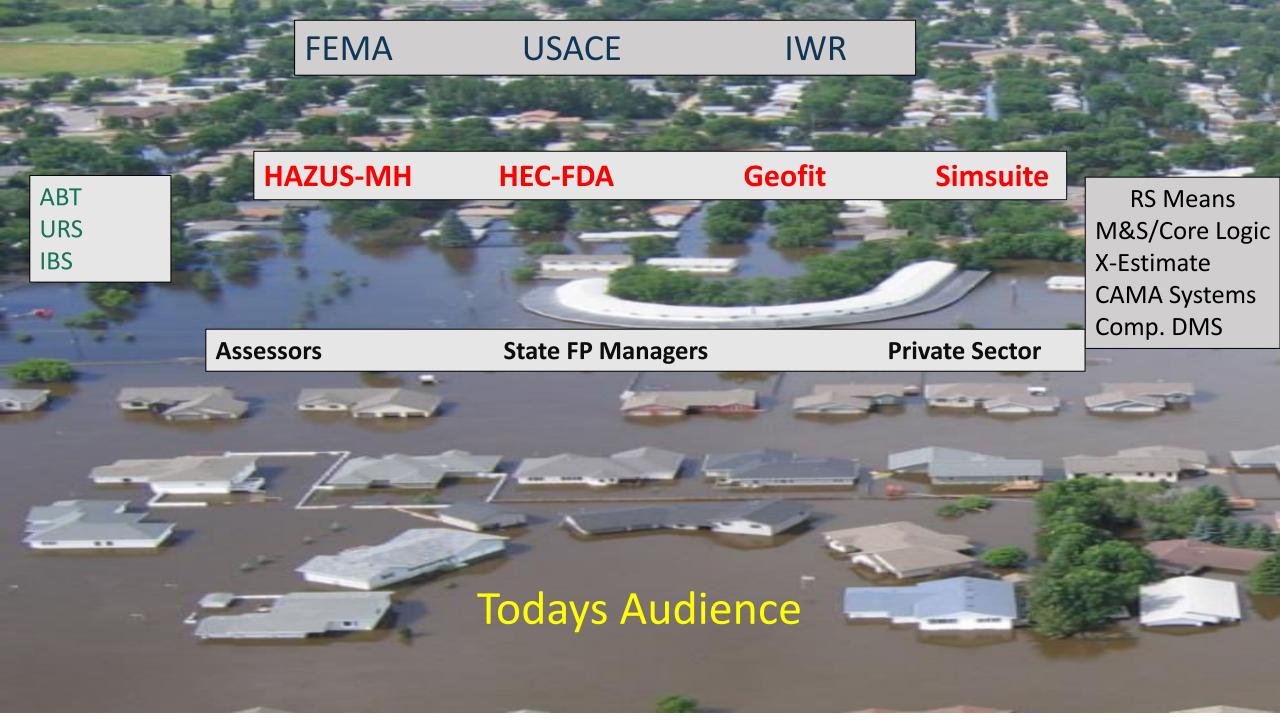






### Phase II. How Acurate is HAZUS-GBS Data & Can it Be Improved?





### The Cost Approach: Summary

Reproduction or Replacement Cost of Improvements

Depreciation on Improvements

Site Value

Property Value

#### **Potential Tax Assessor Reported Cost Approach Data**

Assessed Value (total)

Improved

Land/Lot/Site

Extra Improvements

Age

Condition

Quality

Eff. Age

Depreciation (Phys Vs Economic)

RS Means M&S/Core Logic

X-Estimate

**CAMA Systems** 

### **Assessors Rankings of Valuation Approaches (IAAO, 2010)**

	Cost Approach	Sales Comparison Approach	Income Approach
SFR	2	1	3
Multi-family	3	1,2	1,2
Commercial	3	2	1
Industrial	1,2	3	1,2
Non-agricultural land		1	2
Agricultural		2	1
Special-purpose**	1	2,3	2,3

### Phase I (Understanding 3 Existing Structural Inventories)

- DSRVs by Property Types and Floodplain Status
- Feasibility of Using Tax Assessor Data for Estimating DSRVs
- Single-Family Residential DSRVs Across 3 Study Site Locations
- Ratios of Single-Family DSRVs to Assessed Tax Values
- Factors Influencing Single-Family Residential DSRVs
- Alternative Cost Estimation Data Sources (Minot, ND)

### Single-Family Residential DSRVs Across 3 Study Site Locations

- 1. DSRVs do Vary by Value/Age/Size/Style (stratified sampling)
- 2. Use \$/SFT Metrics not total values and Medians due to severe outliers
- 3. Modest variations across locations (extrapolations across different locations with relatively similar housing stock and values possible)
- 4. Overall Conclusion: Not optimal to rely on these simplistic valuation measures alone

(Assessment Ratios or Multiple Regression are Better Alternatives)

### SFR DSRV to Improved Value Ratios (Fargo/MHD)

(better than Total Value Ratios, medians superior, Vary by Location and Characteristics

	Mean	Median	Std. Dev.
All properties	1.2	1.10	1.00
De Electulais Chatas			
By Floodplain Status			
100-Year Floodplain	1.1	1.07	0.89
Non-Floodplain	1.2	1.1	1
By Value			
< \$90,000	1.03	1.01	0.76
\$90,000 to \$188,000	1.08	1.07	0.17
>\$188.000	1.34	1.17	1.5
By Size (AGSF)			
< 1000	1.06	1.05	0.47
1000-1500	1.16	1.08	0.78
1500-2400	1.25	1.14	0.86
>2400	1.42	1.18	2.2
By Style			
One-Story	1.17	1.09	0.98
Two-Story	1.32	1.16	1.25
Bi-Level/Split Levels	1.18	1.11	0.7

### Reverse Engineering Through Multiple Regression (Sarpy County, SFR Properties n=47k, R2 .96)

Variable	Coefficient	Std. Error	t-stat
Above_Grade_SF	64 (.030%)	0.3	218.5
Base_Fin_SF	44 (.031%)	0.3	149.5
Base_Unfin_SF	15 (.018%)	0.3	54.0
Age	-317 (.42%)	5.0	-63.7
Garage Stalls	4,101 (3.6%)	87.4	46.9
Quality	6,441 (2.5%)	22.6	284.4
Condition	733(1.2%)	27.0	27.1
Bathrooms*	133	187.9	0.7
1_Story	10,101 (1.3%)	387.4	26.1
2_Story	-1,696 (2.1%)	404.3	-4.2
3_Story	-108	442.2	-0.2

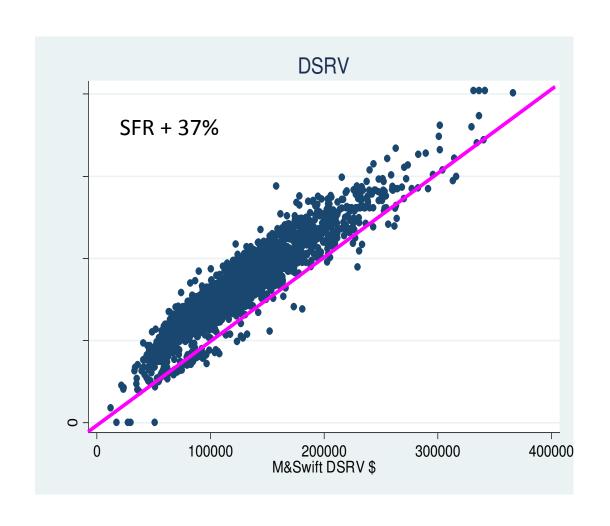
# Commercial Structures Median DSRVs/Sft Sarpy vs Minot (vary substantially and across structure types within general classes)

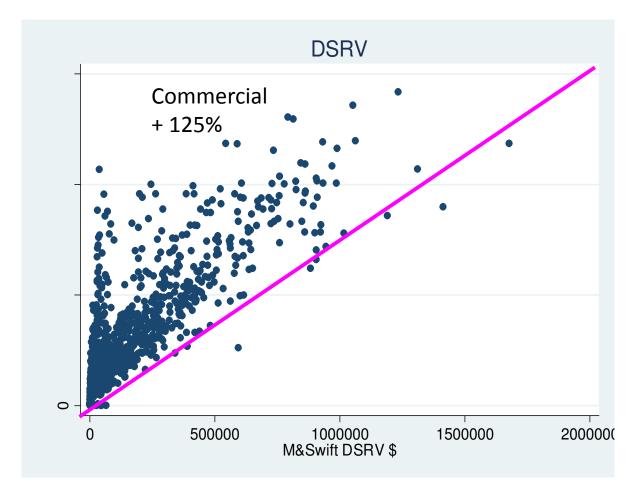
Property Type	Difference
1) Retail	4%
Bank	57%
Restaurant (FastFood)	-44%
Restaurant	-24%
Retail Store	26%
2) Office	67%
3) Multiple Residence	51%
4) Warehouse/Storage	41%
Storage Garage	-4%
Warehouse, Mini	40%
Warehouse, Storage	52%
Warehouse, Distribution	76%
5) Industrial	
Equipment Shop B	-19%
Industrials, Light	112%
Service Repair Garage	15%
6) Special Use	15%
Clubhouse	47%
Barber Shop	2%
Convenience Market	-7%
Day Care Center	-29%
Tavern/Bar	91%
Light Commercial Utility	40%
Mini-Mart Convenience	-39%

# Ratios of Commercial DSRVs to Assessed (Improved Values) by Property Type and Study Site Location

	Sarpy County			Fa	rhead	
Property Type	Mean Median Std. Dev.		Mean	Median	Std. Dev.	
Retail	2.5	1.2	10.9	2.7	1.5	7.1
Office	1.7	1.1	4.3	4.6	2.3	4.6
Multi-Family	1.5	1.3	1.2	4.9	2.4	14.6
Warehouse/Storage	2.2	1.3	5.1	2.7	2.4	2.2
Industrial	3.1	1.3	13	11.7	3.2	31
Special Use	1.2	0.9	1.5	3.49	1.81	12

### What Cost Data to Use: RSM Vs M&S (Minot)





### Phase II (National Level/HAZUS-GBS)

### Potential Uses

• HAZUS-MH, SimSuite, HEC-FDA, National Reporting

### **How the GBS is created**

- Residential (Census & Regional Building Data)
- Commercial (Dunn & Bradstreet 2000 extrapolated to 2010 with Unknown Methods)
- Valuation Source: RS Means
- RCNV (quietly reported)
- Depreciation: Flood Model Only (Residential Block Group Level Age Categories & Smoke & Mirrors)
- Improved Location Specificity Across Blocks with Dasymetric Mapping

HAZUS Level II Analyses: Recommend but often ignored and/or done incorrectly

**Prior Research Evaluating HAZUS Data** 

# Why it is Important to Get GBS Accurate (and how to do it)







### Previous Research Evaluating the GBS (10 known studies)

1) 2000. Mylonakis, Fish, and Spiteri. Development of a Building Inventory for Manhattan Region. (2 NYC Census blocks + 575%).

2) 2004. Congressional Testimony (2004) by Anthony S. Lowe.

'Evidence that GBS accurately represented the built environment based on comparison to wind hurricane damage compiled by property insurers.'

3) 2004. Meyer. M.Sc. Thesis (Louisiana State University): Comparative Analysis Between Different Flood Assessment Technologies in HAZUS-MH

(- 6% due to HAZUS inability to account for new growth)

4) 2007. Maheshwari, PhD. Dissertation. Disaster Damage Estimation Models: Data Needs vs. Ground Reality

Square Feet Only: Seattle: (-33%) Long Beach, CA -2%

5) 2008. Ding, White, Ullman, and Fashokun. "Evaluation of HAZUS-MH Flood Model with Local Data and Other Programs." Nat. Hazards Rev

Texas SFR Dominated County (Vs. Assesed Values Mix Approach): +63%

6) 2010. Rozelle et al. Analyzing Potential Flood Damage to Fargo, North Dakota Using a Detailed HAZUS Level 2 Analysis, FEMA Report GBS Vs. Assesor Values + 26%

### Previous Research Evaluating the GBS

7) 2010. Association of State Floodplain Managers. Comparing HAZUS Flood Loss Estimates across Hazard Identification Methods and Building Stock Inventory Data Albien Township. Dana County, Wisconsin (a semi-rural area deminated by SER)

Albion Township, Dane County, Wisconsin (a semi-rural area dominated by SFR) Assessor data almost 10 years newer than GBS. (+35% to 66%)

8) 8) 2011. Cummings, Todhunter, & Rundquist. Using the HAZUS-MH flood model to evaluate community relocation as a flood mitigation response to terminal lake flooding: The case of Minnewaukan, North Dakota, USA. Applied Geography

9) 2014. Tate, Muñoz, and Suchan. Uncertainty and sensitivity analysis of the HAZUS-MH flood model. Nat. Hazards Rev.

Iowa City (sensitivity analyses with structural data but not values per se)

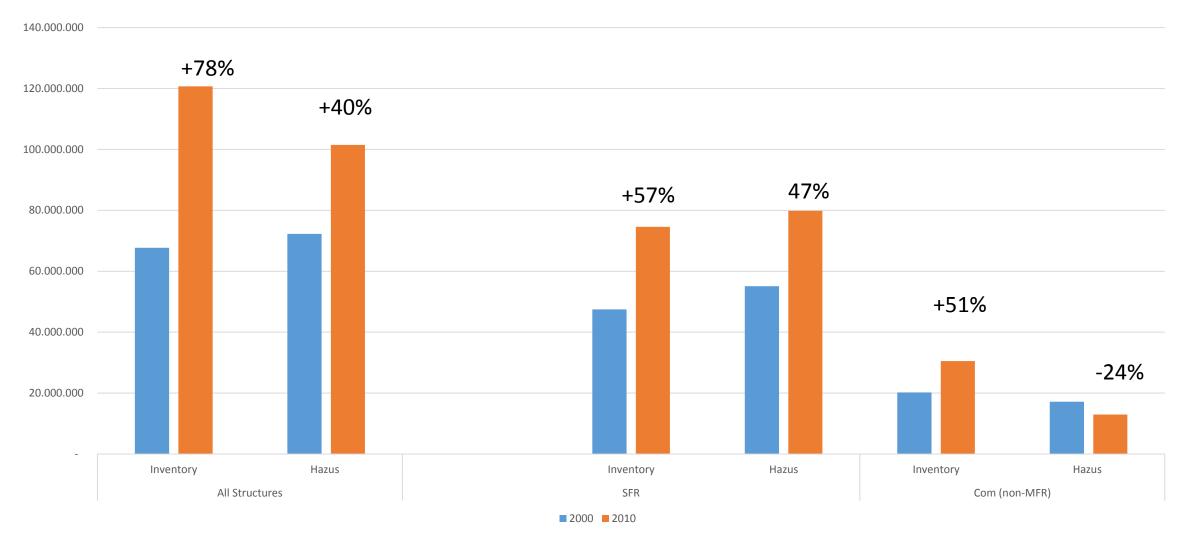
10) 2014. Banks, Camp, and Abkowitz. Scale and Resolution Considerations in the Application of HAZUS-MH 2.1 to Flood Risk Assessments

Nashville, TN Only a moderate correlation GBS and actual damage

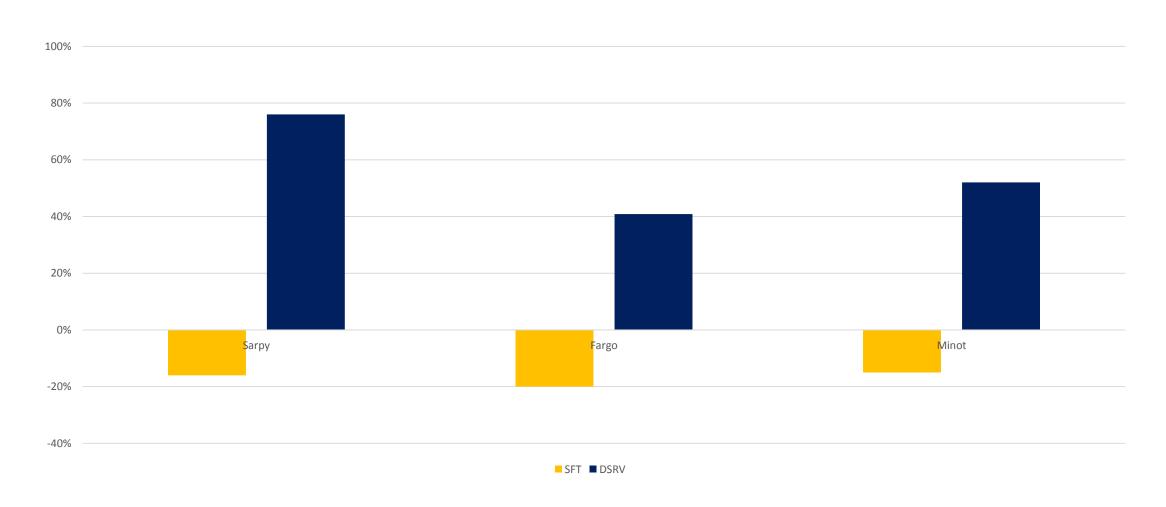
# Summary of my GBS Evaluation Slides (Minot, Fargo, Sarpy (Omaha)

- Building Square Feet Estimates (AGLA): Inventory vs. GBS (2000 to 2010/15), Sarpy County, NE
- 2010 GBS Vs. Inventory (SFT & DSRV): All Structures, 3 Locations
- 2010 GBS Vs. Inventory (SFT & RCNV): SFR
- 2010 GBS Vs. Inventory (SFT & RCNV): COM
- 3 Regression Correction Models

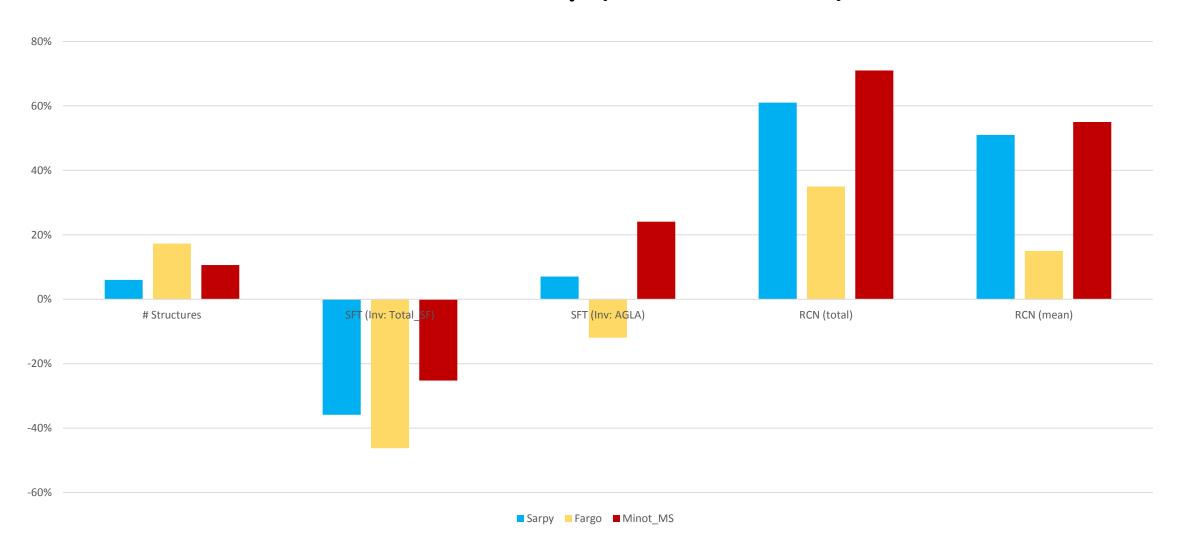
# Building Square Feet Estimates (AGLA): Inventory vs. GBS (2000 to 2010/15), Sarpy County, NE



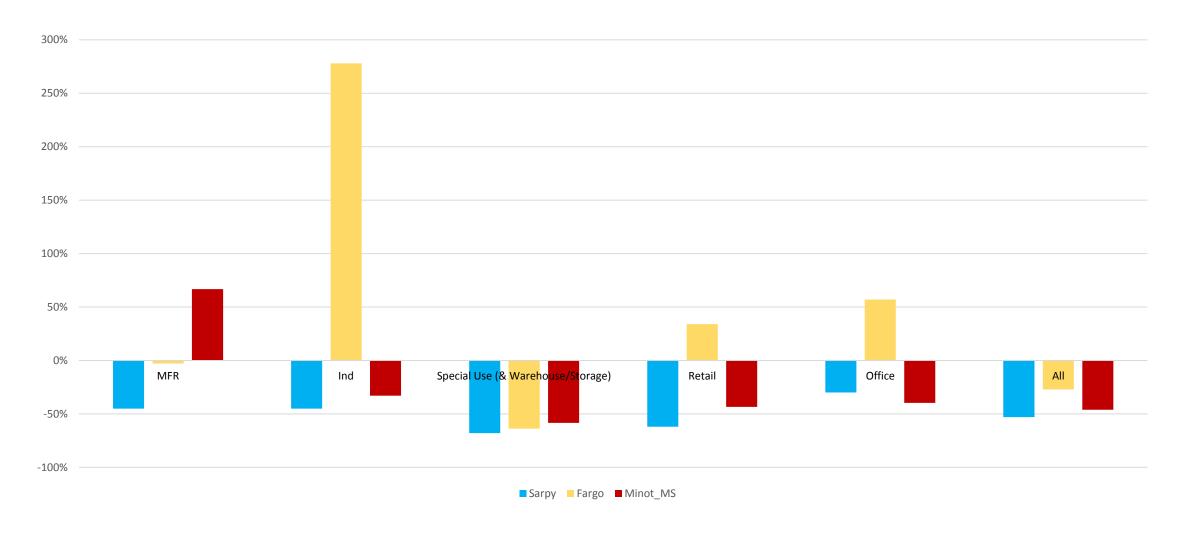
## 2010 GBS Vs. Inventory (SFT & DSRV): All Structures, 3 Locations (Avg: 56%) RCNV Differences (Avg: 31%)



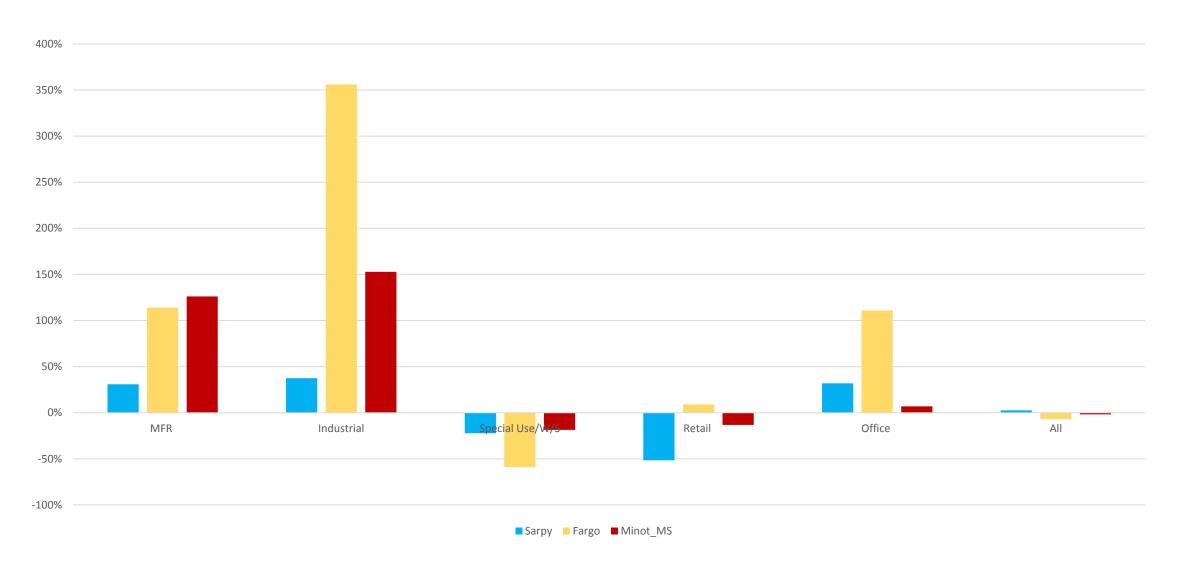
### 2010 GBS Vs. Inventory (SFT & RCNV): SFR, 3 Locations



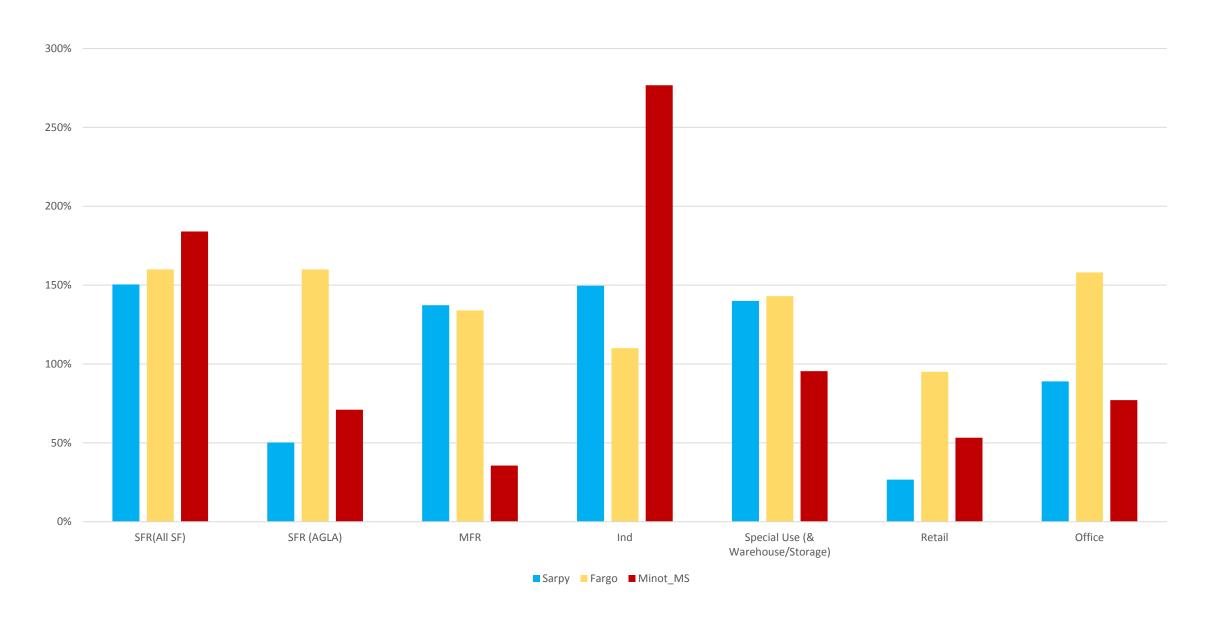
### 2010 GBS Vs. Inventory (SFT): COM, 3 Locations



### 2010 GBS Vs. Inventory (RCNV): COM, 3 Locations



### Differences GBS VS Inventory RCNV \$/SFT



### Why the GBS may be Inaccurate

- -Temporal issues (decennial census)
- -Key data on structures is regional
- -Simplistic and potentially over-valued (RS Means) valuation data
- Missing and/or opaque and simplistic depreciation approaches

HAZUS Vs. Actual Structure Data, Sarpy County (SFR)

	GBS (Regional)	Assessor	Inventory Std. Dev.*
%1_story	50%	67%	29%
%2_Story	46%	19%	26%
%3_Story	2%	7%	14%
%No Garage	17%	5%	22%
% Basement	56%	95%	17%

### Core logic: The Google or Amazon of Real Estate Data

	Property Characteristics	<b>Property Transactions</b>
Number of Records	148 million	309 million
Years of History	Up to 50 years in some counties	Up to 50 years in some counties
Coverage	99.9 percent of the population; 3,132 counties	<ul><li>99.4 percent of the population;</li><li>2,990 counties</li></ul>
Representative Key Data	Value, tax amount, book and page prior sale date, square footage, bedroom count, bathroom count	, Sale amount, recording data, lender company, second mortgage liens

### How to Correct GBS Inaccuracies

- Global Adjustments (31% to 56%)
- Adjustments Specific to Property Types & Locations
- Correction Models (Multiple Regression)
  - SFR (block)
  - MFR (block group)
  - COM (block)
    - IND
    - Retail
    - Office
    - Special Use
    - Warehouse

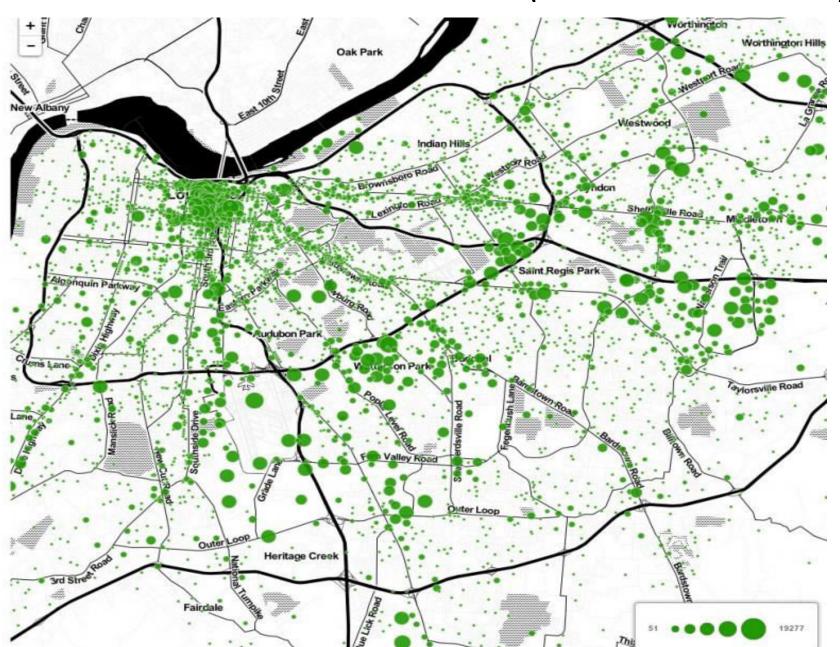
### Alternative SFR Regression Models to Correct GBS Data: Specifications and Relative R<sup>2</sup> Values

Model Specification	Adjusted R <sup>2</sup> Value
1) Basic (SFT/SVAL)	
A) GBS SFT	.59
A) GBS SVAL (RCNV)	.63 (+7%)
A) GBS SFT Detailed (SF/Manuf./Duplex)	.62
A) GBS RCNV Detailed (SF/Manuf./Duplex)	.65 (+3%)
2) With Other HAZUS Data	
(inc-ratio, vacant, mtg, renter_occp,	
popsqmi)	
A) GBS SFT	.68
A) GBS RCNV	.69 (+1%)
3) With Potential HAZUS Variables	
A) GBS SFT	.83
A) GBS SVAL (RCNV)	.83

# Regression Results ( $R^2$ Values), Commercial Value by Structure Type (Census Block and Block Group Levels)

	Block	Block Group
GBS SFT	.33	.54
GBS RVNV	.33	.54
SFT + Potential GBS Variables (mean stories, age, depreciation)	.46	.59
SFT+ Potential GBS + Census Variables (popscmi, renter_occ, h_units_vac)	.53	.58

### Commercial Correction Model (with LEHD Jobs Data)

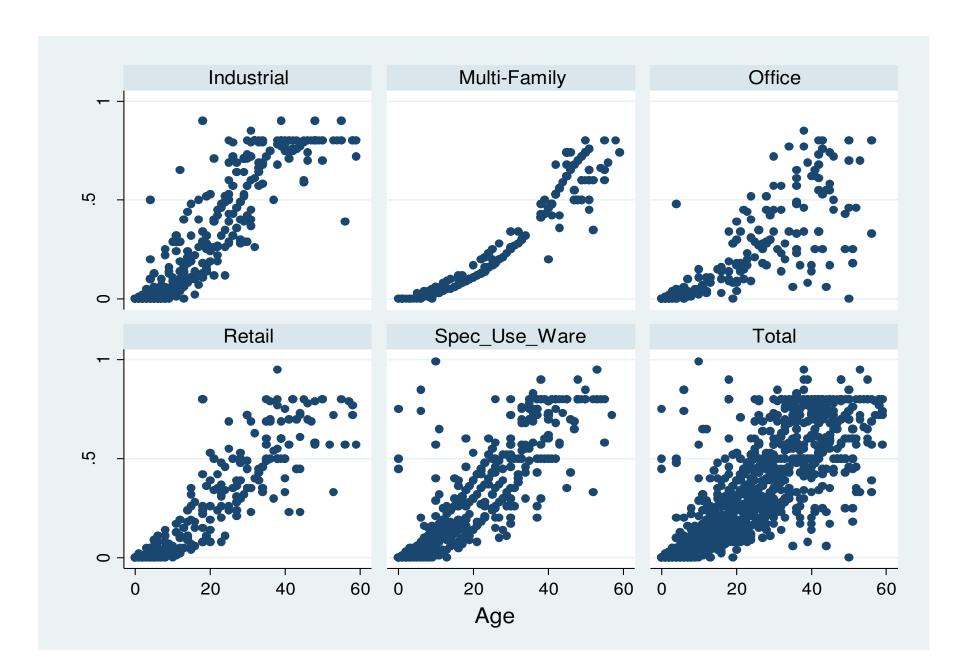


# Regression Results (R<sup>2</sup> Values), Commercial Value by Structure Type (Census Block Level)

	GBS_SFT	Jobs	SFT & Jobs	SFT/Jobs/Age/ Stories/Depr.
Industrial				
DSRV	.02	.19	.19	.20
RCNV	.00	.19	.19	.21
Office				
DSRV	.08	.01	.09	.26
RCNV	.05	.00	.05	.22
Retail				
DSRV	.25	.26	.38	.37
RCNV	.25	.29	.40	.35
Special Use				
DSRV		.00		.70
RCNV		.04		.23
Warehouse/				
Storage				
DSRV		.17		.14
RCNV		.17		.15

### Conclusions and Future Research

- 1. Face Reality because HAZUS is Being Used for Economic Analyses & Policy (adjust if necessary or give core-logic \$5 million)
- Open Access to GBS Methodologies & Encourage Collaborative Research
   National data sets, Jobs Data, Core-Logic Data Purchases.
- 2. Repeat Inventory Comparisons in Other Locations
- 3. Continued SFR regression predictive/corrective models (meta-analyses)
- 4. More exploration of Commercial Predictive models
- 5. (new: block level, more precise Bldg. Types, Jobs Data)
- 6. Promote and Learn From Level Analyses
  - -Guidelines, Standards, Improvements to within the framework of the CDMS (if made external to HAZUS)
- 7. Take Depreciation Seriously (Achilles Heel)



### Ideas (from Audience)

Ways to Improve GBS
How to Disseminate
Potential Collaborators/Case Studies





