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Community Impacts of Decision Modeling for Foreclosed Redevelopment

Michael P Johnson, Jr., *University of Massachusetts - Boston*
Alvine Sangang, *University of Massachusetts Boston*
Buki Usidame, *University of Massachusetts Boston*

COMMUNITY IMPACTS OF DECISION MODELING FOR FORECLOSED REDEVELOPMENT

Michael P. Johnson, PhD
Alvine Sangang
Omobukola Usidame
Department of Public Policy and Public Affairs
University of Massachusetts Boston

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Introduction

- Research goal: Apply decision modeling to assist community-based organizations engaged in foreclosure response
- Purpose of talk: Generate range of alternative residential property acquisition strategies based on policy impact metrics and demonstrate social benefits of decision-assisted foreclosure response as compared to current practice
- Current project:
  - *Decision Science for Housing and Community Development: Local Evidence-Based Responses to Foreclosures* (with Jeffrey Keisler, Senay Solak, David Turcotte, Armagan Bayram and Rachel Drew)

POLICY, PLANNING AND ANALYTICS PRELIMINARIES

The foreclosed housing crisis is a primary cause of community distress

Aggregate effects:

- Over 4 million homes lost to foreclosure
- 30% decline in house prices
- $7 trillion in home equity lost

- Socio-geographic concentrations:
  - High-priced areas that overbuilt
  - Economically struggling cities with high rates of subprime lending
  - Lower-income and minority households
- Social and economic consequences of foreclosures:
  - Residential stability
  - Personal well-being
  - Spill-over effects

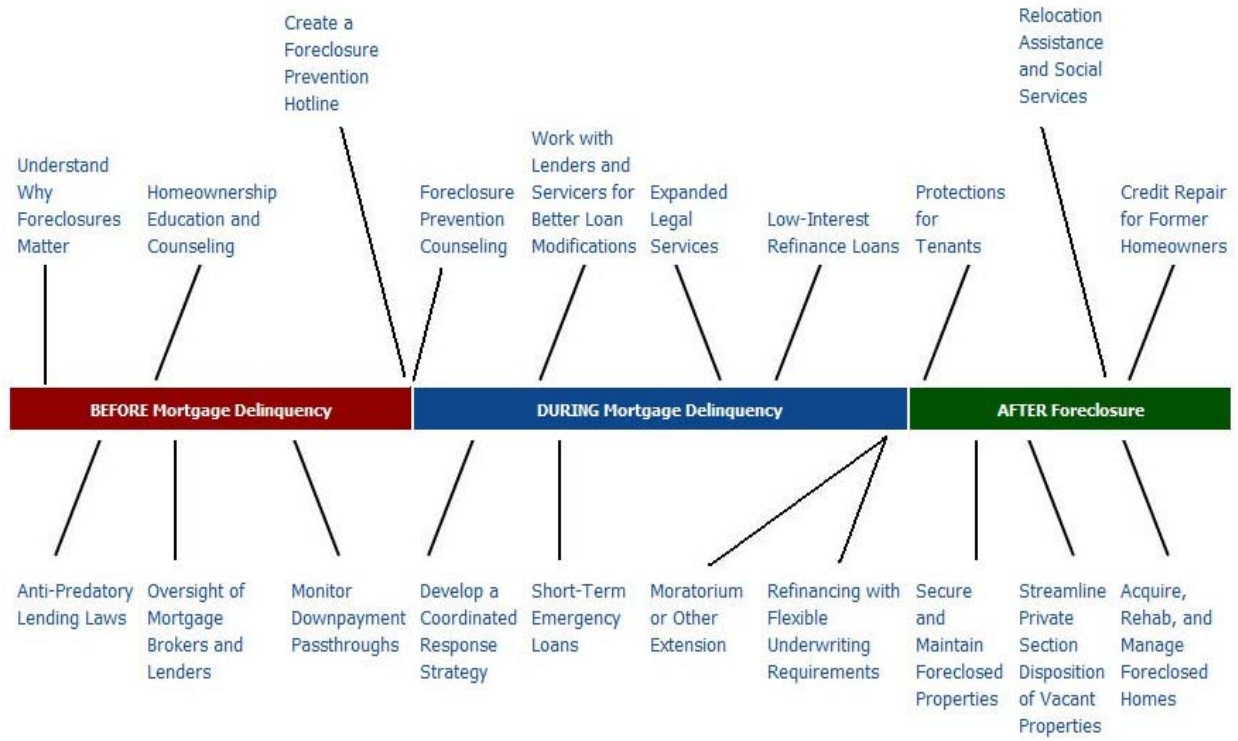
(Sources: Joint Center for Housing Studies 2013; Immergluck 2010; McKernan et al. 2014)

Many regions also face long-term social and economic decline

- Symptoms:
  - 30 cities with 500,000 or more residents have lost 8.61% of their populations on average
  - Number of vacant housing units has increased by 44%
  - Eight cities facing population declines have incurred $23 billion in debt before declaring bankruptcy
- Causes:
  - Urban deindustrialization
  - Federal policy supporting out-migration to suburbs
  - Foreclosed housing crisis and the Great Recession
- Traditional remedies:
  - Investments in housing, employment and physical infrastructure

(Sources: Popper and Popper 2002, Hollander et al. 2009)

In working housing markets, consider a range of conventional responses

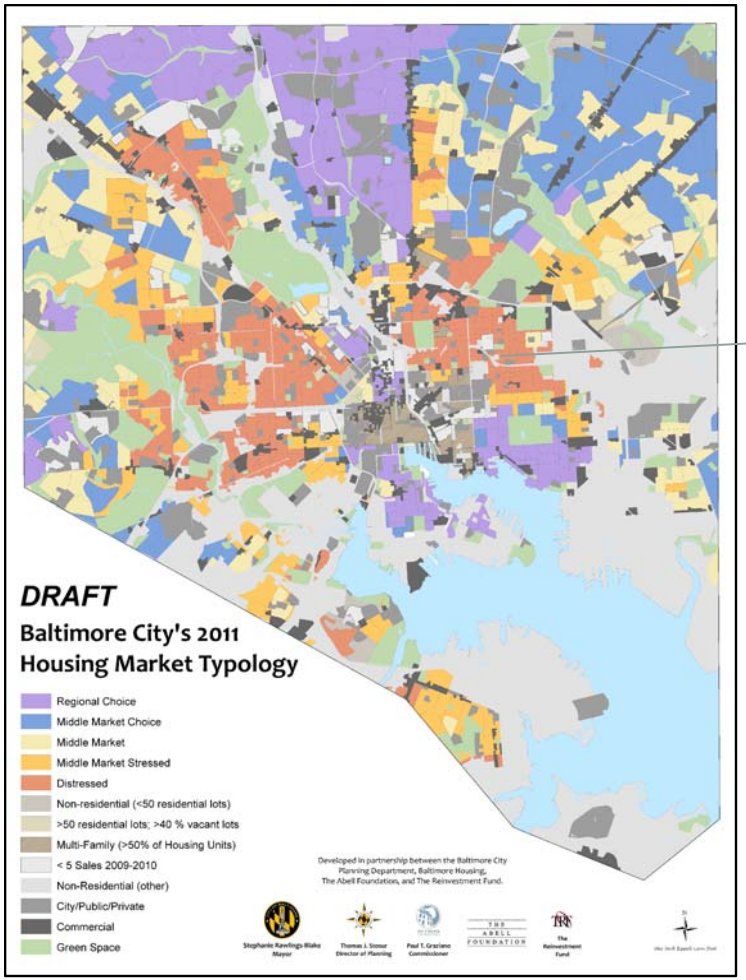


Source: foreclosure-response.org (2013a)

Which responses may be most appropriate for which neighborhoods at which times?

What is an optimal strategy associated with a particular response?

If markets are weak, consider alternative land uses



'Distressed' parcels

- Urban agriculture
- Environmental remediation
- Recreation
- Future development
- ⋮

Which options are most appropriate for which parcels at what time?
How to balance multiple objectives?

Source: Baltimore City Department of Planning (2012)

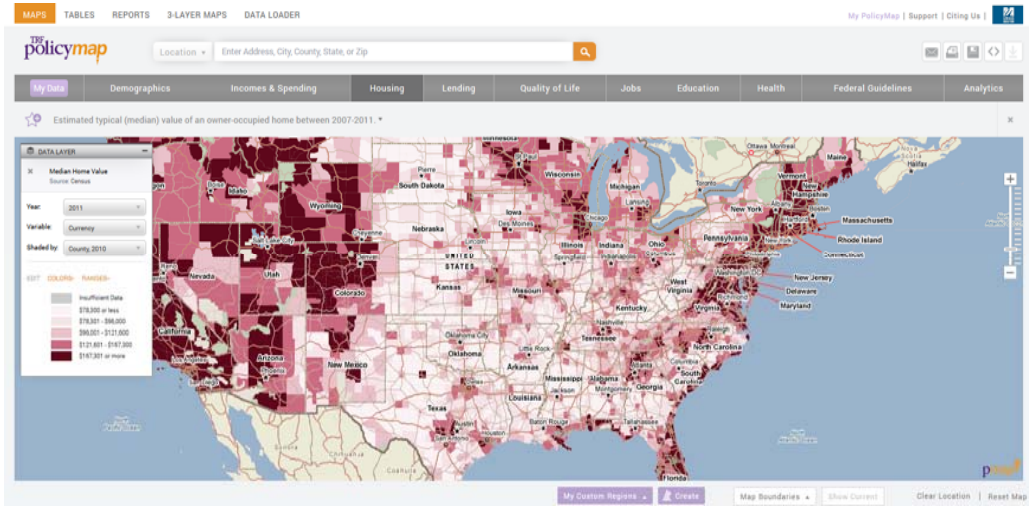
'Data analytics' can help design innovative responses

- Purpose of analytics is to derive knowledge and actionable insights from data
- Analytic tools are applied to datasets to determine
  - What has happened (descriptive analytics)
  - What is likely to happen (predictive analytics)
  - What course of action to follow (prescriptive analytics)
- Community-focused data analytics is different from applications to large and/or for-profit organizations
  - Values-driven
  - Collaborative
  - Inductive
  - Multi- and mixed-methods
  - Appropriate use of resources and capacity

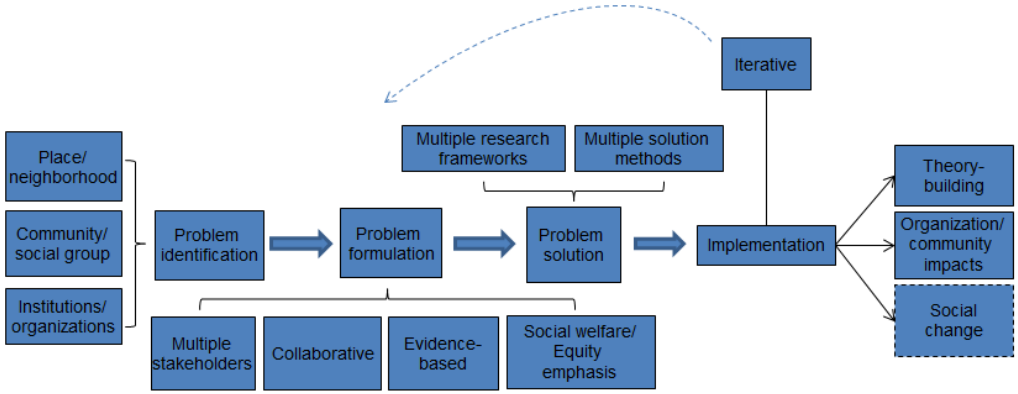
(Source: Johnson 2014)

Multiple types of data and technologies can meet community organization needs

- Visualization-based technologies
- Database-driven technologies
- Model-driven technologies



Source: http://www.policymap.com/



Source: Johnson (2012)

DATA ANALYTICS FOR FORECLOSURE RESPONSE

Example: Foreclosure responses depend on the level of foreclosure risk and housing market strength

MARKET STRENGTH	FORECLOSURE IMPACT RISK		
	C. Actual high foreclosure density	B. High risk of high foreclosure density	A. Low risk of high foreclosure density
1. Strong	Facilitate rapid sales to sustainable owners, low/no subsidy	Lower cost effort to prevent foreclosures and vacancies, low/no subsidy	Lower priority
2. Intermediate	High payoff/priority, rehab and rapid sale to sustainable owners, target subsidies, neighborhood maintenance	High payoff/priority, prevent foreclosures and vacancies, emphasize neighborhood maintenance	Lower priority but watch carefully, head-off emerging problems early
3. Weak	More emphasis on securing/demolishing, land banking to hold until market rebound	Lower cost effort to prevent foreclosures and vacancies	Lower priority but watch carefully, head-off emerging problems early

Which neighborhoods should receive what kinds of services?

Source: foreclosure-response.org (2013b)

Census tracts can be classified according to foreclosure risk and housing market strength

Boston-Cambridge-Quincy, MA-NH

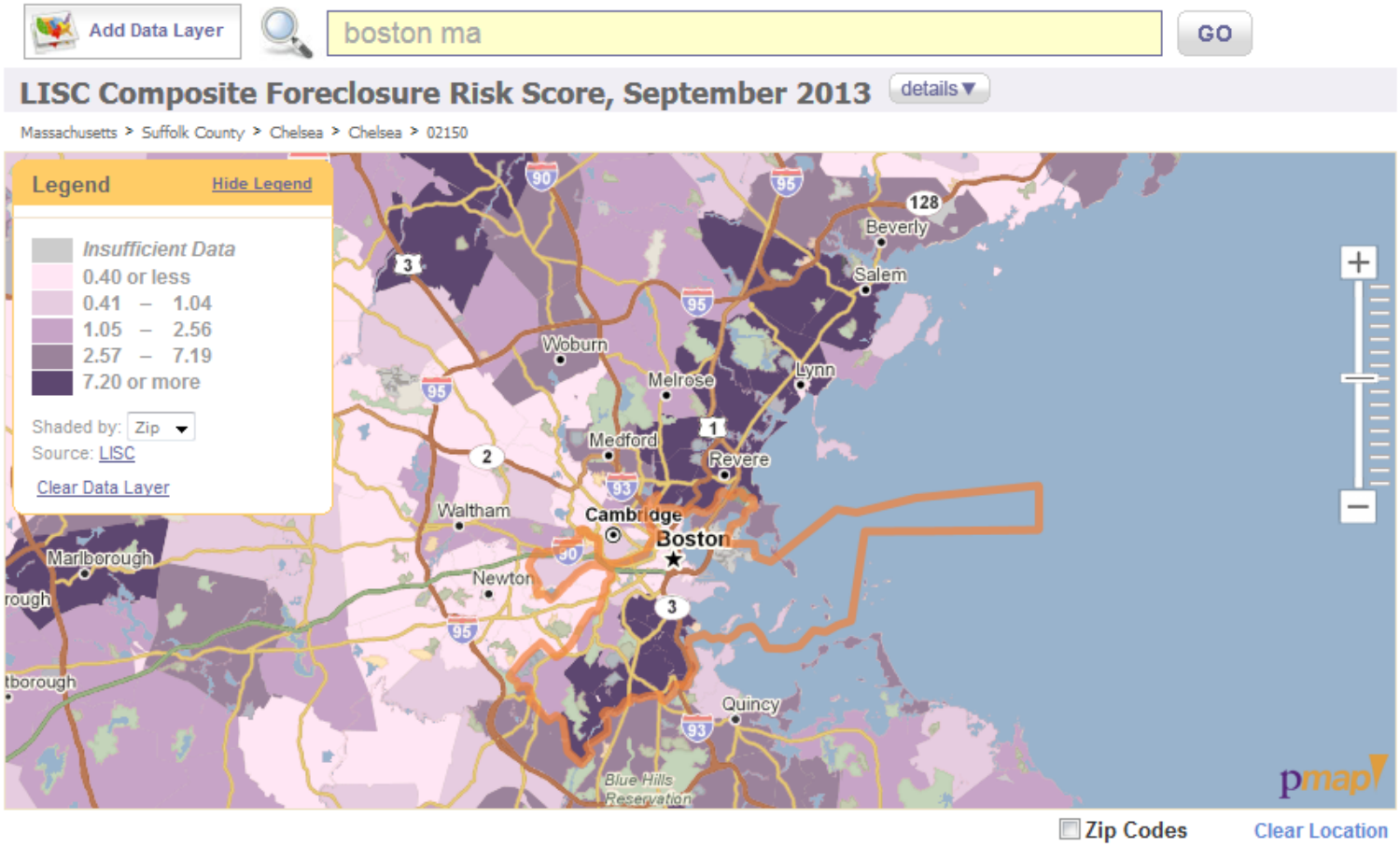
Market Strength (Weakest ---> Strongest)	1	2	3	4	5	6	7	8	9	10
10	0	1	2	0	0	2	6	7	33	40
9	0	0	0	0	4	6	14	14	24	29
8	1	0	1	7	10	19	16	19	9	9
7	3	1	5	7	15	15	16	14	12	3
6	3	10	8	16	12	11	16	7	4	4
5	4	9	15	16	18	10	8	5	4	2
4	6	13	15	13	13	9	6	15	0	1
3	15	13	15	13	14	10	2	5	2	2
2	18	23	19	10	2	7	6	3	2	1
1	41	21	8	12	3	2	0	3	1	0

Foreclosure Risk (Highest ---> ---> ---> Lowest)

How can we analyze data for specific cities or neighborhoods?

Source: foreclosure-response.org (2014c)

We can scan on-line maps to view neighborhoods one variable at a time…



Source: http://www.foreclosure-response.org/maps_and_data/lisc_maps.html

Or we can develop city-level tabulations to identify concentrations of risk

Boston, MA

Market Strength (Weakest ---> Strongest)	1	2	3	4	5	6	7	8	9	10
10	0	0	1	0	0	0	1	4	2	22
9	0	0	0	0	2	0	2	3	0	12
8	0	0	0	1	1	0	4	5	0	2
7	2	0	2	0	3	1	2	4	1	2
6	2	4	2	3	2	1	3	3	1	3
5	1	0	3	1	1	0	1	0	2	2
4	0	0	2	0	3	0	0	2	0	1
3	3	1	5	3	0	0	0	1	1	2
2	7	7	2	2	0	0	0	0	1	1
1	12	4	2	5	0	0	0	2	0	0
	1	2	3	4	5	6	7	8	9	10
	Highest ---> ---> ---> Lowest									
	Foreclosure Risk									

Dorchester, MA

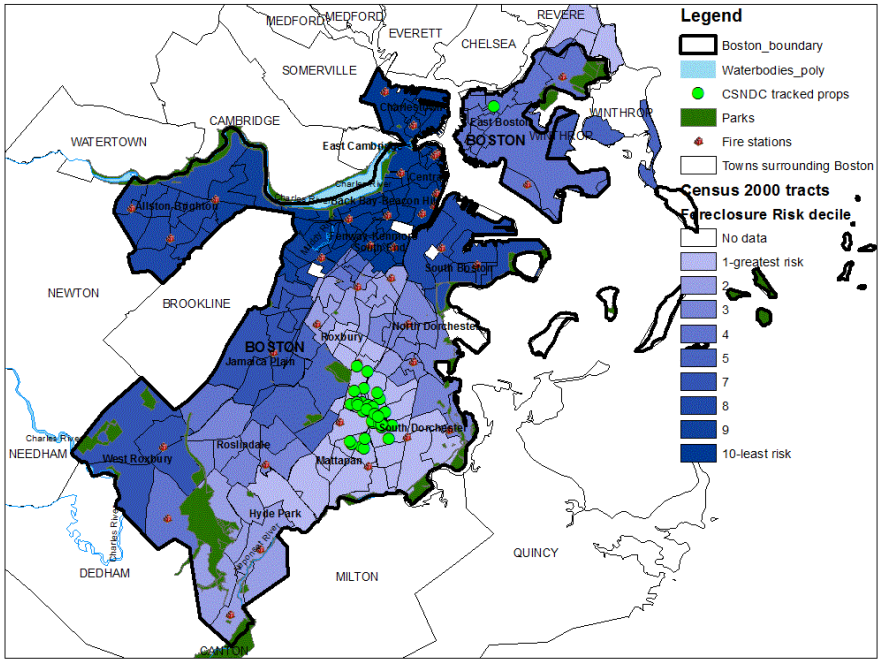
Market Strength (Weakest ---> Strongest)	1	2	3	4	5	6	7	8	9	10
10	0	0	1	0	0	0	0	3	0	2
9	0	0	0	0	0	0	1	2	0	0
8	0	0	0	0	0	0	0	3	0	0
7	2	0	0	0	1	0	1	1	0	0
6	2	1	1	0	2	0	1	0	0	0
5	0	0	2	0	0	0	1	0	0	0
4	0	0	2	0	0	0	0	0	0	0
3	3	1	4	2	0	0	0	0	0	0
2	7	4	2	0	0	0	0	0	0	0
1	11	3	2	0	0	0	0	0	0	0
	1	2	3	4	5	6	7	8	9	10
	Highest ---> ---> ---> Lowest									
	Foreclosure Risk									

But where are these tracts actually located?

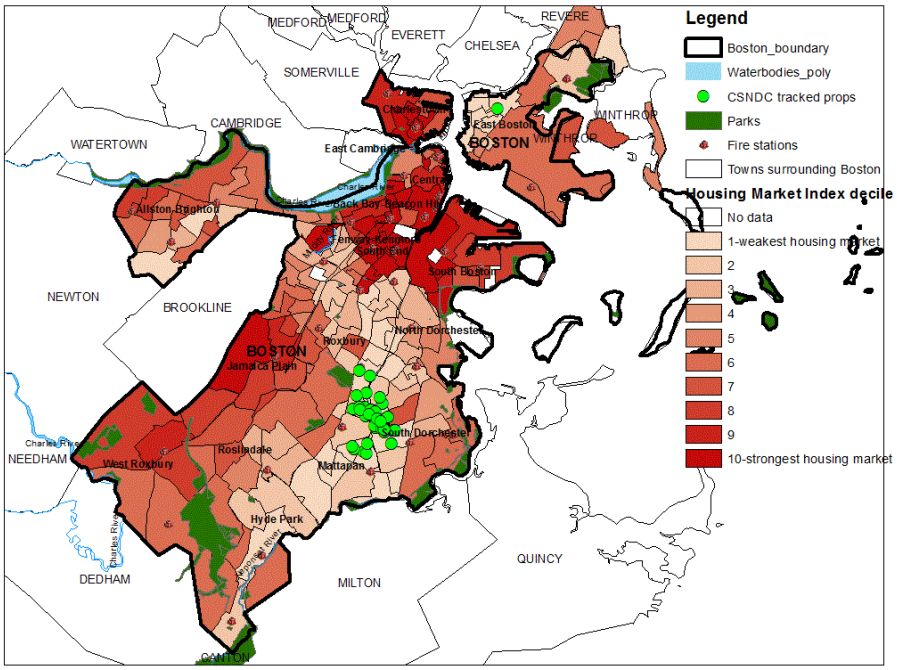
Source: Data from foreclosure-response.org (2014c); authors' calculations

Foreclosure risk and housing market strength are clearly concentrated in specific portions of Boston…

City of Boston showing Foreclosure Risk

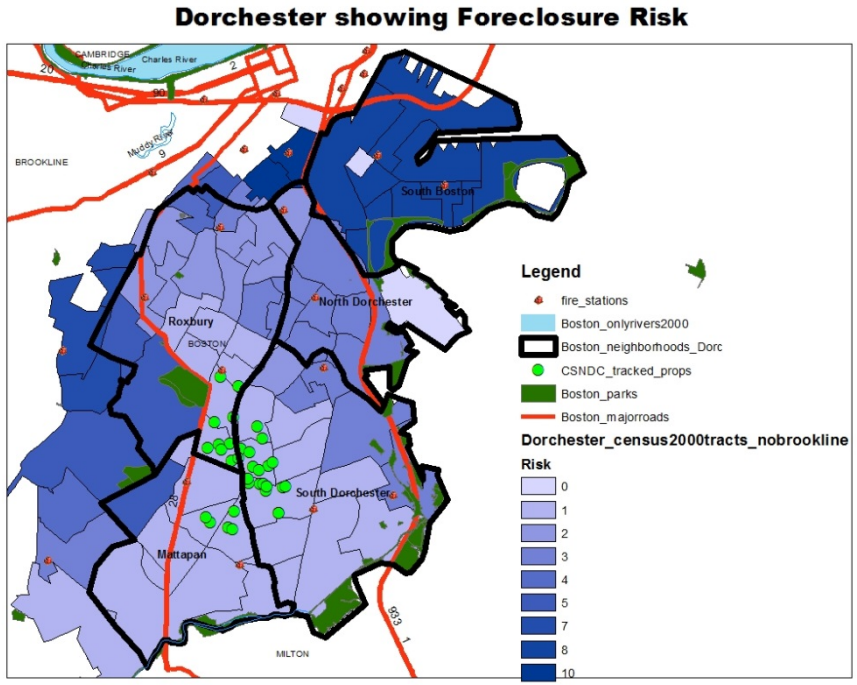


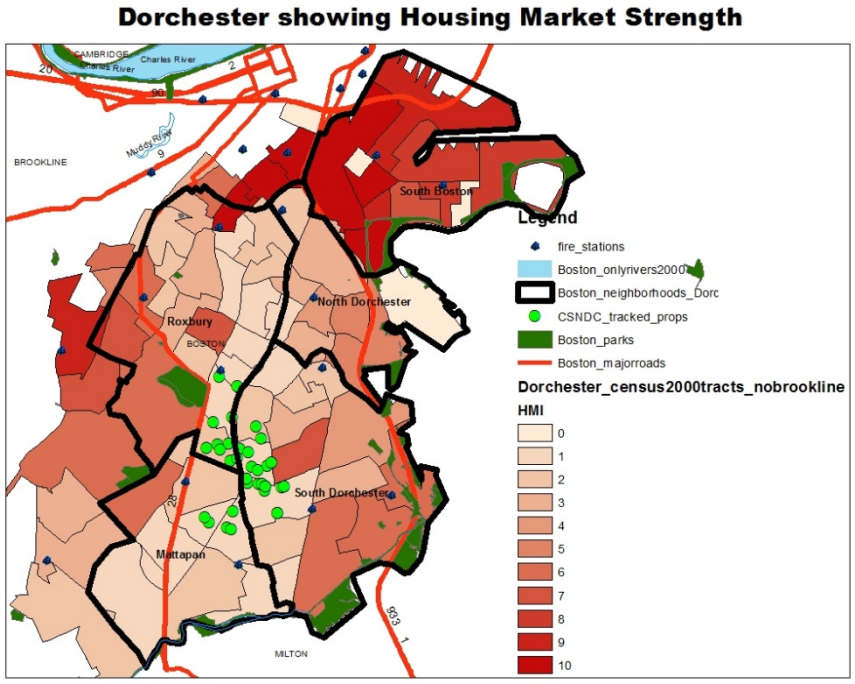
City of Boston showing Housing Market Strength



Source: Data from foreclosure-response.org (2014c); created using ArcGIS 10 (ESRI, Inc. 2011)

…and in Dorchester





Now we can decide what kinds of responses may be best-suited for specific geographies, and justify our decisions with data

Source: Data from foreclosure-response.org (2014c); created using ArcGIS 10 (ESRI, Inc. 2011)

We have used data analytics to identify specific interventions at a local level

MARKET STRENGTH	FORECLOSURE IMPACT RISK		
	C. Actual high foreclosure density	B. High risk of high foreclosure density	A. Low risk of high foreclosure density
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Challenge now is to translate qualitative descriptions into specific prescriptions

Foreclosure response decision model optimizes two social objectives

Index:

$i = 1, \ldots, N$: $index\ of\ candidate\ properties\ for\ acquisition$

Decision variables:

$$x_i = \begin{cases} 1, & if\ foreclosed\ property\ i\ is\ acquired\ for\ redevelopment \\ 0, & otherwise \end{cases}$$

Parameters:

S_i: $Estimated\ strategic\ value\ associated\ with\ acquisition\ candidate\ i$

P_i: $Estimated\ social\ value\ associated\ with\ acquisition\ candidate\ i$

C_i: $Estimated\ acquisition\ cost\ of\ acquisition\ candidate\ i$

B: $total\ funds\ available\ for\ purchase\ of\ acquisition\ candidates$

N: $total\ number\ of\ units\ to\ be\ acquired$

We solve two model variants corresponding to CDC practice

Optimize $\{S(\boldsymbol{x}) = \sum_{i=1}^{n} S_i \cdot x_i \,;\, P(\boldsymbol{x}) = \sum_{i=1}^{n} P_i \cdot x_i\}$ ← Jointly optimize social objectives

s.t.

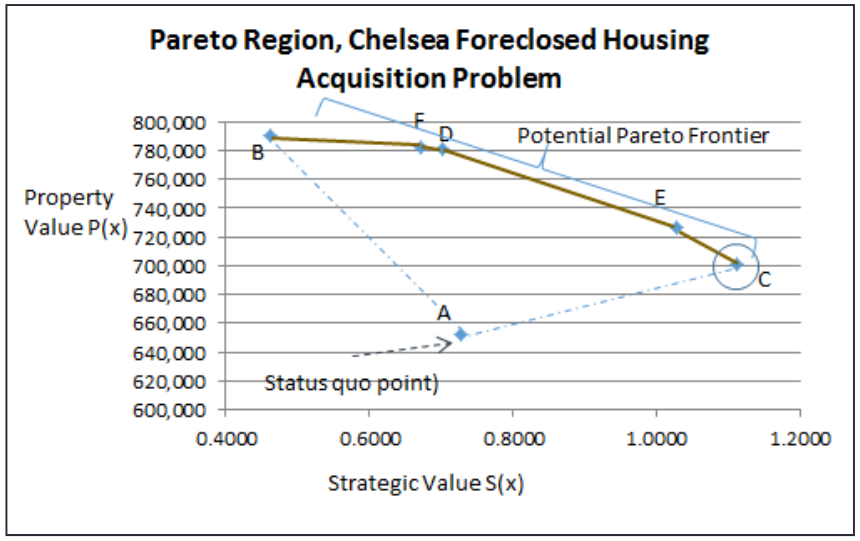
$\sum_{i=1}^{n} C_i \cdot x_i \leq B$ ← Limit expenditures to budget available

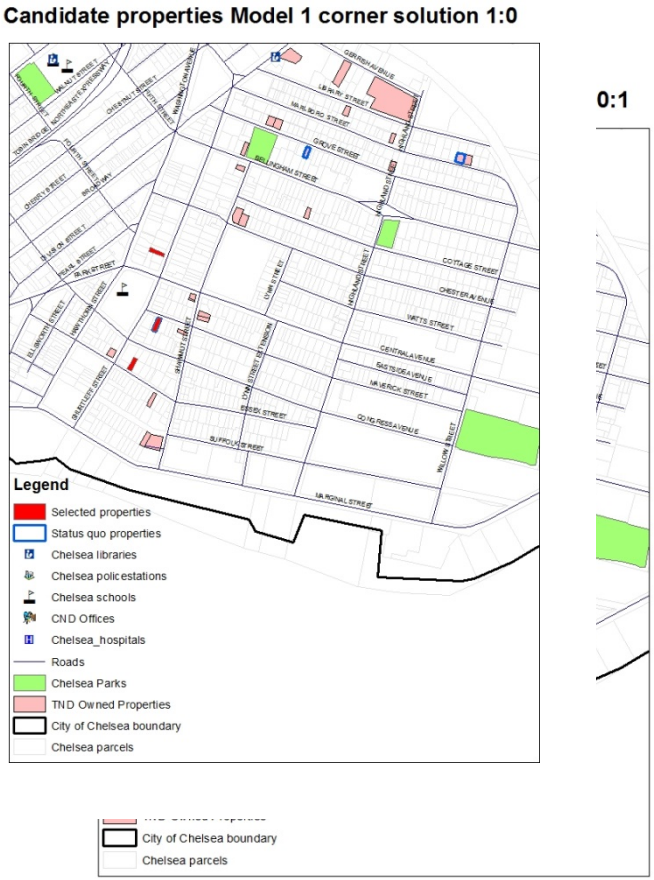
- or -

$\sum_{i=1}^{n} x_i = N$ ← Acquire only a given number of properties

$x_i \in \{0, 1\}, i = 1, \ldots, n$

Model results can be viewed in ‘objective space’ as well as ‘decision space’





Source: Johnson et al. (2014)

DATA ANALYTICS FOR MUNICIPAL SHRINKAGE

Example: Select parcels in declining neighborhoods for re-purposing

Land Use or Planning Classification	***Metrics***
Urban Agriculture	• 0.5 acre or greater • Slope < 5% • Tree cover cannot exceed 30% of cluster area
Stormwater Drainage	• 1/8 acre or greater • Slope < 5% • Within 20' of a stormdrain
Potential development opportunity	• Housing Market Typology (1/4 mile from 'Regional Choice' or 'Middle Market Choice') **AND** • (¼ mile from anchor institutions **OR** • ¼ mile from minimum of 2 building permits plan)
Blight Elimination	• >50 % vacant • Distressed HMT • Public Safety 'hot spots' • High visibility blighted areas: 1. Primary street 2. Adjacent to public destination

Source: Johnson and Hollander (2013)

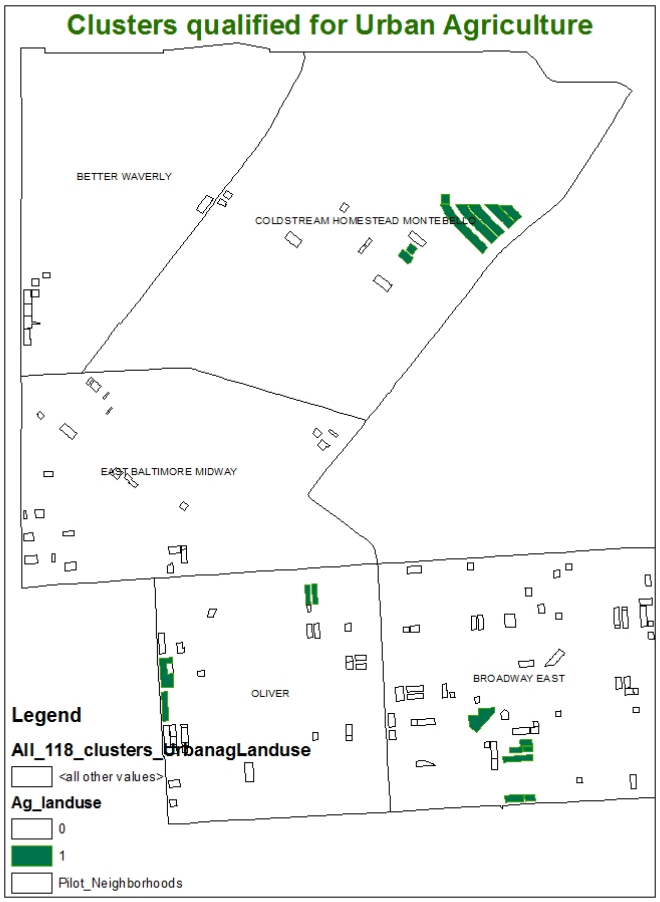
Clusters qualify for a variety of uses

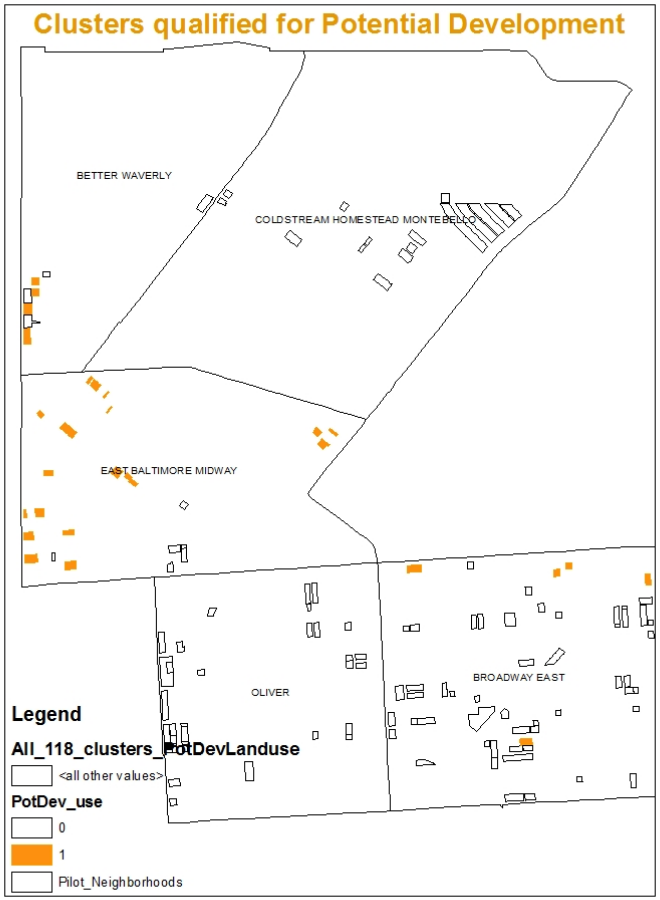
Cluster	OBJECTID_1	Location	Neighborhood	Urban agriculture							Stormwater						Potential dev. Opportunity (AND & OR)						Blight elimination											
				>=0.5 acre	Y/N (1/0)	Slope <5%(gridcode=1 or 2)	Code	Min. tree cover <30%	Y/N (1/0)	Qualify? Y/N (1/0)	>=0.125 acre	Y/N (1/0)	Slope <5%	Code	20ft of stormdrain Y/N	Qualify? Y/N (1/0)	1/4 mile HMT	1/4 anchor inst	1/4 mile from min. 2 bldg permits	No. of permits	Y/N (1/0)	Qualify? Y/N (1/0)	>50% vacant	%	Y/N (1/0)	Distressed HMT	911 calls	Public safety	BPD priorities	Y/N	High visibility	Pry str.	Public dies	Y/N	Qualify? Y/N (1/0)
1_27	378_379	2700 Tivoly Ave (e-1)	Coldstream Homestead Montebello	1.7197	1	1	1	9.71	1	1	1.7197	1	1	1	1	1	1	0	0	0	0	50.94	1	1	0	0	0	1	0	1	0		
2_30	382_383	2700 Fenwick Ave (o)	Coldstream Homestead Montebello	1.2458	1	1	1	12.47	1	1	1.2458	1	1	1	1	1	1	0	0	0	0	35.90	0	1	1	1	1	1	0	1	0		
3_35	388_389	1500 Carswell St (o)	Coldstream Homestead Montebello	0.1749	0	1	1	24.03	1	0	0.1749	1	1	1	1	1	1	0	0	0	0	80.00	1	1	0	0	0	0	0	0	0		
4	390	1400 Homestead St (o)	Coldstream Homestead Montebello	0.3877	0	1	1	34.28	0	0	0.3877	1	1	1	1	1	1	0	0	1	0	0.00	0	1	1	0	1	0	1	1	0		
5	393	3000 Loch Raven Rd (o)	Coldstream Homestead Montebello	0.1201	0	1	1	56.39	0	0	0.1201	0	1	1	1	0	0	0	0	0	0	50.00	1	1	0	0	0	1	0	1	0		
6	394	2600 Greenmount Ave (o-1	Better Waverly	0.5930	1	3	0	46.81	0	0	0.5930	1	3	0	0	0	1	1	1	0	1	26.67	0	1	1	1	1	1	0	1	0		
7	395	500 E 27th St (e)	Better Waverly	0.1483	0	1	1	4.61	1	0	0.1483	1	1	1	1	1	1	1	1	0	1	16.67	0	1	0	1	1	1	0	1	0		
8	396	2700 Boone St (o)	Better Waverly	0.1105	0	1	1	45.27	0	0	0.1105	0	1	1	0	0	0	1	1	0	0	80.00	1	1	0	1	1	0	0	0	0		
9	397	3000 Loch Raven Rd (e)	Better Waverly	0.3945	0	1	1	65.90	0	0	0.3945	1	1	1	1	1	0	0	0	0	0	37.50	0	0	0	0	0	1	0	1	0		
10	408	500 E 20th St (o)	East Baltimore Midway	0.3186	0	1	1	7.52	1	0	0.3186	1	1	1	0	0	1	1	12	1	1	50.00	1	1	0	0	0	1	0	1	0		
11	418	600 Saint Anns Ave (o-3)	East Baltimore Midway	0.0507	0	1	1	68.40	0	0	0.0507	0	1	1	0	0	1	1	1	0	1	100.00	1	1	0	0	0	0	0	0	0		
12_48	420_421	600 Gutman Ave (e)	East Baltimore Midway	0.2534	0	1	1	9.38	1	0	0.2534	1	1	1	0	0	1	1	2	1	1	40.00	0	1	0	0	0	0	0	0	0		
13	426	1100 E North Ave (e)	East Baltimore Midway	0.1543	0	1	1	0.24	1	0	0.1543	1	1	1	0	0	0	0	4	1	0	60.00	1	1	0	0	0	1	0	1	0		
14	427	1900 Aisquith St (e-2)	East Baltimore Midway	0.2185	0	1	1	18.57	1	0	0.2185	1	1	1	0	0	0	0	3	1	0	25.00	0	1	0	0	0	0	0	0	0		
15	456	1100 E Hoffman St (e)	Oliver	0.1023	0	1	1	8.43	1	0	0.1023	0	1	1	1	0	0	0	28	1	0	100.00	1	1	0	0	0	0	0	0	0		
16	458	1600 Aisquith St (o)	Oliver	0.1135	0	1	1	15.31	1	0	0.1135	0	1	1	0	0	0	0	7	1	0	100.00	1	1	0	0	0	0	0	0	0		
17_67	466_465	1700 N Dallas St (o)	Oliver	0.4414	0	1	1	23.56	1	0	0.4414	1	1	1	1	1	0	0	14	1	0	48.15	0	1	0	1	0	0	0	0	0		
18	469	1700 N Bethel St (e)	Oliver	0.1388	0	1	1	35.19	0	0	0.1388	1	1	1	0	0	0	0	11	1	0	100.00	1	1	1	0	1	0	0	0	0		
19	485	1700 E North Ave (o)	Broadway East	0.3041	0	1	1	29.85	1	0	0.3041	1	1	1	1	1	1	0	6	1	0	81.82	1	1	1	0	1	1	0	1	1		
20	494	1300 N Broadway (o)	Broadway East	0.1842	0	1	1	35.92	0	0	0.1842	1	1	1	1	1	0	0	32	1	0	0.00	0	1	1	0	1	1	0	1	0		
21	503	1400 N Gay St (e)	Broadway East	1.0519	1	1	1	9.95	1	1	1.0519	1	1	1	1	1	0	0	12	1	0	3.57	0	1	1	0	1	0	0	0	0		
22	509	2000 E Hoffman St (o)	Broadway East	0.2215	0	1	1	3.76	1	0	0.2215	1	1	1	0	0	0	0	5	1	0	90.00	1	1	1	0	1	0	1	1	1		
23	527	2400 Llewelyn Ave (e)	Broadway East	0.0726	0	1	1	0.00	1	0	0.0726	0	1	1	0	0	0	0	4	1	0	100.00	1	1	0	0	0	0	0	0	0		
25	576	1600 N Bethel St (e-2)	Oliver	0.1089	0	1	1	9.54	1	0	0.1089	0	1	1	0	0	0	1	13	1	0	33.33	0	1	0	0	0	0	0	0	0		
26	584	2600 Greenmount Ave (o-2	Better Waverly	0.6962	1	3	0	27.44	1	0	0.6962	1	3	0	1	0	1	0	1	1	0	12.50	0	1	0	1	1	1	0	1	0		
28_29	380_381	2700 Tivoly Ave (o)	Coldstream Homestead Montebello	2.3197	1	1	1	16.83	1	1	2.3197	1	1	1	1	1	1	0	0	0	0	36.23	0	1	1	1	1	1	0	1	0		
31	384	1600 Abbotston St (e)	Coldstream Homestead Montebello	0.3580	0	1	1	47.01	0	0	0.3580	1	1	1	0	0	1	0	0	0	0	75.00	1	1	1	1	1	0	0	0	0		
32_33	385_386	1600 Carswell St (e)	Coldstream Homestead Montebello	0.5271	1	1	1	21.33	1	1	0.5271	1	1	1	1	1	1	0	0	0	0	20.00	0	1	1	1	1	0	0	0	0		
131	579	1400 Holbrook St (e-1)	Oliver	0.1394	0	1	1	58.69	0	0	0.1394	1	1	1	0	0	0	0	32	1	0	100.00	1	1	1	0	1	0	0	0	0		
132	580	1000 E Hoffman St (e-1)	Oliver	0.0810	0	1	1	7.10	1	0	0.0810	0	1	1	0	0	0	0	33	1	0	100.00	1	1	1	0	1	0	0	0	0		
58_133	454_581	1400 Ensor St (o)&1400 Holl	Oliver	0.6532	1	1	1	32.47	0	0	0.6532	1	1	1	1	1	0	0	38	1	0	23.68	0	1	0	0	0	0	0	0	0		
134	582	1000 E Hoffman St (e-2)	Oliver	0.1525	0	1	1	43.53	0	0	0.1525	1	1	1	1	1	0	0	38	1	0	36.36	0	1	1	0	1	0	0	0	0		
135	583	1900 Aisquith St (e-1)	East Baltimore Midway	0.0525	0	1	1	0.00	1	0	0.0525	0	1	1	1	0	0	0	3	1	0	100.00	1	1	0	0	0	0	0	0	0		
136	625	2300 Oliver St (e-2)	Broadway East	0.0898	0	1	1	0.00	1	0	0.0898	0	1	1	1	0	0	0	5	1	0	50.00	1	1	0	0	1	1	0	0	0		
137	626	500 E 27th St (o) (MB 5-8)	Better Waverly	0.1464	0	1	1	45.29	0	0	0.1464	1	1	1	1	1	1	1	0	0	1	33.33	0	1	0	1	1	1	0	1	0		
138	627	1700 N Montford Ave (o)	Broadway East	0.3853	0	1	1	21.55	1	0	0.3853	1	1	1	0	0	0	0	2	1	0	77.78	1	1	0	1	1	0	0	0	0		

Use/Classification	Number of Clusters that Qualify
Urban Agriculture	10
Stormwater Drainage	38
Potential Development	23
Blight Elimination	7
Total clusters (combined)	118

Source: Johnson and Hollander (2013)

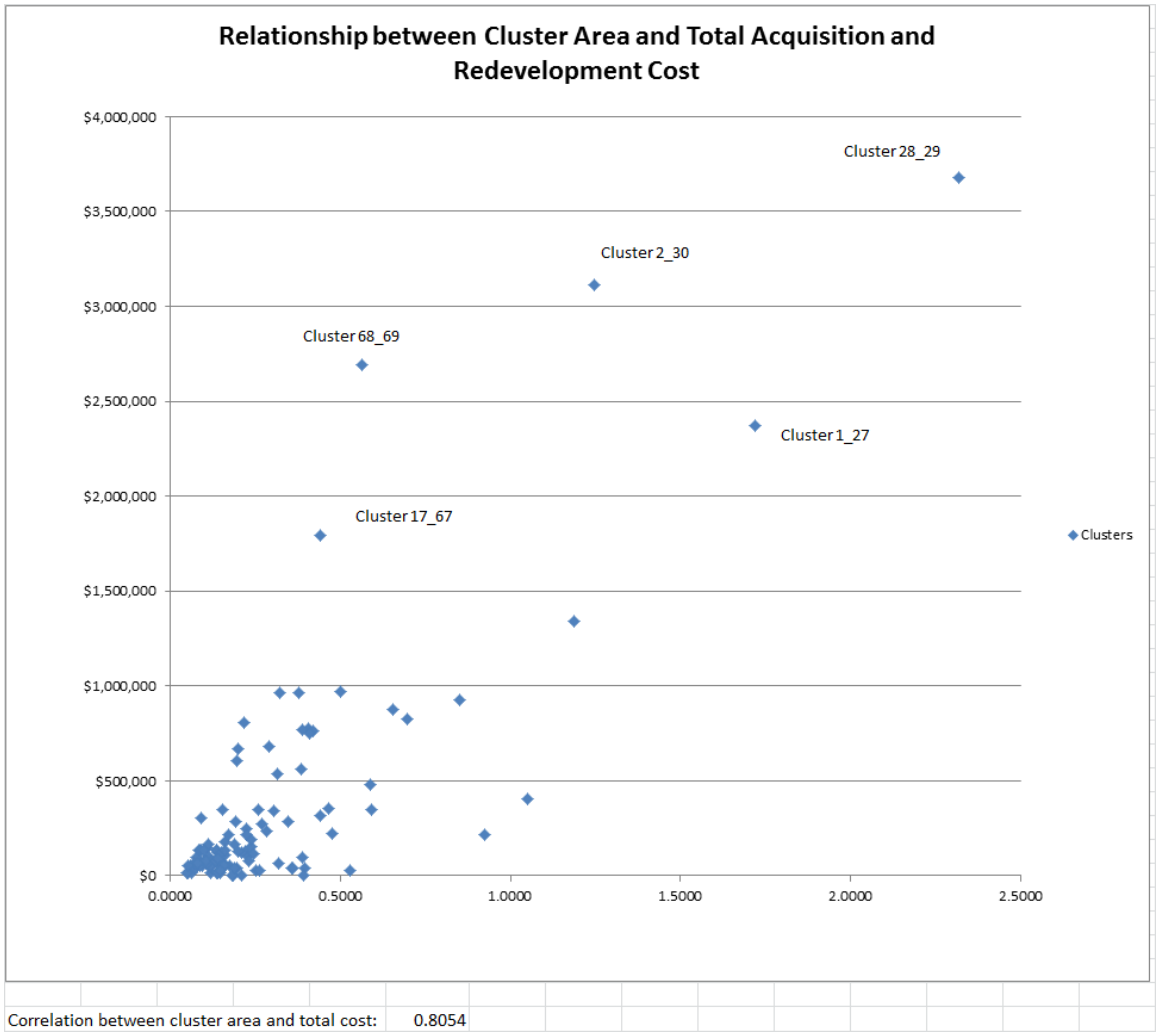
Eligibility sets vary over space





Source: Johnson and Hollander (2013)

Clusters vary widely by size and cost



Source: Johnson and Hollander (2013)

Baltimore Planning decision model is a stylized attempt to generate strategy alternatives

Index and set:

$i = 1, \ldots, N$: $index\ of\ clusters$

$j \in \{U, S, D, B\}$: $set\ of\ land\ uses\ \&\ classification$

Decision variables:

$$x_{ij} = \begin{cases} 1, & if\ cluster\ i\ is\ acquired\ for\ land\ use\ or\ classification\ j \\ 0, & otherwise \end{cases}$$

Parameters:

$a_i = size\ of\ cluster\ i, in\ acres$

$c_i = acquisition\ and\ demolition\ cost\ for\ cluster\ i$

$B = acquisition\ and\ demolition\ budget$

The model assigns land uses to clusters to optimize multiple planning objectives

$$\text{Maximize } \{U(\boldsymbol{x}) = \sum_{i=1}^{N} a_i \cdot x_{iU}, S(\boldsymbol{x}) = \sum_{i=1}^{N} a_i \cdot x_{iS},$$

$$D(\boldsymbol{x}) = \sum_{i=1}^{N} a_i \cdot x_{iD}, B(\boldsymbol{x}) = \sum_{i=1}^{N} a_i \cdot x_{iB}\}$$

← Jointly maximize land area devoted to specific uses

s.t.

$$\sum_{i=1}^{N} \sum_{j \in J} c_i \cdot x_{ij} \leq B$$

← Budget

$$\sum_{j \in \{U,S,D\}} x_{ij} \leq 1, \quad i = 1, \ldots, N$$

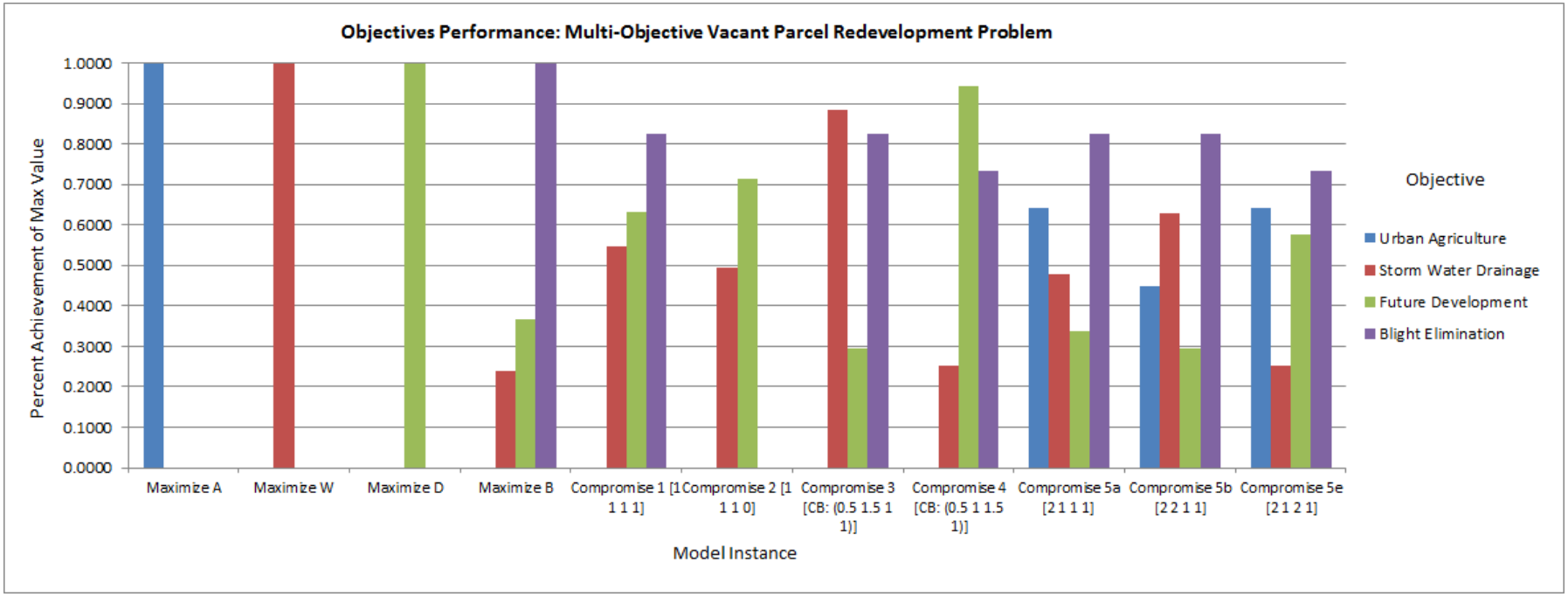
← Single land use

$$x_{iB} \leq \sum_{j \in \{U,S,D\}} x_{ij}, \quad i = 1, \ldots, N$$

← Cannot assign to classification category unless selected for land use

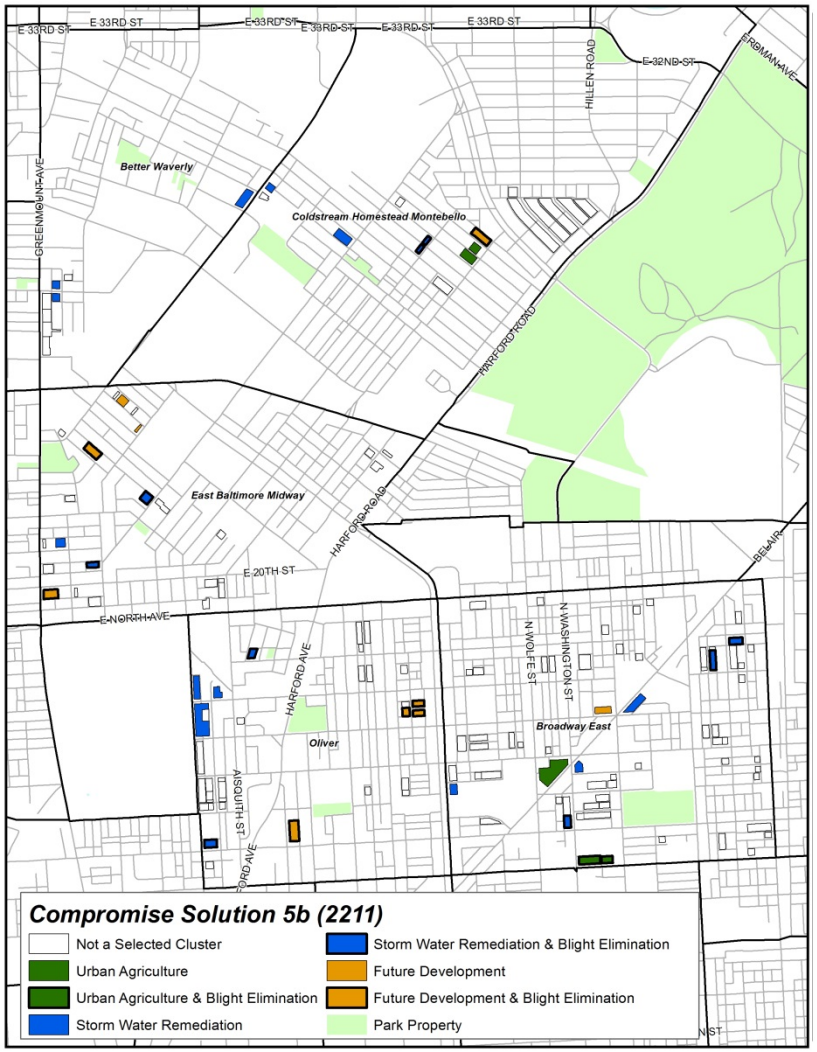
$$x_{ij} \in \{0, 1\} \; \forall i, j$$

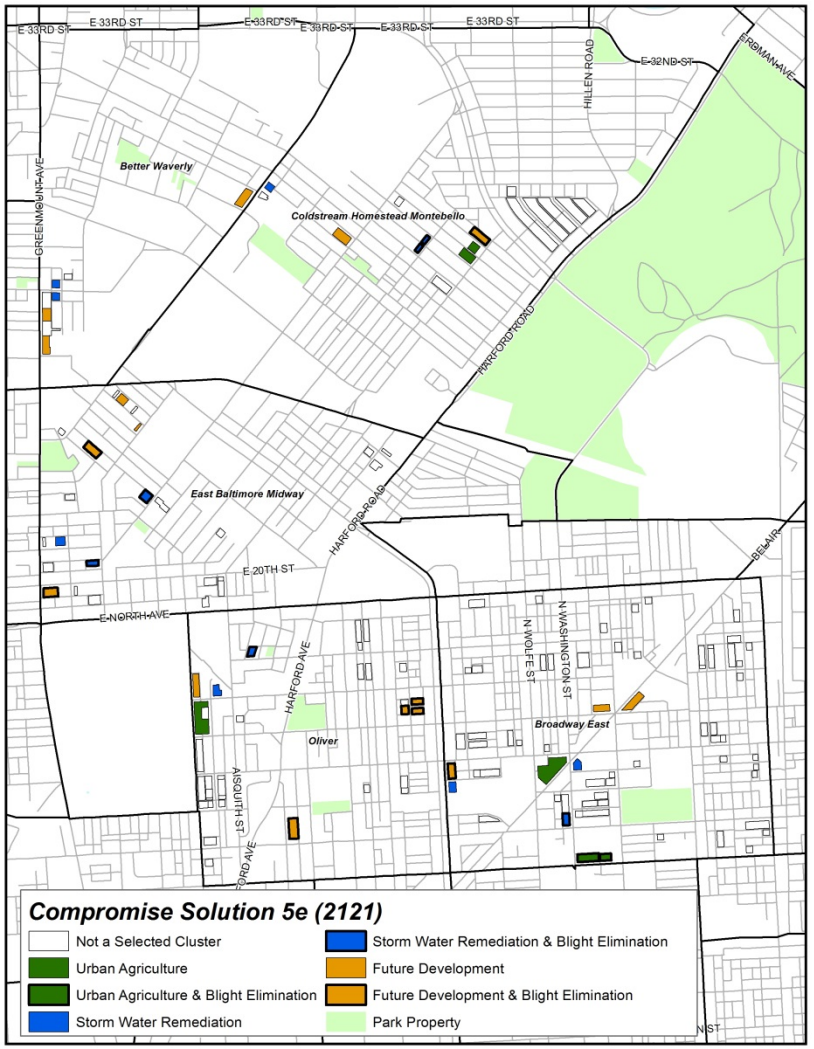
Objective-space results demonstrate wide variance in objective values across problem instances



Source: Johnson and Hollander (2013)

Decision-space results show variation in acquisition and re-purposing decisions





Conclusion

Creative data analytics involves multiple methods and technologies

- Geographic information systems
- Database analysis
- Decision science

…and multiple data types

- Qualitative data, from stakeholder engagement
- Quantitative data, from administrative datasets

…to generate a range of policy alternatives that consider

- Multiple competing objectives and resource constraints
- Practitioner expertise

Best use of these methods may fulfill the promise of community development that is “integrated, broadly collaborative, data-driven, and focused on what works, and entrepreneurial” (Seidman 2012)

Thanks!

Foreclosed housing project book (under development):
http://works.bepress.com/michael_johnson/58

Foreclosed housing project description:
http://umb.libguides.com/foreclosed_housing

Resources

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