Forewarned:

The Use of Neighborhood Early Warning Systems for Gentrification and Displacement

Karen Chapple and Miriam Zuk

Abstract

The 1980s saw the emergence of neighborhood early warning systems that use indicators to assess patterns of neighborhood change. More recently, new systems and analyses are measuring the risk of gentrification and displacement. Based on a dozen interviews with developers and users, as well as a survey conducted in one region, we show that policymakers, community residents, and other stakeholders are actively using these early warning systems strategically, tactically, and for empowerment. Though it is unknown the extent to which the analyses have actually caused policy shifts, they clearly have influenced the urban debate over housing and neighborhood change. However, the durability of these efforts remains an outstanding question. Cities have not yet sought to develop these tools and strategies for more equitable, inclusive neighborhood change, yet city government is a logical home for early warning systems, especially given new technological capabilities.

I.   Introduction

Neighborhoods change continuously, due to the movement of people and capital, both private and public. Change is often visible, as newcomers walk the streets or buildings and infrastructure are built and demolished. At the same time, change may be hard to discern, as property transfers and even the arrival of new tenants are not publicized. The process may take decades to unfold, and may be nonlinear: Change can stall or reverse, and the neighborhood may never fully transform itself.

As local residents and policymakers struggle to discern the nature and extent of changes, researchers have devised "neighborhood early warning systems" to describe change processes and even predict future transformation. These toolkits, which take the form of either reports or online guides, tend to focus on economic and racial/ethnic change at the neighborhood scale, via demographic and property data. The idea of early warning is that by tracking investment, disinvestment, and population flows at the local level, policymakers can design cost-effective interventions before the pace of change accelerates and patterns become entrenched (Snow, Pettit, & Turner, 2003). In the case of neighborhood decline, this might mean identifying crime hotspots or abandoned properties. For neighborhoods that are revitalizing, toolkits tend to focus on areas of housing sales, racial transition, and new amenities, among other factors.

The first generation of toolkits, from the 1980s and 1990s, has now disappeared.[1] But both the overheating of the housing market and the planning of new transit systems have led to new interest in understanding neighborhood change, specifically in the form of gentrification and displacement. New early warning systems with an online presence, have emerged in Portland, the San Francisco Bay Area, Chicago, and Minneapolis, and many other regions have conducted analyses. This new generation of toolkits has the potential to transform policies to stabilize and/or revitalize neighborhoods, especially if, this time around, they find more permanent homes. One pathway might be to expand the "smart cities" movement beyond its current focus on efficiency to proactive policy-making around inclusion (Pettit & Greene, 2016).

Yet, little is understood about precisely how stakeholders are using the systems, and what impact they have on policy. Early warning systems have complex and multiple goals, in contrast to smart cities systems, which primarily attempt to make city systems more responsive to constituents. To make the case for integrating early warning systems into city operations, it is important to understand their value. This article describes the intent and use of these toolkits, assessing their ability to make policy more effective, their potential sustainability, and, for a few, their predictive capability.

The next section discusses the evolution of urban data capabilities, and then describes the first generation of early warning toolkits. Next, we survey the landscape of current toolkits, including the Urban Displacement Project tool in the San Francisco Bay Area, which we developed. Based on a dozen interviews with developers and users, as well as a survey conducted in one region, we explore the different ways that toolkits have been used. Finally, we lay out next steps for system development, suggesting ways to increase the relevance of toolkits to the planning and development decisions that elected officials and communities are facing.

II.   Perspectives on smart cities, neighborhood change, and early warning toolkits

The use of data and maps in cities and neighborhoods

Shortly after Geographic Information Systems (GIS) became widely available on personal computer in the early 1990s, a set of intermediaries emerged to create more democratic access to data, many part of the Urban Institute's National Neighborhood Indicators Partnership (Treuhaft, 2003).[2] These intermediaries, often community-based organizations working in

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[1] Snow, Pettit & Turner (2003) profiled four early warning systems: the Chicago Neighborhood Early Warning System, by the Center for Neighborhood Technology; Neighborhood Knowledge Los Angeles, at UCLA; the Philadelphia Neighborhood Information System, at the University of Pennsylvania; and the Minneapolis Neighborhood Information System, at the University of Minnesota. Each has either disappeared, or has not been updated in many years.

[2] The National Neighborhood Indicators Partnership (NNIP), founded in 1996, consists of a loose network of data intermediaries in 30 cities.

partnership with universities, gather neighborhood-level data, organize it into a database, and help community actors map and analyze it by themselves. The focus thus was on *empowerment*, building trust and capacity in communities that historically had been on the wrong side of the map, e.g. through practices such as redlining (ibid.).

The movement to democratize data has recently morphed into interest in smart cities, which optimize urban systems and service delivery through real-time monitoring and control. The promise of smart cities is that new digital tools that aid in the collection, analysis, and dissemination of data will help cities shift from a compliance to a problem-solving mode (Goldsmith & Crawford, 2014). At the same time, it is believed, technology will strengthen civil society, as constituents coproduce solutions with government (ibid.). Yet, absent from smart city experiments is the application of technology to more equitable outcomes, particularly in neighborhoods, as well as the input of community organizations (Baud et al., 2015, Pettit & Greene, 2016).

Despite the enthusiasm about moving towards smarter cities and more democratic data, questions remain about how the data and maps produced are actually used. Data analysis and maps either remain for internal use in decision-making, whether by government agency or community organization, or are made available to external audiences in order to garner attention or generate new ideas. Users, particularly community groups, may use maps in a *strategic* way, e.g. to identify needs or target resources; as a *tactic*, to raise awareness or implement solutions; for *administration*, e.g. for service delivery; for *organizing* or building the capacity of a constituency; or simply for *exploration*, to see if spatial knowledge legitimizes local experience or raises questions about city policy (Craig & Elwood, 1998; Ghose, 2011). Over the long-term, GIS analysis and maps are thought to have the potential to transform planning, policy, and programs (Ramasubramanian, 2011)—yet, there is little systematic evidence of this.

The rise of neighborhood early warning systems

Scientists and social scientists alike have long coveted the ability to predict the future. As the availability of new data made it possible to identify the factors predicting or simply correlated with different phenomena, researchers have tried to use these indicators to predict future change. Thus there are early warning systems for crime hotspots and gang homicides (Gorr & Lee, 2015; Sampson, 2011), housing abandonment and foreclosure (Hillier, Culhane & Smith, 2003; Williams, Galster, & Verma, 2013), housing price appreciation (Galster & Tatian, 2009), land use change (Waddell, 2002), and even tornados (Oleske, 2009).

The first neighborhood-level early warning system was pioneered beginning in 1984 by the Center for Neighborhood Technology in Chicago. The idea was to create a portal of property data, such as information on tax delinquencies, code violations, and utility shutoffs, which could then be used to monitor neighborhood housing conditions (and thus spur intervention). Because many forms of financial disinvestment are invisible, identifying patterns in a timely manner can be preventative. An early Urban Institute report describing four such systems (in

Los Angeles, Minneapolis, and Philadelphia in addition to Chicago) found that they all provided indicators of financial disinvestment based on parcel-based data – aggregated in different ways depending on the issue -- obtained from the local government (Snow, Pettit, & Turner, 2003). With an audience of government agencies and community-based organizations, the systems were disseminated on the web and housed at academic or research institutions.

Cities and other stakeholders are interested in monitoring neighborhood decline for both immediate reasons – the potential that families will lose their shelter – and long-term issues, particularly the spiral of decline that can result in a variety of costly impacts for families and cities alike (Wilson, 1987). In contrast, the rationale for monitoring neighborhood revitalization or gentrification is murkier.

Gentrification is a simultaneously spatial and social practice that results in "the transformation of a working-class or vacant area of the central city into middle-class residential or commercial use" (Lees, Slater, & Wyly, 2008:xv) – meaning the influx of both capital (real estate investment) and higher-income or –educated residents. Displacement – when households are forced to move out of their neighborhood-- can be a negative outcome of gentrification, but may also precede it (Marcuse 1986). Real estate investors, including prospective homebuyers, certainly take an interest in gentrification. For cities, it is important to understand neighborhood upgrading in order not only to stabilize communities but also to intervene proactively before intervention (e.g., mitigating displacement) becomes costly and difficult (Pettit & Greene, 2016).

One of the earlier iterations of work predicting gentrification is a presentation by researchers from the Urban Institute (Turner & Snow, 2001). They characterized the process of gentrification by: a) shift in tenure, b) increase in down payment and decrease in FHA financing, c) influx of households interested in urban living, and d) increase in high income serving amenities such as coffee shops or galleries. Analyzing data for the DC area, they identified the following five predictors of future gentrification (defined as sales prices that are above the D.C. average) in low-priced areas: 1) adjacency to higher-priced areas, 2) good metro access, 3) historic architecture, 4) large housing units, and 5) over 50% appreciation in sales prices between 1994 and 2000. Census tracts were scored for each indicator and then ranked according to the sum of indicators with a maximum value of 5.

In 2009, the Association of Bay Area Governments sponsored an analysis of neighborhood change in the San Francisco Bay Area from 1990 to 2000 which predicted neighborhood susceptibility to gentrification, with a disclaimer that it was not possible to measure resident displacement via this method (Chapple, 2009). Chapple adopted Freeman's (2005) definition of gentrifying neighborhoods as low-income census tracts in central city locations in 1990 that by 2000 experienced housing appreciation and increased educational attainment above the 9-county regional average, and then constructed a multivariate statistical model that had gentrification as the dependent variable, and a set of 19 socio-economic, locational and built environment factors for 1990 as independent variables. When census tracts scored above the

regional average for each variable, they received a value of 1; the susceptibility index summed the scores across the variables.

In 2011 Atkinson and coauthors characterized household vulnerability to displacement from neighborhoods that gentrified between 2001 and 2006 in the Melbourne and Sydney greater metropolitan areas. A vulnerability score (from 1 to 13) was measured based on tenure, number of employed persons per household, and occupation. Displacement rates were calculated by dividing the number of out-migrants with vulnerability characteristics by the number of households with these characteristics exposed to the likelihood of moving in 2001. Neighborhoods that had higher than projected numbers of high income, occupied and professional populations were designated gentrified.

Researchers have used myriad indicators and sources of data for characterizing residential gentrification displacement, each with its own set of advantages and disadvantages (Table 1). This table summarizes quantitative data sources only; however, data on many of the drivers and impacts of gentrification and displacement are not regularly gathered or are hard to quantify.

Table 1 Indicators and Data Sources for Analyzing Gentrification and Displacement

Indicator Type	Indicators	Data sources
Change in property values and rents	Sales value, property value	County tax assessor's office, finance departments, data aggregator
	Rent	Data aggregators, apartment operating licenses, craigslist
	Changes in availability of restricted affordable housing	HUD, housing departments
Investment in the neighborhood	Building permits, housing starts, renovation permits, absentee ownership	Jurisdiction's building or planning departments
	Mortgage lending and characteristics	HMDA and assessor data
	Sales (volume and price	County assessor's office, data aggregators
	Condo conversions	Assessor office, housing department, department of public works
	Change in community and business orgs (#, membership, nature of activities, etc.)	Chamber of commerce, Dun & Bradstreet, neighborhood or local business associations, etc.
	Public investments (transit, streets, parks, etc.)	Public works departments, transit agencies, parks and rec, etc.
Disinvestment	Building conditions, tenant	Surveys, Census, maps, building

	complaints, vacancies, fires, building condemnation,	departments, utility shut-offs, fire department
	School quality, crime, employment rates, neighborhood opportunity	Department of Education, Police Departments/crime maps, Census, Bureau of Labor Statistics
	Neighborhood quality	Local surveys
Change in tenure and demographic changes	Tenure type, change in tenancy	Building department, assessor's office, census
	Evictions	Rent board, superior court
	Foreclosure	HUD, proprietary data sources
	Demographics data on in- vs. out-movers (race, ethnicity, age, income, employment, educational achievement, marital status, etc.)	Census, voter registration, real estate directories, surveys, American Housing Survey, Department of Motor Vehicles
Investment potential	Neighborhood and building characteristics (e.g., age and square footage, improvement-to-land ratio)	Tax assessor, Census, deeds, etc.
	Neighborhood perceptions	Surveys of residents, realtors, lenders, neighborhood businesses, Newspapers, TV, blogs, etc.
Reasons that people move in/out of 'hood	Reason for move	Surveys of in- and out- movers, state housing discrimination complaints database.
Coping strategies / displacement impacts	Crowding/doubling up	Census, utility bills, building footprint
	Increased travel distance and time	Census

The future of neighborhood early warning systems

More than thirty years after the first neighborhood early warning system emerged, they arguably have failed to meet their potential. In fact, the first early warning systems for neighborhood decline have not survived the test of time. Although more research would be necessary to determine why, three explanations seem likely. All of the systems were housed at nonprofits or universities, where changes in personnel and leadership can change institutional focus (as opposed, for example, to a city, which has a more constant mission). All relied primarily on funding from philanthropy, which changes its focus frequently, and/or HUD, which has experienced repeated budget cuts in the last few decades. Finally, it seems likely that none developed a broad base of users (beyond community-based organizations).

The first generation of early warning systems innovated new uses of local data and offered considerable promise to shape policymaking (Snow, Pettit, & Turner 2003). But their lack of sustainability suggests that they failed to convince potential users about the importance of early warning and preventive approaches to neighborhood change. Moreover, three decades after the first research on gentrification and displacement, we continue to struggle to predict which neighborhoods will gentrify and who will benefit (and suffer). Most of the debate about gentrification and displacement has remained in academic spheres, outside of the policy realm -- until the recent arrival of warning systems for gentrification and displacement.

Yet, the emergence of the smart cities movement suggests the potential of these tools. Research has suggested that data on gentrification and displacement underrepresents the most disadvantaged populations and presents a mismatch between data and lived experience (Zuk et al. 2015). This might be overcome by user-generated geographic content, volunteered by residents and posted via interfaces like Flickr (Goodchild, 2007). With better data, prediction might improve, and with more accessible portals, different stakeholders might coproduce more effective policies. As Pettit & Greene (2016:2) envision:

> But what if city leaders and community groups could get ahead of these changes and act early to direct neighborhood changes towards more inclusive outcomes? Using big data and predictive analytics, they could develop early warning systems that track key indicators of neighborhood change and predict future trajectories.

We turn next to an overview of how is the next generation of early warning systems is faring.

III.   Neighborhood Early Warning Systems: Surveying the Landscape

In order to examine further the use of early warning systems for neighborhood change – and gentrification and displacement in particular – we next establish the universe of systems via a web scan. Two starting points were the Urban Institute's National Neighborhood Indicators Project and the Obama Administration's open data portal, The Opportunity Project. We also searched the web on terms such as "neighborhood," "gentrification," and "displacement," and asked our interviewees for systems we had missed.

We identified three types of websites that explore neighborhood issues: neighborhood indicator maps (typically of development, such as local educational attainment or housing construction, or quality of life, often represented by amenities), opportunity maps, and racial/economic change maps (including gentrification).[3] To narrow our focus, we chose just the sites focusing on gentrification within this last category, which included projects in Chicago, Minneapolis (two projects), Portland, San Francisco, and Washington DC. We excluded several sites that depict neighborhood change without an explicit focus on gentrification or assessment

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[3] Our scan identified 24 of these websites, but we suspect that many more exist.

of risk.[4] We then added several cities that had produced recent assessments of gentrification or displacement risk with a report, rather than a web interface, as the final product. These included Charlotte, Houston, Los Angeles, Seattle, and St. Louis. Again, we excluded recent gentrification reports that were not framed as risk assessments.[5]

Of the eleven projects, we interviewed nine of the system creators and attended a presentation of one; the last site is our own. Most of the interviews occurred via telephone and lasted 45-60 minutes, using a semi-structured format; one interview was by email. The analysis also draws from a survey of users (n=33) of our Urban Displacement Project toolkit.[6]

The projects generally fall into two broad categories, those developed by universities, with online map interfaces, and those developed by cities as reports for internal use (Table 2). Perhaps because of the role of city government in many of the projects, the majority of the analyses examine neighborhood change within city, rather than regional, limits. The most common audience, both intended and actual, is city government and community organizations; others specified regional agencies, community members, and elected officials as their target audience. All of the sites rely primarily on U.S. census data at the tract level, typically using the data with standardized census tract boundaries provided by Geolytics or Brown University. Most of the projects span at least two decades (1990-2010 or 1990-2014), and a couple (Chicago and St. Louis) use 1970 as the starting year. A couple of the sites (Portland and San Francisco) also add parcel-based data on recent home sales, and two (San Francisco and Washington, DC) add data from the Longitudinal Employment Household Dynamics on job accessibility, as well as a rail transit station layer. One (San Francisco) also uses data on amenities (parks, transit, walkability), property characteristics (from the tax assessor), and nonprofits.

Analyzing risk

The first generation of reports analyzing gentrification and displacement risk generally followed the same methodology: Run correlations or regression to identify predictors of gentrification

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[4] These included HUD'S Affirmatively Furthering Fair Housing Assessment Tool, https://www.huduser.gov/portal/affht_pt.html#affhassess-tab; Code for Boston's Ungentry, http://codeforboston.github.io/ungentry/; and sociologist Michael Bader's racial/ethnic change maps for New York, Los Angeles, Chicago, and Houston: http://mikebader.net/media/neighborhoodtrajectories/map.html?city=newyork

[5] These included the 2016 NYU Furman Center annual report on New York City housing, http://furmancenter.org/research/sonychan and two reports on Philadelphia, by the Federal Reserve Bank (Ding, Hwang, & Divringi 2015) and the Pew Charitable Trusts (unpublished).

[6] The Urban Displacement Project solicited survey responses from a list of 395 stakeholders in the nine-county Bay Area, including housing policy advocates, planning directors, and elected officials. After two email solicitations, 33 responses were received (a response rate of 8%). The survey asked users ten questions about how they used the site (maps, case studies, and policy inventory), as well as how the site could be improved.

and/or displacement, and then assign each factor a value to come up with a susceptibility score (Atkinson, 2011; Chapple, 2009; Turner & Snow, 2001). The analyses behind the current set of

Table 2. Neighborhood Early Warning Systems for Gentrification and Displacement.

City/Region	Type of Project	Host	Geography	Goal	Users	Format	Policy Influence?
Charlotte	neighborhood change analysis	City of Charlotte	City	**tactical**: understand how to do equitable and inclusive development	city, some community organizations	internal report	N/A
Chicago	gentrification index	University of Illinois-Chicago	City	**tactical and empowering**: measure change and provide tools	community organizations	report and maps online	Yes
Houston	gentrification index and at risk indicator	Local Initiatives Support Corporation	City	**strategic, tactical, empowering**: use as advocacy tool for LISC	LISC, community organizations	internal report	Yes
Los Angeles	gentrification index	City of Los Angeles	City	**strategic**: help city target initiatives within a large grant program	mayor's office	internal report	N/A
Minneapolis/St. Paul	housing market index	University of Minnesota-Minneapolis-St.Paul	Twin Cities	**strategic, tactical, empowering**: start a conversation, inform policy makers and residents	community organizations, city	report and maps online	Yes
Minneapolis/St. Paul metropolitan area	gentrification index and at risk indicator	Minnesota Center for Environmental Advocacy	Region	**strategic, tactical**: spark conversation, implement mitigations, obtain funding	community organizations	report and interactive maps online	No
Portland	gentrification index and at risk indicator	Portland State University (hosted by The Oregonian)	City	**tactical, empowering**: show where gentrification is happening in Portland	city, community organizations	report and maps online	Yes
St. Louis	index of "neighborhood vitality"	University of Missouri-St. Louis	City	**tactical and empowering**: show which neigborhoods are "rebounding"	community organizations	report online	Yes
San Francisco Bay Area	gentrification index and at risk indicator	University of California-Berkeley	Region	**tactical and empowering**: describe current patterns of neighborhood change and city policies	local government, community organizations, elected officials	report and interactive maps online	Yes
Seattle/Puget Sound	neighborhood typology and at risk indicator	Puget Sound Regional Council	Region	**strategic and tactical**: provide jurisdictions a tool for station area plans	local government, community members	report online	Yes
Washington, DC	gentrification index and at risk indicator (not yet released)	University of Maryland-College Park	Region	**tactical**: understand change primarily around transit (Purple Line)	local government	maps online	N/A

early warning systems -- in Chicago, Houston, Portland, San Francisco, and Seattle, as described further below -- have improved upon this methodology by looking at the dimension of time, i.e., past and present neighborhood change dynamics, in addition to the extent of vulnerability. Many also make a useful analytic distinction between gentrification and displacement, while still analyzing both.

The Chicago gentrification index (Nathalie P. Voorhees Center, 2014) determines relevant factors based on a literature review. It provides a "score" for each "Community Area" in 1970, 1980, 1990, 2000, and 2010, based on a composite index that compares the community area to the city at large for 13 indicators. Then, a neighborhood change typology (displayed in maps) is constructed not just from these scores but also their change over 1970-2010. A separate toolkit identifies housing, land use, and other tools appropriate for each of three stages: before gentrification, mid-stage gentrification, and late-stage gentrification (Nathalie P. Voorhees Center, 2015).

Building off the same methodology as Chapple (2009), LISC researchers construct a model predicting gentrification in neighborhoods of Houston, using a slightly narrower definition of gentrifying neighborhoods (Winston & Walker, 2012). The LISC researchers use the regression coefficients and continuous independent variables in predicting susceptibility to gentrification.

In Portland, Bates (2013) predicts market changes based on vulnerability to displacement, demographic changes, and housing market conditions, a method that was replicated in the Twin Cities gentrification risk assessment performed by the Minnesota Center for Environmental Advocacy. Tracts are vulnerable to displacement in 2010 when they have higher-than-average populations of renters, communities of color, few college degrees, and lower incomes. For housing market conditions Bates defines neighborhood market typologies as 1) adjacent tracts (low/moderate 2010 value, low-moderate appreciation, next to high value/appreciation tract), 2) accelerating tracts (low/moderate in 2010 with high appreciation rates), and 3) appreciated tracts (low or moderate 1990 values, high 2010 value, high 1990-2010 appreciation). Combining this information with demographic shifts for vulnerability factors between 2000 and 2010, the study identifies six neighborhood types ranging from early to mid- to late-stage gentrification. Bates then uses these typologies to recommend how to tailor policy approaches to the specific characteristics and needs of neighborhoods.

In the San Francisco Bay Area, the Urban Displacement Project provides a typology analysis that characterizes Bay Area neighborhoods (census tracts) according to their experience of gentrification and risk of displacement.[7] This early warning system is based upon a gentrification index that adapts the methodologies of various researchers (e.g., Freeman 2005;

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[7] This project was a side product of a larger study funded by the California Air Resources Board and the Metropolitan Transportation Commission (via HUD's Sustainable Communities Initiative) that involved extensive qualitative and quantitative regional analysis to better understand the nature of neighborhood change and displacement in the Bay Area and its relationship to transit.

Bates 2013; Maciag 2015) to characterize places that historically housed vulnerable populations but have since experienced significant demographic shifts as well as real estate investment.

The loss of low income households between 2000 and 2013 was used as a proxy for displacement. On average Bay Area census tracts' low income population grew by 59 households between 2000 and 2013. The typology therefore assumes that any neighborhood that experienced a net loss of low income households while stable in overall population is a result of displacement pressures.[8] After constructing regression models to estimate the predictors of both gentrification and loss of low-income households/displacement, the project developed place typologies for risk of either gentrification-related displacement or exclusion-related displacement (which occurs in higher income neighborhoods). Unlike the other studies, results were vetted via several workshops with a project advisory committee, as well as community forums. Based on these interactions, tracts were divided into low income and moderate-high income tracts in order to capture the displacement pressures occurring in non-gentrifying neighborhoods that are also losing low income households. Table 3 presents the resulting typology. The website also includes an inventory of policies available in each jurisdiction (Figure 1).

Table 3. Displacement/Gentrification Typologies[1]

Lower Income Tracts (> 39% of HH are considered Low Income)	Moderate to High Income Tracts (<39% of HH are considered Low Income)
Not losing low income households or very early stages • Does not fall within any of the below categories	***Not losing low income households or very early stages*** • Does not fall within any of the below categories
At risk of gentrification or displacement • Strong market • In TOD • Historic housing stock • Losing market rate affordable units • Employment center	***At risk of displacement*** • Strong market • In TOD • Historic housing stock • Losing market rate affordable units • Employment center
Undergoing displacement • Already losing low income households, naturally affordable units, and in-migration of low income residents has declined • Stable or growing in size	***Undergoing displacement*** • Already losing low income households • Decline in either naturally affordable units or in-migration of low income residents • Stable or growing in size

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[8] We assume that a tract that lost low income households during this period underwent some process of displacement when combined with other indicators such as a loss of market rate affordable units or a decline of the in-migration of low income population into that tract beyond the regional median. Although the change in low income households could be due to income mobility (e.g., low income households moving into middle or upper income categories, or vice versa), from our analysis of data from the Panel Study on Income Dynamics we estimate that there would have been a net increase in low income households in most places likely due to the Great Recession; therefore, our estimates of displacement are likely an underestimate.

Advanced Gentrification	Advanced Exclusion

• Gentrified between 1990 and 2000 *or* between 2000 and 2013 based on:
    o Neighborhood vulnerability
    o Demographic change
    o Real estate investment
	• Very low proportion of low income households
	• Very low in-migration of low income households

[1] Tracts with 0 population in 2010 were excluded from the analysis (8 tracts). In addition, tracts where over 50% of the population in 2010 was in college were excluded from the analysis (11 tracts).

Figure 1. Policy Inventory on Urban Displacement Project Website.

The Puget Sound Regional Council project, conducted with the Center for Transit Oriented Development, used descriptive methods to construct a typology of neighborhoods based on risk factors (the "people profile") and market strength (the "place profile"), which then formed the basis for suggesting policy responses (PSRC 2013). For the "people profile," one axis consisted of social infrastructure and access to opportunity. The other axis - change/displacement - measured risk of displacement due to recent neighborhood change, current community risk factors, and current and future market pressure. The "place" profile also consisted of two dimensions: urban form that supports a dense and walkable transit community and the likelihood that the community will change due to real estate market strength. Combining the people and place typologies, they identify eight general typologies, for each of which they identified implementation and policy approaches.

Thus, early warning systems and related projects are gradually improving in methodology in an attempt to predict change more accurately. Notable methodological shifts include the analysis of multiple stages of both gentrification and displacement, building on the approach of Bates (2013); the shift to a regional, rather than municipal framework; and the mixing of quantitative and qualitative approaches. Conceptualizing gentrification and displacement as a long-term,

multi-stage process, rather than a binary state or on/off switch, has helped build local buy-in into the early warning systems. Looking at many different cities within a region helps localities understand regional housing market dynamics and learn about different policies. Checking results with local residents and key informants helps ensure that the maps represent conditions on the ground.

However, methodological problems remain, particularly in terms of the predictive ability of the models. Methods are still far from transparent: models are not readily replicable, and the scores can be hard to understand. The following section describes how stakeholders are using the models in practice, as well as the effectiveness of the new approaches.

IV.   The Use and Impact of Neighborhood Early Warning Systems

This section examines the use and impact of these projects, looking at those that assess gentrification and/or risk (Chicago, Houston, Minneapolis, Portland, San Francisco, St. Louis), as well as the other neighborhood change reports (in Charlotte, Los Angeles, Minneapolis, and Seattle).[9] We assess first how internal actors, and then external stakeholders, use early warning systems. We then examine what impact the projects have had on policymaking and how accurate they are at predicting change.

Internal use

One obvious use for early warning analyses is in strategic planning for housing and neighborhoods. Maps that show how neighborhoods are changing and anticipate future change can help stakeholders bring attention to imminent problems and target resources. If the map suggests that change is in very early stages, the neighborhood can strategize about actions to take over the long term, e.g.: "…in Houston, we are a few years or a decade, behind other metropolitan areas in terms of the waves of gentrification and things coming. So what we realized is that by doing research now, we could get ahead of that." The gentrification analysis showed where change was anticipated yet land was still cheap, so that intermediaries could target land acquisition funds strategically.

The Houston project was strategic not just in terms of timing, but also policy approach and ownership. Prior to the analysis, there had been some disagreement among stakeholders about how to spend disaster recovery money. Having the data helped advocates to say, "if we're doing this investment, let's also create and preserve affordable housing opportunities in places at risk of gentrification" – but without making enemies by specifically endorsing certain policies within the report itself.

Concludes the Houston creator:

> "We had a strategically placed piece of analysis that could help community stakeholders on our side make a point about what policy ought to be. Not a distraction, not

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[9] Because the Washington DC site has not yet been launched, it is too early to assess its use and impact.

something that came out of Washington, DC, saying this is what y'all ought to do. Because that would have been suicidal."

Another strategic, internal use of maps is targeting resources, as with the Housing Market Index in Minneapolis, which helps determine the blocks where funds to fix vacant property can be most effectively spent. Says one of its developers: "It has been very, very, very useful...When you're involved in politics, and competition for scarce resources, the more facts you can provide, the better you are. The HMI are facts. And that speaks much louder than any political will."

In Charlotte, where the use of the report remained internal to the city government, the analysis became a tactic to broaden the framework and discussion of neighborhood change. The initial referral from the City Council had been to look at gentrification, but instead the city

> "looked more broadly at neighborhood change and the challenges that can arise in the context of gentrification across all neighborhoods, plus the close ties that this issue has with economic opportunity and the historic patterns of economic and racial segregation in Charlotte – consequently, we looked at a broad range of indicators."

Ultimately, the analysis supported the development of a much broader housing strategy than anticipated, with a wide array of tools and strategies to manage neighborhood change.

Once the analysis is in place, it can create its own momentum. In Seattle, the PSRC analysis established – after considerable debate with advocates -- that four neighborhoods in Southeast Seattle were at high risk. Years later, planners working on the update to the Seattle Comprehensive Plan used the analysis as a background document to show that the community was at risk. Developers of the gentrification typology in the Twin Cities have a similar intent, to create the momentum to fund and implement the mitigations for neighborhood preservation and equitable development in the Central Corridor Development Strategy.

External use

The most common use of early warning indicators and maps is as a *tactic*, to spark a conversation, generate new ideas, or show how to implement solutions. The survey of users of the Urban Displacement Project suggested that this was the primary use of that warning system. Users volunteered that it was a tool to start dialogue: "I've used the maps to show policymakers that my neighborhood is at risk of displacement."

In the Bay Area, the tool also serves to legitimize other work:

> "My organization provides legal research, advice, education, and advocacy to support communities in developing community-owned economic structures. This data has been useful in better understanding the dynamics of displacement internally, as well as in communicating about the importance of our work to the public."

It also lets advocates know where cities lack anti-displacement policies, so they can push for implementation: A user of the Urban Displacement Project in the Bay Area reports using the site "to assess which areas have been most impacted in order to identify mitigation strategies for nonprofits that lease in those areas." Users reported using it "to check on what policies have been implemented by Bay Area jurisdictions to produce more housing." and "assessing opportunity for preservation strategies and making the case for funding." Because the maps are regional, advocates use them to advocate at the regional level: "[We] identify which cities are performing well and which are not. [We] advocate for MTC [Metropolitan Transportation Commission] to use this info to guide funding through OBAG [a regional grant program to encourage density] to incentivize better local policies."

In St. Louis, the release of the index of "neighborhood vitality" also brought new attention to "rebounding" neighborhoods, helping to spark a conversation about how reinvestment occurs. The university sponsors a morning panel that highlights "come back" neighborhoods, with a panel of people from the neighborhood that tell the story of what was done to strengthen the community.

Maps of neighborhood change at a regional scale can help bring perspective to communities that had considered themselves immune to affordable housing need. In Seattle, the conversation took a new turn:

> "Roosevelt community…is 'Improve Access' [type]…[it is one of the] station areas that were predominantly white, affluent station areas in a wealthier city. When having conversations about what to do with surplus lands the transit agency will have, I was able to go in and talk about the typology exercise, which highlighted that adopting tools to ensure affordable housing was a central need for places like Roosevelt. Which helps counter some of the community members who want to use those for parks and open space."

The Twin Cities gentrification typology is also meant to educate the suburbs, developers, and others who don't comprehend the extent of housing pressure on the urban core. Says the developer: "It's like driving down the road using your rearview mirror, and all of this demographic change is in front of you. You're going to end up in the ditch."

The maps often serve to validate disenfranchised perspectives. One place this occurred was Portland, where many planners didn't understand the issues:

> "And then there was this big explosion around a bike lane project…historically black part of Portland. That was the first wave of displacement. So it's on the bike boulevards plan…they were not going to do any of the pedestrian safety stuff that black folks had asked for. Huge conflicts between bike lanes and buses. So all the transportation planners were like, 'Wait what is this gentrification thing people are talking about?' so that was one of the first goals was to get people on the same page of what are we talking about."

The maps made the issues more real: "So for the Urban League, and some other black [organizations, it was like]: 'See this thing we told you was happening, has happened, is real. It's in the data.'"

When the City sponsors the project, as in Portland, it can help legitimize the entire conversation. Says the creator, "One of my first conversations with them in talking was, 'you should all stop saying that you're trying to gentrify stuff. It's not going over well.' They would routinely say that. 'Oh this area needs gentrification…' with no comprehension of what they were saying…I think it was really important that there was an acknowledgment on the part of the City that this was not a purely market accident. So that started happening more in the popular conversation."

Likewise, a creator of the Chicago maps argues that depicting how neighborhoods are changing, even where the gentrification process is just barely starting, is effective because users can recognize themselves – and their own economic struggles -- in the maps.

> "Inequality perpetuates this narrative of gentrification, the fear of gentrification, even if it's not really happening. When you can't get into the middle, when you're middle income and you can't buy a house, then there are structural forces at work. But you want something to blame, and so the narrative about how gentrification is occurring feels right."

In Chicago, the active dissemination of the index into communities by the university helped locals shift into action and policy design. As communities looked at the new index, they wanted to deconstruct it and shift into figuring out strategies: "Communities are looking for that sweet spot, where they can prevent excessive development but still get enough to have resources." Part of this conversation was spurred by media attention, a radio reporter who became interested in the issue because of her own neighborhood, Bronzeville. The interest led the university to add the policy toolkit, which then spurred many new conversations in different communities.

Another way to use data analysis and maps is to organize or empower a constituency. In Portland, the housing advocates formed a new coalition and reframed it around displacement, broadly defined – an umbrella that could include those fighting gentrification, or for renter protections, or to stabilize communities. For the projects being used by community organizations, all of the interviewees reported empowerment and capacity-building as an outcome. From Minneapolis to the Bay Area, community organizations use the maps to organize their constituencies. The data doesn't just show that "it's real"; it provides evidence that advocates point to in meetings with and letters to policymakers.

In St. Louis, the analysis revealed that every "rebound" neighborhood had strong civic engagement:

"My main surprise is that when we go out to the neighborhoods that we identified as these rebound neighborhoods, that there really is a—groups on the ground that are talking about this. About what they can do to help the neighborhood. And it's sort of, they find it extremely gratifying to be identified as a neighborhood that's coming back. There seems to be a very upbeat conversation about these neighborhoods."

Interacting with communities about the early warning maps helped creators realize that locals needed to be equipped to deal with different stages of gentrification. In Chicago: "We quickly realized that we needed to show people how different tools are appropriate for different stages of gentrification." For instance, when gentrification is late stage, as in the East Side of Pilsen, the strategy should be to preserve the diversity and stabilize the community by building coalitions across different groups.

<u>Policy impact</u>

Many of these early warning systems and reports are in the public domain, and have become an established resource in the ongoing civic conversation about housing. This social context may have aided the process of policy learning, as policy communities construct shared definitions and debate ideas (Bennett & Howlett, 1992). Most of the interviewees can point out different ways that the analyses have shaped the policy conversation, though it is hard to know how pivotal a role they played in the passage of specific policies. Even the cities using their new neighborhood change tools internally, such as Los Angeles and Charlotte, reported shifts in how their governments thought about housing needs and targeting resources.

In St. Louis, the report influenced conversations by the Ferguson Commission about the siting of Low Income Housing Tax Credit Housing in poor areas. Also, the report's finding that there were no rebound neighborhoods in the north of Delmar area helped spur a new conversation about using tax increment financing to fund infrastructure. In Houston, the analysis of gentrification risk "kept the drumbeat going" at City Hall, and also helped convince the Houston Endowment to provide $1 million for a loan fund in a transitioning neighborhood. In Chicago, the maps likely contributed to the passage of the SRO Preservation Ordinance. Portland has a new focus on housing policy throughout the civic arena, with the declaration of a housing emergency and many different new policies, such as the redistribution of tax increment finance revenues to affordable housing.

The evidence of policy influence is clearer in the Bay Area, where displacement and gentrification pressures are particularly acute and the Urban Displacement Project has garnered considerable media attention (over 50 articles). Several policymakers responded to the user survey that they use the early warning system to design policy. Said one local councilmember, "[I use the site] to assist in writing public policy for the city I represent as a public official. It is very valuable and useful." Said another official, "For my work with the City of Oakland, I used these to understand how our existing anti-displacement policies could be improved." San Francisco's Interim Mission Controls requires developers of new projects in the Mission to write

a report on their project's displacement potential, drawing from the early warning system. City Councilmembers in several cities, including San Mateo and San Rafael, have referenced the project during council meetings to confirm the city's displacement risk, show what policies neighboring municipalities have adopted, and justify passing new anti-displacement policies. The Berkeley mayor used the policy inventory to identify new policies to incorporate into his comprehensive housing plan. The Metropolitan Transportation Commission is considering incorporating more stringent anti-displacement targets in its next long-range plan. Affordable housers have used the maps to target sites for subsidized housing development. And there are unintended audiences as well: real estate brokers have reported using the assessment of gentrification risk to identify profitable areas for investment.

Clearly, many users point to the early warning systems to validate their claims that the neighborhood is gentrifying. The tools also seem to be spurring policy changes (though it is impossible to know whether the new policies would have appeared in the absence of the maps). Arguably, the methodological improvements in the new generation of toolkits have helped to make policy more effective. By identifying neighborhoods in early stages of gentrification and displacement, they put the issue on the radar of local stakeholders. By extending the analysis to the region, the systems clarify that housing markets operate regionally, affecting peripheral as well as core areas. And by incorporating users into the development of the tools, early warning systems have become more accurate – but with limitations, as the next section discusses.

<u>Using early warning systems for prediction</u>

In general, the system developers interviewed did not encourage the use of systems for prediction, but found that policymakers and residents were eager to do so. As one intermediary explained, "Either the analysis is not very helpful – it is not revolutionary, like predicting change near the metro – or it is very weak. We can't predict the [new stadium]." Another pointed to the challenge of accounting for "sites of reserve," or property that landlords hold for decades in anticipation of future profit. As they lay fallow for decades, warning systems may suggest disinvestment, but locals know better.

Developers would generally prefer that the maps be used, as one interviewee said, as a "wake-up call":

> "I did not expect that people—especially people in the city—the planning people—to view it as a predictive model. Or try to keep using it as a predictive model, given that the whole point was to have very minimal data and simple concepts. So that surprised me. Was their interest in doing that more so than creating and developing the policy part? Like, how much more studying of data do you need?"

Likewise, in Los Angeles, policymakers describe their tool as a first step. Once they identify areas that have the potential to change, they can add more qualitative knowledge of the neighborhood in order to do "prediction":

"We use it as a way to say 'we can choose between these neighborhoods for the first [project], and between these for the second one; and then within it, we can focus on a sub-area, block, commercial corridor, and then we pull in a lot more information. So it's definitely not something where you can just enter in some basic search parameter and then it'll tell you exactly where to do it….every policy item will have different things to consider, different political ramifications, and other factors that go well beyond just describing what's happened….And once you have a few good candidates, you have to take in all these additional considerations. Where are different community groups working in this particular space that you could partner with?"

Even if the developers advise caution, users are eager for more explicit prediction. As one intermediary explained:

"The precise numbers would be valuable in influencing the city. We are now to the point where we're hearing the city is ready to have a comprehensive housing plan, and cohesive housing policy. So precision in numbers would be useful for that. In terms of how we're allocating resources."

Few developers have systematically assessed the validity of their gentrification and displacement predictions. The exceptions are Houston and the Bay Area. Validating their Houston model using 2007 (2005-2009) ACS data, LISC researchers found 86% accuracy for highly susceptible tracts (i.e. those that the model predicted were 75% likely to gentrify) and 60% accuracy for moderate susceptibility (i.e., between 50% and 75% likelihood). The Urban Displacement Project found that its analysis from 1990-2000 correctly predicted 86% of the 85 tracts that gentrified from 2000 to 2013 (Chapple et al. 2016). However, the rate of false positives was extremely high: of the 512 tracts that did not gentrify, the model predicted that 79% of the tracts would experience moderate or high gentrification. The analysis of household displacement risk revealed the same pattern: a high degree of accuracy in predicting displacement, but also a high rate of false positives (ibid.).

Both the Chicago and Portland projects used 2010 as the end date for the analysis, so it is possible to validate those models by checking their results against neighborhood change from 2010 to 2014. Looking at Portland, we found that the extent of vulnerability had changed very little, but the number of gentrifying or gentrified tracts doubled, from 15 to 30; the model seems to have under-predicted gentrification, which is occurring very rapidly. In Chicago, we found a near-perfect correlation (0.94) between the risk score from 2000-2010 and that from 2010-2014. If anything, the extent of gentrification has slowed in Chicago: the original analysis found that 11.7% of neighborhoods were gentrifying by 2010, but the 2014 update (using tracts rather than the original neighborhoods) finds just 8.8%.

Given that most developers are skeptical of the accuracy of their own risk assessments, the call of Pettit & Greene (2016) for better predictive analytics seems warranted. A disinvested neighborhood that receives a false positive "at risk" categorization may resist new market-rate

development or even other forms of revitalization. To the extent that they offer a "wake-up call," early warning systems are helpful for community organizing. Yet without more precision, systems may actually hinder efforts to develop appropriate policy responses.

## V.	Next Steps

Though the first generation of online neighborhood early warning systems has disappeared, a new set has emerged, now measuring the risk of gentrification and displacement. Policymakers, community residents, and other stakeholders are actively using these early warning systems strategically, tactically, and for empowerment. Though it is unknown the extent to which the analyses have actually caused policy shifts, they clearly have influenced the urban debate over housing and neighborhood change.

Yet, the state of predictive analytics is poor. Despite methodological advances in the new generation, the systems are not yet reliable enough to use to design for specific policies. For instance, they are not able to predict the displacement impacts of specific developments, or identify which of the many anti-displacement policies is useful in different contexts.

For the most part, the early warning systems studied are not well integrated into the smart cities movement, potentially missing an opportunity for analytic improvement and long-term sustainability. None incorporate real-time data on neighborhood change or crowd-sourced data. Unlike the smart systems that are improving the efficiency of city operations, it is not yet clear what the potential of neighborhood systems is – apart from raising awareness and building momentum for policy change. And the smart cities movement has not yet really grappled with issues of inclusion, in addition to efficiency (Pettit & Greene, 2016). As one intermediary commented, "Getting the open data movement to address equity is like moving a big boat."

The durability of these efforts remains an outstanding question. Of the projects profiled in this paper, a few are planning minor updates, but none have long-term plans to institutionalize this work. The nonprofits and universities that sponsor much of the work have little capacity to continue it without a significant influx of resources, and foundation funders come and go. Though city government is a logical home for early warning systems, especially given new technological capabilities, the case has yet to be made for why cities should pursue tools and strategies for more equitable, inclusive neighborhood change. Likewise, the private sector has not yet engaged in neighborhood change debates. Absent such intervention, these early warning systems will most likely vanish, just like the first generation.

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