OPEN DATA FLOWS, SPATIAL HISTORIES, AND VISUALIZING THE FUTURE OF PRESERVATION

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ABSTRACT — Geospatial datasets are the outcome of processes of government regulation, taxation, and innovation in an era of smart cities and big data. The application of these geospatial datasets and geographic methods are bringing together sources of information and methodologies once rigidly divided by discipline. Interdisciplinary alliances are being forged through advancements in spatial history, spatial humanities, and geodesign. This article represents an environmental scan of preservation initiatives and research to understand the implications of a growing number of geospatial datasets and geographic technologies and methods for historic preservation. The article outlines examples where digital humanities, historic preservation, and urban planning are converging in important areas: (1) in our shared understanding of the patterns of urban history through spatial humanities, (2) in methods of understanding opportunities and barriers to preserving historic resources in the present and widening the scope of concern for preservation to address building stock as a whole, and (3) in our abilities to visualize and analyze alternative future scenarios for historic resources. This research also highlights the importance of stewardship of geospatial data and the development of new geographic tools and methods.

INTRODUCTION

Change in the built environment is continuous, and even minute modifications to existing buildings and landscapes can produce a valuable digital trail. Local historic preservation boards debate the appropriateness of remodeling activity and additions to older buildings, issuing certificates of appropriateness. Various forms of adaptive reuse and demolition generate a record of site plan reviews and building permits. The paper trail can be converted into geospatial data that is made publicly available.[1] In cities such as Los Angeles, Detroit, and Austin, data gathered in historic resources surveys have been integrated into local government records in geographic information system (GIS) data sets and open government portals (Bernstein and Hansen 2016; Bertron 2013a; Bertron 2013b; Minner et al. 2015). Proposals for new infill buildings in downtowns

and historic districts are reviewed for compatibility with existing urban fabric, and in the process, building information models and other forms of 3D models are produced. In some cities these 3D models become public information made readily available to the public (Minner and Chusid 2016). As local governments share, the store of knowledge about a community's history and processes of change expands. Just as local government street tree inventories have been used to generate mobile apps that help open people's eyes to the trees around them (Townsend 2013), other forms of publicly available data about historic resources can be used to open our eyes to the past, present, and future of heritage.

While local governments churn out data at a hyperlocal scale, state and federal government agencies also produce and make publicly accessible large stocks of geospatial data about the environment and demographics that provide the basis for understanding trends in society and the built environment.[2] The geospatial "data exhaust" produced from bureaucratic and scientific processes carried out or funded by the public sector can feed deeply creative, community-building endeavors. Meanwhile, a robust and evolving ecosystem of open-source and proprietary GIS and 3D tools opens up an expanding range of methods of analysis.

When readily produced and publicly shared, geospatial data and a variety of analytical and participatory GIS tools can spur scholarship that probes change in society, culture, and the built environment. In this article, I provide a scan of the uses of publicly available geospatial data and the expanding universe of geographic and architectural tools. I seek to answer the question: What implications do a growing number of geospatial datasets and geographic technologies and methods have for historic preservation? I find examples of the power of sharing geospatial data and GIS-based methods. I argue that digital humanities, historic preservation, and urban planning are converging in important areas: (1) in our shared understanding of the patterns of urban history through spatial humanities, (2) in methods of understanding opportunities and barriers to preserving historic resources and widening the scope of concern for preservation to address building stock as a whole, and (3) in our abilities to visualize and analyze alternative future scenarios for historic resources. While the use of GIS in digital humanities and historic preservation is relatively mature, there remains much more that historic preservation professionals and educators can do with the geospatial data and 3D models generated in everyday processes in the built environment. Finally, I stress that if geospatial data is archived with both the future and the past in mind, continues to be shared openly with the public, and is used in participatory processes and public education, the participatory and analytical methods in digital humanities and historic preservation will grow. This trajectory is not a given, but requires stewardship of geospatial data; new partnerships, pedagogical approaches, and educational initiatives; and the involvement of historic preservation and other allied fields to inform the development of new technological tools.

GEOSPATIAL DATA, TECHNOLOGY, AND INTERDISCIPLINARY ALLIANCES

A central function of historic preservation is to build an inventory of places that matter to a community. From Certified Local Governments to the National Register of Historic Places to UNESCO world monuments and sites, a first step in preservation planning is the creation and maintenance of a database of historic resources. This project of inventorying and mapping places enables one to appreciate the scope of preservationists' concern, from the buildings and sites of cultural significance to intangible heritage that is rooted in place (Buckley and Graves 2016; City Lore and Municipal Art Society, n.d.)

Beyond basic mapping, the adoption of geographical information systems as a technology enables the analysis of multiple layers of historic and contemporary data. This layering has the potential to transform methodologies used in understanding local history, place, and the scope of historic preservation. In applying GIS to the study of cultural landscapes and heritage, Fitzjohn (2009) writes: "[GIS] provides an environment where our varied types of archaeological, historic or even public participatory data can be collated and juxtaposed, evaluated and layered with the non-traditional data so that we can start to think and speak about place in new ways" (249). The use of GIS not only enables researchers to employ and compare more layers of data; it can have a significant impact on research outcomes and emerging disciplinary approaches.

Gregory and Geddes (2014) describe "historical GIS," or HGIS, as emerging in the 1980s with debates about the implications for scholarship in history and the humanities. Some scholars expressed concern that GIS would enforce more quantitative and social sciences approaches to history that would overshadow the humanities. Instead, HGIS has evolved to encompass an expanding set of methods that include qualitative research. Gregory

and Geddes assert that the term HGIS, with its emphasis on the specific tool of GIS, is "increasingly being replaced with the term 'spatial history,' an expression that stresses doing a form of history that emphasizes geography" (Gregory and Geddes 2014, xiv). They observe that as GIS has matured as a technology and as practices in both the social sciences and humanities have evolved in response, GIS has become a means of both deepening social science–based HGIS and spurring scholarship in emerging "spatial humanities" (xiv).

While the field of spatial humanities has emerged as a result of new forms of geographic analysis, a broader revolution has been occurring with web-based technologies that enable public sharing of geospatial data and research. This revolution involves new means of interpreting urban history and public history via web-based portals and mobile applications. This trend has grown along with expectations of government agencies to provide open data. This has produced new streams of information accessible to scholars and the public, and also new forms of participation in this production of historical knowledge. This includes web-based approaches for crowdsourcing of digital imagery for heritage purposes (Stathopoulou et al. 2015) and web-enhanced public participation in the collection of information in historical surveys (Minner et al. 2015; Bernstein and Hansen 2016).

Historic preservation is an area of research and a practice that straddles architecture, planning, geography, materials conservation science, engineering, and social sciences. In an effort to articulate the melding of science and allied design fields, Carl Steinitz (2012) coined the term "geodesign." He has observed that GIS enables interdisciplinary practices in design, in which information about abiotic and biotic environmental systems are brought together with information about society (Steiner 2008; Steinitz 2012). In the context of historic preservation, this comingling of social and scientific information includes data about land ownership, historical and cultural significance, scientific knowledge about building materials, and processes of natural deterioration and landscape change.

The tools that historic preservation plies in practice and in research range according to scale—from the individual building, site, or object to the geographic scale of the district, neighborhood (Stewart 2001), and cultural landscape (Minner and Chusid 2016). Geodesign practices that bring together layers of 2D information could also benefit from bridging the disciplinary divide between the 3D tools more common within architecture and the 2D GIS methods used in urban planning. While there have been advances in the integration between 3D modeling and GIS, this divide has not been sufficiently bridged. Architects tend to use computer-aided design and building information modeling tools that are not fully integrated with the 2D GIS tools used by planners and geographers and that have been adopted in spatial history and digital humanities. Gaps between the tools, data, and models can be overcome through the collaboration of interdisciplinary experts. These gaps can also become fertile ground for innovation, where preservation professionals and scholars engage in advocating for or creating new technologies and methods that begin to address these disciplinary gaps

There is a need to critically assess available geospatial data and geodesign tools (Wilson 2015), including the articulation of their shortcomings and possible areas for future improvement. As noted above, there have been a wide range of technological advances for gathering, sharing, and analyzing geospatial data, which have produced new participatory and analytical techniques that can enrich historic preservation. There are spatial statistical GIS tools that have for too long been sequestered within other disciplines such as archaeology, geography, and the social sciences. Their application in preservation research could advance heritage theory and practice.

The next three sections focus on advances in spatial humanities, historic preservation, and planning in areas grouped by the direction of inquiry, from deepening our understanding of the past, to developing a deeper knowledge of present conditions, to the creation and analysis of possible futures. The examples that follow provide windows into the ways in which geospatial data, GIS tools, and spatial methods are transforming disciplines and uncovering the spatial dimensions of preservation and local history.

OPEN PORTALS TO THE PAST, MAKING OF URBAN HISTORY

As discussed by Francesca Russello Ammon (2017) in this volume, strides have been made in recent years in digital humanities initiatives such as the digital scanning of archival records. She describes the City of Philadelphia's georeferenced historical photographs available through an online photo archive called PhillyHistory.org (Ammon 2017; City of Philadelphia 2017). On another online portal, Mapping Inequality (Nelson et al. 2017), federal Home Owners' Loan Corporation (HOLC) maps from the New Deal era are available digitized and georeferenced (Figures 1 and 2). This online resource was

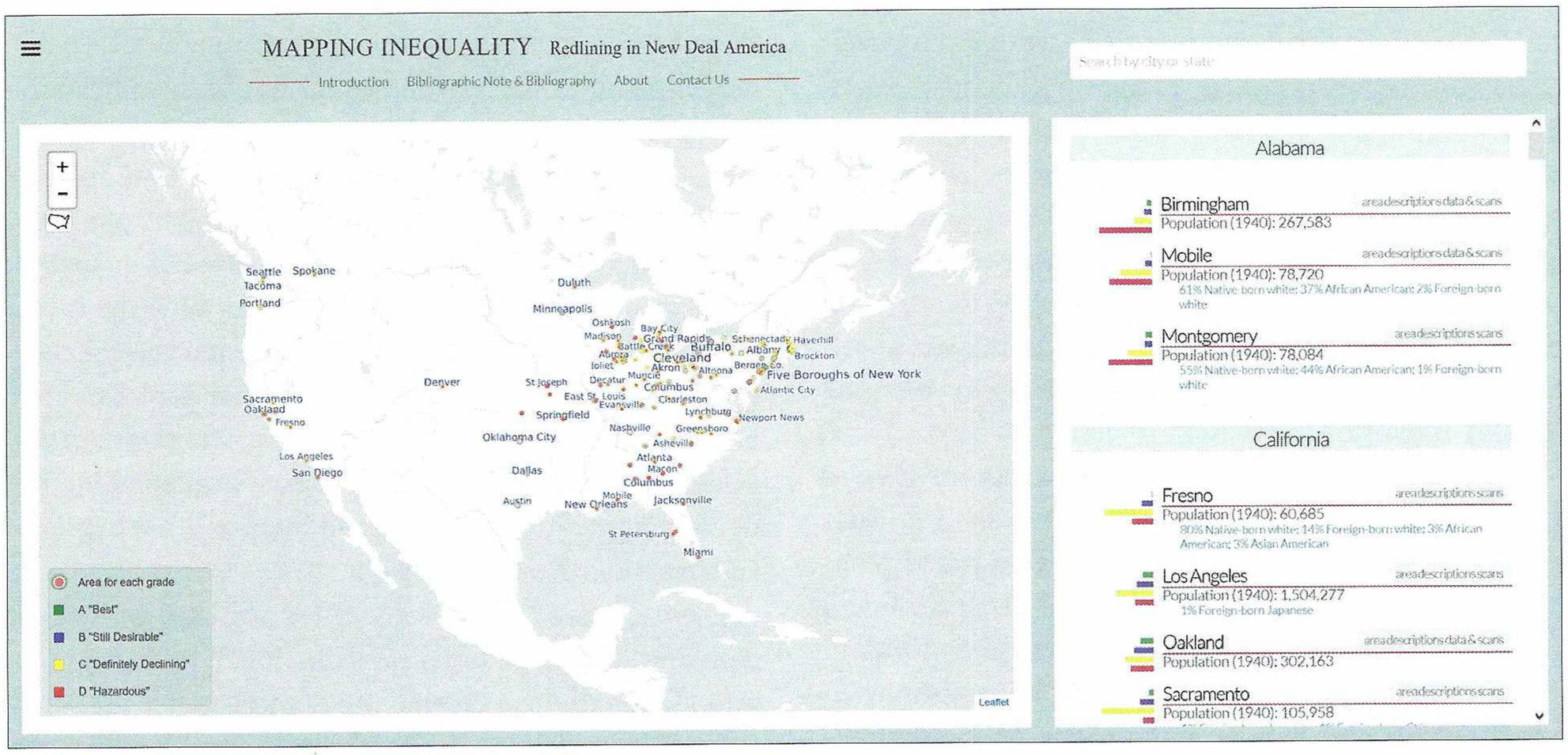

Fig. 1. This image shows the many cities for which georeferenced HOLC maps are available on the Mapping Inequality web portal. (Courtesy of Robert K. Nelson, LaDale Winling, Richard Marciano, Nathan Connolly, et al. The portal and its data are licensed under a Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License.)

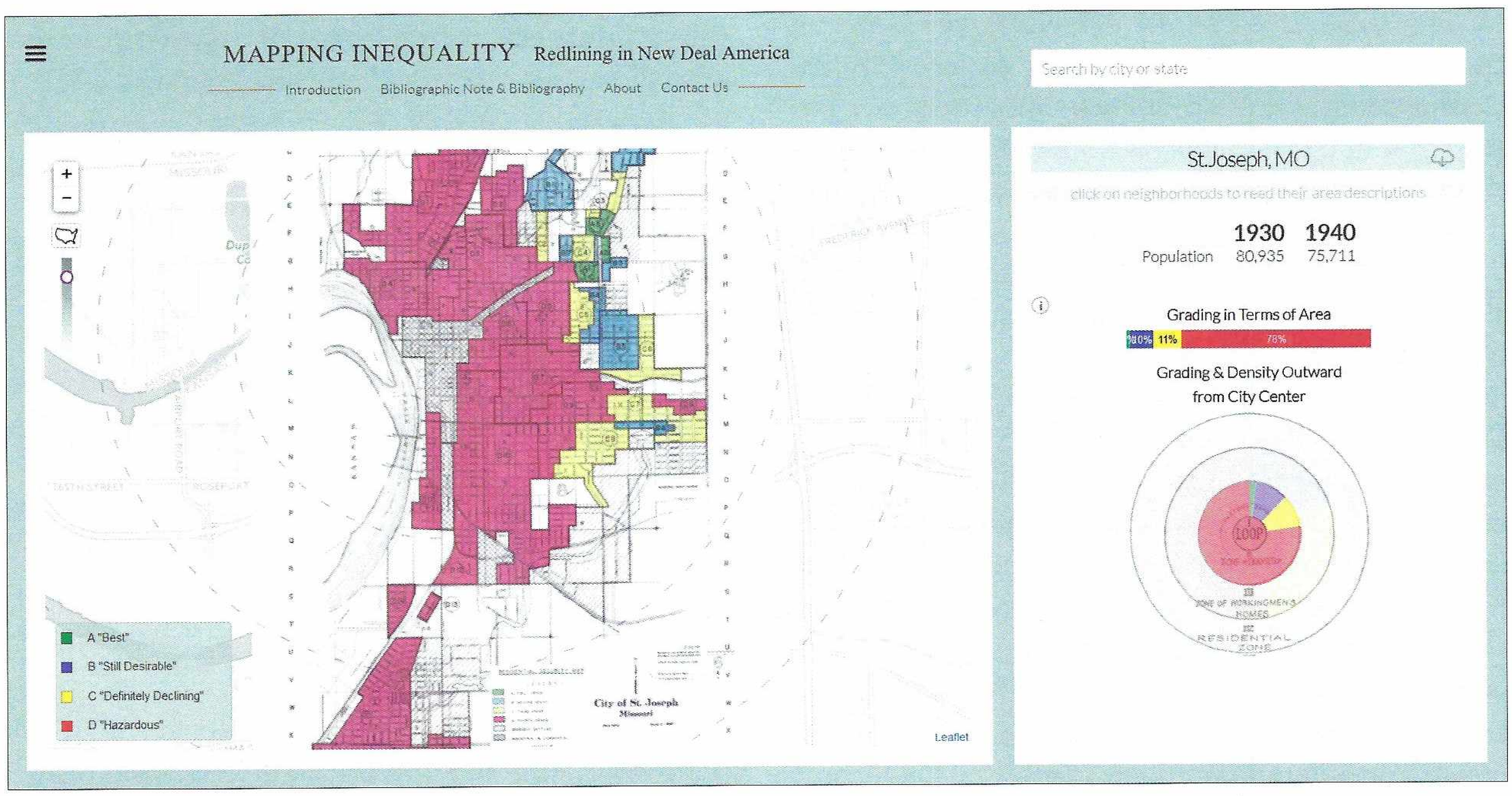

Fig. 2. This image of the Mapping Inequality web portal shows a georeferenced HOLC map for St. Joseph, Missouri. (Courtesy of Robert K. Nelson, LaDale Winling, Richard Marciano, Nathan Connolly, et al. The portal and its data are licensed under a Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License.)

produced through the efforts of researchers at multiple universities and builds on other university-based efforts across the country. More than 150 maps have been made available for cities throughout the United States.

The online portal allows researchers to view the HOLC maps that were used historically to determine the level of risk for public and private investments in urban neighborhoods. HOLC maps utilized a grading system, which ranked neighborhoods in terms of "Best," "Still Desirable," "Definitely Declining," and "Hazardous." The maps are an important resource for analyzing the extent to which redlining reinforced racial discrimination by creating defined zones where residents were likely to have been denied access to capital to purchase or improve their homes (Gotham 2002; Jackson 1985; Silver 1997; Stuart 2003; Woods 2012). The portal is valuable for educational, interpretive, and research purposes. The online resource allows users to download georeferenced, digitized maps and underlying shapefiles, enabling researchers to use data in their own research.

As indicated by the growing availability of online tools, scholarship on urban history has advanced in recent years to incorporate geospatial data and GIS-based analyses of historical data. Other examples include the mapping of racial covenants by Tretter and Sounny-Slitine (2011) in Austin, Texas. This effort led to a deeper understanding of the history of regulation through private agreements, which shaped whole subdivisions and districts of the city, dictating where people could live through exclusions based on race, ethnicity, and religion. This research was integral to the development of a subsequent critical environmental history of Austin (Tretter 2016). Another example is research by Gordon (2008) mapping redlining, suburbanization, and the distribution and impacts of economic development efforts and urban renewal in St. Louis. In these examples, the patterns of discrimination and segregation that affected the development of urban neighborhoods becomes newly visible through spatial data and geographic analysis. Thus, the store of historical maps that predate the era of "big data" can be transformed into a significant geospatial resource. These resources can in turn be used in interpretations of the past as well as an understanding of past processes of urban development.

EXPANDING PRESERVATION'S BREADTH AND SCOPE OF CONCERN TODAY

A robust geospatial data stream has enabled preservation to expand upon its traditional focus on the preservation of individual historic buildings and districts into informing a broader set of urban policies related to and affecting the built environment. The Preservation Green Lab, the research wing of the National Trust for Historic Preservation, has focused in recent years on initiatives that push the purview of historic preservation beyond officially designated or eligible historic resources to wider concerns about urban form and building stock. In a report titled *Older, Smaller, Better: Measuring How the Character of Buildings and Blocks Influences Urban Vitality*, the Preservation Green Lab brought together local government, federal, and proprietary geospatial data to probe relationships between older building stock and indicators of urban vitality (Powe et al. 2016; National Trust for Historic Preservation 2017a). The research empirically tested Jane Jacobs's hypothesis that older, ordinary building stock is integral to making urban neighborhoods vital (Jacobs 1958; Jacobs 1961; Powe et al. 2016). The study was initially undertaken in a limited number of cities undergoing substantial population growth and redevelopment pressure, including Seattle, San Francisco, Tucson, and Washington, DC. Another series of related studies undertaken by the Preservation Green Lab and the Urban Land Institute identified opportunities and barriers to building reuse in Baltimore, Detroit, Chicago, Philadelphia, and Los Angeles (National Trust for Historic Preservation 2017b). In these Partnership for Building Reuse reports, a series of maps identified opportunity areas for building reuse. A subsequent similar analysis was produced for Jacksonville, Florida (National Trust for Historic Preservation–Preservation Green Lab and Jessie Ball duPont Fund 2017).

The collection of local and national geospatial data enabled the Preservation Green Lab to produce the *Older, Smaller, Better* and the Partnership for Building Reuse reports. Maps from these efforts to examine both the attributes of building stock and social and economic indicators are publicly shared via a geospatial portal called the Atlas of ReUrbanism (Figure 3) (National Trust for Historic Preservation 2017a). Although information was only available for a handful of cities on the Atlas at the time this article was written, the Preservation Green Lab plans to roll out information for additional major metropolitan areas across the country (Powe et al. 2017).

Mapping of publicly available data and the use of spatial regression techniques were central to the creation of a character score, made available on the Atlas and in the aforementioned *Older, Smaller, Better* and

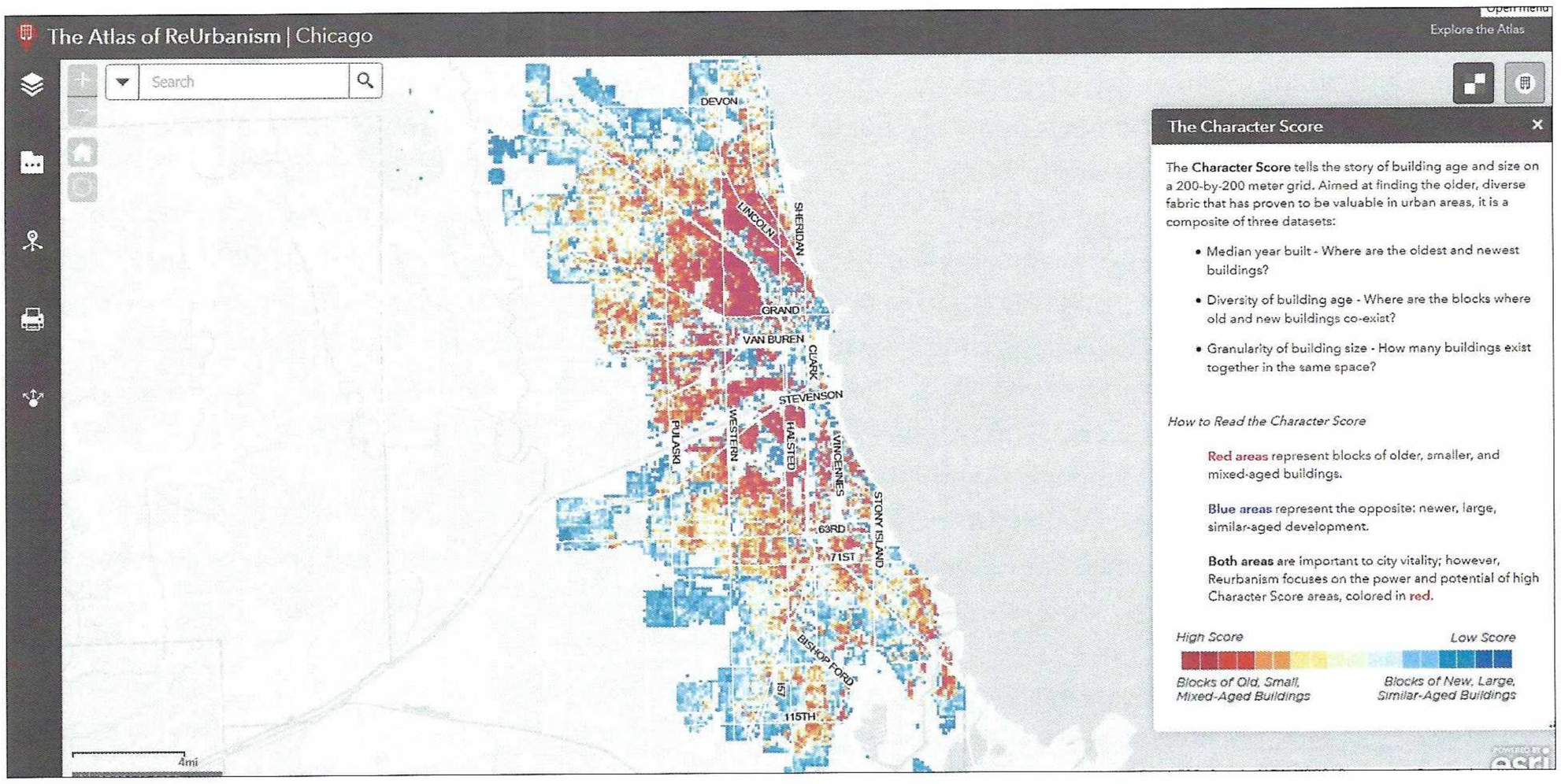

Fig. 3. This image of the Atlas of ReUrbanism shows the character score for building stock in Chicago, Illinois. (Reproduced by permission from National Trust for Historic Preservation – Preservation Green Lab.)

Partnership for Building Reuse reports. The character score is a "composite of building age, diversity of building age, and the average building size, or granularity, of the built environment" and is used in testing relationships between attributes of the built environment and "social and economic density and diversity" (National Trust for Historic Preservation–Preservation Green Lab and Jessie Ball duPont Fund 2017, 17). The Atlas of ReUrbanism makes the character score and other underlying geospatial data interactive, searchable, and digestible by the public and decision-makers. Spatial methods of inquiry, which can extend our understanding of the built environment, are growing in tandem with a global paradigm shift in which preservation efforts are reconnected to surrounding urban fabric in the interest of holistic heritage planning (Bandarin and van Oers 2014). In this case, the Preservation Green Lab has increased the relevance of preservation in policy making and urban planning, by expanding its scope to include the use of older building stock as a whole as a resource.

Within "legacy cities" that have seen population decreases in recent years, mapping efforts and online portals have proven to be useful in collecting and disseminating information about vacant land and abandoned properties. A massive effort to inventory vacant land and abandoned property across Detroit (Davey 2014), involved not only the collection of data about properties but also its dissemination on a public portal called Motor City Mapping (Figure 4). The effort included development of a mobile application to allow "blexting," in which community members use their smart phones to gather photographs and add to or correct data in the inventory of vacant and abandoned properties. Initially, the effort was primarily focused on identifying properties for demolition, especially in areas designated for the use of federal Hardest Hit Fund assistance. However, preservation groups rallied around an effort to survey historic resources to complement the Motor City Mapping project (Scola 2014; Evans 2014). The effort was aimed at preventing the demolition of historic resources.

This example illustrates the potential for apps and geospatial portals to enhance preservation efforts, but it also illustrates limitations. While data about building conditions are still available on the Motor City Mapping website, that website has been archived. Now the building condition data is available on a new website by Loveland Technologies, a private sector company. The results of the historic resources survey were placed in a publicly accessible location, but they no longer appear to be integrated into either the archived Motor City Mapping portal (Loveland Technologies and Data Driven Detroit, n.d.) or a more recent version of the portal called Loveland (Loveland Technologies 2017).

Cities with strong markets and redevelopment threats to historic resources have also put historic resources surveys to work in generating preservation intelligence for

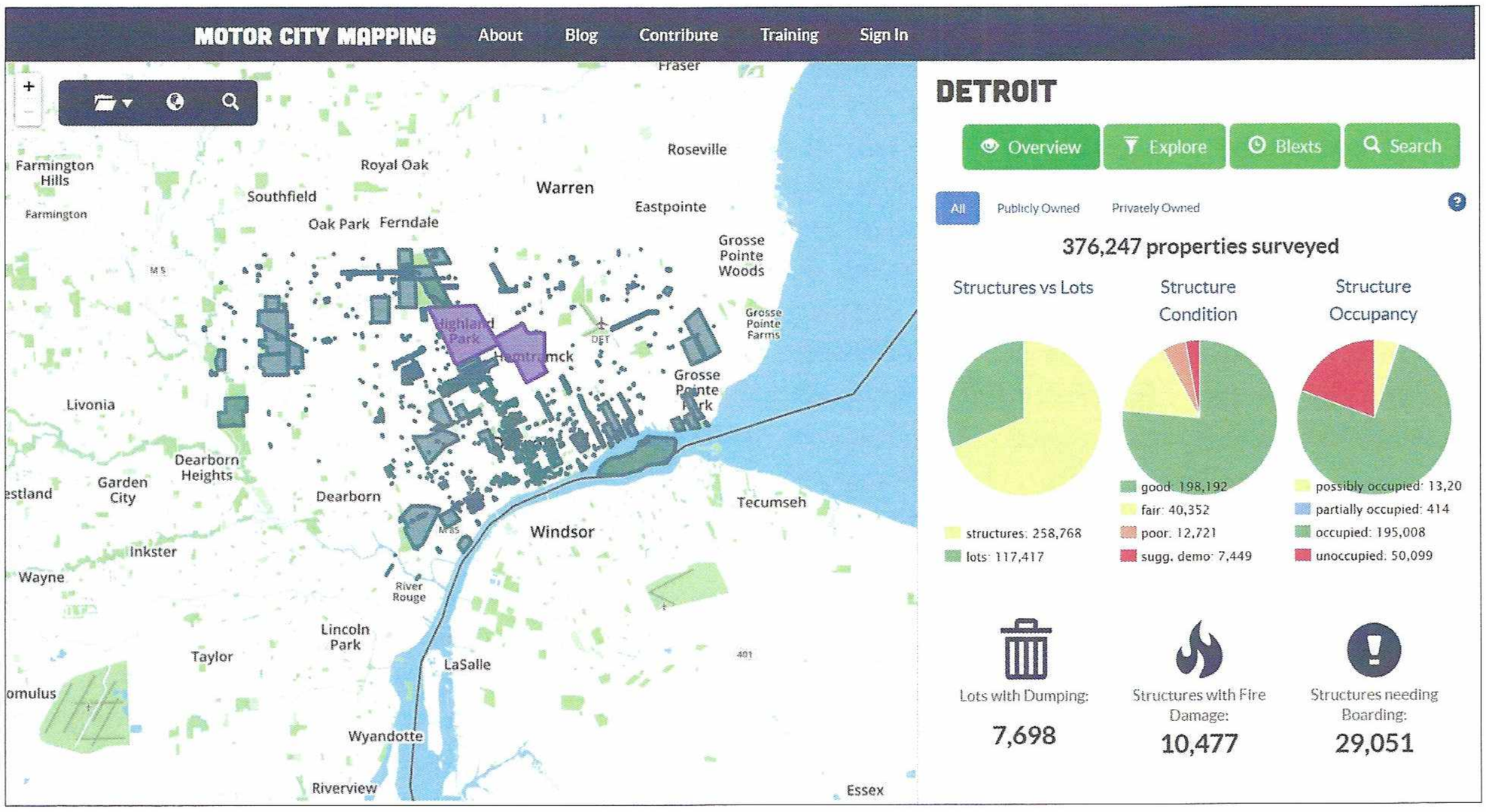

Fig. 4. This image of the Motor City Mapping website shows its display of existing and potentially eligible historic districts. (Reproduced by permission from Loveland Technologies.)

planning processes. These efforts have both benefited from and produced geospatial data and have involved the creation of new geospatial tools. SurveyLA is the City of Los Angeles' multiyear, multimillion-dollar effort to survey more than 800,000 parcels for historic resources (Bernstein and Hansen 2016). The process involved the creation of a new GIS toolbox for professional consultants to use to survey cultural resources in the field. In Austin, Texas, a participatory web-based survey tool was created to enable both professional and community-based efforts to survey historic resources (Minner et al. 2015). The web-based survey tool enables the two-way flow of information between local government and community members.

In both legacy and rapidly changing communities, spatial statistical methods, such as were applied by the Preservation Green Lab, can be used to examine building stock and the distribution and impacts of demolition in the built environment. In another example, Yin and Silverman (2015) built a spatiotemporal database for Buffalo, New York, and applied hedonic price models and logistic regression to understand the spatial distribution and effects of demolition. A study by Hillier et al. (2003) used logistic regression to bring together spatial and temporal data to predict housing abandonment in Philadelphia. In this case, GIS and spatial regression methods are useful not only in identifying areas for building reuse or in examining the impacts of demolition, but also in making predictions that help in directing efforts toward preventative preservation. Spatial analysis and hedonic price modeling have also been used to assess the effects of historic designations and cultural heritage on property values (Lazrak et al. 2014).

Cultural landscape preservation and "landscape scale" preservation efforts can also benefit from techniques that use geospatial data. For instance, Agapiou (2017) describes the use of remote sensing and spatial statistical techniques to understand threats to UNESCO world monuments. Remote sensing uses technologies to capture images based on electromagnetic energy, which "emanates from areas or objects on (or in) the Earth's land surface, oceans, or atmosphere" (Khorram et al. 2012, 2). Remote sensing techniques can be used at a variety of scales and employ different types of sensors. In concert with digital image processing and GIS software, remote sensing techniques are increasingly used in archaeology, the sciences, and urban planning. Lidar (Light Detection and Ranging) from either satellites or unmanned aerial vehicles (UAVs, otherwise known as drones) and high-resolution imagery are used in archaeology (Parcak and Tuttle 2016) and have been used in mapping sea level rise (Ju et al. 2016). Terrestrial laser scanning and georeferenced terrestrial photogrammetry are techniques that

can be used in the documentation of cultural resources (Francis 2016).[5] Remote sensing has been used to create detailed land cover layers at the regional and national scale to understand processes of urbanization and landscape change. For historic preservation and digital humanities, remote sensing techniques can be used to gather information about historic resources that are hard to survey, as well as human-made threats and natural hazards that jeopardize the preservation of historic resources. For example, hyperspectral imaging in conjunction with other remote sensing techniques has been employed in the development of a tool for monitoring historic buildings in seismic areas in Italy (Montuori et al. 2016).

All of the aforementioned examples involve the production and use of geospatial data and utilize geographic tools and methods in ways that expand the focus of preservationists beyond the scale of individual buildings to larger geographic areas. Understanding temporal change is another area of potential development. This may be achieved through innovations in spatiotemporal methods of analysis that can inform an understanding of the distribution of and change among historic resources, as well as the continual and dynamic modifications of and investments in ordinary buildings (Minner 2013) and the built environment as a whole.[6]

GEOSPATIAL DATA AND SCENARIO PLANNING TO ADDRESS THE FUTURE

With information about the location of historic resources in hand, a next step is to plan for their future. Methods of visualization and scenario planning can further expand the knowledge of historic resources in space and time. For the preservation of individual historic resources, understanding alternatives involves visualizing potential changes, often by examining 2D site plans and schematics that detail modifications to buildings. The analysis of alternatives at the district scale involves examination of site plans, elevations, and massing models to understand the visual impacts of new construction on historic resources. To assist in these visualizations, some communities are beginning to require 3D digital models for proposed development. In Portsmouth, New Hampshire, the municipal government requires developers to submit a 3D model of major projects in the downtown historic district (Minner and Chusid 2016). The 3D model is then placed in a 3D representation of its context, using a 3D GIS platform, to enable public comment and deliberation in development review. This represents an advance in visualization of the future scenarios to support decision making about preservation and planning by placing architectural 3D models in their larger spatial context.

Climate change research has spurred concern at a global and national scale for understanding potential impacts on and the future of cultural resources (Sabbioni et al. 2012; National Park Service 2013). Rockman (2015) points out that inventories of cultural resources should "prioritize areas that are most at risk from broad geographic climate impacts" (42) and emphasizes the need to link cultural resource databases with GIS in these efforts. Advances in remote sensing and predictive modeling described in the previous section can facilitate these efforts. In an analysis of statewide hazard mitigation and historic preservation planning, Appler and Rumbach (2016) use publicly available data to examine the vulnerability of historic resources to flooding, one of many potential natural hazard events that may increase as a result of climate change. In doing so, they highlight both the value of publicly available geospatial data about flooding hazards and the analytical tools afforded by the use of GIS.

Another predictable threat to historic resources is in the completion of large-scale transportation and redevelopment projects. The Department of Transportation Act of 1966's 4(f) rule and the National Environmental Protection Act are examples of federal legislation that anticipate the potential impacts of large projects on historic resources. This legislation requires review processes aimed at mitigating potential adverse impacts to historic resources resulting from federally funded projects. However, at the local scale there are few planning tools to assist in assessing the potential impacts of local transportation and redevelopment projects.

A GIS-based scenario-planning tool called the Corridor Housing Preservation Tool (CHPT) was recently developed to measure the relative benefits of affordable housing units and access to jobs along transit corridors, as well as assessing vulnerability of the affordable housing units to redevelopment (Hilde, Mueller, and Torrado 2016; Mueller, Minner, and Steinberger 2017). The CHPT is available in Envision Tomorrow, a suite of freely available planning tools (Fregonese Associates, n.d.). Planners can prioritize transit corridors and other areas for affordable housing preservation efforts using the tool. Use of the tool requires access to a GIS software package, the download of a free Excel tool, and local data about building permit activity.[7] The scenario-planning tool can be downloaded

with a geospatial dataset constructed using public datasets from the Environmental Protection Agency and the Department of Housing and Urban Development. The CHPT has value for both planning and preservation practitioners and scholars, as it aids in probing the value of existing building stock and prioritizing preservation efforts. In addition, it is conceivable that a similar scenario-planning tool could be developed with indicators for the relative benefits of building stock and measures of redevelopment pressure and vulnerability on historic resources in redeveloping areas.[8]

STEWARDSHIP OF PUBLICLY AVAILABLE DATA

A common denominator among the diverse sets of public education, preservation research, and spatial history and preservation efforts described above is the availability of geospatial data. High quality, available data for digital humanities, historic preservation, and studies of communities' building stock is of utmost importance. The archives that store and provide access to historical information have long been recognized as a resource. With trends toward digitization of government records and the open sharing of government information online, it would be easy to overlook uncertainties about the availability of data in the future. However, a statement by the president of the American Association of Geographers offers a cautionary note by describing a "direct and dangerous" attack against "geospatial data and geographical research that could have a dramatic chilling effect on applied geographical research and ultimately on racial equality in the United States" (MacDonald 2017, n.p.). The statement describes proposed legislation to prohibit the use of federal funds "to design, build, maintain, utilize, or provide access to a Federal database of geospatial information on community racial disparities or disparities in access to affordable housing." MacDonald goes on to point out the troubling nature of this legislation: "Not only would the creation of new Federal geospatial databases on racial disparities be prohibited, so too would access to existing geospatial information of this sort and the use of Federal funds from agencies such as the National Science Foundation to study such data" (MacDonald 2017, n.p.). The proposed restrictions expose the vulnerabilities of public geospatial data to public policies and funding shifts that could undermine its collection and dissemination. Strong public support for open government data must be maintained. New partnerships between public, nonprofit, and private sectors should advocate for and take actions to preserve the valuable digital trails that are vital to developing a fuller picture of past and present conditions and in forging consensus toward policy directed at the future.

Archiving of detailed geospatial data is essential. Local historians, preservationists, and urban planners have a stake in making sure that local government geospatial data is not only up to date and shared, but that the geospatial data produced in the past remains available. When GIS data is updated, it should be done in such a way that data from prior years is maintained and remains accessible for the study of change in the built environment over time. As an example, value accumulates as georeferenced building permit data is added year after year. This allows for longitudinal study of the composition and spatial distribution of rehabilitation and remodeling activities, new construction and demolition. These detailed records can help analysts understand incremental change in the built environment. For the digital humanities, this cumulative record can help to build more detailed and accurate narratives of change. Given that local government agencies may not recognize an immediate business need for archiving detailed information, partnerships with nonprofit and private sectors may be required.

The complexities of how various actors find opportunities, incentives, and means to archive and share geospatial data are formidable; however, there are actionable ways of striving toward new forms of collaboration. With preservation scholars providing both in-depth statistical analysis and geoportals, such as the Atlas of ReUrbanism, that have broader usability, the gap between digital humanities and urban policy making begins to close. The Atlas of ReUrbanism highlights social and economic benefits from the retention of existing building stock with urban policymakers in mind. In addition, Yin and Silverman's (2015) spatial statistical research in Buffalo found that public investment in demolitions does not translate into intended benefits. Similar analyses of readily available public data can encourage informed deliberation about the most effective uses of increasingly scarce public funds. Both examples demonstrate the relevance of historic preservation to urban planning and policy making, further strengthening what has been at times an uneasy alliance (Birch and Roby 1984; Minner 2016).

Preservation educators can take steps to develop in students a greater understanding of geographic processes and methods of analysis. Skills in GIS are often viewed as optional, rather than requirements of a preservation education. Preservation education would benefit not

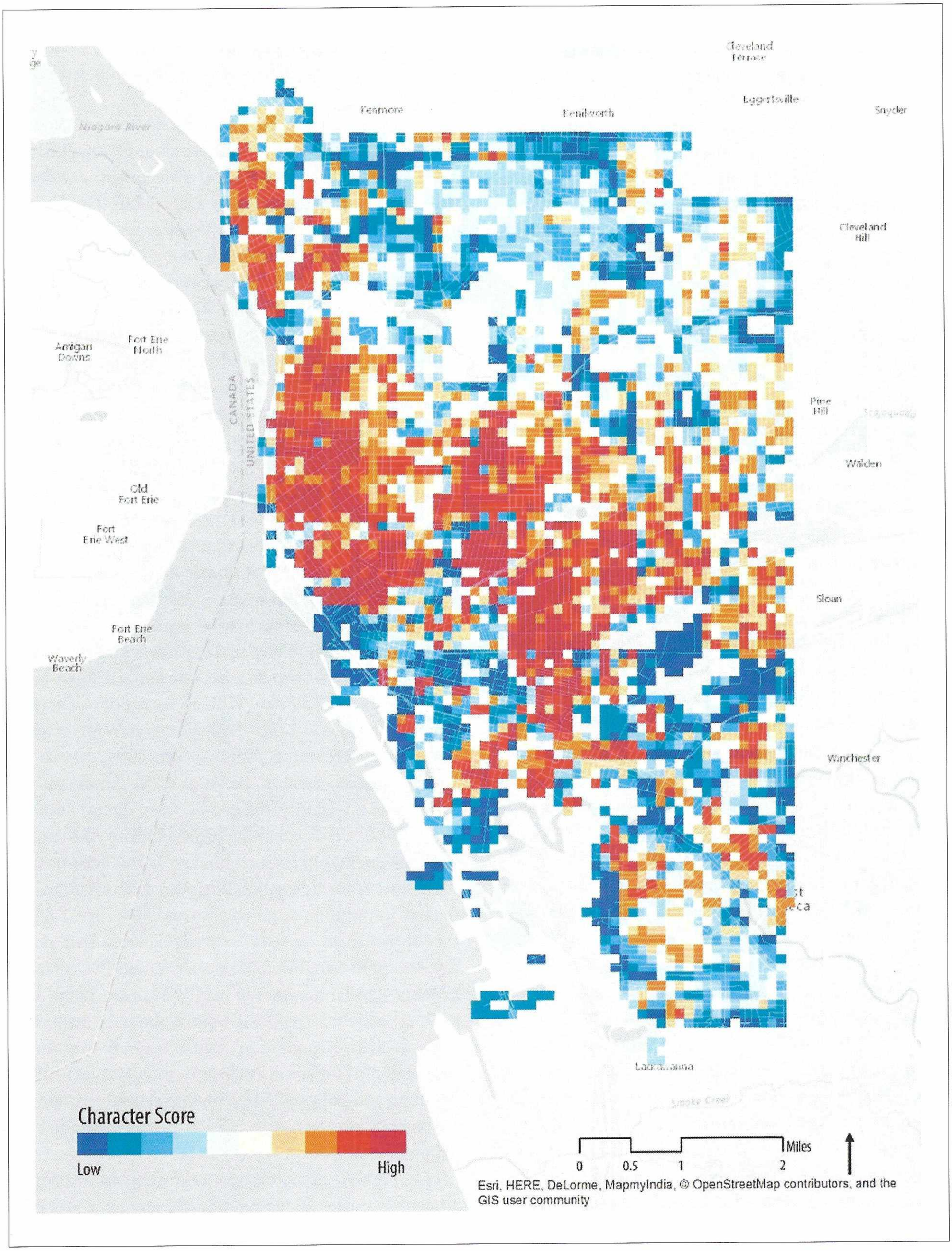

Fig. 5. This is a map of the Preservation Green Lab's character scores for Buffalo, New York, which students in a workshop at Cornell University used as the basis for further investigations. (Map produced by Zach Small.)

only from GIS as a skill but from ensuring that students have a working knowledge of local government planning and geographic inquiry. At Cornell University, in a joint master in historic preservation and city planning workshop called the Equity Preservation Workshop, graduate students engaged with the Preservation Green Lab, the Preservation Rightsizing Network, and Preservation Buffalo Niagara in researching connections between "national preservation and building reuse policy and local communities" (Minner et al. 2017, 6) and providing "a snapshot of Buffalo's preservation climate, while highlighting the challenges and opportunities that neighborhoods face in preserving the built legacy of the city" (ibid.). Using spatial statistical methods to analyze data from the Atlas of ReUrbanism and municipal building permit data from the City of Buffalo (for example, see figures 5, 6, and 7) in concert with other means of inquiry such as interviews with community leaders, visual observation, and document analysis, students pulled together an analysis of the geography of reinvestment and the extensive types of community preservation strategies being employed in Buffalo. They also developed a toolkit of policies and preservation strategies applicable in communities across the country.

Demonstrations of the usefulness of geospatial data streams and ways to analyze them can catalyze future interdisciplinary efforts among the next generation of professionals and scholars. This can be accomplished through new collaborations and experiments in the use of geospatial data and spatial methods. Preservation education and research should encourage preservationists to press for better tools to unite the architectural and geographic within GIS and 3D modeling tools (Minner and Chusid 2016), and they should be encouraged to be creative and entrepreneurial in the creation of new tools and methods. New community, professional, and academic alliances can be forged and aimed at producing technological advancements (Drummond and French 2008). These alliances should embrace digital humanities and include partner libraries and archives (Wong 2016).

It is important to emphasize that there are likely formidable challenges for the expansion and provision of access to digital humanities collections consisting of data that is not directly related to patterns of investment, urban policy making, or the geospatial data streams produced from government records related to taxation and property development. We must discourage assumptions that all data must directly serve economic interests or political deliberation. Unfortunately, solutions to full public funding seem elusive within the United States, where there appears to be little political will to support the humanities. Furthermore, a pressing challenge is how to address barriers to realizing a more diverse cultural heritage as represented in digitized collections. A preliminary analysis by Martin and Runyon (2016) on funding by the National Endowment for the Humanities, a major source of funds for the digital humanities, reveals "systematic inequalities in digital humanities funding based on race and gender" (26). Expanding the diversity and accessibility of digital humanities can benefit preservationists and society at large, by providing a solid foundation for stewardship and interpretation of the built environment. This can help to address critiques that preservation is too focused on preserving particular kinds of architecture or reinforcing aesthetic taste (Longstreth 1994), that it is overlooking opportunities to preserve social history (Hayden 1995; Page 2016), and that it is missing opportunities to further community and cultural preservation.

Advocacy and outreach initiatives are necessary to reestablish the political will for equitably funding digital humanities. It is time for vocal "town and gown" efforts to advocate for the continued flow of geospatial data from public agencies. It is also necessary to press for full public support for increasing and preserving the reservoir of available geospatial data and to demonstrate the value of its use in professional practice as well as scholarship.

CONCLUSIONS

Geospatial datasets are the outcome of processes of government regulation, taxation, and innovation in an era of smart cities and big data. Historic preservation can benefit from the digitization of historical sources as well as publicly available geospatial datasets that are currently being produced. Spatial datasets and methods are bringing together once-disparate sources of information and methodologies divided by discipline. Interdisciplinary alliances are being forged through advancements in spatial history, spatial humanities, and geodesign. Geospatial methods and geographic approaches can help in understanding historic patterns of development over time and space, which are useful in the development of local histories, in historical surveys, and in understanding processes of community revitalization as well as gentrification and disinvestment.

Publicly available geospatial data and spatial analysis techniques were central to the Preservation Green Lab's *Older, Smaller, Better* and Partnership for Building Reuse reports. This research illustrates how preservation and

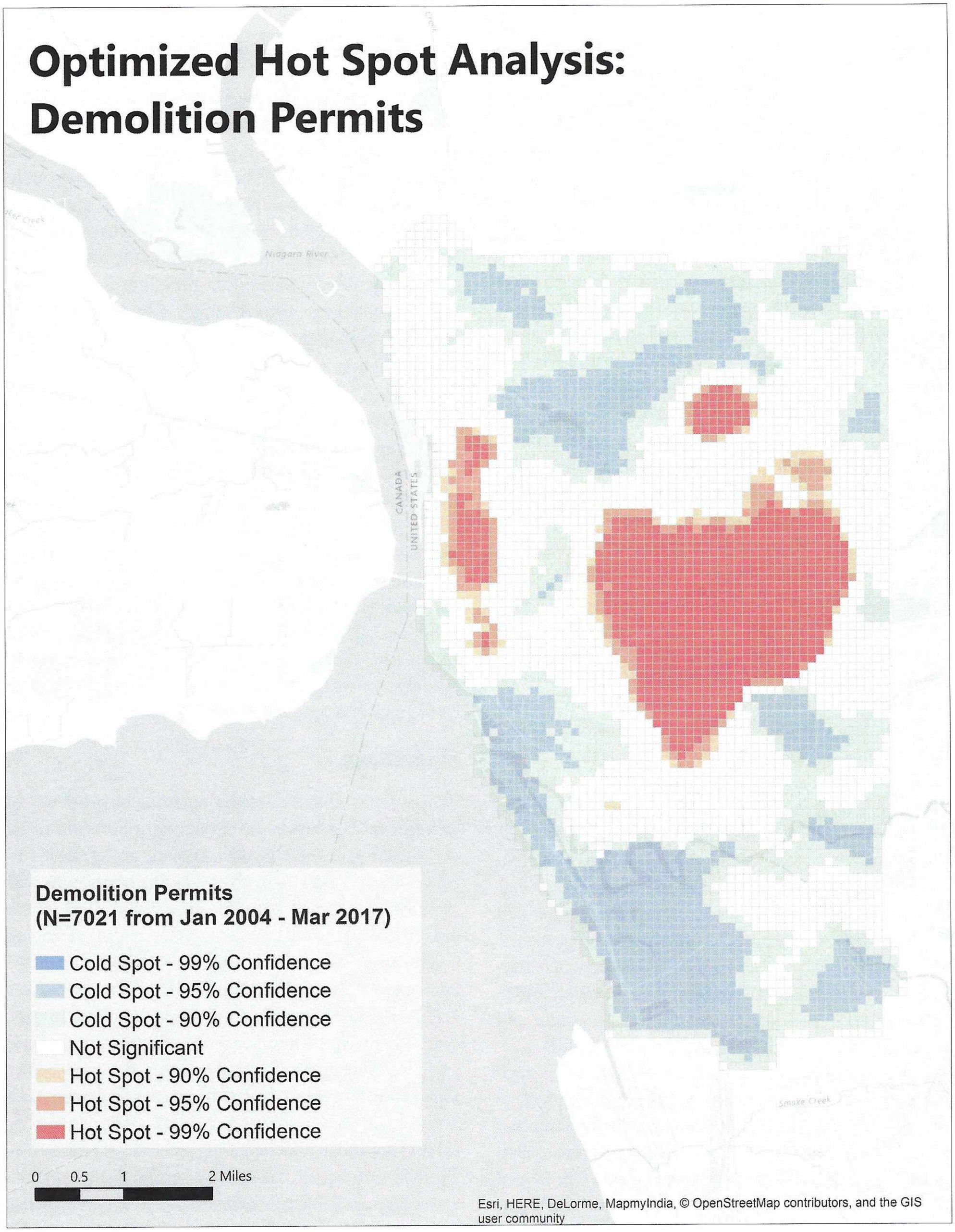

Fig. 6. This map shows hot spot and cold spots for demolition permits in Buffalo, New York, between 2004 and 2017. (Map produced by Jennifer Minner and Tom Pera. Demolition permit data provided by the City of Buffalo.)

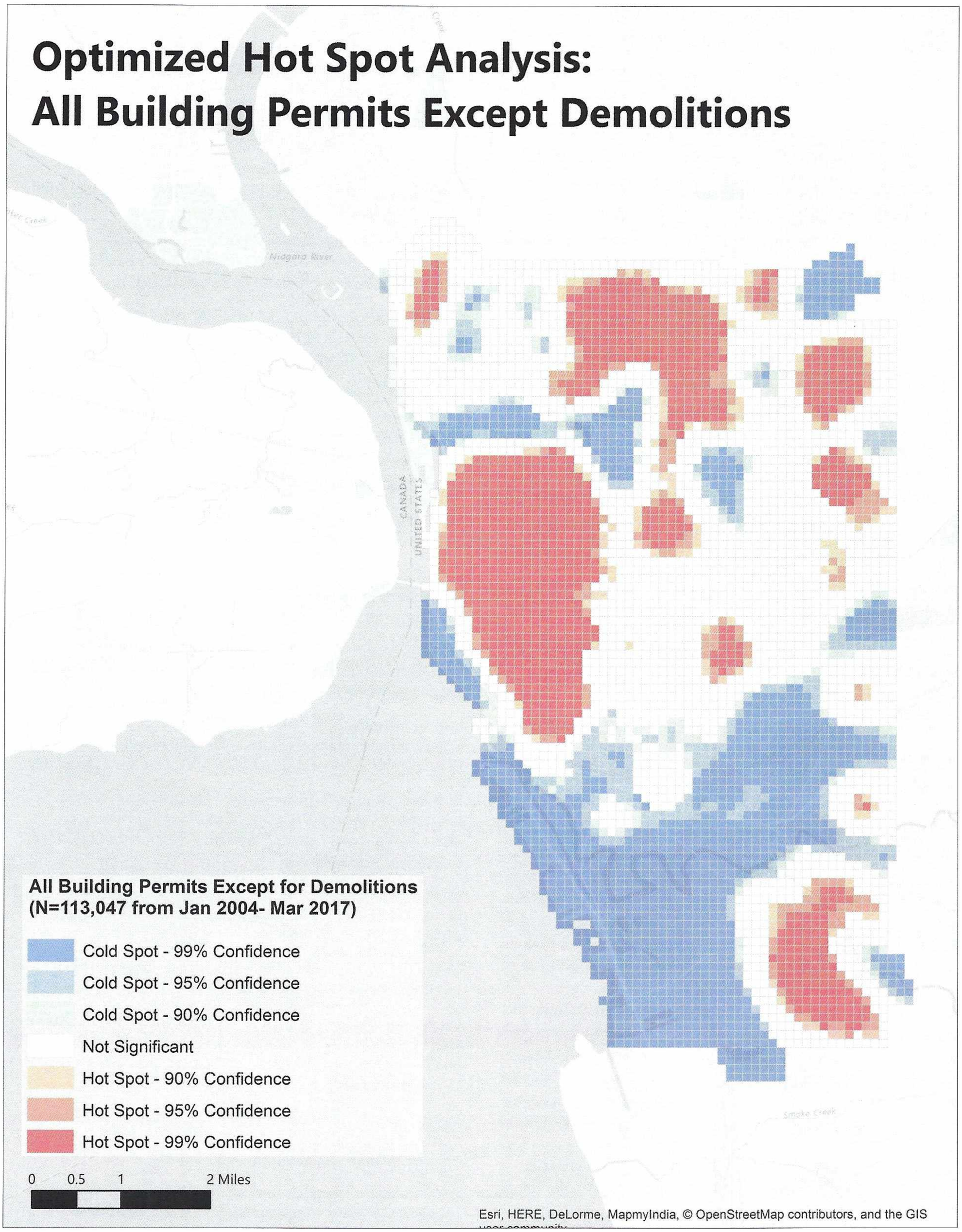

Fig. 7. This map shows hot spots and cold spots for building permits in Buffalo, New York, between 2004 and 2017. (Map produced by Jennifer Minner and Tom Pera. Building permit data provided by the City of Buffalo.)

geography are becoming allied both in new ways that can benefit community planning and in the conceptualization of a community's building stock as a sustainable resource. Local government data and GIS- and web-based tools have also been central resources for the inventory of historic resources. Historic survey efforts, enriched by technological developments and the development of public datasets, have enhanced preservation and planning where historic resources are threatened by rapid redevelopment and where communities are experiencing population loss and disinvestment. Finally, 3D modeling and GIS-based tools can facilitate visualization and analysis of scenarios that can help to guide historic preservation efforts.

Preservation education and research must engage in the stewardship of the geospatial data streams and aid in the development of new geographic methods and technologies. The interdisciplinary pooling of geographical knowledge can inform communities' understanding of the past, knowledge of present resources and opportunities, and prospects for the future. Preservation knowledge is a resource that requires a steady flow of geospatial information, which can enhance our ability to appreciate and sustainability manage our cultural resources.

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Minner's experience includes planning, research, and community mapping projects related to land use and sustainability, historic preservation, environmental education, institutional research and higher education assessment, and economic development. She served as chair and heritage commissioner on the Olympia Heritage Commission in Olympia, Washington. She is a past president and a founding board member of the Mid Tex Mod chapter of Docomomo US, a nonprofit dedicated to documentation and conservation of the Modern movement, in central Texas. She also previously served on the Ithaca Landmarks Preservation Commission.

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ENDNOTES

1. For instance, the City of Austin regularly makes its building permit and site plan data available as shapefiles on the city's website.

2. Just a few examples include mapped demographics from the US Census Bureau, GIS data for transportation and demographics compiled in the Environmental Protection Agency's Smart Location Database, georeferenced datasets of properties on the National Register of Historic Places, and data on flood hazards and sea level rise provided by the National Oceanic and Atmospheric Administration.

3. Some scholars have recently questioned the actual strength of the effect of HOLC maps. Greer (2013) concludes that "while race certainly informed the development of these maps, the presence of nonwhites and foreign-born ethnics are rather modest (albeit clearly negative) correlates of the final HOLC mortgage risk grade" (277). Greer indicates that "age, quality, upkeep, repair, and price of housing, in addition to the willingness of private sources to make mortgage investments into a neighborhood's housing market, are even more robust predictors of HOLC's grade of mortgage

risk" (Greer 2013, 277). Using statistical techniques to analyze HOLC in Cleveland, Brennan (2015) found evidence of possible discrimination against African Americans, but also concluded that actual HOLC classifications had little to no influence on "actual HOLC lending practices from 1933 to 1936 or on foreclosure rates in the years immediately following HOLC activities" (24).

4. Another example is the Urban Transition Historical GIS Project, which uses a digital transcription of the 1880 census, with information for approximately 50 million American residents, for the purposes of historical research (Logan et al. 2011). Information has been aggregated and mapped with the intention of facilitating historical research on "urban structure and population geography" (Logan et al. 2011, 49).

5. A recent master's thesis by Brown (2016) evaluated four digital documentation techniques, comparing photogrammetry with laser scanning, multimedia GIS, and three-dimensional modeling.

6. See, for example, Stevenson et al. (2013) for a spatiotemporal analysis of building permits. Minner and Shi (2017) also provide a method of analyzing the relationship between investments in existing building stock and larger scale mixed-use redevelopment, which involves an approach to analyzing spatiotemporal processes of change.

7.Step-by-step instructions, the Excel-based Corridor Housing Preservation Tool, and a geodatabase can be found at http://envisiontomorrow.org/corridor-housing-preservation-tool. The step-by-step instructions are specific to Esri's ArcGIS. Geospatial data for use with the Corridor Housing Preservation Tool have been packaged into a geodatabase for easy download from the Envision Tomorrow website and the geodatabase is native to ArcGIS. In order to perform the analysis in a GIS package other than ArcGIS (such as QGIS), data must be converted from the geodatabase format into shapefiles or collected as shapefiles from publicly available sources cited in the Corridor Housing Preservation Tool's documentation.

8. Such a tool could build from the National Trust for Historic Preservation's groundbreaking work in developing spatial methods to understand opportunities for building reuse.