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Developing a Vacant Property Inventory through Productive Partnerships: A University, NGO, and Municipal Planning Collaboration in Trenton, New Jersey

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Developing a Vacant Property Inventory through Productive Partnerships: A University, NGO, and Municipal Planning Collaboration in Trenton, New Jersey

This paper analyzes the development of an inventory of vacant buildings and land in Trenton, New Jersey that resulted from a research partnership between the Rutgers University Center for Urban Environmental Sustainability; Isles, Inc. a Trenton-based non-governmental organization; and the City of Trenton. Participatory research design between university and NGO staff led to a smartphone GIS survey tool that functioned through web and desktop GIS. University students and community residents collected data through a smartphone GIS application and visually inspected almost every property within the city's boundaries. Although many vacant land inventories have successfully used secondary data, this project required fieldwork to identify vacant properties because data were unavailable through secondary data. The survey was developed collaboratively with the NGO for their use and modification of it in future work, and to understand locally-specific visual markers of vacancy. The data informed the City of Trenton's vacant property management policy, and served as a foundation for a variety of Isles' community development programs. While smartphone applications may improve NGO access to GIS, the need for web and desktop GIS to complete data collection and analysis requires expertise and time that pose additional challenges.

Keywords
vacant buildings, vacant land, smartphone GIS, participatory GIS, urban policy

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INTRODUCTION

Vacant urban land has long been recognized as both a problem and an opportunity for planners and non-governmental organizations (NGOs) seeking to address community social and land use concerns (Mathie and Cunningham 2003; Pearsall and Lucas 2014). Vacant land is often stigmatized as synonymous with blight and decay, and so conventional planning practice prioritizes real estate development of vacant spaces to increase ratables (Jakle and Wilson 1992; Bowman and Pagano 2004). However, there are examples of reusing vacant land to support livable communities, such as providing green or social space, storm water management functions, and urban agriculture (Kahn 1982; Francis 2003). Participatory approaches that obtain local stakeholders' input in neighborhoods facing high vacancy rates (Godschalk 2004; Garvin et al. 2013) can lead to diverse land use potentials (Spirn et al. 1991; Grewal and Grewal 2012; Foster 2014). Simply put, vacant land can be seen as an opportunity and community resource (Bowman and Pagano 2000; Németh and Langhorst 2014), and vacant land inventories have increased in recent years as a key step in finding solutions to vacancy (Horst 2008; Mendes et al. 2008; Taylor and Lovell 2012).

Secondary data and geographic information systems (GIS), along with participatory approaches, have been important to vacant land inventory methods. Two key data sources are remotely-sensed imagery and databases of publicly owned land (Balmer et al. 2005; Johnson et al. 2011; McClintock et al. 2013). Tax assessment data from local government has also been a baseline of vacant properties from which to identify suitable sites for re-use (Eanes and Ventura 2015). ArcGIS and Google Earth have emerged as ways to use proprietary and free software to identify and analyze inventories (Taylor and Lovell 2012; McClintock et al. 2013; Eanes and Ventura 2015). Participatory approaches also complemented GIS analysis of secondary data. Local stakeholders shaped research objectives, provided data, and set criteria for including parcels in inventories (McClintock et al. 2013; Eanes and Ventura 2015).

Vacant land inventories have not, however, systematically employed GIS or participatory approaches for the collection of primary data. Primary data has taken mainly a supportive role to verify or ground truth secondary data or to provide further analysis. For example, site visits and soil samples were done for quality control and assurance, and to select locations for pilot projects (Balmer et al. 2005; Mendes et al. 2008; McClintock et al. 2013). Still, there is a need to develop systematic primary data methods given limitations to using secondary data as a baseline inventory of vacant properties. Although lists of tax-delinquent properties have been sources of secondary data, such data are not accurate in rapidly changing urban environments (Myers and Wyatt 2004). Furthermore, as noted in one project where fieldwork was used to verify analysis of secondary data, additional vacant parcels were identified that were not in the original dataset (Eanes and Ventura 2015). These new parcels were seen because of their close proximity to vacant parcels listed in secondary data, but it was unknown how many vacancies went unidentified citywide. Thus, initial fieldwork to comprehensively classify whether buildings and lots are unused can complement existing approaches that start from secondary data. Doing so provides a "synoptic view" that could improve site selection in future studies (Eanes and Ventura 2015).

This paper examines the development of a primary data method designed in a participatory approach to smartphone GIS. Smartphones represent a way to encourage different types of participation: they enable data collection by laypeople (Dunn 2007; Gura 2013), and we propose that smartphones may also address issues of access that local NGOs face in building their GIS capacity. In this project, we worked with NGO staff to develop a smartphone data collection method. We chose this approach because the NGO wanted to build capacity to conduct future surveys without external assistance and smartphones were less expensive than specialized GPS handsets. University faculty and students worked with NGO staff to build on their existing GIS expertise but within constraints of a limited budget—using the free ArcGIS Collector smartphone application and trial version of ArcGIS Online with existing GIS desktop software. We developed a survey tool whose criteria of vacancy was shaped by the objectives of the NGO and local government; while the former was interested in community development and food access, the latter aimed to develop vacant property policy and increase the city tax base. The smartphone method also allowed residents to participate as data collectors alongside student interns. Data collection lasted seven weeks and surveyed 31,161 parcels in the City of Trenton, New Jersey.

The rest of this paper traces the development of this survey by starting with an argument for participation of local stakeholders in primary methods. We then provide details about the process of building the survey tool, which involved GIS distributed across desktop, cloud, and smartphone platforms. Discussion and conclusion sections elaborate how the project influenced the work of our partner NGO and local government, how the project addresses issues of access to emerging models of distributed GIS, and how conflicting objectives by different participant groups can be integrated into primary data methods of vacant property inventories.

THE CASE FOR PARTICIPATION IN PRIMARY METHODS

Part of the challenge in understanding the extent and capacity of vacant urban land is in its definition. Because "vacancy" is an imprecise term that represents spaces with a variety of physical and social characteristics, various methodologies use different definitions of vacancy. Urban agriculture has been the topical focus of recent vacant land inventories, yet even here, there are many ways to define vacancy. For example, vacant land has been defined as any unbuilt land, all publicly-owned land, only underutilized or available public land, or only land that is agriculturally suitable (Horst 2008; Mendes et al. 2008; Johnson et al. 2011; McClintock et al. 2013). In broader conceptual discussions, vacant land has also included unbuildable land due to physical limitations, or land with abandoned buildings (Northam 1971; Spirn et al. 1991; Bowman and Pagano 2000). One lesson is that there is no universal definition; the second is that definitions are shaped by project objectives.

The relationship between vacancy definition and project objective is demonstrated in recent land inventories that have identified potential locations to begin food production or to estimate potential urban agriculture outputs (Colasanti and Hamm 2010; MacRae et al. 2012; McClintock et al. 2013; Eanes and Ventura 2015). These inventories can be better understood as inventories of *suitable* vacant land rather than lists of all unused properties. This is not a shortcoming but rather a reflection of the objectives of these projects. Whether or not land was included in an inventory depended on whether that land was considered useful for agriculture, and how usefulness was defined. For example, biophysical characteristics such as whether land is arable or covered with impervious surface, and the slopes of parcels, may determine whether land is considered vacant (McClintock et al. 2013; Eanes and Ventura 2015). These criteria may also depend on envisioned cultivation practices, such as planting in-ground or in raised beds. Ease of access can be another important criterion and publicly owned land has been a focus of inventories (Horst 2008; Mendes et al. 2008). Other inventories targeted land already in use for food production; classifications of different urban agricultural uses, as well as locations of food production, may extend beyond vacant land to include home gardens (Balmer et al. 2005; Taylor and Lovell 2012). The diverse characterizations that result in different land inventories are the result of various objectives and suitability requirements underlying data collection and analysis.

However, what if an inventory aimed to identify buildings and lots that were unused, without regard to any specific re-use such as urban agriculture or condition such as whether land is publicly owned? While the criteria to identify current and potential urban agriculture sites may be accurately observed via secondary data, the criteria to assess whether properties are unused may be more difficult to identify this way. Slight differences between vacancy and use, such as whether lots are maintained or have unkempt vegetation, and whether building doors and windows are properly secured, may be undetectable in remote imagery and not considered in tax assessment data.

Local stakeholders' participation has been important to inventories using secondary data, and it is likewise crucial for defining vacancy in primary methods. Local knowledge is needed because visual inspection through field surveys depends on identifying characteristics of vacancy. Such characteristics may be unique to a particular city, and local stakeholders should be more knowledgeable than external researchers. Local knowledge can come from many types of partners, including residents, local NGOs, or local government. We argue that partners with experience working with vacant and abandoned properties across a city, such as local NGOs, can thus be resources for defining vacancy criteria. However, local government may have the capacity to implement policies arising from vacant property inventories, and their input into research design may be warranted. Although residents may most closely know which neighboring properties are unused, Eanes and Ventura (2015) argued that working solely with residents to inventory an entire city is time-limited. An alternative for residents who may not have time to participate in research design and analysis is to participate in data collection (Gura 2013). Indeed, different entities may be interested in participating in different ways. As discussed above, though, objectives shape the structure of inventories and different participant groups may bring conflicting objectives into a project. A potential issue when engaging different participant groups is thus to reconcile differences in objectives and vacancy definitions.

ORIGINS OF THE TRENTON VACANT PROPERTY INVENTORY

A local NGO, Isles, initiated the vacant property inventory in Trenton, New Jersey, and its objective was to classify every building and lot in the city as occupied or vacant. The project was situated in an urban context that was once a center of industrial production, but suffered a decrease in employment and increasing vacancy and abandonment in the later decades of the

20th Century (Cumbler 1989). Isles is located in Trenton and has operated a variety of community and economic development programs aimed at lower-income residents there for more than 30 years. Programs include support for community gardeners through technical assistance and education, green-collar job training, and youth education programs.

Isles wanted to use the inventory to develop a range of future, but yet undefined, projects. One prospect was expanding the capacity of the local food system by supporting food processing, distribution, and retailing, in addition to urban agriculture. As such, they were interested in not only vacant land, but also vacant buildings. The City of Trenton was simultaneously developing policy on vacant and abandoned properties and needed accurate vacancy data in order to institute new policy. Given the close relationship between Isles and the municipal government, a project emerged to classify the status of each parcel in the city.[1] Together, these objectives called for the identification of vacant properties--buildings and land. Three goals included 1) developing a field survey tool that could be replicated in the future by Isles, City of Trenton staff, or other stakeholders; 2) creating an inventory of vacant buildings and vacant lots; and 3) developing the database structure to house the inventory. Given the limitations in secondary data collection methods that we discuss below, field surveys were needed for this project. Due to limitations in staff and in research capacity of Isles and local government, Isles invited the Rutgers University Center for Urban Environmental Sustainability (CUES) to collaboratively develop a field survey tool to collect and analyze data.

Due to the lack of secondary data that would allow property classification according to existing condition and use, the project required primary data collection through fieldwork and *in situ* observation. Isles received a list from the city government of 3,340 addresses that were considered vacant, but the list was insufficient: it was six years old, did not include the entire city, had been collected by multiple entities using non-standardized protocols, and there were duplicate entries. Furthermore, the list did not consistently differentiate between vacant buildings and vacant land. Given our objectives to classify the status of buildings and land, the existing data were not useable.

Not only was there a lack of systematic secondary data on vacant properties, the criteria for vacancy required personal observation of site characteristics. To classify vacant buildings, one attribute, for instance, was whether a building's entry was secure with a functioning lock and without broken windows. In terms of vacant land, our criteria differentiated between informally used land and land that was truly vacant. Land that had no authorized or legal use, but appeared to be used as social space, was not classified as vacant. For example, if properties served as functional places for the community—socializing, recreation, food production—they were not considered vacant or available for redevelopment. Field observations were necessary in order to classify parcels accordingly. Since the actual use might not be directly observable, we aimed to identify if a parcel was maintained, and an attribute used to determine whether land was vacant was vegetation height exceeding 2.5 feet (0.76 m). We discuss these criteria in more detail below but introduce them here in order to emphasize the need for primary data.

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[1] Parcel was the unit of analysis because it was the discrete land entity used for taxation purposes by the City of Trenton.

DEVELOPMENT OF THE SURVEY TOOL AND COMPLETION OF THE INVENTORY

After developing a typology to classify properties, the project was divided into three phases: developing a multi-platform GIS for data collection, training surveyors to visually identify vacant property characteristics, and executing fieldwork survey protocols. The first step was to define vacancy criteria and develop a typology of properties, completed by Isles staff according to characteristics drawn from New Jersey's Abandoned Properties Rehabilitation Act and Isles' knowledge of Trenton vacant property characteristics. This typology involved two levels of classification for each parcel. The first level classified parcels with and without structures into seven categories (Table 1). Parcels with structures were categorized as either vacant buildings, buildings with vacant ground floors but unclear upper levels, or occupied buildings.[2] Parcels without structures were categorized as parking lots, open space (e.g. parks, gardens, or cemeteries), utility or rail, and lots. Secondary attributes were assigned for all categories except "utility or rail" and "occupied building" (Table 2). These secondary attributes provided additional context to analyze vacant properties. The first-level designation of "lot" meant that a parcel did not have a structure and did not fit another category; these were not necessarily vacant. Vacant lots were identified as lots that were "unmaintained," determined by the presence of weeds exceeding 2.5 feet (0.76 m).[3] The secondary attributes also distinguished vacant buildings that were under construction and those that appeared to be abandoned.

Table 1 First-level parcel typology

Parcels with structures			**Parcels without structures**			
Vacant building	Vacant lower	Occupied building	Parking lot	Open space (Park, garden, or cemetery)	Utility or rail	Lot

[2] The category "vacant ground floor but unclear upper levels" typically applied to commercial areas, where a storefront or office on the ground floor was vacant but it was unclear whether the floors above were occupied.
[3] This criterion may not work effectively in arid climates where unused lots may not have any vegetative growth; however, during a midsummer survey in New Jersey it was an effective indicator.

Table 2 Secondary attributes observed

Attribute	Observed for the following parcel types
Trash	All except occupied building and utility or rail
Dumping	All except occupied building and utility or rail
Lot surface (earth or paved)	Parking lot; lot
Weeds (over 2.5 ft.; 0.76 m)	Parking lot; open space; lot
Maintained? (Yes or No)	Parking lot; open space; lot
Active construction or demolition	Vacant building; vacant lower
For rent / sale signs	Vacant building; vacant lower
Unsecured	Vacant building; vacant lower
Animals present	Vacant building; vacant lower
Fire dept. [x]s	Vacant building; vacant lower
Rehabilitation needed?	Vacant building; vacant lower

Developing a Multi-Platform GIS

Next, Rutgers University faculty and Isles staff developed a field survey tool that allowed data collection via smartphones. Since one objective was to develop a tool that Isles could use again without university assistance, we chose GIS resources that aligned with the NGO's current and planned assets. Isles staff had GIS expertise and planned to write a grant for a future purchase of ArcGIS software, but had limited budgets for other purchases. We thus chose ArcGIS Collector, a free smartphone application and paired it with university-provided software. Collector also required integration with ArcGIS Online (AGOL). However, AGOL normally functions as a paid subscription and we used a free trial with the goal to keep costs low. The workflow of this platform was thus as follows. The front-end of the system relied on ArcGIS Collector. Surveyors tapped on an individual parcel on a Trenton map and then entered attributes. The back-end of this system was built on ArcGIS Desktop, and AGOL was the link between the front and back end.

Integration across these three platforms required a series of iterative steps. Work began in ArcGIS Desktop to create domains to record parcel types and attributes, along with a geodatabase with feature classes representing each parcel type. Feature classes were in simple point format; each feature class was then assigned field names and attributes based on the parcel typology (Tables 1 and 2). Fields had set responses based on the geodatabase domains. This database structure provided the basis for data entry by surveyors using smartphones.

Limitations in AGOL, along with slow data transfer rates, prevented the use of the entire parcel shapefile as one data entry mechanism. At the time we were unable to upload shapefiles containing more than 1,000 features. The citywide shapefile of Trenton's parcels was separated into neighborhoods of less than 1,000 parcels before being uploaded to the AGOL. These neighborhood maps formed the next component of the data collection structure. Seven features from the geodatabase (each parcel type) were added to each neighborhood web map, with full editing ability by users, but the parcel layer's editing was disabled so that no accidental changes could occur.

The cloud-based part of the workflow served as the link between desktop software and surveyor smartphones. The data entry windows that appeared in Collector were configured in AGOL such that only the parcel types and sub-attributes would appear and not the underlying parcel metadata. AGOL communicated with each mobile device's ArcGIS Collector app to share maps and data, sending that information through a Wi-Fi connection.[4] After data was collected via the ArcGIS Collector app, the phones stored updated maps locally until synchronizing with AGOL; data stored online was downloaded to desktop software for analysis.

Smartphones were then configured with the ArcGIS Collector application. Due to budget limitations, we used smartphones without cellular service and utilized the app's offline data collection capabilities. We downloaded data from AGOL to each smartphone using wireless internet; new basemaps were created for each neighborhood on the smartphones due to the collection process being performed in offline mode.

Technical expertise in GIS was required to develop the survey tool. However, the project leaders designed a data collection system that did not require surveyors to have specialized GIS training, just the ability to use a smartphone map and data entry application. The database configuration created in GIS desktop software and AGOL automated surveyor data input, so surveyors only had to be familiar with smartphone apps in general (i.e., how to read maps, tap, scroll, and enter text). Surveyors entered data by tapping on a parcel and entering data through a series of data entry windows.

[4] Mobile data can also be used but was not in this project.

Training Surveyors

The team developed a field guide to assure consistency in data collection. CUES student interns collected data, and they were supported by 35 community volunteers recruited and managed by Isles. Surveyors attended a one-day training session hosted by Isles to identify signs of vacant properties in Trenton. Observable criteria allowed surveyors to decide the status of each parcel based on the presence or absence of certain features (Table 2). Surveyors identified buildings as occupied by observing the presence of functioning electric meters, neatly-kept garbage and recycling bins, the accumulation of mail, and other signs of occupancy such as flowers or curtains. Secondary attributes included the categorization of buildings as unsecured if basement or ground floor windows were broken and not fully boarded, or if signs of entry to upper floors were visible (e.g. ropes to climb up). Additional attributes included the presence of large X letters that fire department officials painted on the front of buildings they deemed to be structurally unsound. Attributes recorded for lots included the presence of trash (amounts of litter that could be bagged) or dumping (a quantity of garbage requiring a dumpster to remove). Surveyors made some subjective decisions about whether vacant buildings needed significant, moderate, or no rehabilitation.

Fieldwork Protocols

Weekly field observation goals were scheduled based on the time required to complete the survey in predetermined neighborhoods. Survey teams were assigned individual streets each day, including the specific side of the street. Teams included two or three people; one person on each team was responsible for smartphone data input. The other person assisted by identifying site characteristics. We used this level of detail to reduce the risk of duplicate data entry from multiple survey teams. At the end of each day, the GIS support team uploaded smartphone data to AGOL and prepared the handsets with maps for the following day. The research team began and ended each day at one of 17 "field bases" that Isles arranged with neighborhood organizations and individuals. The field bases allowed us to work neighborhood-by-neighborhood and to include local residents on the survey teams.

Processing and Analysis

Considerable post-processing using GIS software was required to create a single file of all Trenton parcels. This was due to the trial version of AGOL, which forced us to use separate neighborhoods as the basis of data collection. This also resulted in seven shapefiles for each neighborhood—one for each parcel type in Table 1. A series of merge and join operations were used to complete this task. The result was a GIS dataset of parcels whose attribute table listed all of the fields that had previously existed across seven separate files.

Upon parcel dataset completion, additional GIS processing was needed to count vacant lots and buildings. Vacant land was identified through a two-part process. Although the City of Trenton was interested in knowing the number of undeveloped parcels, from Isles' perspective, if a lot was serving residents' well-being, it did not make sense to consider it available for redevelopment—even if it was undeveloped and not on the tax rolls. This was addressed in part through the parcel typology; surveyors were directed to classify community gardens as open space so that they were not seen as vacant and available. Still, this left parcels that were recorded as lots, but appeared to be used and well-maintained as yards. These sites typically were adjacent to parcels with occupied buildings and shared the same owner. In practice, these "vacant lots" were simply the side lots of houses. However, due to their legal standing as discrete parcels, they could be sold separately from the house, and so Isles decided to differentiate vacant lots as those lots that were unmaintained. Maintained lots already served as green and social space for Trenton residents, while the latter were clearly unused. Isles considered these unmaintained vacant lots as candidates for repurposing into urban farms, community gardens, or other uses related to healthy food availability.

Vacant buildings were then extracted from the comprehensive parcel dataset. This was necessary because the number of parcels classified as vacant building did not match the number of actual vacant buildings. An individual structure can cover multiple parcels; if one vacant building took up three parcels, the survey team recorded all three parcels as "vacant building." If the raw numbers of parcels were listed as vacant buildings, this would have resulted in over counting the number of vacant buildings. To address this issue, we combined contiguous parcels classified as vacant buildings if they were under the same owner by referencing identification codes in the parcel dataset that linked parcels together.

EVALUATION AND OUTCOMES

Over seven weeks, the survey team documented 31,161 out of 31,574 Trenton parcels (99%). Analysis by Rutgers University identified 1,376 vacant lots (totaling 68 hectares of vacant land) and 3,850 vacant buildings, and spatial patterns of these vacant properties were analyzed (see Drake et al. (2015) for spatial statistics discussion). The university ceased direct involvement after this initial analysis. The project was then managed by the Trenton Neighborhood Restoration Campaign, which was led by Isles and included representatives of other Trenton organizations, local government, and residents. Isles staff performed spot checks in the field to collect missing attributes, re-analyzed and re-classified the data to align with City of Trenton objectives, and made updated datasets publicly available online. This further work is addressed below, following evaluation of the university's involvement with the project.

In practical terms, the survey method had advantages and disadvantages. The advantage of this method, once it had been prepared, was its efficiency: surveyors were equipped with maps and entered data on phones, without needing to know or look up addresses or enter data into Excel spreadsheets. This efficiency was also enabled by the relatively small geographical area compared to other capital cities—Trenton is 20 km^2 of land compared to 347 km^2 of land in nearby Philadelphia—and the assistance Isles received from 30 organizations around Trenton that served as field stations from which surveyors were based. The involvement of diverse stakeholders and the unique fieldwork method were mentioned in numerous local news reports, which likely helped provide momentum for the activities that have continued to follow completion of the survey.

However, disadvantages included some constraints to field observations. Surveyors were forbidden from entering buildings or trespassing on properties, and for reasons both of safety and to ensure that they entered observations against the correct parcel, they recorded their observations from the street rather than fully circling a building to check its condition. Therefore, parcels located behind or surrounded by other parcels were not recorded, and so 413 inaccessible parcels were not surveyed. In addition, there was an unknown level of accuracy for certain attributes based on these restrictions. Significant damage to a roof on the rear of a building could be unnoticed, or a property whose front was well boarded but whose back entrances were open would still have been categorized as secured. Since all observations occurred during the day, surveyors could not confirm whether lights were on after dark in an apparently vacant building; this was an issue for buildings whose electric meters were not visible from the street. Another limitation of this method related to multi-family buildings such as condominiums and apartments, because surveyors were not able to evaluate the occupancy rates within those buildings. If such buildings appeared to be partially occupied, we did not consider them vacant.

Although there were some limitations, Isles and the City of Trenton considered the accuracy of the data acceptable because the comprehensive survey was the first of its kind for Trenton, and because further data collection and analysis has been ongoing since the initial fieldwork ended. There have been no more citywide surveys, but between October 2014 and July 2016, Isles performed spot checks to collect missing data and verify listings in the inventory. Some of this additional work arose from questions related to the initial analysis, but some came from the need to respond to feedback from property owners and residents. The City of Trenton notified 2,200 owners of vacant property identified through the inventory, and approximately 500 owners disputed the vacant categorization. However, Isles staff visited the disputed properties to verify claims and only reclassified 41 buildings; 15 buildings were reclassified from vacant to occupied, and 26 buildings were reclassified from occupied to vacant.[5]

The inventory served as an empirical basis for a new Trenton policy to address vacant properties by providing data on the number of vacancies and their locations, and Isles has also used it as a monitoring and reporting framework. In October 2014, Trenton Mayor Eric Jackson announced a vacant property strategy overview based on the inventory, and initiated a housing condition and market pilot study conducted by a separate research team. The strategy included five points: a vacant property registration ordinance; the housing condition and market study to expand on the property survey; a pilot program to allow first-time homebuyers to purchase city-owned properties at low cost; a stabilization program to maintain and demolish a subset of properties adjacent to prospective development projects; and a sales program to auction foreclosed properties. Three auctions occurred between June 2015 and June 2016, transferring a total of 204 properties, requiring updates to the inventory before and after each sale.

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[5] The main reason for changing the status was because the building was vacant during the survey but had become occupied by the time the notices were sent. Buildings that were under construction were classified as vacant, and if those buildings' construction finished and became occupied then the status changed.

Furthermore, Isles created a web map from the inventory data in order to solicit corrections from residents regarding their property status. The web map also provides geospatial information about properties scheduled to be auctioned, and data layers about quality of life drawn from a study conducted by other partners. Isles also uses the inventory for vacant lot stabilization and urban agriculture planning. As of July 2016, Isles hired five residents to clean up and maintain 150 vacant lots, with the hope of engaging neighbors in activating those spaces. Isles staff also use the data to conduct GIS analyses to identify potential urban agriculture locations. Taken together, university faculty and students helped Isles create and conduct the survey, which Isles then extended into an ongoing program of research and engagement on vacant properties.

Smartphone Methods

In theoretical terms, the project also contributes to better understandings of participatory GIS in the context of smartphone-based data collection. Prior studies have used smartphones as data collection tools and as data sources. They provide real-time data capture that can be simultaneously geocoded through smartphones' embedded GPS and uploaded to data servers through cellular connections (Lwin and Murayama 2011; Lwin et al. 2014). Although mobile GIS has been in use for some time, the increasing capacity of smartphones to collect data in this way has expanded "citizen science," where data collectors do not have to be geographically proximate to a research team (Gura 2013). Second, other studies have used smartphones as data sources to understand movement patterns. Scholars have examined both the locations of smartphone users as well as their check-ins on social media (e.g. Foursquare); such methods are also used to develop participatory data management strategies (Williams and Currid-Halkett 2014; Wilson 2014; Williams et al. 2015). However, there is a nascent literature applying the traditions of participatory GIS to smartphones.

Debates within participatory GIS follow the shifting relationships between technology and society, and a longstanding concern has been access and equity (Weiner et al. 1995; Elwood 2006). Although web GIS has undergone a series of critiques in this vein, there has been less discussion of smartphone GIS given its recent yet rapid rise. Discussions of web GIS addressed claims that web technology democratizes GIS by reducing the need for laypeople to rely on traditional GIS or cartography experts. Instead, these critiques argued that issues of power and the types of knowledge that can be represented in GIS were reshaped but not eliminated by web technology (Haklay 2013).

The development of our survey method showed that issues of access are complicated by industry trends to distribute GIS functions across desktop software, web services, and mobile devices. Since we aimed to build Isles' capacity to conduct future property surveys independently, the university was involved not simply to conduct research for NGO staff but to work alongside them to develop and conduct the survey, one approach used in participatory GIS and action research (Gilbert and Masucci 2006; Cameron 2007). The focus was thus on working from the current and planned assets of the NGO, rather than the technical superiority of the university's resources. For instance, we used ArcGIS Desktop software because Isles had GIS expertise and planned to purchase an ArcGIS Desktop license but were limited by the budget for equipment purchases. As such, we also used free versions of ArcGIS Online and ArcGIS

Collector. Although there were university resources available to more quickly design a mobile GIS system for this project—for example, handheld GPS units that could be programmed by university staff to collect property characteristics—that approach would have left all of the data collection and analysis capacity with the university. We instead chose a smartphone method because of its low cost compared to traditional mobile GIS equipment: Isles bought unlocked handsets and local retailers donated some as well; the ArcGIS Collector smartphone app was free and we used Isles' handsets without voice plans or data connections.

However, the development of the survey tool encountered several challenges. We used the free version of the cloud-based component, but it presented many technical challenges, such as site crashes and the aforementioned requirement to divide the citywide parcel shapefile into neighborhoods, which we addressed iteratively. Moreover, the back-end development of the survey tool required ArcGIS Desktop software. This multi-platform GIS addressed the project objective of developing a survey tool that the NGO could use in the future, but this capacity was enabled by staff members' existing GIS skills.

Smartphones and applications such as Collector may partially address issues of access in terms of cost, but GIS expertise is still a barrier to entry. Existing smartphones can be used with Collector and data can be collected offline to prevent mobile data charges. However, GIS expertise was still required to design and implement the survey. While it should be possible for a university team to design a smartphone method for an NGO partner that could be used for later projects, an NGO without such expertise would face difficulties modifying the method. A significant point to be made is that although Collector was free, ArcGIS Online, which was required to set up the application, was only available free through a trial membership, meaning that our use of it was limited by time and functionality.

Taken together, the distribution of GIS over desktop, cloud, and smartphone platforms raises further issues of access and equity. The use of smartphones in participatory GIS is part of a multi-faceted process that spans multiple platforms. Each platform, and the links between them, must be assessed for feasibility in a given organization's context; access to one part does not guarantee a successful project. This is a fundamental shift from early stages of PGIS where scholars worked with community organizations through a single desktop computer. Since GIS is moving in a direction where a project may rely on multiple devices and cloud services, community use of GIS will become more complex in terms of participation in the linkages across these platforms.

Reconciling Differences in Objectives and Vacancy Definitions

The participatory research design also relates to ontological concerns about the nature of vacancy and the impacts of how project partners define vacancy. Given the multiple objectives of our partners, it is important to explicate the meaning of vacancy in the development of the inventory (Bowman and Pagano 2000). While Isles was focused on community and economic development along with food system programs, the municipal government had a broader interest in facilitating sales of vacant properties to return them to tax rolls. These aims could result in different definitions of vacancy—which is consequential in the relationship between institutions with the capacity to reuse and develop vacant properties, and residents who may or may not agree with such actions. Given these objectives, Isles was an important intermediary between local government and residents in terms of understanding vacancy.

The definition of vacancy is important in primary and secondary methods because, whether explicitly or implicitly defined, vacant property inventories are shaped by assumptions of what is vacancy, as discussed above. Thus, the question becomes one of who defines vacancy, since the objectives of those individuals or organizations will delimit what counts as vacant or occupied. The City of Trenton, with its goal to return properties to tax rolls, previously used tax payments as criteria. Yet the turn toward community engagement and participatory planning suggests the need to rethink definitions of vacancy and to consider informal uses such as community gardens (Francis 2003; Godschalk 2004; Garvin et al. 2013).

Since it was not feasible to systematically engage residents in this project, Isles was a proxy for these perceptions since staff were familiar with signs of vacancy across Trenton and maintained strong ties with residents and neighborhood organizations across the city. The criteria that we developed put community gardens and any lot with active food production into an open space category, and only unused lots that that had excessive weeds were considered vacant. Still, this inventory engaged 35 residents with high school students and community volunteers as surveyors and we encouraged all surveyors to talk with residents to explain the project and to assist with the classification of properties if residents wished to provide assistance. Unfortunately, we did not collect metadata about interactions between surveyors and other residents or how many classifications were changed on the spot as a result.

At the same time, however, the city government's objectives had to be accommodated in order to produce data that was seen as legitimate, and thus actionable, by institutions responsible for land use planning. To this end, after the university completed the survey, Isles redefined vacant lots as any lot that was not a side yard, and removed the maintained-unmaintained distinction. Nevertheless, gardens remained classified as open space. In the three auctions that have occurred, only those listed as vacant properties have been candidates for sale, with open space and other categories not under consideration. In sum, the inventory gained legitimacy for public policy once it aligned with the City of Trenton's policy goals, but governmental and non-governmental actions were catalyzed by fieldwork. This fieldwork generated reciprocity because of Isles relationships with neighborhood organizations that provided field bases and because of the cognizance that every property had been personally visited.

CONCLUSION

This paper examined how primary methods of collecting vacant property data intersect with issues of participation and technology. The question driving the paper was how participants with different objectives might shape primary data methods, and the discussion focused on issues of access in smartphone GIS and the process of defining vacancy. Isles' project goals shaped the choice of smartphones in the survey method. Our aims were not simply to provide data, but also to help Isles build capacity to conduct future surveys independently. To that end, we saw the opportunity to pair this option with the GIS expertise of Isles staff, choosing smartphones because they were more affordable and could be used with the free ArcGIS Collector app without a cellular data plan. While such expertise was needed to develop the method, our approach also allowed residents to participate, because surveyors only needed to be familiar with using smartphones.

The participatory nature of the project addressed certain aspects of access and equity, in terms of GIS and vacancy definitions, but challenges remain. Our use of smartphones coupled with cloud and desktop GIS reflects a distributive model where “the days of standalone GISystems are mostly over” (Longley et al. 2011, 23). This is perhaps a shift beyond web GIS or neogeography, which garnered attention and critique for providing map-making tools over the internet to non-experts. Whereas the democratizing aspects of web GIS have been previously critiqued, a distributive model poses more challenges for participatory research. Such a system entails not just having access to one component (e.g. a website or software), but to all components—and to knowing how each part interacts with the other. For this project, smartphones allowed efficient data collection without having to resort to specialized equipment, but using the Collector app required both ArcGIS Online and Desktop software. While we had access to all three, we did not anticipate the time needed to integrate the parts and to process data. Overcoming these obstacles called for GIS expertise, time, and by extension, money. Isles staff and Rutgers faculty and students had that expertise, but many organizations may not have access to these capabilities. It could be argued that such challenges are due to the proprietary software, but customizing and implementing open source systems would have required training in programming. Although GIS expertise has long been a challenge in participatory GIS, the distributive model has further complicated issues of access and equity.

Isles’ role as a proxy for community concerns, as well as a partner of local government, also affected the criteria for vacancy and occupancy. Objectives of vacant property inventories drive what qualifies as vacant, and this study was no exception. Although the Trenton inventory began as a seemingly benign search for what was simply unused, rather than suitable unused properties, the partners’ objectives ultimately shaped our definitions. At the center was an NGO interested in a general understanding of geographic patterns of vacant buildings and land, with aims in community development and healthy food access. Municipal government wanted to return delinquent properties to tax rolls. Although this type of partnership can be critiqued as an offloading of responsibilities to an already-burdened non-profit sector (Lake and Newman 2002; Rosol 2012), the technique of “reading for difference” alternatively places the NGO in an important role in protecting community interests (Gibson-Graham 2008; Williams 2016). Starting with the issue that different objectives may lead to contested definitions of vacancy, a key point here is that community gardens were classified as open space and continue to be listed as such, instead of as vacant lots—even after three property auctions. If local government had conducted the property survey, it is unknown whether the same values would have guided the conceptual framework to define vacancy and what to include or exclude from a list of vacant properties. Furthermore, Isles’ ownership of the project and its data have led to additional projects that may not have been likely without that degree of ownership, such as the vacant lot stabilization and analysis to identify suitable sites for urban agriculture activities. Nonetheless, it is an ongoing task to identify and resolve tensions between competing, and sometimes conflicting, goals and to garner support for vacant property solutions.

In closing, fieldwork can provide systematic and timely data on vacant properties but is most useful when criteria are not identifiable through secondary data. Since criteria used in fieldwork are likely to be unique to each place, participatory research design can engage local stakeholders and produce relevant data leading to actionable outcomes as demonstrated here. When involving stakeholders in an inventory, one must consider their existing capacity to do such work and not just the expected outcomes. Critical attention is also needed regarding the decision-making processes between multiple stakeholders on vacancy criteria—who gets to decide what is vacant? This is important given the consequences of categorization, such as property auctions. In our case, we relied on the NGO to speak for both the city and communities' interests. Future studies, however, could incorporate focus groups of residents to develop criteria relevant to their neighborhoods. Residents (in addition to the property owners as used in our study) could also be engaged to verify classifications. In sum, there are opportunities to further develop primary methods for vacant property inventories and explore the ways that local stakeholders can be involved in various steps of the research process.

LITERATURE CITED

Balmer, Kevin, James Gill, Heather Kaplinger, Joe Miller, Melissa Peterson, Amanda Rhoads, Paul Rosenbloom, and Teak Wall. 2005. *The diggable city: Making urban agriculture a planning priority*. Portland, OR: Portland State University School of Urban Studies & Planning.

Bowman, Ann O'M., and Michael A. Pagano. 2004. *Terra incognita: Vacant land and urban strategies*. Washington, D.C.: Georgetown University Press.

Bowman, Ann O'M., and Michael A. Pagano. 2000. "Transforming America's Cities: Policies and Conditions of Vacant Land." *Urban Affairs Review* 35 (4):559-581. doi: 10.1177/10780870022184534.

Cameron, Jenny. 2007. "Linking participatory research to action: Institutional challenges." In *Participatory action research approaches and methods: Connecting people, participation, and place*, edited by Sara Kindon, Rachel Pain and Mike Kesby, 206-215. London: Routledge.

Colasanti, Kathryn, and Michael Hamm. 2010. "Assessing the local food supply capacity of Detroit, Michigan " *Journal of Agriculture, Food Systems, and Community Development* 1 (2):41-58.

Cumbler, John T. 1989. *A social history of economic decline: Business, politics, and work in Trenton*. New Brunswick, NJ: Rutgers University Press.

Drake, Luke, Beth Ravit, Iana Dikidjieva, and Laura Lawson. 2015. "Urban greening supported by GIS: From data collection to policy implementation." *AIMS Environmental Science* 2(4): 910-934. doi: 10.3934/environsci.2015.4.910.

Dunn, Christine E. 2007. "Participatory GIS — a people's GIS?" *Progress in Human Geography* 31 (5):616-637. doi: 10.1177/0309132507081493.

Eanes, Francis, and Stephen J. Ventura. 2015. "Inventorying land availability and suitability for community gardens in Madison, Wisconsin." *Cities and the Environment (CATE)* 8 (2): Article 2. Available at: http://digitalcommons.lmu.edu/cate/vol8/iss2/2.

Elwood, Sarah. 2006. "Critical Issues in Participatory GIS: Deconstructions, Reconstructions, and New Research Directions." *Transactions in GIS* 10:693-708.

Foster, Jennifer. 2014. "Hiding in plain view: Vacancy and prospect in Paris' Petite Ceinture." *Cities* 40, Part B (0):124-132. doi: http://dx.doi.org/10.1016/j.cities.2013.09.002.

Francis, Mark. 2003. *Urban open space: Designing for user needs*. Washington, D.C.: Island Press.

Garvin, Eugenia, Charles Branas, Shimrit Keddem, Jeffrey Sellman, and Carolyn Cannuscio. 2013. "More than just an eyesore: local insights and solutions on vacant land and urban health." *Journal of Urban Health* 90 (3):412-426.

Gibson-Graham, J.K. 2008. "Diverse economies: Performative practices for 'other worlds'." *Progress in Human Geography* 32 (5):613-632.

Gilbert, M R, and M Masucci. 2006. "The implications of including women's daily lives in a feminist GIScience." *Transactions in GIS* 10:751-761.

Godschalk, David R. 2004. "Land use planning challenges: Coping with conflicts in visions of sustainable development and livable communities." *Journal of the American Planning Association* 70 (1):5-13.

Grewal, Sharanbir S, and Parwinder S Grewal. 2012. "Can cities become self-reliant in food?" *Cities* 29 (1):1-11.

Gura, Trisha. 2013. "Amateur experts." *Nature* 496:259-261.

Haklay, M. 2013. "Neogeography and the delusion of democratisation." *Environment and Planning A* 45 (1):55-69.

Horst, Megan. 2008. *Growing green: An inventory of public lands suitable for community gardening in Seattle, Washington*. Seattle, WA: University of Washington, College of Architecture and Urban Planning.

Jakle, J.A., and D. Wilson. 1992. *Derelict landscapes: The wasting of America's built environment*. Savage, MD: Rowman & Littlefield.

Johnson, Peter A., Nora Belblidia, and Stefan Campbell. 2011. "Neogeographic tools to create open-access data: Mapping vacant land parcels in Detroit." *URISA Journal* 23 (2):33-37.

Kahn, Charlotte. 1982. "Scroungers, activists, organizers." *Journal of Community Gardening* (February):46.

Lake, Robert W, and Kathe Newman. 2002. "Differential citizenship in the shadow state." *GeoJournal* 58 (2-3):109-120.

Longley, P A, M F Goodchild, D J Maguire, and D W Rhind. 2011. *Geographic information systems & science*. 3 ed. Hoboken, New Jersey: John Wiley & Sons.

Lwin, Koko, Misao Hashimoto, and Yuji Murayama. 2014. "Real-time geospatial data collection and visualization with smartphone." *Journal of Geographic Information System* 6 (2):99-108.

Lwin, KoKo, and Yuji Murayama. 2011. "Web-based GIS System for real-time field data collection using personal mobile phone." *Journal of Geographic Information System* 3 (4):382-389.

MacRae, Rod, Joe Nasr, James Kuhns, Lauren Baker, Russ Christianson, Martin Danyluk, Abra Snider, Eric Gallant, Penny Kaill-Vinish, Marc Michalak, Janet Oswald, Sima Patel, and Gerda Wekerle. 2012. "Could Toronto provide 10% of its fresh vegetable requirements from within its own boundaries?" *Journal of Agriculture, Food Systems, and Community Development* 2 (2):147-169.

Mathie, Alison, and Gord Cunningham. 2003. "From clients to citizens: Asset-based community development as a strategy for community-driven development." *Development in Practice* 13 (5):474-486.

McClintock, Nathan, Jenny Cooper, and Snehee Khandeshi. 2013. "Assessing the potential contribution of vacant land to urban vegetable production and consumption in Oakland, California." *Landscape and Urban Planning* 111:46-58. doi: http://dx.doi.org/10.1016/j.landurbplan.2012.12.009.

Mendes, Wendy, Kevin Balmer, Terra Kaethler, and Amanda Rhoads. 2008. "Using land inventories to plan for urban agriculture: experiences from Portland and Vancouver." *Journal of the American Planning Association* 74 (4):435-449.

Myers, Danny, and Peter Wyatt. 2004. "Rethinking urban capacity: identifying and appraising vacant buildings." *Building Research & Information* 32 (4):285-292. doi: 10.1080/0961321042000221061.

Németh, Jeremy, and Joern Langhorst. 2014. "Rethinking urban transformation: Temporary uses for vacant land." *Cities* 40, Part B (0):143-150. doi: http://dx.doi.org/10.1016/j.cities.2013.04.007.

Northam, R.M. 1971. "Vacant urban land in the American city." *Land Economics* 47:345-355.

Pearsall, Hamil, and Susan Lucas. 2014. "Vacant land: The new urban green?" *Cities* 40, Part B (0):121-123. doi: http://dx.doi.org/10.1016/j.cities.2013.10.001.

Rosol, Marit. 2012. "Community volunteering as neoliberal strategy? Green space production in Berlin." *Antipode* 44:239-257. doi: 10.1111/j.1467-8330.2011.00861.x.

Spirn, Anne, Michele Pollio, and Mark Cameron. 1991. *Vacant land: A resource for reshaping urban neighborhoods*. Philadelphia: West Philadelphia Landscape Plan.

Taylor, John R, and Sarah Taylor Lovell. 2012. "Mapping public and private spaces of urban agriculture in Chicago through the analysis of high-resolution aerial images in Google Earth." *Landscape and Urban Planning* 108 (1):57-70.

Weiner, D, T A Warner, T M Harris, and R M Levin. 1995. "Apartheid representations in a digital landscape: GIS, remote sensing and local knowledge in Kiepersol, South Africa." *Cartography and Geographic Information Science* 22:30-44.

Williams, Miriam. 2016. "Searching for *actually existing* justice in the city." *Urban Studies*. Advance online publication. doi:10.1177/0042098016647336.

Williams, Sarah, and Elizabeth Currid-Halkett. 2014. "Industry in motion: Using smart phones to explore the spatial network of the garment industry in New York City." *PLoS ONE* 9 (2):e86165. doi: 10.1371/journal.pone.0086165.

Williams, Sarah, Adam White, Peter Waiganjo, Daniel Orwa, and Jacqueline Klopp. 2015. "The digital matatu project: Using cell phones to create an open source data for Nairobi's semi-formal bus system." *Journal of Transport Geography* 49:39-51. doi: http://dx.doi.org/10.1016/j.jtrangeo.2015.10.005.

Wilson, Matthew W. 2014. "Geospatial technologies in the location-aware future." *Journal of Transport Geography* 34:297-299. doi: http://dx.doi.org/10.1016/j.jtrangeo.2013.09.016.