Experiences with Volunteered Geographic Information (VGI) on a Small Street Tree Inventory

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Abstract: This paper revisits early ideas of the promise of volunteered geographic information (VGI) and investigates ways that current VGI tools and methods do or do not support simple VGI projects. The primary lens for this investigation is a community mapping project that has built a geospatial database for an annually updated street tree inventory. While simple in its conception, the project has encountered various citizen science and VGI barriers to maintaining its annual progress.

Keywords: Volunteered Geographic Information, citizen science, urban forestry

1 Introduction

Writing about local government GIS in 1995, Ventura predicted that "As local citizens' groups learn more about GIS databases and technologies, they may force local government to use GIS more effectively." A decade later, volunteered geographic information (VGI) had emerged as an important counterpoint to public participatory GIS (PPGIS), showing his prescience while raising questions about whether VGI and PPGIS were becoming indistinguishable (TULLOCH 2008). In that moment it seemed that an imminent proliferation of new technologies, then loosely categorized as neogeography, would erase old disciplinary boundaries and disrupt processes in ways that would alter basic public-interfacing GIS work. Today, faced with a myriad of user-friendly handheld technologies and tools, it is worth reflecting on the changes that have occurred, but also those that have not.

This paper reflects on perspective of VGI collection by examining a basic volunteer GIS project: a community street tree inventory. Many VGI projects have been far-reaching, like the worldwide data-collection and data-correction approach of the Open Street Map (HAKLAY 2010). More recently, attention-grabbing VGI research has included high-volume options like iNaturalist (YAN et al. 2020) demonstrating that VGI is an expansive field with scientific applications. The nature of a community street tree inventory is useful for the examination because of its seeming simplicity, but also through its need for updates reflect a dynamic set of features. For the example considered in this paper, the project has relied on different quantities and quality of volunteers across more than 5 years of a public inventory process. Its progress as a volunteer project rather than a consultant-produced product has forced useful conflicts that still often result in practical decisions about mixing generations of technology (e. g., jumping between paper field maps and online interactive maps without using handheld input apps).

However, this also raises questions that, in 2008, seemed like they would be more resolved by now. While initial concerns about replicability and reproducibility may have imagined wild hypothetical outcomes, scientific applications have suggested that the usability of contributed data can be substantial when situated properly (OSTERMANN & GRANELL 2017). With voluminous contributions made globally to citizen-science databases like eBird and

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iNaturalist (ZHANG 2021), shouldn't a focused community resource VGI project be fairly straightforward? The volunteered data portion has proved to continue to be difficult. Why?

2 Highland Park Street Tree Inventory

Highland Park Borough is a small municipality covering less than 5 square kilometers in Central New Jersey, USA. With only about 15,000 residents, it is a modest sized community with neighbourhoods where many houses and streets were built around 100 years ago. As such, it is known in part for some areas with large old street trees and a mature urban forest that extends beyond the streets. Responsibility for the street trees is held by the Borough government and overseen through an official Street Tree Advisory Committee (STAC) of resident-volunteers appointed by, and reporting back to, the Borough government.

In the most densely populated state in the US, much of which is either urban or densely-populated suburban, information about street trees is an important potential piece of information infrastructure. However, for many communities, street tree and urban forestry management and maintenance are largely funded with state or other external grant support. Grant proposals often include a scoring mechanism that rewards communities with street tree inventories already in place. This is a challenging problem as New Jersey is divided into over 500 municipalities, which includes over 300 that have fewer than 10,000 residents. Communities with smaller populations are continually challenged to use mapping technologies in ways that appropriately reflect and, perhaps, shape their landscapes, hence the opportunity to leverage volunteers as a way to improve the work of the STAC and secure more funding.

In 2016, the Highland Park Street Tree Inventory (HPSTI) was initiated by a resident with geospatial experience using multiple approaches to capture potential locations of trees. Several high school students were trained to use basic GIS tools and taught to identify a few common species of trees. They went into the field with maps of the potential locations to verify or correct the initial dataset. At the end of a second year of fieldwork, with the help of a few adults and the students, the HPSTI completed a first map of the entire borough and over 3,000 verified street trees.

Over the next several years, the techniques had to change as the students graduated and became unavailable and as some potential volunteers had different levels of comfort with technology (tree lovers are not always the most computer savvy community members). However, in each subsequent year, he HPSTI has been updated with a re-confirmation of the existing trees, adjustments in species identification or location and additions and losses as trees are planted or removed. Integrating the updates across different geographies, with information from multiple sources and technologies, the HPSTI has experienced inconsistent methods and techniques to develop the best possible easily-captured data that does not use methods that might exclude or alienate potential volunteers.

Table 1: A count of frequency of species (by common name) with over 50 trees in the database

Pin oak	480	American linden	82
London plane	329	Dogwood	64
Norway maple	252	Redbud	63
Honeylocust	241	Sugar maple	58
Red maple	169	Silver maple	57
Flowering cherry	120	Ash	54
Pear	89	Black locust	50
Japanese zelkova	86	Red oak	50
Serviceberry	86		

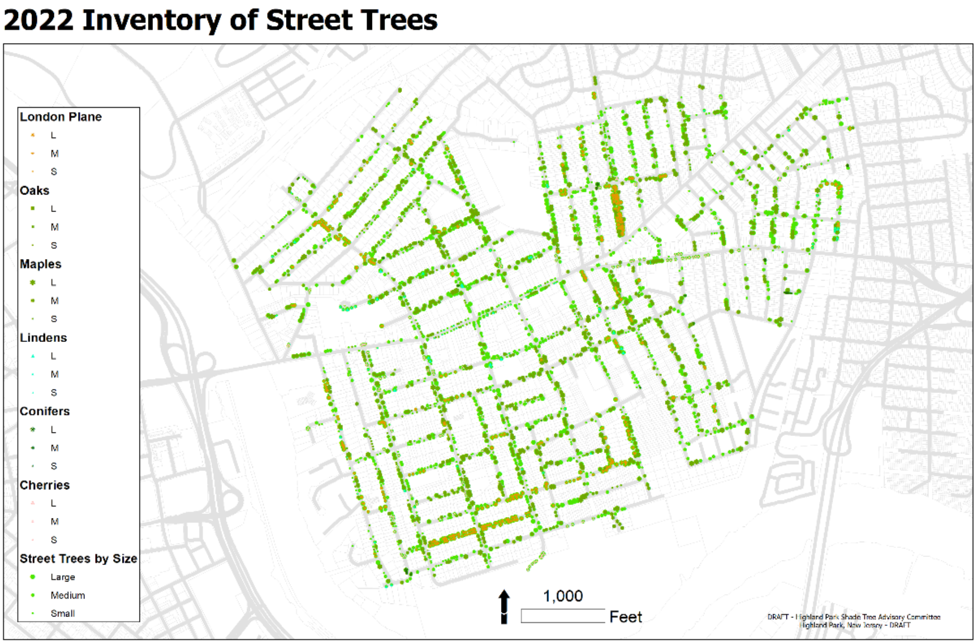

Fig. 1: Borough-wide map of Highland Park Street Tree Inventory (HPSTI) produced at the end of the 2022 season. Even with limited symbology and general species info, astute map readers should be able to identify patterns and areas worth further investigation.

While a few species are uncommon, a small number of species represent the majority of trees. The inventory found that 6 species each had over 100 trees, and combined to represent just over half (51%) of the street trees in the borough. The inventory found 16 species with 50 or more trees, which combined for 75% of the Borough's street trees (Figure 1). This is similar to many other cities, but also demonstrates the opportunity to employ volunteers with limited plant identification skills. As noted later, however, it is unclear if perceptions of expertise limit volunteer confidence.

3 Cooperation and Compromises

Early in the project, a common concern was that complex methods or high expectations might cause the volunteers to quit without completing a first round of inventory. In order to improve the chances of successful completion, the HPSTI volunteers and the STAC cooperated to identify unnecessarily time-consuming tasks. One early example came after experimentation with different measurement techniques like Biltmore sticks and diameter tape (devices commonly used by arborists to quickly estimate or measure tree size based on the trunk's diameter) when it was decided that simpler size classes and estimation would suffice in many situations. Another was the decision to collect data on tree condition and damage to canopy, except in extreme situations.

As the project advanced, mapping compromises emerged. Handheld GPS devices gave way to phones. Data collection apps like Survey123 were tried, but novice volunteers balked at the complexity and GIS-educated volunteers wanted more editorial access. Experiments are being considered applying data collection tools integrating real time kinetics (RTK) and global navigation satellite system (GNSS), which are high-precision alternatives to traditional GPS. But for much of the work, the inventory streamlined the field workflows by extracting a draft database from multiple years of aerial photography and then using field visits to confirm locations, identify errors of omission, and identify specimen size and species. It may reflect on the potential volunteers with interest in trees, but technology did little to draw in more volunteers. Instead, simple processes and a feeling of completion were seen as key elements. More importantly the particularly narrow, linear nature of the database altered the ways in which spatial accuracy mattered, shifting the needs in the field. Ultimately, the database reflects a combination of multiple techniques.

With a completed database and several years of updates, the simply-developed HPSTI has also been used to generate a variety of more-advanced analytical outcomes. Online mapping has been used to generate feedback. The data have been analysed to identify opportunities for new planting. Stretches of homogeneity have been marked as areas of concern for pests and disease management. And change over time has been illustrated in animated cartographic products.

4 Implications

There have been much larger street tree or urban canopy VGI projects (e. g., FOSTER & DUNHAM 2015). But the promise of VGI included local empowerment and individual applications, so reflections of VGI success and failures should include modest work and diverse funding and training support. In addition, a continuing concern has been the ways that ubiquitous technologies, sensors and feedback might change users (JOHNSON et al. 2020) but the HPSTI and its community instead shifted more to ways that technology needed to adjust to fit the project and its volunteers.

For years this smaller project has relied on motivation in ways that seemed different than other citizen science research (JENNETT et al. 2016). Novelty accounted for little, despite its prominence elsewhere. Still, new technologies continue to pique the curiosities of potential volunteers. Handheld apps using the phone camera and AI to identify plant species have recently sparked new interest. It may be that novelty can still be leveraged as a means for recruiting participants.

While larger cities will remain data-rich environments, this project serves as a reminder that there may be ways to collect data and build databases relying on VGI or other crowdsourced approaches. Even as landscape architects organize community workshops and encourage the public to share opinions and local knowledge, there are larger opportunities to structure these inputs and collaborate with motivated residents. While these more closely resemble scientific ground-truthing citizen science than creative charettes, they may still result in buy-in and lasting support.

5 Revisiting VGI, Participation and Engagement

Early efforts in citizen science and VGI raised concern with public contributions that purported to be science-based without an appropriate knowledge level. Included in these early framings were questions about 'Why do people do this?' (GOODCHILD 2007) How should these contributions be vetted or confirmed? Should the contributors be vetted or certified? Some of the larger citizen science projects have leveraged VGI to advance science; eBird has produced large VGI datasets used to model seasonal patterns of avian populations (FINK et al. 2020). But VGI has also been demonstrated as useful for smaller projects like the community infrastructure and geodesign project by SEEGER et al. 2014.

In addition to inventory volunteers, the project has also received a modest amount of input from the general public. The interactive online map assigns each tree a unique ID and asks for submissions about existing trees to use the ID. Additionally, the HPSTI page requests submissions informing the Borough's STAC of new street trees. In 5 years, there have only been a handful of public submissions; all were corrections or modifications rather than potential omissions or removals; twice the submissions have been made by homeowners wanting to be sure their personally acquired unusual or exotic specimen was acknowledged in the database). While public engagement is high when verifying street trees in the field, the online database may overwhelm even fairly interested parties. In addition, GIS maps carry an implied seriousness that makes them seem complete even when accompanied by requests for community-generated updates, corrections and edits.

Early examples also raised concerns about whether the novelty of the tools was part of the appeal. It was hoped that phone apps and interactive online maps would attract a wider variety of volunteers, especially since the initial group of volunteers included several high school students. Instead, the volunteers of all ages have largely preferred paper maps. After at least six years of trying different technologies and approaches, paper maps are still dominant as the HPSTI tool for annual field work (Figure 2). The hand-marked field maps are referred to later, to edit the database using desktop GIS software.

Ultimately, a larger question is simply whether the tool fits its public. While they may have been focusing on larger applications for complex democratic processes, SIEBER & HAKLAY (2015) point out how important context can be for appropriate outcomes: "Framing a civil society participation via VGI (and its mobile permutations) requires a conscious effort to render the technology and the way that it is used in a specific social context relevant to the values of an organisation or case study."

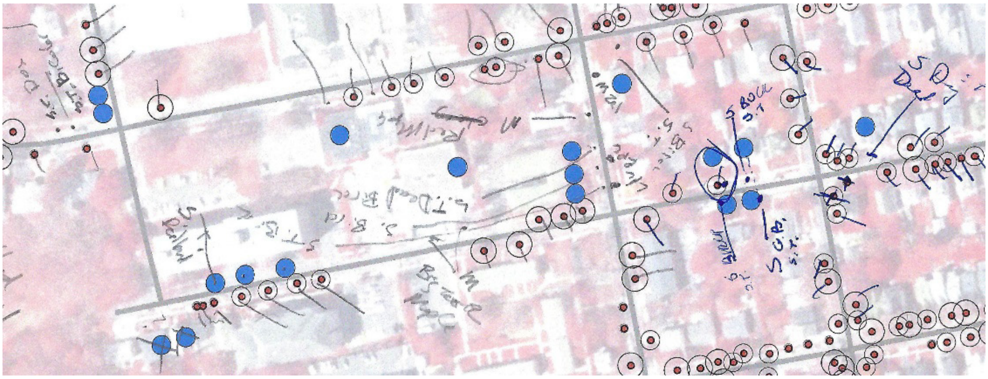

Fig. 2: A hand-marked inventory map for updating the database of over 3,000 street trees

The continued efforts to expand engagement with the HPSTI, in a community where many residents appear to be interested in the associated public resource decisions, would suggest that there is a potential misfit between the currently constructed tool and the community. This isn't meant as a highly negative comment as much as a recognition of the remaining potential for VGI to see increased use in a motivated community like Highland Park. Still, maybe the gap is the combination of citizen science with community policy. Which one would volunteers be participating in? Without a clear distinction, do other motivating factors get minimized? Fortunately, the inventory continues, with each year's field confirmation and updates presenting a new opportunity for testing new ways to engage and sustain participation from community volunteers.

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