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REFEREED PAPER

Upside-Down GIS: The Future of Citizen Science and Community Participation

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This article will focus on the changes in time, technology and data that have affected traditional partner relationships using participatory geographic information systems (PGIS). Project development roles of reliance held by the community, and managed by university agents, has shifted from cooperative to, in some cases, complete independence. The modern model of citizen participation includes a resident-planner toolkit with greater access to neighbourhood data and low- to high-tech analytical tools. Many community-led quality of life studies have a limited scope and focus on policy issues that do not serve a larger constituency. Many neighbourhood plans exclude self-reported neighbourhood knowledge and, due to the frequency of municipal reporting cycles, leaves gaps and data mismatch. Given this, the traditional public participation GIS (PPGIS) model may be less data driven due to a more mission-driven resident-led PGIS solution. Planners in practice and in academia have raised levels of concern about data standards, interoperability, reliability, error and metadata. How and why Citizen Science influenced the progression of PPGIS, participation GIS, crowdsourcing and now community-managed data in both theory and practice are provided. This paper will reflect on how top-down strategies to include neighbourhood knowledge are being reframed by the United States Federal Community of Practice. The future of data integration focuses on both the process and products of data development from both the bottom-up and top-down perspectives.

Keywords: citizen science, public geographic information systems, crowdsourcing, citizen participation, neighbourhood planning

INTRODUCTION

Residents indirectly provide government mandates by voting on policies and politicians who should reflect their desires. However, using the ballot box to prioritize policies leaves many residents out of the process and relegates choices based on voter bias. The availability and use of technology to achieve the goals set by the government to meet community needs has increased significantly. There is an increasing need to identify new ways to use resources that will maintain or improve the quality of life for residents. The on-going challenge faced by municipalities is to provide a broad spectrum of solutions that are diverse and meets user-defined needs. In an effort to reach community voices yet unheard, advocates in government and academia sought to adopt methods, tools and techniques that would increase resident input. Traditional citizen participation (CP) models (Arnstein, 1969, p. 216) identified an approach whereby the government designed and delivered programs and plans from the top-down. Over time, models of public participation engaged citizens before policies were crafted or implemented. The goal of CP varies but in the field of planning a 'top-down' model was the traditional approach. Efficiencies in community participation (community engagement + public participation) were improved by using technology, such as geographic information systems (GIS), from the bottom-up (Talen, 2000, p. 279). Networked and web-based (*e-technology*) were embraced by residents, government and academia with the promise of new delivery systems for projects. The benefits of collaboration could now be measured by reduced direct and indirect costs, decreased time in project design, increased speed of implementation and the expansion of expertise and tools. The ability to measure and evaluate success in community program implementation became easier when standards were created to measure project effectiveness. The ability for municipal government to allocate resources, or for an academic research project to report on results, became easier with integrated data systems. However, the ability to monitor neighbourhood change using these new data streams collectively by the community, government or the university still remained inconsistent. This lack of consistency in data development and use limits the ability to use the variety of information

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available at all geographic scales (e.g. neighbourhood/local, community, city/state, national).

Measuring recovery or growth at the city or regional level has traditionally been accomplished through the use of secondary or proxy data by municipal governments. The use of technology to support community level analysis has not been evenly distributed nor have the public data or university resources been readily available. Residents using neighbourhood knowledge are better positioned to monitor and report on micro-neighbourhood changes. In an effort to overcome the data divide, neighbourhood organizations began to create volunteered geographic information (VGI) to create or complement data that was either incomplete, not available or too expensive to obtain. For example, residents have access to hand-held, web-enabled technology to gather neighbourhood data. This enhanced neighbourhood data is being used to engage and inform the residents, establish a policy framework for recovery/reinvestment, filling data gaps for the local government and, in some cases, the research community.

Agents from municipal agencies and academic departments typically disseminate, interpret and maintain data developed through cooperative collection activities. 'Local data intermediaries, an institutional innovation in this field that has emerged since the early 1990s, are designed to address those barriers by assisting other local institutions in assembling community information and applying it productively' (Kingsley *et al*., 2014). The role of data intermediaries has shifted with the advent of and more prominent role by Citizen Scientists who may develop, analyse and report on community-led activities. The roles of local, state and federal actors who influence data collection standards/definitions, uses and access remains key in creating information that can be disseminated to the public. There are limits to data access, now more than ever, due to privacy concerns and the potential or perceived misuses of data. Most data that is available at the address or personal level will not be delivered from the Federal government due to privacy laws and Homeland Security policies. Opening pathways to share data requires a realignment of public participation that focuses on how the citizen and government can find common ground. The definition of what data is, how it can be used, the implications of excluding data, methods of integration and development has moved into a 'community of practice' (Citizen Science, 2015). The academy still serves a role in providing examples, education and documenting community-led data-driven projects and processes. Public participation GIS (PPGIS) or participation GIS (PGIS) will continue to be developed through public, government and university collaboration. Fortunately, projects are not limited by historic data nor predictive models. The ability to choose a top-down or bottom-up PGIS model still depends upon the values, mission, needs, goals and desires of the community and their willingness to participate.

This paper provides how theoretical models of CP contributed to the development of the Citizen Science movement. The definitions and characteristics of PPGIS and CS may have developed separately (some suggest simultaneously) but they vary in scope and use based upon the discipline. The relationship and contributions made by PPGIS and PGIS by VGI and Crowdsourcing have been well-documented. This research will provide examples for post-Hurricane Katrina (Katrina 2005) and how these models have been applied. Finally, some discussion on how technology, such as web-based applications has begun to re-define PGIS and its' use in the case of US Federal CS will be provided.

TERMS AND RELATIONSHIPS IN PLANNING: CITIZEN PARTICIPATION, CITIZEN SCIENCE, PPGIS, PGIS, VGI, CROWDSOURCING, GISCIENCE

The birth of citizen science and citizen participation

Numerous academics and practitioners lay claim to defining, developing and launching PPGIS. However, the activities that preceded PPGIS were found in Citizen Science. The term '*Citizen Science*' has been attributed to both Alan Irwin who described 'how people accumulate knowledge in order to learn about and respond to environmental threats' while Rick Bonney referred 'to public participation in scientific research' (U.W. England, 2013). The use of Citizen Science (CS) extends beyond, and is inclusive within, all disciplines and practice. The application of CS theory and application lies on the foundation on which it is built, the motivation of the actors, the systems and resources available for a project, the measurement of established outcomes and the results (whether intended or unintended). Citizen science is a form of open collaboration in which members of the public participate in the scientific process, including identifying research questions, collecting and analysing data, interpreting results and solving problems. For the purposes of this research, 'Citizen science' will be defined as '… community-based urban planning or environmental science projects that are responsive to community needs and involve lay people in the conduct and governance of research' (Woolley *et al*., 2016, p. 3). While the term was coined recently, activities of Citizen Science pre-date community participation in the use and dissemination of data collected through PPGIS.

'The term PPGIS originated at two meetings of the National Center for Geographic Information and Analysis (NCGIA) as attendees struggled to frame the next generation of GIS, or GIS/2 (which was read as two or too) that would ground technical advancements in social and political contexts' (Sieber, 2006, p. 491). A PPGIS is typically comprised of community, municipality and university participants. The purpose of developing this PPGIS event was to collect data that either was not accessible to residents (e.g. city data) or may not exist (e.g. concentration of blight) with an intent to empower the community. Initial PPGIS projects were led by organizations (e.g. academy or data intermediaries) whose role was to (Sawicki and Craig, 1996, p. 512):

(a) *Collect demographic, administrative, environmental or other local-area databases*,

(b) *Do something to the data to make it more useful locally* (*e.g. address matching of individual records; creating customized tables*) *and*

(c) *Provide this information to local non-profit community-based groups at low or no cost*.

The unprecedented advances in computer technology in the last 40 years have been accompanied by a series of technologies such as local to regional urban models, relational database spreadsheets, 'smart' planning support systems, open source GIS and the world wide web. Klosterman suggested that '… each promised to revolutionize planning practice and research' but 'Unfortunately, planners rarely use computer-based models and methods to help communities engage the future because the current generation of planning models and methods generally does not overcome the realities of planning practice' (Klosterman, 2013). There are fields that may benefit from this form of *GIScience* but due to the community and project variability, a single PGIS model is not possible for the field of planning. The variability begins with the identification of the community project starting with the definition of 'community' or 'neighbourhood'. The definition of community can vary from a collection of residents … to agencies … that act as a proxy for 'citizen'. For example, community engagement exercises used for the *Unified New Orleans Plan* (UNOP, 2007) were met with limited favour, and were not seen as credible, because the Lower 9th Ward/Holy Cross (L9W/HC) residents were not able to participate due to disaster-forced outmigration. The definition of resident was modified to include organizations, advocates and/or individuals who could participate in the community engagement process.

The traditional models of participation in planning theory relegate the community as a subordinate partner when identifying the needs, policies and plans at the neighbourhood level. Harris and Weiner (2002, p. 246) illustrate how social and political influences the data used in a GIS. Early adopters and champions of PPGIS such as Sieber (2006, p. 491) and Ramasubramanian (1999, p. 359) 'have shown how the use and impact of GIS may be shaped by organizational capacities and characteristics, noting that grassroots, non-profit, and community-based organizations have unique needs and resources with respect to GIS and digital data access and application' (Elwood and Ghose, 2001, p. 19). PPGIS offered an alternative to the top-down method of planning and community engagement that reinforced unbalanced and, many times, unequal power relationships. The 'multiple scales of interaction' between the project partners were 'shaped by social, political, and economic power relations' (Elwood and Ghose, 2001, p. 21). In the case of the Lower 9th Ward/Holy Cross, the social networks were decimated, the political structure eliminated and the economic power relations became non-existent.

The introduction of technology, in particular GIS, changed the power dynamic between government and citizen and/or community-based organization (CBO) since modern projects may be *community-led* (*CL*), *community-driven* (*CD*) *and community-maintained* (*CM*) without the direct or indirect participation of the academy or government. Thompson/Arceneaux (2016, p. 6) suggests that all three models can be used depending upon the community needs. In post-Katrina New Orleans, the model of choice relied on the personal, political and/or financial resources available in each neighbourhood. PPGIS remains an important tool for academic or municipal agents to engage and empower communities. CP is key to the success of any resident-led project. In 2001 the CP model expanded by a rung when technology was added to the e-ladder (Carver, 2001). By 2011, the Carver e-ladder was extended and reoriented from a ladder to a tree. The *Thompson Technology Tree* reorganized the interaction of the PPGIS projects starting with an 'identification' phase which was followed by 'communication'. Communication begins with identifying the issue of concern and developing a common language and definition before moving up the ladder of cooperation and project development. Through better communication, 'cooperating organizations will then be positioned to better define both short and long-term strategies to achieve both individual and organizational goals' (Thompson, 2015, p. 24). PPGIS projects may start with a similar premise of identifying a problem to solve, developing an action plan with appropriate time, talent and technology. However, the social, cultural, economic and political landscape affects the project plan which may branch into a completely different project at the end of the process.

While technology has provided ease of use and access, barriers still can impede the level of engagement and/or willingness of a citizen to manage responsibilities that were formerly relegated to the municipality. Technology helps with restructuring project development and implementation. There are still fundamental engagement relationships that must be considered depending upon the capacity of the community, resources of the academy and support by government in the overall project plan. Many of these issues relate to what the community issue is and if questions being asked can be answered by the data collected. In 2007 ACORN Housing and a University Collaborative collected, mapped and reported on the property conditions of the L9W/HC. The University Collaborative results was hampered by limited knowledge of pre-Katrina property conditions, lack of access to the City's parcel layer, hand-made street signs and no coordination with the local academic and practicing planning professionals. The Quality of Life (QoL) rating system measures for 'good/fair/poor' property condition allowed for increased variability of status interpretation and potentially inaccurate findings. With these limitations acknowledged, this baseline data was used to develop a neighbourhood plan that was found credible and adopted by the City of New Orleans City Council in spring 2007 (NOPI, 2007). While the level of community input and engagement varies, the contribution of standards in CS and customizing these in PPGIS has led to multiple CPs models [(*CL*), (*CD*), (*CM*)] which increases data streams and types.

DATA: ACCESS, USE, STANDARDS, BIG AND SMALL

Data can be collected in a variety of ways using formal and informal means both, with and without technology. Data that is collected through voluntary contributions from a large group is known as '*crowdsourced*' (Howe, 2006). Typically the group of unknown individuals or 'the crowd' are collecting the data for a common purpose but they may engage for a single event which may or may not be replicated. This activity varies from VGI (Goodchild, 2007) which has

prescribed survey methodology, intentional measurement tools, volunteer training, metadata (*data about the data*) and data quality controls. A PPGIS resident-supported data collection process that a university or municipality converts into geospatial data forms the basis for VGI. VGI can be used without a spatial component and may not always be considered adequate CP. 'Putting GIS on the Internet therefore does not in its own right, constitute an effective participatory decision support solution, if only because it is such a complex beast and the data difficult to interpret. GIS-based decision tools should provide the means by which stakeholders can explore a decision problem using existing information, experiment with possible solutions, view other people's ideas, formulate their own views, and share these with the wider community' (Carver, 2001). For example, a PPGIS team studio with *Muungano Support Trust* (*MuST*), the University of Nairobi and residents of the Kosovo squatter settlement documented unmet needs of residents. *MuST* comprises a small group of professionals that includes planners, architects, sociologists, accountants and journalists. 'The resulting plan provided access to constant piped water for each of the 3,000 households in Kosovo. The Nairobi Water and Sewer Company installed new water pipes on the agreement that the community members maintained the service and paid their water bills' (Gibson, 2013). The ability for the PPGIS in the Nairobi, Kenya to move ahead relied on the government trust in the data. Without the combined efforts of the residents, advocates, philanthropy (Rockefeller Foundation), university and the government, the project would have been a study in collaboration and not an implemented life-altering project. In general, crowdsourced information has increased data options but has not solved the lack of VGI integration with municipal data.

Over time, municipalities have responded by creating portals where citizens may view, download and independently use public data. Not all formats are compatible nor are all metadata provided in a standard form. The problem is that the trend toward government enterprise data systems has still not reached many communities, and in many cities, the data of interest are currently stored in individual agency database silos. Community groups may recognize the need for cross-topic neighborhood-level data, but it would obviously be extremely wasteful for all such groups to go from agency to agency to try to collect the woefully inadequate data typically being released to the public (Kingsley *et al*., 2014, p. 1). Many projects rely on the development of data collection instruments and e-storage by project partners.

In 1995 the *National Neighborhood Indicators Partnership* (*NNIP*) focused on expanding the data collection and management through the use of intermediaries which could be a single or multiple institutional collective (NNIP, 2015). Organizations such as the Greater New Orleans Community Data Center (renamed 'The Data Center', 2013) was a critical entity post Hurricane Katrina/Rita when local, regional and in some cases statewide community data was needed for hazard response, recovery and reinvestment planning. The goal of an intermediary is to 'provide accurate and useful data on multiple topics to all groups that need it and that will commit to continuing the data provision over the long term' (NNIP, 2015). An interruption in the planning process, such as *Katrina,* requires creative solutions and modification in the roles of planners and intermediaries. For example, the lack of municipal cooperation and warehousing of data during the *UNOP* process left the non-government organizations and community data advocates with few reliable data choices. In order to properly match census, migration, blight, crime, property condition survey or other *QoL* data required for community recovery analysis, a rogue copy of the City of New Orleans parcel layer was being shared (Ross, 2015). *New technologies such as these have helped to generate a wealth of new data and led to what is known as the 'big data' movement. In the past two decades, society has moved from discussing data in terms of kilobytes and megabytes to gigabytes and petabytes, and ultimately yottabytes* (Manyika *et al*., 2011). However, the collection of mega-data does not necessarily mean it is the 'right' data.

GISCIENCE, DATA-DRIVEN GIS

Early PPGIS projects were motivated by the lack of data and the ability to collect it quickly, efficiently and independently. Users of these new streams of data continue to raise concerns about data accuracy, validity and quality. 'Spatial data quality includes many facets, such as positional accuracy, attribute accuracy or completeness. Therefore, there is a need to evaluate the validity of Linus' Law for the different aspects of spatial data quality' since '… the relationship between the number of contributors and the quality of the data is not linear' (Haklay *et al*., 2010). The goal of GIScience and PGIS advocates has an increased focus on establishing standards for VGI quality assurance. These standards apply to non-VGI projects as well. *Van Oort's (2006) comprehensive synthesis of various quality* standards identifies the following elements of spatial data quality discussions such as *Lineage* (history), *Positional accuracy* (*x*,*y* coordinate), Attribute accuracy (shape and attributes), *Logical consistency*, *Completeness* (data gaps or excess), *Usage, purpose and constraints* (fitness-for-purpose declaration) and *Temporal quality* (relational database and update rates) (Haklay, 2015).

Governments have expanded opportunities for citizens to use data but also participate in evaluating the construction of public data sets. In an effort to increase citizen engagement there has been an increase in open forums of government performance management programs and process improvements. Municipalities are including citizen input at the front end of data-driven decision making. There is an increased level of government transparency and accountability which may be attributed to enterprise technology which improves the delivery of programs and services. These public accountability programs are driven in large measure by the theory that 'what gets measured gets done' (Drucker, 1982). This model of project management and asset mapping was used in creation of the City of New Orleans *Office of Performance and Accountability* which manages the reporting on an innovative blight reduction program, publicly open inter-departmental meetings. The following Departments and organizations participate and/or report on the challenges and accomplishments: Mayor's Office, Office of Information Technology and Innovation, City-GIS, Legal Department, Department of Code Enforcement, New Orleans

Redevelopment Authority, Office of Community development. *Blightstat* was launched in November of 2010 with a goal to eliminate '43,755 blighted homes and empty lots in New Orleans (identified) in September 2010. Coupled with 9356 vacant but habitable housing units, nearly 25% of residential homes and addresses in New Orleans were blighted or vacant, representing one of the highest rates of abandonment in the country' (City of New Orleans, 2014). By January 2014, the city program achieved its' goal of eliminating 10 000 units between September 2010 to April 2013 (Yaukey *et al*., 2013). The ability for residents to monitor the activity, map the progress and allow researchers (such as faculty at the University of New Orleans) to evaluate the 'success' could not have been possible without the use of open, free and reliable access to municipal e-data.

The New Orleans community was provided with an inside view on what the challenges were/are for a city on the cusp of launching an enterprise GIS. Citizens were provided with data definitions and a better understanding of the opportunities and constraints of being able to access e-government data. This unique approach to increasing citizen engagement, improve the public participation planning process, provide ground truthing of city data analysis and monitor government management innovation was a major departure from the previous administration (and GIS Manager who refused access to the parcel layer). In 2012, the Harvard University Kennedy School of Government Ash Center for Democratic Governance and Innovation recognized New Orleans' blight reduction strategy as a 'Bright Idea in Government' (Ash, 2012). The data and maps presented at each Blightstat meeting was immediately accessible to the public on an external website and used by citizens, organizations and businesses. The ability for citizens to validate data by providing feedback on the dataset became part of an enhanced 311 system whereby any quality of life concern could be reported outside of the meetings and tracked by email and on the city data portal. The New Orleans Blightstat example provides an approach to *PGIS* which focuses on engaging citizens in an inclusive and holistic manner. The ability to provide this innovative forum does not solely rely on technology but a willingness to be an equal partner in data development and accountability.

THE GIS COMMUNITY OF PRACTICE

The advantages of open communication, ground truthing, accessibility and data integrity far outweigh deliberately preventing access of municipal assets (such as public data) to the community. 'Past research has called for investigating the ways in which local political context shapes GIS use, information access, and participation in these endeavors, calling for evaluation of such factors as the openness of local government to sharing necessary resources for urban GIS analysis (such as government-collected data on housing conditions or tax valuations), openness to including community groups as authoritative participants in planning, and local government agencies' own experience and expertise with using GIS for urban applications' (Elwood and Ghose, 2001; Elwood and Leitner, 1998; Ghose, 2001; Ghose and Huxhold, 2001; Ramasubramanian, 1999; Sieber, 2006). Efforts to create data standards, definitions, policies and protocol vary by municipality. For those communities with advanced data development needs or for municipalities who seek to improve or create standards can access resources through the *National Spatial Data Infrastructure (NSDI)*. The NSDI is part of the *Federal Geographic Data Committee* (*FGDC*) and '… provides a basis for spatial data discovery, evaluation, and application for users and providers within all levels of government, the commercial sector, the non-profit sector, academia and by citizens in general' (FGDC, 2015). The creation of standards for municipal government still has not addressed the access concerns, a mechanism to standardize VGI or find resources (money, time and talent) to maintain data created through Citizen Science.

The barriers and concerns of using crowdsourced data in Citizen Science has significantly changed due to policies enacted by US Federal Agencies, particularly under the Obama Administration. 'We believe that additional data quality issues can be addressed by thinking more holistically about the nature of error in citizen science, and the stages of research in which error can be corrected or ameliorated. Focusing on the use of carefully designed data entry forms can improve the quality of data, and data mining techniques for analysis of large-scale but biased or incomplete data can be valuable for improving the validity of resulting interpretations' (Wiggins *et al*., 2011). In an effort to address those concerns, New Orleans data intermediaries began to develop, use and publish their policies and protocol before, during and after data development. *WhoData.org* is a PPGIS that established QoL property condition surveys using local knowledge, established a 'train the trainer' field training kit and integrated the national NSDI protocols for data creation, cleaning, maintenance and reporting. WhoData.org was established in 2009 in response to the needs of the community who needed a way to evaluate and prioritize community needs post-Katrina. The data collection forms were modelled after the New Orleans Redevelopment Authority (NORA) property record cards and the data definitions were initially based on the City of New Orleans GIS (CNO GIS). At the request of then U.S. Senator Mary Landrieu a 100% survey of the property conditions for the Lower 9th Ward/Holy Cross was led by the WhoData.org team using a *community-driven* project model. The result is the New Orleans LA Lower 9th Ward '*Gumbo Map*' which included Summer 2011 and 2012 property conditions, Lot Next Door (NORA program), Growing Home (NORA program), Neighborhood Stabilization Program 2 (Federal/US Housing and Urban Development program), Soft Seconds Program (State/Office of Community Development) and Code Enforcement Blight Citations (City of NOLA, Code Enforcement and Municipal Court).

The *New Orleans Lower 9th Ward map* (Figure 1, below) exemplifies how maps can tell stories that few words can express adequately. All of the green areas are areas that previously were residential dwellings with generations of families who lived in the Lower 9th Ward and Holy Cross. The volunteers, university students and residents conducted a 100% survey of 7169 parcels since the City of New Orleans did not have the capacity (manpower, time, not talent) to conduct this property condition survey. The immediate use for the map was for then US Senator Mary

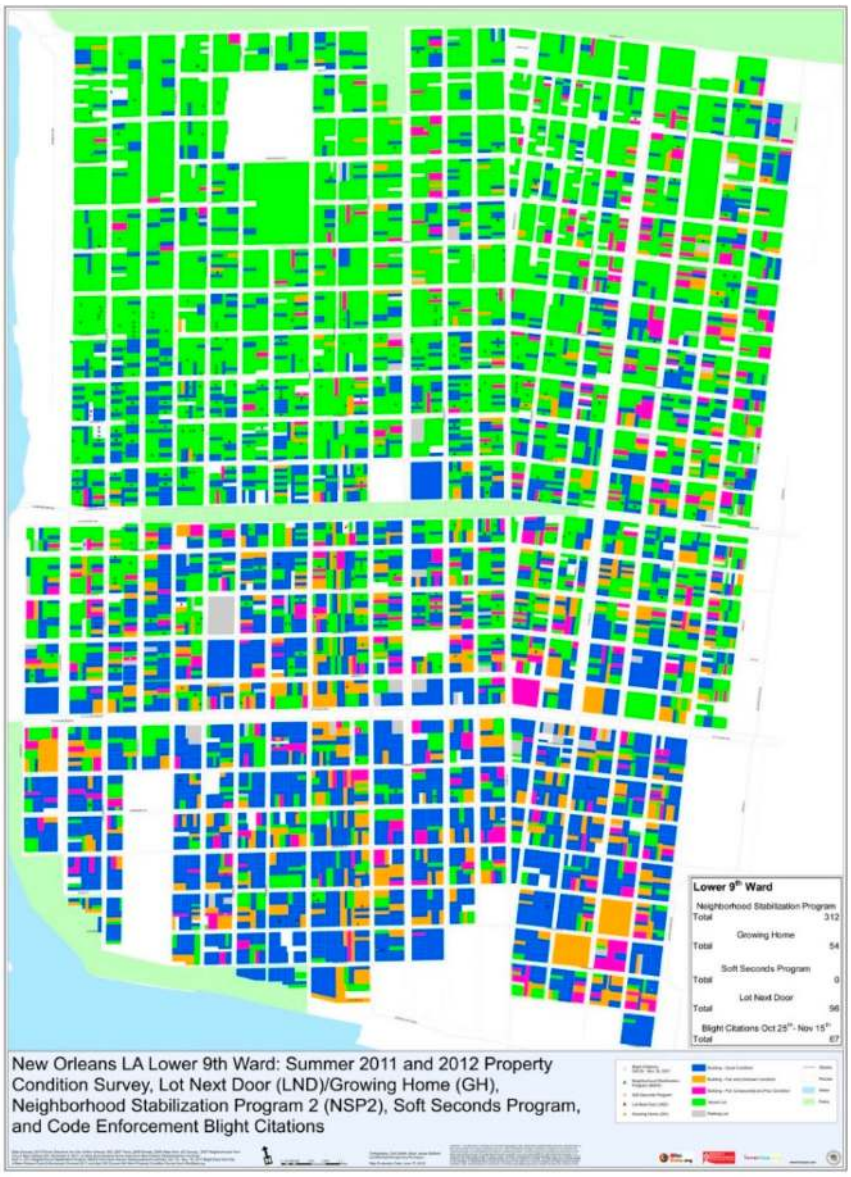

Figure 1. New Orleans LA Lower 9th Ward (Thompson, 2012)

Landrieu (12/11/11) to facilitate housing, employment, education and infrastructure meetings which focused on areas of resettlement. The incorporation of data from the *Road Home* (Louisiana Land Trust), *Lot Next Door* (New Orleans Redevelopment Authority), *Neighborhood Stabilization Program* (US Housing and Urban Development), *Soft Second Mortgages* (Office Community Development) and *Blight* data from Department of Code Enforcement was the only map of its' kind. The map, data and analysis was presented to Mayor Landrieu for use by and for the residents of New Orleans. While the WhoData PPGIS data was considered vital, it still remains a reference source and not integrated in the CNO GIS data warehouse.

The creation of the '*Gumbo Map*' also represented the limits and opportunities that can be gained in a PPGIS if data remains in open access. The lack of data sharing and transparency resulted in project duplication, data mismanagement, unnecessary fund dispersement, frustrated and1 disenfranchises community members, disillusioned neighbourhood planners and a lack of clear strategic plan to monopolize on the wealth of data, talented GIS technicians and post-Katrina funds that were unequally, but not sparingly, distributed.

The CNO GIS policy under the Nagin Administration hampered efforts to have a successful, viable and sustainable enterprise GIS.

The City of New Orleans was not alone in missed and mismanaged opportunities to create big data post-Katrina. The academic community repelled into NOLA to examine, collect and ultimately squander the time, talent and tenacity of 'locals' who participated in PPGIS 'experiments'. In 2007 ACORN Housing and a University Collective were hired as neighbourhood planners during the Unified New Orleans Plan. The development of data collection standards

outside of the community, 'real' citizen engagement, limited to no coordination with local experts (such as the UNO College of Urban and Public Affairs) and a political environment that resulted in the firing of the team contributes to the lack of trust in PPGIS and PGIS processes (NOPI, 2007). When *WhoData.org* was established in 2008 the goal was to ameliorate the concern by residents, CBOs and citizen scientists that data wouldn't be collected and taken or sold back to the community. With the completion of the first PPGIS project with three neighbourhoods, the 'Walk the Block' (Harmony Neighborhood Development, 2011) project set a new standard for NOLA PPGIS that is recognized nationally as one of the 'best' examples of *applied* Citizen Science (Ross, 2015).

The City of New Orleans used the WhoData L9W/HC data to launch a *pilot mowing program* of the properties that were part of the Louisiana Land Trust properties that were incorporated after Katrina due to resident turn over or acquisition (City of NOLA, 2011). State Representative Wesley Bishop used this compiled data to establish a state-wide referendum to force NORA to sell or inspire building on LLT-owned parcels in the (2015) $100 Lot sales program (Fox 8, 2014). The lack of affordable housing remains an issue city-wide but remains a tragic reminder of Katrina in the L9W. The 2011 maps and data were used as the basis for selection of sites by *New Orleans, Habitat for Humanity* to develop and sell affordable housing.

US FEDERAL GOVERNMENT EXPANDS COMMUNITY OF PRACTICE

Many of the concerns that local government are found at the Federal level as well: privacy, data quality, compliance with the Paperwork Reduction Act, liability for the agency and volunteers, agency culture, perceived utility of the data, lack of successful crowdsourcing and citizen science endeavours, lack of active support or (project) champion and a lack of IT Department support. The Open Government National Action Plan specifically commits the Federal government to 'convene an interagency group to develop an Open Innovation Toolkit for Federal agencies that will include best practices, training, policies, and guidance on authorities related to open innovation, including approaches such as incentive prizes, crowdsourcing, and citizen science' (White House, 2015). In the 2013 *Second Open Government National Action Plan*, President Obama called on Federal agencies to 'harness the ingenuity of the public by accelerating and scaling the use of open innovation methods, such as citizen science and crowdsourcing, to help address a wide range of scientific and societal problems'. On 21st November 2014, the *Office of Science and Technology Policy* (OSTP) kicked off development of the Toolkit in partnership with the Office of Personnel Management's human-centered design practice known as 'The Lab' and the *Federal Community of Practice on Crowdsourcing and Citizen Science* (FCPCCS), a growing network of more than 100 employees from more than 20 Federal agencies (White House, Community of Practice, 2015). The *Federal Community of Practice on Crowdsourcing and Citizen Science* (FCP CCS) works across the government to share lessons learned and develop best practices for designing, implementing and evaluating crowdsourcing and citizen science initiatives.

In October 2015 the White House Office of Science and Technology Policy (OSTP) launched the *Federal Crowdsourcing and Citizen Science Toolkit* (White House, Toolkit, 2015). The Toolkit will help Federal practitioners find resources to pitch, develop, implement and improve citizen science and crowdsourcing projects. The approach focuses on using PGIS since many of the strategies for engagement require e-government tools and web-based survey and reporting mechanisms. 'The amount of relevant data available to the public has been vastly expanded. These sources include new national data files with small-area or address-level data (from the federal government and commercial sources), as well as publicly available local government administrative files and data available from commercial sources' (Kingsley *et al*., 2014). The multi-phased approach includes modules that guide the Federal Agency through the participation/engagement process: 'Scope out your Problem', 'Design a Project', 'Build a Community', 'Manage your Data' and 'Sustain and Improve' (White House, 2015).

The Federal, State, City and Community data provided an example for how interoperability and data standards can facilitate better quality of life, decrease costs, improve access and expand CP. Concerns about data quality and accuracy were minimized due to the multiple levels of sources and data quality control and assurance through use of FGDC and WhoData.org data standards. 'We hope that raising awareness of the community information field for practice and research among local and national stakeholders will ultimately result in more informed and inclusive decision making in communities across the nation' (Kingsley *et al*., 2014). The proactive plans of innovation by city, state and federal departments to embrace the opportunities that Citizen Science, Crowdsourcing and VGI data have already demonstrated benefits in a new culture within this community of practice. The Citizen Science Association is working closely with local, national to international public, private, non-profit, academic and municipal organizations to: 'Establish a global community of practice for citizen science; Advance the field of citizen science through innovation and collaboration; Promote the value and impact of citizen science; Provide access to tools and resources that further best practice; Support communication and professional development services and Foster diversity and inclusion within the field' (Citizen Science, 2015). The strength and future of PGIS and how it has extended the definition of citizen scientist may contribute to building a sustainable bridge that fills the gap of data access, knowledge and power.

CONCLUSION

The use of data in both small and big ways will continue to expand with each new technology and related innovation. Opportunities to identify, view and integrate public and private data from varying geographies (the household to the nation) is now possible. In an attempt to democratize and increase data streams for advocacy and research, the academy set forth a mechanism to test a theory of community

engagement using technology. In many cases the university held the resources, time and talent to clean public data that was not easily accessible, inexpensive or in a format that could be used as a primary source. CP has always been an integral part in evaluating the effectiveness of social, political and economic processes. In 2001, Carver expanded the 1968 model ladder rungs both upward and outward by introducing technology as an option. The ability for citizens to more fully participate in the development of neighbourhood studies increased as the municipal partners expanded data resources and universities acted as data interpreters and project advocates. Empowering residents brought forth a new agent, the Citizen Scientist, who began to lead the community-based projects using conventional survey methods, scientific data analysis and reporting standards. The theories of citizen engagement shifted to 'community participation' which was redefined by technology and leadership. The advent of PGIS suggests that there are now more models where the municipal and university agents supported, but did not define or direct, project goal and communication was finally a two-way street.

In all cases, data has been and will be the element that will enhance or limit project success. With the PPGIS model where the university or non-profit organization acts as a data intermediary, there is an assumption that data has fewer errors and has followed standards and conventions. Data created through Citizen Science (CS) was given more validity and credibility since the process of development mirrored those found in academic research and followed scientific protocol. Concerns about volunteered geographic data (VGI), which may be part of CS, have been of greater concern. VGI data development did not always include training on how to validate community data. As a result, local governments were not willing to incorporate VGI data since there was a large variation in data gathering techniques, data definitions re-surveys and limited means to conduct community-government comparative data analysis.

There has been a significant rise in neighbourhood data created through crowdsourcing. Critics suggest that crowdsourced data has the potential to be biased, unfiltered and have significant error due to the lack of quality control. A national movement to create standards for data creation, development, maintenance, analysis and reporting through the FGDC did not recognize the interests or contributions of CS, PGIS or crowdsourced data. However, there has been a change in the approach to community data information systems at the local to national levels. Municipal governments facing enormous data gaps, with limited means to ground truth or have 'real-time' sources, have turned to PGIS organizations to collect and disseminate data using resident-led projects or CS groups. This is not a recent phenomenon nor is it limited to European or North American communities. The promise of community integrated data systems, within Detroit to Nairobi and from Shanghai to Nepal, may hold future promise. The US Federal government has joined a Community of Practice which increases the possibility of interoperability data systems and processes using Citizen Science through PGIS. The ability to develop, share and use crowdsourced data *by the people and for the people* has been advanced during the Obama Administration. The need for a comprehensive data standards remain but more focus has been on understanding the nature of error, and correction through feedback loops, throughout the development process. By using both bottom-up and top-down strategies, the new order of small and big data development becomes an upside-down practice that can work effectively in either direction. The issue no longer is if data can be obtained but, in the future, where to put it all.

BIOGRAPHICAL NOTES

Michelle M. Thompson is an Associate Professor at the University of New Orleans in the Department of Planning and Urban Studies (UNO PLUS). Michelle teaches courses in geographic information systems, community development finance, urban public finance, housing, urban studies and land use planning. She received a Masters in Regional Planning'84 and Ph.D.'01 from the Cornell University Department of City and Regional Planning with a focus on community development and spatial analysis using geographic information systems (GIS). Michelle received her Bachelor of Arts in Policy Studies from the Maxwell School of Citizenship and Public Affairs from Syracuse University in 1982.

Michelle's research focuses the application of public participation geographic information systems (PPGIS) in community development and reinvestment. Michelle is the Project Manager of the web-based community mapping service, *WhoData.org,* which combines parcel level neighbourhood condition information with public data to monitor socio-economic and demographic changes. The WhoData.org Team and Students from UNO PLUS have supported individuals and organizations locally and nationally to identify areas of potential reinvestment while evaluating community health and safety.

Michelle is also the Principal of Thompson Real Estate Consultants LLC, a real estate research and education firm. Michelle has also worked in both public and private companies related to the finance of residential and commercial real estate. Michelle has a long-term interest in working with community development organizations to provide technical support, market research and evaluation services.

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