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GIS and Public Engagement: Geo-Spatial Support' and the Space of Flows

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Abstract

For thirty years, the social GIS literature has warned that powerful mapping technologies can become normalized in society through naïve empiricism. Technologies come to seem value-free and even to transcend history in their usefulness, while at the same time, underpinning power laden networks that promote uneven development. Supporting the findings of the present study, the public participation GIS (PPGIS) literature has argued that few meaningful paths to participation in local planning exist. Here, three major findings are presented based on previous ethnographic case study research in a Central California city: 1) Even when used without dynamic mathematical models, GIS leverages time in flows of space. 2) To accomplish this, GIS coordinates spatial and spatialized information which is then used to avoid public scrutiny in local planning. 3) This convergence of power-knowledge and dominance has created a virtually hidden 'internal' space within cities connected to what Manuel Castells terms the space of flows. These findings suggest that the usefulness of GIS in local planning centers on the manipulation of space and, to a larger degree than in other mapping technology, time. In this way, technologies like GIS gain power by following more closely the flows of space in nature. This paper discusses the spatial implications of these findings bridging the structuralist and post structuralist theories of Manuel Castells, David Harvey, and Michel Foucault, concluding with policy suggestions for a more empowered community GIS in planning.

Keywords

Social GIS, Community Geography, Local Planning, Manuel Castells

In the industrial mode of development, the main source of productivity lies in the introduction of new energy sources…In the new informational mode of development the source of productivity lies in the technology of knowledge generation…

the action of knowledge upon knowledge itself as the main source of productivity…

—Manuel Castells, The Rise of the Network Society

But alongside this crumbling and the astonishing efficacy of discontinuous, particular, and local critiques, the facts were also revealing something…we have seen what might be called the insurrection of subjugated knowledges.

—Michel Foucault, Society Must be Defended

1. Introduction

In 2016, President Barack Obama described the social impact of information technology in American society when he discussed the "wild West media landscape." As information technology over a century has made information and media central to economic exchange, Obama's remark is more poignant than it appears at first glance. Manuel Castells (2010) has termed the networked dimension of this pervasive informational impact the space of flows. Patterns of material relations have expanded in scale through the increased speed of information (Harvey, 1989), creating a new experience of space, defined here as assemblages of relations between people, things, and the environment. As with David Harvey's (2007) concept of a spatial fix in which perceived risk such as unionized labor is "fixed" spatially by offshoring factories, the space of flows seeks to resolve the contradictions of state-regulated economic systems, in part, through *in situ* knowledge domination. This article uses findings from the author's previous ethnographic research of planning in a medium-sized California city in which high quality information technologies like GIS are referred to by city employees as part of 'internal' in contrast to 'public' space. 'Internal' planning space, according to informants, has expanded with information technology. The character and meaning of this 'internal' space connected to the space of flows (Castells, 2010) along with an *in situ* variation of Harvey's spatial fix (1989) is explored here in relation to low levels of meaningful public participation GIS (PPGIS) (Barndt, 1998; Brown, 2012). Castells and Harvey provide ways to assess patterns of economic exchange related to GIS planning space revealing the technology's capability to leverage time as it relates to land development and urban form. However, the paper uses a diffuse concept of power (Foucault & Gordon, 1980) not normally associated with Castells' and Harvey's more abstract structural theory. A more diffuse view of power allows the research to take multiple vantage points meant to overcome the illusion of unified meaning around powerful IT such as GIS. Echoing the spirit of early critical GIS literature (Miller, 1995; Pickles, 1995, 1999; Schuurman & Kwan, 2004; Sheppard, 1995), the goals of this paper are to uncover the role of GIS in planning and to make suggestions about how subjugated knowledges (Foucault et al., 2003)—knowledge discounted due to the non-expert status of those who express it—might be accessed through GIS.

In the case presented here, cities have not lost control over the system of land use planning forged a century ago, rather they have failed to gain similar control

over the new spaces of information technology and networks which have come to dominate land use planning. Castells' idea of the space of flows addresses the changing structure of space in relation to meaningful input into things like planning. Harvey's spatial fix, meaning movement of investment to cheaper and less regulated markets, refashions the idea of a technological fix in which inconvenient labor issues are resolved by replacing labor with technology (Harvey, 1989). Castells suggests similar changes in the mobility of the factors of production due to information networks and connects these changes to the social experience of space. While the technological fix describes the historical turn to concentrated steam technology and, more importantly, newly mobile labor, Castells' (2010) space of flows describes connections between dominant people, knowledge, and cities in networks in which a sphere of informal control is created by knowledge acting on knowledge. These connections are accomplished through coordinating services like accounting, legal, R & D, and university research which, Castells argues, have come to dominate the formerly place-based, zoned, and regulated cities of the mid twenty first century. The cost, Castells argues, is increasing inequity between those people connected to the space of flows and those on its edges, including less control by the state. In cities, information-coordinating tools like GIS coincide with Castell's description of the changed informational mode of accumulation and the effects of networked information over the planning efforts cities control.

The case presented here analyzes the City of Nayoras, California [pseudonym], a leader and early regional adopter of GIS as evidenced at the time of fieldwork by two proprietary GIS platforms along with leadership by city staff in a regional geo information sharing network. In Nayoras, GIS is used almost entirely for what staff describe as 'internal' processes distanced from city council deliberation and, though GIS provides coordinating services for most planning and infrastructure maintenance, it is all but invisible in public engagement. In Nayoras, GIS for planning purposes is accepted by both residents and professional planners as outside the purview of the larger population because of its professional usage and technical nature. Indeed, participant observation and interviews revealed that it is primarily IT staff who are aware of GIS, though few use it in any meaningful way. More importantly, this lack of public access to GIS was not questioned by staff, elected officials, industry, or community advocates. Early social GIS literature describes this phenomenon as "naïve empiricism" (Taylor as quoted in Pickles, 1999, p. 51) in that the role and impact of GIS in local planning go unquestioned due to its positioning as a technical tool. Community geography (Fischer et al., 2021; Robinson et al., 2017; Shannon et al., 2020) and public participation GIS (PPGIS) (Carver et al., 2001; Kahila-Tani et al., 2016; Robinson et al., 2017) literatures have focused, in part, on individual-level motivations, population factors outside of planning, and lack of technical knowledge in communities as limits to GIS in local planning. However, results presented here support the longtime critical GIS argument that social and institutional factors may actively block the availability of

paths for meaningful GIS use in public forums such as the city council or public engagement even when GIS technology is available to the community and is used skillfully.

More specifically, efforts to reduce barriers to information-related public engagement through university-led community geography and increased technical skills among marginalized populations (Fischer et al., 2021; Robinson et al., 2017; Shannon et al., 2020) have had difficulty overcoming barriers to meaningful use of GIS by people outside of planning. This paper argues that the positioning of IT within spheres of expertise in local government (Castells, 2010) explain this outcome. The GIScience literature suggests that the continually expanding functionality of GIS is meant to meet the geo-spatial needs of organizations including a pervasive presence in planning worldwide (Miller & Goodchild, 2015, see also Sheppard, 1995 and Pickles, 1999). Moreover, this function requires "vision" from users for the direction of new GIS capabilities (Dangermond & Goodchild, 2020: p. 8), meaning that major innovations are not inherent in the technology but instead are designed to meet client needs. Historically, this has meant expanded functions in real time and big data to produce a much-expanded capacity to spatialize data storage and provide quick access for IT professionals in industry and government, thus leveraging time more effectively in accumulation processes such as urban development (Richardson, 2013). However, the PPGIS literature argues that there are widespread barriers to GIS use when the focus turns to public engagement (Barndt, 1998, 2002; Brown, 2012; Brown & Kyttä, 2014), in part, because dominant industries with connections to local government have little interaction with the organizations that promote public engagement in the community (Barndt, 2002).

2. Methods

I conducted formal fieldwork for this project over a period of a year and a half in Nayoras, California (pseudonym), a Central Valley city of over three hundred thousand people. Several observable phenomena related to information and planning were evident, but the interconnection between the setting and these occurrences was unclear. Because of these factors, the research lent itself to the case study method as outlined by Yin (2003). Information in planning included both varied data sources (Yin, 2003) and concepts from across the structuralist, e.g., Castells and Harvey, and post-structuralist, e.g., Foucault, schools of thought.

2.1. Data Collection

Data included field notes, archival material (e.g., planning documents, meeting minutes, and agendas), participant observation, informal conversations, semi-structured interviews, and focus groups. Interview and focus group participants included private planners, city staff, elected officials, advocates, and industry professionals. I spent several hundred hours in the field from June 2013 to December of 2014 in public or quasi-public planning meetings. I observed the city council,

planning commission, community outreach, and internal planning department committee meetings and took extensive fieldnotes per Spradley (1980). An interview protocol was used in a first round of interviews (Patton, 1990). This protocol asked planning experts and advocates well-known in the community to describe flows of information and visual representation such as GIS in the context of a recent planning process. I used these semi structured interviews to facilitate evaluation of the research, consistency between interviews, and efficiency within a time-constrained framework.

In 2014, a second round of data was collected from focus groups regarding a possible City of Nayoras water rate increase. While interviews were conducted largely in or around city hall, four focus groups were held at the geographically separate water division offices. Participants discussed the ways information tools influenced communication between the city and water rate payers. This method encouraged participants to discuss topics in a group setting, allowing them to examine ideas they might not otherwise have thought of themselves.

2.2. Procedure

The City of Nayoras is not known for strong environmentalist sentiments. The Central Valley of California is a conservative area even among members of left leaning political parties. Often academics can be seen as troublemakers akin to the widely discussed 'hothead' community members described by staff who have contact with the public. Because of this, though I maintained confidentiality and informed consent, city staff may have experienced a heightened sense of risk to their organizations as well as to their own career trajectories from possible 'public' airing of city processes. For this reason, pseudonyms are used throughout and care was taken to avoid any exposure for the city, its staff, or any other community members who participated in the research. This reaction may have produced interview responses designed to dampen environmentalist or community-oriented critique of powerful local information systems. However, these characteristics also drove informants to reveal unexpected risk-related strategies central to this case, both in their behavior toward myself and in verbal responses to questions. My previous knowledge of the region proved to be a strength as I sifted through these motivations and sought informants who could verify events, processes, types of interactions, and organization of space.

2.3. Data Analysis

Field notes were initially coded using inductive categories following Spradley's participant observation and discourse-based ethnographic interview method (1979, 1980). The initial focus was on types and flows of information including GIS maps and formal planning documents. This analysis produced emergent themes related to the organization of information in social space. Subsequent rounds of coding related to these themes were based on planning documents and fifteen transcribed interviews using the interview protocol (out of 35 in all) in ad-

dition to fieldnotes. To stay true to inductive categories used by informants, autochthonous terms are offset throughout the paper by use of single quotations. After data was organized by themes and dimensions using these inductive methods, data was then analyzed using Bourdieu's field theory. In the present article, this analysis was expanded to include GIS in relation to time, space, and public engagement using theories that facilitate the use of multiple vantage points apparent in the data.

3. GIS in a Postmodern Network Economy

Although still limited by human categories, GIS enables more powerful representation of flows of space than in the past. By the late 1980s, the move toward real time and big data in GIS took mapping technology from a static representation of space toward a more dynamic representation even when spatial analysis does not include dynamic mathematical models. Although GIS has become more dynamic, the technology still relies on fixed categories of data limiting the representation of nature's constant movement (Li, 2021; Schuurman, 2006). While based on these static categories, GIS powerfully coordinates the dynamic, human-initiated relations of space, often for economic or planning purposes (Dangermond & Goodchild, 2020; Miller & Goodchild, 2015). The term dynamic is used here to suggest that time in a GIS leverages knowledge about change in space. For example, the vetting of water infrastructure projects to new developments takes much less time than in previous decades. According to informants, almost all pertinent physical systems and objects, things that might need to be moved or avoided at the building site, are now depicted in a single mapping technology. Before GIS, this work might have included at least one site visit along with consultation of paper maps to ensure that everything from sewer lines to tribal burial grounds were not in the path of new construction. Time is leveraged by GIS in that information necessary for this project vetting is meticulously maintained and then easily accessed to show any changes in spatial configurations affecting the project.

As science has advanced, economic exchange has used advances in the understanding of time in relation to space to increase accumulation (Castells, 1992; Harvey, 1989). Space is not fixed, as objects move in relation to a single frame of reference or inertial frame in which space and time are sides of a coin. At human scales, this means that relations between perceived objects and even the objects themselves are always changing since any object is also simply a set of relations between smaller objects—bodies, molecules, atoms, particles. In this sense, the genius of GIS is not a better representation of absolute space (Lefebvre, 1991), but a closer representation of dynamic space in which change is more closely tracked, recorded, and measured (Foucault & Gordon, 1980).

The transformation of nature is related to the production of space in geography (Lefebvre, 1991; Smith, 1990), meaning, in part, the material relations underpinning urban form. This paper suggests that human systems act more powerfully today, if unevenly, to transform nature and produce space as knowledge about

knowledge (Castells, 2010) such as that seen in GIS is more closely aligned with nature's underlying mobility. In planning, for example, while things like infrastructure and zoning continue for the most part under twentieth century frameworks (during fieldwork for this case study, Nayoras staff used paper maps for contact with the public about utilities), the role of newly powerful, fast, and connected information systems used for the manipulation of space is virtually unknown to those outside planning and technical staff and a few elected officials. In this way, here, GIS is seen as both a type of knowledge, an information coordination system that more closely bridges space and time, and as a new but less visible component in the production of uneven urban outcomes.

The role of information in the production of space (Smith, 1990) has received attention in the social sciences. Across disciplines, at least three major theorists address this link. With an eye to the theories of David Harvey and Michel Foucault, this paper centers on Manuel Castells' (2010) concept of the network society through which Castells examines the social meaning of space and time. To understand the role of GIS in relation to space, Castells' (2010) space of flows suggests a dynamic component of space in which cities come under the powerful action of economic and political actors seeking to accumulate resources and avoid risk. Castells' treatment of space suggests an increasingly boundaryless realm of power termed the space of flows through which these goals are accomplished. Castells' concept of the space of flows is a type of spatial logic centered on economic activity but affecting all of society, in contrast with what Castells terms the space of places. The space of places is defined by Castells as locations imbued with the meaning and connection for everyday people often seen by public agencies as their greatest source of risk (Beck, 1992, 2009). This perception of risk propels the space of places to become more and more estranged from the flows of information and transactions meant to produce accumulation in the space of flows. In relation to local planning, the firms and institutions that manage information-based coordinating services—e.g. legal, technological, R & D, innovation, accounting—dominate the knowledge production and information necessary to transform and manage urban space. These advanced services follow global markets but are themselves also organized by the market in new transnational spaces of exchange that still require fast and reliable information about its material basis. Advanced telecommunications and transportation technologies like GIS have, if unwittingly, become part of the dominant globalizing system that coordinates these material transformations while drawing attention away from projects meant to come under public scrutiny (Sassen, 1996, 2006).

The physical manifestation of this evolution is uneven with an increasing scale hierarchy of connection to the space of flows. The cities most central to the space of flows rise within a global network of places vying for positioning in an evolving political economic system. Cities and even regions compete for position in a hierarchy based on their ability to connect to the space of flows (Castells, 1992, 2010). Castells notes, however, that this hierarchy of cities is complex with all nodes be-

coming connected in some way to the global network. While the agglomeration of skill, innovation, and knowledge moves some cities up the hierarchy, other cities compete by strengthening regional ties, as in the case of medium-sized cities such as Nayoras which, like other medium-sized cities, has shown a propensity to combine forces in regional economies (Castells, 1992).

David Harvey (1989) describes a shrinking experience of space which has allowed for mechanisms such as the spatial fix, where space is used more powerfully to avoid internal contradictions. The spatial fix (Harvey, 2017) highlights the centrality of information in emerging international scale spatial patterns. In geography, Harvey (1989) coined the term space-time compression to describe the changed experience of space in relation to time through fast transportation and information technology. Harvey suggests that a new post-modern era is characterized by a loss of faith in human rationality and stable societal moorings. The apparently stable moorings of modernity have been undermined, in part, by an emerging much more flexible economic system (Woodward & Jones, 2008). Harvey turns to the notion of the annihilation of space by time to explain this turn from modernism (postmodernism) historically and culturally. He argues that information and transportation have unleashed society's moorings related to urban political economic patterns. In response to much more common political arguments linking industrialization to the rise of the liberal individual, Harvey argues against apparently technologically determined paths to change, instead using a spatial critique through which he describes the ways contradictions are resolved by reorganizing inconvenient elements (e.g., regulation, sources of labor, environmental degradation) in space. Harvey's focus on space leaves room for variations of the spatial fix that have arisen with the increased speed of information, e.g., *in situ* spatial expansion created by new spheres of informational space meant to serve powerful economic interests.

In sociology, Michel Foucault's (1977) concept of diffuse power-knowledge seeks to unify cultural explanations from structural theories like those used by Castells and Harvey with additional social meaning. Foucault accomplishes this by examining socially internalized control exercised through knowledge and information, a substitute for historical systems focused on bodily punishment. In later work, Foucault connects these ideas to mobile space. In a published set of interviews with the French geographical journal *Herodote*, Foucault describes the spatial implications of knowledge in modern forms of social control in words that envisage the role of GIS in local planning:

A critique could be carried out of this devaluation of space that has prevailed for generations…space was treated as the dead, the fixed, the undialectical, the immobile. Time, on the contrary, was richness, fecundity, life, dialectic…They did not understand that to trace the forms of implantation, delimitation and demarcation of objects, the modes of tabulation, the organization of domains meant the throwing into relief of processes—historical ones, needless to say—of power. (Foucault & Gordon, 1980: p. 70)

In this passage, written early in what is now termed the network age (Castells, 1992), Foucault means to re-value space by suggesting its underpinning plasticity over time. In the process, he lists functions of the state now largely coordinated by GIS in local planning: delimitation and demarcation of objects (GIS ontologies, vector and raster data, "3 D"), modes of tabulation (tabular data, tabulation functions), organization of domains (data layers, shapefiles). Moreover, Foucault theorizes resulting forms of domination, e.g. field, region, territory, as deeply social. While avoiding absolute notions of space (Lefebvre, 1991), Foucault hints at a definition in which any entity with boundaries is both an object and a collective.

Borders and firm boundaries have remained a method of control for Western populations, but over time powerful multinational conglomerates dominant in the space of flows have loosened the role of borders (Castells, 2010; Sassen, 1996). The spatial plasticity produced by these powerful networks freed from state-centered control most strongly impacts those who do not hold this freedom themselves. While often far from decision-making and information centric spheres, the majority of affected publics play a part in legitimating informational effects on local planning through what Foucault terms diffuse power-knowledge. For example, local planning and maintenance depend on the fine grained, abstract spatial categories embedded in GIS that categorize the constituent elements of urban space (also termed formalization, see Schuurman, 2006; Li, 2021). Foucault's hint at the connection between space and knowledge brings out flows of space measured by or dependent on this diffuse knowledge that are difficult to see under the structuralist ideas of Castells and Harvey. Foucault allows a more fine-grained analysis overall by focusing on the localized dimension of knowledge as a form of control. As informational power moves to more internal spaces in local planning, the meaning public engagement changes. As reflected in the PPGIS literature, if most of those affected by GIS-coordinated planning are on the outside of the space of flows—meaning they have no access to places in which it is possible to use information to bring about change—even well-designed public engagement takes on the role of risk reduction for public agencies pressured by those with much more access.

4. The Case: GIS in Nayoras Local Planning

Through powerful technology like GIS, dynamic systems changing slowly through ecological processes or under urban land use can be manipulated and reconfigured much more quickly compared to mapping technologies of the past. The visualization through GIS of those flows of space that are naturally occurring or human initiated is necessary in local planning either because they are important to the development process or mandated by law. In essence GIS in Nayoras serves to streamline mundane spatial aspects of local government planning, what planners term "geo-support." Coordinating new development and maintaining large infrastructure systems like water and waste is fundamentally spatial. GIS in Nayoras centralizes the storage and use of the information needed to accomplish these spa-

tial tasks of local government. In the words of city staff, in part, GIS is used to coordinate 'internal' informational processes related to planning (Castells, 1992, 2010). To understand this newly 'internal' planning space and attempt to add to its theorization, the role of GIS in Nayoras has a meaningful history.

According to interviews with city staff, the City of Nayoras implemented an aggressive GIS program after ESRI was founded in the early 1980s. However, the late 1990s saw this program gutted after decision-makers came to believe that GIS was a fad that wasted financial resources on a system that would soon go out of style (personal communication, May 2, 2014). Despite this setback, during the time of this fieldwork, the city had two separate user interfaces supporting GIS. The first, uMAP, was written by staff for use in planning. The application was built to serve the spatial data needs of the building community through the Resource Management and Development Department (RMDD) and is run somewhat independently of the broader GIS system maintained by the Department of Technology Support (DTS) (personal communication, November 22, 2014). At the time of fieldwork, the program was self-funded by15-20 subscriptions of $1,795 per year largely to engineers and developers. The staff member responsible for the user interface writes: "uMAP was developed out of a need for information in a visual and easily accessible format" (email communication May 30, 2014). At the time of fieldwork the system had three separate user capabilities so that the most sensitive information could be closely monitored 'internally' with a free, more limited version accessible to everyone. The two 'internal' versions were meant for: 1) information storage and geo-support for city managed functions and 2) for development subscribers. The term 'internal' was used by informants to describe city processes that occurred among these trusted insiders, including individuals not employed by the city.

GIS use was distinct between unique 'internal' and public daily users. The system averages over 450 unique 'internal' users per day, however, staff were unwilling to estimate the number of public users on ViewNayoras. As this system was designed to reduce external users' trips to city hall, it has become a largely 'internal' coordination tool for information regarding utilities, their maintenance, and the status of documents/processes within the workflow process. For example, documentation of maintenance tasks for city water infrastructure. The latter is a more recently added function to the system. Staff's reluctance to estimate daily users of the public GIS system may indicate that there are relatively few 'hits' and that the system does not currently provide information the public is motivated to use for participation. This did not surprise staff because they saw most stores of public information as technical and, implicitly, too difficult to interpret for most people. This finding supports peripherally the PPGIS literature's assertion that there are few paths to participation in public GIS systems and low numerical participation (Barndt, 2002; Brown, 2012; Brown & Kyttä, 2014; Carver et al., 2001). In this way, GIS had a clear public role of information storage and representation central to planning that became 'internal' when the city's object became public participation.

A second function of GIS in local planning is sharing information across jurisdictions:

We also have some data-sharing partners that access the external subscription version. The County, Nayoras Irrigation District and Nayoras Flood Control District share their GIS information with us regularly. We display that information in uMAP and NayorasMAP for users benefit. In exchange for this data, we provide those agencies with access to NayorasMAP so they can see their data in context with our utility data. This contributes to avoiding conflicts of underground facilities. In some cases, it eliminates the need for an agency to develop their own similar system (email communication May 30, 2014)

Utilities and other departments who produce geo-located data in shapefile format are considered data owners, an important distinction for regulatory frameworks but also for the ways technically oriented city staff think about their jobs. In other words, GIS is used to store information created by technical staff based on the geo-location of infrastructure, legal boundaries, or maintenance. Called 'data' by city staff, this information is owned by the jurisdiction, department, or agency who created it and is offered for use by business, government, and, ostensibly to the public.

5. Results

GIS in Nayoras local planning coordinates relations between things and people quickly to enhance the economics of land development. Those who use GIS do this by representing viable planning configurations, e.g., future plans, or important change in infrastructure such as maintenance, for decision-makers. The manipulation of naturally occurring as well as human initiated flows of space is both coordinated by and can be observed through GIS in local planning. For instance, GIS is designed to synthesize large, spatialized databases available to planners and decision-makers when considering the needs of future imagined neighborhoods. In an interview, one planner states: "…it's not like people who haven't bought into a neighborhood are concerned about a neighborhood that doesn't exist. It's a dirt field" (interview, July 31, 2013). Here, the quote addresses planning of future urban space but suggests that a related space of coordination, virtually invisible to residents, is needed to bring it to fruition. New neighborhoods are both out of sight for residents because they do not exist yet and out of mind because communities are unfamiliar with the central role of technologies like GIS. Regarding the relatively powerless general plan documents in California, relatively 'toothless' documents considered something like a city's constitution, another planner states.

How the heck are we going to know looking out 25 years to know exactly what's going to happen, but general plans are updated every five years so that's just the process. You look out, you plan as well as you can. And then in 10 years you're updating your general plan and then you look out again. As they are always looking out and then looking back and modifying and aligning the theoretical with

what's projected, with what's reality all the way (interview, August 29, 2013).

Taken together, the two informants frame planning in terms of visualizing future spatial relations in line with legal and economic constraints, the central function of GIS as observed in this study. For city staff, GIS provides 'geo-support' for those visualizing these future material relations and planning for them either for more immediate development projects or longer-term planning documents. Information is easily stored in a GIS, synthesized so that viable spatial assemblages can be considered, and reorganized quickly with little additional effort to create various options.

Staff report that about 95% of work time devoted to GIS is spent maintaining systems and databases, while only about 5% is spent actually producing 'geo-support' maps for decision makers. In Nayoras, information-dense representations created in GIS are central to real change in urban space under local government (e.g. transition from rural to urban land uses, new development, resulting habitat degradation, changing hydrology, infrastructure maintenance and construction). However, many formal planning documents are much less central to what happens in the real world, including general plans. This paper argues that this result has an important spatial dimension centered on powerful technologies such as GIS. The results recorded here suggest ways that the more dynamic character of GIS (though underlying mathematical models may not be dynamic) offers the land development industry real points of leverage in local planning. Because GIS is frequently taken as given and accepted as value-free (Miller, 1995; Pickles, 1995; Schuurman & Kwan, 2004), new spheres of IT space that coordinates this leverage is left unquestioned. The following sub-sections examine the role of GIS in creating these points of leverage, motivating insiders to keep information within GIS hidden in 'internal' space, and producing control through pervasive forms of knowledge related to the space of flows.

5.1. Spatial Flows Recorded in GIS Occur at Points of Leverage over Time

GIS in local planning speeds up the vetting of plans for land development and, at least theoretically, helps decision-makers visualize a range of future options. In this way, new internalized space leverages time in relation to space for development, an economic sector dependent on the state to provide services to urbanized land. In GIS-related planning, change in space depends largely on what Castells (1992, 2010) describes as the coordinating services constituting the space of flows, meaning accounting, finance, design, consulting, etc. With Castells, Harvey (1989) suggests that these services use time to "annihilate" space by facilitating the geographical spread of powerful economic systems. In local planning, material accumulation occurs more efficiently when spatial representation like GIS uses time in relation to space reflecting more closely the space-time of nature. For instance, GIS leverages real-time data and big data to reduce both costs and risk in the development (later maintenance) process. In local planning, even more simple ad-

ditions of time in maintenance workflow and land use visualization leverage this power. These points of power are sometimes based on IT professionals' 'geo-support' for decisions connected to land development which is closely related to the city's financial standing and the infrastructure projects dependent on it.

An important example of leverage over time supported by GIS according to interview data is risk management around the transition of land into parcels with developed infrastructure. Protecting the city's access to financing for this infrastructure—a process closely related to the cost of time—motivated staff to keep even moderately risky information 'internal,' hidden from the risk of public scrutiny. These patterns echo Ulrich Beck's (1992, 2009) argument that technology has become central to a pervasive sense of risk in society. For example, according to interviews the City of Nayoras has chosen to approve larger development projects in recent years because increased project size reduces risk for political approval, environmental reporting, and financing. That is, public infrastructure projects related to land development depend on debt financing to pay for improvements such as urban roads, water, sewer, and storm drains. This infrastructure enables land to enter urban land uses, e.g., housing, industrial, commercial. External financing for infrastructure is also necessary to protect the city's cash flow, according to informants. External financing is based on the city's bond rating—the equivalent of a credit score for an individual. The bond rating, according to staff, can be affected by media reports or other events perceived as conflictive by financial institutions. Conflict with the community or opposition to development projects can affect the bond rating based on the city's reputation. Avoiding this conflict is a motivation for staff to keep most development information 'internal.' In this way, processes related to finance leverage time, both as a mechanism of control over information and a tool to affect material change on urban systems.

5.2. GIS Coordinates Space

In Nayoras, the city council did not appear to be a part of those individuals privy to the early, visionary phases of 'geo-support' provided by fast information technology like GIS. Instead, when making decisions, elected officials depended largely on relatively slow information, which at the time of fieldwork often came in the form of paper-based staff reports. This material was full of information stored in or manipulated by GIS; however, those interviewed did not comment on the role of GIS even in response to an interview protocol focused on information and mapping. The status of staff as purveyors of knowledge from applied sciences such as planning, engineering and architecture, all types of knowledge falling under Bourdieu's concept of cultural capital, emerged in the qualitative data. Because of this status, city council members, the final stamp of approval for most projects, did not oppose technically skilled staff directly, though staff often fielded questions about proposed projects or maintenance. Instead, council members chose to express opposition to proposals largely in a yes/no council vote, a moment in the decision-making process with a much-diminished information basis.

A type of spatial reorganization has evolved from more accessible spaces of the past, evidenced by decreasing public access to physical space masking the real framework for decision-making. While this shift in spatial organization speaks to the strategic importance of 'internal' informational space, a deeper examination reveals an underlying spatial strategy or *in situ* spatial fix by the development community. This change is reflected first through physical space in city hall. According to interviews, physical space connected to local planning that is accessible to the public has decreased over the past 50 years from about 50% to about 20-25% today, though the square footage of city government buildings has increased in an absolute sense through construction of new facilities. Even the city council chamber, arguably the most public of spaces in local government, is now closed to the public during regular business hours. Spaces in which information-intensive processes occur are some of the most protected from the public with paper-based (slow) and digital (fast) processes occurring in a palimpsest of planning practice over time. This 'internal' space is where the coordinating services of the space of flows occur locally.

The impact of GIS in local planning has indeed become lost as leverage over moments of change is buried in many all-but-meaningless planning activities masking real moments of leverage. In response to a follow-up question regarding the impact of formal planning documents, one planner agreed vehemently that general plans have little impact on land development. Many, though not all, formal documents such as general plans now seem to mask real leverage over time instead of revealing them. For instance, though a large amount of staff time was dedicated to the general plan update, sometimes spanning five years or more, the general plan was almost meaningless in terms of guiding resource distribution or land use. Cities concerned with risk, try to focus advocacy and other 'conflict' on twentieth century planning tools like public engagement for a general plan update. Tools like the general plan are based on the much slower, often paper-based, information of historical urban planning but are presented to the public as if they fit today's much more dynamic information environment. Meanwhile fast information tools like GIS play a much larger part in molding the character of urban space but become effectively lost to public scrutiny though information is available on the city's public platform. When asked if an instance of project approval was public, one informant stated, "The more I involve the public, the more hassles I have. It was public in a sense…but we didn't invite the public.…The public didn't have access to this information…It didn't go to council…It's not public because politics starts to play a part and politics screws it up" (interview, August 23, 2013). Such commentary, opinions, and even processes described here as separated from public scrutiny are not new, however, the size and content of this emerging 'internal' space is substantial, including to some extent most planning and maintenance activities. Thirty years after the publication of early social GIS literature, calls to examine the underlying meaning, history, and impact of GIS on society seem visionary (Harvey, 2007; Harvey et al., 2005; Schuurman & Kwan, 2004; Miller,

1995; Pickles, 1995; Sheppard, 1995).

5.3. 'Internal' Space and Power

The expansion of 'internal' space described above, i.e., processes and things housed in public agencies but not accessible to the public, has implications on sovereignty and local control of planning. In Nayoras, the information economy has decoupled sovereignty from the state (Castells, 2010) through a unique policing role of information and knowledge (Foucault, 1977; Foucault & Gordon, 1980) as use of powerful information can only be used effectively by those close to the flows of power, largely technologically savvy insiders. Moreover, in Nayoras, sovereignty is affected by the increased importance of outside knowledge related to these social flows of power, meaning that knowledge produced outside of the (local) state dominates both planning and individuals affected by it. As noted above, space created by fast information technology like GIS leverages time in planning (e.g., development, land use, infrastructure). This means that while information from GIS or other technologies is available to local decision-makers, it has little impact on the categories through which that information is perceived by users (Scott, 1998). Today, these modes of perception in GIS are termed ontologies, meaning kinds of data representing domains and defining semantic relationships within them according to ESRI. Unification of meaning across data types and semantic rules has become important among the over 350,000 GIS using organizations worldwide according to the UN Statistics Division. The term ontology, the study of being in the rest of science, indicates the certainty GIScience has about its representation of nature and the correspondence between technical measurement and being or existence. This word choice reflects Foucault's concept of power-knowledge as power is leveraged in local planning by entities and individuals that affect change through a now globally homogenizing set of categories meant to universally represent being in nature. Powerful interests are so deeply reflected in one set of fixed categories of information and the limited set of possible end products determined by GIS functionality, that practitioners can come to feel they are manipulating nature itself, not a representation of it (Braun, 2006; Couclelis, 2019).

When high leverage projects from the planning department (community plans, large development projects, etc.) require more technical ability and include an element of visual representation, a few employees within key departments manage the visualization of information through GIS mapping tools, such as uMAP. Although key to spatial change in the city, this visualization falls at the lowest end of the continuum of spatial analysis possible in GIS and speaks to the limited input even city staff have on change. The 'geo-support' conducted by tech savvy staff is considered data management (i.e. query, reasoning, measurement, transformation) as opposed to spatial data analysis (i.e. exploration, descriptive statistics, optimization, inference or modeling) (O'Sullivan & Unwin, 2010). Data management serves to represent data visually for the end user instead of exploring, de-

scribing or interpolating spatial trends. In other words, the city does not normally perform statistical analysis of spatial data, though a handful of employees have the skills to accomplish these tasks. The spatial modeling that is utilized in relation to transportation and housing planning associated with SB375 (the Sustainable Communities and Climate Protection Act), meant to reduce greenhouse gas emissions, is performed by the regional planning organization for the county (Council of Governments, COG). In this way, while GIS uses an element of time to leverage strategic moments in land use and infrastructure planning in Nayoras, statistical, predictive, and more dynamic analysis is completed in the private sector, leaving local planning to implement spatial knowledge developed by companies they hire or other knowledge producers.

Another indication of reduced sovereignty is the uniform but limiting use of applied knowledge across city staff and residents involved in advocacy. At the level of resident experience as expressed by city staff and advocates in interviews, residents involved in advocacy compared their neighborhoods with others in terms of perceived level of service and types of amenities. Residents saw 'amenities' as signs of a neighborhood's position among other neighborhoods and this vision reflected the character of advocacy efforts, notably ignoring residents' own (subjugated) knowledge of urban form and nature. Marginalized neighborhoods in Nayoras have a high concentration of diverse subcultures, immigrant, and first-generation American populations. Well-meaning advocates are trained to facilitate change and increase community capacity by educating residents about urban amenities using dominant planning vocabulary, e.g., 'street trees,' sidewalks with 'landscaped areas,' and 'urban green space.' Residents involved in advocacy learn to compare their own amenities to those of other communities as measures of urban positioning. A city staff member regularly responsible for gathering community input states:

Several of the residents were concerned about the need for green space in that area that, you know, they hear on the television for example the need for green space and childhood obesity and what they have to do to reduce weight:…'And yet we don't have anything around us where we can exercise in a safe manner' (interview, August 16, 2013).

According to interviewees, in the context of advocacy, residents thought about amenities based on the learned social calculus described above instead of their own cultural or subcultural understandings, here, the need for 'green space.' Meanwhile, immigrant groups' autochthonous categories (e.g., urban farming, creative/ethnic landscape architecture, a sense of connection to nature), though often directly related to residents' levels of activity, diet, and resulting body composition, were not considered educated enough for planning discussions. In this way, residents' description of space come to reflect dominant 'internal' space policed by knowledge originating in the space of flows. While this paper does not argue here that planning terms that define GIS categories are not useful or are inherently dominant, this knowledge filters down to residents across the many

language groups in Nayoras, revealing the symbolic violence (Bourdieu, 1986) exercised by knowledge itself in globalizing cities.

6. Results

Based on these results, there are several implications for planning. In line with Castells, dominant systems of knowledge have motivated the expansion of 'internal' space in a variation of Harvey's (1989, 2001) spatial fix in which virtual space has become a much expanded realm of accumulation. Public space (i.e., that which is accessible to the public, both material and virtual), is structured by knowledge found in planning and zoning regulations, statutes, and professional training prevalent in the twentieth century. In comparison, 'internal' space related to planning, in particular, that space with the most powerful information technologies, has not undergone the same level of public scrutiny through regulation and oversight. Political ecology literature describes situations in which, because of strong economic pressure from globalizing economies, the rural poor use centuries-old subsistence practices on marginal land and are then blamed for environmental degradation (Blaikie & Brookfield, 1987; Robbins, 2019). With little entitlement to economic exchange, the poor have few options as they experience malnutrition or even starvation as a result of this resource squeeze (Sen, 2000). In Nayoras, a comparative resource squeeze is experienced by immigrant and marginalized residents as planning processes ignore residents' knowledge about the composition of space (i.e., relations among elements in urban form, connection to nature, resource use). Residents who want to participate in urban planning must adopt not only dominant practices but also a cognitively invasive view of the world embodied in the language of planning. Although planning terms and categories are not dominant in themselves, they are made dominant in local planning through the protected and almost invisible space connected to the space of flows. At the same time, residents have little access to information exchange with decision-makers and, because of the increased power of local planning, even the ability to mold their own urban space (e.g., ethnic neighborhoods in cities of the 19th and early 20th centuries). Thus, residents have difficulty expressing diverse cultural practices that include useful information about relating to urban nature and, if they participate in planning, even the autochthonous concepts and meaning expressed in colloquial terms.

Only a few of those interviewed revealed knowledge of the coordinating role of GIS in local planning. Instead, interviewees focused on the very secondary and 'toothless' general plan. This limited awareness indicated that the major spheres of production and accumulation coordinated by local planning, the major impactors on urban land use change and use, include very few paths of outside input even by city staff. This result matches the wider national trend related by Obama in the introductory statement. In short, a new spatial fix using virtual social space has established networks of relations validated by experts. This hidden space requires deeper scrutiny at the level of state and federal regulations as well as social

awareness. Deeper scrutiny should indicate paths to greater public engagement related to land use and urban form.

7. Conclusion: Policy Suggestions

This research has asked why GIS becomes powerful for people only under certain conditions, suggesting that the reasons may be social. Fieldwork reveals that 'geo-support' from GIS is present in many planning settings not only powerful decision-making contexts. What varies across contexts is the technology's power to impact planning outcomes. In Nayoras, this power clearly did not rest in the hands of 'the public' even when people participated in numbers and were well informed. Latinx residents expressed this in the statement, "Van a hacer lo que quieran," meaning "They [elected officials] are going to do whatever they want." Residents with advocacy experience learned to expect that community input would hit systematic barriers. Residents felt as if elected officials had this power, however, the research presented here revealed that most planners and elected officials did not impact plans significantly. Although GIS was more powerful in the hands of insiders meant to assemble plans, its role was to concentrate dominant knowledge from engineering, architecture, science, and design. But even this power was limited as expert staff and consultants applied knowledge from technical fields within the bounds of financial constraints and in line with professional standards, specifications, and templates (often 'boilerplates'). In this way, these results explain the experience of advocates, planners, elected officials, and community leaders at the local level frustrated by ineffective public engagement efforts and startlingly homogenous city planning across now global sites.

Although GIS was more powerful in the hands of those positioned to use it in local planning (e.g., planners, staff, and public officials), the direction and outcomes of this power originated outside Nayoras planning spheres (Castells, 1992; 2010). This is the finding that most speaks to mechanisms enabling participation and producing the uneven benefits associated with that participation. While fast IT like GIS is used in many ways that leverage time, it is not used to reveal the location of that leverage or its nature. While residents experienced social control associated with dominant planning terms, planners also experienced this individual level control by maintaining and policing the meaning and role of this knowledge. This informal conflict control was understood as the unspoken goal of public engagement. At the grass roots, residents who wanted to participate in urban planning in Nayoras had to adopt not only unfamiliar strategies of planning and public engagement but also the socially invasive view of the urban environment embodied in this language. At the same time, the increased control apparent among planners, city staff, and elected officials was in many ways fictitious though they wielded information more powerfully. They too, though much more familiar with central terms, were informationally limited by formalized categories not created by them. Power, in this way, was wielded by those tasked with using information as control.

This paper reveals several spatial implications of dominant knowledges (Foucault & Gordon, 1980) used to track the flows of space by fast information technologies like GIS. The study's results suggest that, based on expanded 'internal' space and dominant knowledge, local planning has become part of a well-oiled machine in which development decisions take place far from meaningful paths to community input even when technologically savvy GIS is used. Moreover, these flows of power prevent even socially conscious planners from changing globalized processes by themselves (Kuo & Chou, 2023). Community advocacy, that is, the flow of information power back to decision-makers, if much weaker than the space of flows, could change this equation. Particularly in local planning, meaningful input may depend on powerful information tools like GIS that can adequately synthesize and represent the flows of space along with related accumulation as urban development leverages time. In response, more strategic advocacy could address the power exercised in land development by creating public/community space outside of the state in which knowledge about knowledge (Castells, 2010) matches the knowledge used in the space of flows. This paper suggests that it is information-based power along with effective mechanisms for using it (increased local democratic process) exercised at the community level that is missing in order to address local land development and its dominant knowledges. As I have argued in other research (McCullough & van Stokkum, 2021; van Stokkum, 2022, 2024), meaningful negotiation could occur about everything from places for urban gardening to the management of local streams and the use of open spaces for sports leagues [Nayoras staff talked extensively about the need to stop what were termed 'phantom soccer leagues,' meaning leagues formed by farmworkers and other marginalized groups in a context in which they had no access to formalization processes and very high obesity rates]. Since development decisions including the size of projects, their urban form, and their location, are decided far from community input, community planning space could provide a framework for both opposition to unwanted projects and for ecological and hydrological planning on a smaller scale. Increased membership in community groups and local advocacy could become a central part of widespread city-based civics meant to provide a foundation for more active democratic process across public systems. City staff could become agents for coordinating this work across jurisdictions.

The characteristics of this community space are important. In Nayoras, to add fuel to inequities experienced across the state, a historically ethnic neighborhood has been denied access to project funding won by them in statewide carbon reduction initiatives based on intensive community planning. Marginalized communities have learned through these experiences and decades of neglect, that planning in their neighborhoods indicate a coming change in demographics and are not meant for current residents. Perniciously, these changes may be planned through the work of socially conscious planners who, in good faith, expect communities to benefit from planned infrastructure projects (van Stokkum, 2022). Confidence in subjugated knowledges at the local level should be the center of

community GIS and can be supported using tools created by qualitative GIS (Alarasi et al., 2016; Boschmann & Cubbon, 2014; Brown et al., 2017; Jung & Elwood, 2010; Kwan & Ding, 2008) such as drawing, narratives, and photography (Dennis, 2006). However, community knowledge should also focus on the element of leverage over time in the citywide land use context by using GIS to track development projects and infrastructure. Building on these existing strengths, GIS could be used to give voice and power not only to marginalized people but also their knowledge through new community planning spaces, both virtual and physical. Meaningful change will not only involve using widely used technologies such as GIS but also resisting the all-encompassing dominance of power-knowledge deriving from the space of flows.

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The author declares no conflicts of interest regarding the publication of this paper.

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