

Leaves, Pebbles, and Chalk: Building a Public Participation GIS in New Delhi, India

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Harris and Weiner 1998

Obermeyer
Kellog
Talen 1999
Bond
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Ghose 2003
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Kyem and Kwaku 2000
Kyem and Kwaku 2002
Harris et al.
Han and Peng

GEOGRAPHIC Information Systems (GIS) technology has customarily been regarded as complicated and costly and a technology that is primarily used by experts to carry out complex planning projects. During the 1990s, major criticisms regarding the technology's inaccessibility and elitist qualities triggered the Public Participation GIS (PPGIS) movement which aims to develop alternative systems that democratize the use of the technology, create easy access to government-generated data, and incorporate local knowledge. Central to the PPGIS movement is the belief that GIS is a powerful tool for facilitating collaborative planning processes and empowering citizens to influence planning and policy-making. PPGIS is an acronym used to describe the many different types of participatory-based geographic information systems being implemented in countries throughout the world. Scholars agree that such systems are created locally and influenced by the social and political contexts in which they reside. In this paper, we argue that PPGIS is both a computer-based information system and an interactive human process which facilitates collaborative planning efforts, but that its ability to effectively empower participants is largely determined by the local context—that is, the social and political relations that link or divide individuals, groups, and institutions.

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The stages of a typical PPGIS initiative include collecting data, working to record data digitally, analyzing data, maintaining and updating data, and communicating a shared vision of the community's strengths and weaknesses. By contributing to the construction of a PPGIS system, participants work hand-in-hand with local officials and leaders. Thus, the process alters local social and political relationships and results in the manifestation of a useful instrument which allows local government officials to make more responsive decisions about the allocation of resources. In short, every PPGIS initiative has the potential to improve community-government relationships.

Harris and Weiner 1998
Ghere and Rismiller
Ghose 2001

This paper examines a PPGIS initiative to create more inclusive planning processes for water service delivery and infrastructure in informal settlements throughout New Delhi. To frame an examination of the nexus between a PPGIS initiative and its ability to effectively empower participants, this paper answers the following questions: What types of data collection methods allow traditionally marginalized residents—like women, youth, and people who are illiterate—to communicate their knowledge and express their concerns about a place? How can community members use local knowledge to leverage improved public services? What are the barriers and opportunities associated with sustaining a city-wide PPGIS?

New Delhi's Settlements and Water Demand

Rapid urban growth in India, both in terms of population and area, is resulting in an ever-increasing demand for infrastructure and basic services. Severe shortfalls in housing, transportation networks, water supply, and waste management facilities are common in many cities and towns. Moreover, slum settlements are proliferating throughout India, especially in and around New Delhi. The provision of public infrastructure such as piped water, sanitation, and drainage to informal areas is highly inadequate largely due to the inability of planning agencies and other local bodies to cope with such rapid changes.

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Urban areas in India are generally characterized as either formal (legal) or informal (illegal). New Delhi's informal city includes the slum settlements (also referred to as JJ Clusters), unauthorized colonies, and some villages. The number of people living in these areas is difficult to approximate, but the first enumeration by the Census of India for New Delhi in 2001 estimated that

Office of the Registrar General

MOEF and GNCT

1,850,000 people were living in slums settlements. For the same period, the Ministry of Environment put the figure at two and half times the Census at 4,700,000. While these data suggest that between one-fifth and one-third of the total city population resides in slums, it is important to note that these calculations exclude the people living in the recognized, yet underserved, areas like resettlement colonies.

According to the National Slum Policy (NSP), a slum settlement is a compact area with huddled and poorly built tenements in an unhygienic environment usually with inadequate infrastructure and lacking proper sanitary and drinking water facilities. Largely due to high in-migration, an ever-increasing demand for cheap labor, and high birth rates, slum settlement populations grow rapidly despite adverse living conditions. Population estimates, however, are elusive. As shown in Table 1, estimates vary by agency. For example, a survey completed in 1999 by the National Institute for Urban Affairs (NIUA), a think tank of the Federal Ministry of Urban Development, estimated that there were approximately 1,190 slum settlements in New Delhi, yet the Delhi Jal Board (DJB)—the agency responsible for managing the city’s water resources—acknowledges the existence of only 820 settlements. Finally, periodic surveys by the National Sample Survey Organization (NSSO) estimate 52,000 slums exist across all cities in the country; New Delhi with 1,847.

National Sample Survey Report
No. 486

Unauthorized colonies are settlements that are on land not specified for residential use in the City Master Plan and generally contain the more affluent households that are able to make personal arrangements for water supply (via ground water extraction), sewerage (via septic tanks and pit latrines), and waste

TABLE 1
Population Estimates for Settlements in New Delhi

<i>Source</i>	<i>Delhi Development Authority (1994)</i>		<i>NSSO (2002)</i>	<i>Delhi Planning Board (2003)</i>		<i>DJB (2004)</i>
	<i>NIUA (1999)</i>			<i>Board</i>		
Slum Settlements	1,080	1,190	1,847	1,080		820
Resettlement Colonies	—	—	—	44		44
Unauthorized Colonies	—	—	—	1,017		1,017
Urban and Rural Villages	—	—	—	354		345

Source: National Capital Territory of Delhi

disposal (via private sweepers). Recognized colonies are eligible for service delivery by agencies and several attempts have been made to regularize these colonies through appropriate political processes, but most have been unsuccessful.

The once rural areas that are now within the city limits are called urban villages, or Lal Doras. Having a special status, these villages are administered under a separate set of building by-laws and planning norms. Such villages are characterized by narrow, winding lanes which pose problems for laying water and sanitation lines. Additionally, small-scale industries tend to thrive in these areas and have raised the demand for water. The rural villages are mostly at the edge of the city, but as urbanization increases, many rural villages get re-categorized as urban. It is costly to extend the infrastructure to these very distant areas and most remain neglected. As a result, many land developers have moved in to create residential complexes or unauthorized colonies.

Resettlement colonies are slum settlements developed by the Municipal Corporation of Delhi (MCD). In the mid-1970s, approximately 2,500,000 slum dwellers were relocated to 45 resettlement colonies. Several studies have demonstrated the lack of comprehensive planning for services in the areas. Despite an allotment of 25 square yards of land for each dwelling unit, water and sanitation services in these colonies were supplied through public stand posts (one tap for every 40 households), hand pumps (one for every 20 households), and community latrines (one latrine seat for every seven households). More recently, a large number of inner-city slum settlements were resettled in the northwest and south sides of New Delhi. Though the operation and maintenance of the infrastructure developed by the MCD is the responsibility of the Delhi Jal Board (DJB), a recent report shows that the poor who resettled here now have access to less water than before because the government considers the resettlement area a rural area and networking to existing water supplies would be too costly.

Ali Environmental Scenario
Ali Major Problems

Hazard Centre

The Delhi Jal Board and Water Supply

The DJB, established in 1998 when the New Delhi Water Supply and Sewerage Disposal Undertaking were turned over to the Delhi State Government, oversees water production, quality control, distribution, and monitoring. The DJB is also charged with managing the city's wastewater treatment and disposal.

In 2000, Delhi's Planning Department, the National Commission on Population, and the DJB reported 100 percent coverage for water supply through both in-house connections and public stand posts. In contrast, the National Sample Survey Organization (NSSO) (58th Round) indicated that although service outreach in Delhi had gone up by 14 percent from the previous round (the 54th), it only reaches approximately 84 percent of the city's population. Furthermore, while infrastructure in the form of taps and hand pumps do exist in slums, supply of water is both erratic and of poor quality, making the presence of infrastructure meaningless.

Grover

Although the norms stated by the different agencies diverge on the issue of quantity, the DJB clearly distinguishes between individual and community services based on the status of land tenure. All slum settlements and unauthorized colonies are denied "in-the-house" supplies of reliable and safe drinking water. Instead, they receive less reliable services at community points. According to the Government of India, norms for community level stand posts are mandated by the Environmental Improvement in Urban Slums (EIUS) scheme which recommends one tap for every 50 people. Slum dwellers are dependent on hand pumps installed by the DJB, and water from 40 percent of these hand pumps is unfit for drinking.

Hazard Centre

Inequities in distribution are further exacerbated because different agencies recommend divergent norms that vary by city size, presence of sewerage infrastructure, and land tenure. For example, data provided by DJB reveals a supply norm of 225 liters per-capita-per-day (lpcd) which is much lower than what is recommended (363 lpcd) in New Delhi's Master Plan. Despite these benchmarks, a survey conducted by the National Institute for Urban Affairs (NIUA) in the mid-1990s noted that slum dwellers generally received fewer than 25 lpcd of water. In 2002, Delhi 21 measured supply to one-third of the city as between 4–10 lpcd through stand posts.

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MOEF and GNCT

Case Study: The New Sanjay Amar Colony

Since 1998, the NIUA, in partnership with Cities Alliance, USAID, Care India, UNICEF, 15 NGOs as well as city and state governments, has been working with informal settlements in New Delhi to build community capacity and increase government responsiveness to community needs. Initially, the program focused

on education; however, since 2002 it has expanded to include the provision of basic services, particularly water. Project activities in these settlements consist of community organizing, leadership building, identification of community priorities, community mapping, and the development and implementation of action plans for the achievement of community priorities. As a byproduct of these efforts, a city-wide PPGIS was created. Today, the PPGIS not only contains basic data layers such as streets, railways, rivers, and political boundaries, but it also has layers that depict the geographical boundaries of nearly 1,200 informal settlements throughout New Delhi. In addition, it hosts detailed demographic information for individuals living in approximately 300 settlements and data regarding service delivery and infrastructure for 20 settlements.

The New Sanjay Amar Colony (NSAC) is an informal settlement in eastern New Delhi. It is one of the 20 settlements that have received special attention by the National Institute for Urban Affairs (NIUA). The NSAC consists of more than 5,700 households and approximately 35,000 inhabitants. Although the first squatters arrived in 1975, the people living here continue to be without secure land tenure, adequate public services such as water, sanitation, and electricity, and viable employment opportunities. Early on, the NIUA discovered that the NSAC residents considered the inadequate water supply, especially in the C and D blocks of the settlement, to be the most critical of their problems. In these two blocks, about one-third of the stand posts were broken and long queues often formed at ill-functioning stand posts, resulting in a ratio of one tap for every 441 households. Furthermore, the volume of water delivered to the existing stand posts was low because it was transported from the water main into the community through a very thin (2' diameter) pipe.

To make matters worse, local politicians—in connivance with low-ranking Delhi Jal Board (DJB) officials—unjustly arranged for the installation of illegal taps near their homes. Consequently, some households at the end of the distribution chain did not receive any water. This approach alleviated water supply problems for a few households, but decreased the already low water pressure for many and heightened tensions between neighbors. As a result, many residents responded to these conditions by adopting a number of harmful coping mechanisms like making late-night runs for water which disrupted sleep cycles and caused fatigue. Some residents unsuspectingly installed hand pumps that drew highly contaminated ground water from

a now-defunct motor lubricant factory and others asked their children to sacrifice educational opportunities and retrieve water from adjacent communities during the day.

Grover
Joshi et al.

The DJB failed to adequately and equitably provide water to the New Sanjay Amar Colony (NSAC) for a variety of reasons. In New Delhi, the Supreme Court recognized the essentiality of water for survival, yet the High Court barred local authorities from installing infrastructure in illegal settlements. Therefore, slums receive a deficient level of services because local authorities like the DJB are prohibited from investing in these informal settlements. Second, like other informal settlements, there is a lack of information about the NSAC which makes it virtually impossible for agencies to plan service delivery in an effective manner. For example, no records of population existed at the DJB office for estimating water demand. In the absence of local area water supply zone maps and other types of information, the DJB's approach to planning was ad hoc. At the local level, the junior engineer was perhaps the only representative with an accurate, yet undocumented, picture of water facilities in the area. Lastly, people living in slums are often excluded from decision-making processes involving the allocation of public resources and services because occupation of the land by squatters is perceived as illegitimate and most squatters are reluctant or unable to organize themselves to effectively express their concerns. In short, these legislative and institutional barriers make DJB staff generally unresponsive to the needs of those living in informal settlements and they frequently place such settlements—including the NSAC—in a lower category of service.

Data Collection Methods and Community Empowerment

Talen 1999
Talen 2000
King
Corburn

PPGIS, as a system and as a process, requires local data collection. Yet, few studies describe how to work hand-in-hand with residents to collect local knowledge, i.e., record spatial data from participants' knowledge and experience of a place. To document the growing gap between the demand for and the supply of water to the NSAC, NIUA facilitators used Planning, Learning and Action (PLA) techniques to collect information in the field from 2002 to 2003. PLA techniques, a form of Participatory Rural Appraisal methods, were adapted by the NIUA in the late 1990s. Participatory rural appraisals, first used by development practitioners in the 1970s and 1980s, are a set of informal

techniques for collecting data. In the past, practitioners employed such methods as part of a broader needs assessment process; today they are used in a range of settings and for a variety of purposes. PLA techniques involve the use of community visioning and mapping exercises, seasonal and historical diagramming, semi-structured interviewing, and focus group discussions to facilitate information sharing, analysis, and action among stakeholders. Data collection and analysis occurs with the assistance of facilitators and provides a framework for systematically recording non-conventional data such as resident perceptions, values, and expectations.

Typically, the NIUA staff holds *nukkad* (corner) meetings on street corners throughout the neighborhood to meet and interact with current or potential community leaders and gain a general understanding of the community's problems and aspirations; however, NIUA had already made a soft entry into the NSAC as part of its Primary Education Enhancement Project (PEEP). By engaging residents in a dialogue on the need to educate children in the settlement, NIUA staff had won the support of local political leaders and had close working relationships with many women.

To obtain information and mobilize residents toward a common goal, in this case improved water delivery services, the NIUA applied a range of PLA techniques. Community visioning, for example, involves the symbolic use of *chappatis*. A *chappati* is a flat, round-shaped bread that Indian families eat on a daily basis. To involve the participants, a visioning workshop facilitator distributes small, medium, and large pieces of round-shaped cardboard. Next, she asks the residents to associate the most important problems for the community with the large *chappati* and other, but less significant, problems with the smaller *chappatis*. Following the workshop, the *chappatis* are pasted to posters and displayed in popular, public gathering places to enhance awareness, increase dialogue, and garner support around a single issue. To capture information describing the way problems or conditions change over time, facilitators rely on seasonal diagramming techniques. This method of data collection involves the creation of a community seasonal matrix which is populated using small objects like seeds. To begin, the facilitator constructs a matrix. Each row depicts a problem, like pneumonia or flooding, and each column represents a month of the year. Every participant receives 12 seeds and indicates the time of the year each problem occurred by placing a seed in the appropriate block.

As demonstrated in the two previous examples, PLA techniques rely on the use of symbols to communicate information. This approach is effective because it encourages illiterate adults and children to participate, thus increasing the number of people actively contributing to the dialogue. Similarly, community mapping exercises not only allow residents to share information, but they also stimulate discussion and enthusiasm among large groups of people. As shown in Figure 1, facilitators use chalk to draw a map of the community directly on the ground. Residents are asked to use leaves, pebbles, and sticks to communicate important demographic information about their household, as shown in Figure 2. For example, a woman who lives with her husband, her mother, and two children will place a stick (men), two leaves (women), and two pebbles (children) in the square on

FIGURE 1
Mapping Community Information in Wazirpur, New Delhi



Source: Photo by Channarn Tirapas

FIGURE 2
Community Visioning Exercise in Tigri Village, New Delhi



Source: Photo by Claudia Canepa

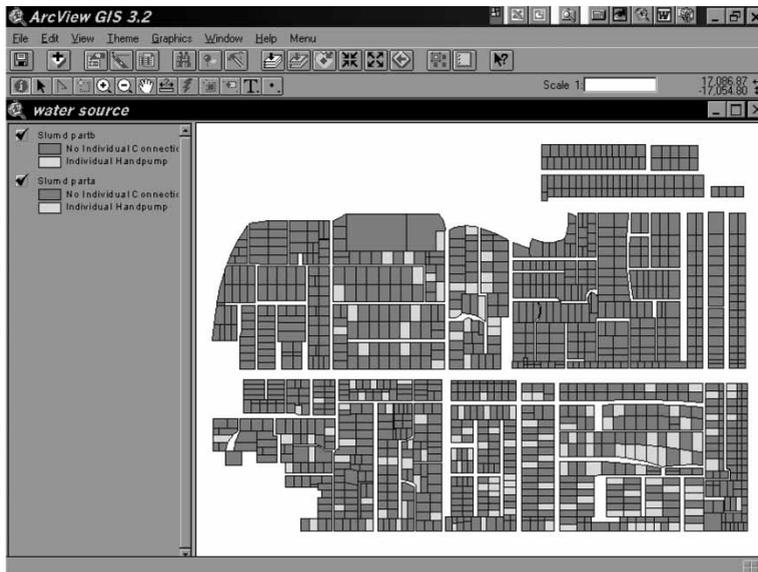
the map which represents her dwelling to symbolize each member of her household. Community volunteers and facilitators from the National Institute for Urban Affairs (NIUA) then transfer the information that is collected on the ground to paper.

Facilitators send the paper maps to NIUA headquarters where the information is digitized. This entails the use of Auto Cad to scan the maps and the application of a customized script to convert the data into spatial data layers. Because these maps are not drawn to scale, they are simply hyperlinked rather than spatially integrated with the existing data layers for New Delhi, as shown in Figures 3 and 4.

Using Local Knowledge to Improve Public Service Delivery

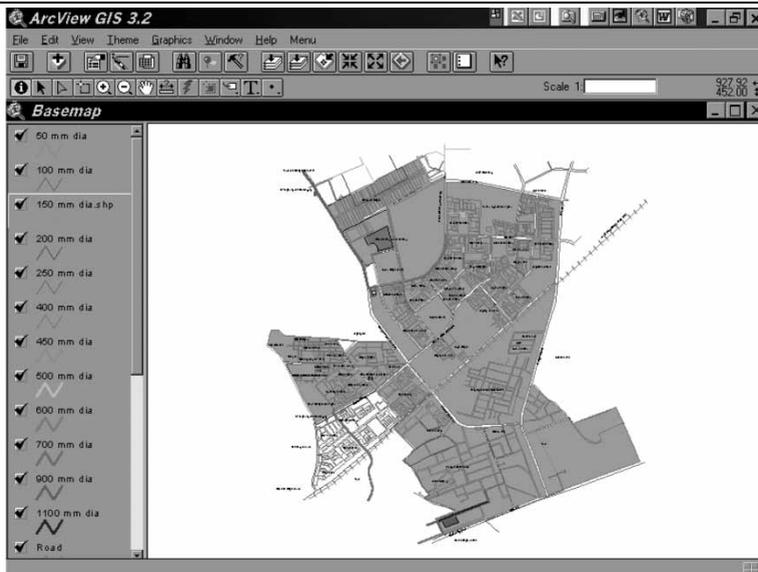
At the New Sanjay Amar Colony (NSAC), the NIUA also collected information pertaining to community needs through a series of mapping workshops. Residents, having already identified the provision of water as the most critical problem, found that the NSAC had an insufficient number of water taps, a preponderance of broken water taps, unequal access to water taps, and insufficient

FIGURE 3
Digitized Map Depicting Households with Individual Handpumps



Source: National Institute of Urban Affairs

FIGURE 4
Ward Map with Water Supply Infrastructure



Source: National Institute of Urban Affairs

water delivery systems. Unexpectedly, they also expressed concern that the current Pradhan (elected neighborhood representative) was abusing his power; they reported that he had arranged for the provision of water to households in his area at the expense of residents living elsewhere. Pradhans and political leaders are the only means by which the poor are able to access basic services in their settlements and are responsible for the compact between the service providers and communities. Because the Pradhan was known for colluding with the authorities, the women decided to focus on improving water supply for households throughout the settlement rather than confronting the Pradhan or those families that had paid for the illicit connections. To begin, residents from each block in the settlement organized into teams; this format allowed them to build consensus and identify task leaders more quickly. As a new set of community leaders emerged, the group challenged the Pradhan's practices. NIUA's field facilitators and supervisor supported the effort by informing the women about their rights, scheduling weekly meetings, and accompanying them to meetings at the local DJB office. While the Pradhans played a central role in NIUA's community building efforts in other settlements, the NIUA recognized this Pradhan's reluctance to provide unbiased representation and organized a group of women in the NSAC who protested at the local DJB office in April 2002. Armed with maps that articulated the spatial mismatch between household demands and water delivery, the residents submitted applications to the DJB requesting specific service improvements.

Moreover, under the Right to Information Act (RTI), residents demanded information related to water standards, norms, and processes. With the knowledge that the settlement had one tap for every 135 households (when non-functional taps were excluded from the calculations) and emboldened by their growing ability to articulate their demands, the NSAC inhabitants and NIUA staff supervisors challenged the DJB's supply norm of one tap for every 70 households. Residents relied on the information collected through the community mapping exercises to show DJB engineers the location of existing taps, broken taps, points of low water pressure, and stand posts with the longest queues. During site visits, DJB staff were informed that the placement of water lines in the drainage system resulted in sanitation leaks into the drinking water. Since decisions were consensual and local DJB engineers were able to explain the technical feasibility of adding new connections, no conflicts arose among the inhabitants.

In the end, some of the negotiations with field engineers were led by women residents who have customarily had little or no say over service delivery improvements; a construction crew broke ground to lay new pipelines and install new stand posts; and the user-tap ratio decreased to one tap for every 60 households. It is also important to note that during the exit phase, women leaders from these communities were trained to maintain the new infrastructure.

The NIUA's PPGIS initiative includes a community-based information system which contains data representing conditions at four distinct levels: the city, ward, settlement, and household. In addition to hosting data from the Census of India, the National Sample Survey Organization (NSSO), and the State Department of Education, it has the ability to communicate locally-acquired knowledge about the household size, assets, expenditures, shelter type, employment status, water consumption as well as the location, condition, and ownership of taps and platforms, water quality and pressure, and platform condition, as shown in Figure 5.

It is too early to assess the long-term effects of this project; however, it is evident that tensions between residents were reduced, queues outside taps have disappeared, and people are sleeping through the night instead of chasing water. The short-term benefits of the project have resulted in alternative political structures within the NSAC and improved working relationships between residents and government officials. In summary, this

FIGURE 5
Community Data Entry Form

WATER		
ID 45	House_no VN-149	Basti Name New Sanjay Amar Colony
	Water Source Community Tap Individual Tap Handpump Other	If Individual : Tap Connection Legal Illegal
	Water Quality Satisfactory Non Satisfactory	User charges per mo < 50 > 50
	Supply_time (hours in a day) 2	Payment made to DJB Local Contractor
	Time_taken to collect water (minutes) 45	Collection Responsibility Adult <input type="checkbox"/> Male Child <input type="checkbox"/> Female

Source: National Institute of Urban Affairs

case shows that PPGIS initiatives instigate community development. Yet, we might challenge these claims by asking: Was the true catalyst for community development the process of creating a PPGIS or the intervention of a well-recognized intermediary institution like the NIUA? The answer is unclear. The NSAC was not an organized settlement and the PPGIS effort grew from the need for NIUA to respond to service-related queries about this slum settlement. Through the process of using participatory tools to collect demographic information, new relationships materialized and a community-based information system emerged. Both outcomes will empower residents to implement self-help strategies in the future.

Sustaining a City-Wide PPGIS

A sustainable, city-wide PPGIS initiative dovetails with the goals outlined in the National Slum Policy (NSP). Because land and urban development are state subjects, the NSP has contributed to urban planning by providing clarity to issues of land tenure and legal status of informal settlements, and it is critical to improving residents' access to basic services. As mentioned previously, it defines the word slum and creates an enabling framework by mandating that the local government provide services to all vulnerable groups through improvements in the delivery of public services. Moreover, the NSP is an effort to provide direction to local bodies and to address the broad range of community priorities through community engagement and private-sector involvement. It also promotes efficiency by encouraging municipal governments to improve via financial management, partnership building, convergence, and monitoring and evaluation.

What are the social and political challenges associated with sustaining a city-wide PPGIS in Delhi that allows the staff of the DJB as well as residents, for example, to input and analyze data? What are the conditions required for the success of such a project? Although the NIUA has collected a wide range of data for many settlements, the integration of divergent data sets for collaborative planning purposes is one of several important and remaining challenges. Currently, the community-drawn maps are not created at scale or geo-referenced and cannot be integrated with the more accurate administrative spatial data layers. This design limits the user's ability to conduct spatial queries and identify spatial relationships, thus making it less attractive to NGOs and

Kingston et al.
Carver et al. 2001
Carver et al. 2000
Peng

government agencies. Therefore, the aim to create a uniform system of standards and procedures for collecting, verifying, and maintaining data persists. Beyond data integration, the NIUA is struggling with other issues including the development of a dynamic, versatile Web-based application that allows the government and the public to update information. It is not unusual for organizations to make GIS projects available on the Internet as a means of facilitating public participation and local decision making. This multi-tiered, comprehensive data system is of value to a wide range of constituencies and available online at <http://www.niua.org>. This site is useful because it makes valuable information about informal settlements publicly available. Settlement profiles for places like the New Sanjay Amar Colony (NSAC), Udham Singh Park (USP), and Gangaram Colony (GC) allow visitors to review settlement information such as land area, year established, inhabitants' origin, land-tenure status, settlement population, number of households, literacy rate, proportion of children in school, average family size, housing types, and employment. Additionally, there are maps that examine each settlement's most serious problem from various perspectives. For example, there are a set of static maps that help visitors visualize patterns like water collection by women, water collection by children, and distance to water source for the NSAC. Similarly, GC's maps focus on livelihood, informing viewers of inhabitants' employment status, wages, commuting distances, and conveyance modes.

Elwood and Leitner

It is common for PPGIS advocates to express concern with respect to accessibility and believe that users should have the ability to analyze, update, and maintain spatial data. And the NIUA is interested in implementing a training program aimed at improving users' technical skills and visual literacy. In particular, the Institute it is looking to create an online tutorial that would permit users such as residents, government officials, and NGOs to improve their skills in a place and at a time that would meet their needs.

In addition to challenges related to data integration, the establishment of standards, remote access, and training, a sustainable city-wide system would require a long-term commitment from a stable set of government officials. For example, negotiations with government agencies are far too often interrupted by political instability in the Office of the Commissioner. Frequent changes subvert the agenda because new officials fail to comprehend the value of the work. Such changes also intensify the cynicism

between communities and administrators, thus weakening relationships and decreasing the likelihood of success. However, a coalition of informal settlements involved in a city-wide PPGIS initiative has the ability to apply collective pressure to local agencies and invoke policy changes. Though the DJB's engagement with informal settlements is in an embryonic stage, efforts to integrate local data are under way and show promise. Also, water service obligations to the poor are being defined and included in contractual arrangements.

Scaling the PPGIS to include all informal settlements in New Delhi will bring about greater transparency in service provision. While this strategy will undoubtedly improve local governance, it will also face opposition from those resistant to change. Existing power structures will be threatened by the institutionalization of such a system because it grants citizens the ability to scrutinize government decision-making processes and resource allocation. As shown in the case of the NSAC, the potential for good far outweighs the obstacles to implementation.

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