Bottom-Up GIS

A New Tool for Individual and Group Expression in Participatory Planning

Emily Talen

While the integration of GIS in the planning process is becoming more commonplace for efficient description of basic facts, it has not been widely used by planners for the incorporation of local knowledge. This article describes a new approach, termed "Bottom-Up GIS" (BUGIS), in which GIS is placed in the realm of expression and used as a means of expression. The advantage of using GIS in participatory planning activities is that it provides spatial complexity, spatial context, and interactivity and interconnection in the articulation of viewpoints. Thus, BUGIS can be an effective tool to deepen our understanding of residents' perceptions of local issues and preferences.

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GIS is getting cheaper, faster, easier to use, and packed with more and better data. As vast amounts of local data become readily available in GIS format, the outlook for GIS in local area planning looks extremely bright. This article argues that in addition to using GIS to inform and analyze in the conventional sense, planners should consider using it as a cognitive tool. In this alternative approach, residents learn to manipulate GIS data to express their views about planning issues, neighborhood meaning, and future preferences.

This alternative view of how GIS can be used in planning is prompted by recent concern that conventional use of GIS in planning is top-down, rationalist, and technicist (Aitken & Michel, 1995). Thurstain-Goodwin and Batty (1998) have observed that GIS that is purely technological in orientation will fail in the same manner that large-scale urban modeling of the 1970s failed. These observers bemoan the unquestioned proliferation of GIS in planning practice because it only intensifies reliance on "fact"-based planning in the rational tradition.

Because GIS is essentially about providing and analyzing spatial data, it is difficult to envision how it could be used in local communities in a way that is not essentially technicist. One could take an optimistic view that GIS, by enabling the interactive display of spatial data, has gone some way toward eliminating the "red herrings, factual disputes, and unrealistic predictions" (Nystuen, 1997, p. 144) that clog the planning process. One could take the alternate view, however, that just when we were beginning to effectuate a more democratic approach to planning in which the processes of communication and interaction are given weight, in walks GIS to dictate how, and with what data, such communication is to proceed. Indeed, the notion of more and more layers of government-generated spatial data garnered with increasingly sophisticated means of data capture and dissemination, and manifesting increasingly complex means of data analysis positions GIS as a power that few planners, let alone local residents, care to challenge.

This article describes a new way of thinking about the use of GIS in the planning process. Rather than "experts" using GIS strictly to *inform* in top-down fashion, GIS can be used in a bottom-up way that lets residents characterize their local environment. I have dubbed this approach "Bottom-Up GIS" (BUGIS). It involves using GIS as a spatial language tool for acquiring local knowledge and communicating residents' *perceptions*, rather than conveying only objective facts (although the two are not necessarily different). It is an approach that is not dissimilar to cognitive mapping; however, by positioning such perceptions squarely in a GIS context, it is more conducive to the methods of contemporary planning practice.

Top-Down vs. Bottom-Up GIS

While the integration of GIS into the planning process has become standard at all levels of planning activity (Nedović-Budić, 1998), conventional use of GIS is largely *top-down* in the sense that GIS data is provided, manipulated, and presented by technical experts. Skepticism about the value of top-down GIS focuses on the issue that certain groups and certain types of local knowledge are marginalized by GIS-based decision-making processes (see Harris & Weiner, 1998; Rundstrom, 1995). The debate has fostered a number of important studies of grassroots organizations that use GIS (Craig & Elwood 1998; Elwood & Leitner, 1998; Leitner et al., 1998) and how local organizations are empowered by better access to geographic information technologies (Chavan & Orland, 1998; Howard, 1998; Kim, 1998; Obermeyer, 1998). To ensure more participatory, *bottom-up* uses of GIS, researchers have developed innovative tools to improve how decisionmakers interact with GIS in the planning process (Al-Kodmany, 1998; Florence et al., 1996; Shiffer, 1994, 1995), particularly using multimedia and hypermedia components (Shiffer & Wiggins, 1993; Shiffer, 1995).

Another way to ensure a more bottom-up approach to GIS is to focus on the incorporation of local knowledge in GIS. There are a few examples of this in the context of planning. Some researchers (Craig & Elwood, 1998; Elwood & Leitner, 1998) have attempted to incorporate local knowledge in the building of GIS databases, working to incorporate value-based, traditionally intangible information, such as how residents value their homes or their feelings about the uniqueness of a given area (Bosworth & Donovan, 1998). Because these approaches seek to give local residents greater access to GIS, they are aligned with other community-based uses of GIS (Elwood & Leitner, 1998). However, they also add the attempt to incorporate resident, or local, knowledge. This article describes how BUGIS could facilitate the incorporation of local knowledge in planning.

BUGIS Defined

BUGIS is an approach in which residents use GIS to communicate how they perceive their neighborhood or community, via their description, evaluation, or prescription for their local environment. BUGIS is both the tool used to explore an issue and the medium of its expression. Thus it is closely aligned with collaborative approaches in which GIS is used to help residents work through an idea, scan for information, and visualize large amounts of data (see Shiffer, 1995).

The primary task involved in setting up a BUGIS is to formulate a way in which environmental perception—constituting local knowledge—can be translated into a form suitable for GIS. Local knowledge can be described as "the mixture of knowledge built up through practical experience and the frames of reference people use to filter and give meaning to that experience" (Geertz, 1983; quoted in Healey, 1998, pp. 39-40). To resolve the environmental-perception-to-GIS problem, there are two general strategies. First, planners can focus their efforts on building more sophisticated spatial data models, artificial intelligence, and visualization techniques to better capture environmental cognition. The second strategy, and one that I think is better suited to current planning practice, is to focus on the translation of meanings into GIS. In the context of neighborhood planning, local residents can derive meanings via *description*, *evaluation*, and *prescription*—all of which are based on how they perceive their local environments. In the evaluation and prescription phases in particular, perceptions are expressed in terms of environmental preferences: what is liked, disliked, or desired about a particular area. Revealing such preferences identifies particular meanings associated with elements within the sociospatial environment. The development in this way of a "transparent" GIS (Thurstain-Goodwin & Batty, 1998) capitalizes on the subjectivity of map construction and complements the conventional use of GIS as a tool of objective science.

With BUGIS, residents can redefine the questions asked within GIS. For example, "Where are roads most congested?" becomes "What streets do I view as undesirable due to traffic congestion?" "What is the spatial distribution of parks relative to the spatial distribution of children?" becomes "What parks are most frequently used in my neighborhood and who uses them?" The answers to the first type of question create an entirely different representation than the answers to the second type. The result is that the content of the evaluations obtained may be significantly enhanced. Using BUGIS, explorations of residents' perceptions that result through conventional visioning processes in statements such as "We need to have more public transportation" become statements such as "Here is where we need to travel and where we want to travel," and "Here is where we currently can and cannot travel."

GIS cannot be made to substitute for the wide array of ways in which residents express their views about their environment. Certain qualities of meaning cannot be expressed in a spatial context, and thus there are limits to what the logic of GIS can be expected to represent. The goal of BUGIS is not to capture all meaning, but rather to strengthen the quality and depth of communication about residents' issues and preferences.

Current Approaches

A wide variety of methods have been devised to assist in the expression of individual and group issues and preferences. Existing techniques, usually part of a consensus-building process, include "interacting groups, silent reflective techniques, surveys, focus groups, and dialectic groups" (Kaiser et al., 1995, p. 270; see also Nutt & Backoff, 1987). In many of these processes, participants are encouraged to identify their individual goals, problems, and issues prior to engaging in collective goal setting.

The expression of preferences in consensus building can be as simple as responding to a written questionnaire, or more involved, using role-playing or simulation techniques. In a group setting, residents may be given laminated maps and colored markers to write comments, add local knowledge, and make tentative decisions. In Kansas City's Neighborhood Prototypes Plan (Neighborhood Prototypes, 1997), residents are encouraged to use maps showing the street framework and boundaries of the neighborhood to indicate what is liked or disliked about the neighborhood, including the location of landmarks, paths, activity centers, and the like. In the design charrette tradition, various planning guides promote the use of paper maps to record group input, for example: "Mark in green those things . . . that are good—features that should be protected or built on. Mark in red those things that are problems or liabilities" (Jones, 1990, p. 125).

More formal survey methods are also used. These may involve open-ended answers to questions about what is liked and disliked about a given neighborhood, or Likert scale rankings of selected, isolated neighborhood conditions. For example, residents may be asked to rate the degree to which vandalism, abandoned property, traffic, commercial activities, noisy streets, or parking are problematic (Adams, 1992; Dahmann, 1985). Community profiling involving needs assessment or community "audits" (see Hawtin et al., 1994) are of a similar genre. Visual Preference Surveys extend the non-spatial survey approach and use slides in the evaluative process (Nelessen, 1994).

BUGIS vs. Other Approaches

BUGIS adds to these existing survey methods by offering a new approach to gauging residents' perceptions of their neighborhood that expands upon more conventional verbal and written discourse. How is BUGIS really different from simply using laminated maps and colored markers to summarize individual and group expression? While BUGIS does not necessarily replace other forms of expression, there are areas where it offers something fundamentally different from existing methods: spatial complexity, spatial context, and interactivity and interconnection.

Spatial Complexity

GIS greatly improves the ability of residents to integrate complex information in their expression of issues and preferences. It is a valuable tool for representing individual or group preferences simply because of the wealth of data it can efficiently store and retrieve. New data can be added to the GIS by residents based on their perceptions, or residents can use existing GIS data if they concur with how the data represent a particular aspect of their neighborhood.

Paper maps and cardboard models are not as effective at representing spatial complexity. They cannot, for example, simultaneously relate underlying soil stability, employment data, building ownership, and traffic flow—data that may be important to the expression of preferences. In a GIS, residents can retrieve and query this data in a highly efficient way. This ability is important because it allows them to base their expression of preferences not simply on whatever data happens to be represented on the base map being used, such as building outlines or land use, but on a wide variety of variables.

Their perceptions can therefore be represented in multiple dimensions, which can go well beyond conventional base data. Perceptions of neighborhood boundaries, the spatial extent of friendship networks, sources of neighborhood satisfaction that can be spatially referenced, elements of the local environment that contribute to sense of place—all of these can be expressed using GIS. Other elements might include variables related to territorial functioning, such as outdoor property maintenance, gardens, signs of personalization, symbols of protection, and nonverbal messages of control (see Perkins et al., 1992); physical and social incivilities, such as loitering youths, litter, unkempt lots, dilapidated housing, and abandoned cars; defensible space features, such as fences, gates, walls, or areas of perceived danger or stigmatized areas (see Ley, 1974); or change over time, such as areas perceived as having deteriorated.

Spatial Context

Second, GIS is an effective way to contextualize discussion and expression of issues and preferences. Obviously, not every expressed issue or preference has a spatial context. For example, unemployment and political conflict in local areas cannot necessarily be articulated using GIS. Yet in much of planning, particularly at the neighborhood level, issues are raised and solutions are sought in a spatially contextualized format.

In a GIS context, neighborhood preferences which previously may have seemed too nebulous and unstructured for practical use may become better "grounded." For example, a resident who wishes to express the view that an area has lost its "sense of place" may be able to use GIS to explore the spatial elements of this expression, such as current distribution of public areas, outmigration of population in certain blocks, density of commercial enterprises, or locations and distribution of dilapidated buildings.

As discussed above, the search for neighborhood preferences often consists of nonspatial brainstorming techniques and map labeling strategies. These techniques are appropriate in some contexts, but there is room for improvement: both the form and the substance of the questions could be significantly deepened. In terms of form, vague questions about what is liked or disliked about a given area can be made much more spatially specific in a GIS context, and therefore, one could argue, more meaningful. In substance, these could evolve from non-spatially-referenced lists to a spatially referenced identification of local assets, where the resident uses GIS interactively. Such use could involve any number of spatial queries, such as distance, direction, area, or proximity.

The value of basing the evaluative process on GIS is that it emphasizes spatial thinking, ideally in a period of spatial exploration before preferences are cast. Residents who begin to evaluate their neighborhood using GIS will be able to articulate the spatial dimensions of their perceptions. The use of GIS data thus stimulates the expression of residents' descriptions and equips residents with a more complex spatial vocabulary than a simple paper map.

Interactivity and Interconnection

Using GIS, residents can build their expression of issues and preferences in a way that is highly interactive. With the assistance of a GIS facilitator, residents can query data, turn coverages on and off, and use various GIS tools (such as distance or area calculations) in an interactive process that can lead to greater depth in their expressions. Paper maps are easily drawn on, but they do not interactively respond to queries relevant to resident perceptions.

The value of the interactive nature of GIS is as basic as being able to change the scale of the view, to zoom in and out, to pan east or west. Residents may choose to express their preferences at a variety of scales, using one or many coverages (a coverage is a theme or layer of data). Interactivity greatly enhances the ability of residents to make these choices.

The interactive nature of GIS means that the expression of preferences is more fluid and dynamic. Residents are not locked into a single expression made with the marking of a pen on paper. In essence, GIS can be used to discover relationships that may lead to reappraisals and redefinitions of preferences. Perhaps most significant is the manner in which GIS allows residents to view more than one spatially distributed variable, turning coverages on and off as desired, and allowing them to see and react to interconnections of issues. Viewing the spatial distribution of a variety of variables over a number of different coverages, a resident may begin to formulate an expression of issues and preferences in a way that is completely different than originally conceived. Residents viewing a particular coverage may decide that they had misjudged an issue, or had neglected to think of it as important. This could result when a resident views any spatial distribution of a given variable. For example, residents seeing the distributions of crime incidents or demolitions may change their formulation of issues and preferences.

BUGIS and Participatory Planning

BUGIS is focused on the expression of residents' viewpoints, and as such, it can be used in the planning process at any point where public discourse and participation enter in. Figure 1 represents a simplified view of how BUGIS could fit into the process at a conceptual level. Participation in planning can have a variety of goals, from the building of relationships (as in communicative planning) to prescription or goal selection (as in instrumental rationality). In a typical participatory planning process, such as the formulation of a neighborhood revitalization plan, participants move through a process of description, evaluation, and prescription. This process is variously described as one involving "search, synthesis and selection" (Kaiser et al., 1995), or involving discourse aimed at "recollection, description, and speculation" (Shiffer, 1999; see also Arias, 1996). In the instrumental rationality model of planning, public discourse is sought at various points along the way from problem identification through problem resolution. In other types of planning, such as communicative planning, various techniques are used to strengthen the use of communication as the basis of action (Healey, 1992; Innes, 1996, 1998).

Public participation, isolated in Figure 1 in order to clarify the role of BUGIS, starts with some form of individual expression (e.g., verbal or written) and is ultimately directed toward some form of consensus building. Consensus building implies that a group-level expression on a particular issue is attained. BUGIS facilitates both individual and group expression. In terms of the latter, BUGIS can be used to express the description, evaluation, or prescription of a group. BUGIS is not, however, set up as a consensus building technique per se. Instead, it can be used to support a more multidimensional expression of views. In effect, group dynamics add an additional dimension to the interactive process of building a BUGIS. The process remains focused on human interaction; BUGIS simply aids the dialogue, ultimately expressing whatever representation is most meaningful to a particular group.

In some situations, it may be valuable to present a synthesis of individual views expressed using GIS. This procedure, which is different than a group BUGIS process, is described in a later section (see "Synthesis").

Case Study

The BUGIS steps described below are based, in part, on my experiences with attempting to capture local knowledge in GIS during two separate "visioning" events held in Dallas, Texas. Both events were facilitated by The Dallas Plan, a private, nonprofit, long-range planning enterprise funded by the City of Dallas. Graduate students from the University of Texas at Dallas were instrumental in all phases of the project.

The first event, held at a downtown conference center in October 1998, was part of a process to produce a plan to stimulate community revitalization and economic development in areas south of the Trinity River as it flows through downtown Dallas (see Figure 2). The event was entitled the "Trinity River Corridor Community Action Conference" and involved several hundred participants over a 2-day period. The second event in July 1999 was an informal visioning event held for the Cadillac Heights neighborhood in the Trinity River Corridor. Its purpose was to solicit information from local residents about what was liked, disliked, or desired for their community (i.e., the beginning phase of a strategic plan

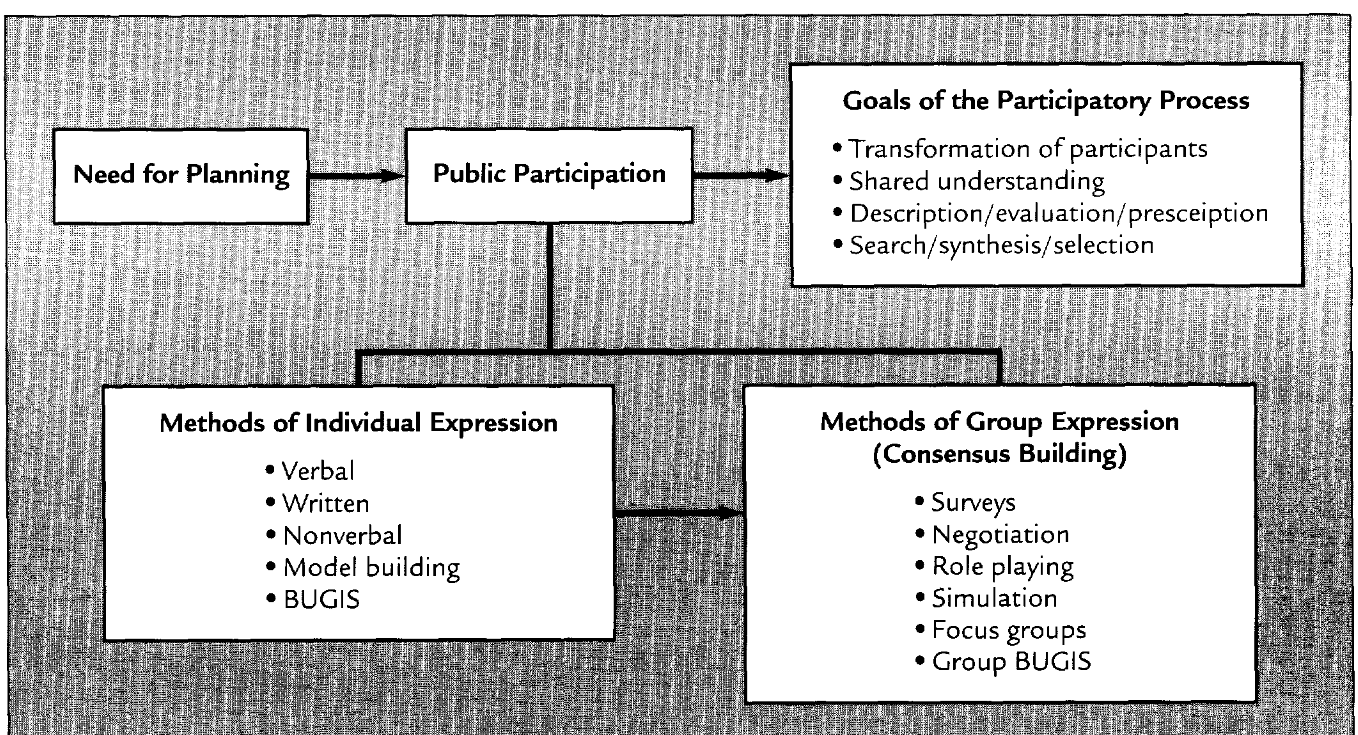

FIGURE 1. Conceptual model of BUGIS in the planning process.

for the neighborhood). This event was called "The Cadillac Heights Community Mapping Project." Approximately 10 residents were scheduled over two Saturdays to participate in the BUGIS in space provided by a local business.

The essential steps for a successful BUGIS are described below.

Step 1: Choosing the Right Venue

Bottom-Up GIS is a tool used to communicate how a resident or group of residents would describe, evaluate, or prescribe a course of development for a particular area. This expression ideally takes place in a structured session with a GIS facilitator rather than a standard community meeting. This is because BUGIS, as conceptualized here, is not intended to be done "on the fly." As Shiffer (1999) has acknowledged, GIS currently does not effectively support real-time descriptions in collaborative settings.

Both the Community Action Conference and the Cadillac Heights visioning events were pre-arranged sessions that had the specific goal of soliciting resident expressions of views and preferences about a wide range of topics. BUGIS is most appropriate for situations where residents want to participate actively. For the larger Community Action Conference, these activities took place in six separate conference rooms (organized by neighborhood), where participants gathered for two sessions lasting several hours. During these sessions, the use of GIS to express resident views was facilitated, but other forms of expression also occurred. For the Cadillac Heights event, residents arrived at scheduled times for sessions devoted exclusively to GIS use. Residents used GIS to express their views in sessions lasting between 30 minutes and 2 hours, working individually or in groups of two or three.

Step 2: Preparing Data and Software

Before participants construct their GIS of neighborhood issues and preferences, all available relevant GIS data for the local area must be compiled and integrated. The main goal is to provide residents with as much information as they might need to represent their descriptions, evaluations, or prescriptions. Successful data preparation requires some forethought as to the types of issues of relevance to residents (as opposed to planners). Ideally, residents should be involved in determining what data will be available.

Data preparation for the two Dallas events was fairly straightforward. For each neighborhood, all available coverages were compiled from data available from the City of Dallas, The University of Texas at Dallas, and The Dallas Plan. Graduate students at the University were assigned a particular neighborhood, and worked to compile the data for it in a consistent format.

For this data presentation, we used the standard ArcView interface, although it would be appropriate in future events to make the graphical user interface (GUI) between the resident and the GIS more accessible and meaningful (the GUI provides on-screen buttons and menus for performing various GIS-related tasks). One way would be to convert concepts such as points, lines, and areas in the GUI to include neighborhood concepts that have more meaning and relevance, such as areas that feel safe, community focal points, frequently walked paths, vistas, areas in transition, etc. On a more technical level, it could be valuable to develop improved point and click operations (e.g., through the use of tools such as digital pens) and incorporate multimedia to aid in the identification of GIS-based elements (for more information on the use of multimedia in GIS, see Shiffer, 1999).

Step 3: Role of the Facilitator

The primary role of the GIS facilitator is to guide the participants through the process, introducing spatial concepts where needed, and broadening the discourse enabled by a GIS-based approach to the expression of views and preferences. In both Dallas events, student facilitators operated the computers at the sessions and worked interactively with the residents to translate their views to produce maps that reflected group and individual preferences.

Figure 2 lists the kinds of GIS queries that were (or could be) involved. The list covers many of the basics of spatial reasoning in GIS, and facilitators must be prepared to respond to whatever is needed to appropriately represent the views and preferences of residents. The spatial concepts involved include distance, direction, connectivity, adjacency, proximity, clustering, patterns, shapes, distributions, and hierarchies (see Worboys, 1995). In BUGIS, spatial reasoning becomes an integral part of the interactive process of building a map of perceived issues and preferences.

Not all of the queries meant to broaden evaluative discourse will be explicitly conceptualized by residents. Yet the explicit use of spatial concepts (for residents) is not a prerequisite for the successful use of BUGIS. Indeed, in the interactive building of resident preferences in the two events in Dallas, many spatial concepts were implicit. Cognitive studies have demonstrated that there is a significant relationship between commonsense geo-

- Location/Number of occurrences of entity A
- Location of occurrences of entity A relative to entity B
- Area, perimeter, length of entity A
- Centroid of occurrences
- Number of occurrences of entity type A within distance D of entity type B
- Which entities are next to entities having certain combinations of attributes
- Attributes of entity A...Z at location point B
- Location of point B relative to entity A...Z
- Distance/shortest paths between locations
- Direction of flow
- Area, perimeter
- Overlay, intersection of spatial data
- Differentiation of areas according to some criterion or combination of attributes

FIGURE 2. Possible queries in Bottom-Up GIS.

graphical worlds and GIS representation (Golledge et al., 1994), so that residents who are not accustomed to thinking spatially may nevertheless possess the ability to use spatial reasoning in the evaluative process. Obviously, the GIS facilitator plays a critical role in making this translation.

Step 4: Constructing the BUGIS

With the venue selected, the data organized, and the facilitators trained, the process of constructing a BUGIS can begin. Listed in this section is the format that was used for the Cadillac Heights visioning event. Depending on local context and need, as well as the purpose for the BUGIS, the format will vary.

Participant Preparation

The actual construction of a BUGIS begins when a participant sits down with a facilitator in front of a computer screen in either an individual or a group session. Assuming the participant has no prior experience with GIS, the facilitator begins by showing the participant the following:

1. The coverages of the local area available in the GIS (e.g., parcels, neighborhoods, census data by block, locations of parks).

2. The types of neighborhood features involved and the way in which these features are represented as point locations (e.g., street intersections, buildings), linear features (e.g., streets, transit lines), or areas (e.g., commercial districts, blocks).

3. Basic GIS tools. How the user can turn coverages on and off, change the scale, zoom in and out, or pan left or right. How to calculate areas, perimeters or distances easily.

4. The different ways in which the evaluation can be expressed in a GIS format. The facilitator must demonstrate to the participant how these processes work. When preferences are solicited in a GIS format, three types of GIS functions are relevant: selection (of objects), drawing, and ranking. Each of these functions corresponds to a distinctive type of evaluative question. Object selection results from an evaluative question that involves, for example, what elements in a neighborhood are liked or disliked. Questions that involve GIS drawing functions are in response to questions about location in space or movement through space. Ranking functions result from questions that involve assigning relative weights to selected objects or spatial elements that have been added.

Constructing the BUGIS

Expression of views and preferences in GIS may be entirely open ended or may be based on specific evaluative questions. Open-ended evaluation and prescription requires more adept manipulation of spatial concepts, such that an individual resident can conceptualize preferences in terms of selection, drawing, and ranking of GIS elements.

Since it is more likely that a participant will not have prior GIS experience, the facilitator may work with a set of specific questions, at least in the initial stages. These questions could correspond with three types of expression in the planning process: description, evaluation, and prescription. Throughout this process, spatial complexity, spatial context, and the interactivity and interconnection of ideas in GIS become important tools in the formulation of this expression.

Description. Residents could begin by using GIS to describe their personal activity patterns: places visited for social purposes, for shopping and services, for recreation and community-oriented functions, or essential destinations such as places of work. Linear features could be selected to describe the residents' routes through the area and method of travel.

Residents could then describe conditions not necessarily linked to their personal activity patterns. For example, they could identify places where they believe there has been a lot of change, in terms of physical change, migration, or areas in positive or negative transition. They could identify areas with specific conditions, such as ones where there is a lot of activity, noise, gangs, demolitions, redlining, mixed uses, or civic events. Residents can use any combination of GIS drawing, selection, or ranking functions in their descriptions.

Taking the description to a higher level, residents could use GIS to describe such concepts as the identity or distinctiveness of an area (where are the focal points for the area?). Seeing what layers residents choose to represent this distinctiveness would be particularly insightful. Can distinctiveness be represented using sociodemographic data?

Residents who have a slightly more sophisticated perception of neighborhood may be able to express such concepts as "connectedness." To what extent is the area connected internally, such as between individuals and places, between blocks, or between open spaces? Is the area connected externally to other parts of the city? Simple drawing tools in GIS could be used to describe these connections.

Evaluation. In addition to descriptions (which are inherently, if indirectly, evaluative), survey questions could be geared more directly toward evaluations of the neighborhood. Residents could begin by using GIS to express their evaluations of personal activity patterns. This could begin with the attachment of qualitative attributes to activity spaces, for example, in terms of frequency of visits and relative importance. Qualitative attributes could be assigned to activity routes, such as frequency of travel along a given route, importance of that particular route, and perceived quality of the route in terms of maintenance, safety, or traffic.

Residents could use GIS to express the degree to which they believe places for particular purposes are sufficient in terms of numbers, quality, or location. For routes, they could identify whether or not routes used to get to destinations are sufficient in terms of time and distance, quality, safety, and mode of travel. Whether or not a particular place (a point location or an area) is perceived as accessible or inaccessible could be explored interactively and expressed using GIS.

Residents may choose to use GIS to express their evaluation of the positive and negative aspects of a given area. They may support their view of areas that portray a positive image by selecting places that are interesting or entertaining, architecturally distinctive, well maintained, or that have superior views. Alternatively, a positive image could be expressed by emphasizing the spatially distributed social qualities of an area. Negative images may be expressed by indicating areas with retail vacancies, poor lighting, vacant lots, or environmental pollution. Again, these images can be added to the GIS, or residents can add their evaluations to existing coverages.

Prescription. A third use of BUGIS would allow residents to prescribe desired outcomes in a GIS format. While the expression of alternative development scenarios in GIS is fairly standard, in BUGIS the resident would use spatial complexity, spatial context, and interactivity and interconnection to build an expression of preferences for a prescribed course of action. For example, residents could use GIS to identify all places (points, lines, or areas) that they believe have the most potential for revitalization, choosing from a number of different coverages to communicate their view. To express what needs to be added or improved and where, residents could use GIS tools and functions to combine existing data and add to it.

Examples of BUGIS

While it is difficult to represent the interactive process in a static picture, this section presents three examples of what an output map from a BUGIS might look like. These examples are based on actual constructions obtained in the two community visioning events described above. However, the examples shown in Figures 4-6 are generalized and do not reflect the opinions of any particular, identifiable individual or group. Further, they have been augmented in order to demonstrate more fully the range of information that GIS-based expression can include. The main point of the figures is to illustrate how GIS can be used to express resident views, not simply to inform residents about the locations of things. The examples pertain in particular to walkable urban neighborhoods, although the concepts could apply to a range of other types of neighborhoods. Figure 3 shows the locations of the different views represented in the three examples, Figures 4, 5, and 6.

The most striking aspect of the three examples is that although they represent the same general area in

Dallas, they reflect entirely different views of neighborhood. The residents who constructed these maps based their perceptions on very different features and layouts, giving each a completely different picture of what elements are important, desirable, or undesirable. The figures are therefore most reflective of description and evaluation, rather than prescription.

One of the most obvious uses of GIS in neighborhood description is to investigate how residents delimit what they consider to be their neighborhood (i.e., neighborhood "imageability"; see Haney & Knowles, 1978; Downs & Stea, 1973). Conventionally, the operational delineation and consequent definition of an urban neighborhood is based on either statistical measures (typically using census data), or on open-ended resident descriptions. The former approach uses multivariate statistical techniques such as factor analysis to "cluster" elementary spatial units into neighborhoods (Johnston & Herbert, 1976). The latter, more ethnographic in nature, derives the boundaries from direct queries of residents, such as asking respondents to draw boundaries on existing maps (Lee, 1968) or simply to verbally describe their neighborhood (Haney & Knowles, 1978). In BUGIS, residents are equipped with the spatial com-

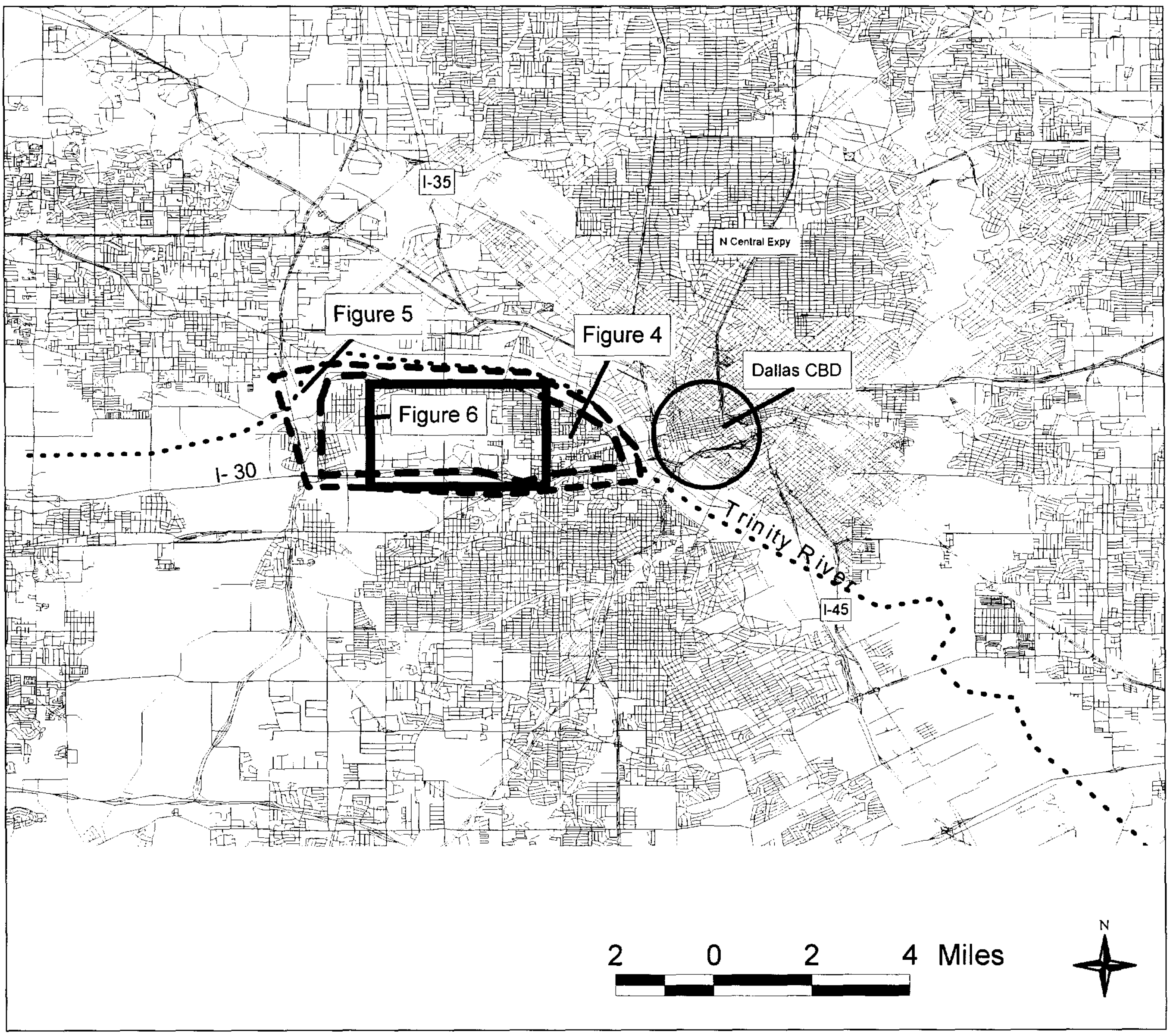

FIGURE 3. Approximate boundaries of BUGIS examples (Figures 4–6) relative to Dallas CBD.

plexity, context, and interactivity/interconnection inherent in GIS to express their perception of boundaries.

Figures 4–6 give an indication of how boundaries might be expressed in BUGIS. Figure 4 gives the most explicit delineation, in which a resident used GIS drawing tools to identify the limits of several neighborhoods. Point locations of employers, business parks, and public services marked the boundaries. If residents don't have a clear conception of boundaries, they can identify various locations that have meaning to them, for example, local movement paths or "activity routes" and other "behavior settings," such as places frequented for shopping or leisure.

Figures 4–6 represent entirely different perceptions of what neighborhoods consist of. The elements selected as important in Figure 4 are primarily schools, businesses, and employers, while in Figure 5, EPA (toxic) sites, business areas, and the location of paths and trails give meaning to the neighborhood. Figure 6 concentrates on various types of land use.

The BUGIS approach to delineation of boundaries enables each resident to use spatial queries. This process is difficult to demonstrate on Figures 4–6, but it can be described. In BUGIS, interactive selection of variables (drawn from a wide array of potentially meaningful variables) and spatial queries are readily integrated in the process of selection. For example, residents might be interested in the spatial distribution of population subgroups, the area calculation (e.g., acres) of a given spa-

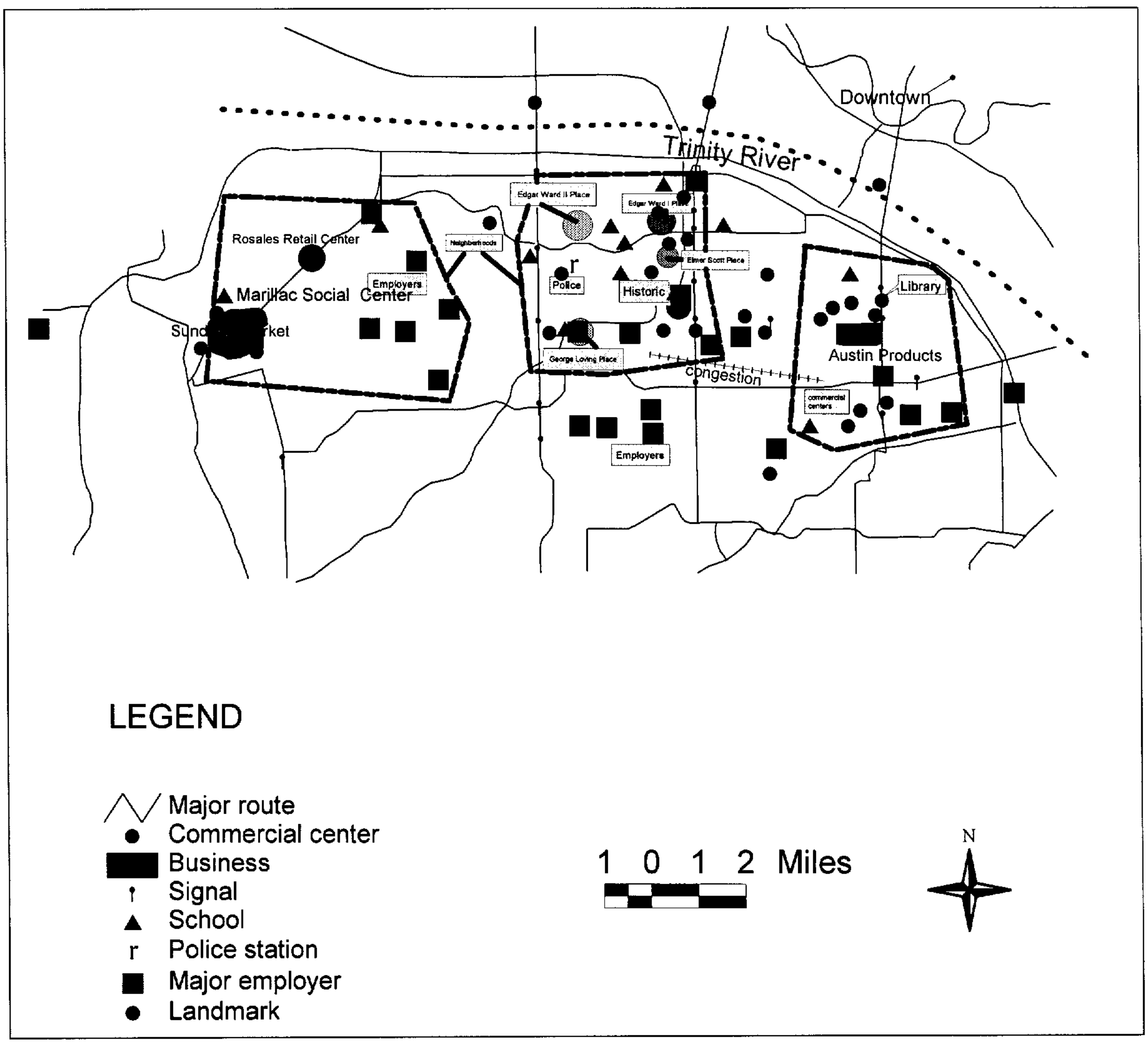

FIGURE 4. Example BUGIS, Dallas.

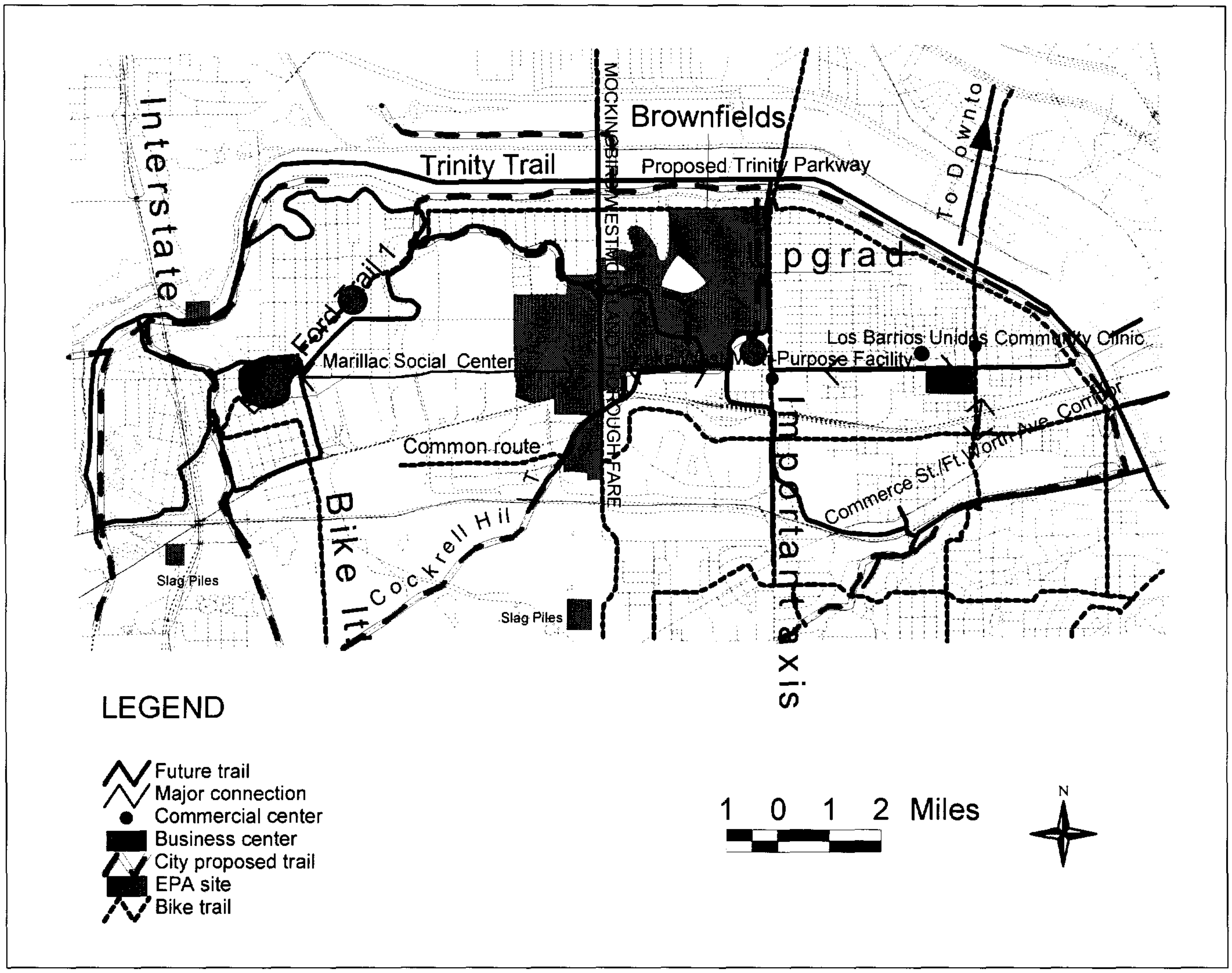

FIGURE 5. Example BUGIS, Dallas.

tial element, or the shortest path between two neighborhood points.

Neighborhood issues and preferences are articulated by the scale used, the elements selected, the areas drawn, and the elements at the resident's disposal that are *excluded* from the description or evaluation. In this regard, meaningful elements included in Figure 6 but not in Figures 4 and 5 create a much different characterization of the neighborhood. The map shown in Figure 6 is not only of a smaller scale, but the resident has chosen to represent the area (and its issues) in terms of safety factors, personal movement paths, and polygonal data. While some residents will tend to stress distributions of data by polygon, others may make use of point locations of a wide variety of facilities, thus articulating their perceptions in terms of physical structures as opposed to spatially distributed variables.

An obvious application of BUGIS would be to explore how residents perceive their access to various public services, facilities, and spaces. Using whatever GIS data layer is considered to be an important factor of access (sidewalks, traffic lights, safety), residents can construct a perceptual map of accessibility. In addition, GIS could be used to determine what would be the limits of, for example, a "10-minute walk"—based on distance, traffic barriers, and topography. Using GIS, residents could indicate the locations of undesirable and desirable facilities in relation to walking paths—originating from the resident's house, for example—that are either used (safe, desirable) or avoided (unsafe, undesirable). This

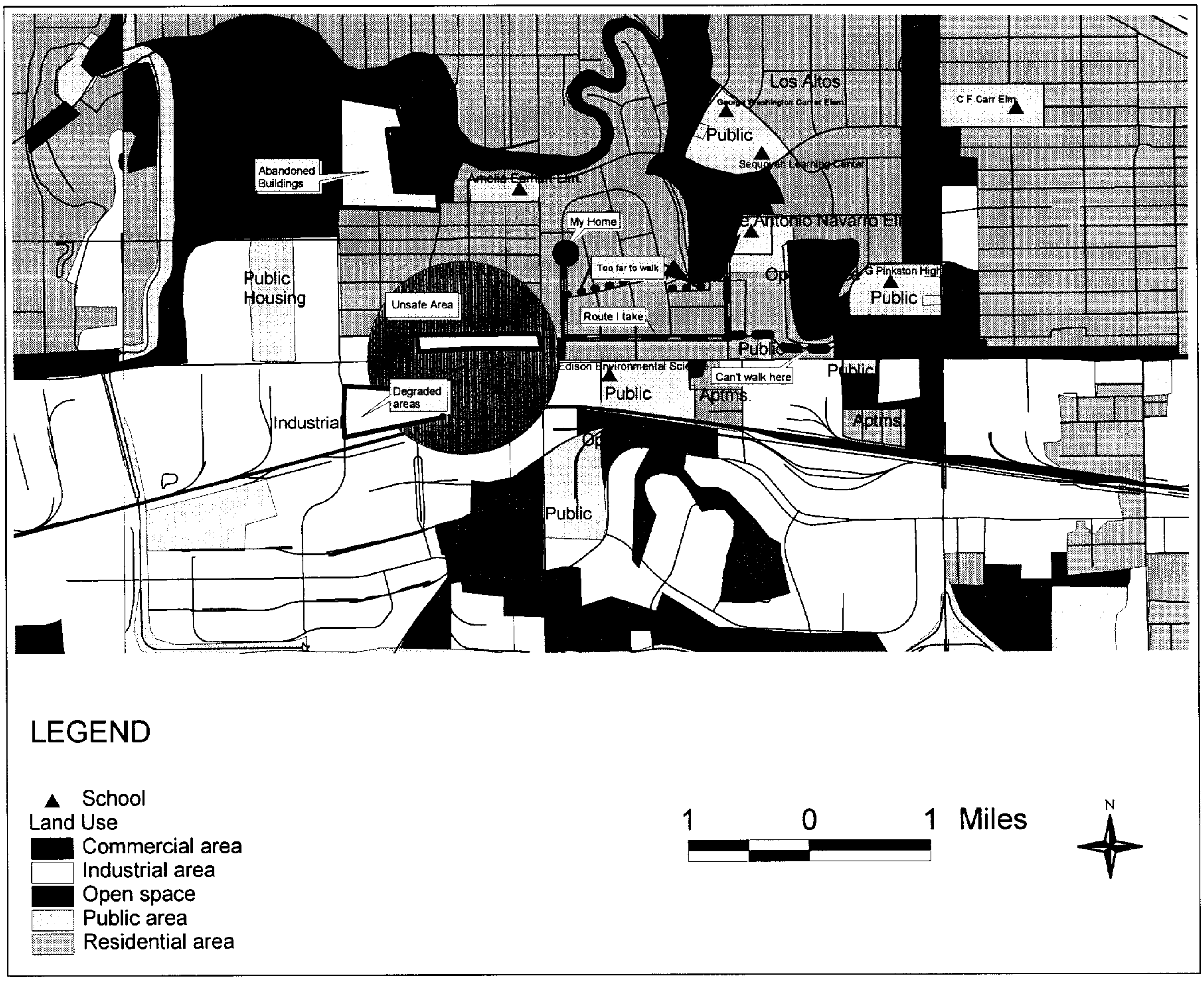

FIGURE 6. Example BUGIS, Dallas.

approach is fundamentally different from conventional evaluations of accessibility in GIS, which use various metrics of spatial access (see Talen, 1996). Determining accessibility on the basis of resident views is more in line with an approach that evaluates access as a socially constructed phenomenon involving racial and gender-based restrictions (Staeheli & Thompson, 1997).

Figures 5 and 6 give some indication of perceived access and how it varies. Figure 5 seems to present a much more open view of access, emphasizing linkages to other parts of the city and movement through the area. The resident has a clear view of alternative means of travel and represents the area's accessibility according to these different modes. Figure 6 has a more closed view. The resident indicates the existence of unsafe and degraded areas, as well as an area where the resident cannot walk. The entire map is centered on the person's home ("My Home") and stresses the impediments associated with its location.

These figures also reveal how GIS can be used to express residents' evaluations and, to a limited degree, prescriptions. The identification of areas to be targeted for improvement is based on residents' perceptions of significant unsafe or undesirable points, paths, or areas (see Figures 5 and 6). Residents may be aided in this determination by, for example, the overlaying of a variety of variables that reflect the kinds of criteria residents use to prescribe a course of action, such as the location of toxic sites, crime statistics, unkempt lots and other physical incivilities, or known street gang activity. The visualizing power of GIS equips residents with a powerful tool to elucidate these perceptions.

Synthesis

The most significant value of articulating residents' preferences via GIS is its potential to strengthen and deepen communication about neighborhood issues. A GIS that reflects individual residents' viewpoints could aid in the communication process simply by exposing underlying perceptions otherwise obscured by a lack of appropriate communicative format. Yet there may be contexts in which a synthesized view of individual expressions is valuable, particularly if the goal is to prescribe a desired course of action. Obviously, there is a danger that such syntheses might compromise individual viewpoints and seriously undermine the very purpose of BUGIS (i.e., the expression of perceived issues and preferences). Thus the synthesized preference maps described below must always be seen as part of a broader process in which residents are actively involved and in agreement with the result.

Some syntheses of expressed preferences are easily derived. For example, it is possible to collapse perceptions of "safe/desirable" streets versus "unsafe/undesirable" streets into a composite view that indicates a ranking or percentage of streets falling into various categories. Targeted areas could be drawn and shaded to reflect these rankings. A composite picture of "desirable" streets could show the type and number of facilities excluded or included. Individual preference maps could be "decomposed" into GIS "primitives," such as essential points, linear features, and areas, and summed using simple algebraic operations (see Armstrong & Densham, 1995).

The delineation of a neighborhood boundary is particularly conducive to mapped synthesis. Individually drawn boundaries could be overlain, or each boundary could be weighted by how many residents attach themselves to it. Such a synthesis could produce a weighted centroid of all boundaries or identify intersecting boundaries. These overlays may help in a discussion of neighborhood preferences, particularly in the identification of a neighborhood "center."

This kind of synthesis of perceptions is not new to planners. Kevin Lynch pioneered the construction of aggregated maps of perception (e.g., 1960), and geographers have a long history of experience with the collapsing of cognitive views. For example, composite cognitive maps have been made of perceptions of fear, perceived stress levels, and resident views of the geography of social class (see Knox, 1995). Even so, the application of these techniques in GIS, with a clear demonstration of their utility in the neighborhood evaluation process, is by no means standard practice.

Recent work on aggregation issues in cognitive mapping may help planners to synthesize GIS-based evaluations of a neighborhood. An article by Kitchin and Fotheringham (1997) is particularly useful. The authors investigate three different ways in which cognitive views can be aggregated:

- *disaggregation*, in which individual views are pooled only for comparison;
- *collective aggregation*, where the data are aggregated and then analysis is performed on the resulting dataset; and
- *individual aggregation*, where "the data are analyzed at the individual level but the results are both pooled and averaged and either the mean or median values are taken to represent the members of the whole group" (p. 269).

The last approach may be particularly useful for neighborhood BUGIS where the focus of the synthesis is on discovering what a group of individuals' perceptual maps consists of, as opposed to focusing on the overall cognition of a place (collective aggregation).

Limitations of BUGIS

As planners gain more access to GIS technology, they have a responsibility to put GIS in the hands of local residents, not simply as a way to access data, but as a medium through which residents can express themselves. Yet there are significant costs. Planners who are accustomed to using GIS as a way to inform residents must be willing to turn its conventional use around, allowing *residents* (rather than GIS) to convey the character of an area. Assuming planners are willing to make this change, they must commit the time and resources needed to complete the required steps—choosing the right venue, preparing the data and software, preparing the facilitators, and finally constructing the Bottom-Up GIS. BUGIS requires a signficant degree of time and willingness on the part of both planners and residents.

It must be assumed that most residents lack the technical capabilities required to manipulate GIS for the purpose of expressing their views. GIS facilitators—planners—are therefore needed to assist residents as they build their GIS-based statement of neighborhood issues and preferences. A significant limitation, therefore, is that biases could be introduced from two factors: (1) the need to work with (or from) existing databases; and (2) the involvement of GIS facilitators in the construction of the BUGIS. These biases, however, could be lessened by ensuring that the GIS representation is acceptable to the *resident* first and foremost, not the facilitator. While no one would claim the complete mitigation of subjective influence, the planning profession does have experience with the successful integration of facilitators in the planning process. Planners have been enlisted as reconcilers of conflicting facts (Helling, 1998)—active participants who, for example, use their planning expertise to serve the group decision-making process without controlling it (Lindblom & Cohen, 1979; Innes, 1996).

Planners and residents must have a clear view of the benefits of a BUGIS approach. They must recognize the value of improving the ability of residents to express their views in multidimensional ways. These benefits must be tempered with an understanding of the intrinsic limits to what BUGIS can be expected to accomplish. Some issues may be better explored outside the realm of GIS, such as discussions of how a neighborhood is externally perceived or how a neighborhood's commercial base should be marketed. Other issues may not be appropriate topics of residents' perceptions. For example, it may not be particularly useful to explore residents' perceptions of water and sewer infrastructure locations or of socioeconomic indicators such as employment or poverty levels. These limitations, together with the costs involved in setting up a BUGIS, must be weighed against the advantages of establishing a fresh approach to the expression of views.

Conclusion

This article has presented a few examples of how GIS can be used in the exploration of residents' perceptions. The main contribution of this approach is that it fosters better articulation (and thus understanding) of residents' perceptions of issues relevant to the local planning process, such as what is liked, disliked, or desired about a given locale. Placing GIS in the realm of perception contributes to the "bottom-up" use of GIS, and thus represents a significant departure from current uses of GIS in planning.

In fact, much of the activity of determining residents' preferences and evaluations of their local environment—inherent in the community visioning process—is conducive to the use of GIS. Lists of assets and needs involve entities at given locations, attributes of entities at given locations, or hierarchies of entities within an area, all of which are appropriately explored using GIS. Preferences having to do with neighborhood appearance or architectural issues can exploit GIS/multimedia connections. Evaluations that include the availability of service or convenience of location involve distance-based attributes, which are well suited to articulation in a GIS environment.

There are other tangible benefits to pursuing a bottom-up approach to the use of GIS in planning. Discussions of values and preferences are made spatially specific in GIS. The spatial implications of specific values or preferred strategies for neighborhood improvement are revealed. Preferences that involve spatial relationships are seen in the context of the location of other, perhaps competing, spatial elements. The interactive process involved in expressing views and preferences may deepen the exploration of issues, allowing residents to articulate ideas that were previously unexplored.

Putting GIS in the realm of residents' perceptions strengthens participation in neighborhood planning by providing a new communicative outlet, encouraging participation by residents previously reluctant to express their views via other, more traditional formats. GIS, in fact, may legitimize individual expression by giving it a technical edge. Residents' perceptions in the form of local knowledge are elevated to the level afforded basic socioeconomic or environmental database themes that are the traditional and often exclusive domain of GIS. Most importantly, finding ways to incorporate local knowledge may open up GIS to individuals and groups whose cognizance may not conform to conventional knowledge representation. Toward this end, planners can, hopefully, build on some of the ideas expressed here and cultivate an approach and methodology through which local knowledge is readily incorporated into the language and structure of conventional GIS.

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