Environment and Planning B: Planning and Design 2003, volume 30, pages 181 – 200

DOI:10.1068/b12977

Neighborhoods as service providers: a methodology for evaluating pedestrian access

Emily Talen
Department of Urban and Regional Planning, University of Illinois at Urbana-Champaign, 111 Buell Hall, 611 Taft Drive, Champaign, IL 61820, USA; e-mail: talen@uiuc.edu
Received 16 April 2001; in revised form 10 May 2002

Abstract. Research on neighborhoods is dominated by a focus on the social aspects of neighborhood life. The ability of neighborhoods to function as service providers is a critical and understudied aspect of neighborhood research. This paper offers a methodological contribution of the analysis of neighborhoods as service providers. Provision of services is defined in terms of accessibility, or the spatial proximities between residents and the facilities. Because the focus is on neighborhoods, access is defined on the basis of the pedestrian rather than the automobile. In addition, the needs of the neighborhood population are considered. A case study of Portland, Oregon, is used to demonstrate how an evaluation of pedestrian access could be conducted at the neighborhood scale.

Sixteen years ago, sociologist Wekerle (1985) argued that research on neighborhoods was dominated by a focus on the social issues of neighborhood life. Research on neighborhoods, Wekerle argued, should include the analysis of neighborhoods as service providers. Although it is useful to investigate social phenomena in neighborhoods—primary group formation, patterns of social interaction, or social breakdown and disorder—the ability of neighborhoods to function as service providers is vital and understudied.

In this paper I offer a methodological contribution toward the analysis of neighborhood as service provider. Three concepts underlie this investigation. First, 'service provision' is defined on the basis of *access* to facilities. Provision of services, therefore, is defined in terms of spatial proximities between residents and the facilities that are important to their daily life needs. Second, access is investigated from the point of view of the pedestrian (which includes the bicyclist), not the automobile. This gives meaning to the notion of 'neighborhood-level' facilities, which are defined here as facilities that a neighborhood resident could walk to. Third, access to services is related to the needs of the population residing in a particular neighborhood. Need is defined on the basis of selected census population characteristics that indicate the degree to which the population is mobile (that is, that has ready access to a car). Using this conceptual framework, a case-study analysis is presented. The paper is intended to be a methodological contribution, motivated by an underlying agreement with the view that the analysis of neighborhood as a locale for the delivery of urban services has been understudied (Wekerle, 1985).

The importance of accessibility

Elevation of the role of accessibility in neighborhood evaluation ties in closely with the view that planners should promote settlement patterns in which priority is given to increasing access between humans, their places of work, and the services they require. Accessibility is not conceptualized as an issue of private mobility but is refashioned as a community-wide, public problem. Accessibility, thus, is defined here as the ease with which a resident can reach a given destination. As the scale is neighborhood, furthermore, that ease is evaluated on the basis of walking distance to destinations that are neighborhood in scale. Such destinations—parks, schools, and local retail outlets—tend to satisfy the daily life needs of neighborhood residents.

Recent debates in planning and geography seem to be working against the idea that accessibility in and of itself is a crucial goal. There is an implicit approval of the fact that physical distance is lessening in importance, that technology is obfuscating the need for centered settlements, and that low-density suburban development is merely the inevitable outcome of the post-Fordist urbanization process (Dueker, 1996). The idea of access is systematically downplayed as tangential, despite the importance of pedestrian-oriented access for those who lack mobility (the elderly or disabled, the poor, and working parents). The downplaying of access inherent in most academic critiques of new urbanism (Harvey, 1997) means either that access is not deemed relevant or that market forces are deemed too difficult to overcome. In practice, the role of accessibility in transportation planning takes a back seat to concepts such as congestion reduction; alternatively, an accessibility-based approach, such as the one demonstrated here, would focus on maximizing land-use and transportation choices (Levine, 1998).

The quality of access and its function of promoting the integration of activities are long-standing components of theories about good urban form (in particular, see Duany and Plater-Zyberk, 1991; Jacobs, 1961; Jacobs and Appleyard, 1987; Lynch, 1981). Most notably, Lynch (1981) held 'access' as a key component of his theory of ideal urban form. In the broadest sense, Lynch argued that access could be used as a measure of 'settlement performance' (that is, a measure of what makes a 'good' city) by factoring in (1) the feature to which access is being given and (2) the person receiving access.[(1)] Most recently, 'new urbanists' have developed a specific town-planning manifesto (CNU, 2000) based on enhancing access at the level of the region (by promoting a variety of transportation alternatives), the metropolis (by promoting compact urban form), and the neighborhood (by promoting mixed uses and housing density).

The evaluation of access is also especially significant for the consideration of spatial equity issues (Talen, 1998). The issue is one of who has access to a particular good or service and who does not and whether there is any pattern to these varying levels of access. Thus, in a distance-based analysis, the purpose of research on access might address the question of whether access to a particular good is discriminatory. Such inquiries might entail an examination of the extent to which there is a spatial pattern to varying levels of access and whether that spatial pattern varies according to spatially defined socioeconomic patterns. This is also important because, for locally oriented populations—residents who rely on modes of transport other than the automobile (for example, the elderly and the poor)—accessibility to urban services may be more important because distance is not elastic (Wekerle, 1985).

Evaluating accessibility

What is needed is a methodology in which access as a quality of neighborhood can be operationalized. The approach can be straightforward. Planners can make use of the notion of access by looking at just two aspects of it: the ability to reach urban places, and the quantity and quality of places that can be reached. Together, these two aspects of access provide a powerful indicator of neighborhood-level (that is, pedestrian) access.

[(1)] From these basic categories, Lynch delineated a large number of additional complexities; for example, the flow of information, access variation by time and season, the fact that access is not always a quantity to be maximized, the need to be able to shut off the flow of access, perception of access, and the benefits of moving to as well as arriving at a given destination.

Despite the importance of accessibility, the analysis of neighborhoods in terms of access to services is hardly a standard protocol of local planning departments. In the remainder of this paper, I outline a basic approach for evaluating access to services and how access varies among different neighborhoods. The approach relies on the power of maps and the visualization of quantitative data to allow conclusions to be made about how access varies across the urban landscape. Exploration of these data in a visual way is a powerful tool for making comparisons about the urban pattern.

Variations

Accessibility can be measured in a variety of ways. At one end of the spectrum, accessibility measures can be based on random utility theory, where access is based on the desirability or utility of a set of destination choices for an individual (Handy and Niemeier, 1997). Another similar approach uses travel diaries of individuals to estimate 'personal accessibility', based on daily movement patterns (Kwan, 1999).

How access is measured should be based on how the measure is to be used. The approach I advocate for evaluating urban spatial pattern can be termed 'place-based' accessibility—a measure that serves as a characteristic of a place. This conceptualization of access carries with it a number of variations in and of itself, and the main parameters involved are summarized in table 1. These variations are mentioned only briefly here but have been discussed more extensively in other publications (see Handy and Niemeier, 1997; Lucy, 1981; Pacione, 1989; Talen, 1998).

Table 1. Accessibility measurement variations: approaches.

Approach	Definition
Container	The number of facilities contained within a given unit (for example, census tract)
Coverage	The number of facilities within a given distance from a point of origin
Minimum distance	The distance between a point of origin and the nearest facility
Travel cost	The average distance between a point of origin and all facilities
Gravity	An index in which the sum of all facilities (weighted by size) is divided by the 'frictional effect' of distance

There are at least five measurement 'approaches', listed in table 1. One of the most widely used is known as the 'container' approach, which is simply a count of the number of facilities within a given 'container' such as a census tract, political district, or municipal boundary. In the 'coverage' approach (where coverage is sometimes referred to as the 'cumulative opportunities' of a given location) one counts the number of facilities within a given spatial unit or range. In the 'minimum-distance' approach one measures access as the distance to the nearest facility, whereas in the 'travel cost' approach one calculates the distance (cost) between an origin and all included destinations (for example, all parks within a city). Last, a 'gravity' potential measure can be used in which facilities are weighted by their size (or other characteristic) and adjusted for the frictional effect of distance.

In table 2 (see over) I list various measurement factors. As a first step in the analysis of urban access, points of origin are selected. This could range from point locations of individual housing units on a parcel, to centroids of larger geographic units (for example, blocks, block groups, or tracts). A fundamental issue here relates to the question of obtaining resident attributes for the analysis. It is likely that planners will want to consider the socioeconomic characteristics of a population in looking

Table 2. Accessibility measurement variations: factors.

Factors	Description
Origins	Location Type Attributes of individuals at origins
Destinations	Location Type Quality
Modes of travel	Pedestrian Bike Public transit Automobile
Travel route characteristics	Quality of route Sidewalks Design speed Safety
Distance calculations	Straight line (Euclidean) Manhattan block Network

at access, as such information allows some assumptions to be made about mode choice. For example, it is likely that residents in poorer areas will be more dependent on public transit, have lower access to private automobiles, and will therefore require greater access. Even though distance is the most critical factor in determinations of access, when the goal of evaluation is assessment of urban spatial pattern (regardless of mode of transport) it is prudent to factor in socioeconomic considerations because for poorer areas there is a higher distance-decay factor, access is not elastic, and lower levels of accessibility are particularly detrimental.

Generally speaking, the greater the level of disaggregation of data, the higher the level of precision in measuring access. Thus use of individual parcels may be most appropriate for analyzing urban spatial pattern. However, the disadvantage with using parcel-level data is that socioeconomic attributes are not easily obtained for a given parcel. If a census geographic entity is used, such as a block, block group, or tract, socioeconomic characteristics for that entity can be used in the assessment of spatial equity (this aspect of analyzing accessibility is discussed in more detail below). Although it is possible to interpolate characteristics of a given census region to a lower level of aggregation, such as a land parcel, this approach engenders the ecological inference problem and can be invalid (see King, 1997). The problem has to do with reconstructing individual behavior from aggregate data—specifically, it is not always valid to attribute a characteristic measured for an entire geographic area to an *individual* residing in that area.

Thus the trade-off to be made is this: if parcels are used, the locations are known but the characteristics of the individuals within those locations can only be assumed. If census geography is used, the locations are compromised by using centroid locations, but socioeconomic characteristics aggregated by zone can be determined.

Next in the procedure is the determination of destinations, in which some decision is made about the qualities in an urban environment to which it is important to have access. Obvious categories would be shopping opportunities, public amenities such as parks, and employment. Often the best data for characterizing facilities are parcel-level data, or data at the level of an individual building or street address.

Fortunately, parcel-level data that include the primary use of the parcel are available in many cities from the tax assessor's office.

The amount, type, and quality of a given destination could also be factored in, and some of these data (such as size or square footage) may be available from the tax assessor. It should be noted that some consideration of the relevance of these characteristics is warranted, as different socioeconomic groups have different sets of destination opportunities, either because of their perception of access or because of monetary or cultural constraints (Hanson and Schwab, 1987).

Mode of travel and travel-route characteristics are also elements that could be factored in. If bicycle access is being considered, factors that affect the route include topography, design speed, bike-lane width, and number of lanes of traffic. For pedestrian access, perceived safety, sidewalk quality and width, parking, and traffic volume are important factors. In fact, many of these qualities are continually evaluated by transportation planners and thus would be useful to include. One interesting example is the Bradshaw walkability index (UQC, 1999), which uses criteria such as density, offstreet parking places, 'sitting spots', and sidewalk 'dips' at each driveway to measure the walkability of an area (see also FDT, 1993; USDT, 1992).

Travel route characteristics are readily incorporated in an analysis based on a geographical information system (GIS), most likely as weights that quantify the walkability of a given street segment. A significant drawback to their use is that detailed data about walkability factors such as sidewalk quality are often not available. Obtaining reliable data requires extensive fieldwork that needs to be updated continually. One possible remedy to this problem is the use of remotely sensed imagery. The finer geographic resolutions required to assess things such as sidewalk width and quality are becoming more widely available.

Last, measurement of the distance between two spatial locations can be based on several different metrics. First, a route can be based on the shortest straight-line distance between destination and origin (the Euclidean distance). This is straightforward, but may not approximate actual travel behavior very well. A second approach is to calculate distance along an existing street network, factoring in such attributes as street direction. A major disadvantage of this approach is that it can be very computationally intensive.

A third option is to compute distances within a spatial framework —not along a street network but by using an approximation of one. This can be justified if the area being analyzed is covered by a fairly dense street network so that distance can be approximated fairly readily. This approach also has the advantage of being much less computationally intensive. A disadvantage is that the approximation of distance is less precise within areas that are not covered by a street network, for example, in more rural areas. If the street network is sufficiently dense, one way to calculate distance by using a spatial framework rather than a network is to calculate distance based on either latitude–longitude locations ('arc distance') or Manhattan block distance (Anselin, 1995), where distances between two locations are computed such that the distance between the origin and the destination is measured along a grid that approximates a street (Manhattan) network.

Methodological steps

Theoretical grounding for accessibility analysis is already fairly well established in the writings of Lynch (1981), and, more recently, new urbanist models of compact urban form. Less established is a practical implementation procedure that could be used to evaluate accessibility. In this section, the explicit steps involved in implementing

Table 3. Methodological steps.

Step	Main task	Decision framework
1	Determine purpose of accessibility analysis	Neighborhood focus Regional focus
2	Obtain relevant data	Origins Destinations Route characteristics
3	Compute distances	Street network Geometrics
4	Compute access measure	Nearest distance Total distance
5	Perform analysis	Citywide access Intraurban variation Targeted access

an accessibility analysis for local planning are spelled out in detail. The steps are summarized in table 3.

Step 1

In the first step, there must be a determination of what the focus of the accessibility analysis is to be. To get to the analysis of pedestrian access there must first be a recognition that cities should be designed to accommodate a variety of transportation modes—walking, biking, private automobiles, and public transit—and that there is a significant value to evaluating pedestrian access as a specific focus. If this is accomplished, then pedestrian access can be used as the basis of the analysis, where other forms of movement—automobile or public transit—are excluded, because these measure a different dimension of urban life.

Step 2

Once the principles of pedestrian access are recognized and valued, the next step is to begin data collection of origins, destinations, and other characteristics delineated in tables 1 and 2. The availability of data may be decisive for many of the measurement factors listed. Fortunately for planners, digital data about urban pattern are becoming more available, although availability varies widely among cities. At a minimum, needed data consist of three types: locations and characteristics of origins (places of residence), destinations (for example, facilities, shops, or places of employment), and the routes between these. Specific data requirements under each of these categories is determined based on what factors listed in table 2 are deemed important (or obtainable) for the analysis.

As mentioned above, data on travel route characteristics, such as sidewalk availability, are important, but they are difficult to obtain for a multineighborhood study. Data on origins and destinations are essential. Data for origins will be based on whether parcel-level, block-level, or some other spatial level is deemed appropriate. Again, parcel-level data have the advantage of precision, whereas block-level data (or another, higher level, of aggregation) have the advantage of allowing the assessment of need to be made. If there is a view that access should be higher for those that are most in need of it, then census-based origins should be used. In keeping with the focus on pedestrian access, this means that the assessment of access for those who are not likely (or are less likely) to drive—children, the elderly, low-income residents, and those without cars—is the goal.

The determination of what the essential destinations should be is also part of the second step. Access should be evaluated either for one destination or for a diversity of urban opportunities. In neighborhood planning, important destinations are likely to be neighborhood-level facilities, that is, those that meet the requirements of daily life, as opposed to services or facilities that are needed only occasionally. Daily-life needs generally include parks, schools, and shopping areas. Employment destinations could also be used but are usually thought of as regional as opposed to neighborhood-level destinations.

Step 3

Once the data have been obtained, the distances between origins and destinations must be measured. There are several options available for computing the distances. First, if a street network is available, GIS software such as ArcView or ArcGIS can be used. In the case of ArcView, an ArcView extension can be run to compute distances between multiple origins and destinations (Neudecker, 1999). The procedure is very straightforward. In ArcView, the user is prompted to enter two coverages representing origins and destinations in addition to a network coverage consisting ideally of streets.

ArcInfo uses a different approach. In ArcInfo 8, the `NodeDistance` command can be used to compute distances between all points. The computational requirements are usually very large because, if parcel-level data are used, the number of origins and destinations will run into the thousands or, for larger cities, hundreds of thousands. However, the procedure itself is straightforward.

A third option is to use Spacestat software (Anselin, 1995), which computes distances between locations based on their latitude–longitude coordinates. With locational data inputted as an ascii file for two sets of points, Spacestat computes the distance between each origin and each destination by calculating either the Euclidean distance, the arc distance (in which the curvature of the earth is accounted for), or the Manhattan block distance (measured along a grid).

Step 4

Once the distances are computed, either along a street network or by using arc, Euclidean, or Manhattan-block distances, the access measure can be computed. Approaches listed in table 1 have different emphases (for a further elaboration of these different emphases, see Talen, 1998). For the purpose of using access as a measure of neighborhood service provision, 'coverage' and 'minimum distance' are probably the most appropriate. This is because the normative approach to pedestrian access essentially revolves around these two concepts of access: first, how far does one have to walk to reach a destination, and, second, how many urban opportunities are within walking distance? For the first question, minimum distance is measured between some point of origin (such as a block centroid) and the point location of the given facility. For the second question, a covering radius is drawn around the point of origin and the number of facilities within, for example, walking distance is determined. In both cases, nearest distance drives the analysis. Other approaches listed in table 1 emphasize either counts of facilities (for example, the 'container' approach) or total distance.

Step 5

Once access has been measured for a set of origins, it serves as an indicator that can be used to answer three main evaluative questions: How accessible is the city, overall? Who in the city has good access and who does not? Do areas with higher access need to have correspondingly higher access? The last two questions assume that the determination was made in step 2 that census units such as blocks, block groups, or tracts would be used as points of origin.

Citywide access

The first question to be answered is whether, in general, an urban environment is performing well in terms of pedestrian access: just how accessible are its blocks and neighborhoods to urban amenities and services? How well does the city measure up in terms of a minimum standard of access? Although many factors affect travel behavior, how supportive is the spatial structure to begin with? The answers to these questions provide an interesting basis on which to evaluate urban patterns.

Obviously, in order for such information to be meaningful, it is necessary to establish some standards against which the citywide access data can be evaluated. Lynch (1981) stressed the need to set minimum standards for access and to use a variety of measures that take into account population need and other factors. In terms of minimum standards, planners have been able to establish some general principles about the willingness and ability of residents to walk to their destinations. There is some variation, but the walking distance parameter is usually defined as $\frac{1}{4}$ to $\frac{1}{2}$ mile (CNU, 2000), depending on what the specific destination is (that is, the frictional effect of distance is less for certain destinations, and therefore people are willing to walk further for some types of uses).

In a GIS-based analysis in which the centroids of zones are used as origins, it may be prudent to allow some latitude for the minimum walking distance standard used. The reason is illustrated in figure 1. The figure shows that, although the distance between a parcel located at the perimeter of a block group and the nearest school may be less than $\frac{1}{2}$ mile (in the example shown, the distance is $\frac{1}{3}$ mile), the Manhattan block distance between the block group centroid and the nearest school may be 1 mile.

Figure 1. Block group centroid compared with parcel distances.

For this reason, in the case study presented in the next section, a more lenient distance measure of 1 mile is used (that is, in figures 4–6).

The application of standards is just one way to evaluate citywide access. There are at least three other approaches to assess how well a city is performing in terms of access:
1. By time: have the figures changed over time, and in what direction?
2. By place: how do the computed measures compare with those of other cities?
3. By population: how do the figures compare with the population needs of the city as a whole?

The third measure requires making some assessment of the accessibility needs of the population. This can be done, for example, by calculating the percentage of children, elderly, or poor in the area under study and making the assumption that, at a minimum, the percentage of accessible blocks should be similar to the percentage of the population that could be characterized as having a high need for access. This is a fairly basic representation, but it can be an effective way of beginning the task of evaluating access in a citywide sense.

Intraurban variation

The second main question has to do with intraurban variation—determining what kind of variation exists in access levels for different parts of the metropolitan area. The purpose of such an investigation is to identify areas with more or less access, such that relative comparisons of access can be made.

The question is fairly simple: How much overall variation in access is there? Even without considering population parameters, what kind of dissimilarity exists? Is it highly skewed in different directions, or is there an even distribution? What parts of the city fair better? This is not always intuitively obvious. For example, denser downtown areas would seem to offer the greatest access to retail facilities, but some densely populated inner-city areas lack essential retail services.

It makes sense for an evaluation of pedestrian-level accessibility to discuss neighborhood-level variation of access. By using the accessibility measures calculated in step 4, one can calculate a neighborhood accessibility index. An appropriate example is an index developed by Murray and Davis (2000), explained with use of the following notation:

τ_i is the neighborhood index, equal to the percentage of the block groups (area i) in the neighborhood having a minimum standard of access.

N_i is a set of neighborhoods l in area i;

λ_{il} is the proportion of population in the block group (area i) found in neighborhood l;

d is the distance between the block group centroid and the nearest park;

S is a minimum standard for access; in this case, 1 mile.

By using this notation, the index of neighborhood access can be defined as follows:

$$\tau_i = \sum_{l \in N_i} \lambda_{il} \mathrm{f}(\bar{d}_l, S) ,$$

where

$$\mathrm{f}(\bar{d}_l, S) = \begin{cases} 1, & \text{if } (\bar{d}_l \leqslant S), \\ 0, & \text{otherwise} . \end{cases}$$

The variable τ_i gives the proportion of the population in the neighborhood that is a minimum distance of 1 mile to the nearest park. In other words, one determines the percentage that a particular block group in a particular neighborhood contributes to the total population of the neighborhood. This percentage is included only if that block reaches the minimum standard, S, for access (within 1 mile). The summation produces an index measure.

Targeted access

The final question concerns 'targeted access' and essentially considers population access need in the evaluation of intraurban variation. Here, one asks, does access make sense? Specifically, do areas with a higher population needing access have correspondingly greater access to facilities? Presumably, areas with greater access would have populations with greater access need as the result of a self-selection process. But is this generally the case?

Lynch (1981) made the argument that access should vary according to population characteristics. In particular, confinement based on gender, age, and low income should be taken into account, such that the needs of women, children, the elderly, and low-income populations are accounted for. Ideally, the determination of need and the criteria on which it should be measured would be made during step 1, when the priorities of the accessibility study are being formulated.

Beyond the determination of variables to be used as indicators of need, weights could also be assigned. For example, planners and residents may decide that the lack of a vehicle is a more important indicator of access need than is household income. Construction of a need index involves determining what variables are to be used, whether the variables or indicators are equal in importance in determining a measure of need, and how the variables can be combined (either in a linear or in a nonlinear fashion).

A multivariate need index, $\mathit{\Phi}_i$ can be calculated as simply a linear function of a derived value for each need indicator (Murray and Davis, 2000). This can be formally expressed as follows:

$$\mathit{\Phi}_i = \sum_j w_j R_{ij} \, .$$

The variables are either weighted (represented here as w_j), or the indicator variables need to be transformed and standardized so that their linear combination makes sense. If weights are not used, as in this example, R_{ij}, a derived value, can be constructed based on where a particular value falls within a distribution. For example, each of the need variables could be arranged from high to low, corresponding to high need, low need, and so on (in the case of income, low income corresponds to high need). Each block group, for example, could then be assigned a score of 1, 2, 3, or 4, depending on where its value is located in the distribution. Interval values could be assigned in any number of classes and could be based on standard deviations, quantiles, natural breaks, and so on (see Murray and Davis, 2000).

Case study

Thus far I have presented a justification for the importance of access measurement and have laid out the methodological steps for its practical application in planning. In the remainder of the paper I present an example of how the evaluation of access in the context of local planning practice could take place.

The evaluation of access is demonstrated here with data for Portland, Oregon. Data were obtained on CD-ROM from Portland Metro, the regional planning organization for the Portland area that maintains detailed data available to the public for a minimal fee. To make the data requirements manageable but still maintain a sufficient amount of detail, only locations in Multnomah County, in which the downtown area is located, were used.

In table 4 summary information is provided about which of the parameters listed in table 2 were selected for the case study. With 'minimum distance' selected as the measurement approach, the measurement factors included: housing units by block

Table 4. Accessibility measurement variations: factors used in the case study.

Factor	Description
Origins	Location: block group centroid Type: housing unit Attributes of individuals at origins: census block group data
Destinations	Location: facility centroid Type: parks, schools, stores
Mode of travel	Pedestrian Bike
Distance calculation	Manhattan block

Note: the measurement approach taken was to determine the minimum distance (that is, to measure the distance between the point of origin and the nearest facility).

group (as the origins); parks, schools, and stores as the destinations; pedestrian and bike travel as the assumed mode of travel; and a distance calculation based on the Manhattan block distance (the approximation of a street grid). The primary purpose of the case study is to demonstrate the methodology; thus it should be recognized that a number of important variables not included—such as the quality of the destination or the quality of the route—may be important to include in other contexts.

In figure 2 the geographic boundaries for the elements in the GIS that were used for the analysis are shown. The origins, for which access is calculated, consisted of 499 census block group centroids. The destinations, which included stores, schools, and parks, are also shown in figure 2. The data for these facilities were more detailed than the census block groups and were composed of 3267 parcel centroid locations. The original source of these data was the Multnomah County tax assessor's office.

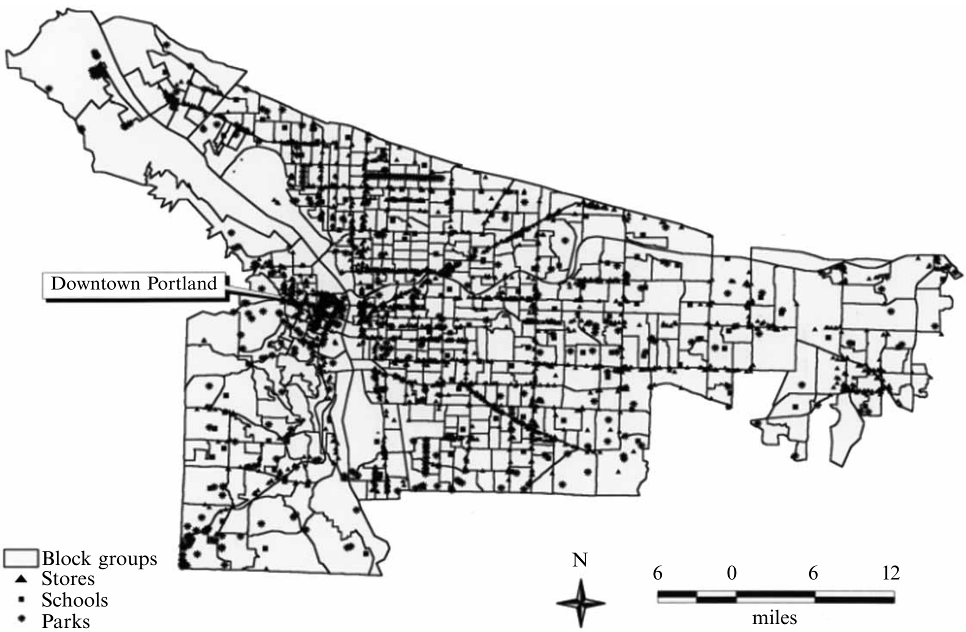

Figure 2. Block groups and facilities, Multnomah County.

The parcel-level destination data were pared down in several ways. First, only elementary schools were used, which resulted in a total of 117 schools. For parks, only neighborhood-type parks were included in the analysis—regional parks, golf courses, amusement facilities, and similar large-scale facilities were excluded. Thus a total of 345 parks were included in the dataset. Last, all parcels that could be identified as 'stores' were selected for the analysis, which resulted in 2805 locations. All three destinations—schools, parks, and stores—were represented as point locations. Other than location and type of facility, no other attribute information for these destinations was used.

For the 499 census block groups, some attribute data were obtained from the 1990 census to characterize access need. These variables, specifically, were: percentage of population aged under 18 years, percentage of population aged over 65 years, median household income, and percentage of occupied housing units with no vehicle available. These four variables were combined to derive an access need index, as described above.

In this case study, measures were calculated for two spatial units: for individual block groups and for neighborhoods as a whole. The delineation of neighborhood boundaries can be approached in an almost infinite number of ways. The approach taken here was to select two spatial levels: a smaller census boundary (the block group) and the neighborhood boundaries used by planners in Portland. Specifically, the boundaries of ninety-one neighborhoods in Multnomah County were obtained from Portland Metro, and are based on neighborhood planning information from the City of Portland. Block groups are more arbitrarily defined and serve as a basis for comparison with the more formally defined neighborhoods used by Portland planners. The advantage of using block groups as one definition of neighborhood is that data are readily available for each spatial unit. To obtain sociodemographic information for the neighborhood, data from the block groups, apportioned according to the neighborhood within which the groups were located, were summarized.

In terms of analytical tools, two software packages were crucial for the analysis. First, Spacestat software (Anselin, 1995) was used to calculate distances and compute the access measures for the block group centroids. In this case, the access measure consisted simply of determining the minimum distance for each origin to the nearest park, school, or store. Second, ArcView GIS software was used to compute the neighborhood access and access need indices, as well as to produce the visual maps for the output.

In tables 5 and 6 I give examples of the kind of information that can be obtained simply by listing some basic access statistics. In table 5 I list the number of block groups as well as households that are within three minimum distance standards (1 mile, $\frac{1}{2}$ mile, and $\frac{1}{4}$ mile) to the nearest park, school, or store.

Table 5. Citywide access statistics for block groups and households. Total number of block groups = 499; total number of households = 234 940 (source: Portland Metro, 1994). Figures in parentheses are percentages.

Facility	Within one mile of facility		Within $\frac{1}{2}$ mile of facility		Within $\frac{1}{4}$ mile of facility	
	block groups	households	block groups	households	block groups	households
Park	163 (33)	81 375 (35)	55 (11)	25 145 (11)	26 (5)	10 785 (5)
School	119 (24)	51 995 (22)	33 (7)	15 268 (6)	8 (2)	2 410 (1)
Store	355 (71)	152 517 (65)	167 (33)	69 833 (30)	55 (11)	23 055 (10)

Table 6. Citywide access statistics for neighborhoods. Total neighborhoods = 91; total block groups = 441 (source: Portland Metro, 1994). Figures in parentheses are percentages.

Facility	Neighborhoods[a]
Park	27 (30)
School	15 (16)
Store	61 (67)

[a] Number of neighborhoods that have 50% or more block groups that meet minimum access standard.

In table 6 an assessment of proximity according to neighborhood boundaries is made, giving the number of neighborhoods that have 50% (or more) of their block groups (that is, the block groups within their boundaries) within the minimum distance standard for access. In this analysis, 441 block groups are used because not all the 499 block groups included in table 5 fall within the boundaries of an established neighborhood. It can be seen from table 6 that 30% of Portland's neighborhoods have at least half their block groups within the minimum distance standard for parks (in this case, 1 mile), 16% of the neighborhoods meet this standard for schools, and 67% for stores.

The information in tables 5 and 6 gives an initial impression of access in Portland: the population has much higher access to retail facilities than it has to parks and schools, largely a function of the much greater incidence of store locations, and access is relatively low for parks and schools for most of the population. But this information needs to be compared with other statistics to make it meaningful. For example, it would be useful to compare this information with that for a number of different cities, or for more than one time period. Alternatively, the percentage of block groups and neighborhoods that have high access needs according to population characteristics could also be compared.

Figure 3 (see over) consists of three views of the County that can be used to compare intraurban variation, in which block groups with a minimum standard of 'good' access to parks, schools, and stores are revealed. The figure corresponds to the data presented in table 5. In figure 3, 'good' access uses the standard of $\frac{1}{2}$ mile, and it can be seen that, especially in the case of parks and schools, relatively few block groups meet this standard.

Figures 4 and 5 (see over) are maps showing the intraurban variation of access to parks in Portland with use of a 1 mile minimum distance standard. Maps can be produced for all facilities combined into one access measure (that is, the sum of the minimum distance between each block group centroid and the closest park, school, and store), but distance to parks was selected here (and for the remainder of the figures in this case study). Also, because these are choropleth maps showing the quantile distribution of a variable, the shading conforms to standard cartographic procedure in which darker shading represents a higher number (in this case, greater distance and thus lower access).

In figure 4 it can be seen that areas immediately to the east and west of downtown have lighter shading, shorter distance to parks, and thus greater access to parks. In areas further out from the downtown, in the southeast and far eastern sections of the city, for example, block groups have less access to parks, but there is also a fairly high level of variation. It is not difficult to pick out clusters of block groups that appear to have relatively less access (greater minimum distances).

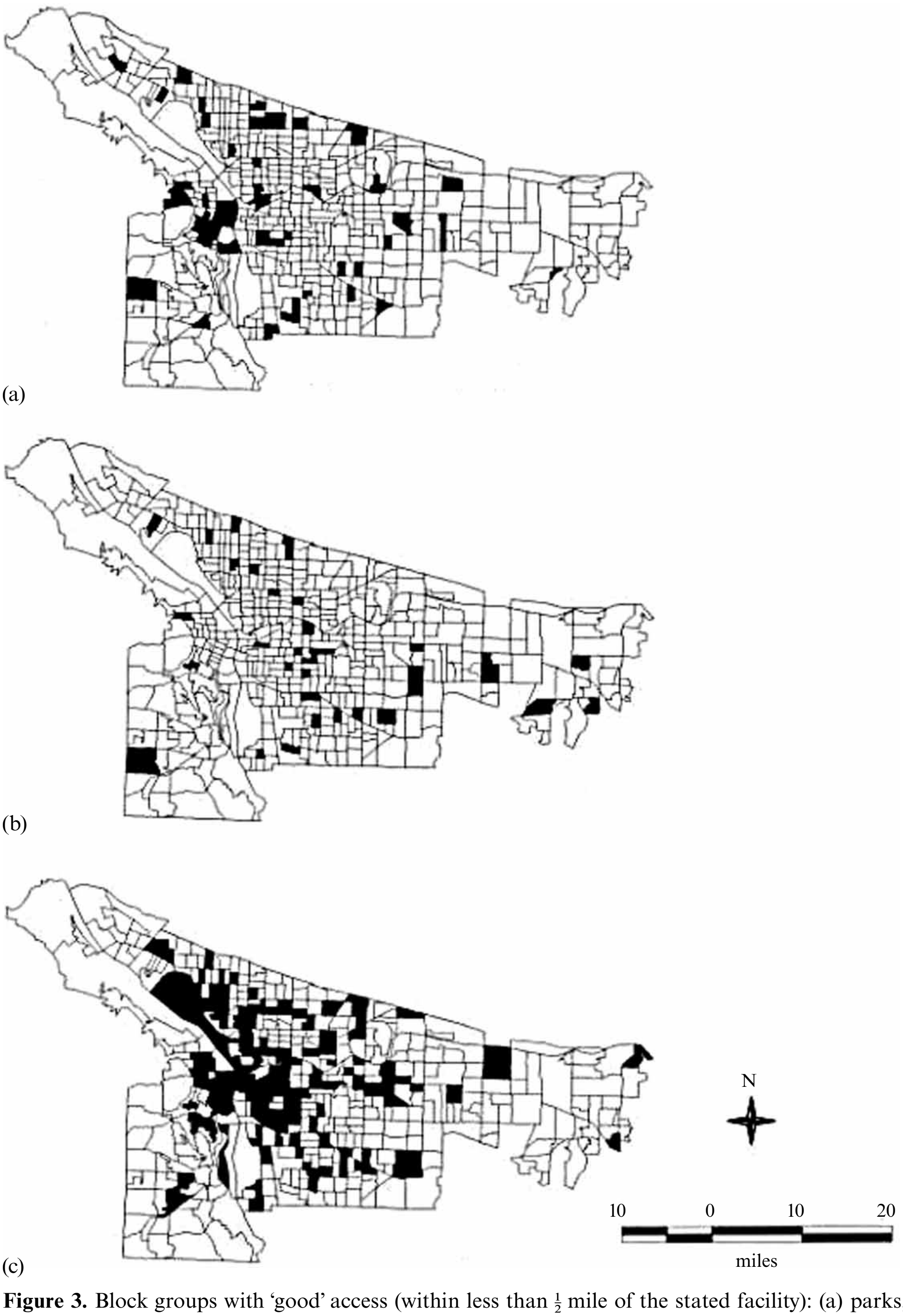

Figure 3. Block groups with 'good' access (within less than $\frac{1}{2}$ mile of the stated facility): (a) parks, (b) schools, and (c) stores.

Figure 4. Minimum distance to the nearest park, in quartiles, by block group.

Figure 5. Neighborhood access index. Note: darker shading indicates lower access.

The case has been made that it may be more in keeping with local planning practice to discuss access variation in terms of neighborhood-level variation. In figure 5 I present an evaluation by neighborhood based on the construction of an index, as outlined above. The map can be used to evaluate intraurban access variation between different neighborhoods. The map shows that neighborhoods in the southwest, north, and northwest have relatively low levels of access.

The following criteria were used to determine need:
percentage of population aged under 18 years,
percentage of population aged over 65 years,
median household income,
percentage of occupied housing units with no vehicles available.
The index of need for each block group was obtained by summing its derived value (an assignment of 1 – 4, depending on where it fell in the distribution) for each of the four indicator variables. In figure 6 the output from this summation process is shown. In the southwest section of the city, blocks tended to score low on one or more indicator variables and thus have a low need score. Blocks to the north and southeast of the downtown tended to score higher, and their combined scores reflect a high access need.

In figure 7 the way in which the information in figures 4 and 6 can be combined to select specific areas in the city where access is low and access need is high is shown. This, again, is a relatively straightforward procedure, except that the parameters for making the selection of block groups is open-ended. In the example in figure 7, there are twelve blocks in the city that score in the top quartile for both minimum distance (the access measure) and access need (the combined score). If different cutoff points are used, more or fewer blocks would be highlighted. One strategy may be to determine ahead of time how many block groups should reasonably be selected and then to determine the threshold levels that produce the desired number of selections. In the example in figure 7, twelve out of 499 blocks fit the criteria.

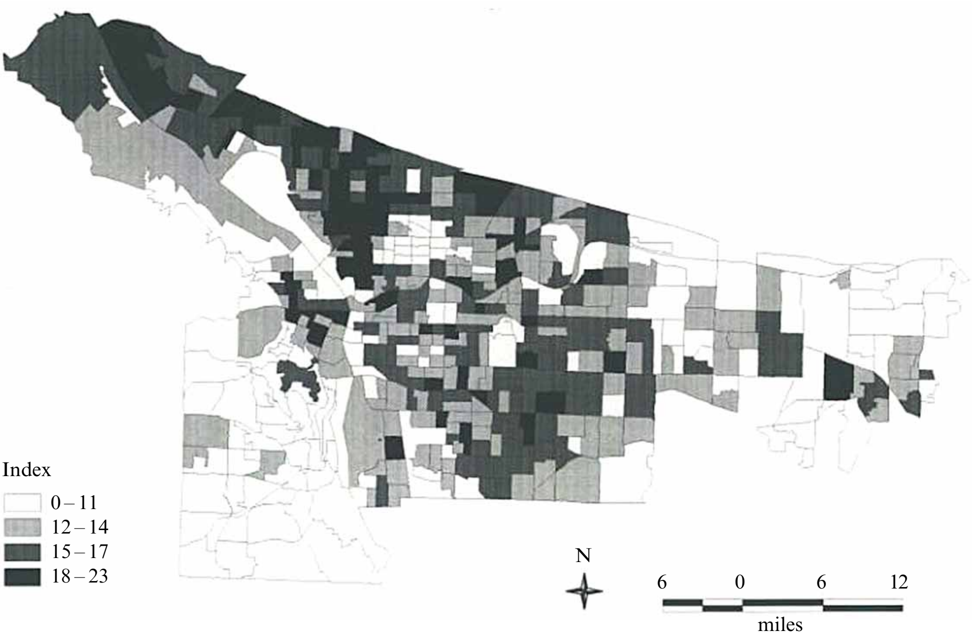

Figure 6. Need index, by block group, in quartiles. Note: darker shading indicates greater need, based on age, income, and vehicle availability.

A final approach in the analysis of targeted access is to combine the access need scores for block groups into a neighborhood measure. The need index for each of the ninety-one neighborhoods is shown in figure 8. The process is the same as that demonstrated for figure 5, with different parameters, thus representing a kind of sensitivity analysis of access evaluation. For the determination of need, in which the block group score is multiplied by '1' or '0', the cutoff used was a combined need score of 14. This is

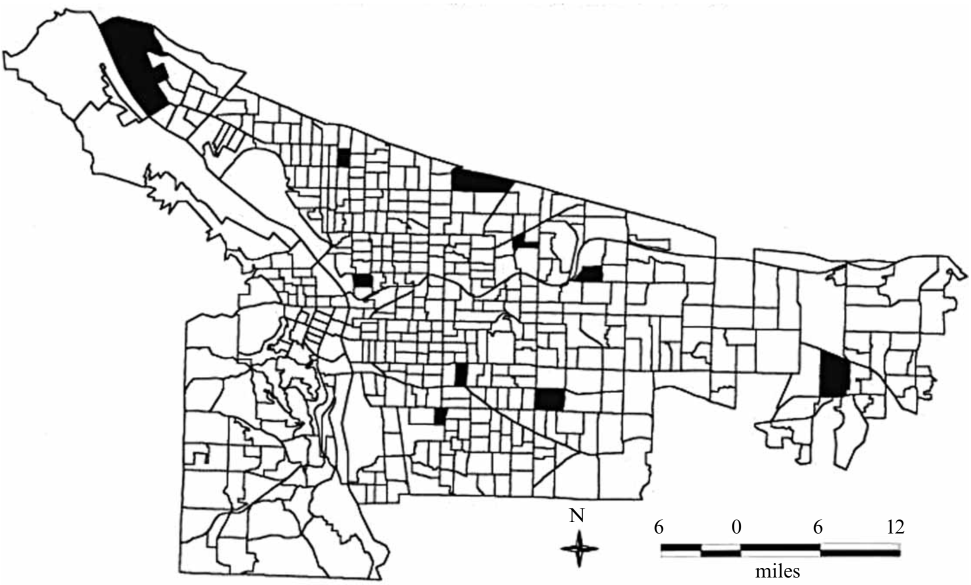

Figure 7. Block groups with high need and low access: shaded blocks.

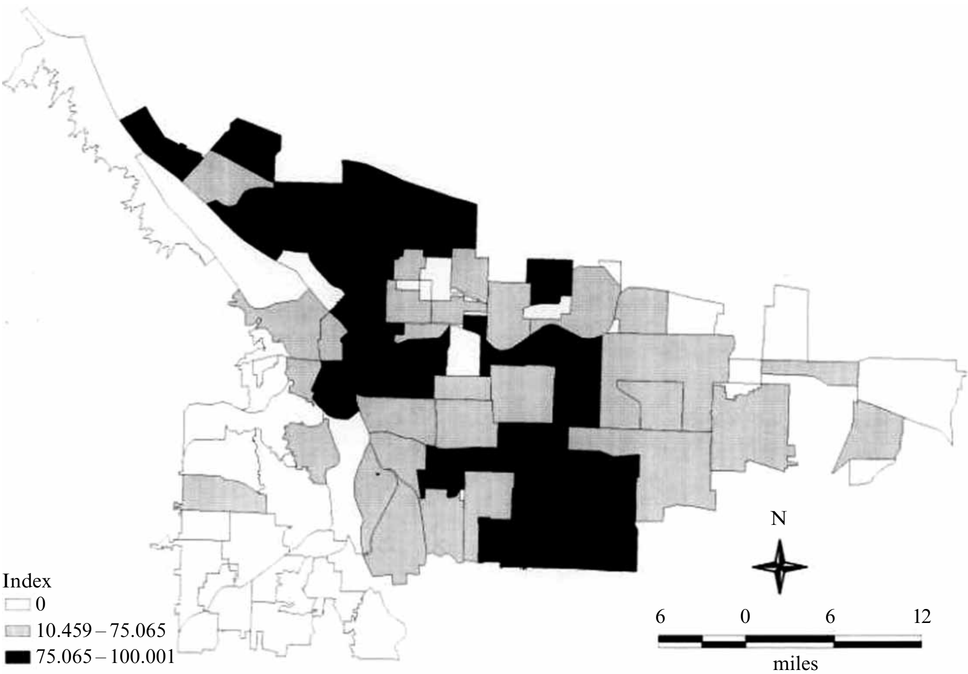

Figure 8. Neighborhood need index. Note: darker shading indicates greater need, based on age, income, and vehicle availability.

the median point in the summed scores when using the four indicator values listed above. The percentage population that each block group contributes to a particular neighborhood is therefore added to the total score (that is, multiplied by 1) if it is in the top half of the distribution of need variables. If its total need score is in the bottom half of the distribution, it is multiplied by 0 and is therefore not counted. This is simply one approach; again, the cutoff criteria can be changed to result in a different number of neighborhoods in each category of need.

Although each neighborhood therefore received a need index score, the mapped distribution shown in figure 8 simply categorizes these scores into three classes. It can be seen that neighborhoods in the southeast, east of downtown, and northwest have the highest access need. This is not dissimilar to the characterization of the data reflected in figure 6; it simply, perhaps, structures the data in a way that is more meaningful to the planning process.

The need index by neighborhood can then be combined with the neighborhood access scores shown in figure 5 to determine a final planning outcome: the determination of specific neighborhoods that have high need and low access. The four selected neighborhoods shown in figure 9 scored in the top category in figure 8 (that is, they were in the high-need category) and at the same time scored in the top category of the minimum distance map (figure 5; the higher the distance, the lower the access). Again, more neighborhoods could be selected by changing the cutoff criteria and other parameters.

If resources are limited, as they usually are, and if access to urban amenities and services is deemed valuable, then the information contained in figure 9 should be of value in the local planning process. For these four neighborhoods it has been demonstrated that the population is likely to have greater need for pedestrian access to services relative to other parts of the city, and, at the same time, that the existing distribution of urban services is relatively low.

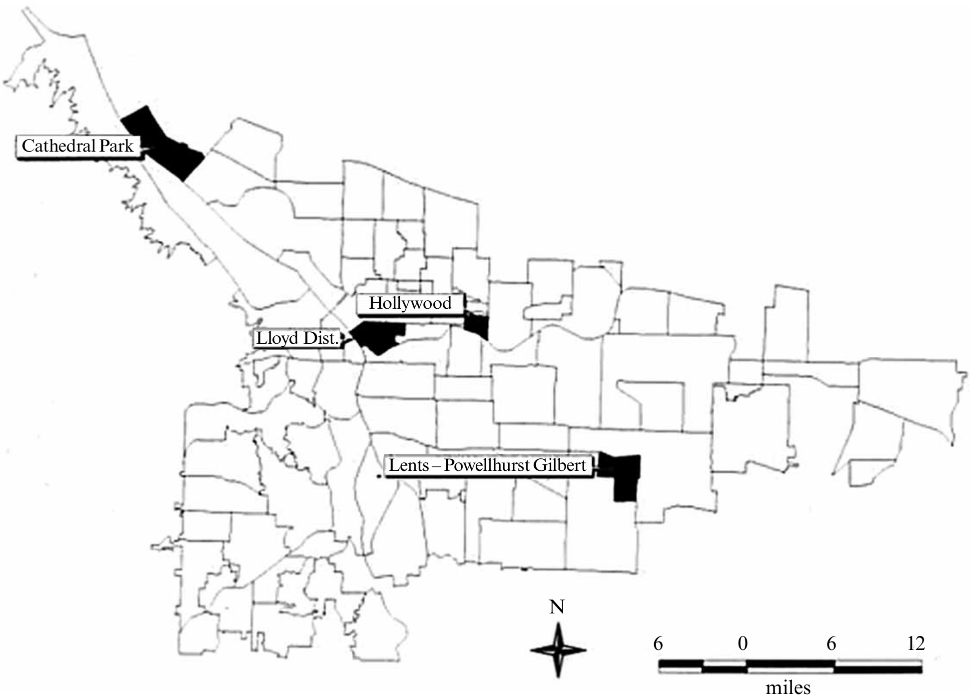

Figure 9. Neighborhoods with high need and low access (shaded blocks). Note: Dist., District.

Conclusions

The physical design of cities and neighborhoods affects quality of life in significant ways: in particular, access to facilities profoundly affects the poor, the immobile, and children. However, it is doubtful that planners spend much time evaluating neighborhood-level access. The City of Portland, considered to be an exemplar of planning practice in the USA, is a case in point. The city's Parks and Recreation Department recently completed an extensive survey and 'vision plan' for Portland parks and recreation (PPR, 2001). This impressive document includes detailed analyses of land holdings, recreation facilities, program offerings, and funding, but the plan does not include any kind of analysis of the degree to which neighborhood residents are able to walk to neighborhood-level parks, other than an accounting of the total number of park acres that exist in subsections of the city.

Given the importance attached to neighborhood-level access in urban areas, planners should be well versed in evaluating, planning for, and promoting pedestrian access, yet the concept has not received much attention in practice or in planning scholarship. Lack of practical application of accessibility measures may be a result of conceptual complexities, extensive data requirements, and demanding computations. This situation is changing rapidly, however. In this paper, I have demonstrated how an evaluation of neighborhood-level access to services can readily be made with a GIS of origins, destinations, distances, and corresponding attribute information.

As with any analysis that attempts to quantify neighborhood quality of life, there are limitations as to what the method can achieve. To begin with, there are practical limitations related to data quality and data acquisition. More philosophically, some may object to the top-down, technicist appraisal of neighborhood quality. Although it is likely that there will always be issues related to data quality and acquisition, the limitation based on technical orientation can be kept in check by acknowledging that the analysis constitutes an input to the planning process, not an output. It is meant to be a form of exposure, an uncovering of one aspect of quality of life—the provision of neighborhood-level services.

Toward that goal, a series of maps as produced in this analysis can be a very effective planning tool. If planners and neighborhood residents are concerned about access to services, planners should be able to make a comparative appraisal about which neighborhoods in fact have relatively long distances to travel to reach needed services, and which neighborhoods do not. Most importantly, they should be able to make intelligent recommendations about which neighborhoods are in need of better access to facilities relative to population needs. This constitutes a basis for action. Planners and residents should be able actively to seek development where it is most needed. By providing a nonarbitrary evaluation of relative deficiency and need it may be possible to target the development of needed facilities in a more proactive way.

References

Anselin L, 1995 *SpaceStat Version 1.90* (University of Illinois at Urbana-Champaign, Champaign, IL)

CNU, 2000 *Charter of the New Urbanism* Congress for the New Urbanism (McGraw-Hill, New York)

Duany A, Plater-Zyberk E, 1991 *Towns and Town-making Principles* (Rizzoli, New York)

Dueker K J, 1996, "Neotraditional design: resisting the decentralizing forces of new spatial technologies", in *Spatial Technologies, Geographic Information, and the City* Ed. H Couclelis (National Center for Geographic Information and Analysis, Santa Barbara, CA) pp 56 – 58

FDT, 1993, "Walkable communities: twelve steps for an effective program", Florida Department of Transportation, State Safety Office, 405 Suwannee Street, Tallahassee, FL 32 399-0450, http://www.sustainable.doe.gov/pdf/walkable.pdf

Handy S L, Niemeier D A, 1997, "Measuring accessibility: an exploration of issues and alternatives" *Environment and Planning A* **29** 1175 – 1194

Hanson S, Schwab M, 1987, "Accessibility and intraurban travel" *Environment and Planning A* **19** 735 – 748

Harvey D, 1997, "The new urbanism and the communitarian trap" *Harvard Design Magazine* Winter/Spring, number 1, pp 1 – 3
Jacobs A, Appleyard D, 1987, "Toward an urban design manifesto" *Journal of the American Planning Association* **53** 112 – 120
Jacobs J, 1961 *The Death and Life of Great American Cities* (Vintage Books, New York)
King G, 1997 *A Solution to the Ecological Inference Problem* (Princeton University Press, Princeton, NJ)
Kwan M-P, 1999, "Gender and individual access to urban opportunities: a study using space – time measures" *The Professional Geographer* **51** 210 – 227
Levine J, 1998, "Rethinking accessibility and jobs – housing balance" *Journal of the American Planning Association* **64** 133 – 149
Lucy W, 1981, "Equity and planning for local services" *Journal of the American Planning Association* **47** 447 – 457
Lynch K, 1981 *Good City Form* (MIT Press, Cambridge, MA)
McLafferty S, 1982, "Urban structure and geographical access to public services" *Annals of the Association of American Geographers* **72** 347 – 354
Murray A T, Davis R, 2000, "Equity in regional service provision", working paper, Ohio State University, Department of Geography, Columbus, OH
Neudecker K, 1999, "Shortest network paths", ArcView Avenue Script, http://arcscripts.esri.com/
Pacione M, 1989, "Access to urban services—the case of secondary schools in Glasgow" *Scottish Geographical Magazine* **105**(1) 12 – 18
PPR, 2001, "2020 vision plan", discussion draft, Portland Parks and Recreation, 1120 SW 5th Avenue,Portland, OR 97204
Talen E, 1998, "Visualizing fairness: equity maps for planners" *Journal of the American Planning Association* **64** 22 – 38
USDT, 1992, "Reasons why bicycling and walking are and are not being used more extensively as travel modes", US Department of Transportation, Federal Highway Administration, Washington, DC
UQC, 1999 *Urban Quality Indicators, Issue 14* (Urban Quality Communications, Ann Arbor, MI)
Wekerle G R, 1985, "From refuge to service center: neighborhoods that support women" *Sociological Focus* **18**(2) 79 – 95