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COMMUNITY-BASED ORGANIZATIONS AND NEIGHBORHOOD ENVIRONMENTAL PROBLEM SOLVING: A FRAMEWORK FOR ADOPTION OF INFORMATION TECHNOLOGIES

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Abstract *Community-based organizations (CBOs) today seek improved capacity to address environmental problems in urban neighbourhoods. Many seek access to information technologies such as the Internet and Geographic Information Systems (GIS) to expand information about their neighbourhood's environmental quality to support their planning and service efforts. Experience with the Internet has been bolstered somewhat by programmes to create community networks. This experience and experience with GIS in planning at the municipal and state levels reveals a set of technical, organizational and personal prerequisites that bolster successful and effective adoption of information technologies. This paper reviews these prerequisites as they pertain to CBOs and makes recommendations for transactions that could enhance CBO adoption of the Internet and GIS to address environmental problems in urban neighbourhoods. The paper concludes that a constellation of prerequisite conditions, most predominantly data availability problems, staff skill acquisition and staff retention problems, offer the greatest challenges for CBOs seeking to adopt information technologies to manage environmental problems more effectively.*

Introduction

Two recent trends portend the need for environmental planners and managers to focus on the role of community-based organizations and citizens in resolving urban environmental quality problems: a continuing devolution in the locus of environmental management from the federal or national level toward the local level; and the revolution in information technologies. The locus for environmental planning and policy has devolved from the federal and state level toward the local level in the US, particularly over the last two decades (Hamilton, 1990; Beach, 1993; National Association of Environmental Professionals (NAEP), 1996). Several recent federal environmental initiatives seek increased participation from local levels—including government, non-governmental organizations, and citizens—in environmental management programmes and include a focus on increasing local access to environmental information. For example, the US Environmental Protection Agency's (USEPA) Community-based Environmental Protection (CBEP) initiative is designed to encourage participation in environ-

mental management at the local level (USEPA, 1997). USEPA has also begun several regional initiatives that provide information to bolster local participation in actions to address urban sprawl, provide real-time air quality data to increase citizen awareness of automobile emissions, and offer local data on watershed function to encourage citizen participation in watershed management programmes.

Given this devolutionary trend, the role of community-based organizations in environmental management becomes more important. Citizens and their community-based organizations welcome increased access to information and seek the capacity to use that information so they can address their high-priority environmental problems more effectively and participate in decisions that will affect environmental conditions in their communities (Sawicki & Craig, 1996). Community-based organizations offer the best opportunity to bridge the gap between federal and state environmental agencies and citizens because they have strong ties with neighbourhood residents and understand the neighbourhood's assets and needs (Forester & Krumholz, 1990; Keating *et al.*, 1996).

Simultaneously, the revolution in information technologies (IT) in the last decade, particularly the development and diffusion of higher-capacity 'personal' computers, has dramatically changed the way information can be disseminated by environmental agencies in their role as data providers. Environmental regulatory and planning agencies have long been required to provide information to the public,[1] but are often limited by resource and staff constraints and have been uncertain what can be done to best suit the needs of community organizations and citizens (Skowronski, 1997). Public information managers in government agencies are today adopting information technologies (Naisbitt, 1994) as a way to provide information to citizens, the regulated community, other government agencies and advocacy organizations (Coder, 1997).[2]

Two information technologies in particular, the Internet and Geographic Information Systems (GIS), have potential to change the role of the public and their community organizations in environmental decision making as well. The growth of the Internet in its many forms now gives people greater access to an increasing variety of information. Powerful software programs such as GIS can enhance data storage and analytical capacity to understand and manage environmental problems more effectively. Of concern, however, is whether the information technology revolution is passing by urban neighbourhoods (Ramasubramanian, 1995; National Center for Geographic Information and Analysis (NCGIA) 1996; Benton Foundation, 1998). The potential of IT to enhance access to, and effective use of, information is particularly critical for low income and minority communities seeking to address environmental quality concerns. Some evidence suggests that residents in these communities tend to be exposed to more pollutants because they live closer to ageing industrial plants, near or on contaminated land, and in degraded structures (Bullard & Wright, 1992). These communities also traditionally have fewer resources to access and use scientific and technical information (Lee, 1992).

This paper explores the role that GIS and the Internet can play to increase the effectiveness of community-based organizations (CBOs) working in low income, urban neighbourhoods on environmental issues. Can community-based organizations use information technologies to overcome traditional impediments to information access, create new opportunities for broadened participation in science-intensive environmental decision making that affects urban neighbour-

hoods, and use information technologies to have more influence over decision-making processes that affect them (Ramasubramanian, 1995)? Our purpose is to develop a framework by which to assess the obstacles to and opportunities for successful adoption of the Internet and GIS by community-based organizations as they seek better access to, and more effective use of, the environmental information provided by government agencies and other information organizations.

Community-based Organizations, the Urban Environment, and Information Technologies

Community-based Organizations and Neighbourhood Environmental Problems

Community-based organizations (CBOs) are non-profit organizations that operate in urban neighbourhoods to benefit neighbourhood residents and address their concerns. CBOs typically serve a relatively small geographic area, tend to have a small full-time staff and often depend on neighbourhood volunteers for programme delivery.[3] CBOs are characterized foremost by their close working relationship with neighbourhood residents and block-based organizations.

CBOs have a long history in the US, beginning in the later 19th century, and have consistently worked to improve living conditions in America's poorer, urban neighbourhoods (Silver, 1985). The early organizations included settlement houses, school co-operatives, playground advocates and public health organizations (Davis, 1983). Today, community-based organizations also include community development corporations, small business associations, affordable housing coalitions and social service providers. These thousands of organizations address the social, economic and physical aspects of community development and include crime mitigation, housing rehabilitation, maternal and infant health care, youth programmes, job training, tenant advocacy, recreational activities, small business assistance and neighbourhood planning in their activities (Keating *et al.*, 1996).

The role of community-based organizations has grown in importance over the last several decades as the US Federal Government has devolved responsibility for implementation of many programmes that address urban problems to the local, sub-municipal and neighbourhood level (Wilson, 1991). City governments often view community-based organizations as a useful and even preferred vehicle for service delivery and citizen participation (Keating *et al.*, 1998). In many cities, CBOs have assumed many of the service delivery, educational and technical assistance responsibilities in neighbourhoods with limited resources (Ramasubramanian, 1995). The devolution of federal and state environmental programmes may follow a similar path if community-based organizations enhance their capacity to address environmental problems.

By and large, community-based organizations have not tended to focus on what had been labelled 'environmental' problems by the traditional environmental advocacy community. CBOs, however, do have a long history of addressing quality of life issues such as unhealthy housing conditions, children's health and contaminated vacant lots, which have now been redefined as 'environmental' problems in the broader environmental community. Today, many community-based organizations seek information about environmental hazards and assets that affect residents' health and quality of life (Heiman, 1997). While their

knowledge and skills in environmental issues may not be yet fully developed, community-based organizations can be the best locus from which to begin environmental problem solving because they can more easily identify strategies appropriate for a given community, as they have previously done in non-environmental activities (Keating *et al.*, 1996).

Community-based Organizations and Information Technologies

By information technology (IT) we mean the devices and systems designed to transfer information through telephone, fibre optics lines or airwaves, the computer hardware that receives and stores the information transferred, and the computer software programs and data storage devices that facilitate such transfer and allow the recipient to use and analyse data to create information for a specific purpose. We focus in this paper on the Internet and Geographic Information Systems (defined below).

The use of information technologies is given great potential for overcoming impediments to information access (Naisbitt, 1994; Negroponte, 1995). However, great uncertainty exists about whether these technologies can be adopted in ways that empower traditionally disenfranchised citizens and their community-based organizations (Ramasubramanian, 1995; NCGIA, 1996). An equally likely scenario, based on past experiences with more traditional information resource access, is that inequality in accessing information via the Internet and using powerful software such as GIS will lead to increased social polarization (Castells, 1989). It appears that information technologies have only begun to counter that tradition in a small way.

A search of both Internet-based literature and more traditional outlets for scholarly research reveals dozens of articles on the need to bring IT to inner city, urban, poor and low income neighbourhoods. The preponderance of these articles and reports focus on community use of the Internet. Recent US federal studies of the use of computers reveals significantly lower frequencies of household computer possession and on-line access among central city residents and among households whose income is less than $25 000. Among households with both these characteristics, less than 10% have on-line service (National Telecommunications and Information Administration (NTIA), 1997a).

The US federal Telecommunications and Information Infrastructure Assistance Programme (TIIAP) projects have made funding available for development of community information technology networks, reflecting the Federal Government's assessment that urban and poor communities were not receiving equal access to the IT revolution (NTIA, 1997b, 1997c).[4] A recent study of community IT networks describes their benefits for urban neighbourhoods, including increased user participation in political activities, increased access to education and enhanced community development (Avis, 1998). Despite federal programmes and the apparent success of some community networks, concerns persist that low income central city residents are becoming an 'information underclass' at the same time that the Federal Government is asking individuals and communities to become more self-sufficient (NCGIA, 1996; Benton Foundation, 1998).

GIS, or Geographic Information Systems, are computer software applications that integrate one or more spatially-referenced databases with a computer-generated map. Use of GIS in public-sector decision making has increased

dramatically as thousands of cities, counties and states have adopted GIS in the last 20 years to address a variety of urban issues (Levine & Landis, 1989; Harris & Barry, 1993). Agencies adopting GIS expect, and in many cases have found, that its use improves organizational efficiency (cost reduction, improved productivity, better customer service) and effectiveness (improved decision support, better planning analysis) (Eason, 1988; Wiggins & French, 1991; Budić, 1994).

CBOs could use GIS for similar purposes, albeit for a smaller geographic territory. To be effective in creating and sustaining environmentally healthy neighbourhoods, CBOs need access to information about use of resources and quality of life conditions (Andranovich & Lovrich, 1996; von Hagen & Kellogg, 1996). Mapping key community assets and environmental conditions can be an important step toward empowering the community to participate more effectively in decision making (Fischer, 1994; Bertrand & Mock, 1995). CBOs in urban neighbourhoods provide information and assistance to residents, collaborate with neighbourhood-based organizations and carry out revitalization programmes that change the built and natural environment. In the course of this varied set of activities, they need information that could be inventoried, mapped and analysed using GIS. CBOs would benefit from easily-accessed information about: the location of vacant parcels that become dumping areas; leaking underground storage tanks; storage of hazardous materials at neighbourhood industrial facilities; hazardous waste transfer routes through the neighbourhood; older housing at risk because of lead pipes and paint; lots appropriate for community gardens and greenspaces; and discharges of pollutants into air and surface water. These conditions affect neighbourhood residents at the micro-scale, block by block, and parcel by parcel.

The need for mapping this smaller geography, particularly because of the disconformity of planning boundaries with environmental agency data organization, is where GIS offers its great potential for community-based organizations. The technology offers the capability to reconfigure boundaries and reassemble data attached to points or geometric areas to generate and analyse data for a particular geographic territory (Wiggins & French, 1991). Such reconfiguration could become easier if a greater variety and amount of environmental data were available over the Internet. A recent essay suggests that community-based organizations are best suited for structuring information access systems to meet the needs of low income communities (Miller, 1994).

We asked then how relevant, appropriate and possible it is for CBOs to invest the time and resources to develop the skills needed to adopt the Internet and GIS into their environmental problem solving activities? What obstacles would such organizations face in adopting the Internet and GIS? What conditions are needed to support adoption? What transactions could satisfy these conditions? These questions guided our project.

Theoretical Framework: Adoption of Technological Innovation

Adoption of an innovation is generally a complex, iterative, and often messy process where one or more of the following happens: the organization clarifies the potential of the innovation for its purpose and operation; the use of the technology is redefined by organization members to accommodate the organization's needs and structure more closely; the organization routinizes the innovation's use into the functional activities of the organization; and the organization itself changes to accommodate the new technology (Rogers

& Shoemaker, 1971; Rogers, 1983, 1993; Campbell, 1996). Adoption of new technology is a social process of organizational and human changes as much as one of artefact design innovation (Bijker *et al.*, 1990; Innes & Simpson, 1993) resulting from the "interaction between the technology itself and potential users within particular cultural and organizational contexts" (Campbell, 1996, p. 31).

Accordingly, we expect that presence or absence of a constellation of technological, organizational and personal prerequisite conditions will affect the degree to which CBOs, as organizations with unique contextual conditions and cultures, can successfully adopt Internet and GIS technologies. To the extent that these prerequisites are satisfied, the organization will more easily adopt a new technology. Successful adoption may also depend on a constellation of transactions, defined as changes in or to the organization initiated from within or from its environment, that will satisfy the prerequisite conditions (Stake, 1967; Ingram, 1989).

The Nature of Technical, Organizational and Personal Prerequisites

By technical prerequisites we mean those associated with the computer artefact, its operating systems, the means by which it is linked to other computers and sources of information, the availability of relevant data and the software systems used for data manipulation and communication. By organizational prerequisites we mean the structural and functional characteristics of the organization such as its dominant culture, its mission or purpose, and the operational routines that shape the management of information and transfer of knowledge within the organization. By personal prerequisites we mean the human skills, knowledge and attitudes that facilitate or impede use of the technological artefact (Nedovic-Budić & Godschalk, 1996),[5] the "knowledge and practices necessary to transform the capabilities of artefacts into useful outputs" (Innes & Simpson, 1993, p. 231). Such knowledge and practice is a product of both personal and organizational qualities, which are sometimes better predictors of the successful adoption of an innovation than any qualities of the artefact itself (Department of the Environment, 1987; Innes & Simpson, 1993). These prerequisites are discussed in detail below and are summarized in Table 1.

The remainder of this paper lays out a framework for understanding the importance of these prerequisites for community based organizations seeking to use IT to improve management of environmental quality concerns in their neighbourhoods. First, we describe prerequisite conditions that have supported adoption of GIS and other information technologies. We look to the academic literature on adoption of innovations and to the professional literature on the experiences of planning and other government organizations for guidance. We also discuss US federal experiences in funding community computer networks.

Second, we ask to what extent are CBOs likely to exhibit these prerequisites? The answer to this question lies in part in the nature of community-based organizations, their current activities, and the activities they now seek regarding environmental quality management. We identify the adoption prerequisites likely to present the greatest challenge and support to CBOs. We draw on several years of community-based work with several CBOs in Cleveland, a study of Ohio CBOs and the US national information on community networks in TIIAP and other programmes. (See Appendix for a more detailed description of data sources for this paper.) Finally, we identify the transactions that likely will

Table 1. Prerequisite conditions supporting successful adoption of IT/GIS

	Relevant literature
TECHNOLOGICAL PREREQUISITES	
Equipment	
Adequate computer equipment	Department of the Environment, 1987; Gallagher, 1992
Resources for maintenance and upgrades to equipment and software	Gallagher, 1992
Electronic data retrieval and data preparation capacity	Lang, 1990; Department of the Environment, 1987
Data	
Data availability	Department of the Environment, 1987; Lang, 1990; Innes & Simpson, 1993
Adequate data standards	Croswell, 1991
ORGANIZATIONAL PREREQUISITES	
Culture	
Support from leaders in organization/internal catalyst	Dalziel & Schoonover, 1988; Wiggins & French, 1991; Budić, 1994
Perceived relative advantage to organization	Zaltman *et al.*, 1973; Rogers, 1983; Stinchcombe, 1990
Adequate planning and co-ordination	Croswell, 1991
Information management	
Organizational support for staff skill development	Department of the Environment, 1987; Campbell, 1993; Budić, 1994
Presence of a staff GIS specialist	Budić, 1994
In-house database development capabilities	Lang, 1990; Gallagher, 1992
Effective use of information	Budić, 1994; Sawicki & Craig, 1996
PERSONAL PREREQUISITES	
Computer orientation and skills	
Existing staff computer skills	Zaltman *et al.*, 1973; Nedovic-Budić & Godschalk, 1996
Supportive communication behaviour among staff	Nedovic-Budić & Godschalk, 1996
Perceived individual relative advantage	Nedovic-Budić & Godschalk, 1996
Substantive knowledge	
Expertise in substantive field	Godschalk & McMahon, 1992; Innes & Simpson, 1993; Budić, 1994
Knowledge of data sources	Innes & Simpson, 1993; NCGIA, 1996

be necessary to satisfy prerequisite conditons and recommend strategies to support successful adoption of GIS and Internet technologies. These recommendations are for CBOs considering adoption of information technologies, for funders funding expansion of the use of ITs, for intermediary organizations, including universities, seeking to offer technical support and for on-line data providers seeking to facilitate enhanced use of IT as an information source for community participation. Table 2 summarizes likely CBO status and recommended transactions.

Technological Prerequisites

Several recent studies indicate that creation of a complete technological system in the organization is a key prerequisite to successful adoption of IT/GIS for

Table 2. Summary of prerequisite conditions, CBOs characteristics and recommended transactions

Prerequisite conditions	Status and relevance for CBOs	Recommended transactions/strategies
TECHNICAL		
Equipment Selection/acquisition Upgrades Data retrieval/preparation	• insufficient funding for latest hardware and software • grants for hardware/software/networks highly competitive • upgrades difficult (not covered in grants) • insufficient knowledge of hardware requirements for IT among new users • low incidence of modems for on-line retrieval • slower modems make Internet use inefficient • data preparation software (spreadsheets) in use at moderate levels	• plan for and incorporate equipment needs into operational budget • seek donations of 'obsolete' computers from local corporations and government agencies • organize to increase federal and state funding for CBO purchase and upgrades • form local CBO equipment exchange network • seek technical assistance from local universities or computer user-groups • seek donated telephone lines from local providers • intermediary organizations provide access to server for CBOs
Data Availability Standards	• data needs wide in type and geographic scope • limited regulatory data available on-line • most data needed accessed in hard copy (at agency office/via mail) telephone • data sources multiple and diffuse and out of traditional scope of CBOs • data collected using multiple units and standards • much information about small geographies not yet collected • CBOs indicate need for • technical assistance to identify data sources • parcel-level digitized base maps key for GIS use; often difficult to obtain	• create/access existing community information networks • get to know information officer at each agency to shorten data source identification • form partnerships with local environmental organizations for help in identifying data sources • CBOs collect neighbourhood data with assistance from local university or high-school students • data providers expand data collection and availability to address CBO-level concerns • environmental and socio-economic data providers standardize neighbourhood-scale data
ORGANIZATIONAL		
Culture Support from leaders Adequate plan/co-ordination Perceived relative advantage	• awareness of IT advantages for environmental information limited • awareness of relative advantage for organization growing • planning difficult with limited knowledge of benefits and needs	• leadership training programmes by state and federal agencies targeting CBOs • technical assistance for CBO organizational development
Information management Staff skill development Presence of GIS specialist In-house database capacity Meaning and significance of data	• very limited resources for staff training • staff with GIS training soon leave for better pay • many CBOs already use spreadsheets	• create total CBO information management system • train CBO staff in problem-solving strategies and use of information • train more than one staff member in GIS and Internet

Table 2. Summary of prerequisite conditions, CBOs characteristics and recommended transactions—*continued*

	• frequent staff changes impede organizational capacity to manage information • significance and use of environmental information not adequately recognized	• improve overall staff skills in GIS support activities • create/adapt intermediary organization to provide ongoing IT training service for CBOs
PERSONAL		
Computer-orientation/skills Existing staff computer skills Communication behaviour Perceived advantage	• hard to attract staff with advanced computer skills at typical CBO pay • small staff size lends toward communication and skill-sharing • individual orientation toward computers mitigates perceived advantage	• CBOs pool resources to increase salary to hire GIS specialist shared among organizations • in-house training of all staff in basic computer operation
Environmental knowledge Expertise in substantive field Knowledge of data sources	• relatively less expertise in environmental science • relatively less knowledge of environmental regulatory framework • minimal knowledge of data sources for environmental and environmental health issues	• partner with local environmental organizations and universities to learn more about environmental science • train CBO staff in risk concepts and regulations used by agencies • information providers identify neighbourhood level concerns and provide on-line sites to focus there

environmental problem solving. For example, for local governments adopting GIS, purchase of computer equipment with adequate memory, speed and other operating features was important (Department of the Environment, 1987; Gallagher, 1992). Adequate resources to maintain technology are important, as information technologies are under constant development, and maintenance and upgrades to equipment and software can be costly (Gallagher, 1992).

Possession of adequate data preparation resources such as technologies to access and retrieve data electronically and software to transform data to useful formats is key. Development of a database is the most time-consuming and often the most challenging aspect of GIS implementation (Department of the Environment, 1987; Lang, 1990). Availability of data concerning a particular problem can be a critical prerequisite. Has appropriate data been collected and is it available to the public through a government agency or university or other public source (Department of the Environment, 1987; Lang, 1990; Innes & Simpson, 1993)? Have data standards been developed for data particular to an organization's needs? The absence of standards was the most frequently cited obstacle to adoption of GIS in a review of relevant literature by Croswell (1991).

The advent of more user-friendly desk-top GIS software (Van Demark, 1992) and development of an Internet organized by servers with search capabilities has enabled more organizations to use the technologies, but GIS and the Internet are still infrequently used by non-profit community-based organizations serving smaller geographic areas. Stoecker & Stuber's study (in 1996) of such organizations in Ohio is illustrative.[6] Of the 189 CBOs responding to a detailed survey concerning use of computers, only five indicated that they currently used GIS and only three indicated access to and use of the Internet (Stoecker & Stuber, 1997).[7]

Acquisition of adequate hardware and software is a substantial problem for many CBOs to a greater extent than for government agencies. The use of GIS software and the Internet for data retrieval requires substantial expanded CPU and printer memory, modems and efficient networks, many of which are beyond CBO resources. In our experience, it is not infrequent that CBO staff share computers with other organizations, limiting the time available for use of the computer. Of 189 CBOs surveyed in Ohio, only 16 had hardware the researchers considered adequate for relatively easy Internet use (Stoecker & Stuber, 1997).[8] Adding GIS would likely exceed the hardware capacity in these organizations. Purchase of additional equipment and inevitable upgrades places a strain on limited CBO resources. The US federal funding available through TIIAP and the Department of Housing and Urban Development's (HUD) Neighbourhood Networks for CBOs to purchase hardware can provide a source for funds, but the process to obtain these monies is highly competitive.

These conditions match our field experience. One organization with which this author has worked for several years has three computers, with only one containing a 486 processor. The organization has not yet found funds to purchase an Internet software program and has only recently installed a second telephone line. The GIS package it owns was purchased with a grant and is now four years old, and the organization has not as yet secured monies to upgrade to a newer version. We anticipate at some point this will deter our efforts to assist the organization in its use of GIS, in that the software at the university from where it secured the initial GIS training and from where it retrieves assistance from students' projects has been upgraded three times during that period.

When seeking information about specific places at the neighbourhood level, electronic data retrieval capacity can save the staff precious time. The method of data transfer must be compatible with CBO capabilities. Is the agency that holds the information technically able to transfer information readily electronically? If data is not available and transferable electronically, or in the right format, or if the CBO does not have appropriate software to finish data preparation, data management costs will be too high for many small community-based organizations.

Data availability is a critical prerequisite for CBOs addressing environmental problems as well. Community-based organizations that serve urban neighbourhoods traditionally focus on events in their own 'backyards' more closely than on distant events (Lake, 1993; Groothuis & Miller, 1994) because of their relatively small service areas. Environmental problems that affect an urban neighbourhood might be generated within the neighbourhood, but may also drift into the neighbourhood from afar. Residents rely on CBOs to help them identify how conditions in the broader community affect them in their homes and neighbourhoods. For these reasons CBOs need a wide variety of types of environmental information, ranging from the parcel level to the regional scale. They need information about regulated pollutants, but also about land use, environmental amenities and quality of life issues. Several characteristics of the US legal and administrative system impede CBO access to the information needed, however.

US citizens have a right to know about a set of pollutants, a right guaranteed by Title III of the federal Superfund Authorization and Reauthorization Act (SARA) of 1986. Access to the information must be provided by a Local

Emergency Planning Committee, usually housed in a municipal or county agency, which sometimes levies a charge for assembling data electronically. Some of the information CBOs need falls under purview of SARA or the older Freedom of Information Act, but much does not. Administratively, the wide range of environmental data sought at the neighbourhood level is held by a multitude of environmental, public health and planning agencies and other organizations at the federal, state and local levels. Identification of which organizations hold what kind of environmental or quality of life information needed to assess the broad scope of environmental conditions in urban neighbourhoods presents a formidable obstacle to CBOs. This situation is relatively more difficult than for information regarding socio-economic aspects of urban communities, where standardized data has been collected by the US Census and US Department of Housing and Urban Development and made available to local governments and non-governmental organizations through designated census data repositories. Standardized and relevant environmental data, collected over this continuum and available electronically are key prerequisite conditions for CBOs to use ITs efficiently. The use of the Internet as a data source, particularly with its search capabilities, is of particular relevance for CBOs. When Internet connections are efficient and the desired information is available, downloading data from the Internet can save time-pressed CBO staff hours of effort.

CBOs require data assembled for their service area. In recent surveys, community-based organizations in Ohio indicated a need for technical assistance in their efforts to acquire information, particularly information about environmental issues (Stoecker & Stuber, 1997; Earthday Coalition, 1998).[9] Service area boundaries are often designated by the organization and may not correspond to service and planning boundaries established by the city, the state or the Federal Government. Environmental health and pollution data possessed by the agencies rarely are organized by neighbourhood or by local jurisdictional boundaries. Most data are organized by county, zipcode and census tract which are unlikely to conform to a territory that residents consider their 'community'. The predominant agency emphasis has been on collecting and processing data from and for the regulated community to ensure permit compliance. This emphasis has structured what information is collected and how it is made available.

The feasibility for using GIS to address a CBO's service area depends as well on the existence of appropriate parcel base maps. Existence of such a digitized parcel map needed for GIS depends in great part on either the financial and technical resources of the organizations to hire consultants to map their neighbourhood (Simons & Salling, 1995), their time and ability to work with university faculty and students (as in our projects), or upon efforts by county and local governments to adopt GIS as a dominant planning tool. As more planning and engineering agencies adopt GIS, which appears to be the case (Gallagher, 1992; Budić, 1994), the likelihood that city or county wide parcel base maps will be available to CBOs increases.

To summarize, for CBOs to use GIS efficiently, the data on problems relevant to CBOs needs must be available, preferably on-line or on disk, and in a format that can be collected and mapped by the community organization. Two of our experiences working in the community illustrate problems that can arise for CBOs. In one community, staff at neighbourhood centres working on children's health issues sought to know the location of children with elevated blood lead levels and to identify the sources of lead for these children. GIS could assist in

this analysis, by incorporating the location of vacant lots where children play, pre-1970 high traffic areas and homes painted before the 1970s (when lead was taken out of gasoline and paint), and then showing their spatial relationship to blocks with higher frequencies of children who tested positive for lead in the city's testing and abatement programme. This would let the organization target lots and houses to analyse whether the soils and paint contain lead and whether children are exposed to them during play. To use GIS for this task, however, the data on location of vacant lots, housing stock condition, traffic patterns and paediatric lead levels must be available.[10] Absence of any of this data, easily obtained, increases data preparation costs dramatically and is prohibitive for small organizations such as the ones we know.

Another example from our community experience illustrates the disconnect between agency information and CBO needs. Pollution data such as the Toxic Release Inventory[11] or Title V Air Permits, provided on-line at the USEPA website, are collected and organized according to a set of identifiers, including the street address, the facility's postal code and an agency identity number for each discharging facility. Our recent experience with one CBO reveals a serious obstacle: the street addresses given in the database for the neighbourhood's postal codes were not necessarily facility street addresses. Because we knew the location of many of the company facilities in the neighbourhood, we soon realized that many of the addresses included in the databases were corporate headquarters located in another part of the city. In addition, in some cases the facilities spanned many legal parcels or even blocks in the neighbourhood, so the street address of the facility told us little about the actual location of the discharge point. These data standardization problems make use of a parcel map to explore relationships between discharge points and resident or population location very difficult. The data would be far more useful to CBOs seeking to understand the affect of discharges on their neighbourhood if USEPA included a parcel number for each permitted emission point as a searchable variable in the databases. Parcel numbers for discharge reporting are not currently required, but this identifier would immediately locate each emission or release point to a specific parcel, something highly desirable at the neighbourhood scale. As an alternative strategy, CBOs can conduct facility audits to observe the locations of discharge points as best they can (Harker & Natter, 1995).

Organizational Prerequisites

A set of interconnected organizational prerequisites, broadly characterized as organizational culture and organizational information management, can support or thwart adoption of technology innovations. Strong support from organizational leaders as an 'internal catlyst', highly motivated for change, can be a powerful impetus to adoption of innovation (Dalziel & Schoonover, 1988; Kellogg, 1998). This catalyst could be someone in a position of formal authority, or a member of the organization with technical expertise sufficient to perceive the benefits from change. Organization leaders and members sharing a common perception that the innovation brings a relative advantage for improved performance or economic efficiency to the organization enhances adoption (Zaltman *et al.*, 1973; Rogers, 1983; Stinchcombe, 1990). For GIS, strong organizational support has been a prerequisite condition to successful adoption

(Wiggins & French, 1991; Budić, 1994). Adoption of a complex technology such as GIS is a long term process, and financial support and personal encouragement from leadership in the organization can convince organization members that GIS is a worthwhile investment of their time.

Do staff at CBOs perceive IT as a relative advantage to improve the performance of the organization? There is some evidence that support for adoption of IT among CBOs is quite strong. Of 189 organizations surveyed in Ohio, GIS and the Internet were the two most often software types desired. While only five CBOs in the Stoecker & Stuber study indicated they currently used GIS, and only three indicated on-line service, approximately 60 indicated they wanted to use GIS for their organization's tasks and nearly 50 indicated they desired access to the Internet (Stoecker & Stuber, 1997). These figures demonstrate a significant level of perceived relative advantage among these organizations for utilization of ITs. Stoecker & Stuber also found that 35 organizations had included funds for computer technical assistance in their annual budgets. Half the organizations with operating budgets exceeding $100 000 wanted to acquire the hardware necessary to go on-line, and were budgeting as best they could for the technical assistance on what hardware and software would best suit their needs and the training they would need to use it. The high financial and time costs of acquisition and implementation of ITs appeared to outweigh as yet a largely unknown benefit for many CBOs with small staff and operating budgets under $100 000.

The lack of planning for, and management of, the adoption process by the organization is one of the most frequently cited obstacles (Croswell, 1991). The need for carefully planning the innovation adoption process is supported by lessons from the US TIIAP programme. Organizations considering creating community information networks are urged to carefully plan projects with CBOs they seek to serve to meet the needs of end users, recognizing that the individuals using the technology and the people they serve often have limited experience (NTIA, 1997b). CBOs involved in these projects would require similar planning in order to take full advantage of services offered by community networks.

A second set of organizational prerequisites focuses on organizational capacity to manage information. This capacity is a product of the organization's culture as it influences the routinization of the innovation into organizational function. Through these routines, old staff are retrained and new staff are acculturated. An organization needs to provide opportunities for staff to develop skills required to adopt and implement an innovation (Croswell, 1991; Godschalk & McMahon, 1992; Budić, 1994). For example, effective use of GIS is predicated on data management capacity that includes staff mastery of hardware, software and database management elements (including use of spreadsheets or other database management software) and practice integrating data in a variety of formats and from a variety of sources (Department of the Environment, 1987; Campbell, 1993; Budić, 1994). In-house database development resources and capabilities are key because of the myriad database tasks associated with support of GIS (Lang, 1990; Gallagher, 1992; Campbell, 1993). In one study of planning agencies, presence of a GIS specialist on staff ensured more effective use of GIS (Budić, 1994). Knowing how to use data once assembled to create useful and meaningful information is key for effective use of the technology (Budić, 1994; Sawicki & Craig, 1996).

Skill development among CBO staff is critical, and poses particular challenges. In a community environmental leadership project implemented in this past year in Cleveland we trained 18 staff, board members and resident volunteers from CBOs in environmental problem-solving, including use of the Internet. We found a substantial need for training on the computer. Participant skills ranged from two people who already used the Internet on a regular basis at home or work to several participants who had never used a Windows-environment computer or a mouse. Many participants were anxious about using a computer when beginning the Internet portion of the training. Our experience mirrors that reported by projects throughout the US in the TIIAP programme. Working with CBO staff to implement a community IT network and access centres, project managers noted the need for an emphasis on training programmes. They found they could not assume CBO staff and residents had familiarity with computers. The rapid turnover of staff in participating agencies and the frequent changes in technology necessitated that training be integrated on a continual basis in their projects (NTIA, 1997c).

Training is even more critical for CBOs seeking to adopt GIS. Building proficiency in GIS is very much like learning a new language. It requires significant investment of time to learn the software and to build GIS databases, and also requires practice on a regular basis. Research suggests that the presence of a GIS-specialized staff person with the time for improving skills and developing databases has been a key feature of successful use of GIS in municipal and county planning agencies (Budić, 1994). In our work with a small community development corporation, a staff person in the CBO had been trained in MAPINFO™ through funds provided by a grant. The staff person was a community project manager whose activities were split among GIS and other responsibilities. It is unlikely that when a CBO staff person is trained, his or her time will be devoted exclusively to GIS. Shortly after our project began, the GIS-trained person assumed the position of interim director of the organization and had little time for practice. Personnel changes in non-profit CBOs are frequent, raising the possibility that the GIS-trained person may change responsibilities.

Working with CBOs in seven US cities, Sawicki & Craig (1996) describe how people who were trained in GIS while at the CBO left for better-paying jobs they could acquire with their new skills. This situation is a serious detriment to sustained use and improvement of GIS capacity in CBOs. In our community work with another CBO, a young professional hire, already trained in GIS, was key to consideration of adoption of GIS by the organization. That person acted as an internal catalyst and motivated the organization toward purchase and use of GIS and additional training for himself. This staff person is 'entry-level' at the CBO, and will most likely move on in a few years, perhaps taking the organization's GIS capabilities with him.

Based on our work in the community, the typically small staff size in CBOs does tend to foster shared knowledge systems for performance of many of the functions of the organization, mitigating this situation somewhat. The question is whether GIS, because of its labour-intensive nature both in training and use, is qualitatively different and cannot as readily be adopted as part of a shared knowledge system.

Our experience with GIS and the internet mirrors others regarding internet training, recently described in a review of TIIAP projects, in which participant

providers commented that the 'boss' of the organization has to be willing to commit staff to do training, that without continuing organizational development, adoption of the technology 'won't work' (NTIA, 1997b). In the study in Ohio, only 37 of 189 CBOs included funds for computer training, however (Stoecker & Stuber, 1997).

In-house database development capacity is a key prerequisite condition for effective use of both the internet and GIS, and will likely be met with difficulty by smaller CBOs. This capacity rests not only on a set of GIS and internet skills, but more fundamentally on the organization's overall capacity to manage information effectively. As more environmental information is put on-line by the US federal government and made more user friendly by environmental and community development advocacy organizations, data available for database development will improve. Skills developed for non-environmental database generation can then be utilized. Regarding existing use of computers for databases, the evidence we have is somewhat encouraging. In Stoecker & Stuber's (1997) study, 65 of 189 CBOs indicated they currently use database and spreadsheet software.

Another key component of information management is the capacity to recognize the significance of data and information once obtained. Sawicki & Craig (1996) report that the lack of technical sophistication among community groups was a key challenge faced by information providers working with CBOs across the US. CBO staff seeking assistance in obtaining data often did not know how to read the data, could not identify its meaning once analysed, needed help putting data into its broader context, and needed to learn how to use information and analysis to affect policy or its administration. Based on our community experiences, we suspect that this problem would be very challenging for CBOs obtaining scientific data on environmental conditions. CBOs need information on environmental problems such as air pollution from facilities in close proximity to residence, contaminated land which stymies redevelopment, the affect of deteriorated housing stock on paediatric blood lead levels and respiratory problems, and the lack of green space and greenery, all of which threaten the physical and psychological well-being of neighbourhood residents. Understanding these relationships requires significant familiarity with scientific evidence.

We have delivered a variety of environmental data and information to a CBO over the last two years. The organization has used materials in its outreach programmes to residents. We have also worked with block clubs on specific facility discharge problems in their neighbourhoods. In one meeting, residents expressed great irritation as they realized the high amounts and characteristics of pollutants discharged into their neighbourhood. They were overwhelmed, and the data did not show them a course of action. Which chemicals were more threatening to the neighbourhood? Which chemicals posed a higher risk? Students worked with them to develop a ranking system for the discharging facilities based on the volume of discharges and the health risks associated with the discharged chemicals. The ranking system helped prioritize which facilities they should bring forward to their councilman, who had offered to help them.

Personal Prerequisites

The skills and attitudes of individual members of an organization provide the foundation for organizational prerequisites that support adoption of an inno-

vation. Previous development of the computer skills needed to learn GIS (Nedovic-Budić & Godschalk, 1996) support a successful adoption, as do the attitudes of individuals in the organization. A positive staff attitude toward computers in general will support adoption. If a staff person perceives knowledge of IT as a relative advantage within the organization's reward system, he or she will pursue its adoption (ibid.).

Effective adoption of the internet and GIS in an organization is based on transfer of knowledge among members of the organization. Individual communication behaviours can support adoption to the extent that staff members are willing to share their existing or growing knowledge of how to use the internet and to apply GIS software to organizational functions (ibid.).

Compatibility of the innovation with previous experiences among organization staff will support adoption of an innovation (Zaltman *et al.*, 1973; Kellogg, 1998). This prerequisite was critical in two of our community projects, although with opposite outcomes. In one case, the staff member with previous computer training during graduate studies pushed for adoption of GIS and the internet in the office. In contrast, in another community project, the CBO staff member's discomfort with the internet in the environmental leadership training seemed to cool his efforts to secure on-line capabilities for his organization.

In the experience of local governments, expertise in a substantive field was a critical support to GIS adoption (Godschalk & McMahon, 1992; Innes & Simpson, 1993; Budić, 1994). GIS was more effective when staff had an understanding of how GIS could be used in conjunction with substantive knowledge, including knowledge of the science of environmental problems and the regulatory system (Innes & Simpson, 1993; Godschalk & McMahon, 1992). Expertise in the problem area also supported adoption of GIS because staff had an existing knowledge of data sources (Innes & Simpson, 1993; NCGIA, 1996).

For CBOs seeking to address environmental problems, prior scientific or technical knowledge about the problem to be addressed is critical to support the use of a new technology. It is likely that first-hand knowledge of environmental issues and the regulatory system would be relatively less well developed among CBO members, given their traditional focus on housing, economic development and social service programmes. Environmental and health issues are often highly technical and scientific in nature, best understood by staff with prior experience or formal education, which CBO staff are likely to need. Knowledge of data sources is a critical challenge to any organization using the internet and GIS, but of particular concern for use of GIS by CBOs addressing environmental problems or creating a comprehensive picture of environmental conditions in their neighbourhoods. As noted above, environmental data are collected and stored by a wide range of entities at federal, state and local levels. When developing an environmental resource guide for a CBO in a Cleveland neighbourhood, we contacted several different agencies, offices and searched many websites before we identified from where data useable by the neighbourhood were available. The high data input demands to use GIS to its full potential require staff knowledge of the various sources of data, which in turn is based on a good knowledge of which agencies are responsible for what information through their regulatory function.

Recommended Key Transactions for CBOs and Other Organizations

What can CBOs and other organizations seeking effective adoption of IT do to

overcome obstacles described in this paper? What transactions or changes do we recommend? Our first recommendation to CBOs and organizations providing technical assistance to them is to carefully assess the present status of the prerequisites described above in the CBO organization. Such assessment will provide a clearer picture of the resources and transactions needed to support adoption. The effort should increase the likelihood of success in adopting information technologies. While the internet may provide increased access to environmental information with relatively less cost and investment of staff, the adoption of GIS requires such a large investment of staff time and financial resources, we recommend that CBOs proceed with caution.

Technological Prerequisites

To address expected problems with resources for hardware and software acquisition and upgrades, and barring substantial increases in federal monies available for hardware purchases, we suggest CBOs seek out donations of computers from local corporations and government agencies. Often this hardware can be upgraded to be adequate for internet access and GIS software. For example, several federal agencies have programmes to donate 'obsolete' computers from facilities to community organizations. Our hope is that federal and state funding for expanding information technology hardware and software to urban organizations and neighbourhoods continues. CBOs and their supporting organizations may find lobbying efforts at the local, state and federal levels to increase the level of funding for these purposes an effective strategy.

Adequate data retrieval via electronic means requires a modem. CBOs can seek donations of equipment and should seek out assistance in selecting hardware and software. Often local computer user groups or universities can offer guidance at no cost. Other intermediary organizations can offer their assistance by contracting to provide access to a server for CBOs. One intermediary to community development organizations in Cleveland has recently done so, offering its member CBOs access to an internet provider for about $11 a month.

Availability of data relevant and easily manipulable to the neighbourhood scale would support adoption of the internet and GIS to address neighbourhood environmental concerns and can be improved by several transactions carried out by information providers, intermediary organizations and CBOs. Initiatives by US federal and state agency environmental information providers such as the USEPA's Community-based Environmental Protection (CBEP) initiative require a conceptual reconfiguration of the territory that is the object of planning and management efforts (USEPA, 1997). Such reconfiguration bodes well for CBOs if database access formats are reconfigured as well, and work in this area is now beginning (Coder, 1997).

The recent reorientation to neighbourhood-based studies among some academic researchers, coupled with increasing development of intermediary organizations working to support CBO efforts, is promising as well. As devolution of authority for urban service delivery continues, new coalitions are arising between community organizations, intermediaries and universities working to design comprehensive strategies for urban improvement. These coalitions need to understand the needs of specific neighbourhoods when developing their

programmes (Rabrenovic & Pattavina, 1997) and need neighbourhood-specific indicators to measure progress. As a result, the demand for neighbourhood-level databases is growing.

Finally, CBOs themselves will likely need to develop data collection skills, as their data needs may well be met through a combination of Internet access, traditional collection methods and neighbourhood-based studies. CBOs currently with Internet access can begin with community-based networks. A review of the Internet reveals that local governments and non-profit organizations in several cities have developed comprehensive websites that feature information about the community, including organizations and data on environmental quality and health concerns. Hundreds of community-based networks and freenets exist in the US. Many of these provide access to information on a series of topics, including environment, about the community.[12] CBOs will likely find examples of how community organizations used existing data for environmental problem solving.

Despite the important developments in Internet information access, most information about territory at the neighbourhood level is still available through more traditional means, including telephone calls and visits to agency offices. Development of information for specific neighbourhoods on a comprehensive scope (collecting data on air quality or paediatric blood lead levels, for example) will likely only result from efforts originating at the city or county level. For example, Cuyahoga County (the greater Cleveland area) is creating a parcel base map for the entire county which, when complete, will provide a useful tool for CBOs if they obtain and begin to use GIS. CBOs joining together to request this service from the county level is a viable strategy to help ensure that county and state data resources will be spent on information and services of use to CBOs. As a second strategy to address data access, CBOs should identify the information officer at each local, state and federal agency that provides environmental, environmental health or quality of life information. A call to that person can save dozens of calls to the wrong technical staff or hours spent on unfocused searches of the Internet.

CBOs will also need to invest their resources in developing data sets specific to their neighbourhoods, and can collect and use primary environmental, health and planning data when given appropriate training and assistance (Heiman, 1997). A partnership with a local university or high school could provide students and faculty with expertise to guide CBOs through data needs identification and collection.

Organizational and Personal Prerequisites

Based on our review of the prerequisite conditions, we conclude that effective adoption of information technologies including GIS and the Internet in urban neighbourhoods depends upon community participation in the development of an information management system within which these technologies are used. Otherwise, the benefits to be gained from adoption of new information technologies, including GIS, will not be realized by urban residents and their organizations. Information management includes setting priorities, identifying information needs to address these priorities, building capacity to understand and use sometimes highly scientific and technical data, processing that data into

information that is meaningful, and communicating that information effectively to improve participation and decision making (Kweit & Kweit, 1987; Kellogg, 1998). Good information management capabilities are precisely those that are required for effective use of GIS and the Internet by community-based organizations so they can access, understand and use information as part of their ongoing community development and environmental protection efforts.

How will this transformation occur? What transactions are needed? Here a strong role for local environmental organizations, environmental management agencies, local universities and other intermediary organizations in the community is required. Leadership training can be a first step toward building awareness among CBO directors that their environmental and quality of life problem-solving can be improved through the use of the Internet and/or GIS and can help CBOs to identify the ways IT can be used to achieve organizational objectives. CBOs need to build partnerships with intermediary organizations and local universities to facilitate their own capacity to manage information, but universities and intermediaries should take a strong leadership role in seeking out CBOs.

One current example of a community–university partnership is the Sustainable Cleveland Partnership (SCP). The partners include a mix of local, state and federal environmental and public health agencies, the county planning commission, several environmental organizations, a community development intermediary, several community-based organizations and this author representing the University. The partnership developed and delivered a series of workshops for CBO staff in four Cleveland neighbourhoods. The workshops took participants through a process of goal-setting, problem-solving strategies and information management training concerning environmental problems identified as priorities by neighbourhood participants. The workshops concluded with Internet training and a review of the mapping capabilities of some of the best websites for federal environmental agency data. The SCP reasoned that in order to use the Internet effectively, CBO staff needed a foundation of training in environmental problems, risk assessment as the basis of policy, the locus of information as a result of agency regulatory responsibilities, and information retrieval methods as a preparation for carrying out searches on the Internet. The partnership also developed an Internet-based environmental health guide designed for CBOs and neighbourhood residents.[13]

Training in GIS and the Internet needs to be ongoing according to our review of TIIAP programmes and our experiences. Of particular concern is the frequency of staff changes that occur in CBOs. This situation makes the routine availability of training for CBOs a key transaction for adoption of these technologies. Intermediary organizations in the community that currently provide technical assistance to CBOs appear to have potential. Frequent CBO staff turnover requires that more than one person in the organization be trained to facilitate knowledge exchange and sustainability of use. It might be that intermediary organizations are the appropriate locus for intensive training in GIS. They could train CBO staff and act as technical support when CBO staff have questions about the use of GIS software. It is critical that CBOs and their traditional technical assistance organizations build the capacity of organizations, not just individual staff members, to manage information so that it can be used for GIS and other purposes.

Local universities have a particularly strong potential and responsibility to

assist community organizations. Universities generally possess hardware and networks well beyond CBO capacities, and universities could offer technical assistance and training in the use of Internet and GIS technologies to CBOs and intermediary organizations. Any university-sponsored work with CBOs must focus as much as possible on enhanced CBO capacity. Our projects in Cleveland neighbourhoods always deliver not only environmental data, but a resource guide focused on the environmental problem we have addressed with the CBO. We include a summary of existing law, the regulatory agency responsible for administration, the specific source of the data gathered and, whenever possible, a specific contact person at the agency for the CBO staff to call if they have additional information needs in the future.

Summary and Research Recommendations

This paper has presented a framework that identifies the prerequisites for adoption of IT/GIS by community-based organizations and a set of recommended transactions that would ameliorate some of the obstacles to satisfy prerequisite conditions. This framework can be used by CBOs to assess the feasibility that they can successfully adopt information technologies. Given the wide variety in the size, capabilities and resources of community-based organizations, we would expect to see an equally wide variety of experiences among organizations seeking to use IT in their planning and programme delivery activities. Future research should assess the relevance of specific prerequisite conditions for specific types of organizations. We are now completing a study of community-based organizations in Ohio based on the framework presented herein. We would recommend more state-wide or even a national study of the use of IT by CBOs. These studies could analyse additional variables that might affect adoption of IT, such as the impact of state or federal programmes. A study of organizations that use TIIAP-sponsored and other community networks would be useful as well. Additional studies should also identify the conditions and transactions that sustain the use of IT after it is initially adopted by an organization.

A second area of research that would be useful to scholars and practitioners alike is the role that intermediary organizations which traditionally offer technical assistance to CBOs (organization operations, financing, community organizing, etc.) might have in supporting adoption of IT. Further study is needed to identify these organizations and assess their capacity to provide technical assistance concerning environmental problems and use of computers, including training for use of the Internet and GIS. Study is also needed to identify which technical assistance delivery mechanisms would be of most benefit. We have begun such a study in Ohio but, again, other state-wide or a national level study would allow us to compare across a broader geography and type of community-based and intermediary organizations. Based on our experiences, we suggest that any technical training regarding the use of IT for environmental planning and management by community-based organizations must include development of a cadre of practitioners who have substantive knowledge about environmental problems as well as knowledge of data availability, skills for using data and skills in the use of the artefact.

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Notes

1. The Administrative Procedures Act of 1946 first standardized requirements for public hearings prior to administrative rule-making (Ethridge, 1989).
2. USEPA Regional 5 webpage on urban sprawl is available at: http:www.epa.gov/region5/sprawl/; the EMPACT webpage on air quality in Northeast Ohio is available at: http://www.epa.gov.realtime.facts.fohio.htm; and USEPA Surf Your Watershed is available at: http://www.epa./gov/surf/).
3. The mean size of Cleveland CBOs is 4.4 full time staff (Center for Neighborhood Development, 1997); in Ohio, only 1/2 the CBOs had more than 2 full time staff members in 1996 (Stoecker & Stuber, 1997).
4. Descriptions of TIIAP projects are available at the following URL: http://www.ntia.doc.gov/otiahome/tiiap/resources/netpeopl17.htm.
5. The author acknowledges the substantial use of Nedovic-Budić & Godschalk's framework (1996) to the development of the personal prerequisites section of this paper.
6. The study surveyed community and neighbourhood-based organizations in the Metropolitan Statistical Areas of Akron, Cincinnati, Cleveland, Columbus, Dayton, Toledo and Youngstown. The study was a joint effort of the Urban University and Neighbourhood Network (UUNN), and co-ordinated by the University of Toledo.
7. This author was given access to the data frequencies for organizations in Cleveland surveyed in Stoecker & Stuber's study. I gratefully acknowledge their contribution to this current project.
8. Classification as 'adequate' (for IBM compatibles) entails Windows 3.0 or higher, a 486 processor or better, 8 MB or higher RAM, 66 MHz or better processor speed, a hard drive capacity of 800 MB or better and a modem speed of 14.4 or faster. These are the most basic features, and will cause some delay in transmission over the Internet and in the function of a GIS program.
9. CBO staff and board member participants in a recent community workshop desired information (in descending order) on these environmental, environmental health and quality of life issues they perceive as problems in their neighbourhoods: brownfields; cancer rates; hazardous waste; drinking water safety; litter/trash; air and water pollution; paediatric lead poisoning and asthma; recycling; reproductive disorders; pesticides; energy; open space; indoor air pollution; traffic and noise; safety of Lake Erie fish for consumption; and public transit availability.
10. Currently, most of these data are only available by searching through a record book at Cleveland's city hall; paediatric lead blood levels have been assembled by census track and are available from a local environmental organization participating in the City's lead abatement programme.
11. The Toxic Release Inventory is a database of facilities in the US that discharge one or more of 600 toxic chemicals designated under SARA. Data are facility self-reported on an annual basis to the USEPA.
12. For example, Neighbourhood Link in Cleveland provides information about Cleveland's neighbourhoods and city services through a system of Internet-capable computers located at 15 public libraries and community centres. Information provided through links includes transportation, property assessments and ownership, census data, a directory of community-based organizations and environmental quality topics (URL: http://little.nhlink.net/nhlink/). Libertynet in Philadelphia contains a webpage called Neighbourhoods On-Line that includes direct links to a range of topics about environmental quality and Philadelphia's neighbourhoods, and the services provided by local, state and federal agencies (URL: http://libertynet.org/community/phila/natl.html). The Renew America website has a variety of links to environmental issues and problem-solving strategies that can be used at the neighbourhood level as well (URL: http://www.crest.org/sustainable/renew_america/). The Chicagoland Environmental Network provides environmental information and links to over 200 member community-based organizations working on environmental issues, and is available at: http://cs-www.uchicago.edu/pub/discussions/cpsr/ccia/ccia.html).

13. The Sustainable Cleveland Environmental Health Action Guide is available at: http://www.nhlink.net/enviro/scp/.

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Appendix: Study Data Sources and Meaning of Results to a Wider Audience

In developing the framework presented in this paper, a mixed-method research design (Gaber & Gaber, 1997), including results from community practice, two surveys and personal interviews, was used to more effectively explore our topic. The author has been engaged in environmental information-oriented service, practice and class projects in an urban neighbourhood for the last three years. The activities have been in partnership with a community-based organization seeking to use the Internet and GIS in its environmental problem solving and have resulted in an assessment of neighbourhood environmental conditions, development of a neighbourhood environmental history and baseline environmental profile, and an environmental resource guide for use by neighbourhood organizations and residents. Development of these resources was accomplished by using the Internet for data collection and using GIS for creating the environmental profile of neighbourhood environmental conditons.

The author is currently working in the Sustainable Cleveland Partnership project with several CBOs, local environmental organizations and environmental management agencies to train CBO staff, board members and resident volunteers in environmental problem solving in four low income neighbourhoods in Cleveland. The project is also developing community-oriented environmental education materials for the Internet (available: http://www.nhlink.net/enviro/scp/). Community participants in that programme were surveyed about their needs for environmental information and their use of the Internet.

The author also reviewed raw data from a 1996 survey of 189 community-based organizations in Ohio, including 44 in Cleveland, that asked CBOs about their use of computers, including GIS and the Internet.

Next, the Ohio-based data was supplemented with US national information that is available. The author reviewed the Internet web pages of environmental agency and non-governmental organizations to ascertain to what extent environmental information is available on-line and reviewed community-based information networks to ascertain to what extent they include environmental or environmental health information relevant to urban neighbourhoods.

Finally, the author also questioned two public information staff members, one at USEPA and one at Ohio EPA, about their expectations and plans for use of the Internet and mapping tools as public participation and information delivery mechanisms. Table A1 summarizes these techniques and the information gained from them.

Based on these activities, the author believes the experiences in Cleveland and Ohio are relevant to the experiences of CBOs in other locations. The emphasis of US federal programmes indicates a need for expanding access to IT in urban American neighbourhoods. While descriptions of community networks are relatively abundant on the Internet, I found no comprehensive study of how CBOs—which are often the targeted user groups for projects—were adopting IT technologies. Colleagues in Ohio's Urban University Neighbourhood Network concur with the absence of a comprehensive study. A search of the academic literature regarding the Internet and GIS use by community organizations turned up few results, and these described specific projects and applications. The project-focused accounts described the role of universities and other intermediary

Table A1. Summary of data sources for project

	Data			
Data source	Environmental information needs	Relevance of internet data	CBO computer use	Data provider expectations
Community service	✓	✓	✓	✓
SCP participant survey	✓		✓	
CBO survey			✓	
Internet review		✓		
Agency staff		✓		✓

organizations that seek to assist CBOs in various uses of information technologies, but did not evaluate CBO adoption itself.

I found evidence to suggest that experience in Ohio is similar to that in the rest of the US based on a review of the US federally-funded TIIAP projects. Likewise, because of its world leadership in development and use of IT, I would logically find it unlikely that circumstances in the US would lag significantly behind circumstances in Europe or the rest of the developed world. An Internet search of Worldcat using keywords "community information technology" resulted in 140 records, 18 of which were relevant to our purpose. The articles, books and reports found there described the following aspects of information technologies: education (4); community networking/information system (3); culture of the internet (2); specific regional or continent focused (2); standards (1); urban change (1); and democratization/power/social aspects (4). The sources were published in the US, UK, the Netherlands and Australia; the cases described were from Africa, Australia, the European Community, Latin America and Japan. It appears that geographically diverse experiences raise issues similar to those in the Ohio studies and experiences described in this current paper regarding use of information technologies. This paper is an attempt to lay out the conditions under which community-based organizations would find adoption of IT supported and facilitated not, at this point, to offer results from a comprehensive assessment of the current situation in the US, which to my knowledge has not been accomplished.