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Adapting GIS technology to the needs of local planning

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Abstract. Our objective in this paper is to argue for a new use of geographic information systems—GIS in local planning as an auxiliary tool for decisionmaking. We review the use of the GIS technique in earlier research studies and represent the empirical findings from using GIS in a quality-of-life study in conjunction with an urban renewal project of a residential area in Stockholm County, Sweden. Special attention is given to the potential of GIS for mapping qualitative data representing people's needs and judgments about their residential areas. We conclude with a discussion of future challenges in using GIS techniques in combination with the Internet for social analysis in renewal planning. One of the arguments proposed is that the tool can be used to promote the involvement of urban residents.

1 Introduction

GIS technology and its applications have been easy targets for many ethical critics during the past few years. Critics have associated GIS-related techniques with information abuse, control, exploitation, unsavoury use, and elitist practices (Clark, 1998; Dunn et al, 1997; Lake, 1993; Pickles, 1995). Parallels are often drawn between GIS applications and rationalist planning of the 1960s or with social engineering.

This debate in fact goes beyond GIS and its social implications. According to Clark (1998) the debate is rooted in ethical issues of the role of information technology and, presumably, of nontechnical methods and procedures. It is not the intention here to discuss the reasons for this debate. Thus it is assumed that, just as any other technology, GIS is a tool that can be used for various purposes. It seems reasonable to agree with Dunn et al (1997) that all geographical information may be problematic in its power of representation, and GIS is merely more so by virtue of its increased technical power and mystique.

GIS tools appeared in the 1970s as elements of a new approach to organising spatial data in computers and as a tool for information processing. GIS combine a database of attributes with geographical coordinates, where the attributes refer to points, lines, or areas defined by the coordinates. Although the majority of GIS applications are concerned with mapping, the term GIS is used increasingly as shorthand for a great diversity of computer-based applications involving the capture, manipulation, analysis, and display of geographic information and the associated services (Wegener, 1998).

Studies conducted in the European context confirm the value of GIS in information processing (Masser and Craglia, 1996). The main users of GIS are central and local government agencies and utility companies (Wegener and Masser, 1996). To date, there is little information on the impact GIS applications are having in local planning and on organisations in which they have been implemented.

With regard to GIS applications in the USA, Nedovic-Budic (1998) affirms that there is agreement among the studies reviewed. Zoning and land-use issues as much as environmental, transport, and economic development planning are the leading areas. Map overlay and census mapping are the two methods most frequently employed

with GIS. In local and regional planning agencies, GIS are used at various points in the planning process, including analytical and synthesis-oriented tasks such as plan development and evaluation. Most planning agencies with operational GIS will employ them on a daily basis.

There is no clear picture of how much the quality of information generated with GIS technology has in fact improved during the last decade, taking into consideration GIS diffusion into local planning. Information of GIS implementation in local planning in Europe is summarised by Masser and Craglia (1996).

GIS have been mostly used for replacing the traditional manual techniques of dealing with maps and also the daily tasks related to data processing. Complex applications, which are demanding in terms of time and knowledge, have little chance of success with such methods. In many cases, knowledge about GIS is generally confined to a tightly knit group in local governments. Campbell (1994) showed that, for British local governments, the success of GIS implementation depends on the organisational culture of local governments. In Sweden the lack of competence among own staff, and decisionmakers, has been considered as one of the most important obstacles for the development of GIS techniques (ULI, 1997). In Denmark and Finland there is a close connection between municipality size, the economic capacity of local government, and the implementation levels of GIS and other related technologies (Kiib, 1996; Nuora, 1995). "Only a few planning schools in Europe offer advanced GIS training" (Wegener, 1998, page 51). Thus, it is expected that the diffusion of simple and effective methods can be a short-term solution for successful implementation and use of GIS technology in local planning.

Computers and, later, the early GIS were tools incorporated in the dominant top-down planning process of the welfare state, putting together official statistics on population, employment, education, health, land use, and infrastructure. In nearly all Western European countries, comprehensive long-term plans were supposed to guide detailed plan decisions and manage the uncertainties of the future. Map methods have always played an important role in those planning activities. GIS methods are now emerging in the field.

Changes in the social and political environment have demanded new ways of problem solving in planning. The need to incorporate the diversity of group opinions in society has been a strong tendency in local planning. GIS, as a tool, can be used for analysis and display of the multiplicity of plan alternatives, including qualitative data. Creative ways should be found to combine quantitative and qualitative approaches (Barndt, 1998). The incorporation of qualitative data imposes a new demand towards professionals working with GIS and planning, requiring training of GIS professionals to work with both quantitative and qualitative data. This leads to the question of making GIS more suitable for the planning process, which includes regular communication with various groups and citizens. It seems that planners need to apply different methods from traditional analytical GIS-based methods in order to make the information derived from the citizen groups meaningful and transparent in the planning process. Among these is how the needs and expectations of social groups can be adequately represented as input in a decisionmaking process by using GIS technology. Such applications are generally under the concept of public participation GIS (PPGIS) and involve diverse approaches.

Weiner and Harris (1999) suggest that PPGIS is characterised by a focus, among other things, on integration of the rich knowledge base of communities, while minimising the structural knowledge distortion of traditional GIS applications and innovative techniques. PPGIS is also directed to the design of systems that specially seek to empower communities and individuals and encourage PPGIS-based decisionmaking.

For example, Dunn et al (1997) given an idea of the potentiality of GIS used in a 'nontraditional' way, where official statistics are not always available for planning. Sketch maps, including cognitive maps, are, according to the authors, an important source of insight into multiple realities and group interests. Further examples of such GIS applications are found in the literature mostly in the United States and United Kingdom (see Al-Kodmany, 1998; Barndt, 1998; Bosworth and Donovan, 1998; Casey and Pederson, 1998; Howard, 1998; Kingston, 1998; Kingston et al, 1999; Krygier, 1998; Parker, 1998; Weiner and Harris, 1999). Such practice has been an exception in GIS applications in Sweden as in many other European countries.

We address here the inclusion of GIS technology in local planning as an auxiliary tool in decisionmaking. The argument is based on examples taken from GIS applications in a programme for residential renewal in Sweden (see Ceccato, 1998). This use of GIS can be seen as an attempt to show how GIS can be used effectively by the community involved. The intention is to incorporate simple techniques in the planning process and to produce results that can be easily used by those who are not experts in GIS but are directly involved in decisionmaking. The novelty with this GIS application is that it not only uses aggregated statistics but also incorporates an alternative approach based on the inhabitants' judgments and mental maps, thus contributing to goals of democracy and to more reliable planning action.

2 GIS in local planning: the case of a programme for residential renewal

The Swedish government has been investing during the last few years in long-term urban renewal programmes to combat the negative effects of ongoing social, economic, and ethnic segregation in large cities. The area of Jordbro in Haninge municipality has been chosen to receive part of these investments, as have eleven other residential areas in Stockholm County. An assessment of Jordbro's problems and potential based on available statistics and residents' own judgments was made in the so-called Jordbro Project. The project is a programme for renewal of residential areas which was started in 1995 with the aim of improving the quality of life of those who live in the suburb of Jordbro. The main goals of the project are to increase well being, security, participation, and quality of life based on resources currently existing in the residential areas. The intention has been to create a network of enablers that support a positive development. Each project leader has formulated a vision for each of a set of resource centres. The contribution of each centre has been discussed closely among the project leaders as well as with other local actors, including the inhabitants (Jordbro Project, 1997).

It was believed that the use of GIS technology could help to target resources to the neediest areas, and thus contribute directly to residents' welfare. An indication of the validity of the incorporation of GIS technology as an auxiliary tool in local planning was also expected. From the beginning of this experience, there was a general awareness that GIS implementation in local planning was not free of problems. When a bottom-up approach is used and information is gathered by means of questionnaires, there is a risk of overrepresentation of certain groups in detriment of others. Besides, the obstacles, as Barndt (1998) points out, can often be related to limited resources, small local organisations with nonprofessional staffs and boards, the degree of distance between grassroots organisations and government or business sectors, and fundamental political differences among many players. As Parkinson (1998) argues, the focus on geographical areas means a potential for the improvement of the prospects of excluded areas by strategically linking them to more prosperous parts of the city. This could also improve service delivery through the integration of policies and resources of different agencies at the local level. The expected result would be increasing community social capital and encouraging good practice and policy innovation.

The approach in the Jordbro case is similar to the so-called community-integrated GIS presented by Weiner and Harris (1998). This approach recognises GIS as an expert system but tests the capacity of the technology in the context of people and communities normally peripheral to spatial decisionmaking processes and politics. In this respect it would contain not just the cartographic and attribute information traditionally associated with GIS but would be expanded to become a forum around which issues, information, alternative perspectives, and decisions revolve. The difference here would be the explicit integration of a community's knowledge and involvement into the system rather than a system that is essentially external to a neighbourhood or community. This system should be issue driven in that local knowledge, concerns, desires, and wishes are actually incorporated and embedded as layers or objects in the GIS. Such open forum GIS have the potential to raise different concerns regarding individuals rights and confidentiality. In this form the GIS provides an arena in which the politics and conflicts of spatial decisionmaking are played out openly.

Jordbro is a residential area with about 9000 inhabitants, 24% of whom were born abroad. In this sense, Jordbro is a multicultural community. There are at least forty-eight different nationalities among the inhabitants, who come from countries such as Finland, the former Yugoslavia, Turkey, Chile, and Somalia.

The provision of houses combined with a local centre with medical care, day-care centres, schools, and other public services was part of the Swedish welfare model when Jordbro was built in the 1960s. The planning and architecture of this programme have been criticised owing to the fact that construction of these areas because focused on costs instead of quality of life. From the original idea of green areas between buildings separated by streets, what remains today are only buildings and car spaces. Parking lots have replaced several green areas. However, the problems in Jordbro are not limited to the physical environment. Increasing unemployment and the gap between socioeconomic groups do not allow residential quality of life to be considered as an isolated issue. Spatial, socioeconomic, and ethnic segregation patterns are evident between the southern and northern parts of Jordbro.

3 How is Jordbro coping: a GIS diagnosis for action

A database containing aggregated data and maps was created by using a desktop mapping system[(1)]. The aggregated statistics covered aspects of residential quality, such as housing characteristics, community safety, outdoor environment, services supply, and social links. Characteristics of the residential population were also used as background variables. Queries and simple spatial analysis based on buffers were the ain procedures used in the GIS. The address-matching tool in the GIS was used for mapping crime statistics.

The novelty with this GIS application is that it not only uses aggregated statistics but also incorporates qualitative data, basically the residents' judgments and mental maps. This attempt is in favour of the existing challenge pointed out by Weiner and Harris (1999), that blending qualitative and quantitative information and providing mechanisms for representing multiple forms of knowledge is still underdeveloped in current GIS. Thus a questionnaire[(2)] was designed in order to provide the subjective data, that is, how people evaluate their place of living.

The first part of the questionnaire contains background questions about the interviewee and his or her household. The second and most important part is composed of

[(1)] MapInfo Professional Version 5.0 (MapInfo Corporation, Troy, NY). It should be noted that virtually any of the other available desktop mapping systems could be used.

[(2)] The questionnaire in Swedish is available on request.

questions including maps referring to the residential quality of life. People could use the maps to indicate which areas they usually use for leisure, sport activities outdoors, or even to define where they feel unsafe based on their own perception. The questionnaire was sent to 1000 inhabitants in Jordbro (people between 18 and 75 years old) based on a random sample. It corresponds to 16% of Jordbro's population in those age brackets in 1997. Before the questionnaire was sent, local newspapers were informed. A letter in five different languages (Swedish, English, Turkish, Spanish, and Serbo-Croat) was also sent out. At the same time, information posters were put up all over Jordbro. Leaders of local associations were also informed about the investigation. A total of 62% of the sample responded to the questionnaire.

The questionnaire output data were entered and processed into a database[3]. Part of these were transferred to a statistical package and late to the GIS database. Open comments from each questionnaire were rewritten to the database. The intention was that those involved in the Jordbro project should have access not only to the aggregated information from the final report, but also to the inhabitants' own words.

GIS maps were employed as a simple way to put together what different groups of a local community judged as important; their needs, fears, and aspirations. Maps could give an overview of the local problems and hidden potentialities, providing support material for those involved in the Jordbro project. An analysis of the nonresponse rate has been carried out indicating which questions could be safely mapped in a GIS, based on the significance of each group or area of interest. Fewer of those living in southern Jordbro (mostly foreign-born household members) answered the questionnaire compared with those living in northern Jordbro (50% and 72%, respectively).

Extra attention was paid to the use of qualitative data in mapping. In certain cases, maps were used just for illustration purposes. This was when the information could not be generalised or made applicable to the group of interest or the spatial unit considered. A report containing a diagnosis of aspects of residential quality, such as housing characteristics, community safety, outdoor environment, service provision, and social links, was produced (Ceccato, 1998). Two examples of GIS applications with their benefits and remaining challenges will be reviewed below.

4 Making segregation patterns more visible

The quality of housing in Jordbro cannot be analysed without taking geographical segregation into consideration. Jordbro has a strong internal spatial-socioeconomic and ethnic differentiation. This phenomenon is being repeated in many urban areas around Sweden (for instance, see Molina, 1997). Private single-family houses dominate the northern part of Jordbro where mainly Swedes with more economic resources live. The southern part of Jordbro, on the other hand, is dominated by public multifamily houses, mostly rental apartments with much higher rates of unemployment and foreign-born residents. Only 15% of the inhabitants with foreign backgrounds live in single-family houses. Geographical segregation itself is not considered to be a problem. However, it is believed that the segregation can in the long term contribute to increasing inequality between groups as regards access to resources and opportunities in general. Using detailed statistics (small-area census statistics) it was possible to design a simple map pointing out the relationship between socioeconomic conditions such as type of tenancy, housing type, and ethnic composition.

One question to ask in order to evaluate the value of the results was whether the available data matched the issues that were to be addressed. It is worth noting that one disadvantage with this type of GIS spatial representation is that the maps can

[3] Microsoft Access 97 (Microsoft Corp., Redmond, WA).

exaggerate the performance of large areas that are relatively poorly populated. A partial solution is to avoid linking data directly to units of different sizes, and mapping data by using homogeneous geographical units, such as pixels. The advantage of using socioeconomic statistics in pixel format is that one can easily combine these with other types of data already in raster format. Another alternative is to produce new units based on certain criteria by using a regionalisation process (for further details, see Wise et al, 1997).

Other constraints are related more to the use of spatial information than to the spatial representation per se. For instance, there is a risk of so-called ecological fallacy[4]. This occurs when correlated aggregated values over a specific geographical area are related to the individual level. For instance, a high percentage of residents satisfied with housing and a high percentage of high-income workers in an area does not mean that all those satisfied with housing are high-income workers. This problem can create stereotypes for geographical areas or groups to which the correlation is applied. The spatial representation of a phenomenon can in other words be complemented with traditional tables of statistics or diagrams.

The pattern of social contacts between the two areas of Jordbro reflects quite well the geographical segregation. Most people have close friends or relatives with whom they associate in Jordbro and more than half of the respondents live in the same area as their friends and relatives, either in north or south Jordbro. The mean distance between the inhabitants interviewed and their friends in Jordbro is approximately half a kilometre. However, this pattern varies according to age, sex, and country of origin. Similar patterns have been found by Brolin et al (1997) when studying pupils' social contacts in Jordbro.

Maps were also used to indicate which places people pass daily in Jordbro and to draw mental maps of their neighbourhood. One of the most significant findings concerns the relationship between the patterns of segregation in Jordbro and peoples' mental maps of the neighbourhood. As an exploratory exercise, the respondents were invited to indicate which areas they perceived as being their neighbourhood. The answers were marked in freehand on a map and were later transferred to the digital map by using GIS. As many as 68% of respondents defined their neighbourhood as something other than the official boundaries of Jordbro (see also figure 1). An imaginary line dividing north and south Jordbro was often drawn as part of the resident's mental map of the neighbourhood, which corroborates the finding of segregated patterns of social contacts as indicated previously. Those who perceive the boundaries as larger than the official ones take their own place of living into consideration and often also parts of neighbouring areas. These neighbouring areas often offer services and green areas that may not exist where they live. Thus the mental boundary reflects spaces used daily and known. In a first attempt to use qualitative information and GIS, Ceccato and Snickars (1998) found similar results in other residential areas in Stockholm County, where there was a clearer relationship between mental maps of housing type and size of neighbourhood. These findings paved the way for the argument that the concept of neighbourhood implies the concept of place, which is richer than just location (around which all GIS are built; see Schroeder, 1997) and often much more important to the people who live in there.

People were also invited to indicate on a map which places they tend to visit daily and also which of these they use for outdoor activities. The urge to walk in the neighbourhood can depend on how nice the environment is perceived to be. It is possible that areas with intense traffic and, consequently, disturbing traffic noise do

[4] The term 'ecological fallacy' was first coined by Selvin (1958) and the issue had first been described by Robinson (1950).

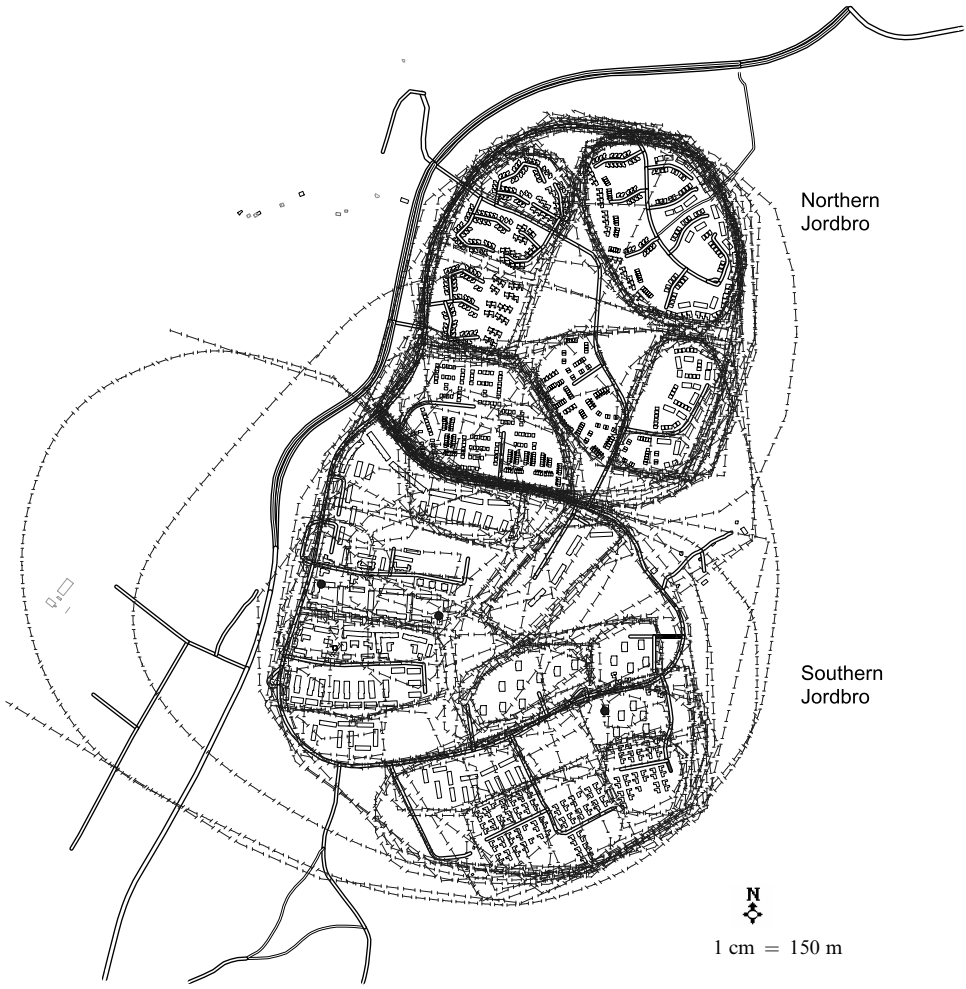

Figure 1. The mental boundaries of the neighbourhood (dashed lines represent statements by respondents by place of residence).

not stimulate people to stay or even to spend time outdoors. Badly maintained public places filled with litter are an indicator of a low attachment of the residents to the place. As a result, local meeting places, according to Gehl (1987), are reduced to bus stations or other public places where only compulsory activities take place. A sense of insecurity can also contribute to people not spending much time outdoors.

In Jordbro there are at least eighteen outdoor places that were identified by the population as areas for leisure activities and for walking. Nonobligatory activities are not confined only to the indoors. There are differences in the use of these spaces between groups of residents and seasons, but not statistically significant between north and south Jordbro, which may indicate that the use of the outdoor environment is less segregated than the patterns of social contacts. Green areas are not only residents' favourite places but also Jordbro's symbol. Regarding their quality, 85% of those interviewed were satisfied with access to these areas but almost all of them felt that there is a need for maintenance, especially among those who most use the outdoor areas. Respondents also indicated, again by using maps, which outdoor areas needed more attention from the municipality. Table 1 summarises the strengths and weaknesses of

Table 1. Strengths and weaknesses of quantitative and qualitative data in GIS for the outdoor environment.

	Strength	Weakness
Quantitative		
Location of the outdoor public spaces including those directed from compulsory to optional activities (Gehl, 1987). Information on maintenance of these outdoor areas combined with levels of traffic noise.	Relatively easy access to data. Generally accessible as official aggregated statistics. Visualisation of supply of outdoor environment. Maps indicate how outdoor areas (suitable for leisure) are distributed over the neighbourhood, allowing planners to gauge the degree of equity (Talen, 1998) and to make inferences of the future impact of predetermined neighbourhood design. It is possible to make measurements of accessibility to these outdoor spaces by using buffer analysis and defining degrees of quality based on differences in accessibility.	Data may represent an incomplete picture. One may have a complete database on supply of outdoor environment, but a substantial number of residents may have been served by other public outdoor places elsewhere. Often zone data are too crude to generate accurate results because of the high degree of heterogeneity within the areas (Barndt, 1998), and risk of ecological fallacy.
Qualitative		
Use, quality, and satisfaction of all outdoor places as well as suggestions for improvements. Frequency of place use (residents were invited to draw on a map how they move around in the neighbourhood in a weekday). Favourite outdoor place.	Maps show the kind of activities the public spaces provide for those living in the neighbourhood. Identification of mostly-used areas as a degree of environment quality and sense of security. Visualisation of the share of residents who are satisfied with the outdoor environment and also what they suggest in order to improve the quality. Suggestions for improvements of the mapped outdoor places exemplify the potential for more democratic spatial decisionmaking through greater community participation.	The acquisition of qualitative data might be expensive. Data from survey give a picture that data are dependent on time and space—the degree of generalisation is low. Risk of creating stereotypes of behaviour and attitude among the different groups of the interviewed population.

quantitative and qualitative data on the outdoor environment for analysing segregation patterns with GIS used mostly as a mapping tool.

5 Patterns of offences and the perception of safety

There seems to be a collective level of tolerance towards security that people use as a reference to define when they feel secure. When this level is surpassed through an increase in crime more people start expressing a sense of insecurity. There are aspects other than an actual increase in crime that may lead to a decrease in this level of

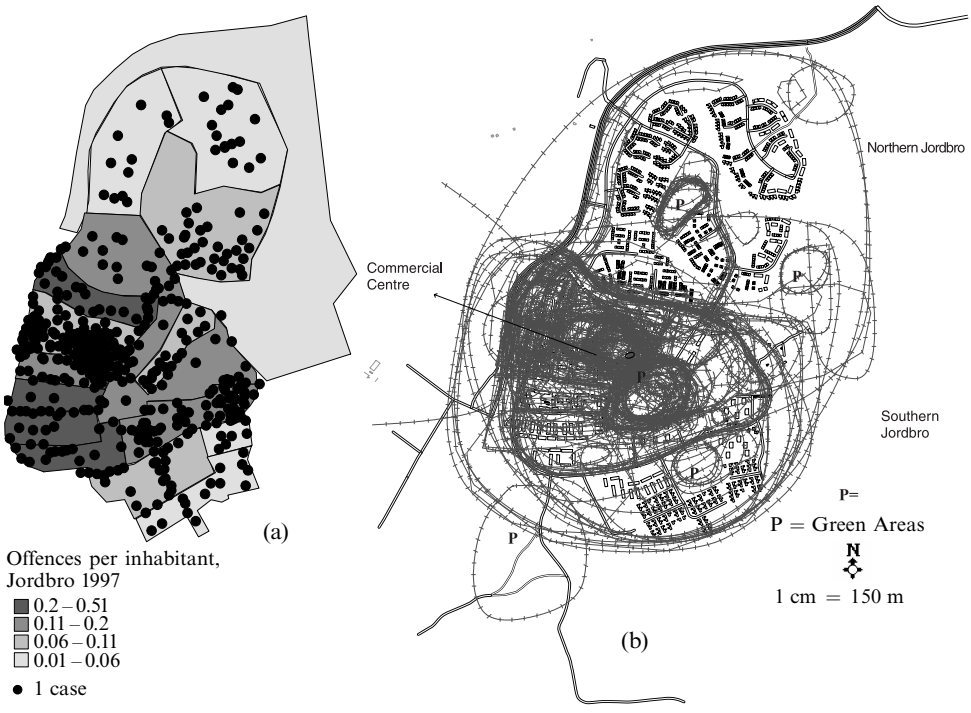

Figure 2. (a) Offences per inhabitant and (b) the perception of security in Jordbro.

tolerance. The media play a significant part in creating a picture of lack of security that is not always a reflection of reality. One may ask whether urban environments are judged as vulnerable to criminality. What is the difference between the official statistics for criminality and the people's mental map of insecurity? The main objective here was to develop a basis for analysing crime prevention measures in Jordbro, in which the local police, the schools, several resident associations, and parents could be involved.

At least 80% of all offences are committed in the southern part, especially in the rental housing areas. Burglary and theft (in houses and from and of cars) are the most common type of offences in Jordbro (see also figure 2). There is a relationship between land use and the types of offences occurring in Jordbro. The commercial centre and its surroundings with mixed land use (tram station and bus stops) seem to be more vulnerable to offences than the surroundings. Similar findings are found in the literature, for example, Hebert (1982) on residential crime in west Swansea, Loukaitou-Sideris (1999) on hot spots of bus stop crime, Maguire and Bennet (1982) on residential burglary in Great Britain, and Roos (1986) on vandalism in two types of Swedish cities. The link between mixed land use and street surveillance, as Jacobs (1961) advocates, does not appear to fit the Jordbro case. The vulnerability of places seems to vary by the hours of the day and by weekday, a common finding within environmental criminology (for instance, see Sykes, 1978).

Small-area units were used as a basis for mapping statistics of offences in Jordbro. The quality of offence data were not sufficient to map all crime occurrences by geographical coordinates. A better system of data collection by the police authorities can, in the future, lead to a geographic representation with higher reliability regarding location. There are a large number of offences in which the time of occurrence is missing. In many cases (especially for car crimes), the offence is reported hours or

days later, which makes it difficult for the victim to indicate precisely when the offence occurred. At the same time, the offence location was also missing or incomplete in several cases. This type of absence of precision in the data is an important source of lack of reliability when one wants to analyse the spatial and temporal pattern of offences. The problem of data reliability and other constraints of using crime data and perceived security in GIS are pointed out in table 2.

Table 2. Strenghts and weaknesses of quantitative and qualitative information in GIS: security.

	Strength	Weakness
Quantitative		
Records of crime occurrences (by coordinates).	Identification of possible 'hot spots', areas with high concentration of crimes. Maps highlight the distinct geographies for different types of crime. Map produces a basis for discussing the link between housing design and crime (for instance, see Coleman, 1990). The identification of differentiated levels of risk for crime over the urban fabric is fundamental to implement programmes towards crime prevention (Stollard, 1991).	One important constraint for mapping crime data is the lack of data accuracy (time and space) often related to data collection by the policy authorities (Knox, 1982). At a neighbourhood level, accuracy is more important than at larger data settings. If 10% of addresses cannot be geocoded, this could represent a large error from a neighbourhood perspective (Barndt, 1998). Examination of crime rates without recognition of the different categories of crime may limit insight into prevention strategies (Barndt, 1998).
Qualitative		
Satisfaction with security by group of residents Mental maps of the areas perceived unsafe. Suggestions for improvements.	Mental maps shed light on the relation between vulnerability of a place to crime and the perceived levels of insecurity by different groups of residents. Identification of aspects that might improve sense of safety in the neighbourhood (such as street illumination, better information on prevention, more security patrols, surveillance). Patterns of perception of security can be associated with the degree of integration of immigrants in the host society (see Wisktröm, 1991).	A constraint is that the gap between crime patterns from official statistics and pattern of perception of security might be related to the way residents are asked about their safety. Questions on perception of security must focus on the differences of crime types; it should separate, for instance, violent crimes from crimes committed against properties. Local perceptions may be different to reality. Residents may be convinced that crime problems are substantial when only small increases have occurred (Barndt, 1998).

Using GIS, it is also possible to create maps regarding the perceived safety for different groups of residents. The qualitative data in this case refer to the people's perception of their personal safety. Such information can improve the quality of information regarding crime prevention measures, which are generally based on aggregated crime occurrence data.

More than half of these respondents are satisfied with their security in Jordbro. South Jordbro is apparently perceived as more unsafe than the northern part. One interesting finding is that people from north Jordbro felt that south Jordbro is more dangerous than those who actually live there. Those who feel unsafe were invited to indicate on a map in the questionnaire the areas they avoid. These sketch maps were later transferred to the basic digital map by using GIS. The lines in figure 2 show the areas people indicate as unsafe. The map shows that those areas that are close to Jordbro commercial centre, the tram station, and the bus stop are perceived as unsafe places with disturbances, which matches quite well the pattern from the map based on official statistics. Open and less guarded green areas are also commonly perceived as less safe. However, not many offences are committed in these places, which indicates the complexity of the relation between vulnerability for crime and perception of safety. In the case of Jordbro it might be related to the way people were asked about their safety. The question should be more specific to each type of crime because each offence type presents distinct geographies and would certainly imply differences in perception of security. For instance, people, especially women, normally associated green and open areas with high risk for violent crimes, an offence that is underrepresentated in Jordbro.

The relationship between social integration and the perception of security is not statistically significant when comparing north and south Jordbro, or when comparing socioeconomic groups or different ethnic backgrounds. Social integration was measured by using indicators of stability such as how long the individual had lived in Jordbro, how often the individual talked with the neighbours, and whether the individual had friends or relatives in Jordbro with whom they have contact. Those variables were compared with answers to the question regarding fear of going out at night. It was expected that according to Wikström (1991) the sense of security is higher in socially more integrated areas, that is, the greater the integration the lower the sense of fear. Improvements to street lighting and more local police on the streets appear to be the most desired security measures. However, there were those who believed that neighbourhood cooperation against burglary, and parents' surveillance of their children, could also reduce offences in Jordbro.

6 Drawing conclusions and looking ahead

Qualitative information from individual surveys can be easily represented as input in a decisionmaking process by using GIS technology. The advantage of using maps is that specific measures can be directed to groups to support their special needs. In this way one can build a basis for discussion about the integration of different social groups in society, promoting the access to resources and democracy. The incorporation of qualitative data (for example, open comments, maps, graphs) by using different types of multimedia on the Web can open channels between those charged with developing projects to renew residential areas, residents, and other groups interested in or affected by information and policies generated in the planning process.

The challenges in using GIS as a support for planning are not linked mainly with the tool itself but with the way in which it is utilised. Among these one can point out that the map may be used to create images of needs or satisfaction among the involved groups that might not be generalised and used as a basis for planning action. Besides,

even though the explorative use of maps for showing qualitative information has an informative value, it must sometimes be used with caution. It is difficult to ascertain whether one spatial distribution of points is similar to another. The use of GIS systems in association with spatial statistical analysis seems to resolve this issue (for more details see, for example, Haining, 1990; Levine, 1996). This may include the use of decision support systems (DSS), systems that in addition to database and mapping capabilities also have a rich model base. In an urban planning context, such models would typically include spatial statistical packages, location–allocation models, advanced spatial interaction and discrete choice models, and possibly a selection of planning methods such as multicriteria evaluation. However, many of these procedures may not fit the daily requirements of local planning. They can be too demanding in terms of manpower and technical knowledge, resources that are not always available in all local governments for those involved in the planning process.

For the near future one can expect an improvement in the capacity of GIS as an instrument for helping decisionmaking via the Internet. Contrary to the scepticism of Clark (1998) there are those who believe that the Internet GIS or the Web-based GIS can provide an opportunity to extend spatial information to a much broad group of users, especially to the general public. Systems such as Web-based GIS and Internet GIS constitute a promise for a more interactive and perhaps a more democratic planning process (for the differences between the two systems, see Peng, 1999).

It is not hard to believe that Internet GIS will have important impacts on GIS users, developers, and institutions. For GIS users it provides a means of data sharing, maintenance, and dissemination besides the possibility of conducting analysis over the Web. For institutions, Internet GIS may facilitate integration and coordination of different departments because spatial data can now be made more accessible and shareable (Peng, 1999). This can in its turn contribute to the success of GIS implementation in local planning.

The most important impact for local planning is, however, the possibility of making the process more transparent for the actors, decisionmakers, interest groups, and the general public. This opens opportunities for the implementation of dynamic and interactive forums around relevant questions for planning where people at large should be invited to participate. For the future it is expected that investments in education directed to GIS could be a priority in order to diminish the lack of competence among staff and potential users in local governments, which is an important obstacle to its development in many European countries.

In the experience from the Jordbro Project, a step towards a more transparent local planning process by using GIS has already been taken. The Internet is already making the planning process more transparent, for instance, through the project home-page[(5)]. Implementation of an information-sharing framework in which the Internet GIS would be a tool for facilitating direct public participation can be seen as a new challenge for the future. Internet GIS associated with multimedia could function as a *common arena* to facilitate the integration and coordination of information among municipal agencies, between public and private actors, NGOs, and citizens in general. Developing such interactive systems locally could allow citizens to assess public services and monitor changes, while also affording the chance for creative alternatives to arise from their own participation in the process leading to more balanced decisionmaking in the long run. Encouraging findings from an ongoing research programme in the United Kingdom show that "... participatory on-line systems are a useful means of informing and engaging the public. This provides mechanisms for the exploration, experimentation and formulation of decision alternatives by the public in future planning processes and

[(5)] http://w1.860.telia.com/~u86000482/jordbroprojekt/projekt/indexjp2.htm (in Swedish).

has the potential to bring the public closer to a participatory planning system" (Kingston et al, 1999).

The arguments suggested above imply the development of new roles and responsibilities not only for professionals who now manage GIS but also for all those directly involved in local decisionmaking, including citizens. The role of GIS professionals seems to be directed towards the public affected by the data they maintain as well as to the needs of their employing institutions. Examples of the results of close cooperation between GIS specialists and elementary schools have existed in the United States since the early 1990s.

This development also leads to new research questions regarding the use of GIS in local planning. One may ask to what extent the new communication technologies and infrastructures, such as the Internet GIS, can be used to improve public participation in local decisionmaking. Based on the experience of Nordic countries so far, one central issue will be to verify whether information flows can be improved between planning actors through, for instance, an information-sharing framework. More practical experiences of this kind should give bases for assessing the main obstacles—technical, legal, institutional, and cultural—that hinder the integration of information between those involved in decisionmaking by using Internet GIS. Issues of confidentiality and privacy are unlikely to be resolved in the short run because new mechanisms and norms need to be established to promote the flow of information, yet protecting the rights of individual privacy. The forecast is that a rapid development will occur in this field. In this context it is important to be able to report on positive experience from using GIS as a vehicle for the interaction between researchers, policymakers, and the general public, as has been done in this paper.

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