Habitat International 33 (2009) 387–396

Contents lists available at ScienceDirect

Habitat International

journal homepage: www.elsevier.com/locate/habitatint

The use of GIS and indicators to monitor intra-urban inequalities. A case study in Rosario, Argentina

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Keywords:
Intra-urban inequalities
Urban indicators
Geographic Information Systems
Argentina

A B S T R A C T

This article presents a methodology that combines the use of urban indicators and Geographical Information Systems (GIS) as a valid diagnostic and prescriptive tool to generate policy relevant information on the complex and multidimensional aspects of spatial inequalities. This methodology allows the systematic monitoring of the most relevant aspects of intra-urban inequalities through an indicator matrix and an approach to incorporate a geographical component into the participatory budget allocation. GIS-based indicators are constructed combining different data sources such as census and administrative data. This methodology is applied in a case study in Rosario (Argentina) and demonstrates how urban indicators and GIS combined are a valuable tool to describe and monitor inequality aspects such as quality-of-life conditions and access to services in order to better target resources.

Introduction

Since the Agenda 21 declaration, the reduction of inequalities within cities has been mentioned as important for sustainable development (European Commission, DG XI (1994), in Mega, 1996; UNCHS, 2001; United Nations, 1992b). Besides, it is indicated that if extreme inequalities are not tackled there will be no progress towards achieving the Millennium Development Goals (UNDP, 2005).

Spatial inequality occurs in urban areas around the world. However, inequalities in habitat conditions or access to social and physical infrastructure are particularly evident in cities in developing countries. In these cities, problems concentrate in certain areas, affecting the quality-of-life of those living in the area. Besides, the increasing gap between better-off and worse-off neighbourhoods persuades policy makers to compensate for disparities and target these deprived areas. However, many cities suffer from an information crisis that undermines their capacity to develop effective urban policy (Moor, 2000). These cities do not have a sustained or systematic approach to assessing the urban problems and cannot evaluate the success of the implemented policies. Urban indicators are seen as a tool that can improve this situation (Moor, 2000). There is also recognition that Geographical Information Systems (GIS) can be used for the collection and analysis of urban indicators. GIS and indicators can help to monitor inequalities, target deprived areas, set priorities, and reallocate resources.

Chapter 4 of Agenda 21 (“Information for decision-making”) specifically promotes the use of information and indicators, and in Chapter 3 the importance of targeting areas is emphasised (United Nations, 1992a).

While many studies have been proposed for monitoring urban poverty and urban sustainability, and indicators have been formulated at global (e.g. Millennium Development Goals), national and city levels, further research is needed to monitor spatial inequality within cities, and in the developing world in particular. Moreover, even though experience in the use of GIS and indicators for urban planning is increasing, there is a much greater need to emphasise inequality issues rather than poverty issues.

The methodology presented in this article intends to help in the application of remedy policies by better understanding the complex and multidimensional aspects of spatial inequalities and better targeting resources. Remedy policies and urban planning actions would reduce spatial inequality and result in a more sustainable urban environment, since it is agreed that social equity is a precondition for the achievement of sustainability.[1] This could

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[1] Inequitable distribution of wealth both causes unsustainable behaviour and makes it harder to change (Mega, 1995).

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doi:10.1016/j.habitatint.2008.12.003

also help to improve governance since better governance implies that policy makers are aware of the needs and differences within the civil society.

The first section of this article describes the problem of spatial inequalities and its policy context. The second section concentrates on the effective use of spatial indicators and describes why GIS can help in their operationalization. The third section describes the characteristics of the case study area, its local policy context and explains the selection of GIS-based indicators. The fourth section presents the empirical application of the methodology and deals with the analysis of inequalities in Rosario. The case study demonstrates how urban indicators and GIS can describe and monitor inequality aspects such as quality-of-life conditions and access to physical and social infrastructure. This research proposes a transparent and easy to grasp methodology to systematically monitor the most relevant aspects of intra-urban inequalities through an indicator matrix and an approach to incorporate a geographical component into municipal budget allocation. Finally some conclusions and recommendations are presented.

Spatial inequalities and urban policy context

Economic transformation is taking place around the world, and globalisation, privatisation and deregulation are usually seen as responsible for an increase in spatial segregation, social polarisation and spatial inequalities (Castells, 1996; Harvey, 2000; Knox & Pinch, 2000; UNCHS, 2001). Recently, concern has been growing about the lack of discussion on inequality, mainly because attention has been given to urban poverty (Mitlin, Satterthwaite, & Stephens, 1996; UNDP, 2001). Increasing attention to inequality and its differentiation from poverty has been reflected in the 2001 Global Report on Human Settlements (UNCHS, 2001: 15):

> "Although absolute poverty is bad enough, it is worse when it occurs amid conditions of plenty. Relative poverty mirrors inequalities that raise important questions of equitable access to rights and resources."

This growing concern on inequalities has triggered local governments to target deprived areas. Area-based policies are one of the tools that have been applied since the 1990s to target geographical areas where problems coexist, and to improve the quality-of-life of the people living in those areas. A shift from universalist (uniform transfers budgeting) to targeted policies is identified as a trend in urban policies in the UK (Smith, 1999) and in other parts of Europe, and they are credited with providing a good framework for concerted action to counteract multiple deprivation (Andersen & van Kempen, 2003). One of the arguments in favour of geographically targeted policies is that they are justified because of the increased polarisation between deprived and more affluent areas (Smith, 1999).

In Latin America, where countries have the world's highest income inequality (UNDP, 2001), there has also been concern about improving the quality-of-life and reducing inequality through a better allocation of resources. This could be seen as a reaction to the dissemination of ideologies that put free market and reduced state intervention on the agenda in the 1980s (Devas, 1993). Urban poverty and inequality became particularly problematic in countries such as Argentina, which has undergone macroeconomic adjustments. Since the late 1990s, there has been a growing awareness among policy makers in the region of the problems that these policies have caused for the most disadvantaged.

For example, the Charter of Porto Alegre (Westendorff, 2002) was signed in January 2001 by more than 50 mayors from South America and an agreement on social cohesion was signed in May 2001 by the mayors of Montevideo (Uruguay), Belo Horizonte, Porto Alegre, Sao Paulo (Brazil) and Buenos Aires and Rosario (Argentina). They specifically addressed the importance of local government to promote social cohesion and reduce inequalities.

From the above it should be clear that the monitoring of inequalities will be greatly needed to target and redistribute municipal welfare within local governments. Studies of patterns of inequality and the use of indicators for the analysis of equity in the access to facilities have a tradition dating back many decades (Smith, 1973; Talen, 1998). The use of social indicators at sub-city level can even be traced back to the beginning of the twentieth century (Booth, 1902, in Pacione, 2001). However, some authors recognise that few studies have tried to develop GIS-based indicators to analyse, for example, the quality-of-life at neighbourhood scale (Ghose & Huxhold, 2002). In Latin America in particular, the increasing availability of census and geoinformation in digital format has been reflected in the appearance of studies dealing with the targeting of poverty areas and the monitoring of processes of social differentiation and segregation. While some studies concentrate on analysing a specific dimension of poverty such as housing needs (Martínez, 2000) others look into the integration of remote sensing and GIS to detect pockets of poverty (Hall, Malcolm, & Piwowar, 2001) and in the study of spatial segregation in particular (Peters, 2005).

Since the segregation of certain segments of the population can be the consequence of the spatial patterning of inequality (Langlois & Kitchen, 2001), the resulting patterns of inequality that emerge from this study can be further analysed in future research as underlying factors of segregation. The approach in this study emphasizes the multidimensional characteristics of intra-urban inequalities by constructing spatial urban indicators that expose the different dimensions of inequality. The following section describes how spatial urban indicators can be used to effectively target deprived areas.

Spatial urban indicators to target deprived areas

The rationale behind monitoring spatial inequalities is that those areas identified as worse-off areas should be targeted and prioritized. To assess the different urban problems and target deprived areas effectively it is required quality and small-area spatial information. Usually, urban indicators are used to monitor problems in urban areas. However, they are frequently collected at global, national and city levels but not disaggregated at district or neighbourhood level.[2] This concern is also expressed as a problem of lack of "spatially relevant indicators" (Kunzmann, 1998). When indicators are generated at high levels of aggregation they can give a misleading idea of the problem they address and quantify. In the case of measuring inequality for example, the degree of inequality observed will be very much a function of spatial scale (Smith, 1994).

To target areas effectively it is not only important to have quality data at a local scale but also to focus on and have an understanding of the way needs can be analysed. Some of the criticism of area-based policy strategies to reduce inequalities argue that targeting is not based on needs and that the areas are not homogeneous, well-known as the problem of ecological fallacy (Knox & Pinch, 2000). Inferences about individuals with data based on aggregates of people, such as provided by census data, can be misleading. Not every person living in a better-off area is necessarily well-off.

[2] One example of using indices below city level is the measurement of deprivation in the UK using census and administrative data. The latest revision of the Index of Multiple Deprivation (IMD) in 2004 included the following domains: income deprivation; employment deprivation; health deprivation and disability; education, skills and training deprivation; barriers to housing and services; living environment deprivation; and crime (ODPM, 2004).

To minimize the problems of ecologically misleading outcomes, this research focuses on the use of small-area units and low levels of aggregation and places stress on "need" more than any other distributive criteria. The solely use of derived needs via indicators can hide individual cases of need. Indicators that are traditionally constructed exclusively from census data for block group level are good for measuring indirect or derived needs but they cannot measure self-expressed needs coming from the population, nor do they reflect the "distribution of opportunities" inherent in the accessibility to social and physical infrastructure. These shortcomings can be overcome by constructing indicators using GIS because different spatial units can be employed tailored to the particular decision problem.

Since the spatial scale matters in constructing indicators, this article also illustrates the influence of scale in the appreciation of inequalities by using a multilevel approach. With the use of indicators constructed with GIS this research shows how it is possible to communicate and make visible the gap between better-off and worse-off areas and how to detect hidden need by using self-expressed need and administrative data. The indicators are constructed combining different data sources such as census data and administrative data.

The previous paragraphs also highlight some of the main functions of indicators and the potential of GIS to operationalise them. While constructing indicators, it is necessary to: organise data, to quantify and to communicate. These three indicators' functions coincide with the usually acknowledged advantages of GIS: data organisation, spatial analysis and visualisation (Ghose & Huxhold, 2002; Burrough, 1986 in: Huxhold, 1991; Webster, 1993). Besides, in the late 1990s the value and potential of GIS to construct intra-urban indicators are increased by a combination of: a growing concern on intra-urban inequalities, the implementation of area-based policies and the developments in ICT and GIS technology.

To interrogate very local inequalities more effectively it is also relevant to understand that an indicator focuses on and renders only intentionally selected areas of the reality (Innes, 1990). Innes puts it this way: "An indicator is simply a set of rules for gathering and organizing data so they can be assigned meaning"…"An indicator, like a piece of research, highlights certain aspects of a situation at the expense of others. It allows observers to 'see' the world through a particular lens" (Innes, 1990: 5). This definition clearly poses the importance of identifying a problem perspective from where to tackle intra-urban inequalities.

To justify that inequalities in cities really matter it is necessary to consider an approach from a social justice perspective. In the case study presented in this article, indicators are used to describe spatial inequality and can be related to the policy objective of targeting intra-urban inequalities. When there is a need to monitor or describe inequalities, it is implied that with the use of planning tools there is the intention to change, improve and/or solve this problem. Hence, there is a concern with what the city should be, and some form of redistributive or compensatory action. Smith (1994) considers that justice involves treating people fairly, which in distributive justice means that whatever is being distributed should go to people in the right quantities. He expresses that "fairness" means that people in the same circumstances should be treated in the same way. A difference can be made between arithmetic equality and proportional equality. In arithmetic equality everyone is getting exactly the same quantity of something and in proportional equality the distribution is justified according to a certain criteria such as need or market demand. Choosing a social justice perspective implies that we are concerned with the question of who gets what where and how, and more precisely who should get what *where* and how (Smith 1977 in: Pacione, 2001).

The case of Rosario (Argentina)

Rosario (Argentina) is the third largest city in Argentina with a population of 923,444 persons according to the 2001 census. It has different levels of housing needs and access to physical and social infrastructure with approximately 11% of the population living in slums (Fundación Banco Municipal, 1996). Inequalities became even worse after the socio-economic and political crisis that burst out in Argentina in December 2001. The percentage of people living under the poverty line in Great Rosario reached 61% in May 2003. At the same time, the number of gated communities increased during the 1990s, causing an increase in housing inequalities, disparities and social segregation (Bragos, Mateos, & Pontoni, 2001).

A policy response to tackle the disparities in the city started in 1995 when the Municipality of Rosario launched a decentralisation programme that led to the creation of six districts. The intention to reduce inequalities between the districts was explicitly stated in the objectives of the programme. In the Plan of Action the importance of comparing different geographical areas is justified "to adjust equity criteria in the assignment of resources".

Within this decentralisation process, a participatory budget process is introduced to define priority themes within the budget in a participatory way. Around 15% of the total budget for 2003 was allocated through a participatory methodology where the neighbours prioritized different activities and projects within each district. It should be noted that the participatory budget is distributed per district in equal parts (Municipalidad de Rosario, 2002).

Each of the six districts is subdivided into six or seven *areas barriales* or neighbourhood areas. Therefore there are two main administrative levels where budget allocation and compensation for inequalities can be effective: at district and neighbourhood area level. There is a clear demand from the local government to compensate for intra-district disparities and there is a clear objective to use neighbourhood areas. Since 2003 the participatory budget has included in every district a *Consejo Participativo* (participatory forum/city parliament), in which every neighbourhood area has two delegates.

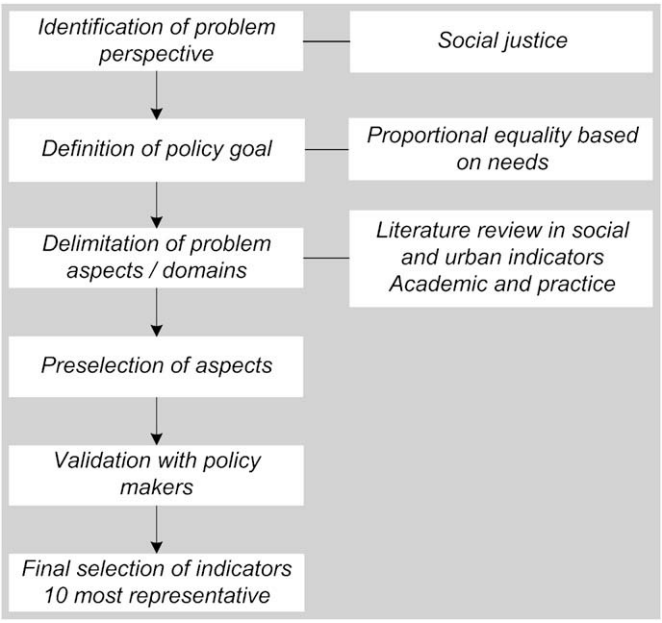

Fig. 1. Steps in the selection of inequality indicators.

Table 1
Matrix of calculated indicators at city and district level.

	Conditions/quality-of-life						Distribution of opportunities/accessibility					
	Physical environment			Socio-economic environment			Physical infrastructure		Social infrastructure			ICT infrastructure
	Overcrowding	Inadequate housing	Expressed housing deprivation	Education level	Unemployment	Health coverage	Tap water in the house	Sewage connections	Access to primary schools (in metres)	Access to health centres (in metres)	Access to day-care centres *Crecer*	Access to Internet
Rosario	**6%**	**11%**	**3%**	**51%**	**34%**	**60%**	**95%**	**66%**	**283**	**1148**	**1101**	**12%**
District												
Centro	1%	2%	1%	64%	19%	81%	99%	97%	161	2948	1692	23%
Norte	5%	10%	2%	53%	33%	61%	95%	60%	281	878	1154	11%
Sur	5%	12%	3%	48%	38%	60%	95%	73%	247	857	1262	8%
Noroeste	8%	14%	4%	48%	38%	54%	94%	40%	318	760	961	8%
Sudoeste	9%	18%	5%	41%	43%	48%	92%	46%	344	692	821	4%
Oeste	14%	22%	6%	38%	43%	42%	89%	37%	344	752	718	3%

To further analyze the policy context of Rosario a series of twenty interviews were carried out with key policy makers. The findings of these interviews show that there is a clear demand for the use of a tool that can help in monitoring intra-urban inequalities and reallocating resources to compensate for disparities. Owing to the decentralisation and participatory budgeting process taking place in the Municipality of Rosario, it was found that the GIS-based indicators could not only be introduced as a descriptive tool in the diagnostic and problem identification phase of the policy cycle but also be used as a prescriptive tool to reallocate resources in a fairer way.

Criteria for selecting and constructing GIS-based indicators

Some of the troubles already identified by the early social indicators movement in the 1960s were that they emphasised the measurement task, while often excluding political and institutional aspects (Innes, 1990). To avoid the same problems, GIS-based indicators should be easily understood and transparent to planners and decision makers as well as related to the local policy context.

Fig. 1 shows the steps followed for the selection of indicators. The first step in the selection of indicators in Rosario was the identification of a problem perspective, which resulted in a social justice perspective. Proportional equality based on needs was the policy goal inscribed in this perspective. To make a delimitation of the problem and to identify its aspects and domains a literature review of social and urban indicators was carried out as well as existing indicators initiatives. In this research, spatial inequality is considered to be a heterogeneous, multidimensional and complex phenomenon with several aspects. Two axes are distinguished: conditions of quality-of-life (both social and physical environment) and distributions of opportunities (access to social, physical and virtual infrastructures).

Finally, a validation of a pre-selected list of inequality aspects was done during interviews with policy makers. This aimed at selecting indicators that are policy relevant and policy applicable. Twenty semi-structured interviews were held in the city of Rosario with the objective to find out how local policy makers perceive inequality as a problem to solve, and to identify which aspects of inequality they found more relevant. These two objectives are closely related to a valid selection of indicators. Among the interviewees were the 10 members of the municipal cabinet and the six directors of the decentralised districts. The criterion when selecting the interviewees was to cover key decision makers in the local government not only at city level but also at district level, considering the decentralisation process that is taking place. To gain more specialised perspectives, it was also decided to extend the interviews to the directors of the Public Housing Service, the Strategic Planning Office (PER), the Origin and Destination Survey Project (Public Service Secretariat), and the Decentralisation Programme.

The reason for not validating the pre-selected aspects of inequalities with a survey based on a large sample (e.g. including different population groups) was that the final indicators and the proposed methodology for monitoring inequalities could be used not only as a descriptive but also as a prescriptive tool by local policy makers. This also explains the importance of understanding both the local policy context as well as the perspective of key policy makers in the municipal cabinet and the decentralised districts.

The interviewees were given a questionnaire with a list of 13 aspects related to inequality. They were asked to indicate how important they considered each aspect applying a 5 points Likert scale.[3]

From these interviews, it was found that the five most important aspects of inequality, according to the policy makers were: overcrowding, education, employment, water connections and accessibility to schools. This selection might be explained by the notion that most of the policy makers shared similar values about basic needs or basic rights.

Following the interviews, it was decided to include a representative set of indicators for the most important aspects of inequality suggested by the policy makers resulting in the final indicators matrix. Self-expressed housing needs, calculated by geocoding administrative data, are also included (Martínez, 2000). This matrix is able to mirror the multidimensional aspects of the phenomenon and to reflect both its socio-economic and physical aspects in the quality-of-life conditions, as well as the distribution of opportunities and accessibility.

To construct the indicators, this research specified operational definitions following UN-HABITAT criteria and the guidelines and recommendations prepared by UN-HABITAT for the Urban Indicators Programme (UNCHS, 1995, 2000a, 2000b). UN-HABITAT is

[3] The choice of a Likert scale was taken after considering several alternatives applied in indicators studies. A more participatory and consensus oriented approach than the Likert scale is the use of a Delphi survey (Hemphill, Berry, & McGreal, 2004). However, the case study of Rosario did not pursue to reach consensus among the different policy makers. A Likert scale is frequently used for measuring the level of satisfaction with different aspects of quality-of-life across the population (Tuan Seik, 2000). A similar alternative is to ask policy makers to rank pre-selected factors related to the problem to be analysed (Wong, 2002). For the case study of Rosario the advantage of using Likert over ranking is that policy makers were able to assign the importance to each aspect independently without being forced to order them. At the same time they were able to assign to different aspects the same importance.

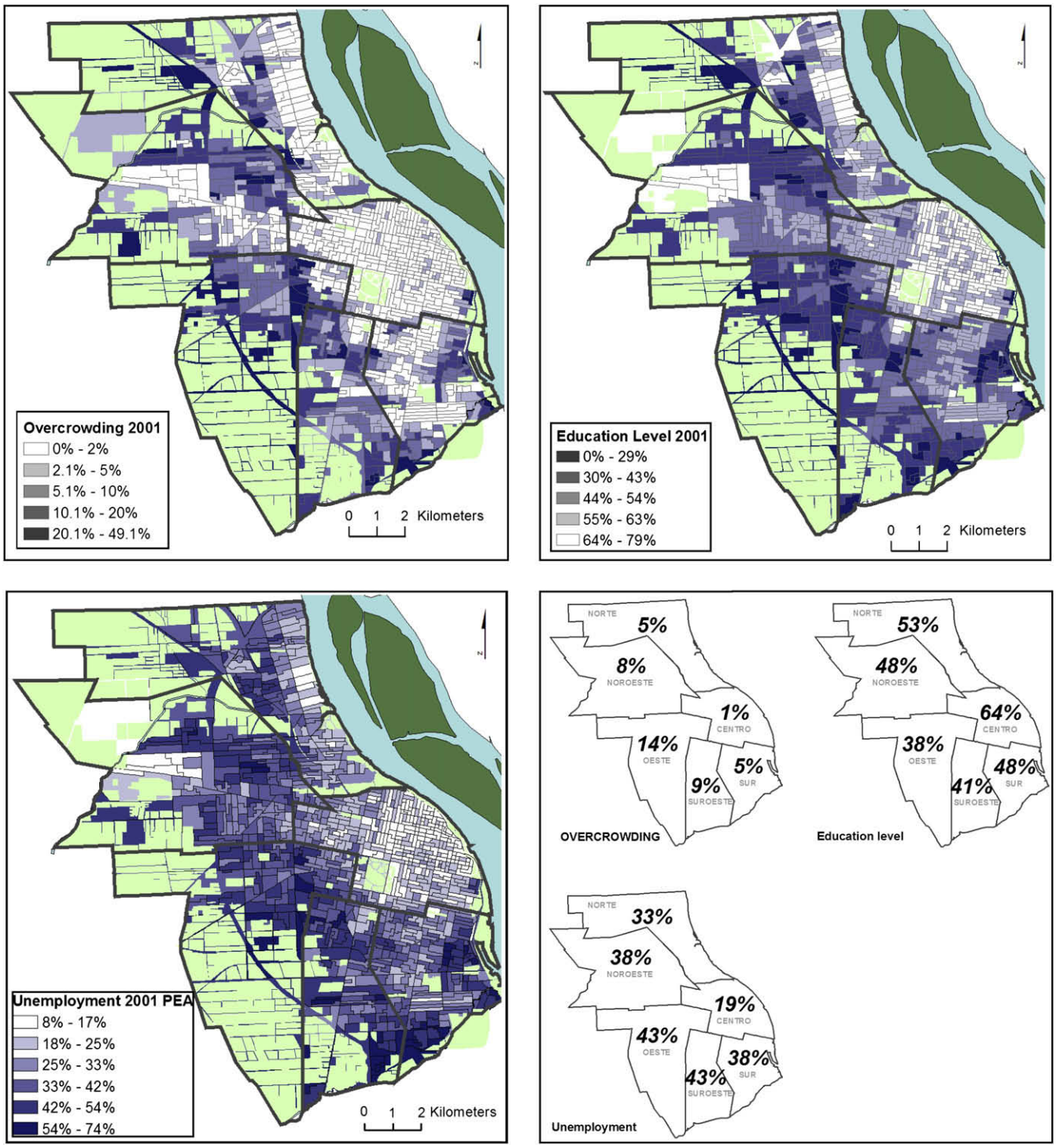

Fig. 2. Spatial patterning of inequalities in Rosario for the indicators overcrowding, education level and unemployment.

internationally recognised for its experience in the development and application of urban indicators. It is also the only international institution with a specific mandate to assemble information on urban areas (Hall & Pfeiffer, 2000: 199). Some of the criteria for selecting indicators according to UN-HABITAT are that they should be important for policy, easily understood, and should be able to be collected in a cost-effective way and on a regular basis. Another important criterion is that indicators should be disaggregated by geographical area where special needs and equity are policy issues. This criterion highlights the importance of using disaggregated urban indicators. The operational definitions were also adapted to the data sources available locally. Data availability is then one of the criteria for the selection of the indicators, in addition to policy relevance.

Monitoring and targeting intra-urban inequalities

Although the analysis of inequalities at district level is a good starting point for discovering the unbalanced situation within the

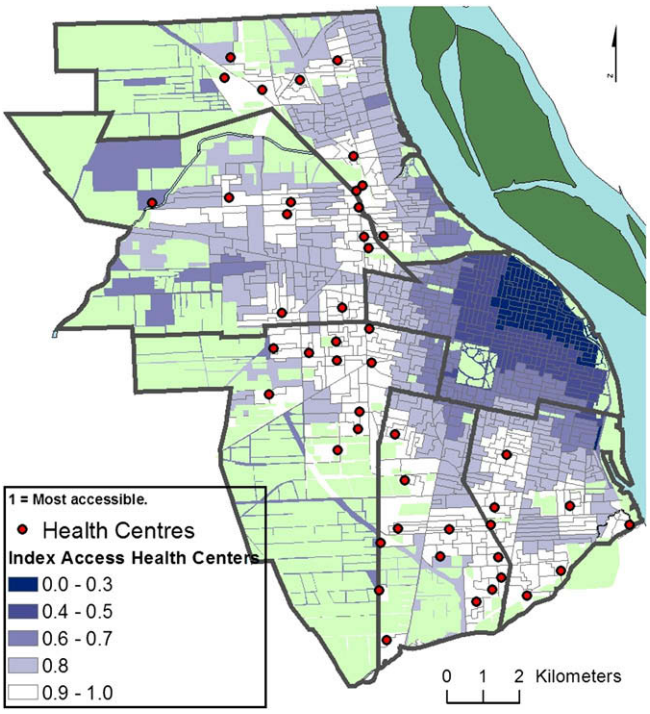

Fig. 3. Accessibility to social infrastructure in particular to primary health centre.

city, intra-urban inequalities can be further analysed at the lowest level of aggregation: the census block groups.

Within a GIS, a selection of 2001 census variables was used to construct and map the selected indicators at different levels of aggregation. The areal units of the indicators correspond to the geography of the census in Argentina. Small-area census data are available in Argentina from the National Institute of Statistics and Censuses (INDEC). The census takes place every 10 years and is a complete count census, which means that every household in the country is visited. The spatial detail of the census data is determined by the boundaries of each census tract. They are established so that every polygon has a similar amount of population regardless of its geographical size.

The city of Rosario has 56 census tracts (*fracciones*) formed of 15 block groups (*radios censales*) on average. There are a total of 901 block groups with an average of 1015 people in each. Block groups are formed by blocks (*manzanas*), the lowest level of aggregation, but for reasons of confidentiality data at such a level are not available.

This research proposes a multilevel approach to better appreciate the inequality problem. The advantage of using GIS to construct the selected indicators is clearly evident at the moment of depicting the problem at different scales. Deprived areas and contrasts that appear when moving into lower levels of aggregation, such as district or neighbourhood area, will be hidden if any indicator is analysed at city level. The results presented in Table 1 indicate that as soon as intra-urban inequalities are analysed by comparing the six districts, the spatial pattern of inequalities starts to emerge: in particular, a well-off city centre (in district "Centro") against a deprived periphery.

Fig. 2 shows some of the resulting GIS-based indicators constructed at block group level, in particular overcrowding, level of education and unemployment. The best-off areas are shown in white and the worst-off areas in dark. For each indicator the typical spatial patterning of inequality can be found with a concentration of needs in certain areas (see Fig. 2). The influence of the areal unit definition in the description of inequalities is very relevant due to the scale factor. As it can be expected, spatial differences might be smaller in larger areal units of analysis. Differences within cities are so marked that averaging social indicators at district level leads to wrong diagnoses and policy allocation mistakes (Kingsley, 1999). Hence using indicators at higher levels of aggregation such as district or city level can be misleading if this problem is not contemplated.

The different GIS-based indicators selected to analyse spatial inequalities indicate the existence of a clear and profound socio-spatial differentiation and polarisation. Rosario is a dual or divided city and, as Hall (2001) suggests, this is based on the evidence of the social divisions within the city. This social polarisation also marks the spatial structure of the city with a clear existence of a better-off core and axes against a worst-off periphery.

The inequalities between the districts and within their neighbourhood areas are marked in each aspect that was considered. However, in terms of the distributions of opportunities and the accessibility to social infrastructure (primary health centres and day-care centres), the results indicate that there is a "socially progressive pattern" favouring worst-off areas.[4] This is particularly the case of health and day-care centres (Fig. 3). A correlation analyses shows that both the distribution of day-care centres "Crecer" and primary health care, favour the worst-off households: the unemployed, lowly educated and health-vulnerable.

Gap analysis

Indicators can describe inequalities in quality-of-life and access to physical and social infrastructure. However, it is in the analysis of the gaps between best-off and worst-off areas that the inequality problem becomes more evident. By describing gaps, it can be seen how (un)equal different areas are. One approach to analyse the intra-urban inequalities is to measure the gap between census block groups. By comparing the best-off block group and the worst-off block group, and the best 10% and worst 10%, it is possible to appreciate the considerable gap between them (Table 2).

The gaps between these two extreme groups are noticeable; for example, the percentage of overcrowding affecting households in the worst-off 10% of the block groups is 13–50 times greater than in the best-off deciles.

For compensatory policies and for the application of indicators at a prescriptive level it is very important to communicate the gap

Table 2
Gaps between best-off and worst-off areas for the five most important aspects of inequality according to policy maker.

	Overcrowding	Education level	Unemployment	Tap water inside the dwelling	Access to schools
Best-off block group	0%	79%	8 %	100%	9 m
Worst-off block group	49%	9%	74%	18%	2995 m
Best 10%	0%	67–79%	8–15 %	100%	9–100 m
Worst 10%	13–49%	9–34%	47–74%	18–88%	551–2995 m

[4] This indicator was constructed calculating the distance from the centroids of the census block groups to the nearest primary care health services. Minimum distance (measured in metres) was chosen as the accessibility measure since it can be easily communicated to policy makers and because in the case of primary care health services the externality effect is minimum (e.g. primary health facilities are mostly used by people living within the neighbourhood). The resulting map enabled every census block group to be re-classified according to its accessibility indicators from 0 to 1 (most accessible).

between different administrative areas: city, districts, and neighbourhood areas. The indicator of overcrowding is a good example to show how intra-urban indicators can clearly expose inequality. Fig. 4 shows how the problem of overcrowding becomes more evident when the indicator is disaggregated at different levels of administrative units.

The gaps between districts and their best and worst-off neighbourhood areas are also notorious. Starting at city level Rosario has an overcrowding of 6%, however when overcrowding is analysed at district level the inequalities among them start to emerge. At the lowest administrative level, the gap between the overcrowding of the best-off and worst-off neighbourhood areas is even bigger. It also seems that districts with more overcrowding are also more unequal internally. In that sense, the district "Oeste" is the most overcrowded district and also with the highest disparity between the best-off and worst-off neighbourhood area.

Finding "hidden need" with GIS

Indicators from census data are good to measure indirect need but they cannot measure self-expressed demand coming from the population. While imputed need (or derived need) can be evaluated indirectly by inference from locational information by means of need indicators, expressed demand can be evaluated directly by recording the expressions of demand by members of the public (Webster, 1993). In the case of housing needs, for example, needs can be evaluated indirectly by means of indicators by calculating the percentage of overcrowded households per census block group. On the other hand, self-expressed demand or need is evaluated directly by recording the expressions of demand by citizens who claim that they have a housing need and therefore need a housing solution (e.g. a bigger house or with more rooms). The number of registered demands for good housing is also considered a good indicator of the unsatisfied needs and may serve as an alternative indicator (Mega & Pedersen, 1998).

Another useful data source to describe inequalities at a low level of detail where census data is not available are administrative databases available at local governments. For example, data from the Public Housing Office (SPV) which contain cases of self-expressed demand for housing solutions. In this research to detect where the self-expressed demand is coming from and concentrates, a point map is produced from that database. The GIS operations geocoding and address matching were used to map the expressed demand. Through geocoding the approximate location of an address can be determined by matching the street names and house numbers of the street map and the attribute table containing the address of the person that voluntarily went to the SPV office and asked for a housing solution or expressed his housing problem.

This approach proved to be efficient to detect cases of housing needs in those areas where derived demand via indicators is showing lower levels of demand or hiding the situation at all. This can help in the detection of the "new poor" normally hidden by many indicators derived from census data. This new poverty is scattered throughout the cities; the people concerned are not living in recognisably poor neighbourhoods but can be found in any middle-class apartment block (Minujin, 1995). The same author explains that contrary to the structural poor, the new poor do not live in the slum areas, they have smaller families, they are better educated, and they have landed up in this situation owing to job loss or a drop in real income.

Fig. 5 illustrates how points of individuals expressing their housing needs were "hidden" in an area classified as within the 10% best-off block groups. At the same time, if we analyse the neighbourhood area (on the left map) we can see how two extreme realities are close to each other: there is a block group (hatched polygon) which belongs to the best 10% areas only 400 m to a block group which belongs to the worst 10% area (grey polygon).

The inclusion of expressed need can help to detect those individuals that might be left out from compensatory policies based on geographical areas. These findings demonstrate how important it is

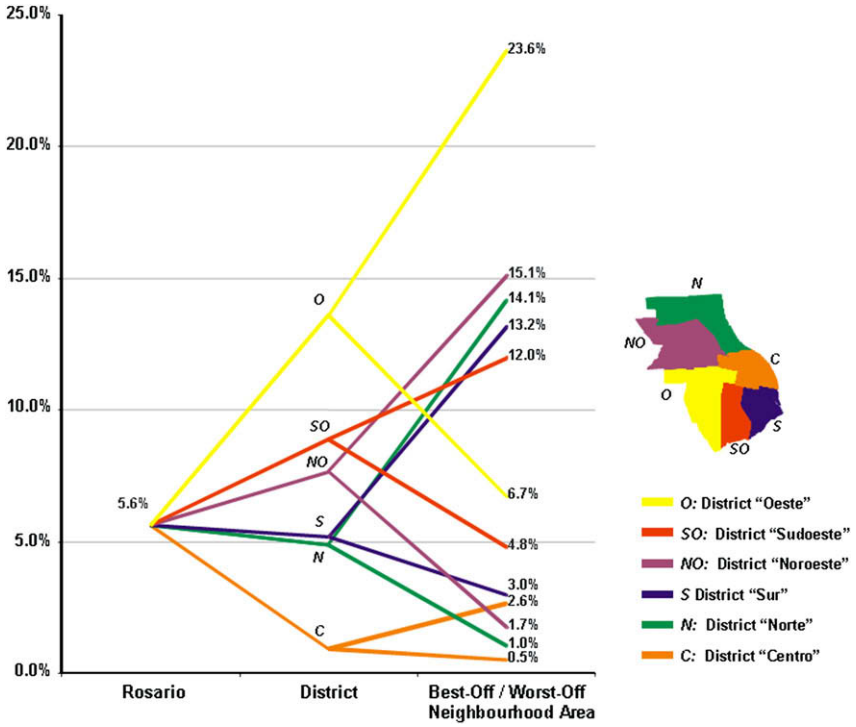

Fig. 4. Overcrowding at city, district level, and gap worst-off/best-off neighbourhood area.

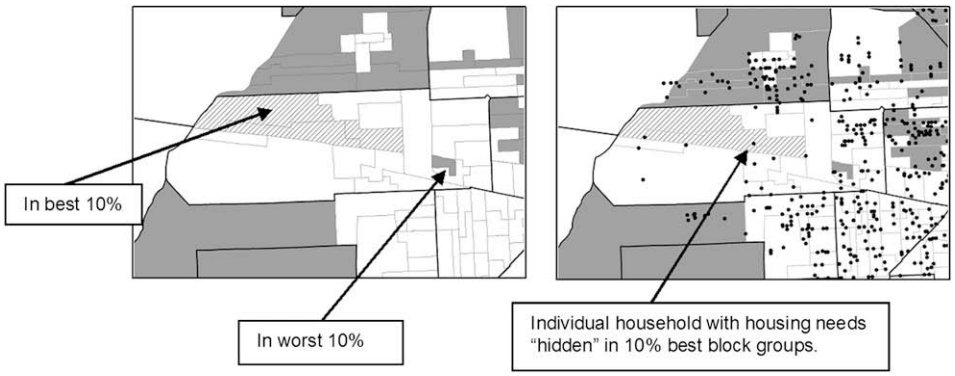

Fig. 5. Neighbourhood areas with contrasting realities. Each dot represents the demand from one family.

to include self-expressed needs indicators to detect deprived people living in better-off areas. This is closely related to the issue of ecological fallacy previously discussed. Making inferences about individuals with data based on aggregates of people, such as census data, can be misleading. Not every person living in a better-off area is necessarily well-off. This study encourages the application of area-based policies, but without omitting to target the "new areas of need" that might appear for example in the city centre (traditionally the best-off area) and that are averaged out by being located in wealthy areas. In this respect, and to apply people-based policies, mapping the expressed need can help in identifying where individual need is concentrated.

If the deprived areas obtained in this research are compared with those obtained by mapping pockets of poverty using remote sensing and satellite imagery (Hall et al., 2001), it is worth noting that some deprived areas do not show up when exclusively using remote sensing and the physical aspects of the house. Individual cases "hidden" in a well-off area or socio-economic aspects such as unemployment are certainly not captured by remote sensing techniques. Furthermore, since poverty in Argentina has grown particularly in the middle-class neighbourhoods, it should not be considered that poverty is restricted to specific, clearly defined areas such as villas (slum areas); rather it is a phenomenon that crosses neighbourhoods (Prevot Schapira, 2002). Having said that, the use of high spatial resolution imagery could be a strategy to follow up the change in slum areas in Rosario, and during the inter-census gaps in particular.

Using GIS-based indicators for area-based budgeting

One of the arguments given in favour of geographically targeted policies (Smith, 1999) is that due to the concentration of problems, targeted resources are more effective since a greater number of deprived people are reached. As it is indicated by the correlation between different indicators, in Rosario the areas of need correlate with each other increasing the negative burden on the population living in those areas. For that reason, targeting priority areas can be used as a complement for other socially sensitive policies. It should be also noticed that individuals living in deprived areas are double disadvantaged: they are poor themselves but they are "trapped" in a deprived area that increases their needs.

Following a social justice perspective, GIS-based indicators should facilitate equity in local government investments. As it was indicated in The case of Rosario (Argentina), the local government of Rosario has explicitly stated in the objectives of the Decentralisation Programme the intention to reduce inequalities. However it should be noted that until now every district has received the same share of the participatory budget independent of its needs. However, a more equitable distribution of resources is indicated as a "future challenge" for the participatory budgeting (Bifarello, 2005: 123).

In that sense, GIS-based indicators could be used to let policy makers know where to target first, and how much – or to which proportion – invest. Here it is proposed the ranking of areas according to the intensity of problems or need of intervention and the allocation of budget within the context of the participatory budget. The participatory budget approach as it is implemented now helps to identify themes perceived as urgent by the population. On the other hand, with the use of GIS-based indicators, an "area-based budgeting" could help to identify the geographical areas where the needs are concentrated.

From a correlation analysis of the indicators, it was found that a household suffering from overcrowding is more likely to suffer from every other aspect of inequality, for that reason and because it was the aspect of inequality most valued by policy makers it is suggested to base the ranking of the most deprived districts on overcrowding.

As an illustration, it is proposed that one third of the participatory budget could be re-oriented to guarantee the investment on the worse-off neighbourhood areas. The prioritized neighbourhood areas (see Fig. 6) can be defined using different cutting points between best-off and worst-off areas. One option is to use the overcrowding measured at city level (city average) as a cutting point. Another option, it is to aim at the 10 worst-off neighbourhoods. Finally, a certain percentage of the affected population can be aimed, for example 50% of the overcrowded households. In any case, the final decision to include or not a neighbourhood area should be taken by policy makers in context with other criteria such as the existence of other programmes in the neighbourhood area. Therefore, here it is proposed that the area-based intervention should be co-ordinated at district as well at city level and that the need of deprived people within better-off areas (not targeted) should be monitored with the combined use of self-expressed needs.

The area-based budget is distributed among the prioritized neighbourhood areas proportionally to their amount of overcrowded households. As a result, neighbourhood areas in greater need will have a higher share of the budget. This follows the social justice approach of proportional equality based on needs. The allocation of the resources might be done in consultation with the directors of the districts and the "Consejo Participativo" (participatory forum/city parliament) where every neighbourhood area has two delegates. Policy makers should finally determine which programme or activity can make use of the budget with the condition that they should be geographically located in the prioritized areas. A common concerted action within a partnership would be the approach for the intervention.

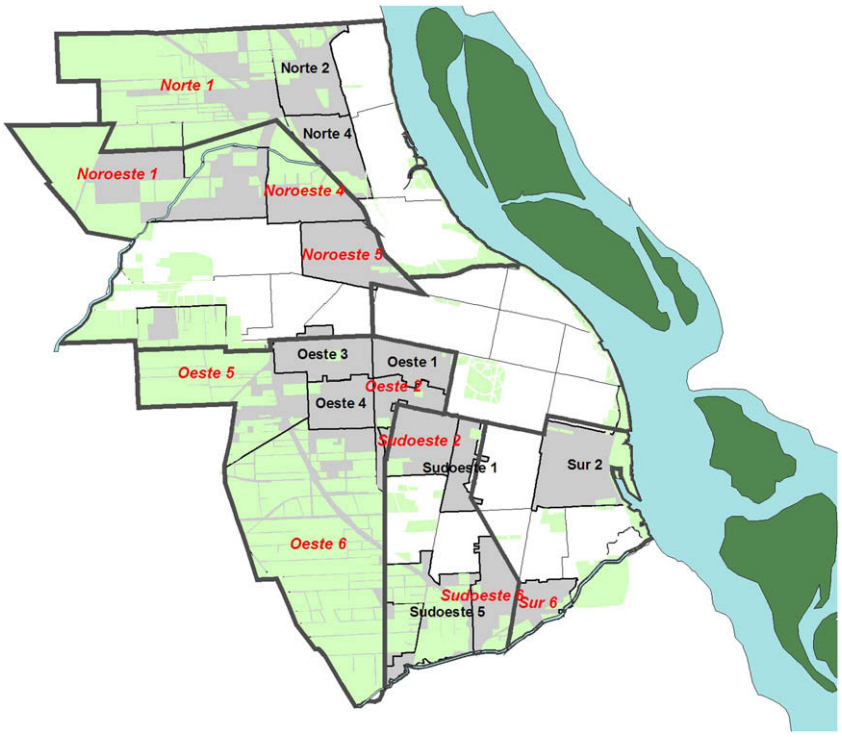

Fig. 6. Prioritized neighbourhood areas proportional to need. Ranked on overcrowding above city level, in italic Worst 10.

A "thematic refinement" can be done with the use of other indicators. An example is to target census block groups with low education level and high unemployment to implement training policies. A "target group refinement" can be done taking into account population groups such as children.

Conclusions

The approach chosen to monitor intra-urban inequalities with GIS-based indicators consisted of a methodology that took policy makers into consideration in the selection of indicators and scale issues in the monitoring of gaps.

The research presented in this article helps in the application of remedy policies by better understanding intra-urban inequalities and better targeting resources. This is particularly useful for policy makers who have to diagnose inequality problems, set priorities, and target worst-off areas.

This research shows that GIS-based indicators constructed from census and administrative data can be used to identify the most disadvantaged neighbourhood areas and to measure the gap between the best-off and worst-off areas. The use of GIS has clearly facilitated the construction of indicators from census block group data. To operationalise these indicators, it is necessary to organise data, to quantify and to communicate. In this case, it was possible to integrate different data sources such as census and administrative data, to quantify needs and analyse the gaps between best-off and worst-off areas, and to generate maps to communicate and detect problem areas. The multilevel analysis of inequality at city, district and neighbourhood levels also proved to be useful for describing gaps and making them visible.

Another strong GIS capability is the construction of self-expressed need indicators. The inclusion of self-expressed need, calculated after geocoding administrative data, proved to be useful in detecting deprived households "hidden" in better-off areas. As a result of this research, the use of both derived and self-expressed need can be suggested. This is particularly sensitive if area-based and people-based policies have to be implemented. While derived need via individual indicators and an index of inequalities can catch the concentrated and predominant aspects of inequality, the expressed need can depict the individual cases that are in need and might be "hidden" or averaged out in a well-off area. The ecological fallacy of area-based policies can then be overcome. In other words, while area-based policies consider a multidimensional approach, the inclusion of expressed need can help to detect those individuals that might be left out from compensatory policies based on geographical areas.

This research also addresses spatial inequality through a budget redistribution with a geographical component. A social justice perspective (fairness in distribution), with proportional equality based on needs is considered.

Finally, it should be recommended that to succeed in the adoption of GIS-based indicators they should be able to respond to the local needs and be policy demand driven. At the same time it is desirable to include local policy makers in the selection and evaluation of indicators, as well as the communication of indicators to citizens before and after the application of area-based policies.

Acknowledgements

The research presented here was carried out in preparation for the author's PhD dissertation thesis: Martinez-Martin (2005) "Monitoring intra-urban inequalities with GIS-based indicators. With a case study in Rosario, Argentina". ITC Dissertation Series No. 127, thesis Utrecht University and ITC. The author wishes to thank his PhD promoters Prof. Dr. F. I. Masser and Prof. Dr. H.F.L. Ottens.

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