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Proposal and application of an environmental quality index for the Metropolitan Area of Buenos Aires, Argentina

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The development and use of indicators and indices is increasingly necessary to understand and properly size matters connected with the living conditions of the population at different levels. In Argentina, however, there is delay in the production of environmental indices in relation to others associated with social and economic variables. To fill this gap this paper proposes the development of an Environmental Quality Index (EQI) composed of 23 variables grouped into three indicators: (1) nature-based recreational resources; (2) socially constructed recreational resources; and (3) environmental problems. The index is applied to the Metropolitan Area of Buenos Aires (Argentina) at a municipal level. The mapping of the environmental contrasts and spatial inequities of this megalopolis indicates the utility of the index which can also be used to formulate appropriate policies for environmental planning.

Keywords: Environmental Quality Index; Metropolitan Area of Buenos Aires; nature-based recreational resources; socially constructed recreational resources; environmental problems

Introduction

Indices combining social, economic and environmental variables can be used to inform the general public and decision-makers about the ongoing living conditions of the population. The current relevance of environmental indices lies in the concern some social groups express regarding the environmental aspects of development and social welfare, which means that there is a constant requirement for more sophisticated environmental information. The major constraints for the elaboration of an index are the accessibility, availability and reliability of statistical data, particularly those describing characteristics at an urban or a municipal level. Moreover, information aggregation and simplification, with the aim of popularising science, reduces the analytical power of the results, although, in turn, it allows all sectors of society to view a large amount of summarised data (Tanguay et al., 2010).

Different organisations at national, provincial and municipal levels periodically produce indicators describing the socio-economic context of their corresponding districts. However, environmental variables usually present scales of analysis and specific features, in addition to scattered sources of information, which render the reconciliation of the environmental data with socio-economic information difficult. Therefore, the creation of an environmental index should seek a compromise between the scale of analysis, information availability and compatibility.

The development and monitoring of an index can be undertaken by means of two approaches: objective and subjective. The former is based on secondary sources of information, while the latter can be considered a complement to 'cold' objective data. Both can be used complementarily, while recognising the scope and limitations of each approach (Sterimberg et al. 2004). An index may consist of qualitative and quantitative indicators, yet most definitions of environmental indicators exclude, either explicitly or implicitly, the application of qualitative indicators and restrict the elaboration of indices to numeric variables. Qualitative indicators, however, may be preferred to quantitative indicators at least in three cases: (1) when there is no quantitative information available; (2) when the attribute of interest is inherently non-quantifiable (as with many cultural or political variables); and (3) when cost considerations become decisive. Indicators based on observational data are called 'qualitative indicators', but become standardised and comparable only when transformed into numerical figures. They are tools for communication, evaluation

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and decision-making that can take quantitative as well as qualitative forms depending on the purpose of the indicator (Gallopin, 1996, 2006). The use of subjective approaches is already present in the environmental field: it is a very common practice in environmental impact assessment (EIA), mainly based on professional expertise. The appraisals of experts engaged in an environmental impact assessment play a significant role in their results due to the considerable subjective decision-making upon which EIA is based (Wilkins, 2003, p. 401). Indeed some parallelism exists between this statement and our proposal of variables selection and measurement, in which, just like in the EIA, professional expertise, intuition and value judgment are acknowledged (Weston, 2000).

In this context, the main objective of our research is to develop an Environmental Quality Index (EQI) for the Republic of Argentina, and to analyse its spatial distribution throughout the districts (municipalities, also known as *partidos*) that constitute the Metropolitan Area of Buenos Aires (MABA, Argentina) considering all the secondary environmental data available plus the subjective information that we think should be included in a comprehensive EQI for Argentina. It is intended that this index should overcome the limitations connected with the temporal and spatial restrictions implied in the collection of environmental data with respect to the current availability of social and economic information, a problem faced by many developing countries that lack a complete environmental statistical programme, especially at large spatial scales. If the results are suitable, they could be integrated with other socio-economic variables in order to create a more comprehensive index and since it is applied at a municipal level it could also serve as a tool for local environmental planning.

Our point of departure was the detailed literature review on the subjective factors needed for urban environmental analysis elaborated by Rogerson (1999). The aim was to demonstrate that it is possible to elaborate an index integrating subjective and objective approaches, showing environmental resources (nature-based and socially constructed) disparities and environmental problems in the territory. We resorted to all the disposable objective environmental data (the few resources available for the proposed scale of analysis) as well as to the subjective data that we considered appropriate for the elaboration of a comprehensive environmental index. This index could be improved in the future with the incorporation of new data. In fact, the idea is to extrapolate it to all the municipalities of Argentina. This explains why this case study contemplates some variables, e.g. tornadoes and mining, which are not particularly relevant to the MABA.

The EQI measures the magnitude of the environmental problems affecting population welfare and in the case of subjective variables, it provides a quantification of perceptions. This research supports the notion that for a better understanding of the meaning of environmental quality, a systematic study of the interrelationships between the objective measures of the environmental phenomena and the subjective variables is required, since the quality of a place or geographic setting is basically a subjective phenomenon (Connerly and Marans, 1985). In this context, the EQI cannot be differentiated from another interdisciplinary concept of growing interest in the geographical area: the quality of life (Marans, 2003). The vagueness of this term has grouped disparate research foci under this notion on different occasions. Geographers and others working with a range of theoretical and methodological frameworks have conducted research on a variety of aspects of life quality and their effects on individuals and communities: overcrowding, natural hazards and environmental conditions, among others (Cutter, 1985; Pacione, 1990). Nonetheless the purpose of the analysis is quite simple, though ambitious at the same time: to promote better conditions of life for entire populations or particular social groups (McCann, 2004).

The proposed index requires a broad conception of the environment, since it can be seen as the different relationships established between society and the physical environment, whether built or artificially made, taking place in a delimited territorial space. It involves a simultaneous consideration of overlapping land uses (Herzer and Gurevich, 2006), mainly evidenced in large cities and in their surroundings, which produce an environment whose main feature is to be 'socially constructed', making it fundamentally different from the natural environment studied in ecology (Metzger, 2006). In general, urban indices incorporate the common environmental variables associated with pollution, water quality, transportation and security. However, a very important feature tends to be overlooked: amenities and cultural aspects. Despite the fact that several studies link tourism to the living conditions of the population, few stress the part that cultural industries play in the growth and development of a city and in improving urban aesthetics (Nissan, 1997). As a consequence, the EQI does not only consider the usual factors associated with the environmental quality but also others related to the elements of the built environment, such as urban amenities.

Economists are among the first to develop indicators and indices to understand the situation experienced by large cities. These indices are primarily based on hedonic methods or contingent valuation procedures that use implicit prices to compare the marginal consumer valuation of various goods, in agreement with the methodological perspective expressed by Kahn (2006) and the empirical approach of Gabriel et al. (2003). They can also be used at intra-level cities, as in the case of Buenos

Aires (Cruces et al. 2008). From this perspective, researchers ask themselves, as an example, about the difference between the wages paid to individuals with the same job in cities with very different crime rates. A major criticism of such procedures has been that they suffer from economic reductionism, since all the indicators considered have to be associated with monetary value, and the city is viewed exclusively as a commodity that has to be labelled as part of a long-distance competition for the attraction of capital and skilled human resources (McCann, 2004; Rogerson, 1999). This work recognises the importance of the environment, notwithstanding the constraints imposed by economics when it comes to understanding and measuring it, as it should be managed by public institutions that do not solely see the market as an allocator of environmental goods, thereby preventing an environmental quality below the desirable standard (Araña et al. 2003).

Metropolitan Area of Buenos Aires: a brief regional characterisation

The Metropolitan Area of Buenos Aires (MABA) refers to the megalopolis comprising the Autonomous City of Buenos Aires and the conurbation around it, mainly the 24 *partidos* or municipalities adjacent to it, which nonetheless do not constitute a single administrative unit (Figure 1). The conurbation spreads to the south, west and north, while to the east the River Plate (Rio de la Plata) serves as a natural boundary. In terms of population, the last census conducted in the year 2010 reported 2,891,082 inhabitants in the Autonomous City of Buenos Aires, the remaining 24 districts accounting for 9,910,282 (Instituto Nacional de Estadísticas y Censos, 2010). This means a total of 12,801,364 inhabitants in the MABA (see CONICET, 2010).

Historically, the metropolitan area that surrounds the Autonomous City of Buenos Aires has been characterised by the different processes of accumulation implemented in Argentina. The accumulation regime of import substitution (1930–1976) favoured the construction of a concentrated industrial belt in the outskirts of Buenos Aires which led to the emergence of a subspace whose structure and hierarchy not only allowed control of the process of accumulation, reproduction and recovery of capital, but also provided better living conditions (Gómez Lende, 2005). When that model was concluded, it was replaced by a neoliberal economy that substantially increased social fragmentation: in the late twentieth century, many Latin American countries such as Argentina, Chile and Uruguay undertook economic reforms that replaced the state-intervened economy with an open market economy. The neoliberals claimed that by reducing the state, adhering to monetarism and freeing the economy, dramatic growth would occur (Silva, 1993). Privatisation measures and the dismemberment of the welfare state increased unemployment and poverty rates to record levels, resulting in social fragmentation. All of

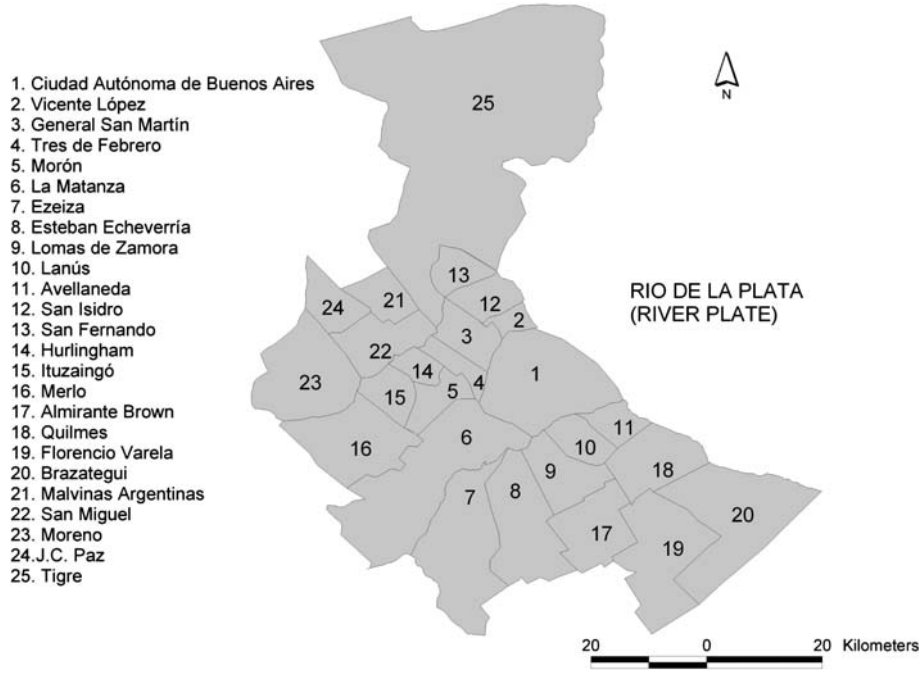

Figure 1. Location of the Metropolitan Area of Buenos Aires (Argentina).

a sudden a relatively homogeneous middle class found itself spatially and socially fragmented, forming a new socio-economic group properly called 'the new poor'.

On the other hand, the 'winners' of this process also created and consolidated their own territorial expression: gated communities that can be regarded as habitat units secured by fences or walls and a proper security infrastructure. Most are equipped with public and private schools, universities, shopping centres or malls, sports amenities that include golf courses and swimming pools or artificial lakes with marinas (Borsdorf et al. 2007). In this way, the residents of these gated communities live isolated from the environmental problems facing large cities: pollution, high crime rates, poor infrastructure, and lack of green spaces, to name a few.

The study area can be differentiated into three sectors: (1) the Autonomous City of Buenos Aires; (2) the first belt of municipalities around the Autonomous City of Buenos Aires; and (3) the second belt of districts surrounding the first one.

(1) The Autonomous City of Buenos Aires is undoubtedly the core of the region. This urbanised area enjoys many of the advantages that 'modernity' provides, and the capacity to outsource some of its costs. For instance, the city dumps the garbage in one of the districts that makes up the MABA. The presence of powerful institutions and decision-makers (national and supranational) makes the Autonomous City of Buenos Aires not only the central hub of Argentina but also the most consolidated city of the MABA. It supplies more and better services, and a higher proportion of the population participates in the prevailing socio-economic system.
(2) The first ring of suburbs is relatively consolidated, although with some degree of contradiction. The municipalities located to the north are better off than those situated in the south and west. This spatial variance is associated with negative externalities (the presence of polluting industries), less development of urban infrastructure and some environmental problems (flooding, garbage dumps, and spontaneous settlements, among others).
(3) The second ring of suburbs constitutes the area with greater problems and spatial fragmentation. The municipalities pertaining to this ring of the periphery, with high population growth rates and the poorest inhabitants in the whole metropolis, often rely on limited resources and face great difficulties in guiding their own urbanisation (Thuillier, 2005). The general use of the automobile as a means of transport for the middle and upper classes, along with the pursuit of a better 'quality of life' and security, stimulated the development of gated communities in this sector. Therefore the urban infrastructure is very asymmetric: within a radius of few kilometres, a community supplied with sophisticated services is surrounded by poor areas.

What do we mean by environmental quality?

Environmental quality is a vague concept addressed by multiple disciplines. It is often associated with other notions, also diffuse and complex, such as quality of life, sustainability and livability (Van Kamp et al. 2003). In fact, for Fishbein (1969) p. 2130, the quality of the environment really means the quality of life since it is a social phenomenon, social because man is the focus of concern. A comprehensive contribution is provided by Luengo (2002) who defines it as the optimum conditions that govern the behaviour of living space in terms of comfort related to the ecological, biological, economic, productive, socio-cultural, typological and technological dimensions. Thus, the environment quality is, by extension, the product of the interaction of these variables that constitute a healthy habitat, comfortable and able to meet the basic requirements of sustainability of individual human life and social interaction within the urban environment. Given the versatility of the concept, Escobar (2006) indicates that environmental quality can be conceived as a component of sustainable urban development, along with economic and social conditions.

Methodology

Elaboration of the Environmental Quality Index

The methodology for constructing an index is largely complex, since it should include variables grouped into indicators that model the state of a specific situation. These variables applied to a specific territory are not directly transferable to other areas, because each one has features and dynamics of its own. Therefore, the variables comprised in the elaboration of an index vary depending on the specific geographical sectors.

When grouping and weighting variables, a subjective component is always present: it is a relatively arbitrary process because no weighting structure can rationally justify the attribution of a greater weight to a given indicator (Tanguay et al., 2010). Moreover, attachment of a variable to an indicator is not definitive since some variables may belong to more than one indicator. Therefore grouping appears as a way to better organise data according to the similarity between the selected variables and the final purpose of the index.

In Argentina, several researchers developed indices at different scales considering the environmental dimension. While some were weighted using purely mathematical

procedures (Boroni et al., 2005; Cepeda et al. 2004; Marinelli et al. 1999) others resorted to direct, subjective methods (Velázquez, 2008) with similar results from a spatial analysis perspective. Meanwhile, Ramírez (2004) and Valpreda (2007) relied upon other methods to assess variables, such as the one known as analytical hierarchy process multi-criteria approach developed by Saaty (1979), based on comparisons of pairs of criteria (variables) that can be used in environmental analyses (Balasubramaniam and Voulvoulis, 2005) and in urban studies associated with life quality (Mendez & Motizuki, 2001). Lucero and Celemin (2008) assigned direct weight to the dimensions of a quality of life index for Mar del Plata city, which also included an environmental component. Celemín and Velázquez (2011) constructed an index of environmental quality for the departments of Buenos Aires province, combining subjective and objective variables. Finally, Velázquez (2010) analysed the relationship between census data related to environmental risks, which are used in this work, and the socio-economic structure of Argentina's provinces.

The EQI is composed of 23 variables (Table 1), grouped into three major indicators (dimensions):

(1) Nature-based recreational resources (30% of the weight).
(2) Socially constructed recreational resources (30% of the weight).
(3) Environmental problems (costs) (40% of the weight).

Table 1. Indicators, variables, approach and sources for the Environmental Quality Index.

Environmental Quality Index			
Indicator	Variable (fuzzy standardisation min 0, max 10)	Approach Subjective (direct) Objective (indirect)	Source
Nature-based recreational resources (30% weight)	A – Beaches	Subjective	Municipal information/field trips/satellite imagery
	B – Resort in streams. rivers and lakes	Subjective	Municipal information/field trips/satellite imagery
	C – Natural spas	Subjective	Municipal information/field trips/satellite imagery
	D – Presence of ice and snow for winter activities	Subjective	Municipal information/field trips/satellite imagery
	E – Relief from a geographic perspective is the variations in height of a land surface.	Subjective	Municipal information/field trips/satellite imagery
	F – Lakes and streams	Subjective	Municipal information/field trips/satellite imagery
	G – Parks and green open spaces	Subjective	Municipal information/field trips/satellite imagery
Socially constructed recreational resources (30% weight)	H – Urban aesthetic/urban heritage	Subjective	Municipal information/field trips
	I – Cultural centres	Subjective	Municipal information/field trips
	J – Shopping malls and other amenities	Subjective	Municipal information/field trips
	K – Sports centres	Subjective	Municipal information/field trips
Environmental problems (40% weight)	L – Use of pesticides in agriculture	Objective	Defensoría del Pueblo de la Nación. (2009)
	M – Participation of industry and mining in GDP	Objective	Instituto Nacional de Estadísticas y Censos. (2003)
	N – Pollution/Noise/Traffic	Subjective	Municipal information/field trips/Urban scale
	O – Hazardous locations	Subjective	Municipal information/field trips/satellite imagery
	P – Locations with negative externalities	Subjective	Municipal information/field trips/satellite imagery
	Q – Crime rate	Objective	Dirección Nacional de Política Criminal. (2008)
	R – Percentage of the population living in slums	Objective	Instituto Nacional de Estadísticas y Censos. (2001)
	S – Percentage of the population living near dumps (less than 300 metres)	Objective	Instituto Nacional de Estadísticas y Censos (2001)
	T – Seismicity and volcanism	Objective	Chiozza and Figueira (1982) Atlas total de la República Argentina. *Chiozza, E. and Figueira, R. Atlas of the Rep. of Argentina (1982)*
	U – Tornadoes	Objective	Geosistemas (1997)
	V – Flooding	Objective	Instituto Nacional de Estadísticas y Censos (2001)
	W – Climatic (dis)comfort	Objective	Instituto Argentino de Normalización y Certificación (1996)

While most variables are self-explanatory, like those comprising the nature-based recreational resources indicator, others deserve further description. For example, hazardous locations refer to places that produce, conduct or store hazardous materials, e.g. nuclear facilities, pipelines, refineries, and military arsenals, among others. On the other hand, locations with negative externalities (or external costs) are linked to industrial production and logistics that pollute the air, soil, and streams as well as generating heavy traffic due to product distribution. Unlike hazardous locations this variable is associated with infrastructure located near cities.

In Argentina, open pit mining is on the increase despite not being allowed in some developed countries. This activity is not present in our study area, but since our intention is to expand the index to the rest of the country, a related variable measuring mining activity in Argentina was included.

Given the large size of the country, as well as its latitudinal and altitudinal development, Argentina has a great variety of climates that favour the existence of extreme temperatures. Climatic (dis)comfort is associated with this feature, although most people in Argentina live in temperate areas, like the MABA.

For the assessment of nature-based recreational resources each place was assumed to have a predominant attraction (beaches, topography, parks, lakes, etc.). Based on its magnitude in relation to resident population, we valued the predominant appeal on a scale ranging from 0 to 10 points. Other less relevant attractions were accounted by assigning additional points according to their quality. The index is intended to be extrapolated to all the municipalities of Argentina (this explains why variables such as tornadoes or mining, which are not particularly relevant to this study area, were included). The term 'resident population' refers to the direct impact of the indicators on the local inhabitants. Some attractions – or problems – are not near to where the population resides. This is not the case of the MABA which is highly populated, but it is common in other parts of the country with very large municipalities and very low population density, e.g. the Patagonian region.

The Secretary of Tourism of Argentina produced very detailed thematic maps which localise the main natural features (from thermal spas to fly fishing maps, to name a few) in the municipalities of the country. This cartography was produced from 1996 to 2004 (Almirón et al. 2007). In the year 2005 the same organisation developed a federal strategic plan for sustainable tourism (Secretaria de Turismo, 2005). It provides comprehensive information and cartography of the touristic corridors (including natural and cultural features) for each region of the country. More recently, different national organisations produced a Basic System of Indicators of Sustainable Tourism (Sánchez, 2009) that also includes some of the indicators that we use in this study. Since all these data are associated with tourism we added parks and green spaces which are the 'main natural attractions' in non-touristic places.

Amenities are part of daily life and affect the welfare of the population. As Santos (1996) argued this is where geography can provide a significant contribution to other social sciences, because the everyday becomes defined by the place, i.e. the way people live their daily life and associate it with the territory. The valuation of socially constructed scenic and recreational resources is based on the assumption that each place usually has several attributes, which can also be valued. In this case, each 'reproducible' (constructed) resource is quantified from 0 to 10 and assigned a final score by setting a statistical mean.

For the socially constructed resources we resorted to the references mentioned in the introduction of this article. Most of them have the same factors: security, aesthetic, number of theatres, among others. However, each place has its own specific features. For example, Trip (2007) considers relevant amenities such as cafés for the cities of Amsterdam and Rotterdam. As we can see, for both types of recreational resources there is not a specific guide of factors since they vary according to the place and information availability. We try to emphasise the main features of each district (natural or social). However, unlike social features, nature-based features are non-reproducible (although they can be improved). This has an impact on their selection and differential weighting.

Despite the fact that initially we considered converting these features to 'more objective' data (establishing a ratio between lakes or green spaces and population, for example), we decided to emphasise quality as not all green spaces and streams share the same characteristics. For instance, many watercourses are highly polluted and many 'green places' are abandoned – they may even lack trees and are used as illegal garbage dumps. We had to qualify rather than quantify these features, and this is where our professional knowledge came in handy, just like a researcher conducting an environmental impact evaluation would do. The same could be applied to the socially constructed component of the index. As mentioned, a quality index should contemplate not only objective data but also perceptions (Marans, 2003) gathered from the resident population, through surveys or by qualified professionals.

Environmental problems can be construed as known processes with negative effects on the sustainability of the environment, including society. If environmental problems are not measured, there is no objective way of quantifying the magnitude of the environmental impact (Fernández, 2000). This indicator includes 12 possible problems. Unlike the two previous dimensions, this one uses primarily secondary data provided mainly by various municipal, provincial and national organisations. Not

being mutually exclusive, all problems are added prior to fuzzy standardisation, to establish the respective subtotal. As listed in Table 1, the EQI results from the weighted combination of:

(1) 30% nature-based recreational resources;
(2) 30% socially constructed recreational resources;
(3) 40% environmental problems.

Therefore:

$$((3 * \text{BNRR} + 3 * \text{SCRR}) + (4*(10\text{-EP})))/10 \quad (1)$$

where:

- BNRR = nature-based recreational resources
- SCRR = socially constructed recreational resources
- EP = environmental problems

We ran a correlation procedure, with its corresponding significance test, indicating the relationship between all variables (Figure 2).

There is a positive correlation between the presence of streams and water bodies and socially constructed recreational sites. The same tendency is displayed among most of the socially constructed recreational variables. A positive relationship also exists between this group and crime: higher crime rates are reported in the most populated areas, which also offer more constructed recreational amenities. A negative correlation can be observed between the localisation of social amenities and flooding. Even though the MABA is located on a flat surface, major infrastructure is placed in areas not prone to flooding. The independence of the nature-based recreational resources and the environmental problems variables is noted by the absence of a significant correlation between them.

We hope that the Environmental Quality Index becomes an open and participatory process in which objective and subjective variables coexist. Regarding objective data, we resorted to secondary sources, while the subjective appraisal came from personal assessment based on information collected from municipalities' websites, photos, videos, field trips, and our long-time residence in the study area. Undoubtedly, the Internet appears as the primary source of information from which subjective data can be collected for this kind of research. The variables and weights can be downloaded from http://www.cig.org.ar (Centro de Investigaciones Geograficas-Universidad Nacional del Centro de la Provincia de Buenos Aires).

Results and discussion

Nature-based recreational resources

The map (Figure 3) highlights the two municipalities with greater presence of these types of resources (from 4.86 to 6.75 points). This group is situated to the north, on the shore of the Rio de la Plata. Here the *delta del Tigre* is the main scenic and recreational resource. The presence of small islands, waterways and vegetation creates an attractive context for recreation and leisure not

Correlations

Variables	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W
A	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
B	a	1	a	a	-.057	.686**	-.146	.461*	.249	.315	.207	a	.209	-.134	-.130	-.049	-.132	a	a	.233	.145	-.176	a
C	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
D	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
E	a	-.057	a	a	1	.330	-.209	.481*	.330	.353	.439*	a	-.112	-.098	-.095	-.292	.085	a	a	-.306	-.005	-.287	a
F	a	.686**	a	a	.330	1	-.632**	.811**	.659**	.682**	.658**	a	.198	.031	.058	-.243	.253	a	a	-.091	.104	-.473*	a
G	a	-.146	a	a	-.209	-.632**	1	-.489*	-.606**	-.564**	-.621**	a	.049	-.219	-.073	.160	-.499*	a	a	.152	-.054	.180	a
H	a	.461*	a	a	.481*	.811**	-.489*	1	.883**	.880**	.887**	a	.143	.136	.073	-.286	.374	a	a	-.284	.117	-.590**	a
I	a	.249	a	a	.330	.659**	-.606**	.883**	1	.959**	.946**	a	.162	.294	.112	-.146	.590**	a	a	-.394	.123	-.559**	a
J	a	.315	a	a	.353	.682**	-.564**	.880**	.959**	1	.944**	a	.214	.270	.073	-.197	.549**	a	a	-.370	.141	-.565**	a
K	a	.207	a	a	.439*	.658**	-.621**	.887**	.946**	.944**	1	a	.200	.255	.050	-.283	.489*	a	a	-.406*	.102	-.528**	a
L	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
M	a	.209	a	a	-.112	.198	.049	.143	.162	.214	.200	a	1	-.325	-.153	.079	-.125	a	a	-.100	.222	-.131	a
N	a	-.134	a	a	-.098	.031	-.219	.136	.294	.270	.255	a	-.325	1	.419*	.178	.615**	a	a	-.240	-.170	-.261	a
O	a	-.130	a	a	-.095	.058	-.073	.073	.112	.073	.050	a	-.153	.419*	1	.531**	.637**	a	a	-.223	-.283	-.275	a
P	a	-.049	a	a	-.292	-.243	.160	-.286	-.146	-.197	-.283	a	.079	.178	.531**	1	.307	a	a	-.005	-.076	.140	a
Q	a	-.132	a	a	.085	.253	-.499*	.374	.590**	.549**	.489*	a	-.125	.615**	.637**	.307	1	a	a	-.415*	-.197	-.465*	a
R	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
S	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
T	a	.233	a	a	-.306	-.091	.152	-.284	-.394	-.370	-.406*	a	-.100	-.240	-.223	-.005	-.415*	a	a	1	.628**	.791**	a
U	a	.145	a	a	-.005	.104	-.054	.117	.123	.141	.102	a	.222	-.170	-.283	-.076	-.197	a	a	.628**	1	.541**	a
V	a	-.176	a	a	-.287	-.473*	.180	-.590**	-.559**	-.565**	-.528**	a	-.131	-.261	-.275	.140	-.465*	a	a	.791**	.541**	1	a
W	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a

Notes: **. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

a. Cannot be computed because the variables have all the same value: i.e. Tornadoes, seismicity and volcanism have all zeros for this study area.

Figure 2. Correlation matrix for the Environmental Quality Index.

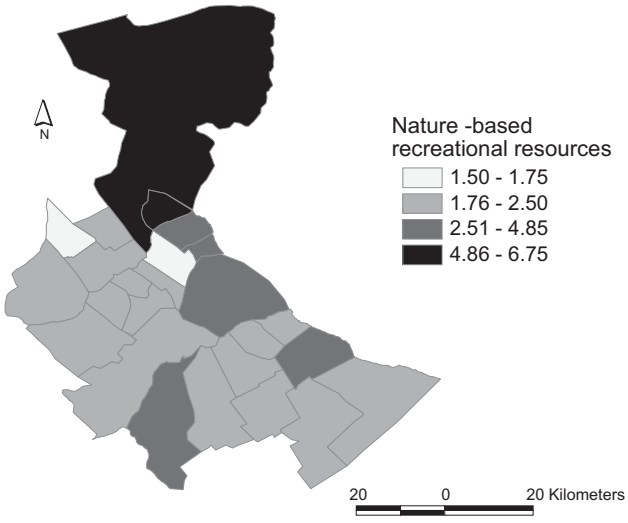

Figure 3. Nature-based recreational resources for the Metropolitan Area of Buenos Aires (Argentina).

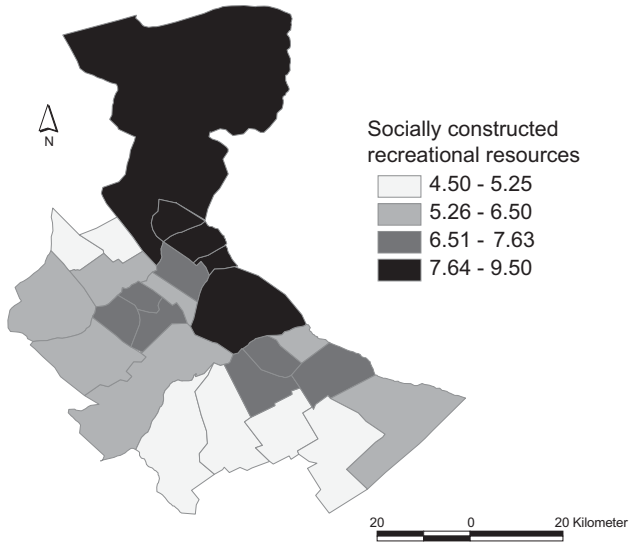

Figure 4. Socially constructed recreational resources for the Metropolitan Area of Buenos Aires (Argentina).

only for local residents but also for those from the whole area. The second category (2.51 to 4.85 points) encompasses four districts plus the Autonomous City of Buenos Aires. Once again, the elements of attraction are linked, in most cases, to the main river. The third group (1.76 to 2.50 points) covers a broad set (16 municipalities) where the resulting score is based on smaller elements such as *plazas* and small parks. They constitute palliative interventions for the recreational demands of these populated districts. This group also includes two municipalities (Avellaneda and Berazategui), whose heavily polluted shores are not available for recreational use. The only exception is a municipality to the south of the conurbation (Ezeiza) with a remarkable forestry presence. Finally, the area lacking most nature-based recreational resources (1.50 to 1.75 points) consists of two populated districts (San Martín and J.C. Paz). Here there is not only a significant shortage of green spaces but also a lack of all types of natural features.

Socially constructed recreational resources

The map (Figure 4) depicts the valuation of these resources in the Metropolitan Area of Buenos Aires. The Autonomous City of Buenos Aires ranks first (7.64 to 9.50 points), accompanied by four other jurisdictions belonging to the northern suburbs. This sector also offers the best and most attractive cultural, commercial and sports activities in the whole region. Six municipalities located in the first urban belt and with a reasonable provision of public services (education, health, stores) comprise the next category (6.51 to 7.63 points). However they lack relevant socially constructed attractions for the daily recreation of the population. The third category (from 5.26 to 6.50 points) contains eight *partidos* with a notable absence of socially constructed amenities. Just a few can be seen in the second urban belt, where municipalities count on some basic services. The most deprived group (ranging from 4.50 to 5.25 points) includes six districts located in the second urban belt, which are still in the process of urban consolidation. Therefore they fail to satisfy the basic needs of their large demographics, not to mention the development and construction of recreational infrastructure.

Environmental problems

The Metropolitan Area of Buenos Aires has environmental problems of a different magnitude (Figure 5). The most troublesome area (2.89 to 3.24 points) includes four districts. Three of them are located in the lower basin of the Río Matanza-Riachuelo which, since the late nineteenth century, has suffered from the effects of industrial pollution. Contamination is still present due to the obsolete technology used in manufacturing processes and to the non-compliance with current environmental legislation. These districts also endure, on a regular basis, flooding problems. The fourth *partido* (San Martín) also has a markedly industrial profile, with a notorious presence of spontaneous dumps and slums. The second category (from 2.69 to 2.88 points) comprises seven municipalities and the Autonomous City of Buenos Aires. These jurisdictions are penalised for various reasons: crime rates in the Autonomous City of Buenos Aires, the presence of illegal dumps in J.C. Paz, Quilmes, La Matanza and Malvinas Argentinas, and slums development in Quilmes and San Fernando. Also, in the

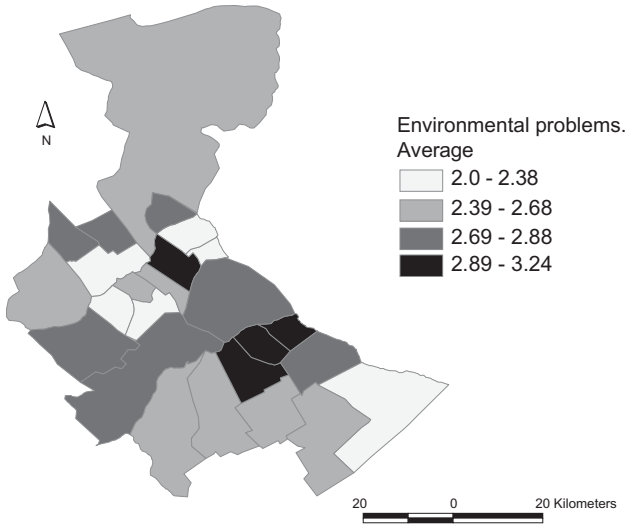

Figure 5. Environmental problems resources for the Metropolitan Area of Buenos Aires (Argentina).

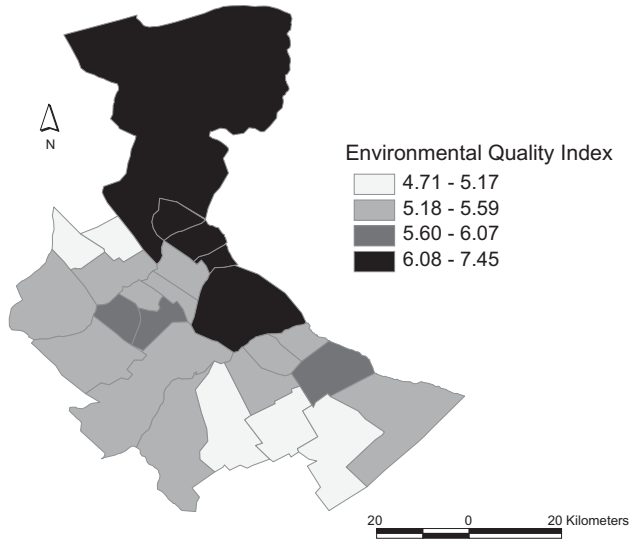

Figure 6. Environmental Quality Index for the Metropolitan Area of Buenos Aires (Argentina).

cases of J.C. Paz and San Fernando, flooding seems to be a recurring problem. The third level (2.39 to 2.68 points) comprises eight *partidos*, the majority located in the second urban belt of the MABA. The four, located to the south (F. Varela, A. Brown, Echeverría and Ezeiza), suffer from recurrent floods and spontaneous garbage dumps. In the three situated to the west (Tres de Febrero, Hurlingham and Moreno), several industries are established within residential areas. The only district in this group located to the north of the MABA is Tigre, affected by flooding problems and the presence of some polluting industries. Finally, in the category with the lowest environmental problems (2.0 to 2.38 points) there are six districts characterised by low industry presence and the absence of negative externalities such as flooding and slums.

Environmental Quality Index

To summarise the situations particularised above, the EQI (Figure 6) reveals that the best situation (6.08 to 7.45 points) is present in four municipalities situated in the northern suburbs that count on a relatively good endowment of nature-based recreational resources (river, delta, green spaces) and a favourable economic background allowing the development of socially constructed resources. In addition, except for some flooding issues, the environmental problems are not as relevant as in other parts of the MABA. This category also includes the Autonomous City of Buenos Aires, which stands out for the existence of socially constructed recreational resources: the combined presence of cinemas, theatres, cultural centres, sports facilities and architectural heritage has created this city as one of the most appealing of Latin America. Here is, once again, the distinctive involvement of the 'most natural' attraction of the whole area: the Rio de la Plata. The second range (5.60 to 6.07 points) includes another coastal district, Quilmes, although in this part of the MABA the river is not as attractive as in the north. Still it remains in a relatively good shape, if compared to its state in the rest of the coastal municipalities. In this category, there are another two districts that benefit from the presence of socially constructed recreational resources: Moron and Ituzaingó. The last two positions (4.71 to 5.59 points) comprise most of the jurisdictions – 17 municipalities. This indicates an obvious lack of recreational resources, both nature-based and socially constructed. These districts are also affected by environmental problems that can make daily life alienating and dangerous. The worst cases are clearly reported in the second belt of the MABA, where the mixture of few recreational opportunities, environmental problems and inadequate basic services promotes a socio-economic context of poverty and degradation.

Conclusions

Environmental quality indices applied to urban areas are considered necessary for their daily management and local development. At other scales, they are often hard to implement due to the quality of information: sometimes data are non-existent, poorly surveyed, not available or not directly comparable to other socio-economic variables. Moreover, they are sometimes measured at a different level of aggregation, among other procedural limitations. In Argentina, like in many other developing countries, these peculiarities are very present since the collection of environmental information lacks the institu-

tional support that socio-economic information has, which is surveyed periodically and systematically by national, provincial and municipal organisations. This is why this paper attempts, with some restrictions, to overcome these limitations by creating an Environmental Quality Index for the Republic of Argentina. The index integrates subjective and objective variables and is applied to the Metropolitan Area of Buenos Aires, as a study and testing area. The index departs from a broad conception of the environment, taking into account not only the natural elements but also the built environment. From the combination of 23 variables aggregated into three major indicators (nature-based and socially constructed recreational resources and environmental problems) it describes the spatial performance of this dimension within the Metropolitan Area of Buenos Aires (MABA). It is a synthesis of the opportunities granted by the natural and built environment in addition to the environmental problems that the local population has to face on a daily basis in this Latin American megalopolis.

The results indicate that the values of the index are within a range of a few points, stressing the lack of significant extremes in its distribution. However, based on the analysis of its indicators, it is possible to establish spatial variations. Socially constructed recreational resources have a certain 'market' logic that corresponds to the most populated areas, specifically those with a high economic level. This means that the infrastructure associated with sports, culture and amenities is not available to everyone because usually it is not for free. Therefore its location often coincides with that of the most affluent sectors.

As regards the nature-based recreational resources, their spatial distribution and municipal ownership are also differential. The main natural attraction of the area is the Rio de la Plata logically favouring the coastal districts. Nevertheless at an intra-departmental level (or intra-urban), groups with higher income are able to enjoy the environmental benefits while outsourcing 'development' costs to the rest of society: illegal dumps, slums, floods, and lack or deficient service provision are among the most common problems encountered by the people residing in the second belt of the MABA.

The application of the EQI reveals that only five jurisdictions of the MABA display the best environmental conditions. This category includes the Autonomous City of Buenos Aires and four municipalities in the north that share a good many natural attractions (water streams, green spaces), socially constructed recreational resources (cultural and sports infrastructure), and relatively few environmental problems.

By contrast, most municipalities have an adverse or undesirable combination of low attractiveness (both nature-based and socially constructed) and environmental problems. In this respect, we hope that in the near future, once the index is consolidated, it could be used as an element for proper environmental management and planning. Moreover it would be interesting to correlate it to other indices associated with socio-economic dimensions, thus emphasising the spatial relationship between environmental quality and socio-economic status, which is incipiently described in this work.

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