Environmental Justice in Berlin: GIS-based method determining an aggregated index for urban planning

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1 ABSTRACT

In the early nineties, a wide discussion about Environmental Justice has started among German health scientists, sociologists, and other academics. In this context, several studies focussing on the disproportional burden of discrete environmental hazards on different socio-economic groups were carried out.

The present paper reviews a method to index several Environmental Justice factors within planning areas of Berlin. In order to examine the current status, the spatial distribution of thermal comfort, green spaces and emissions of PM10 and NOx has been determined, using a GIS-based analysis. These results were then related to data on the social status. The various outcomes show a complex relation between social status and exposure to environmental quality, but reveal a tendency of disproportional distribution, prejudicing groups of lower social status.

In order to develop a planning area based measure of Environmental Justice, the analysed factors were aggregated into a single environmental impact factor and combined with the associated social status. Finally, possibilities of integrating this factor into urban planning in Berlin were identified.

2 INTRODUCTION

The distribution of environmental impacts among the population has been assessed since the 1980s in the United States under the headword of „Environmental Justice“ (EJ). EJ has been defined as ‘‘a concept that promotes the equitable treatment of people of all races, incomes and cultures with respect to environmental laws, regulations, policies and decisions’’ (Todd & Zografos, 2005, p. 484). EJ is a general term to assess distributive justice, procedural justice, policy justice and other aspects in a normative way.

Several case studies showed a relationship between a lower social status and the distribution of environmental hazards like air pollutants, noise, toxic sites, and access to environmental amenities like green spaces.

The relation of environmental quality, health impacts and socio-economic situation is also discussed in Germany. German public health research established coherence between a low social status and a living environment with polluted air, noise and a lack of green space in Bavaria (Bolte and Fromme 2008). One of the first studies which analyses EJ regarding it's spatial distinction was conducted by Köckler et al. (2008) in Kassel, showing relation between households with migration background and/or low-income households and the exposure to noise and particulate matter. Köckler et al. (2008) surveyed data on sociodemographic factors, risk perception, handling strategies, state of health, environmental related behavior and access to green spaces in a standardized household survey.

Social and spatial differences in Germany are less distinctive and environmental hazards are generally lesser than in the US (Maschewsky 2004). As the distribution of environmental burdens is much more managed by spatial planning, an uneven distribution of environmental burdens seems to be less supposable. Maschewsky also points out that race-based indicators employed in several studies in the United States might be less appropriate to the European situation, assuming that EJ is determined rather by the socio-economic situation.

In Germany EJ has not been integrated in planning processes yet. Developing an EJ-Index for the urban area of Berlin, we want to contribute to the raising discussion on EJ. This paper presents only excerpts of the study. The distribution of thermal comfort and availability of green spaces, and the development of the indices will be described more detailed.

3 CASE STUDY BERLIN

Berlin has approximately 3.4 million inhabitants (density: 3849 inhabitants per km²) and is thus the city with the second largest number of inhabitants in Europe (Department for Statistics Berlin-Brandenburg 2009).

Berlin is mainly characterized by its heterogeneity concerning social as well as environmental aspects. In 2008, 9.4% of the inhabitants of Berlin were unemployed and 13.8% received transfer payments. 37.4% of all children under 15 years depend on transfer payments, which is a very high value in comparison to other German cities. 42.8% of all children and teenagers under 18 years are living in families with migration background.

The case study is the first EJ-study of multiple impacts for the metropolitan region of Berlin, Germany. It applies the concept of EJ in its distributional dimension and tests the hypothesis that areas inhabited by population with low social status are disproportionately burdened by environmental hazards. The study was conducted on the scale of the whole city and allows therefore comparisons between areas with different social status.

3.1 Data

The study was conducted at planning area level, which is the most detailed geographical unit on which data is available. Altogether Berlin has 447 planning areas with 7500 inhabitants on average (10 to 31.268) and an area ranging from 0.14km² to 23.70km².

Environmental indicators covered in this study are thermal comfort, availability of green spaces and air quality (PM10 and NOx). This represents a mixture of environmental hazards and qualities.

To represent the socio-economic situation, we used the so-called Status-Index which is determined in the Berlin Senate Department's annual urban monitoring program, and which reflects the socio-economic status of each planning area. The Status-Index integrates data on unemployment, receipt of livelihood benefits and the origin of people separated by age-groups. Planning areas are categorized in deciles and allocated to four levels, whereas 20% have a social status of 1, 60% of 2, and status groups 3 and 4 having 10% respectively.

The chosen environmental indicators are relevant in the urban context and can be influenced by the Senate Department's policies. We utilized data which is regularly collected and already used by the Department for Urban Development.

3.2 Methods

The data on thermal comfort (PMV) and on the availability of green spaces was obtained on block level and was aggregated to the planning area level. To evaluate the relation between environmental factors and social status, estimated values based on cross tables were calculated.

We developed two indices, the multiple Environmental Burden Index and the EJ-Index.

The environmental indicators include both burdens and amenities, which are divided as follows:

- Environmental burdens: all categories of both NOx and PM10, categories II, III and IV of availability of green spaces, categories III and IV of thermal comfort
- Environmental amenities: category I of availability of green spaces, categories I & II of thermal comfort

The environmental indicators which are listed as burdens above, were cumulated in the multiple Environmental Burden Index in the following way: As soon as one of the environmental indicators had a value of IV, the whole planning area was estimated with IV. Once one of the indicators had a value of III, the whole planning area was evaluated with III. The same procedure was done with the values II and I. Assuming that one environmental factor can´t be compensated by another, the assessment of a planning area is based on the worst value of one environmental factor within this area. The information whether there are no, one or two amenities in each planning area was displayed in the map, but not included in the calculation of the index.

On base of the aggregated environmental burdens and the social status, an index was constructed to classify the situation of environmental justice for each planning area. This EJ-Index shows four grades of EJ:

Advantaged (I), moderately disadvantaged (II), disadvantaged (III) and highly disadvantaged (IV) (see Fig. 1). Status-groups 3 and 4 were treated equally, because they contain only 20% of all planning areas.

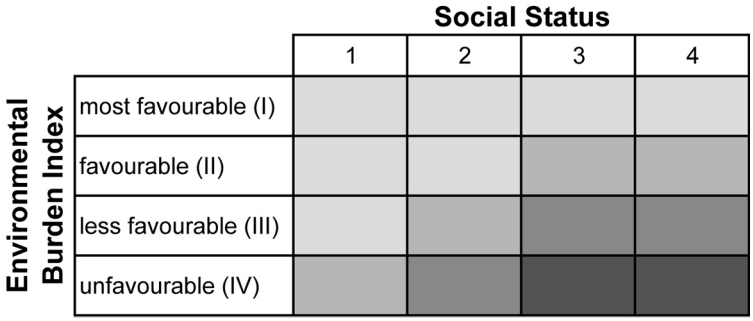

Fig. 1: Categorization of EJ-Index

3.3 Results

The output of our analysis offers information on the spatial distribution of environmental factors and their relation to the social status. The social status groups conform to the given categorization of the Status-Index as describes before. A total of 87 (20%) planning areas have high social status (1), 260 (60%) a middle social status (2), 43 (10%) a low social status (3) and 44 (10%) a very low status (4).

Planning areas with a social status of 3 and 4 are primarily located north and south around the inner circle of Berlin. Due to the urban context, the spatial distribution of all examined environmental factors shows an agglomeration of burdened planning areas in the city centre. The outskirts are characterized by less burdened planning areas and environmental amenities. Exceptions to this are some suburban, more densified centres in the eastern part of Berlin. The examination of conditions of thermal comfort on planning area level reveals that only 7% (32) of all planning areas hold most favourable (I), another 24% (102) favourable (II) thermal comfort. A significant 56% (241) show less favourable (III) and 14% (59) unfavourable thermal conditions (IV). The disproportional distribution of planning areas with favourable thermal conditions among the different status groups is obvious. Of planning areas with high social status (1), only 9 % (10) have less favourable or unfavourable (III / IV) thermal comfort, whereas 98 % (43) of planning areas with low social status offer these conditions.

		Social Status				
		1	2	3	4	∑
Thermal comfort	most favourable (I)	25 / *6*	7 / *19*	0 / *3*	0 / *3*	32
	favourable (II)	52 / *20*	47 / *61*	2 / *10*	1 / *10*	102
	less favourable (III)	8 / *48*	164 / *144*	36 / *24*	33 / *24*	241
	unfavourable (IV)	2 / *12*	42 / *35*	5 / *6*	10 / *6*	59
	∑	87	260	43	44	434

Fig. 2: Thermal comfort

The evaluation of green space access adduced that 39% (165) of all planning areas show a sufficient availability (I) of green spaces. 19% (81) are supplied insufficiently (II), 19% (81) are supplied highly insufficiently (III) and 24% (101) are assigned to be not served (IV) at all. The distribution among the social status groups is similar to the thermal comfort distribution. As an example 90% (76) of planning areas with a high social status offer a sufficient availability of green space, whereas only 9 % (4) of planning areas with a low social status (IV) have a sufficient availability of green space.

Greenspace availability	Social Status 1	2	3	4	∑
sufficient (I)	76 / *32*	78 / *99*	7 / *17*	4 / *17*	165
insufficient (II)	4 / *16*	67 / *49*	5 / *8*	5 / *8*	81
highly insufficient (III)	2 / *16*	55 / *49*	14 / *8*	10 / *8*	81
not served (IV)	2 / *20*	58 / *61*	17 / *10*	24 / *10*	101
∑	84	258	43	43	428

Fig. 3: Availability of green spaces

To evaluate the relation between environmental factors and social status, estimated values based on the provided cross tables were calculated.

The most remarkable outcome is the great difference between counted and estimated values of status group 1. As an example, 76 planning areas with a high social status (1) offer a sufficient availability of green spaces. Based on the assumption, that there is no relation between this environmental factor and social status, only 32 would be expected. The significance of the difference between the existing and estimated distribution was proved on base of a chi-square-test at a 5% significance level. All differences were valid.

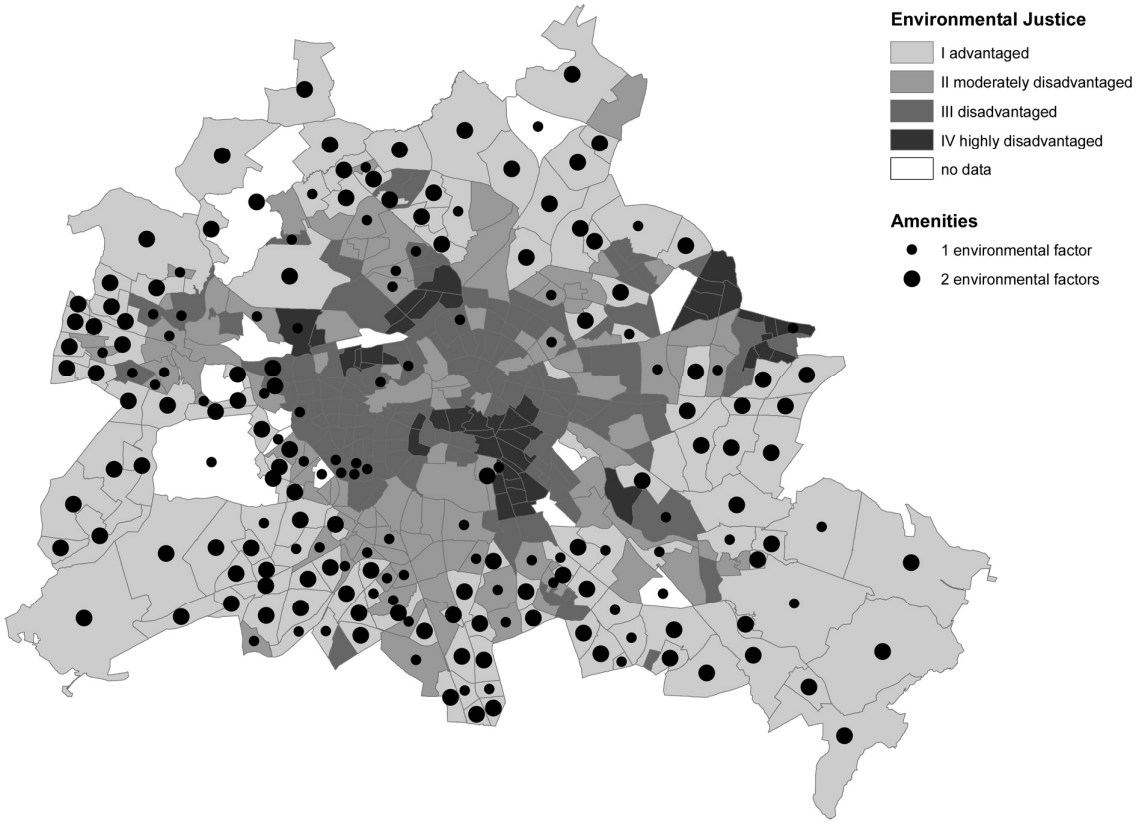

Fig. 4: EJ-Index and environmental amenities

Based on the EJ-Index, 31 % (133) of all planning areas are advantaged (I), 25 % (110) moderately disadvantaged (II), 33 % (142) disadvantaged (III) and 11 % (49) highly disadvantaged (IV). The EJ-Index reveals a concentration of highly disadvantaged (IV) planning areas around the inner city and in the east outskirts. Overall, 15.6% of the total population live in planning areas rated IV, which cover 4.3% of the total area of Berlin. 42 % (191) of all planning areas offer at least one environmental impact, which was categorized as an amenity before (see Fig. 4). These areas which possess also environmental amenities are primarily located in the outskirts. There are very few exceptions of planning areas (3 areas), which were rated IV on the EJ-Index, but offer also one environmental amenity.

4 CONCLUSION

A disproportional distribution of environmental burdens on planning areas with different socio-economic status was found in the metropolitan area of Berlin. The Environmental Burden Index shows a decreasing gradient of environmental quality from suburbs to the inner city, with the exception of scattered densified areas in the suburbs. The EJ-Index provides an overview on areas which are both social and environmental hotspots. The developed indices are supposed to stimulate a discussion about the possibilities of aggregating different environmental burdens and relating them to data on social status. The described method is easy to understand and to handle. It can be adjusted to other situations by including different environmental impact factors or modified by weighting the indicators (e.g. according to their health impact).

The most remarkable result of this study is the great difference between counted and estimated values of status group 1. Therefore disproportional distribution of environmental quality does not necessarily imply higher environmental burden on lower social groups, but a lower environmental burden on groups with higher social status.

This study is also a first step towards an integration of environmental justice issues into urban policies and planning processes. Cities are good test-beds for possibilities to integrate EJ in urban planning due to their administrative structures, social diversity, and the intensity of environmental impacts.

Urban development is strongly influenced and partly determined by urban planning policies. The Strategic Environmental Assessment (SEA) is one European instrument which shall ensure the integration of environmental issues in urban planning. Beside environmental resources the German SEA is required to integrate an assessment of impacts on human beings including human health and on the population in general (German Federal Building Code (BauGB) §1). Walker et al. (2005) and Köckler (2006) emphasize that humans and human health in SEAs should be addressed not only quantitatively but also qualitatively. In contrast to the current practice a qualitative assessment would consider social aspects of human population, which can influence the vulnerability towards environmental impacts. Therefore the SEA in urban planning processes could be a gateway for integrating EJ in decision-making. For urban planning the developed EJ-Index offers an approach to strengthen interrelation and information exchange between the departments of environmental protection, health, and social policies.

Nevertheless the assessment of EJ and the achievability of an equal distribution of environmental burdens might have it's limitations. Usually the exposure to environmental impacts is assessed, but not the real impact on health. It’s generally difficult to determine if the environmental quality entails the social structure or if it’s the other way around. Even if a disproportional distribution is stated, it’s difficult to change.

The idea of environmental justice helps to create awareness on the topic of environmental inequality, which is happening in Europe in an academic debate in the last years. Whether it is helpful to obtain a better distribution of environmental qualities as well, has to be tried out in practice.

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