Health-related inequalities in the global north and south – A framework for spatially explicit environmental justice indicators

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ABSTRACT:

The concept of environmental justice is aiming to provide good environmental conditions and fair treatment for all people so that all have equal opportunities to live their life. As such it is a vision for the future development of cities that addresses socio-economic and environmental crisis in an integrated manner. But to follow visions in a strategic way, it is important to operationalise them. Here indicators play a crucial role. For the application of the vision of environmental justice on the local level an indicator framework has been developed based on the DPSEEA (Driver, Pressure, State, Exposure, Effect, Answer) model (Morris et al 2006). Learning from first generation environmental justice analyses (Walker 2009) we enhance the framework by including different spatial scales and GIS-based spatial analyses depending on the impact area of the various indicators considered. For the implementation the spatially explicit environmental justice indicator framework has to be contextualized on different scales, due to local situations as well as data availability . For testing the frameworks validity and to show different faces of environmental justice in the global north and south we apply the framework in the cities of Dortmund, Germany, Dar es Salaam, Tanzania, and Haldia, India. Text

KEY WORDS

environmental justice; indicators; DPSEEA

INTRODUCTION

Environmental justice is a vision that aims at minimising social inequalities regarding access to environmental resources as well as the exposure to environmental burdens. The unequal distribution of environmental quality is seen as one reason for health inequalities in various countries (Bolte, Bunge, Hornberg, Köckler, & Mielck, 2012; Brulle & Pellow, 2006; Pearce, Kingham, & Zawar-Reza, 2006). The vision of environmental justice was formulated first in the USA in the 1980th especially regarding Afro Americans exposure to waste facilities that was remarkably above average. This was shown by so called distributional justice analysis (United Church of Christ Commission for Racial Justice, 1987). In the last thirty years since the first environmental justice study in the USA has been published environmental justice is a topic in different countries as well as on global scale. Nowadays more and other environmental factors like flooding, noise and air quality or access to green space are considered as well. Moreover in addition to distributional justice analysis new approaches have been developed to understand reasons for environmental unjust situations, such as procedural justice, capabilities and recognition (Schlosberg, 2007; Walker, 2009) for identifying root causes of environmental injustice.

The vision of environmental justice is aiming to provide good environmental conditions and fair treatment of all people so that all have equal opportunities to live their life. As such it is a vision for the future development of cities that addresses socio-economic and environmental problems in an integrated manner. Due to growing socio-economic and environmental crises we assume that the concept environmental justice will become even more relevant in the future. Cities are an important level to find strategic answers on different aspects of the ecologic crisis such as urbanisation (WHO & UN-Habitat, 2010) and climate change (Ostrom, 2009). Furthermore we have to be aware that these global processes come on top of existing local problems and are mutually influencing themselves, in the global north as well as in the global south. For this reason we exemplify our general approach presented in this paper for the cities of Dortmund, Germany and Haldia, India.

To develop strategies on the local level broad concepts and vision such as environmental justice have to be operationalised and contextualised. Here indicators and suitable indicator frameworks play a crucial role as the debate on sustainability has shown (Moussiopoulos, Achillas, Vlachokostas, Spyridi, & Nikolaou, 2010). Furthermore we can learn from the early distributional justice analyses that proximity between environmental burden and exposed population is relevant, but not a sufficient view on environmental justice. Walker (2009, p. 615) points out that “the simple geographies and spatial forms evident in much ‘first-generation’ environmental justice research are insufficient and inadequate to the tasks of both revealing inequalities and understanding the processes through which these are (re)produced.”

Therefore we propose to go beyond first generation environmental justice research by including methods of spatial analysis in a broader framework. By doing so we emphasise the relevance of different spatial scales of the various indicators on socio-environmental interrelationships depending on their respective impact area.

The spatial scale at which environmental just respectively unjust situations are analysed is crucial in two aspects: Firstly, environmental justice issues bear different impact areas depending on the type of factor; some environmental factors for instance have a small reach like noise by streets, that might be a

problem only 10 meters beyond its source, while air emissions might be relevant for a whole neighbourhood and water pollution is relevant for a whole river and finally the impacts of global warming that might effect for example all small islands. In that respect Lewis & Bennett (2013) propose an applied quantitative approach for the geographic designation of areas determined to be at greater relative risk of exposure. Secondly, also the choice of scale and units of analysis is important, as it influences strongly potential findings. Baden, Noonan, & Turaga (2007) could show that the evidence of injustice is sensitive to the researcher's scale and scope choice. Situation that might not appear to be unjust on a large scale might appear to be unjust on a smaller scale, due to the modifiable areal unit problem (MAUP) (Openshaw, 1984). This problem is due to the fact that the question of scale in justice analysis is also one of a reference group to identify a subgroup that is exposed in a disproportionate and therefore unjust way: „The term 'disproportionate' means that the magnitude of health and environmental impacts is greater for a given community or population as compared to a reference counterpart, such as a comparable community or the area surrounding the target community. Two prominent challenges in assessing EJ issues are to evaluate the magnitude of the disproportionality and to develop consensus on providing a methodology to determine whether impacts are disproportionately high." (Barzyk et al., 2011, pp.171f.). Therefore we hold two levels of scale to be relevant: the one relevant from a natural-science perspective on state, exposure and outcome and the one for normative judgement. t

INDICATOR FRAMEWORK

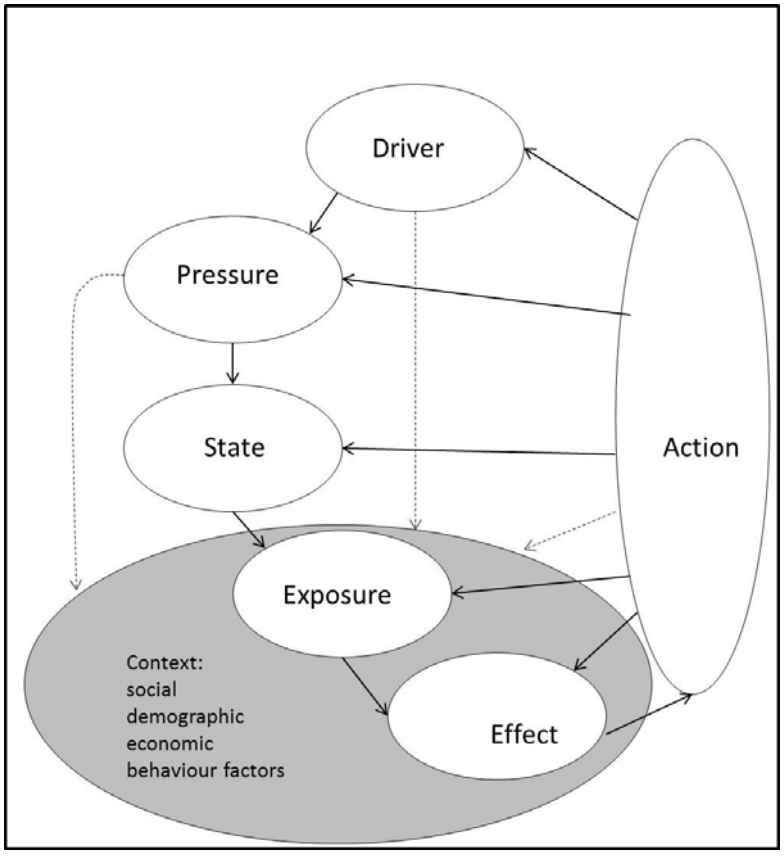
The DPSEEA model (Driver, Pressure, State, Exposure, Effect, Answer) is applied in public health to develop health indicators: "The framework describes the environmental health chain through the following components: Driving force (anthropogenic)—factors that motivate and push the environmental process involved. Pressure (on the environment)—are normally expressed through human occupation or exploitation of the environment. State (of the environment)—status of the environment. Exposure (of humans i.e., interaction between the environment and humans)—take place when humans are exposed to environmental conditions. Effect (in humans)—health effects from exposure to the environmental hazard. Action—policies or interventions aimed at reducing or avoiding health effects, they can be aimed at any point in the framework." (Hambling, Weinstein, & Slaney, 2011, p. 12)

In comparison to the DPSIR-framework (developed by the European Environment Agency), that is often used to operationalise sustainability and is a precursor of DPSEEA, the DPSEEA framework replaces the term "impact" with "effect" and adds the factor "exposure". Both replacements show that the DPSEEA framework is deriving from public health, as it was first published in 1999 by the World Health Organisation (WHO) (Briggs, 1999). Exposure points out, as mentioned in the quotation by Hambling above, that an individual and a certain state of the environment have to be at the same time at the same place. Therefore exposure has a spatial dimension and shows that proximity still matters. The use of the term "effect" instead of "impact" is due to health jargon.

We mainly chose the DPSEEA model as it is action oriented (answer component) and therefore can be applied in decision making processes. Furthermore it includes health as an outcome and provides a framework for spatial analysis of proximity to environmental burdens and deprived people. In the following we enhance this model for our needs to push distributional environmental justice analysis forward beyond first generation analyses.

In line with Morris, Beck, Hanlon, & Robertson (2006) we include a so called "contextual bubble" to stress the fact that especially the level of exposure has to be seen in the locally spatial context. Due to Morris (2006) „The contextual 'bubble' surrounding exposure and outcome […] is particularly suited to representing the local or regional dimension in the relationship between the environment and health at a population level. Thus, effective local actions may be directed not only at the chain of causation but also to external factors that can act upon it." (Morris et al., 2006, p. 897). They include factors like a higher prevalence of the considered factor due to socio-economic class (e.g. smoking), health behaviour or age. By integrating the socio economic class and other compositional and contextual factors, as common in epidemiological studies, the contextual bubble opens the door to include social inequality in this model. We think that the contextual bubble is of major relevance and is itself influenced directly by drivers, pressures and can be influenced by answers, too. This is shown by the dotted arrows in [fig. 1].

In contrast to the different applications in public health we understand DPSEEA not as a chain, but as a cycle representing a sort of decision making process (Hambling et al., 2011; Morris et al., 2006). This is corresponding with the understanding of the DPSIR framework. Here an impact might cause a response. Without obvious (or presumed) impacts resp. effects no societal response is to be expected.

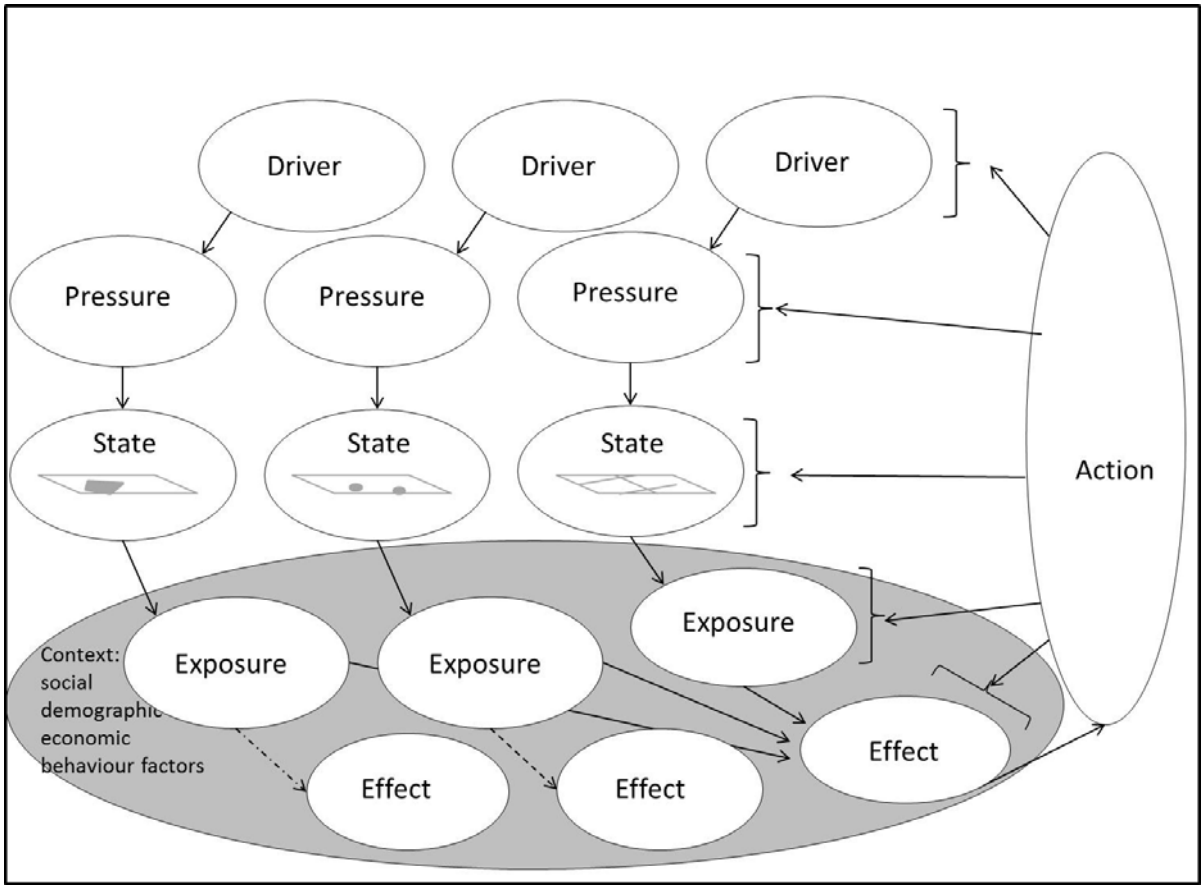


[fig. 1]: DPSEEA cycle (own figure based on DPSEEA chain by Morris et al., 2006)

In recent environmental justice and public health research studies the need for multiple impact assessment is identified as an issue to be addressed, because it can be taken for granted that especially deprived people often have to face several burdens. At first glance the DPSEEA framework as shown in [fig. 1] is not able to take multiple exposures into account. Therefore specific models like the

Multiple Exposure-Multiple Effect model (MEME-model) by Briggs (2003) have been developed. In the MEME-model driver, pressure and state are summarised in the exposure box, that is supposed to cover multiple aspects of each. But we prefer to keep the single factors separately within the framework and understand DPSEEA as a model that can represent different drivers, pressures, states and exposures that lead to a health effect [see fig. 2]. This idea of multiplying the causal chain is used by George Morris, too [unpublished]. While Morris aims at explaining one health effect by multiple exposures and its root-causes, we include multiple health effects. Emphasising one important issue in this paper we added the aspect of different scales (see above) into the model. According to distributional justice analysis we focus on state and exposure within the DPSEEA. Regarding multiple exposures we added different layers representing states in form of different environmental factors having different spatial scales. One environmental state (e.g. noise of roads) is represented as a linear feature having only a limited reach into the built up area, while industrial sites might have an influence on a whole neighbourhood or even city. Thus, different states could have different scales, though not necessarily.

Different scales are relevant for the other DPSEEA elements, too. For example the exposure of a child is usually corresponding with the home where it is living having a limited range of action, in contrast to an working adult, who has a certain exposure at home, at work, during recreation and on his or hers everyday ways. The other components of DPSEEA and their multi-scales are for sure relevant but, due to the focus of this paper not considered in the following.



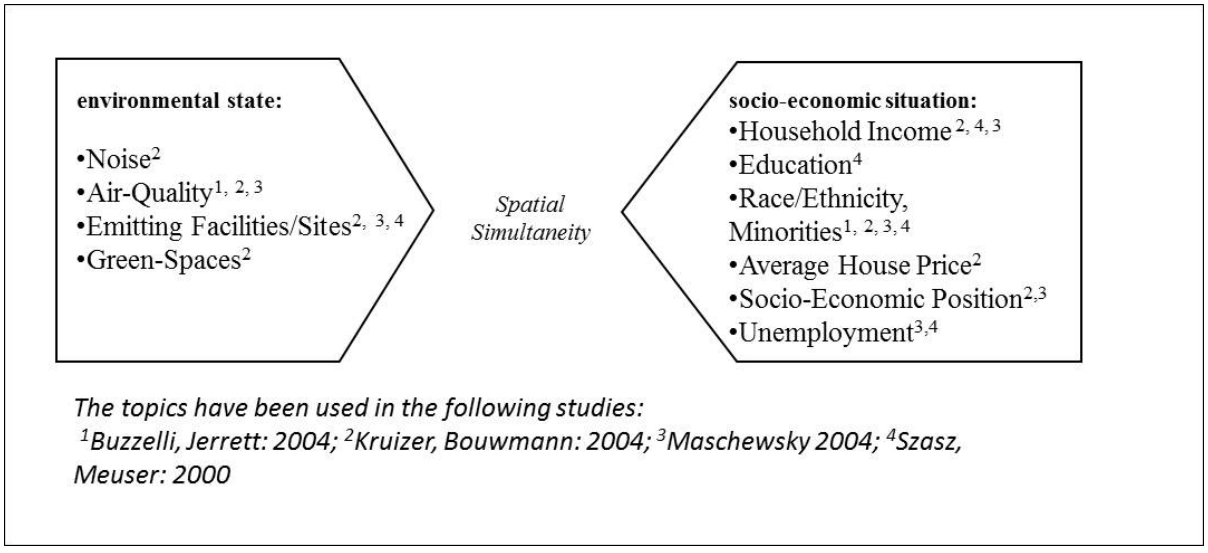
[fig. 2]: DPSEEA including multiple factors and the spatial dimension of state

The component answer is another reason why we chose the DPSEEA framework to put proximity analysis in a broader context. We think it is important to understand such a multiple factor model as presented in [fig. 2] to come to multiple answers. Suitable answers should address at least more than one of the identified drivers, pressures, states and exposures or effects. We represent the aspect of multiple answers in [fig. 2] by the use of curly brackets.

ENVIRONMENTAL JUSTICE INDICATORS

In studies analysing distributional injustice it is common to use environmental and socio-demographic indicators [fig 3]. Results are maps that show a spatial simultaneity of environmental factors and the surrounding population (Bolin Bob et al., 2000; Higgs & Langford, 2009; Szasz & Meuser, 2000), or statistical analysis (by census track or ward) that show correlations or percentage of population exposed to a specific burden (Fairburn & Smith, 2008; Walker, Fairburn, Smith, & Mitchell, 2003) or apply regression analysis (Buzzelli & Jerrett, 2004).

Only rarely health effect indicators are being applied in these studies (Barzyk et al., 2011; Maantay, 2007). Health effects are more often seen as final outcome of several influential variables. Therefore statistical models are used to explain the influence of external environment to a health outcome. Other factors like behaviour, age, sex and socio-economic status influence peoples' health, too. One reason for not regarding health outcome explicitly is data-availability, as often only life-expectancy is available on the level of statistical districts/wards.



[fig. 3] factors considered in environmental justice distributional analysis, Source: (Köckler, 2005)

The factors shown in [fig. 3] have to be operationalised into indicators. Emitting facilities are in the USA usually represented by sites according to the Toxic Release Inventory(TRI) (Bolin Bob et al., 2000; Buzzelli & Jerrett, 2004; Szasz & Meuser, 2000), and in European studies, noise is for example represented by the indicator Lden (an average indicator for day, evening night noise emissions) (Bocquier et al., 2012; Havard, Reich, Bean, & Chaix, 2011). As an environmental resource mainly the access to green areas is being analysed. Here due to different qualities and functions of green space the definition of indicators is much more diverse (CABE, 2010; Kruize, 2007; Walker, 2009, p. 616)than on indicators for environmental burdens shown in [fig. 3].

Factors encompassing the socio-demographic situation are presented by single indicators like unemployed rate (Szasz & Meuser, 2000) or indices like socio-economic position in the Netherlands (Kruize H. & Bouwman A. A., 2004) or social urban development index in Berlin, Germany (BfS, 2011)Analyses in Great Britain often apply the Index of Multiple Deprivation (IMD) (Fairburn & Smith, 2008; Walker et al., 2003). Corresponding to the initial view on environmental justice with the disproportionate exposure of Afro-Americans to landfills (United Church of Christ Commission for Racial Justice, 1987), the socio-demographic factor of ethnicity is especially in the USA often represented by indicators like percentage of ethnic groups that are exposed. As several studies identified that ethnic groups are exposed in a disproportionate way to environmental burdens in the USA the term of "environmental racism" established (Bullard & Johnson, 2000). There is also critique debate, whether race or other correlating factors like education and income are the root-causes and not race itself (Bowen, 2002).

Both environmental and socio-demographic indicators depend on local or national data availability. While in the US TRI data is online available it is used very often, in the UK the IMD is available. For spatially explicit environmental justice indicators data needs to be available spatially resolved (Flacke, 2003), as discussed above. Furthermore most local strategies are spatially explicit, i.e. spatially explicit indicators can help in the identification of hot-spots for action.

Only if at least one environmental and one socio-demographic indicator is combined and in sum an interlinkage indicator is developed it can be called an environmental justice indicator. An interlinkage indicator is an indicator that combines different sectoral aspects of a model. In the discussion on sustainability an indicator combining e.g. a social and an environmental factors (e.g. the no. of people employed in the solar industry) is an interlinkage indicator.

THE EXAMPLES OF HALDIA AND DORTMUND: OPTIONS OF SPATIALLY EXPLICIT INDICATOR BASED ENVIRONMENTAL JUSTICE ANALYSIS

In the following we show the use of spatially explicit data that represents environmental justice indicators in two examples. We chose an example from the global north (the city of Dortmund in Germany) and one from the global south (the urban part of Haldia Municipality, India). In both cases we study the topic of facilities used for storage of explosive industrial goods (gas, petroleum, toxic chemicals). This environmental burden was identified as relevant in other environmental justice studies (Fischbeck, Gerard, & Park, 2007). Locations of these kinds of industrial facilities are mapped in relation to selected socio-demographic indicators representing economic position and ethnicity. In Dortmund, having a better data availability, we used additional environmental indicators to represent issues of other scales like noise as well as environmental resources (green areas).

Defining the scale to identify subgroups bearing environmental injustice is even more challenging in an approach including two cities representing the global north and global south as presented here. In first instance, we argue from a local action point of view taking the corresponding city as a whole as frame of reference. This will show if there is an disproportionate exposure of a subgroup to storages of explosive goods within the city of Dortmund resp. Haldia. By doing so local hot spots can be identified and answers might be developed especially for these areas.

On the other hand the north south approach we are following here asks for some sort of comparison between the cities, but due to data availability we are not able to do in full swing. Nevertheless, for illustrating the relevance of such a cross-national north-south comparison, it is worthwhile to look at the average life expectancy at birth in both case studies. For men in India it is 64 years (WHO, 2013), in Germany it is 78 years (ibid.) while in the city of Dortmund 72 years and in the "Nordstadt" (a deprived area with multiple environmental burdens) 66 years only and therefore close to that of Indian average. We are not able to discuss all predictors of life expectancy in this paper and it is for sure not only the external environment . Nonetheless we want to open the mind for comparing health effects between different countries.

Several studies on environmental justice that include maps as results (Bolin Bob et al., 2000; Szasz & Meuser, 2000), show socio-demographic data on the basis of statistical units (census track, ward). This might give a wrong picture of exposure as they might show socio-demographic data for areas that are partly not used for housing. Hence land use patterns have to be taken into account for assessing proximity relationships. We recommend to visualise socio-demographic data only for built up land used for housing and to exclude e.g. industrial land, streets and green areas (including agriculture and forests) and water[map 1 and 3].

EXAMPLE HALDIA

The industrial town of Haldia lies in the eastern region of India at the southern tip of the state of West Bengal. The Haldia industrial region has grown significantly in post reform era with a major concentration of industries like oil refineries, petrochemicals, chemicals supported by a large port complex and other infrastructural facilities. The total population of the Haldia Municipality is 169.996 persons as per the 2001 Census. The area recorded a growth rate of 32.7 % in its population over the last ten years as a result of increased urbanization and potential employment opportunities. Due to the vast growth in population as well in economic terms and acknowledging a widely absence of formal land use planning in the region (Sengupta, 2007). Haldia today reveals a small-scaled urban structure mixing residential areas in close proximity to industrial complexes, which makes it interesting and relevant for a study of environmental justice issues.

The following indicators are used to map issues of environmental justice:

Environmental state:

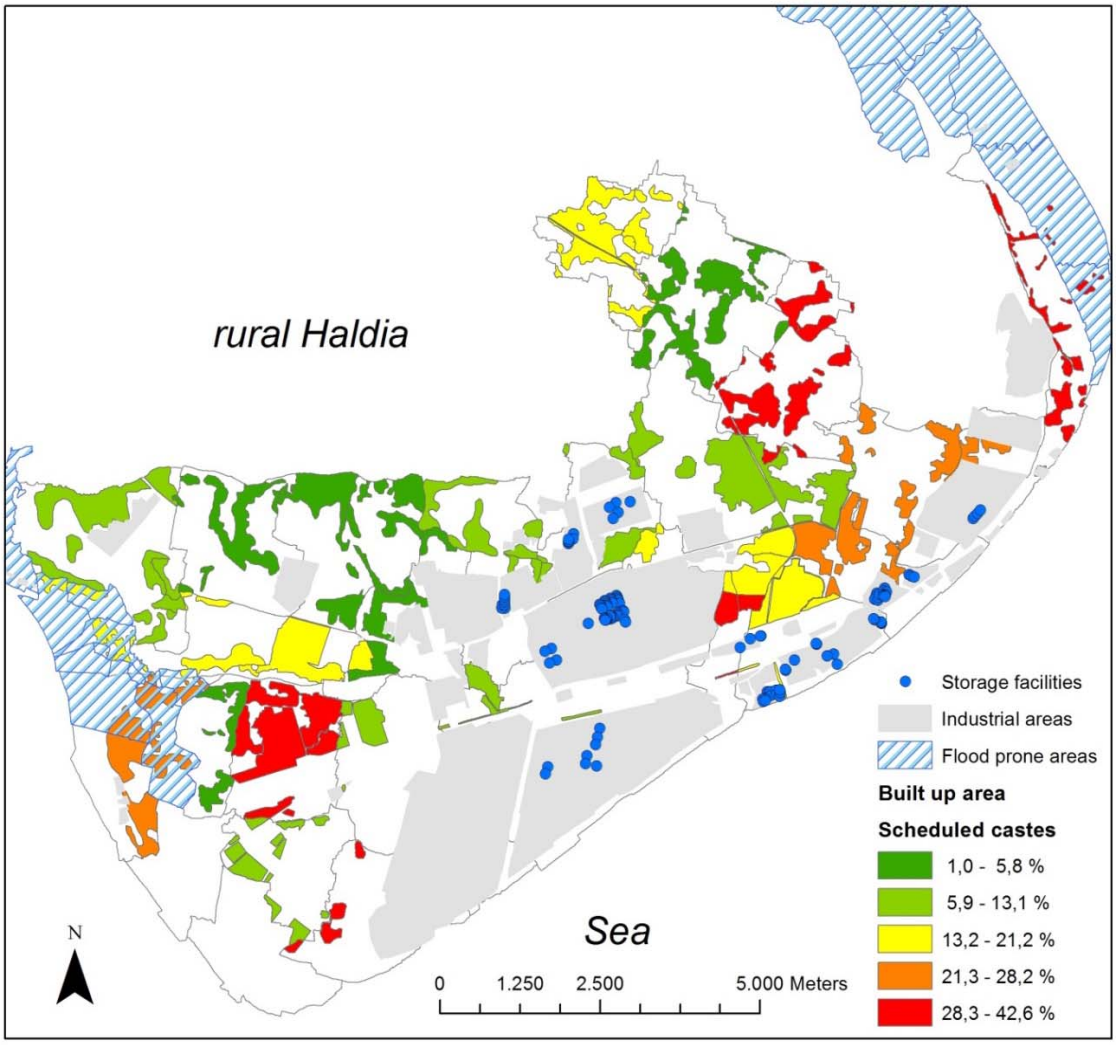
- geographic locations of industrial facilities storing dangerous industrial good
- flooding areas, what is of major relevance as Haldia is in a river delta
-

Socio-economic situation:

- marginal workers per ward (share of workers that worked less than 6 month per year)
- share of citizen from scheduled castes per ward (group of historically-disadvantaged people recognised in the Constitution of India)
- share of illiterate people per ward (persons age 7 years and above who cannot both read and write with understanding in any language)

Data for the socio-demographic indicators is taken from the 2001 census database. Census data is provided on ward level, but is mapped in [map 1] only for the built up area within wards in order to have a more realistic representation of spatial population distribution within the wards. Location of

industrial storage facilities stems from 2010 and is kindly provided by Anandita Sengupta (ITC PhD Student). The analysis as presented in [map 1] is limited to the south-eastern – so called urban part – of Haldia.



Map 1: Combining environmental and social indicators in Haldia

In the case of Haldia we can see that especially in the north eastern part of the urban area the habitation areas reach very close to the industrial facilities storing dangerous goods. It is very likely that in this case the settlements were even there beforehand and due to weak spatial planning instruments it was possible to locate industrial complexes in direct vicinity. Looking at the socioeconomic factors it is very much obvious that the share of population from scheduled castes [map 1] as well as the illiteracy level is significantly higher in the north eastern area. The most north-east ward close to the shore is by far the most deprived ward with respect to all selected indicators. In addition to the exposure to industrial risk this area is also most vulnerable to natural hazards as it can be seen from the flood prone area as indicated in [map 1].

EXAMPLE OF DORTMUND

The city of Dortmund is located in the western part of Germany in the former coal and steel production area called Ruhrgebiet. Since the 1980s Dortmund is going through a long-lasting economic transformation due to closing down of coal mines and several steel production companies. Therefore a high unemployment rate (13,3 %, in Germany 7,1 %) and large number of inhabitants receiving social welfare is a fact in Dortmund. As coal and steel were attractive for migrant workers, many people with background of migration (almost 30 %) live in the City of Dortmund. Regarding urban development the city grew mainly in times of industrialisation and many mixed land-use patterns are still existing.

The following indicators are used to map issues of environmental justice:

Environmental state:

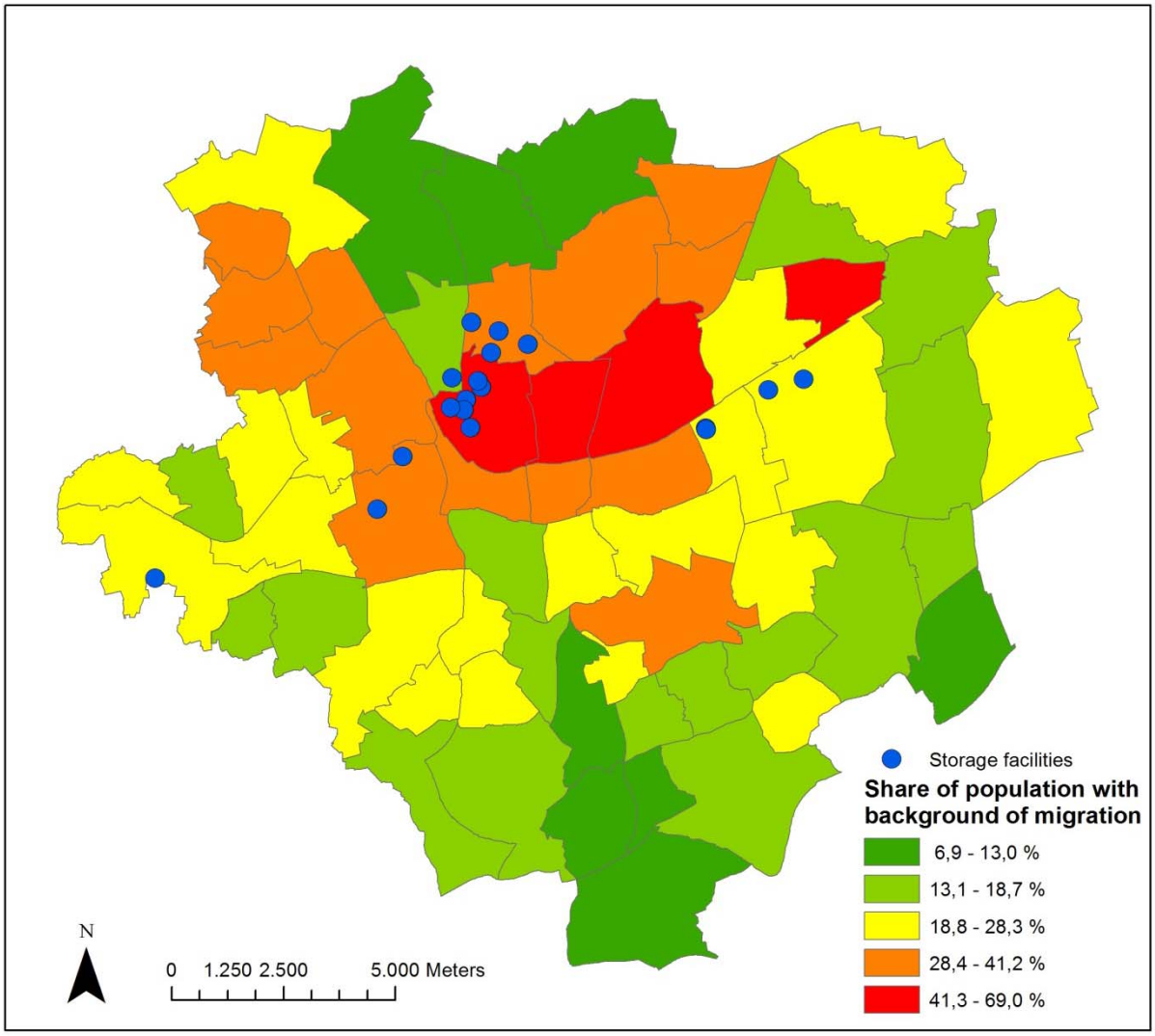
- geographic locations of industrial facilities storing dangerous/explosive industrial goods (facilities according to BImSchG 4.VO Anhang 1, 9.1)
- noise from several sources (street, train, airport and industry) presented by the average level Lden (year 2010)
- green areas public and private green including parks, designed green areas as part of housing of more than 200qm (year 2010)
-

Socio-economic situation:

- background of migration as defined by either having immigrated to Germany after 1949 or being born in Germany as national-foreigner, or having at least one parent with background of migration (Statistisches Bundesamt 2009)
- Share of inhabitants receiving social welfare benefits (in German SGBII Empfänger)

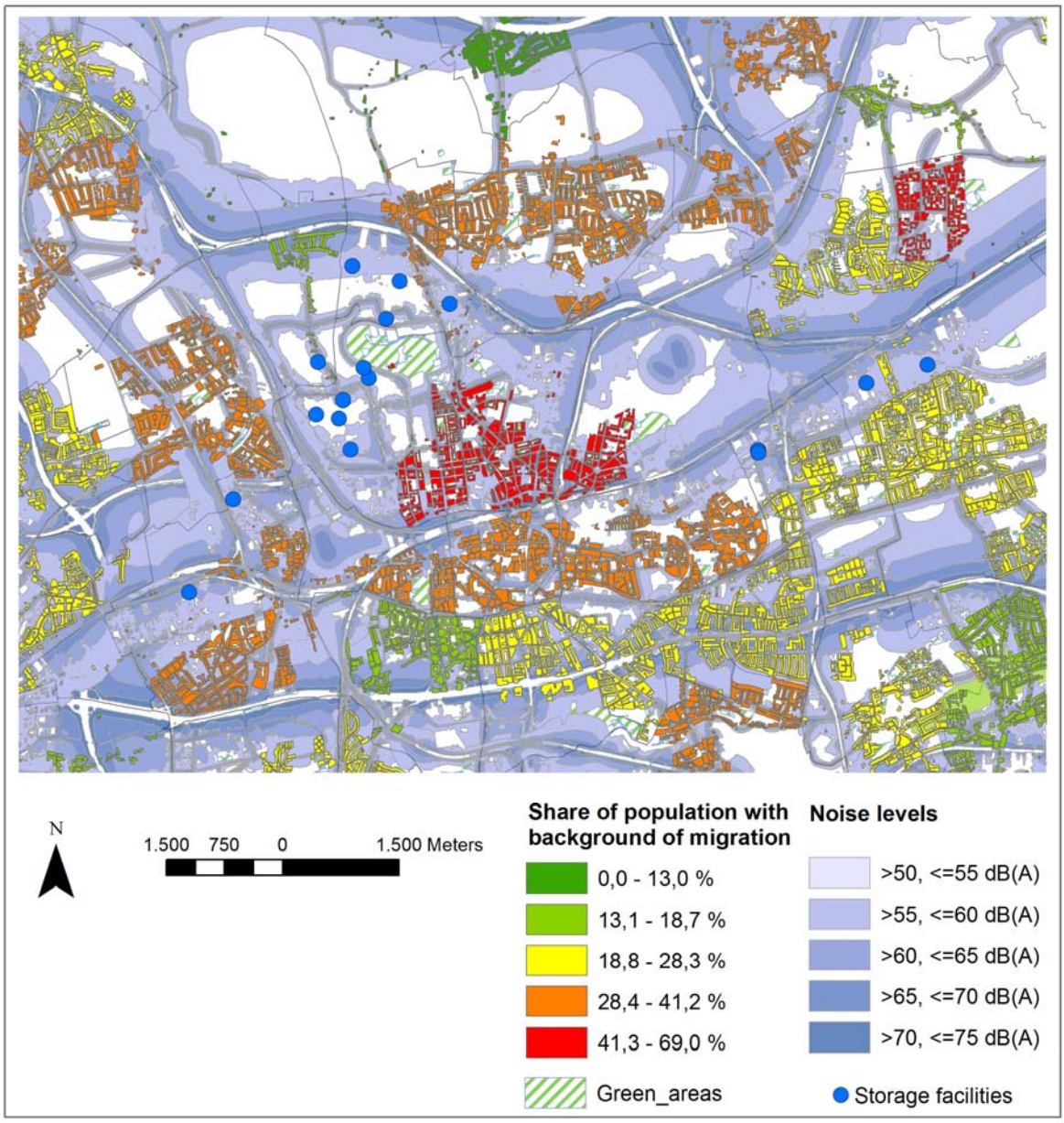
Data for the socio-demographic indicators stems from 2012 and is taken from the municipal database of the city of Dortmund. The data is provided on district level, but is mapped in map 3 only for the built up area within the districts as mentioned above. Location of industrial storage facilities stems from 2012 and is kindly provided by the environment department of the city of Dortmund.

In the following we show results for the social indicator background of migration as these showed clearer patterns than those receiving welfare benefits. [Map 2] shows the locations of industrial storage facilities together with the share of population with background of migration per ward for the entire city of Dortmund. As such the map functions as a reference scale for the local environmental justice analysis of Dortmund. In general the share of population having a background of migration is significantly higher in the northern part of the city compared to the south. One can see also a concentration of the selected storage locations in the northern part of the inner city, the so called “Nordstadt”. The locations are predominantly close to areas with high percentage of population with background of migration. In neighbourhoods with less percentage of population with background of migration no such facilities have been identified.



Map 2: Combining environmental and social indicators in Dortmund

[Map 3] combines different environmental factors (noise, storage with explosive goods and green areas), again with the socioeconomic factor of population with a background of migration, this time mapped only within the built up residential area. The reference scale for assessing unjust situations is again the city of Dortmund as a whole [map 2]. We decided to take the "Nordstadt" as [map 2] showed a concentration of the storages with explosive/dangerous goods here. Some streets have a very high noise exposure of above 75 dB (A) Lden and many of the homes are exposed to levels above 55 dB(A) Lden. The green area in the centre to the left is a public park that is surrounded by several of the storages facilities but not exposed to noise. Therefore recreation is possible without noise impacts. But still it's the only big green area available in the densely populated northern part of the city that is not impacted by noise. [Map 2] further shows, that the sites are not directly bordering residential areas, but are in a distance of 300 meters plus.



Map 3: Combining environmental and social indicators in the northern part of Dortmund

BEYOND PROXIMITY: BACK TO THE BIG PICTURE

Our analysis in Dortmund and Haldia has illustrated how a distributional analysis on environmental justice situations might be done in a spatially explicit manner. In the two cases spatial proximity as a measure of just/unjust situations is still the method of choice. But we can already learn something from this first view on two factors of the DPSEEA framework that goes beyond simple proximity analysis and thereby beyond the "first generation environmental justice analysis" (Walker, 2009). In the following we name only two aspects.

This first step analysis allows for instance to identify questions for further research; e.g.: What is the health situation in these neighbourhoods? (For the city of Dortmund, we know for example that life expectancy in the district with multiple burdens is below average (all over Dortmund male: 74.6 year,

Dortmund Nordstadt male: 66.3 years). But is this due to the environmental exposure? To find answers on this, we need epidemiological analysis and for sure more health outcome data.

We can also come to first recommendations for answers: For urban development municipalities have a tool-kit to answer this situations. By now in Germany environmental planning is not sensible towards social inequalities (Köckler, 2006). The maps for Haldia and Dortmund show inequalities in environmental quality that could be addressed in environmental planning, e.g. in environmental impact assessment or strategic environmental assessment.

CONCLUSIONS: FURTHER NEED FOR RESEARCH

As the use of comparable indicators in Dortmund and Haldia showed it is difficult to carry out comparative environmental justice studies between different nations. This is on the one hand due to data availability: Especially socio-economic data is collected in different ways and not only between Germany and India there are differences. Within the European Union for instance the definition of background of migration is different, and certain socio economic indices, e.g. social urban development index in Berlin, Germany (BfS, 2011) is available in Berlin only, and therefore does not allow an inter-municipal study. Also environmental data like that on storage of explosive materials is not comparable, because the environmental regulations to minimise or avoid risk of such storages as well as law enforcement are different. Therefore a blue dot in [map 1] has another meaning than a blue dot in [map 2 and 3] .

Nonetheless it is worth conducting such parallel (not real comparative) analysis to identify similar local problems. Here one might learn from one another. In Haldia at present different attempts are tried to reduce the high risk situations. Experience in German mixed land uses might be helpful.

Furthermore it is worth having various reference scales in an environmental justice analysis. As global justice is a vision of sustainability it is important to link local debates of justice back to global ones. This makes even more clear that somehow easy solutions like closing down factories in one city will have consequences in other cities.

We come the conclusion that the search for answers to environmental justice in the global north has to include a thinking of consequences for the global south. On the other hand the sustainability debate that is focussing on global injustice should consider that there are inequalities within the countries of the north, too, as life expectancy of men in India and parts of Dortmund has shown.

ACKNOWLEDGEMENTS

We thank Anandita Sengupta from PGM/ITC for kindly providing data for the India case. We thank the City of Dortmund for kindly providing data for the German case. And we thank our joined research group JuFo-Salus for ongoing discussions on environmental justice indicators.

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