

Article

# Environmental Microsegregation: Urban Renewal and the Political Ecology of Health

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Submitted: 30 July 2022 | Accepted: 20 October 2022 | Published: 16 March 2023

## Abstract

In recent years, multiple-burden maps were developed as a tool for assessing environmental health inequities in cities. Maps of this kind are particularly useful in identifying disadvantaged neighbourhoods. In the case of Erlangen (Germany), the historical development of poorer neighbourhoods may mean that their situation as regards environmental assets is relatively favourable. However, urban renewal often precipitates the redistribution of environmental “goods” and “bads” in such a way as to place a disproportionate burden on socio-economically deprived people and privilege the better-off. This type of environmental microsegregation occurs on a scale below that of neighbourhoods, which means that newly developed approaches in urban geography may fail to identify it. This article details the roots of these processes in changes in the structure of ownership and the respective administration of housing and considers possible methods for monitoring these tendencies.

## Keywords

environmental justice; Germany; microsegregation; political ecology; public health; urban renewal

## Issue

This article is part of the issue “Social Justice in the Green City” edited by Roberta Cucca (Norwegian University of Life Sciences) and Thomas Thaler (University of Natural Resources and Life Sciences).

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## 1. Introduction

In many cities, processes of reurbanisation, such as gentrification, redensification, and upgrading of inner-city areas, are making urban space increasingly scarce and intensifying competition for urban resources (Brake, 2011). In the course of socio-economic polarisation, segregation is becoming ambiguous, increasingly dynamic, and smaller scale. In Germany, city administrations seek purposely to promote socio-economically mixed neighbourhoods in order to reduce the negative impacts of social segregation (neighbourhood effects) and to prevent social hotspots from developing (Häußermann, 2012) to add to those currently in evidence in some large urban housing estates (Brailich et al., 2008). However, spatial proximity of diverse groups on its own does not create a genuinely mixed neighbourhood. Architecture

can set out to create social segregation within relatively small spaces; one example might be the “poor doors” observed in Manhattan, Brooklyn, and London (NYU Furman Center, 2015), which are separate entrances to affordable flats on the lower floors of luxury apartment blocks. Behind these doors, there is a strict separation of the thoroughfares and communal areas assigned to affordable housing tenants and those belonging to the exclusive upper floors; the lower floors are less attractive and less well-equipped. As well as attracting severe criticism, such small-scale instances of segregation have sparked debates around whether the number of entrances is more important than the quality of the housing itself (NYU Furman Center, 2015). Do less advantaged population groups benefit from the ability to move into a wealthy neighbourhood, and is it not the case that such mixed areas ultimately make cities more equitable

places? In our view, the answers to such questions are dependent on the effects of housing quality differences on tenants, especially on their health.

We take this topic as a question of political ecology of health, which we see as consisting of a combination of ecological considerations with political economy. There is criticism that newer political ecology often misses to engage with scientific evidence relating to ecology, and on occasion may give the “impression that the answer to any given research question is known in advance” (Gandy, 2022, p. 35). We intend to avoid falling into this trap by refraining from presupposing specific power relations and instead placing an empirical focus on processes of housing management and urban planning that inscribe inequality and injustice into cities. We will commence by explaining the impact of environmental indicators on human health, proceeding from an understanding of health as arising from salutogenic factors and from the biopsychosocial model of disease. We then discuss the use of multiple-burden maps as means of monitoring environmental inequalities within cities and propose a framework in this context, using the core indicators of urban green space and noise pollution. On the ground, we observe that the historical development of less wealthy neighbourhoods in our research site of Erlangen means they often have a relatively favourable situation as regards environmental assets. However, by selecting two specific neighbourhoods with a medium level of burden, we find that urban renewal appears to redistribute environmental “goods” and “bads” to the detriment of financially disadvantaged people. We trace these effects back to deliberate acts on the part of housing agencies and real estate investors to the end of maximising rental revenues or profits. This does not mean that authorities are subservient to capital. German cities have general planning authority (*Planungshoheit*), which means that the city administration designs development plans (*Bebauungspläne*) as well as land use plans (*Landnutzungspläne*), which the city council ultimately has to decide on. City development thus relies on political majorities in the city council.

## 2. Setting the Scene: The Role of Health in Evaluating Environmental Conditions

Environmental justice being primarily concerned with disadvantaged environmental living conditions has become a vibrant field for not only activism but also research offering a vast array of case studies, analysis, methodological reflections, and theoretical approaches (e.g., Coolsaet, 2021; Holfield et al., 2018). At its centre, there are questions of distributive justice with regard to expositions to toxins, air pollution, degraded water resources, or biodiversity. Environmental justice is not restricted to a single discipline but involves social and natural sciences as well as critical and humanist academics. It is dealt with by professionals from public health, city planning, and the judiciary. This “horizontal” expansion

of the agenda was acquainted with a “vertical” expansion opening up the debates to larger transregional, state, or global concerns—for example, issues of climate change (Agyeman et al., 2016). The scope was broadened also by ideas of ecological justice (Low & Gleeson, 1998), multispecies justice (Haraway, 2016), just sustainabilities (Agyeman et al., 2016) and “green” environmental justice, unwanted land use, and questions of privilege (Anguelovski, 2016), ultimately expanding the urban justice debate to an “emancipatory, antisubordination, intersectional, and relational approach” (Anguelovski et al., 2020). In this article, we address distributions of health-relevant environmental factors with regard to less financially potent dwellers. To do so, a holistic understanding of health is crucial, which takes actual living conditions into account.

The conventional pathogenesis model of disease states that a person becomes ill when a pathogen, i.e., a microorganism or a toxin, enters the body and precipitates harmful processes. In this context, behaviour-centred disease prevention aims to encourage individuals to take responsibility for their lifestyles, with exercise, healthy nutrition, and health literacy programmes regarded as health-promoting. Medical research, however, has now shown that this understanding of pathogenesis may be less helpful than more holistic approaches. In this vein, Antonovsky’s (1996) concept of salutogenesis seeks to identify how individuals stay healthy despite their exposure to various stressors. It replaces the “sick”/“healthy” dichotomy with a continuum of constant maintenance of health issuing from resources of resilience strengthened primarily by the experience of life as meaningful and of self-efficacy, an experience termed a “sense of coherence.” Alongside this, numerous medical research approaches, such as psychoneuroimmunology and neurosciences, have validated the complex theoretical idea, first proposed in the 1970s, of disease as a biopsychosocial phenomenon (Engel, 1977). This model asserts that stress is the most significant psychosocial factor. Precarious living conditions and low socio-economic status reduce self-efficacy and are thus detrimental to health (Trabert, 2021). Most recently, the discipline of environmental medicine has begun to explore the environmental factors that are harmful to health, marking a transition to a conditions-centred approach to prevention that incorporates the consideration of local living conditions and social status.

In terms of environmental factors, we can divide them into environmental “bads” and environmental “goods.” The first category includes, for example, noise pollution, which is omnipresent in cities and whose negative effects on health are well known. Noise has many sources, from leisure activities to industrial operations. However, the most harmful source of noise is transport, such as road, rail, and air traffic (cf. European Environment Agency, 2020). Noise can cause damage to the auditory system, such as tinnitus or hearing loss, and psychological stress, which can precipitate sleep

disorders, metabolic or cardiovascular diseases, and even cognitive impairment in children (World Health Organization Regional Office for Europe, 2018). Urban green space is the most relevant environmental factor on the “goods” side. In addition to its general ecological benefits, it has positive mental and physical effects on people. Proximity to urban green space can enable people to maintain the ability to concentrate for longer (Bringslimark et al., 2007; Hartig et al., 2003; Matsuoka, 2010), has a stress-reducing effect (World Health Organization Regional Office for Europe, 2016), and can ameliorate feelings of loneliness (Maas et al., 2009). Further, proximity to a natural environment can encourage people to engage in physical activity, promote relaxation and recreation, and strengthen social cohesion (European Environment Agency, 2020). There is also evidence that people who spend time in green environments improve the functioning of their immune systems (European Environment Agency, 2020) and experience substantial reductions in diastolic blood pressure, salivary cortisol, and pulse rate (Twohig-Bennett & Jones, 2018), a reduced incidence of type 2 diabetes, reduced cardiovascular morbidity, and reduced mortality (World Health Organization Regional Office for Europe, 2016). As significant socio-spatial systems, large-scale urban green spaces (as well as urban bodies of water) have the potential to “promote urban quality of life and neighbourhood identity and thus contribute to increasing community resilience” (Claßen, 2017, p. 200). Ward Thompson et al. (2016) found a statistically significant correlation between the closeness of green spaces to people’s homes and their well-being; this appears of particular importance to lower-income and disadvantaged urban and suburban residents, as poverty is known to constitute a threat to health. We, therefore, see that those environmental factors with the greatest proximity to housing have the most marked impact on residents’ health, which appears to us to be a matter of small-scale environmental justice.

### 3. Methodological Combination of Geographic Information Systems and Ground-Truthing

Research in the field of environmental justice examines the spatially unequal distribution of environmental factors of relevance to health in relation to specific social groups. There is a strong link between the view of something as “unjust” and matters of the distribution of environmental “goods” and “bads”; this makes identifying areas that bear disproportionate burdens a key task of the discipline. The use of geographic information systems (GIS) in environmental justice research, commencing with their emergence in the 1990s, has proved a highly useful tool, featuring in a number of studies (e.g., Chakraborty & Armstrong, 1997; Glickman & Hersh, 1995; Haklay & Francis, 2018; Jerrett et al., 2001; Maantay, 2002; Maantay & McLafferty, 2011). GIS techniques enable the integration of differ-

ent datasets into one map via processing at different scales and these datasets’ direct visualisation in a cartographic format (Sheppard et al., 1999). Nevertheless, researchers have repeatedly highlighted two major shortcomings of the method in the context of environmental justice research. First, practical and technical limitations currently impair the comparability of results (McMaster et al., 1997; Sheppard et al., 1999). Maantay and McLafferty (2011) argue that these limitations can be traced back to deficiencies in data, data aggregation issues, inaccuracies in location data, technological limitations, a lack of temporal data on residential mobility, and constraints in the use of exposure proxies. These shortcomings apply, for instance, to the most frequently used method of spatial-proximity analysis, which often works via “buffering.” This method rarely takes topographical differences within the terrain or the influence of wind speeds into account, and there is no agreement on the distance from the residential area at which an environmental factor can be considered relevant to health (cf. Sheppard et al., 1999). Second, most studies focus on exposures of socio-economically deprived groups to only one environmental factor, such as noise (e.g., Verbeek, 2019), air pollution (e.g., Havard et al., 2009; Jerrett et al., 2001; Laurent et al., 2008), and green spaces (e.g., Barbosa et al., 2007). Some authors advance the view that assessing the complexity of environmental influences on human health and adequately addressing the unequal distribution of environmental factors in relation to lower-income population groups requires the inclusion of multiple environmental indicators (Jerrett, 2009) in such studies. In recent years, in response to these critiques, researchers have used multiple-burden maps to display various environmental factors cumulatively within spatial units and to intersect them with socio-economic data (Flacke et al., 2016; Hölzl et al., 2021; Honold et al., 2012; Klimeczek, 2014; Pearce et al., 2010). These maps have proven particularly powerful for identifying small-scale areas in need of prioritised action, information that can then serve to target policy interventions. In many respects, the environmental justice concept of the German Federal State of Berlin, developed between 2010 and 2019, represents a pioneering model at the national and international levels (cf. Klimeczek, 2021). The project has entailed the compilation of data from government departments covering the environment, health, urban development, urban planning, and social affairs, for 447 small-scale planning areas (termed *lebensweltlich orientierte Räume*), followed by a two-stage monitoring procedure working with five core indicators (noise pollution, air pollutants, availability of green space, bioclimatic pollution, and social problems) and underpinned by several supplementary health indicators. This methodology, however, has only limited applicability to other cities, as many municipalities do not have the data required. In this context, Böhme et al. (2015, 2019), for example, point out that health and social data are subject to special protection

and very little in the way of such data is available at a small-scale level. Most recently, remote sensing has become a valuable tool both in environmental justice research and in urban health as it facilitates the displaying of micro-level environmental conditions (Walker et al., 2022; Weigand et al., 2019). However, following Moretti's (2013) distinction between "distant reading" and "close reading," critical GIS studies have emphasised the necessity of ground-truthing and triangulation of data, avoiding the positivist notion and epistemological shortcomings of GIS (e.g., Burns, 2021; Schuurman & Pratt, 2002; Schuurman et al., 2020). Thus, we design our GIS methodology accordingly and supplement it with qualitative in-depth assessments of the research sites.

#### 4. Research Design

This study, using the example of the Bavarian city of Erlangen, sought to present a simpler methodology for capturing the distribution of two important environmental factors within the city and identifying areas of low, medium, and high stress for analysis with regard to their socio-economic characteristics. We took special care to ensure that the data used were easily accessible and retrievable by municipalities. The procedure entailed three stages. First, we used GIS to map the core indicators "noise pollution" and "urban green space" across the urban area of Erlangen. The data relate to the smallest area classification level, that of housing blocks. Germany has various legal requirements on noise pollution and methods for determining levels. For reasons of comparability, we used the EU's Environmental Noise Directive, which has also been adopted, for example, by authorities at European and German national and federal state levels. We used the 2017 noise mapping conducted by the Bavarian Environment Agency, which is carried out every five years, as the basis for our data. For further processing, we used the Lden (day–evening–night) noise index and intersected the corresponding grid data with housing blocks in Erlangen.

We drew on satellite data to assess the distribution of urban green space throughout Erlangen. We used the normalised difference vegetation index to represent the quality and distribution of these spaces within the urban area, selecting a scenario based on a date in a vegetation-rich season of the year (4 September 2019). In order to reflect local conditions, we developed a site-specific classification rather than using a pre-defined one (see Table 1 in the Supplementary Material). The classification boundaries were determined based on specific locations of urban green spaces visited by the authors—in other words, by ground-truthing. Thereby, urban green was divided into three categories, with high normalised difference vegetation index values in parks and areas of high tree coverage, medium values in areas with lower tree cover, such as courtyards, and low values in spaces with only isolated occurrences of trees and/or shrubs. The second stage of the analysis entailed evalu-

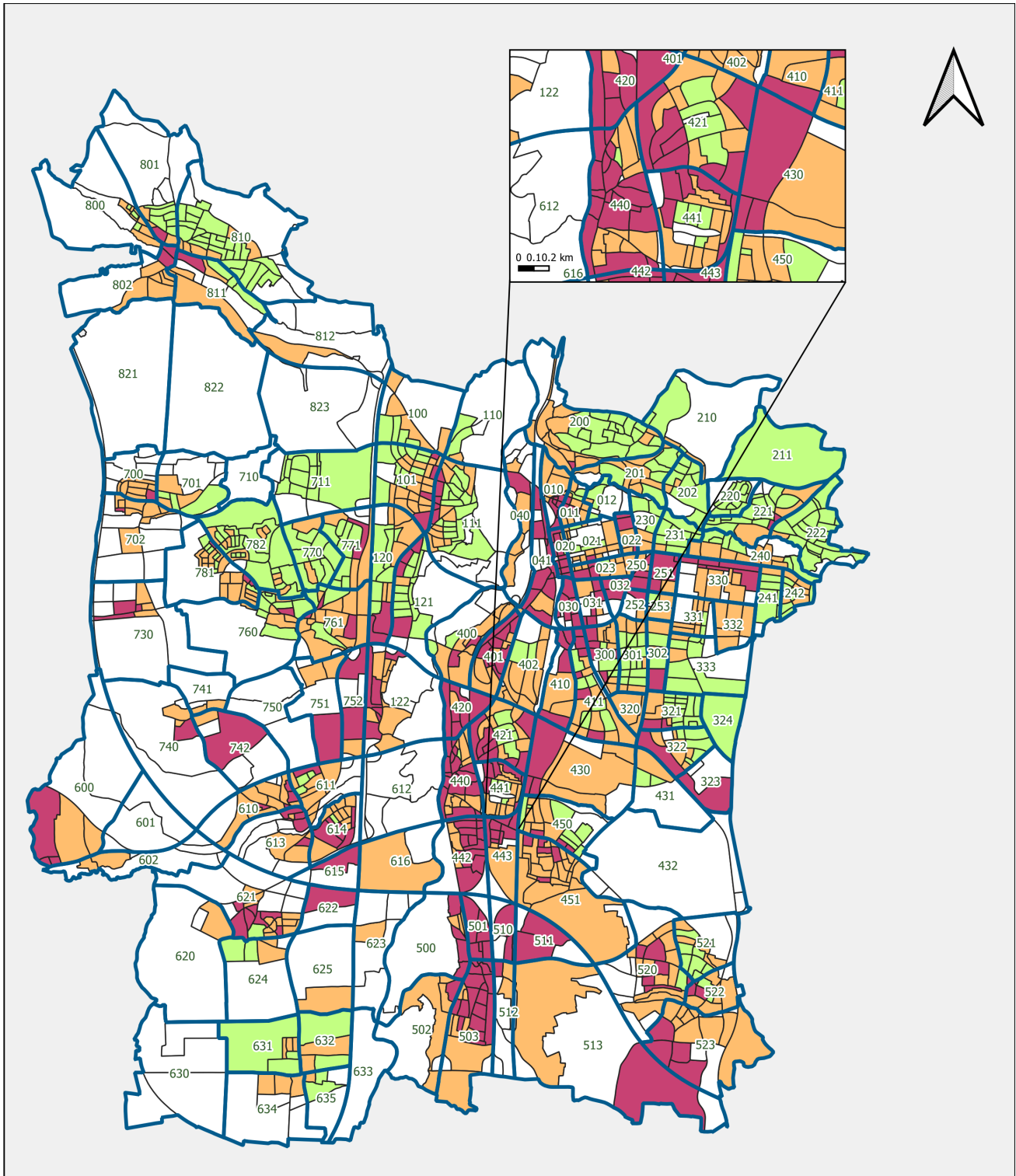
ating these categories for the supplementary indicators "heat stress" (data provided by the City of Erlangen in 2019) and "proximity to bodies of water" (data source: OpenStreetMap). We selected all the indicators used on the basis of their relevance to health and for reasons of data availability. For each core indicator, we formed three classes and aggregated them in a burden map (Figure 1), enabling us to identify areas with a high need for action. Unfortunately, data protection concerns meant we could not carry out our original plan to run a calculation with the third core indicator, "socio-economic data," at the level of housing blocks. We were able to take these data into account at the district level.

For in-depth assessment, we investigated two processes of urban renewal. We selected neighbourhoods in which environmental factors were not the worst and where some environmental assets could be distributed or redistributed. These were the area of redensification in the Rathenausiedlung (part of district 411) and a newly built, privileged residential area at Röthelheimpark (part of district 332). The multiple-burden map shows that both these areas have a single exposure. Walking these neighbourhoods, we documented our routes with photographs, notes, and sketches. As we are interested in the housing situation of less affluent people, one relevant indicator is the housing cubature and its condition. In Germany, detached houses mark the pinnacle of the real estate market followed by terraced houses, and both, due to high land prices, especially in growing cities—of which Erlangen is one—have become hardly affordable even for people of average income. Apartment blocks indicate more affordable rents with especially older structures from workers' estates or flats from the 1970s and 1980s, especially the modernist satellite estates on the outskirts, which have become unpopular and today often provide low-quality flats and affordable housing. As we are especially interested in how urban space is restructured with regard to financially underprivileged people, we also regard housing subsidy programs as an indicator for less affluent tenants, especially since there are often income caps for eligibility. We further conducted 12 interviews with residents and experts such as urban planners working in Erlangen, politicians, and representatives of civil society organisations such as a tenants' association and a church. Each interview was individually designed for the person addressed. We supplemented these activities with information gained from attending public participatory events and a review of local newspapers and the internet.

#### 5. Results

##### *5.1. Heterogeneity of Public Health-Related Conditions Within the Urban Area of Erlangen*

Analysis of the two core indicators as set out above shows substantial variance in the public health status

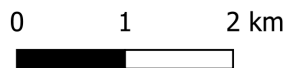


**Differences in burdens within statistical districts**

Burdens by noise level and availability of urban green spaces

- no burden (374 blocks; 41,341 residents)
- single burden (505 blocks; 58,616 residents)
- double burden (293 blocks; 27,844 residents)
- uninhabited housing blocks
- district boundaries

Cartography: David Spenger



Data sources:

- urban green space (NDVI, Date: 4 Sept. 2019): Sentinel Hub ([www.sentinel-hub.com](http://www.sentinel-hub.com))
- noise pollution (noise mapping 2017): Bavarian Environment Agency
- housing blocks: City of Erlangen
- statistical districts: City of Erlangen

**Figure 1.** Multiple-burden map of Erlangen.

of housing blocks within small areas in Erlangen. While some districts are relatively internally homogeneous in this regard, there are others within which all levels of stress occur, and some show diversity of conditions at the block level (see Figure 1). The 115 inhabited districts in the Erlangen urban area can be compared according to the differences in burden and internal heterogeneity which they evidence (see Table 2 in the Supplementary Material). Of these 115 inhabited districts, we can characterise 29 as having a low level of stress. These include 14 districts with relatively homogeneous levels of burden, eight with medium heterogeneity, and seven with marked heterogeneity. Thirty-five of the 115 districts evince a double burden; of these, 17 have low, 14 have medium, and four have high internal heterogeneity. The 17 low-heterogeneity districts have a double burden almost throughout their entire area, with a corresponding impact on public health; this identifies them as areas with a priority need for action (such areas include 030, 041, 250, 251, 420, 440, 442, 501, and 503). When combining this information with socio-economic data (number of social welfare recipients), we found only a few areas where poor environmental conditions coincide with low socio-economic status. At the same time, the comparison with the spatial distribution of the social index of the city of Erlangen, a multi-layered indicator displaying socio-economic status (City of Erlangen, 2021), shows that socio-economically worse-off areas actually often have quite good environmental conditions. This is the case, for example, in areas of districts 421, 450, and 771 (Figure 1). These neighbourhoods contain older multi-storey blocks or/and workers' housing, especially in those parts displayed as not burdened. This reflects general tendencies in the housing structure of Erlangen that are related to historical

developments. In Erlangen, more socio-economically disadvantaged population groups often live in older housing estates once built for factory workers or in storey blocks from the 1970s and 1980s. Such estates have open spaces which are relatively expansive when compared to today's planning standards, and now some of them feature valuable tree populations which have evolved over the years (Figure 2). The living conditions they offer are therefore relatively healthy in terms of environmental factors. In the following, we present qualitative results of the neighbourhoods of Rathenausiedlung and Röthelheim, which are both single-burdened and thus competition for favourable locations can be expected.

### 5.2. Redensification in the Rathenausiedlung

The Rathenausiedlung came into being in the 1960s as a workers' housing estate typical of the period, dominated by three-storey apartment houses with gable roofs. Figure 2 shows parts of the district that are still owned by a housing cooperative and have not yet undergone renovation. The site features wide open spaces between the buildings, loosely studded by relatively old trees. In addition to several playgrounds, the extensive open spaces also provide niches for various groups of residents to take over space for specific needs, ranging from seating areas to low-level urban gardening (Figure 3; interview 1 with Rathenau residents, 27 June 2018). In the redensification area, more than 1,000 trees fell victim with the building work starting in 2018. The newly densified urban ensemble now follows the idea of an urban park (Figure 4) and has accordingly been renamed "Jaminpark." Some areas are now dedicated to specific activities (such as seating, play equipment, monkey bars, etc.), while others have been fenced off due to environmental protection.



**Figure 2.** Typical workers' housing estate as it still exists in the not-yet-redensified parts of the Rathenausiedlung.



**Figure 3.** Residents’ creative use of a niche of green space.

Information boards entitled “nature in the Jaminpark” supply explanations of these areas’ specific purposes in relation to the ecosystem; an example appears in Figure 5, illustrating a site of habitat trees of special ecological value that had been felled elsewhere and set in concrete in this place.

These findings are in contradiction to ideas often raised in discussions around “just green enough” strategies (Curran & Hamilton, 2017; Wolch et al., 2014)

and “green gentrification” (Marcuse, 1985). In the case of the Jaminpark, rent rises and displacement of less well-off groups occur despite environmental degradation. The Jaminpark is built to attract wealthier urban groups. The idea of what a “green” neighbourhood should look like corresponds more with the aesthetics of urban design than ecological value. This fundamental ecological degradation is especially important with regard to climate change.



**Figure 4.** Newly arranged area of the Rathenausiedlung, now renamed Jaminpark.



**Figure 5.** Replantation site of valuable habitat trees felled elsewhere in the area.

### 5.3. The New Housing Ensemble of Jaminpark

The GBW Group (now Dawonia) acquired this neighbourhood in the spring of 2009 and planned its redensification, putting out a tender for architects in 2015; initial building works commenced in 2018. The project's completion is scheduled for 2023. The GBW Group promised to modernise the existing flats for energy efficiency and create homes suitable for elderly residents, but also stated its intention to upgrade the neighbourhood; initially, there was mention of creating approximately 300 to 400 new residential units by adding further storeys to existing buildings and constructing new ones. A tenant information event in April 2018 gave a figure almost double these initial estimates, at 640 planned new residential units (GBW Group, 2018, p. 6); a newspaper article indeed quoted the former head of project development at the GBW Group as referring to 950 planned flats (Reinhold, 2018). These new flats will be located in seven "point buildings," three of which are to be five-storey buildings in the centre of the area (Figure 4; Figure 6, signature C), each with 13 units, alongside five seven-storey buildings along Nürnberger Straße, each containing 28 flats. Further flats are being built in additional linear buildings (Figure 6, signatures A, B, and D), some of which are planned as barriers to noise.

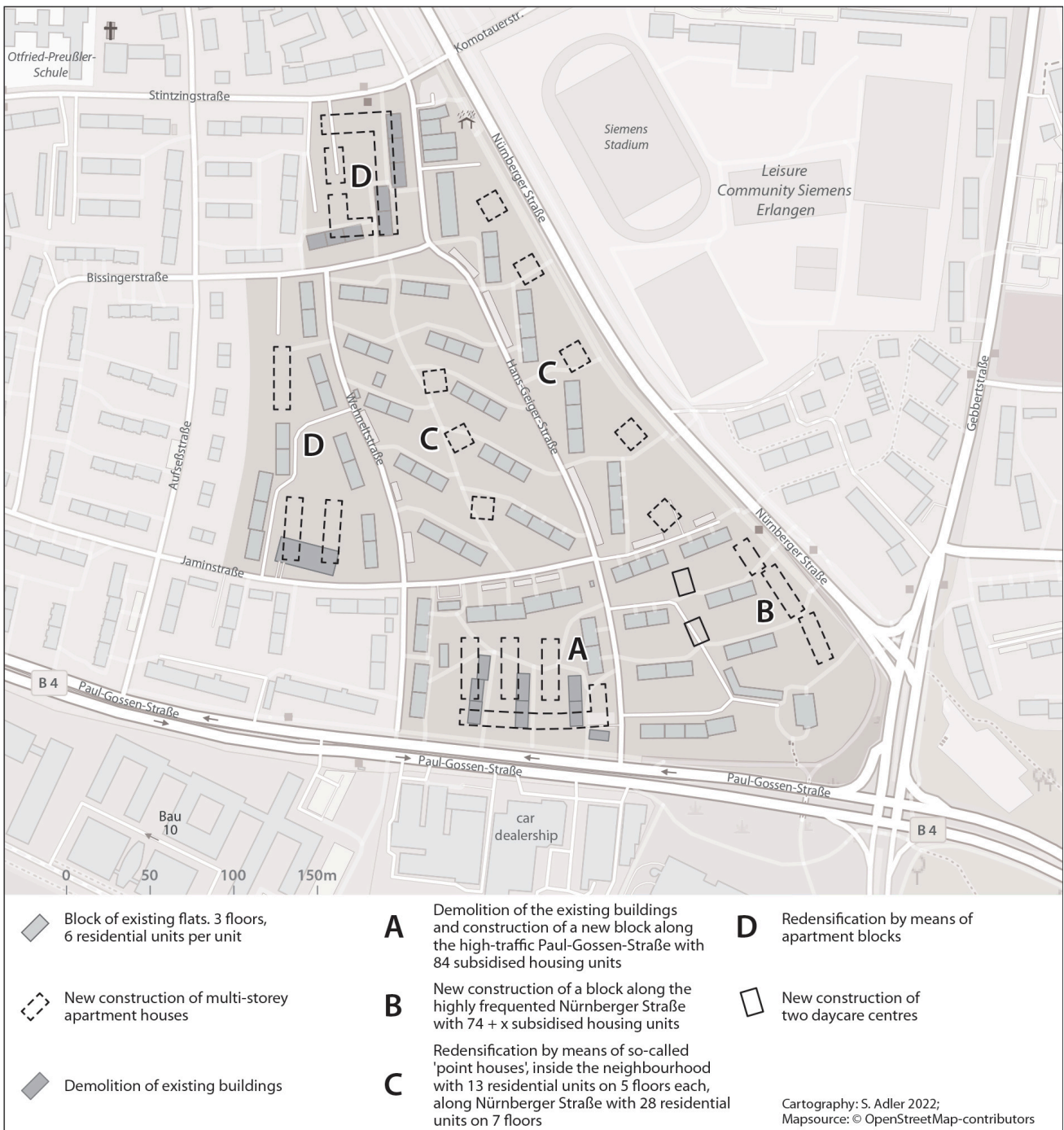
### 5.4. Residential Blocks as Noise Mitigation Measures

The housing company GBW Group refers to "noise mitigation measures in some areas by means of additional buildings as part of its plans for upgrading the neighbourhood" (GBW Group, n.d.-a). The development plan

(*Bebauungsplan*) terms the buildings to be constructed along the two busy roads (Figure 6, signatures A and B) "noise protection blocks"; there is an express stipulation on the part of the city authorities that residents may only move into the flats behind these buildings after their completion, including the installation of all windows (Development Plan 345 of the City of Erlangen). As with all major development projects, the city authorities require 25% of the new housing stock to be affordable/social housing. With a planned total of 650 new flats, this would mean the construction of about 162 affordable units. Seventy-four of these, plus an unspecified additional number, will be located in the block along Nürnberger Straße (Dawonia, 2022). To better shield non-affordable apartments from the four-lane Paul-Gossen-Strasse with its high volume of traffic, three gabled apartment blocks were demolished and rebuilt somewhat further north to make room for a street-side eaved apartment block with 84 subsidised housing units. The "point buildings" in the centre of the neighbourhood, away from noise and dirt, will be realised to a higher specification (Figure 4), generating greater rental revenue.

The GBW Group had promised: "We are planning social modernisation that avoids causing social hardship. Among other things, this means that no tenants will have to leave their familiar living environment because they cannot afford to pay rent increases subsequent to modernisation" (GBW Group, n.d.-b). After renovation for energy efficiency, however, the company will be permitted to increase rents by €2.60 per square metre, meaning tenants may need to expect rent increases of 60% (interview with GBW Group Tenants' Association, 27 June 2018; interview 2 with Rathenau resident, 29 June 2018).





**Figure 6.** Changes in the housing stock in the course of redensification on the Rathenau estate.

Indeed, there are indications that rents could rise by as much as €4.10 “per square metre after renovation is complete” (Kettler, 2019). Residents had achieved the withdrawal, in part, of some previous rent increases after turning to the German Tenants’ Association for assistance; the GBW Group cited system errors, although failed to correct the rents for all tenants. “The GBW,” asserted a representative of the Tenants’ Association, “is of the opinion that it only has to take rent increases back if tenants complain and seek help” (interview with GBW Group Tenants’ Association, 27 June 2018). The GBW

Group has a strong interest in increasing rental income; it appears that the site’s selectively appointed redevelopment measures pursue the intent of attaining higher rents in its more privileged areas.

### 5.5. The Creation of Privileged Residential Areas in Röthelheimpark

As a second example, we studied a neighbourhood in Erlangen’s Röthelheimpark district that underwent fundamental redevelopment from 1997 to 2014 on the

151-hectare site of a former US military base which had been abandoned in 1993. The city of Erlangen acquired the area in 1994 and initially declared it a 25-hectare nature reserve. For the remaining part of the site, the city launched an urban planning competition, won in 1995 by a Munich-based planning company. When work commenced in 1997, its stated aim was to provide “urban living close to the city centre in a family- and child-friendly environment at short distances from green spaces, infrastructure and workplaces” (City of Erlangen, 2011, p. 30); among the associated ambitions were the creation of a “city of short distances,” a “compact city” (with mixed uses of land, including housing, community facilities, commerce, offices, services, trade, and university facilities), and a “car-free city” (featuring underground car parks; City of Erlangen, 2011, pp. 30–40). The original plan envisioned housing for approximately 9,000 inhabitants, a figure significantly reduced during the planning process to 6,000 and later to 3,500 (City of Erlangen, 2011). The fundamental structure of the plan remained, with reductions in the heights of the planned buildings; an area in the northwest of the district was made available to Siemens AG, and, in the southeast, the focal area of our study, terraced or detached houses, a building supplies store, and a clothing shop replaced large swathes of the originally envisaged multi-storey apartment housing.

According to a representative of Erlangen’s urban planning department and a coordinator of the Röthelheimpark project group commissioned to carry out the work, there was no alternative to this reduction in space for housing. Investors showed barely any interest in building multi-storey housing, “not as owner-occupied flats, and certainly not as rented flats” (interview with city planning staff member 2, 19 April 2018). The project group argued that there was no need for housing for so many people in almost exclusively multi-

storey apartment buildings (interview with project group Röthelheimpark member, 28 April 2018). Contradicting this assertion, a member of the city council claimed that there was in fact high demand and accused the council of “building to suit investors,” considering that the city “always backed down when an investor wanted something different” (interview with a city council member, 26 June 2018). In this interviewee’s account, the city council had not centred the needs of the future residents, but rather those of the investors. It can be confirmed that the need for housing had certainly been high, as there had never been enough housing in Erlangen since the end of the 1970s. A 1990 report by the Office of Statistics of the City of Erlangen (1990, p. 1) points to a lack of housing development in the late 1980s and predicts an increase in the number of jobs in the city in the coming years, with a corresponding need for housing. In addition to this, Erlangen had very high rents long before this tendency emerged in the region’s other large cities (Nürnberg, Fürth).

Purposely designed for a wealthy clientele, this neighbourhood shows a differentiated distribution of environmental burdens and resources that correlates with the presumed financial resources of its various groups of residents (Figures 7 and 8). There is a particularly noticeable selective distribution of burdens from road traffic. The road Allee am Röthelheimpark serves as the only thoroughfare through the district and is correspondingly busy. Along this avenue and Kurt-Schumacher-Strasse, which borders the neighbourhood to the east, there is considerable traffic congestion due to commuter flows, especially where the two roads meet. An L-shaped building with affordable flats stands at this intersection, effectively reducing the associated burden for the buildings behind it (Figure 8, signature D). Similarly, the construction of multi-storey buildings along



**Figure 7.** Aerial photo of the studied neighbourhood in Röthelheimpark. Source: Photo courtesy of Jan Gemeinholzer.



**Figure 8.** Residential building structure of a neighbourhood in Röthelheimpark.

the Allee am Röthelheimpark provides shielding from noise and exhaust fumes for the neighbourhood to the south (Figure 8, signature B). The multi-storey apartment houses continue along the streets that accommodate the neighbourhood's access traffic (Figure 8, signature B). Both Willy-Brandt-Strasse to the west and Ludwig-Erhard-Strasse to the east border what is called the "Kanzlerkarree," a space with very little exposure to environmental "bads": "They breathe away the exhaust fumes for us" (group interview with Röthelheimpark residents, 26 June 2018). The Kanzlerkarree provides an artificially created niche as a privileged area for terraced houses and exclusive modern urban home architecture (Figure 8, signature Ak). A special feature of the neighbourhood is the broad green axis that extends into the Röthelheimpark district in the form of a wedge in a north-south direction and leads into a nature reserve (Figure 8, signature C). It offers residents opportunities for recreation close to their homes and serves as a corridor for air exchange. Further rows of terraced houses were created to its west and east (Figure 8, signature A). It is a safe assumption that an influx of people using the space for leisure arrives here from the north. Accordingly, the size of the residential units increases as the load of noise produced by leisure activities decreases towards the south, enhancing the residential location's exclusivity.

The location of the detached houses south of the Kanzlerkarree is especially privileged (Figure 8, signature E). At the planning stage, it was evident that these spaces would be reserved for particularly affluent residents, given the size of the plots, land prices in Erlangen, and the area's planned development structure. This area is shielded from the access traffic on Thomas-Dehler-Strasse to the north by an additional row of terraced houses (signature A) and from the traffic on Kurt-Schumacher-Strasse to the east by an artificial hill (signature F) raised for this purpose. The building supplies store and the clothing shop serve the same purpose. There will be very little noise from the conservation area in the south. Nevertheless, a strip of old trees has been left in a natural state to provide privacy for the southernmost properties.

## 6. Conclusion: Environmental Microsegregation, Justice, and Health

Taking the city of Erlangen as an example, this article has illuminated the inherence of environment-related microsegregation to processes of urban renewal such as redensification and the design of new neighbourhoods. With regard to the noise mitigation buildings of the Rathenausiedlung, the city planning department confirms: "For economic reasons, affordable housing is often built along streets with heavy traffic. This [housing] must not exceed a certain cost, as land also has its price" (interview with Erlangen urban planning staff member, 24 May 2018). It appears that planning author-

ities tolerate or indeed actively envisage the resulting health burden on social housing residents. The way how unequal distribution of burden is meticulously orchestrated in the Röthelheimpark is justified by an idea of "performance justice," according to which someone who "achieves more" (economically) has a right to earn and own more. An ecological understanding of health, however, would point out that this is not a matter of luxury and convenience, but rather one of fundamental well-being and severe threats to health; not only due to exposure to environmental toxins but also with regard to psycho-social factors. Contrary to the not yet modernised part of the Rathenausiedlung, which still provides affordable housing, the new subsidised flats in the Jaminpark are not available to social welfare recipients. The new flats are subject to an income-oriented subsidy scheme (*einkommensorientierte Förderung*) which means that not the poorest but working people with low wages are eligible to rent the environmentally underprivileged units. Welfare indigence intrudes into the midst of society. Inequality in the Jaminpark is cemented in the building structure as tenants with unfavourable flats can no longer apply for better-situated ones as these now are of higher standard and rents. The height of income now determines deprived living conditions in proximity to better-situated people. The impact on health-related factors such as self-efficacy or demotivation through social injustice is hardly assessed. This insight, in our view, demonstrates the importance of an ecologically informed perspective on health promotion for countering current tendencies towards injustice in urban development.

The processes of distribution of environmental "goods" and "bads" that our study recorded take place at a scale far below any statistical unit in common use. They happen within neighbourhoods, at the level of individual blocks of houses, and they are of such a small scale that conventional analyses of social space or multiple-burden maps cannot identify them. On the contrary, as inequality increases, a levelling statistical effect occurs. When the social mix is achieved in areas with residents with high socio-economic status, the statistical key figures are depressed; in areas of greater socio-economic deprivation, they are raised. We need higher-resolution survey instruments if we are to counter this effect and the concomitant invisibility of micro-scale processes. The root cause of the effects observed can be traced back to the profit orientation of actors in the housing and real estate sectors; it is therefore possible, we argue, to anticipate these effects and observe areas of urban development accordingly.

A perspective on urban renewal that draws on the political ecology of health, in concert with a holistic understanding of health, can serve as a means for the evaluation of ongoing urban renewal projects in terms of their impact on the health of various population groups. Health-related environmental burdens and benefits are important factors for objectively assessing the quality

of living conditions and refuting meritocratic arguments that ultimately suggest that economic “achievement” entitles individuals to better well-being. Further, it is imperative to challenge local actors’ conceptions and valuation of health. Multiple-burden maps can serve as a preparatory tool for identifying areas with priority needs for action. Exploratory techniques such as observations, site visits, interviews, and analysis of local media can subsequently capture specific social configurations and environmental benefits and burdens at a scale smaller than the neighbourhood level. We recommend the use of this methodological mix in future studies on local environmental injustice and microsegregation.

### Acknowledgments

Special thanks go to Carolin Eisemann, Fabian Feick, and Stefan Kammerbauer for helping in the research.

### Conflict of Interests

The authors declare no conflict of interests.

### Supplementary Material

Supplementary material for this article is available online in the format provided by the authors (unedited).

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