09.01 Environmental Justice (Edition 2015)

Overview

The term environmental justice refers to the type, extent and consequences of the unequal social distribution of environmental loads and to its reasons. For a long time, it has been known and scientifically proven that social condition is one of the factors for a person's health condition and that it influences life expectancy. The relationship between socio-economic status and the residential and residential environment conditions hazardous to health – and their causal relationships – has not been thoroughly examined in Germany so far. Thus a largely health-related risk analysis and evaluation is lacking. This is especially relevant with respect to the development and implementation of integrative strategies, concepts and measures, and it applies particularly to high-density areas.

In order to compile the necessary fundamentals for the goal-oriented development of action strategies related to environmental and health policy, the State of Berlin initiated the cross-departmental space-oriented pilot project "Environmental Justice in Berlin" in 2008. The handling of the individual topics was closely coordinated with the thematically competent Senate departments, the Statistical Office for Berlin-Brandenburg, several universities and independent research institutions. Since 2012, the Federal Environment Agency (*Umweltbundesamt*, UBA) has specifically supported the development of the new topic and accompanied it with its expertise. The following text is based on the publication **Basisbericht 2014/2015 "Umweltgerechtigkeit im Land Berlin, Grundlagen für die handlungsorientierte sozialräumliche Umweltpolitik im Land Berlin"** (Basic report 2014/2015 "Environmental Justice in the State of Berlin - Fundamentals for an action-oriented socio-spatial environmental policy in the State of Berlin") (SenStadtUm 2015, unpublished).

With a view to the development of a cross-departmental health load analysis, the following questions were in the foreground:

- Which environment-related topics are relevant for health and should be integrated into the context of the investigations?
- How can information, data and analytic results from the thematically competent departments Environment, Health, Urban Development, Urban Planning and Social Affairs be aggregated at the level of the 447 planning areas (PLAs) and combined into a new spatial (informal) level of consideration and planning?
- Which planning areas with health-related multiple loads also exhibit a high density of social problems, and which areas with multiple loads are vulnerable areas in terms of climate change and therefore particularly affected?
- Can general statements and policy recommendations be derived for cross-departmental space-oriented planning or administrative action, and can applicable legal instruments be developed on the basis of the small-scale health load analyses which supplement the Berlin planning system?

The new small-scale or neighbourhood-related Berlin approach to environmental justice closes a gap in the existing reporting and monitoring systems by systematically aggregating environmental aspects hazardous to health and condensing them into a new informal level of consideration and a new field of action. The results are "strategic cornerstones" for environmentally just and sustainable development in the State of Berlin. They confer a greater profile and weight on the socio-spatially oriented environmental policy in the capital and underpin the data concerning social structure with the perspective of environment-related health protection.

The four levels

- environmental justice monitoring (small-scale spatial health load analysis),
- spatial level (mitigation concept),
- implementation level (strategies, measures, projects),

- evaluation

together form the **Integrated Berlin Environmental Justice Conception** (*Integrierte Berliner Umweltgerechtigkeitskonzeption*, IBUk) (cf. Fig. 1).

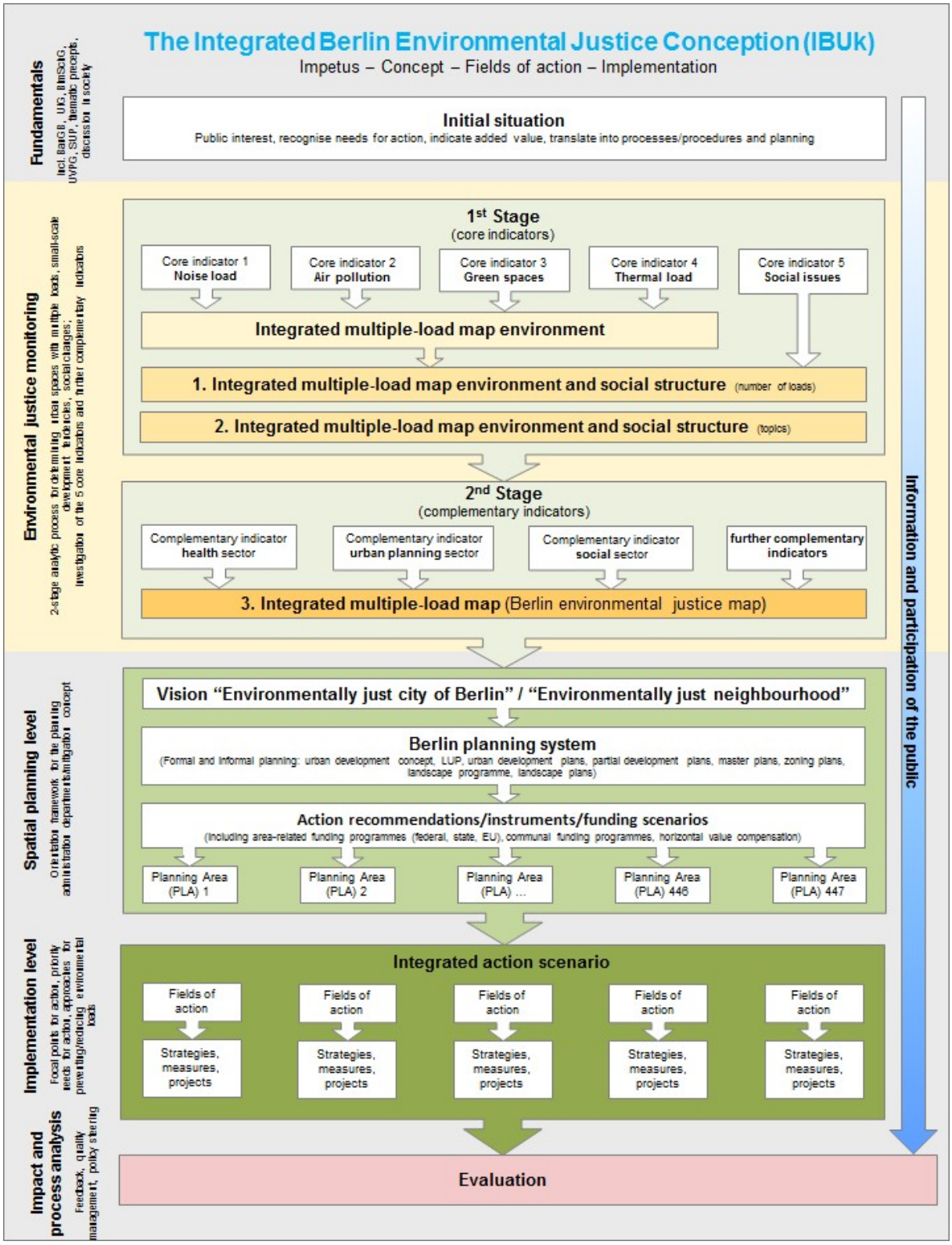

Fig. 1: Concept of the Integrated Berlin Environmental Justice Conception (IBUk) (SenStadtUm 2015)

Statistical Base

Berlin disposes of a broad range of data for the domains of health, social affairs and urban affairs/development. Yet especially small-scale reporting which tackles the causal relationships between environment, health and social condition and systematically investigates the scope of socio-spatial environmental loads is lacking. The reporting concerning the different topics is largely conducted independently, without intersection. The merging of different data sets presents a challenge due to different methodological approaches, diverging acquisition cycles as well as different degrees of detail. Moreover, the processing of data is not uniformly conducted at the level of the living environment areas (LEAs), of which the 447 planning areas (PLAs) represent the smallest-scale entity.

In order to carry out the integrated representation and evaluation it was therefore necessary to:

- acquire or process the thematic data uniformly for the level of the PLAs,
- choose corresponding levels of categorisation which would permit a superposition of the different indicators.

In detail, the **following sources** were used for the development of the environmental load analysis:

- Planning areas (PLA) as the smallest-scale level in the hierarchy of the living environment areas (LEA) (further information regarding the spatial basis of the LEAs can be found here (German only)) (SenStadt 2009)
- Grid Map L_{DEN} (noise index day-evening-night), Sum of all Traffic Sources, SenStadtUm IX C, as of 2013
- Annual averages of the PM_{10} and NO_X concentrations as a 500m x 500m grid, SenStadtUm IX C, as of 2009
- Traffic-related air pollution ($PM_{2,5}$ and NO_2) in selected road sections (Environmental Atlas), SenStadtUm III D 1, as of 2009
- „Versorgungsanalyse für die städtische Versorgung mit Grünflächen (VAG)“ [Availability analysis for the urban availability of green spaces], SenStadtUm I A, as of 2011
- StEP Klima, SenStadtUm I A, as of 2011
- Social Urban Development Monitoring Report 2013, SenStadtUm I A, as of 2013
- Environmental Atlas, map of the urban structure – differentiated, SenStadtUm III D 1, as of 2011,
- Berlin rent index 2009, SenStadt IV A, as of 2009
- Statistical Office for Berlin-Brandenburg (*Amt für Statistik Berlin-Brandenburg*, AfS), summary of data from 2006-2012 from the databases of causes of death and population register, AfS, as of 2013
- Flyover “Berlin at Night 2010” for identifying the urban brightness value, Leibniz-Institute of Freshland Ecology and Inland Fisheries, as of 2012
- Delimitation of the “priority area air purity” in the land use plan (LUP), SenStadtUm I A, as of 2015

Methodology

Thematic approach

The Berlin approach to assessing environmental justice mainly relies on the evaluation and aggregation of available data. It has been conceived as a two-stage process with five core and various complementary indicators, while the data bases are generated at different intervals on a small scale, at the level of the planning areas (PLAs), and are kept available as the respective states of work over a longer period of time.

In order to capture and illustrate the small-scale distribution of environmental loads, four important environment-related topics whose relevance for health has been documented scientifically (noise, air pollution, availability of green spaces and bioclimatic load) were first chosen. The density of social

issues (status index from the Social Urban Development Monitoring) was integrated into the basic indicator set of **five core indicators** as another – fifth – area relevant for health.

In the first step of the analytic process, the data regarding the three core indicators air quality, noise and thermal load were analysed and uniformly classified into the ordinal scale attributes “good”, “medium” or “bad”, according to the health hazard. The classification of the other core indicators “availability of green spaces” and “social issues” was conducted analogously, but without a health-related weighting. Subsequently, the multiple-load factor of each planning area was determined by summing up the core indicators that had been attributed to category 3 (“bad”/”high”). Thus, the number and distribution of spaces with multiple loads as well as the responsible loads are accessible and transparent.

In a second step, the statements from the **multiple-load map** can be further differentiated thematically through **complementary indicators** from the areas of health, social affairs, urban planning and urban development. For example, planning areas with

- multiple loads based on the core indicators very high air pollution and/or very high noise load,
- predominantly simple residential character and
- very high statistical mortality

are characterised as health-oriented “risk attributes”, which are thus subject to a particularly heavy load from the perspective of environmental medicine.

This status assessment (“Berlin today”) via the **two-stage Berlin environmental justice monitoring** thus provides an overview over the environmental quality in the 447 planning areas of the city.

The environmental justice monitoring is conceived such that further existing sectoral or integrated monitoring approaches can be used and combined in order to render the small-scale health load analysis more precise.

Spatial levels of representation

Entire city

In analogy to the Social Urban Development Monitoring (*Monitoring Soziale Stadtentwicklung*, MSS) (SenStadtUm 2013), the data evaluation and cartographic representation of the environmental justice monitoring are based on the spatial classification of Berlin into the three levels of living environment areas (LEA) (SenStadt 2009). For the graded indicator system of the environmental justice monitoring, the smallest entity – the 447 planning areas – with a size of an average of 7500 of inhabitants was chosen.

Delimitation of the “focus area inner city”

The small-scale analyses of environmental loads show that the majority of the multiple-load areas are situated in the inner city and adjacent areas (outside of the S-Bahn ring). To allow a better representation of the impact area of the environmental justice approach with respect to the unequal distribution of the loads and concerning the relation to urban spaces, it seemed necessary to extend the area of consideration to the inner city. This new “focus area inner city” is the third backdrop of the Berlin environmental justice approach, along with the entire urban area of investigation and the boroughs.

The area which is represented as a “priority area for air purity” in the Berlin land use plan (LUP) (SenStadtUm 2015a) is the basis for the delimitation of the “focus area inner city”. This space essentially encompasses the Berlin inner-city boroughs with approximately 100km² area and a predominantly closed and multi-storey architecture. According to the representation of the land use plan, measures to reduce emissions are to be provided when planning in this area. The representation of the “priority area for air purity” sets spatial priorities for restricting emissions by the polluting groups domestic fuel and industry. The “priority area for air purity” is legally secured according to planning laws through the representation in the LUP, and is specified through further immission control regulations.

This backdrop of the investigation makes sense because the strengthening of the inner city, the desired urban mixture and the qualification of the stock are important goals of sustainable urban development in Berlin that is oriented towards climate justice. Moreover, the existing city structures are of special relevance when it comes to the implementation of strategies and measures. The existing

very densely built-up urban structures are mainly situated in neighbourhoods which lie within this newly defined area – the “focus area inner city”.

Borough-level representation and evaluation

The representation for the entire city in the integrated multiple-load map “Environmental Justice in the State of Berlin 2014/15” according to planning areas is also differentiated for the examination at the borough level. Assessing the situation in the respective borough and in the entire city comparatively allows for a differentiated classification of the degree of environmental justice at the borough level. Taking a look at the boroughs allows both the local actors and the affected persons to readily recognize the particularly affected areas and to set priorities accordingly with regard to formulating and implementing projects or measures.

Besides the expression in the map, the borough-level representation also includes the graphical evaluations

- “percentage of inhabitants in the borough of the categories of the multiple load” and
- “share of the planning areas in the borough of the categories of the multiple load in absolute numbers”. These are placed in relation to the situation in all of Berlin.

The following can be represented accurately in tabular form at the level of the planning areas:

- the population, i.e. those affected by the environmental situation,
- the classifications of the core indicators,
- the integrated representation of the load (no load up to fivefold load),
- the classification of the planning areas into the areas with simple residential character with very high noise load and/or air pollution.

Evaluation Results Entire City and Boroughs

The evaluation of the data is compiled in a comprehensive mapping, and its core statements are published in the Geoportal in the form of content-specific maps. This entails, on the one hand, the processing of the five-part core indicator set, on the other hand the aggregating multiple-load maps, which are based on it and intersect the various topics quantitatively and qualitatively. The four integrated multiple-load maps form the core of the integrated Berlin environmental justice monitoring.

Core Indicators

Core Indicator 1: Noise Load

(Becker; U., Becker, T. 2015)

Noise refers to sound events which are perceived as disturbing and/or burdensome for well-being and health due to their individual character. Noise can be named as a central factor affecting health, especially in the urban environment. Depending on the scope, time and length of exposure, noise immission can result in direct or indirect health effects.

In order to consider the environmental factor “surrounding” noise in detail, a categorisation is required according to its sources, which can essentially be subdivided into the main categories industrial and commercial noise, traffic noise (street traffic noise, rail traffic noise, air traffic noise), sports and leisure noise and noise caused by the neighbourhood (Niemann et al. 2005, EEA 2010). Traffic (street, rail and air traffic) can be counted among the main causes for noise in the urban environment. Thanks to the Strategic Noise Maps Berlin, up-to-date calculations at the level of the entire city are available for the main causes, as of 2012 (SenStadtUm 2013b).

Physiological impact	Psychological impact
loss of hearing vegetative disorder heart and/or circulatory problems cardiovascular symptoms high blood pressure reduced quality of sleep headache	nuisance stress, nervousness depression communication disorder reduced output irritation psychosomatic symptoms
Social impact of noise	**Economic impact of noise**
communication difficulties judgment of others reduced willingness to help aggression social disintegration	rent and estate prices noise protection costs health costs disruption of production planning costs

Tab. 1: The most important noise impacts (BAFU 2009)

In order to analyse the different load degrees of the Berlin planning areas, a monetary assessment of the noise impact was chosen, and the results were linked to the socio-demographic structure at the level of the planning areas.

The monetisation of noise is based on the principle of external costs, which financially reflects the utility loss caused by noise. The fact that it is not the producers of noise who bear its negative effects, and that these will be deflected to third parties (or society as a whole), is thus taken into account. Moreover, monetising the noise load measured in decibels (logarithmic scale) makes comparisons from a spatial or social perspective much easier and more transparent.

The cost rates used correspond to the current state of the art in science and specify the harm caused per person by the impact of the disturbance and the health risks as a sum. Noise impact from different sources (street, rail and air traffic) was taken into account, depending on their sound characteristics. The noise immissions were determined separately for all different types of noise, so that the costs of the different types of noise can be indicated separately. Thus the amount of external costs determined using the cost rates underscores the dimensions of the traffic noise problem.

In order to classify them into load categories, the PLAs were sorted according to the external noise costs per inhabitant and divided into 10 deciles. In analogy with the socio-spatial classification of the status index from the Social Urban Development Monitoring (SenStadtUm 2013), the two lowest deciles (20% of the PLAs) are classified as having low noise load. The two deciles with the highest load are attributed to the high category. The six remaining deciles are aggregated analogously. As a result, an evaluation of the entire noise load caused by traffic into three load categories (“high”, “medium” and “low”) is available for all the inhabited PLAs.

The average noise load per inhabitant provides information on how heavy the load is, independent of the population density of the residential areas. Each Berlin inhabitant is burdened by external costs of an average of nearly 45 € p.a. due to traffic noise. There is a high variation of noise load among the PLAs. In the load category “low”, the external costs amount to up to 21 €, while the load category “high” encompasses a range from 40 € up to 103 € per inhabitant.

The spatial distribution of noise load shows a gradual increase from the peripheral city areas towards the city centre. With the exception of the S-Bahn ring, PLAs with a low load are situated in the entire city area, while high and very high loads predominantly occur in the extended city centre, with top values in the impact area of the Berlin-Tegel airport.

Core Indicator 2: Air Pollution

(Kindler, A., Franck, U. 2015)

Especially in urban areas, traffic, industrial and commercial emissions as well as private household emissions contribute to a higher degree of air pollution, outdoors and indoors (for example fine particulate matter ($PM_{10,}$ $PM_{2,5}$, nitrogen oxides (NO_x), sulfur dioxide (SO_2) or ozone (O_3)). After contact with the mucous membranes (as O_3) or absorption via the respiratory system, the pollutants can

impact human health; diseases of the respiratory system, higher risk of lung cancer or negative effects on the heart and/or circulatory system are worth mentioning here.

The goal of the investigation was to determine and assess the air pollution with fine particulate matter ($PM_{2,5}$) and nitrogen dioxides (NO_2) in the 447 planning areas. First, the pollution with fine particulate matter and nitrogen dioxide had to be identified per PLA, in order to be able to make statements regarding the different concentrations of these air pollutants and their spatial distribution within the State of Berlin. Using these results, the air pollution per PLA was assessed in a subsequent step. For the purpose of examining a possible relationship between the social condition of the population and the exposure in the PLAs, information from the Social Urban Development Monitoring was combined with the air pollution and analysed. In the context of spatial distribution and environmental justice, this is meant to provide a basis for possible courses of action for reducing air pollution and minimising health risks, as well as increasing the quality of life and well-being of the population. As a result, an evaluation of the combined air pollution with $PM_{2,5}$ and NO_2 of all planning areas in the pollution categories “high”, “medium” and “low” is available.

The spatial distributions of both $PM_{2,5}$ and NO_2 show the expected increase in concentration from the periphery of the city towards the centre and the environmental zone, with a tendency to slightly higher values especially of NO_2 to the southeast of the environmental zone. The increase in pollution towards the centre also becomes evident when the PLAs are assessed according to their total pollution with $PM_{2,5}$ and NO_2.

In the framework of this environmental justice oriented investigation, the classification of the pollution was conducted according to absolute values, but relative to the air pollution existing at the time of the investigation (SenStadt 2011a). In all, 109 PLAs (24%) were exposed to a high, 259 PLAs (58%) to a medium and 79 (18%) to a low air pollution with $PM_{2,5}$ and NO_2 in 2009.

Core Indicator 3: Availability of Green Spaces

(SRP Gesellschaft für Stadt- und Regionalplanung mbH 2015)

Urban parks and inner city waters have diverse effects beneficial to humans; for example, their services extend to the areas of

- reducing the level of temperature while simultaneously increasing humidity,
- filtering particulates out of the air,
- (partly) reducing noise.

However, urban parks make a particularly relevant contribution as a pro-actively usable health resource. Thus, physical, mental and social health and individual well-being can be enhanced by spending time in nature through leisure, experience of nature and exercise. Public urban parks also provide spaces for social encounters, and by allowing children to play together, for example, they can foster the development of social behaviour and personality, along with motor functions, the immune system, general physical development and creativity. Public green spaces can attain great significance for the local identity of the population of big cities, and publicity beyond the region.

In considering the present situation in the planning areas, a distinction was made between near-residential (intake area of 500 m, approx. 5-10 min. walking distance) and near-estate green spaces (intake area of 1,000-1,500m). The classification into the respective type of open space was carried out according to the size of the area. For the open space type “near-residential”, which is directly associated with the residential environment, green spaces with a small area are generally sufficient; the open space type “near-estate” includes all green spaces larger than 10 ha. The analysis of the availability of open spaces for the population in Berlin is based on 6m² per inhabitant for the near-residential open space, and on 7m²/inhabitant for the near-estate open space in the intake areas, respec a degree of availability relating to the intake area is determined. In the availability analysis, the quality of facilities of a green space is not taken into account.

The planning area related determination of the availability of green and open spaces is based on the procedure “Availability analysis for the urban availability of green spaces” (“*Versorgungsanalyse für die städtische Versorgung mit Grünflächen*”, VAG), with four block-related levels of availability (I, II, III, IV) and on the programme plan “Recreation” in the landscape programme Berlin (SenStadtUm 2015f), which converts the content of the availability analysis into planning statements. For a detailed description of the complex method used here, see the accompanying text for the Environmental Atlas map “Availability of Public, Near-residential Green Spaces” (SenStadtUm 2013a).

The results of the analytic steps were transformed into three PLA categories of availability:

- good, very good
- medium
- bad, very bad, no availability.

On this basis, a three-level degree of availability ("bad/very bad", "medium" and "good/very good") related to the intake area was determined for the planning area related assessment.

An examination of the areal distribution shows that around half of the Berlin population (47%) has "good/very good" availability, a quarter (25%) has "medium" and a quarter (28%) has "bad/very bad" or "no" availability. Only 5% of the inhabitants with a "good/very good" availability live within, 95% live outside of the Berlin S-Bahn ring. The population with bad, very bad or no availability lives within the S-Bahn ring for the larger part (55%), but a significant part also lives outside (45%), though these planning areas can be assigned to the inner city according to their building structure (Wilhelminian-style block structures).

There is a connection between the PLA availability category and the average block-related population density. In the inner city as well as in the periphery the quality of availability decreases with increasing population density. This means that a dense development tends to reduce the availability of green spaces. However, it should be taken into account that even some planning areas with a higher population density have a good availability of green spaces. Thus, 18 planning areas of the inner city are in the "good" availability category 1 with a population density of 146 inhabitants/ha, while 48 planning areas in the periphery whose population density of 163 inhabitants/ha is just 12% higher are in the "bad" category 3.

The quantitative evaluation for a low social structure index together with bad availability of green spaces yields the following picture: In all, 27 planning areas with around 269,000 inhabitants are situated in this category. They are mostly in the inner city area, with concentrations in the districts of Wedding and Gesundbrunnen and in northern Neukölln. Further towards the periphery, some individual planning areas such as the Thermometer estate (Lichterfelde Süd), the Marzahner Promenade, as well as the Schwarnweberstraße and the Klixstraße (Reinickendorf) are affected. Often, these are planning areas which exhibit further loads (3-, 4- and 5-fold loads).

Core Indicator 4: Bio-Climate/ Thermal Load

(Katzschner, L., Burghardt, R. 2015)

The heat balance of the human organism is closely related to the atmospheric environment. Along with air temperature, wind speed, water vapour pressure and the medium radiation temperature are also relevant. Besides toddlers, whose thermoregulation is still unstable, people with health impairments, such as cardiac and/or circulatory insufficiencies or respiratory disorders, as well as elderly people particularly frequently suffer from health impacts of heat periods. Elderly people sometimes manifest multi-morbid disease patterns, which further reduce their capacity to adapt to heat waves. High-intensity rainfalls, floods and storms have a potential to cause acute injuries and psychological impairments (traumatisation).

In addition, a rise in temperature and extreme weather events also impact indirectly on human health – through a higher risk of microbial (re)contamination of drinking water, the increase of allergenic pollen and infectious diseases.

The climatic situation in Berlin is characterised by the influence of a continental climate with a higher potential for a heavy heat load in the summer months, which is additionally reinforced through the urban heat-island effect. Besides, at times of high-pressure atmospheric conditions in summer, the wind speed values, which on annual average are relatively high, undergo a significant decline of ventilation, so that this effect also reinforces the heating and lack of cooling of the city.

When the urban development plan for climate (*Stadtentwicklungsplan Klima*, StEP Kilma, SenStadtUm 2011) was developed, the assessment of the bioclimatic situation was based on the dimensionless evaluation index "PMV". Methodologically, the assessment of the daytime and nighttime situations was carried out differently.

In order to determine the bioclimatic load in terms of the Berlin environmental justice approach, a different evaluation index, the PET, was additionally consulted. The reason lies primarily in the orientation of this evaluation approach, as the environmental medical component enters more strongly into its calculations (cf. Table 2). The values of nighttime cooling were the determining basis for the evaluation.

However, the potential of heat stress during daytime was also taken into consideration, by counting the frequency of summer days with heat load. These were defined as days with a PMV value of at least 1.8, with simultaneous lack of nighttime cooling. Land use information such as the block-related development density formed the basis for the investigation.

The aggregated PET values were determined from these input data and served as a basis for assigning the planning areas to the three levels of bioclimatic load.

PMV Index			PET Index	
PMV	**Thermal sensation**	**Thermophysiological strain**	**Subjective sensation**	**Associated average PET value**
3.5	very hot	extreme heat load	very hot	36
2.5	hot	strong heat load	hot	33
1.5	warm	medium heat load	very warm	31
0.5	slightly warm	weak heat load	warm	29
0	comfortable	comfort possible	pleasant	25
-0.5	slightly cool	weak cold stress		18
-1.5	cool	medium cold stress		13
-2.5	cold	strong cold stress		< 13
-3.5	very cold	extreme cold stress		

Tab. 2: PMV and PET index in comparison (VDI 1998; Matzarakis, A., Mayer, H. 1996; Katzschner et. al. 2007)

In order to be able to assess the factor bioclimate according to the Berlin environmental justice approach, the identified PET values had to be aggregated into a three-level scale.

On the basis of the linear assignment of PMV values to PET values as represented in Table 2, a three-level classification was developed in a further step, which focused on a vulnerability assessment of the affected population. For this purpose, the load levels were identified and integrated according to the criteria mentioned:

- potential for nighttime cooling and
- possible heat stress during the day.

Category	PET (night) °C	PET (day) °C	Δ PET	Description	Bioclimatic load category
1	<10	<24	>14	comfort zone with sufficient cooling	neutral/favourable/low
2	15-21	24-31	ca. 10	limited nighttime cooling	loaded/less favourable/medium
3	>24	>32	<8	nighttime cooling limited with high daytime values	heavy load/unfavourable/high

Tab. 3: Three-level evaluation classification of the thermal index PET (Katzschner, L., Burghardt, R. 2015)

The analysis shows that all urban structures with dense development exhibit heat loads which are not sufficiently compensated, not even at nighttime. Half of the planning areas are affected by a high bioclimatic load. 170 planning areas suffer from a medium load and only 49 are load-free. Berlin-wide, altogether 65 planning areas exhibit a high bioclimatic load and a high density of social problems at the same time. In all, 612,000 inhabitants are affected by this. Planning areas which simultaneously have a bad social structure or high problem density as well as a high bioclimatic load are mainly situated in the following districts:

- Wedding/Gesundbrunnen,
- Moabit,
- northern Kreuzberg (Askanischer Platz, Mehringplatz, Moritzplatz),
- northern Neukölln (e.g. Rollberge, Schillerkiez, Körnerpark, Rixdorf),
- Spandau (e.g. Paul Hertz estate, Darbystraße, Germersheimer Platz, Kurstraße, Carl-Schurz-Straße),
- Marzahn-Hellersdorf (e.g. Marzahner Promenade, Wuhletal, Helle Mitte),
- northern Hohenschönhausen (e.g. eastern and western Falkenberg),
- Reinickendorf (e.g. Letteplatz, Klixstraße, Scharnweberstraße, Märkisches Zentrum).

Thus, the dense extended inner city, mainly characterised by block structures, and the large estates in both of the former halves of the city are focal points.

Core Indicator 5: Social Problems/ Status-Index

(Gabriel, K. et al. 2015)

Countable events such as mortality and vulnerability to disease strongly depend on class. This has been confirmed by studies in the area of health sociology and public-health research time and again. It is statistically proven that the lower the income, the more premature the mortality. At the same time it is true that the lower the social class, the higher the vulnerability to disease. Problem areas thus exhibit a higher disease risk and correlate negatively with a healthy lifestyle – social stress, malnutrition, lack of leisure options, work conditions with a higher health risk are some of the possible consequences. And yet the causal relations that lie behind this and show a clear causal direction require further investigation.

Consequently, in the framework of the environmental justice conception, it is necessary to include the social differences between the individual neighbourhoods and planning areas in as much detail as possible. The Social Urban Development Monitoring (*Monitoring Soziale Stadtentwicklung*, MSS) 2013 provides small-scale information concerning the change of socio-structural and socio-spatial development in the 447 planning areas.

The Social Urban Development Monitoring 2013 relies on a set of six status and six dynamic indicators from the field of social reporting, which are used to form aggregated index values because they fulfil the methodological requirement (high intercorrelation) and at the same time describe the facts of social inequality. The index indicators are represented as “status” and as “dynamic indicators“, with the dynamic indicators showing the change of a status indicator over the course of two years. In coordination with the Statistical Office for Berlin-Brandenburg (*Amt für Statistik Berlin-Brandenburg*, AfS), only the statements about the status index from the Social Urban Development Monitoring 2013 were used for the purpose of compiling the small-scale environmental justice analyses (core and complementary indicators) and for the multiple-load map – the Berlin environmental justice map.

Moreover, with the methodological approach of the environmental justice analysis in mind, as for the other topics the 4-level classification (high, medium, low, very low) used in the Social Urban Development Monitoring 2013 was condensed into a 3-level classification, with the categories “low” and “very low” being merged into one classification. The 3-level classification of the status index of the Berlin environmental justice approach is ordinally described as follows: “high/very high problem density”, “medium problem density” and “low/very low problem density”.

The evaluation shows clear spatial focal points with planning areas with a low/very low social index. These are predominantly districts characterised by Wilhelminian architecture in the former western part of the city. Especially Kreuzberg, Wedding, northern Neukölln as well as the pre-WWII neighbourhoods in the centre of Spandau stand out. A further focal point is formed by the large estates of social or industrial development in both parts of the city. Especially the Märkische Viertel and the Falkenhagener Feld in the west, and Hohenschönhausen, Marzahn and Hellersdorf in the east of the city should be mentioned here. “Smaller” large estates such as Lichtenrade Ost or Lichterfelde Süd are also reflected in the evaluation.

Complementary Indicators

Complementary Indicator 1: Socio-spatial Distribution of the Building Structure

(Planergemeinschaft Kohlbrenner eG 2015)

Taking “healthy living and working conditions” into consideration is a basic principle of the general urban planning laws (§1 (6) clause 1 of the building code (*Baugesetzbuch*, BauGB 2014)). Even before the building code, the maintenance and creation of healthy living and working conditions was an important guiding principle of urban and architectural planning. The reformist urban development of the early 20th century and the demand for “light, air and sun” in construction are representative of the (demand for) consideration of health aspects in urban development.

However, in the process of Berlin becoming a major city and the concomitant rapid constructional growth, there were different appraisals of the general principles and goals of urban planning and their impact on health and general quality of life. One example of this is the dramatically changing cultural estimation of the Wilhelminian block structure. One reason for this change in attitudes lies in the changing environmental conditions. In recent years, the set of problems has changed significantly due to massive reductions in the field of domestic fuel and industrial air pollution through enhanced technologies and different fuels on the one hand, and due to a significant increase of sound emissions, especially by the motor vehicle traffic, on the other hand. In the process, the assessment of the urban planning situation has undergone changes, as the different structural typologies can damp or reinforce the different loads to different extents. Therefore, the building structures must be included in the assessment of the topics of environmental loads impairing health and their planning area related evaluation.

In order to take the building structure into account, one can draw on the extensive elaboration available in the framework of the Environmental Atlas (cf. 06.07 Urban Structure, SenStadtUm 2011c, and 06.08 Urban Structure – differentiated, SenStadtUm 2011d). Regarding the area types with predominantly residential use, it distinguishes the area types depending on their use, origin as well as building and open space structure. The spatial as well as structure-type differentiation carried out there is here reduced to a few succinct structural types that each exhibit similar characteristics of urban development (cf. Fig. 2):

- Block-edge development: This category encompasses the Wilhelminian structures as well as the building structures of the interwar period.
- Row development: This category represents the architectural designs of the interwar and post-war period (multi-storey development in rows, with an open block edge).
- Large estates: From the 1960s until the 1980s, large multi-storey estates were built in the east and west, which tied in with the traditions of the 1920s and 1930s and claimed to implement the aim of “light, air and sun” to an even greater extent, through differentiated large-scale structures (row, block, point), generous availability of open spaces and adequate positioning of the buildings.

  Note: The social differentiation, a partly one-sided occupancy and changed housing demands have in part turned this building type into a social challenge. This impacts on the assessment of the social situation.
- Open development: Different structural forms of estate and detached house development are combined in this category.

Structural characteristics have a significant impact on the load situation in the different urban spaces, though to some extent with mutually opposing effects of de- or increasing the load (for an overview cf. Table 4).

	Dense, closed building structures[1]	**Open building structures** [2]
Noise	Positive effects for building parts/fronts which are protected from noise	Negative effects due to free propagation of sound
Air pollution	Concentration of pollutants favoured by lack of air venting	Stronger air venting and swirl

Bioclimate	Negative effects due to over-heating and restriction of air exchange	Positive effects through cooling and air exchange
Availability of open spaces	Depending on the availability of public open spaces, tendency of negative effects due to high population density with low availability of open spaces for private use	Less dependence on the availability of public open spaces, as open spaces are available for semi-public and private use

1 primarily Wilhelminian block structure

2 row development, complex housing development, row development and detached housing areas

Tab. 4: Environment-related characteristics of different building structures (Planergemeinschaft Kohlbrenner eG 2015)

The point of this representation and integration into the research questions of environmental justice is not to correct the existing assessment of the environmental load topics; the building structure has already been taken into account in their analysis.

Rather, these classifications may serve to quickly match the environmental situation and evaluation with the predominant building structure and to indicate possibilities of urban planning interventions and prioritisations.

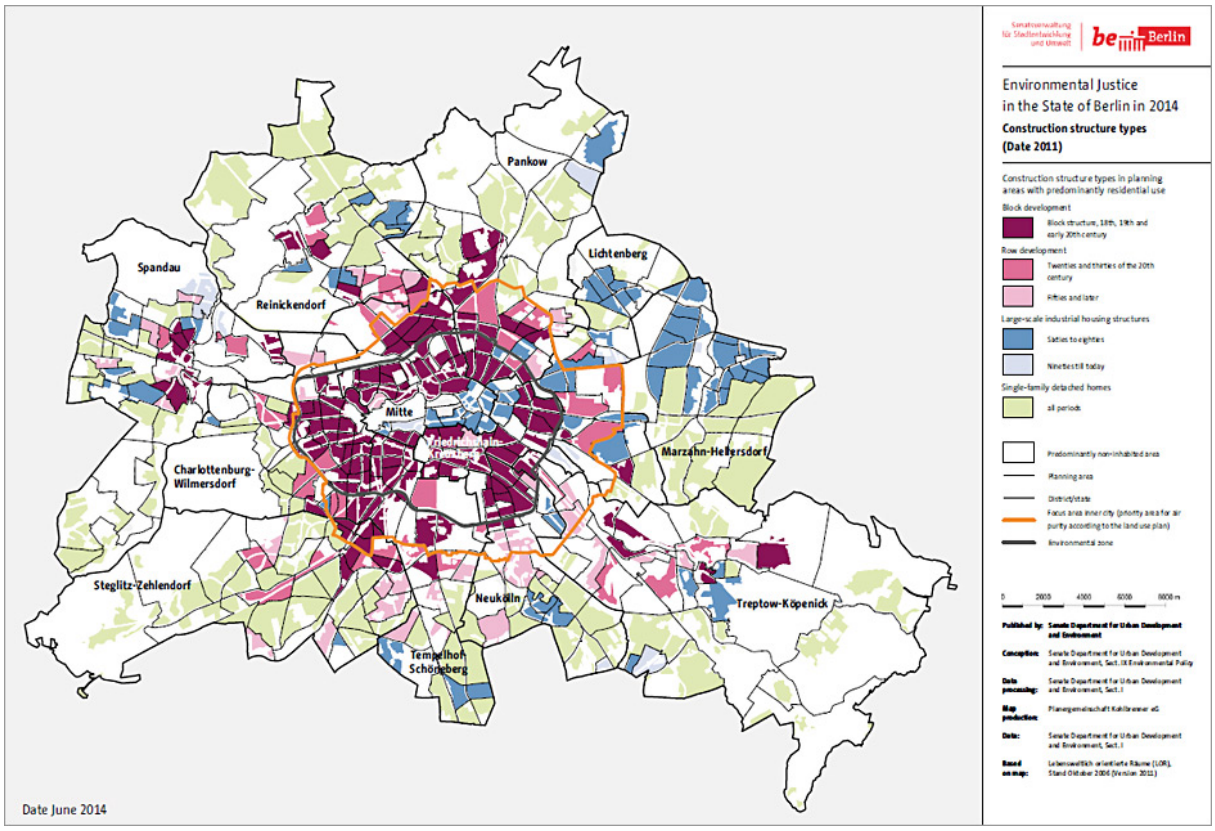

Fig. 2: Distribution of the structural types with predominantly residential use at the level of the planning areas (Planergemeinschaft Kohlbrenner eG 2015)

As the structural type “block” is to be viewed rather as an aggravating factor regarding health hazards, the area requires special consideration regarding the interaction of urban structures and health risks and in assessing a possible course of action to influence the situation.

125 planning areas, i.e. roughly 30% of all areas are to be classified into the block-structure type according to the classification applied. Three quarters of these planning areas are in the area inside the S-Bahn ring, i.e. in the environmental zone. This is where the block structure predominates, with few exceptions (Friedrichstadt, Luisenstadt, Tempelhof, areas east of Alexanderplatz). At the same time, the population density is particularly high, also as compared to the block structure outside of the S-Bahn ring. This indicates the differentiation within this structural type.

Complementary Indicator 2: Socio-spatial Distribution of Residential Characters in Berlin

(Planergemeinschaft Kohlbrenner eG 2015)

The different building structures have an aggravating or attenuating impact on health conditions, well-being and the satisfaction with housing. However, the concrete surrounding conditions are also relevant, since in some circumstances building structures of the same kind can differ significantly with respect to housing quality. Therefore, the Berlin rent index not only includes statements related to housing and buildings but also assesses the surroundings of the location of a dwelling along with the residential character. The following characteristics are featured in the differentiation:

- surrounding use,
- density,
- infrastructure,
- access to public transport,
- access to recreation areas,
- demand and image,
- inner city/suburb.

A high traffic noise load (street, rail, air traffic) is identified as an additional attribute.

Through the residential character, a complex area description is mapped onto a three-level scale, which is supplemented by other descriptive characteristics and can thus contribute to a more differentiated small-scale assessment. The Berlin rent index distinguishes between simple, medium and good residential character.

The information on residential character in the rent index further complements and substantiates the five core indicators and the building structure (cf. Figs. 3 and 4).

Based on the available findings of the Berlin pilot project on environmental justice, the approaches for taking health-relevant factors into account can be further extended and systematised.

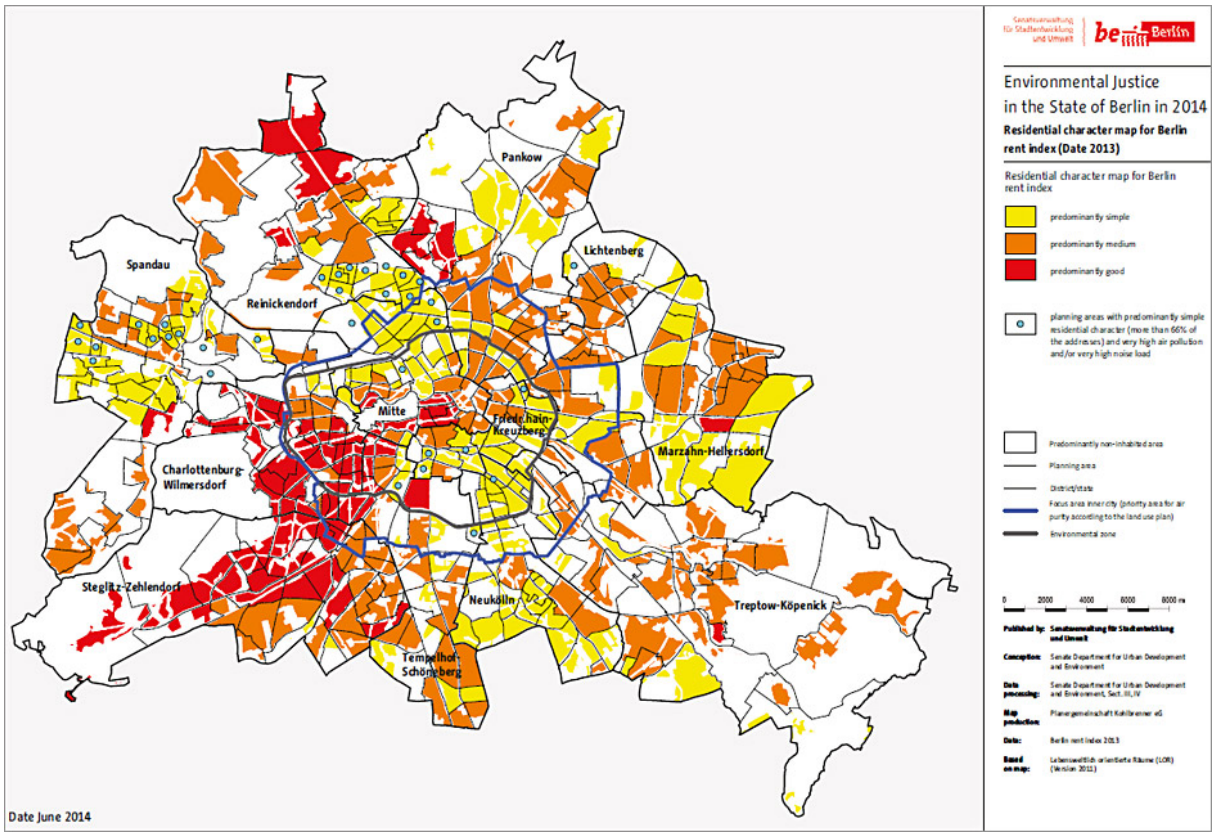

Fig. 3: Distribution of the residential characters at the level of the planning areas in Berlin (Planergemeinschaft Kohlbrenner eG 2015)

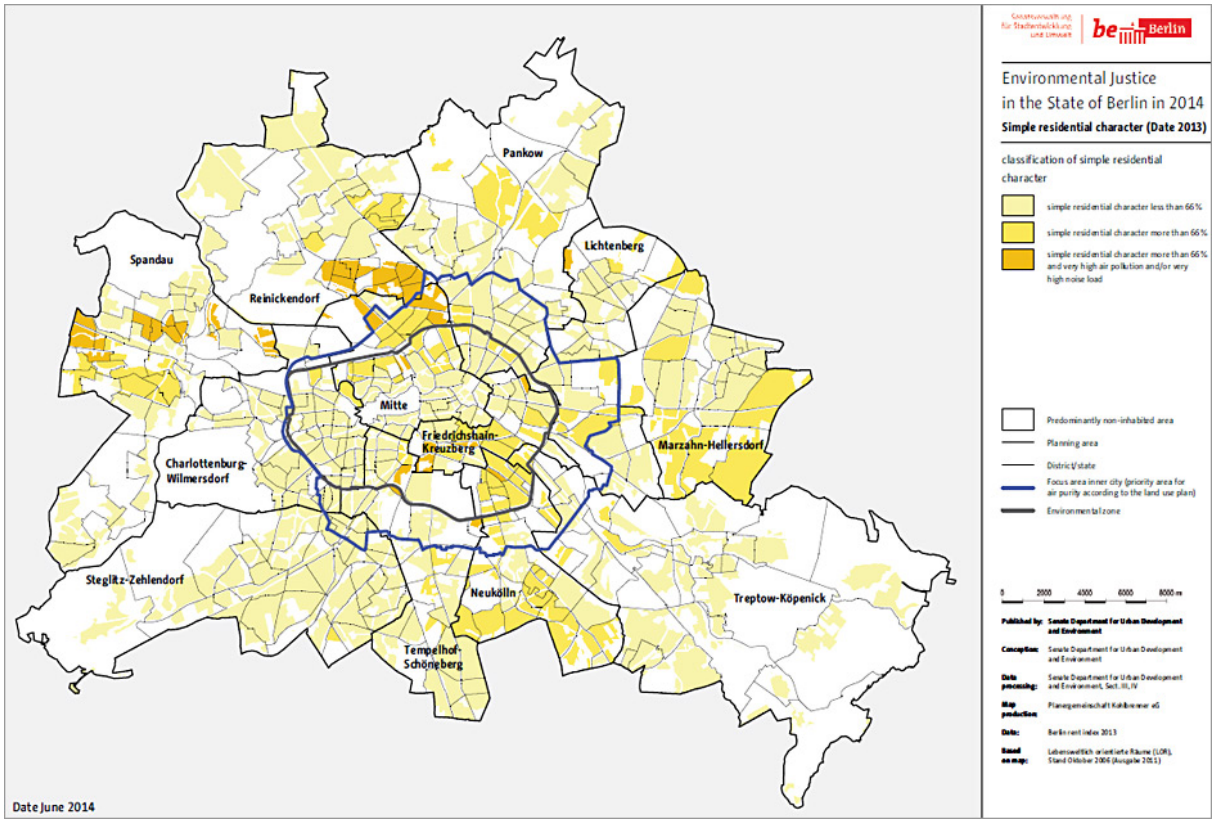

Fig. 4: Distribution of the simple residential characters at the level of the planning areas in Berlin (Planergemeinschaft Kohlbrenner eG 2015)

As described above, the “simple residential character” exhibits many characteristics problematic for health, such as very dense development, few green and open spaces, predominantly untended cityscape, often bad building condition, and in parts a strong impairment through industry and commerce. Its significance as a complementary indicator becomes evident in evaluating the data.

In December 2010, 42% of the 3.37 million Berlin inhabitants had postal addresses with simple, 41% with medium and 17% with good residential character. At the end of 2010, around 960,000 people (28%) were living at an address with noise load, of whom 46% with simple, 37% with medium and 17% with good residential character.

Complementary Indicator 3: Health and Environmental Risks/ Risk Communication

(SenStadtUm 2015d)

More and more people suffer from health impairments whose cause they see in the environment. In a complex and interlinked world, they have great difficulties in assessing risks to environment and health in their immediate residential surroundings and neighbourhood. The scientific evaluation and the societal perception of health risks from environmental effects can differ, and thus their impact and acceptance are sometimes quite contested in politics, science, economy and the population. Moreover, the criteria according to which experts and the public assess health risks are often very heterogeneous. The reason for this lies in the multitude of different risk and impact factors. This can result in insecurity in the population, and in a loss of trust in the authorities. With a view to the health-oriented environmental justice approach, it is important to render processes of risk assessment transparent and more efficient.

Especially in neighbourhoods with a high multiple load, the persons affected should be enabled to understand the risk circumstances to the extent that they can recognise the consequences and make (individual) assessments. The persons affected should not need any expert knowledge for this purpose, but should rather be enabled to understand the consequences as far as they are known. With a view to making the special risks easily discernible, a map of the complementary indicator “Health and Environmental Risks” has been developed based on the available data (cf. Fig. 5).

In order to indicate the areas with particular health and environmental risks, the planning areas were examined whose core indicators noise load and air pollution – deviating from the employed 3-level classification (good, medium, bad) – exhibit a load clearly above this classification. The noise load and air pollution are especially high in these planning areas, and thus the values are particularly significant from the perspective of environmental medicine. “Simple residential character” according to the rent index (cf. Fig. 4) was chosen as another risk indicator. These are mainly areas in the densely built-up inner-city area, with few green and open spaces, predominantly untended cityscape, often bad building condition, and in some parts strong impairments due to industrial-commercial uses. “Premature mortality from disorders of the respiratory system” was used as a fourth risk indicator related to air pollution (see also the statements regarding complementary indicator 4).

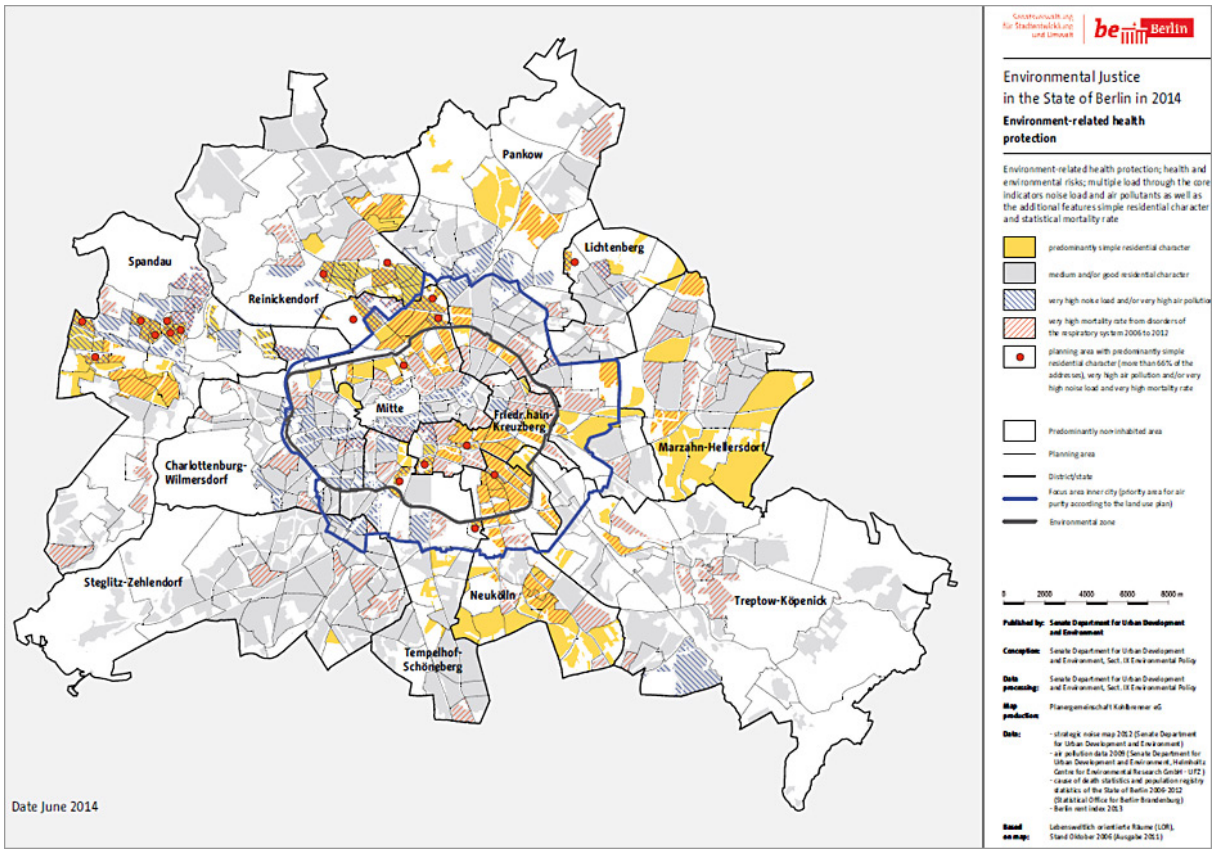

Fig. 5: Distribution of health and environmental risks at the level of the planning areas in Berlin (SenStadtUm 2015d)

At the level of the entire city, the evaluation of areas strongly affected (high mortality combined with simple residential character) (more than 66% of the apartments in the PLA affected) in combination with high air pollution and noise load results in the following picture:

- Out of 447 PLAs, altogether 19 planning areas (PLAs) are affected.
- Out of these 19 planning areas, 8 PLAs are situated in the “extended inner-city area” (priority area for air purity according to LUP), 11 are outside.
- Focal points in the inner-city area are: Mitte (Heidestraße, Soldiner Straße, Gesundbrunnen), Friedrichshain-Kreuzberg (Wassertorplatz, Viktoriapark), Tempelhof-Schöneberg (Schöneberger Insel, Germaniagarten) as well as Neukölln (Donaustraße).

Complementary Indicator 4: Environmental Load, Social Disadvantage and Small-scale Mortality in the State of Berlin

(AfS (Statistical Office for Berlin-Brandenburg), Borough Office Mitte of Berlin, Health Department 2015)

The connection between environmental loads, social disadvantage and health impairments, including higher mortality, has been a topic of scientific research in Germany for quite a while.

However, the contexts for the origins of disease and death are usually far too complex and individual to be derived from the more or less large-scale measurements and calculations of the environmental situation. Thus, the approach that in investigating mortality on a small scale it is highest in the planning areas exposed to the heaviest loads – an idea that seems plausible at first – falls short of reality. For information is usually lacking for the further indicators relevant to individual cases, such as

- exact residential area and duration of residence,
- working conditions,
- leisure time behaviour,
- individual behaviour hazardous to health (e.g. smoking).

Despite these limitations regarding the availability of required additional information, it can be assumed that the criteria

- age,
- social condition and
- the different environmental loads

have a decisive influence on the distribution of deaths and that they can be used for a first planning area related estimation.

In order to determine to what extent the different environmental loads contribute to the (additional) mortality, the analysis particularly needs to consider the “confounding variables” mentioned above, age and social condition. A small-scale analysis of mortality in the State of Berlin in this respect was possible because data regarding mortality, age structure and social condition of the population for the planning areas in the years 2006-2012 are available. In that period, between around 31,000 and a little more than 32,000 people died in Berlin annually. Around 70% of all deaths could be attributed to an underlying disease from the field of tumours (cancer) or diseases of the circulatory or respiratory system.

For the evaluation in this analysis, it was necessary to find a cause for the mortality for which there are a sufficiently many cases as well as a documented connection with environmental loads. Diseases of the respiratory system (e.g. bronchitis, pneumonia, asthma) were chosen for this purpose.

It has been sufficiently proven that the incidence of tumours and circulatory diseases strongly correlates with the social condition of the persons affected. Besides possible environmental loads, the living conditions and the health-relevant behaviour play a major role with respect to mortality. Lung cancer, for example, can be caused both by smoking and through long-term exposure to environmental loads.

The mortality from respiratory diseases also correlates clearly with the status index on the PLA level; however, the possible connection with environmental loads is more obvious in this case than for circulatory diseases, and the potential distortion through confounding variables like lifestyle factors (smoking) is not quite as strong as for lung cancer.

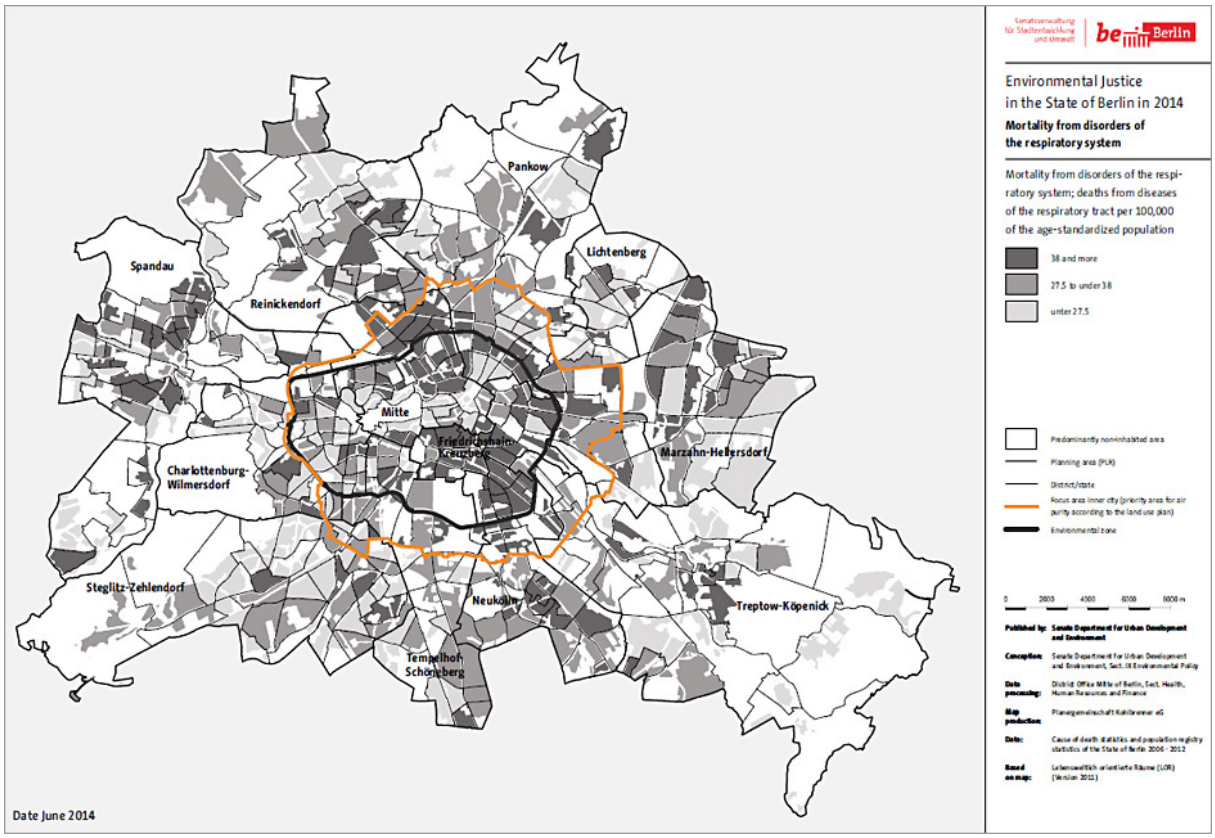

Fig. 6: Distribution of mortality from disorders of the respiratory system 2006-2012 at the level of the planning areas in Berlin (Statistical Office for Berlin-Brandenburg, Borough Office Mitte of Berlin, Health Department 2015)

The analyses generated by calculating the correlation between the standardised mortality rate for respiratory diseases and the environmental justice indicators at least indicate a relatively strong linear relationship with the status index (social condition) in the planning areas. Since much information on the individual level is lacking, it is not possible to determine with the data available whether this is due to lifestyle or rather environmental factors. Further investigations on this issue are necessary in order to make reliable statements.

Complementary Indicator 5: Socio-spatial Loads Through Light Pollution

(Gabriel, K. et al. 2015)

Artificial light is also a potential load factor. Artificial light at night disturbs the circadian rhythm of the human organism and results in an imbalance of production of different hormones, especially melatonin, which is related to the human day-night-rhythm. Moreover, interfering with this rhythm can lead to a higher breast and bowel cancer risk, which is particularly relevant for shift workers. As a result, the term light pollution was introduced, which refers to the negative impact of artificial light. On the other hand, light also features as a social component. The illumination of outdoor areas at night is generally perceived as positive; illuminated areas are considered friendlier and safer. This double meaning of artificial light at night leads to the question how nighttime illumination is distributed in Berlin.

In order to obtain an answer to this question, it was necessary to determine a reliable overview over the artificial illumination at night. Contrary to what is common when investigating the brightness of cities, satellite images were not used, but another approach was chosen. Based on a flyover from 2010 which covered two thirds of the city area, a geo-referenced mosaic was generated with a resolution of 1 m² which allowed for an area-wide analysis of the city. It is to be noted that only light emitted skywards was captured. Light radiated sidewards, e.g. from the windows of houses, cannot be captured with this method. With the help of this night shot “Berlin at night”, it was possible to depict the nighttime illumination at the LEA level. In order to implement this, the “brightness factor” was determined, which had originally been used to determine the brightness of individual types of land use (Kuechly 2012). Here the average brightness value of a land-use type is offset against the overall average value of the city; the resulting brightness value yields a good average value for the illumination situation of a land-use type.

The following proportions of light were found for the city:

Land-use type	Proportion of overall light emission
Street	31.6 %
Industrial and commercial areas	15.6 %
Public buildings	9.6 %
Block development	7.8 %
City centre	6.3 %
Airfields	3.7 %
Miscellaneous	25.4 %

Tab. 5: Proportion of the brightness value in the overall brightness of the city for different types of land use (Gabriel, K. et al. 2015, modified according to Kuechly, H. et al. 2012)

The same principle was then also applied in order to determine the light pollution in the planning areas (PLAs). Following Table 5, the brightness values of the streets were used for determining local brightness, as these contribute the greatest share of the illumination of the city and also have a uniform, direct influence on the houses and the surroundings of the inhabitants. Moreover, this served to avoid a masking effect, as would have occurred when considering the PLA as a whole. The planning area Waldidyll/Flughafensee, in which Tegel airport is situated, affords an illustrative example. In the night shot, it is one of the most obvious points, but when considering the PLA as a whole, the influence of the airport vanishes due to the far larger share of forest area.

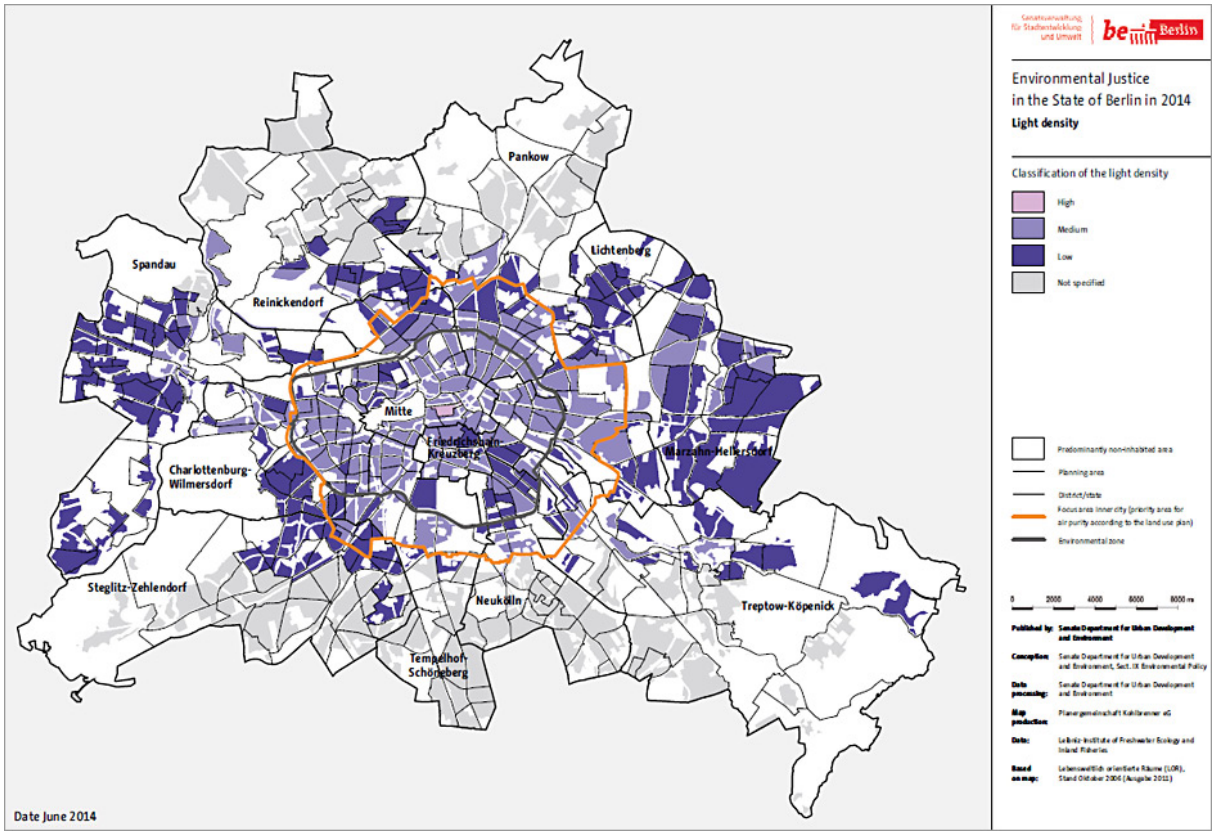

Fig. 7: Distribution of the light density at the level of the planning areas in Berlin (Gabriel, K. et al. 2015)

Using the 3-level evaluation scale employed for the other factors resulted in a seemingly uniform distribution of light pollution within the city. Apart from the PLA “Unter den Linden Süd”, all other PLAs

are at the medium and lower light pollution level. At the same time, there is a general tendency of higher light pollution towards the city centre.

An investigation regarding a connection with residential areas characterised by social issues did not yield a clear result. Thus, pollution with an excessive share of artificial light at night cannot immediately be related to weaker social classes, but rather seems to be a set of problems that affects the entire inner-city area while being less significant in the outskirts of Berlin.

The Four Integrated Multiple-load Maps

Environmental justice needs to be approached as a multi-dimensional topic; an integrated analysis and an integrative representation of different environmental loads but also of the socio-spatial distribution of environmental resources are required.

As a result of the two-step environmental justice monitoring, the following (integrated multiple-load maps have been developed:

1. "**Integrated multiple-load map environment**",
   it shows the four environment-related multiple loads (core indicators air, noise, thermal load and availability of green spaces);
2. "**Integrated multiple-load map environment and social issues**",
   it extends the first map by the fifth core indicator social issues (cf. Fig. 9),
3. "**Integrated multiple-load map – thematic**",
   this map qualitatively illustrates the type of environmental load in the individual planning areas of the city (cf. Fig. 10);
4. "**Berlin environmental justice map 2014/15"**,
   besides the five core indicators, this map also illustrates the particularly high health risk and the affectedness (number of inhabitants in the planning areas).

Results in a city-wide comparison

The evaluation shows: Environmental justice is distributed quite unequally in the city area. Thus, the data acquisition and analysis as well as the measures to be derived from them need to be urgently substantiated. Also, the strong dependency between the social index and the environmental factors under consideration becomes evident:

Core indicator:	Number of PLAs with high total load	Number of PLAs with high load and low social index, absolute and in %
Noise	86	21 (24)
Air pollution	109	26 (24)
Bioclimate	228	65 (28)
Availability of green spaces	100	27 (27)

The correlation of this multiple load of the environmental variables with the social index indicates the connection, that is, the degree of environmental **in**justice, in Berlin.

Thus, the planning areas with two-, three- or even fourfold environmental load show a significantly higher share of low and very low index values. By contrast, PLAs without environmental load are predominantly characterised by very high/high index values.

Focus area inner city

The analysis of the spatial distribution of environmental justice shows a significant concentration in the inner-city area of Berlin, for example a high multiple load from environmental factors, which coincide with a low social status in the northern part of the borough Friedrichshain-Kreuzberg, in Wedding, the southern part of the borough Reinickendorf, and in northern Neukölln. By contrast, a very low/low environmental load and a very high/high social status can predominantly be found in the suburbs.

Upon a closer look at the numbers, especially in the focus area inner city, the following situation presents itself:

- In the extended inner city area, there are around 1.58 million inhabitants in total. Of the population affected by the individual core indicators, around 200,000 (12.7%) are affected by a high noise load, around 730,000 (46.2%) by high air pollution, 870,000 (55.1%) by low availability of green spaces and around 1.45 million (91.8%) inhabitants by a high bioclimatic load.
- The focus area is also disproportionally represented with respect to the number of planning areas with multiple load. 1 PLA with a fivefold load (out of 3 in total) is located here, 11 out of 17 with a fourfold load and 59 out of 71 with a 3-fold load.
- As for the affectedness of the inhabitants, the disproportionate load is also reflected in the individual indicators. Out of the 173 PLAs in the “priority area for air purity”, 29 (6.5% of all Berlin PLAs) are affected by a high/very high noise load, 85 (19.0%) by air pollution, 81 (18.1%) by low availability of green spaces, 152 (43.0%) by thermal load and 42 (9.4%) by a difficult social structure. Out of the 173 PLAs within the inner-city area, 64 (37.0% of the inner-city PLAs) have a predominantly (meaning more than 66% of the postal addresses) simple residential character, out of which 10 (5.8%) are additionally affected by a very high noise load and/or air pollution.

Borough-level evaluation

According to the above, a consideration at the borough level shows – not surprisingly – a severe inequality regarding the distribution of the multiple load.

With respect to the proportions of affectedness of the inhabitants, the Mitte borough has the highest load. At least 50% of the inhabitants are affected by at least a threefold load. Tempelhof-Schöneberg, Neukölln and Charlottenburg-Wilmersdorf are further boroughs with a relatively high share of affected population. By contrast, Treptow-Köpenick and Steglitz-Zehlendorf are the boroughs with the lowest percentage of inhabitants affected by multiple loads.

It also becomes evident that the affectedness varies significantly within the boroughs. The inner-city, densely developed districts (e.g. northern Neukölln) are almost always disadvantaged with respect to the more open areas.

In the Berlin suburbs where some Wilhelminian dense structures or large estates (whether east or west) are present (e.g. Spandau and Marzahn), higher categories of load are also regularly found.

Borough-level comparison of results

Across boroughs:

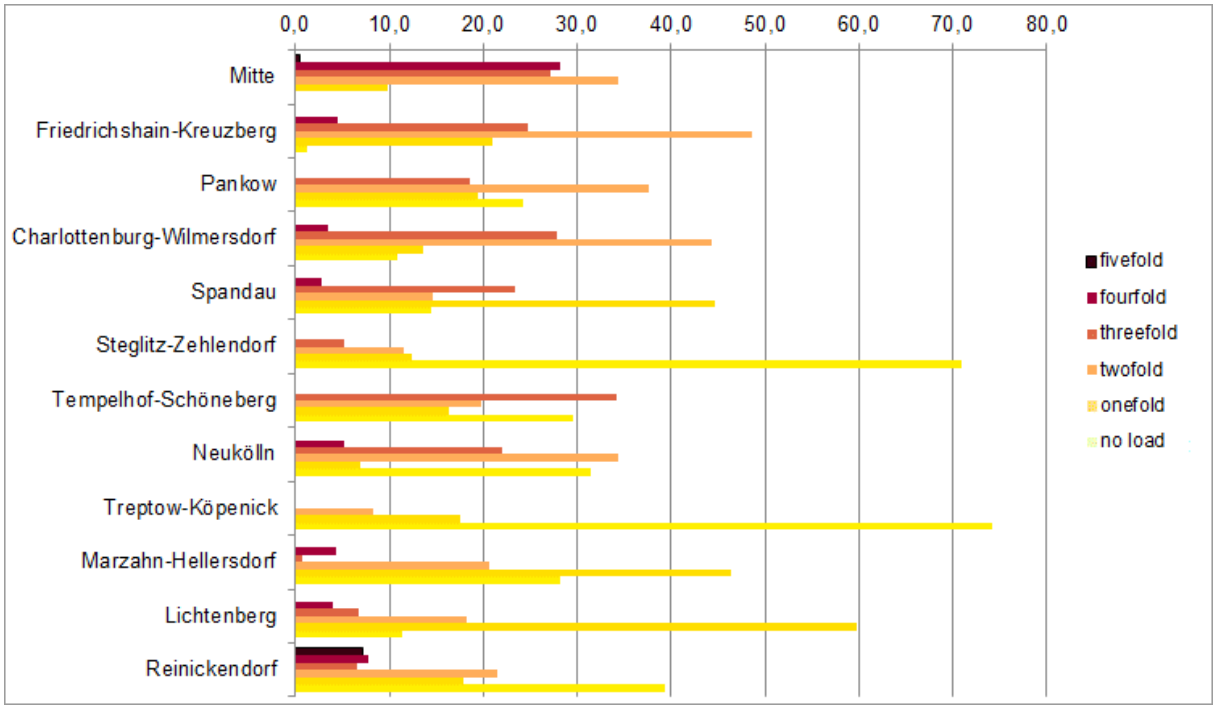

Fig. 8: Share of inhabitants per borough of the multiple load categories in % (Planergemeinschaft Kohlbrenner eG 2015c)

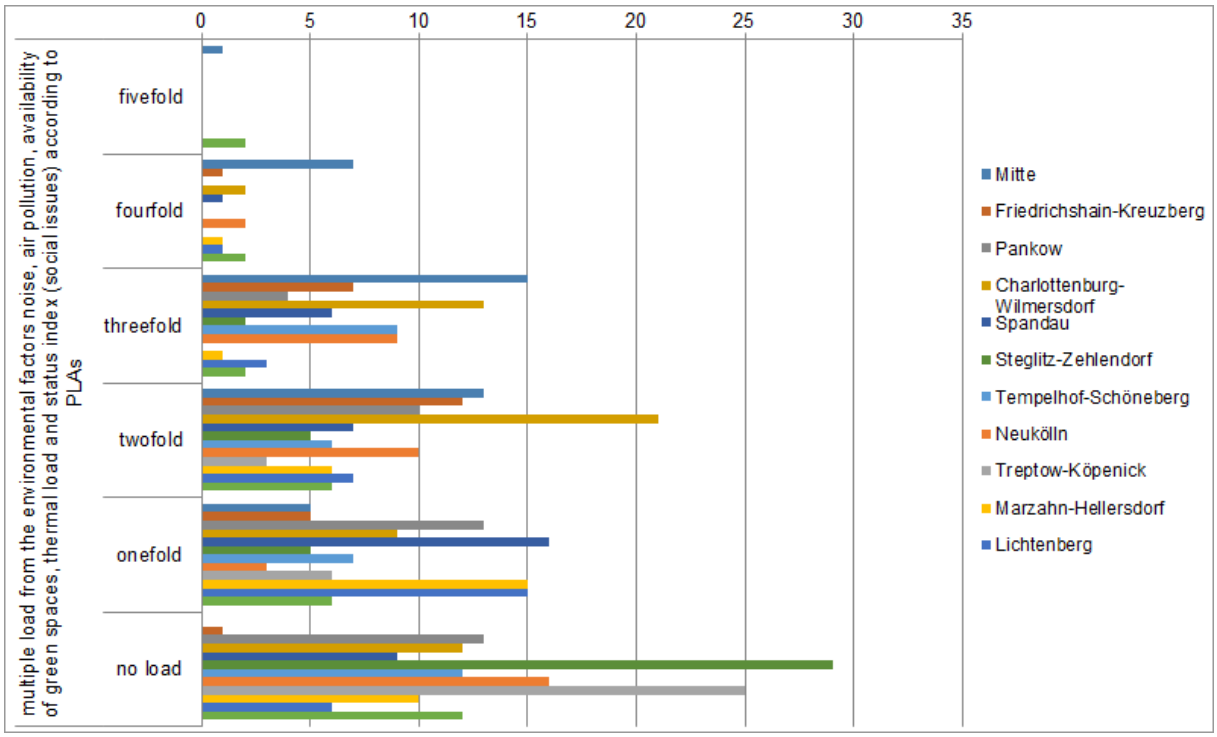

Fig. 9: Share of the multiple load categories of the planning areas per borough, in absolute numbers (Planergemeinschaft Kohlbrenner eG 2015c)

According to boroughs:

Mitte borough

Representation of the core indicators of the planning areas in comparison to the entire city

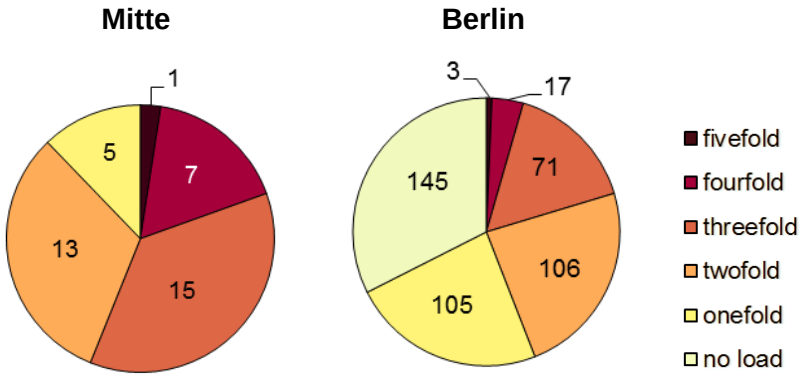

Fig. 10: Multiple load in the Mitte borough due to the core indicators noise, air pollution, availability of green spaces, thermal load as well as status index (social issues) according to planning areas (Planergemeinschaft Kohlbrenner eG 2015c)

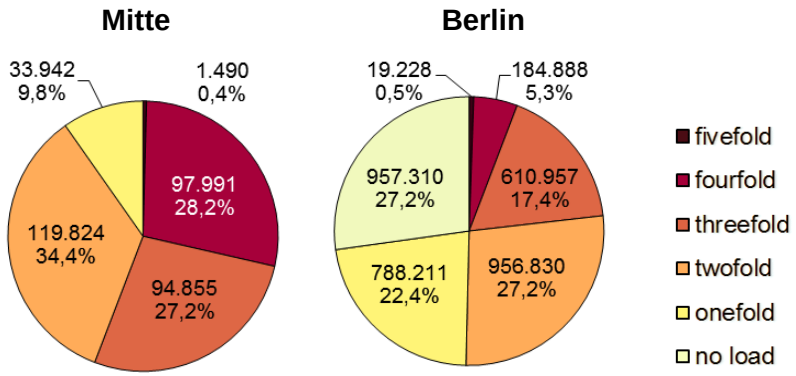

Fig. 11: Multiple load in the Mitte borough due to the core indicators noise, air pollution, availability of green spaces, thermal load as well as status index (social issues) according to inhabitants affected in all planning areas (deviations are due to rounding) (Planergemeinschaft Kohlbrenner eG 2015c)

Overall assessment on the Berlin scale

Mitte is one of the Berlin boroughs with the heaviest load: With 8 out of 20 planning areas with five- and fourfold load (i.e. 40.0%), a disproportionally high number of areas with high loads are situated here. This problem becomes even more evident in view of the number of inhabitants. Mitte accounts for almost half of all affected inhabitants in Berlin who live in the areas with the heaviest loads (99,481 out of altogether 204,116 of all Berlin inhabitants (48,7 %)).

Spatial focal points of the multiple load

The northern districts of Wedding outside of the S-Bahn ring (PLAs Westliche Müllerstraße, Reinickendorfer Straße, Sparrplatz, Soldiner Straße, Gesundbrunnen) as well as western Moabit (PLAs Beusselkiez, Heidestraße) are areas with particularly high loads. The historical city centre also forms an area with significant load; by contrast, Spandauer and Rosenthaler Vorstadt (PLAs Oranienburger Straße, Charitéviertel, Invalidenstraße) are subareas with a comparatively lower load in the borough.

Thematic focal points of the multiple load

The thermal load in the usually very densely built-up areas is a pervasive problem (high categories). Whereas the prognosis area Centre (0101) is characterised by high air pollution almost throughout, the other prognosis areas to a higher extent include planning areas with a medium load. As regards the

distribution of the social condition, the situation is reversed; here the prognosis area Centre (0101) – in contrast to the other prognosis areas – can largely be classified as average, in parts even as good.

Number of affected persons in the planning areas with a particularly high load

The particular load of the prognosis areas Gesundbrunnen (0103) and Wedding (0104) and to a lesser extent Moabit (0102) becomes evident when the population numbers in the highest load categories 4 and 5 are included. Out of altogether 348,102 inhabitants (28.7%), 99,481 people live in these prognosis areas.

Friedrichshain-Kreuzberg borough

Representation of the core indicators of the planning areas in comparison to the entire city

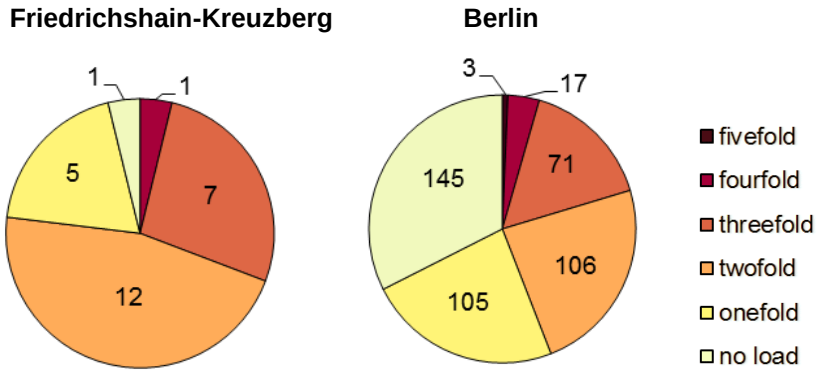

Fig. 12: Multiple load in the Friedrichshain-Kreuzberg borough due to the core indicators noise, air pollution, availability of green spaces, thermal load as well as status index (social issues) according to planning areas (Planergemeinschaft Kohlbrenner eG 2015c)

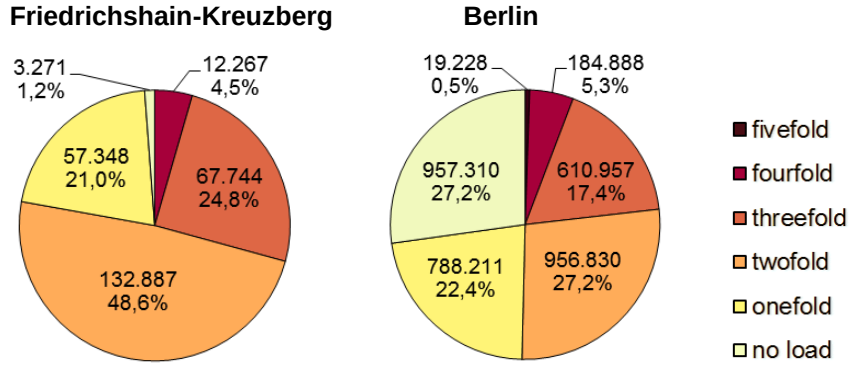

Fig. 13: Multiple load in the Friedrichshain-Kreuzberg borough due to the core indicators noise, air pollution, availability of green spaces, thermal load as well as status index (social issues) according to inhabitants affected in all planning areas (deviations are due to rounding) (Planergemeinschaft Kohlbrenner eG 2015c)

Overall assessment on the Berlin scale

The Friedrichshain-Kreuzberg borough belongs to the most heavily disadvantaged boroughs in Berlin with respect to environmental justice. Two- to threefold loads of the planning areas are the norm. The number of inhabitants negatively affected by several core indicators is also higher than in the Berlin average (borough 212,898 (77.8 %), Berlin 1,771,903 people affected (50.4 %)).

Spatial focal points of the multiple load

The borough as a whole is a focal point of the loads; only some planning areas, for example next to the Tempelhofer Freiheit (PLA Chamissokiez), in eastern Kreuzberg (east and west of the Görlitzer Park, PLAs Reichenberger Straße, Wrangelkiez) and in western Friedrichshain (PLAs Barnimkiez, Weberwiese) show a onefold load.

Thematic focal points of the multiple load

Except for the noise load (which is slightly below the average), all core indicators and the social condition are worse than in the Berlin average. Thus, there is a need for action in nearly all fields of environmental justice.

Number of affected persons in the planning areas with a particularly high load

The share of inhabitants from Friedrichshain-Kreuzberg who live in a load-free planning area is very low. 77.8% (212,898 inhabitants) live in planning areas with at least a twofold load. Consequently, along with the challenges resulting from the social condition, they are also exposed to at least one health impairment.

Pankow borough

Representation of the core indicators of the planning areas in comparison to the entire city

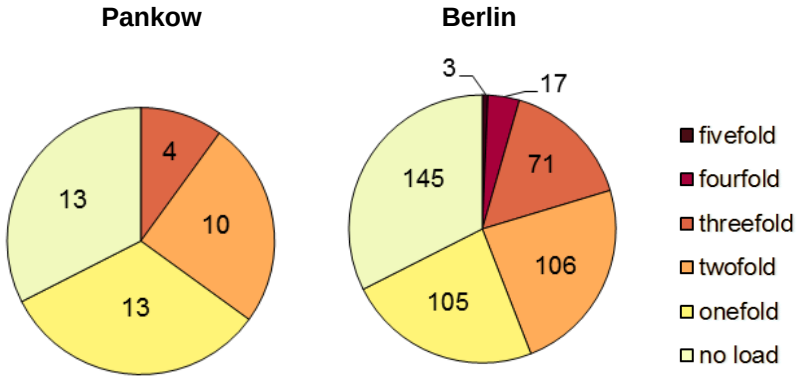

Fig. 14: Multiple load in the Pankow borough due to the core indicators noise, air pollution, availability of green spaces, thermal load as well as status index (social issues) according to planning areas (Planergemeinschaft Kohlbrenner eG 2015c)

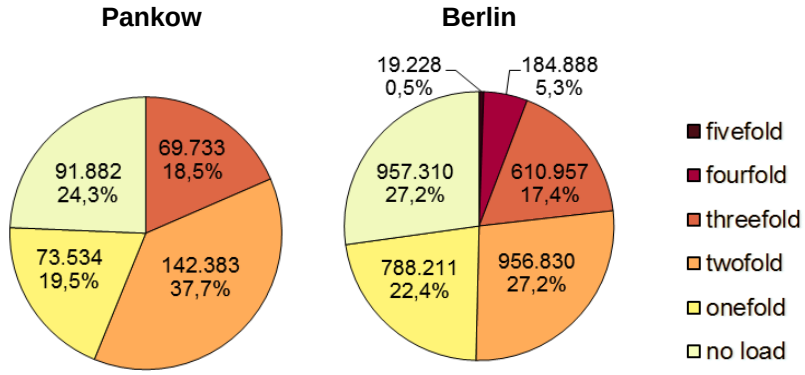

Fig. 15: Multiple load in the Pankow borough due to the core indicators noise, air pollution, availability of green spaces, thermal load as well as status index (social issues) according to inhabitants affected in all planning areas (deviations are due to rounding) (Planergemeinschaft Kohlbrenner eG 2015c)

Overall assessment on the Berlin scale

Regarding the distribution of planning areas according to load, Pankow roughly corresponds to the Berlin average. The same is true with respect to the distribution of the population for the different load levels.

Spatial focal points of the multiple load

The inner-city parts of the borough and the edge of the inner city are the focal points of the planning areas with multiple loads. The most problematic planning areas are situated in the prognosis areas northern and southern Prenzlauer Berg (0306 and 0307, respectively), which are characterised by Wilhelminian architecture and by residential and commercial use.

Thematic focal points of the multiple load

With respect to the four environment-related core indicators, the air pollution shows a strong upward deviation compared to the Berlin average (borough 72.5%, Berlin 57.9%). Moreover, the high share of medium problem density (borough 87.5%, Berlin 59.1%) merits attention. The other core indicators correspond to the Berlin average.

Number of affected persons in the planning areas with a particularly high load

While the share of planning areas with no load or with smaller loads (onefold or twofold) is above the Berlin average, the share of the number of affected inhabitants is higher than in the entire city. Of particular note are the people who live in the planning areas with twofold load (37.7% Pankow, 27.2% Berlin average). The high population density in the inner-city planning areas will have an impact here.

Charlottenburg-Wilmersdorf borough

Representation of the core indicators of the planning areas in comparison to the entire city

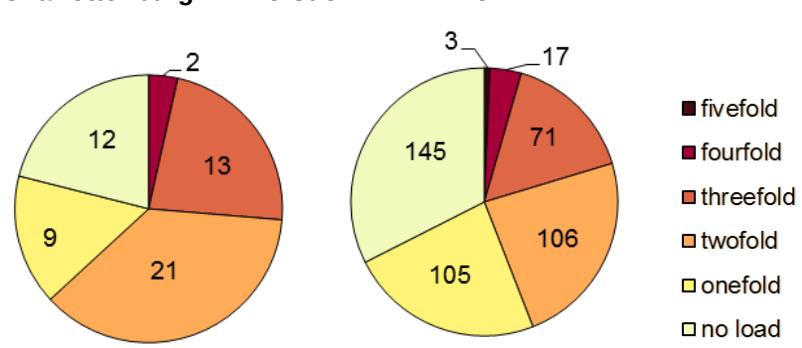

Fig. 16: Multiple load in the Charlottenburg-Wilmersdorf borough due to the core indicators noise, air pollution, availability of green spaces, thermal load as well as status index (social issues) according to planning areas (Planergemeinschaft Kohlbrenner eG 2015c)

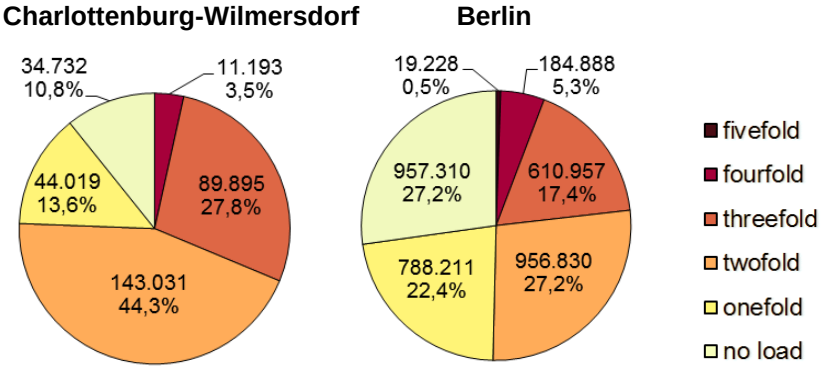

Fig. 17: Multiple load in the Charlottenburg-Wilmersdorf borough due to the core indicators noise, air pollution, availability of green spaces, thermal load as well as status index (social issues) according to inhabitants affected in all planning areas (deviations are due to rounding) (Planergemeinschaft Kohlbrenner eG 2015c)

Overall assessment on the Berlin scale

In comparison to the entire Berlin area, the Charlottenburg-Wilmersdorf borough performs worse with respect to areas with no, onefold and twofold load (borough PLAs with no, onefold and twofold load 73.3%, Berlin 79.6%). This classification is also reflected in the number of affected inhabitants (borough 221,782 (68.7 %), Berlin 2,702,351 (76.8 %)).

Spatial focal points of the multiple load

The S-Bahn ring and the city expressway ring draw a relatively clear line between the planning areas with no or small load and the western inner city with a comparatively homogeneous (twofold to threefold) load. The planning areas with multiple loads outside of the inner city (e.g. PLAs Königin-

Elisabeth-Straße, Schlangenbader Straße) can be attributed to areas with a high traffic load (federal motorway, railway facilities).

Thematic focal points of the multiple load

As regards the individual core indicators, the availability of green spaces and the air pollution are below average in comparison to the entire city area. Regarding the social condition, the Charlottenburg-Wilmersdorf borough is above the Berlin level.

Number of affected persons in the planning areas with a particularly high load

As much of the Charlottenburg-Wilmersdorf population is concentrated in the inner-city planning areas which usually have a higher load, the share of affected persons who live in PLAs with four- or threefold loads is significantly higher than in the Berlin average (borough 31.3%, Berlin 22.6%). Overall, 101,088, i.e. nearly a third of all inhabitants of the Charlottenburg-Wilmersdorf borough, live in PLAs with three- or fourfold load.

Spandau borough

Representation of the core indicators of the planning areas in comparison to the entire city

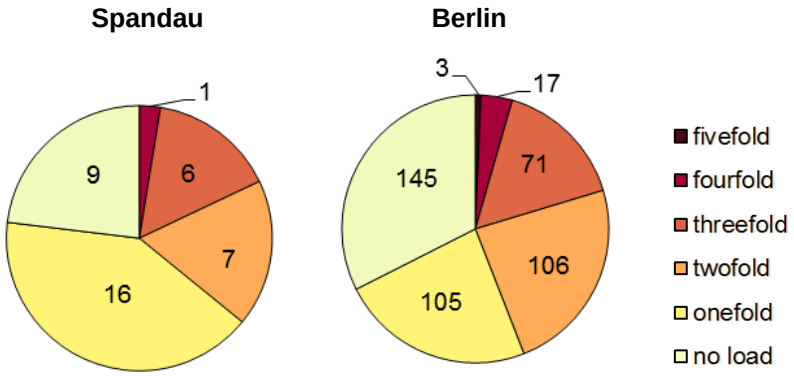

Fig. 18: Multiple load in the Spandau borough due to the core indicators noise, air pollution, availability of green spaces, thermal load as well as status index (social issues) according to planning areas (Planergemeinschaft Kohlbrenner eG 2015c)

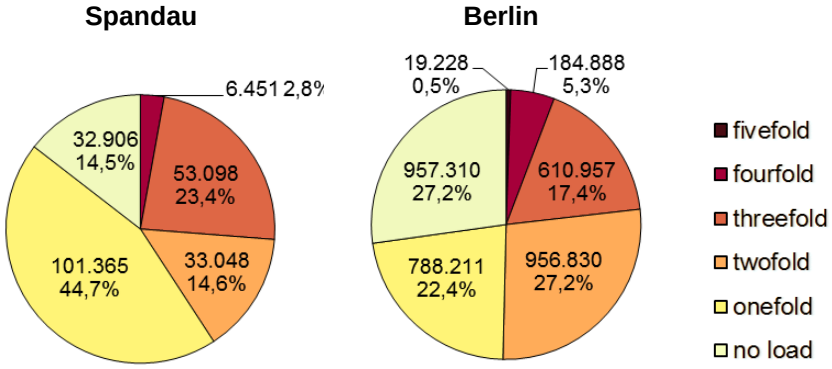

Fig. 19: Multiple load in the Spandau borough due to the core indicators noise, air pollution, availability of green spaces, thermal load as well as status index (social issues) according to inhabitants affected in all planning areas (deviations are due to rounding) (Planergemeinschaft Kohlbrenner eG 2015c)

Overall assessment on the Berlin scale

In comparison to Berlin, the Spandau borough roughly corresponds to the average of the entire city. However, the few planning areas with multiple loads to the east, west and north of the historical city centre are densely populated (92,597 inhabitants live in PLAs with multiple loads). The upcoming closure of Tegel airport will presumably result in a load reduction, as noise in particular will be reduced significantly.

Spatial focal points of the multiple load

The planning areas in the new city and in the Falkenhagener Feld (particularly PLAs Darbystraße, Germersheimer Platz, Eiswerder, Kurstraße, Ackerstraße, Carl-Schurz-Straße, Gartenfelder Straße) form the spatial focal points. In these areas, there are threefold or fourfold loads (Carl-Schurz-Straße) as well as social challenges.

Thematic focal points of the multiple load

In comparison to the Berlin average, the Spandau borough does much better with respect to the number of planning areas with good availability of free spaces (borough 87.2%, Berlin 55.5%). Regarding air pollution, Spandau also belongs to the boroughs with smaller loads in comparison to the entire city. The high share of planning areas with high noise load (PLAs with high noise load: borough 59%, Berlin 19.2%) is a clear “outlier” in the negative sense. A look at the spatial distribution suggests Tegel airport and its approach path as a fundamental cause.

Number of affected persons in the planning areas with a particularly high load

The number of people affected by a onefold load is significantly higher than in the Berlin average. 44.7% fall under this category (Berlin 22.4%). The remaining, worse categories show smaller shares. All in all, this yields a better overall picture compared to Berlin.

Steglitz-Zehlendorf borough

Representation of the core indicators of the planning areas in comparison to the entire city

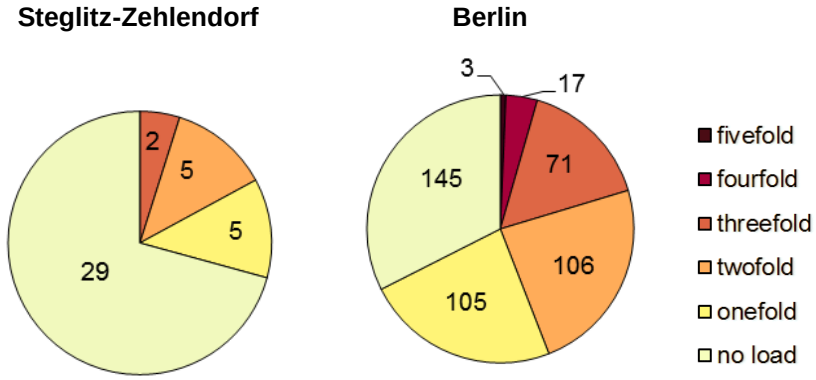

Fig. 20: Multiple load in the Steglitz-Zehlendorf borough due to the core indicators noise, air pollution, availability of green spaces, thermal load as well as status index (social issues) according to planning areas (Planergemeinschaft Kohlbrenner eG 2015c)

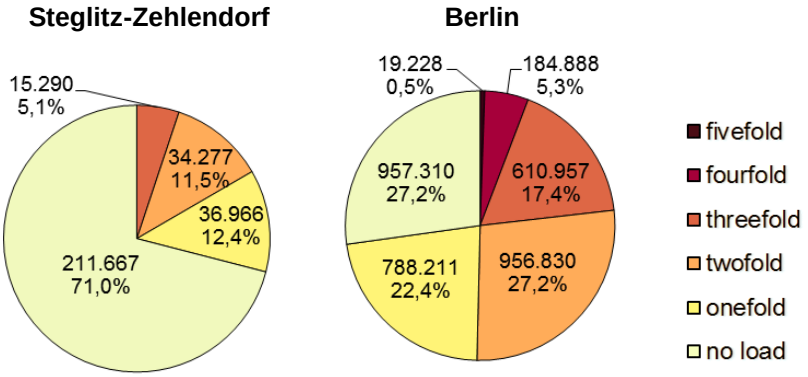

Fig. 21: Multiple load in the Steglitz-Zehlendorf borough due to the core indicators noise, air pollution, availability of green spaces, thermal load as well as status index (social issues) according to inhabitants affected in all planning areas (deviations are due to rounding) (Planergemeinschaft Kohlbrenner eG 2015c)

Overall assessment on the Berlin scale

Steglitz-Zehlendorf is a borough with small environmental loads, in comparison to the entire city. Only the planning areas in the densely built-up area of the Schloßstraße centre as well as individual planning areas in the Südende/Lankwitz area exhibit some load.

The number of people affected is low both in relation to the overall population of the borough and in comparison to Berlin. 16.6% (49,567 inhabitants) live in planning areas with multiple loads.

Spatial focal points of the multiple load

The former borough of Zehlendorf can be classified as load-free in its entirety. Regarding the former borough of Steglitz, a more differentiated picture emerges. The densely built-up area with nearly inner-city character around the Schloßstraße and the Wannseebahn and Westtangente includes planning areas with two- or threefold load.

Thematic focal points of the multiple load

The Steglitz-Zehlendorf borough exhibits low shares of problematic load levels regarding all core indicators, with the exception of thermal load. Accordingly, the share of planning areas with a small load is high. Only 7 out of 41 PLAs show multiple loads.

Number of affected persons in the planning areas with a particularly high load

Almost three quarters (71.0%) of all inhabitants live in load-free areas, only around 16.6% of the population live in areas with two- or threefold load. There are no planning areas with four- or fivefold load.

Tempelhof-Schöneberg borough

Representation of the core indicators of the planning areas in comparison to the entire city

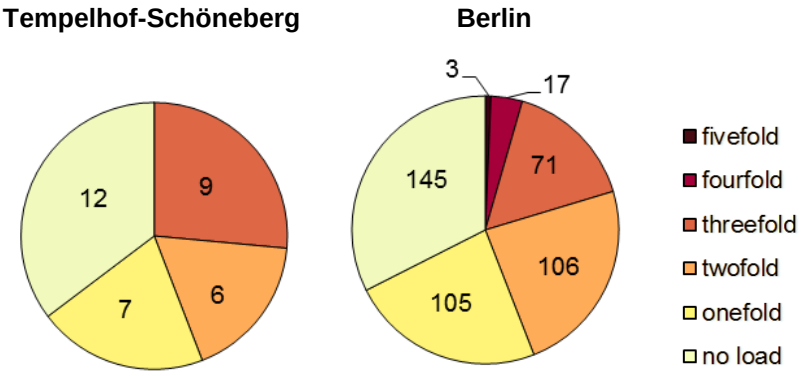

Fig. 22: Multiple load in the Tempelhof-Schöneberg borough due to the core indicators noise, air pollution, availability of green spaces, thermal load as well as status index (social issues) according to planning areas (Planergemeinschaft Kohlbrenner eG 2015c)

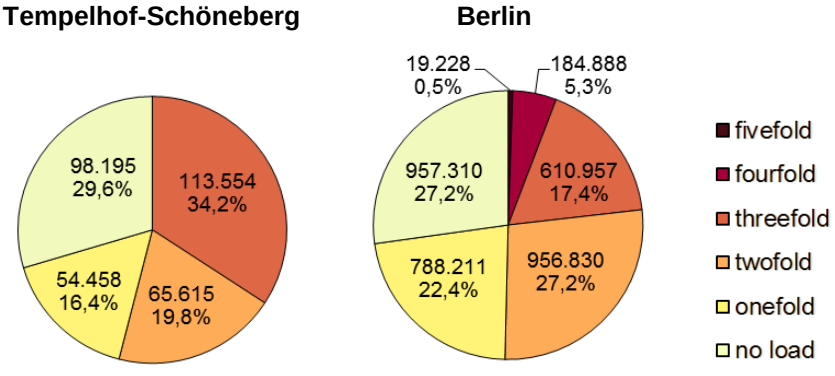

Fig. 23: Multiple load in the Tempelhof-Schöneberg borough due to the core indicators noise, air pollution, availability of green spaces, thermal load as well as status index (social issues) according to inhabitants affected in all planning areas (deviations are due to rounding) (Planergemeinschaft Kohlbrenner eG 2015c)

Overall assessment on the Berlin scale

Regarding the distribution of planning areas, the borough is slightly above the Berlin average. As regards the affected inhabitants, while there is no population with four- or fivefold load, the share of people affected by a threefold load is significantly higher.

Spatial focal points of the multiple load

The inner-city part of the Tempelhof-Schöneberg borough is characterised throughout by varying degrees of multiple loads. Even the areas of Friedenau (0703) and Tempelhof (0704), which adjoin the S-Bahn ring from the south and are characterised by a comparatively high urban structural density and mixed use, usually exhibit a two- or threefold load.

South of the Teltow Canal there are no planning areas with appreciable loads.

Thematic focal points of the multiple load

The divergence from the Berlin average is relatively small for many of the factors. The most negative deviation occurs for air pollution. While the share of PLAs with high air pollution amounts to 41.3% in the Tempelhof-Schöneberg borough, the share in the entire city only amounts to half of this value (24.4%).

Number of affected persons in the planning areas with a particularly high load

Regarding the proportion of people affected in the different load levels, Tempelhof-Schöneberg also roughly corresponds to the Berlin average. The slightly higher share of affected persons in areas with a threefold load is "balanced" by the lack of four- and fivefold loads as well as a higher share of inhabitants in load-free planning areas.

Neukölln borough

Representation of the core indicators of the planning areas in comparison to the entire city

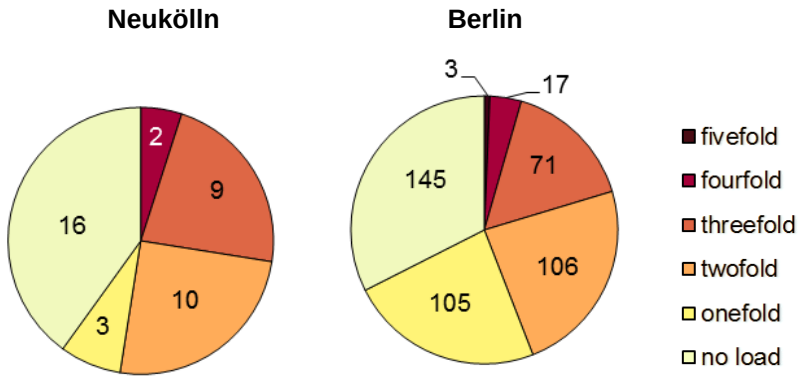

Fig. 24: Multiple load in the Neukölln borough due to the core indicators noise, air pollution, availability of green spaces, thermal load as well as status index (social issues) according to planning areas (Planergemeinschaft Kohlbrenner eG 2015c)

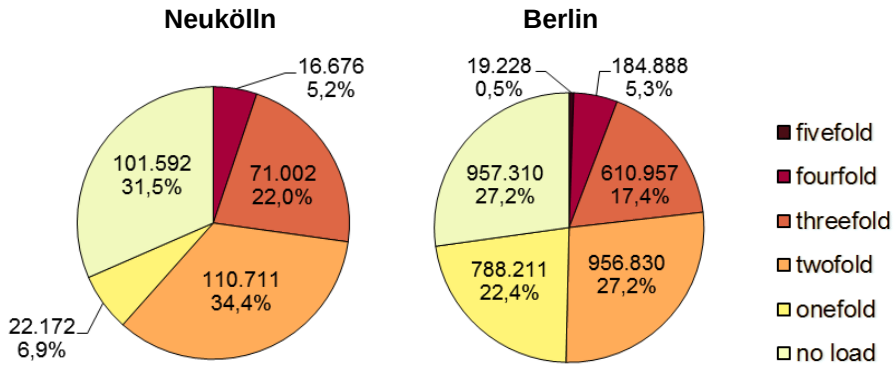

Fig. 25: Multiple load in the Neukölln borough due to the core indicators noise, air pollution, availability of green spaces, thermal load as well as status index (social issues) according to inhabitants affected in all planning areas (deviations are due to rounding) (Planergemeinschaft Kohlbrenner eG 2015c)

Overall assessment on the Berlin scale

The south of the borough of Neukölln hardly suffers from any load. By contrast, the densely developed planning areas of northern Neukölln, which are also characterised by social challenges, exhibit medium or high loads throughout (especially PLAs Wissmannstraße, Flughafenstraße, Körnerpark, Glasower Straße, Bouchéstraße, Reuterkiez, Donaustraße, Rixdorf, Treptower Straße Nord, Gewerbegebiet Ederstraße, Gewerbegebiet Köllnische Heide, Buschkrugallee Nord). At the same time, a large number of Neukölln inhabitants is concentrated in these planning areas. All in all, the Neukölln borough roughly corresponds to the Berlin average.

Spatial focal points of the multiple load

The focal point of the multiple loads is the north of Neukölln, i.e. the planning areas within the inner-city limits as well as areas which still have Wilhelminian character and immediately adjoin the S-Bahn ring from the south. In these areas, the loads are medium to high throughout. By contrast, the situation in the south of Neukölln is largely characterised by small or no loads.

Thematic focal points of the multiple load

The most pronounced downward deviation occurs for the distribution of classifications for the status index. Thus, the share of PLAs with a high or very high problem density amounts to 52.0% in Neukölln, while the share amounts to 22.8% for the entire city. Regarding the environmental factors, the lack of availability of green spaces and the comparatively higher thermal load stand out particularly.

Number of affected persons in the planning areas with a particularly high load

Around two thirds (61.6%) of the inhabitants of Neukölln are affected by at least a twofold load (Berlin 49.8%). Accordingly, a higher percentage of inhabitants is affected by a heavier load in Neukölln. However, in contrast to inner-city boroughs with a similar urban structure like Friedrichshain-Kreuzberg, Mitte or even Charlottenburg-Wilmersdorf, the downward deviation in comparison to the Berlin average is less significant.

Treptow-Köpenick borough

Representation of the core indicators of the planning areas in comparison to the entire city

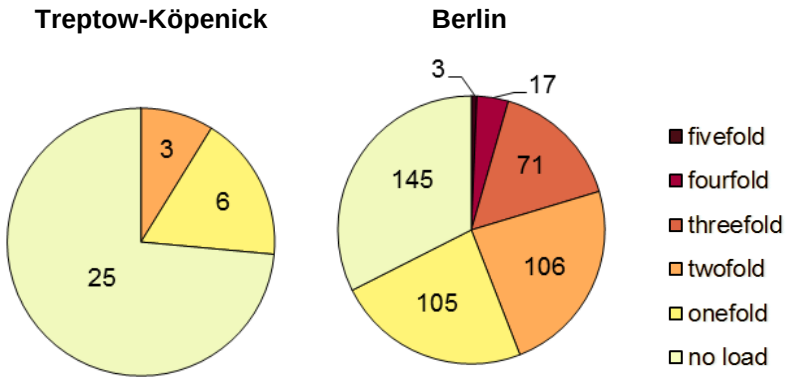

Fig. 26: Multiple load in the Treptow-Köpenick borough due to the core indicators noise, air pollution, availability of green spaces, thermal load as well as status index (social issues) according to planning areas (Planergemeinschaft Kohlbrenner eG 2015c)

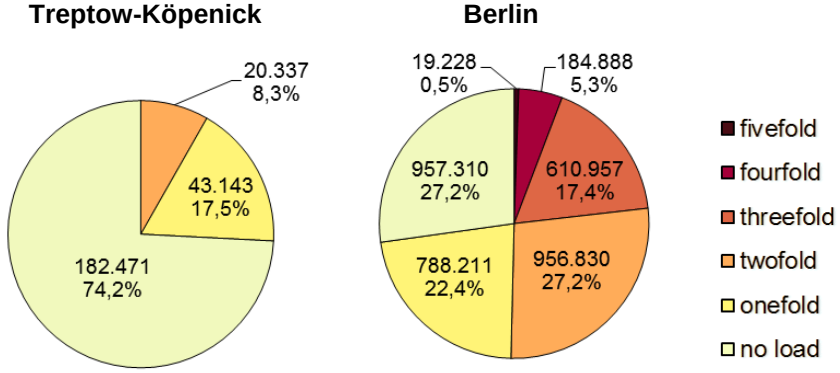

Fig. 27: Multiple load in the Treptow-Köpenick borough due to the core indicators noise, air pollution, availability of green spaces, thermal load as well as status index (social issues) according to inhabitants affected in all planning areas (deviations are due to rounding) (Planergemeinschaft Kohlbrenner eG 2015c)

Overall assessment on the Berlin scale

All in all, the environmental load of the Treptow-Köpenick borough is small – this is true for the number of planning areas as well as for the absolute number of persons affected. Thus, next to Steglitz-Zehlendorf, Treptow-Köpenick belongs to the Berlin boroughs with the smallest load.

Spatial focal points of the multiple load

Few planning areas exhibit any load at all (one- or twofold load), namely the densely built-up areas of Alt-Treptow, Schöneweide as well as the historical centre Köpenick with its outskirts.

Thematic focal points of the multiple load

All indicators in Treptow-Köpenick are better than average in comparison to the entire city of Berlin. Particularly the factors availability of green spaces, air pollution and thermal load are significantly better. The status index also turns out better. Only in the case of the indicator noise, the situation is only slightly better compared to the Berlin average.

Number of affected persons in the planning areas with a particularly high load

Three quarters of all inhabitants (182,471 inhabitants, 74.2%) live in load-free areas. 17.5% of the people affected live in planning areas with a onefold load. This makes Treptow-Köpenick the borough with the smallest load in Berlin.

Marzahn-Hellersdorf borough

Representation of the core indicators of the planning areas in comparison to the entire city

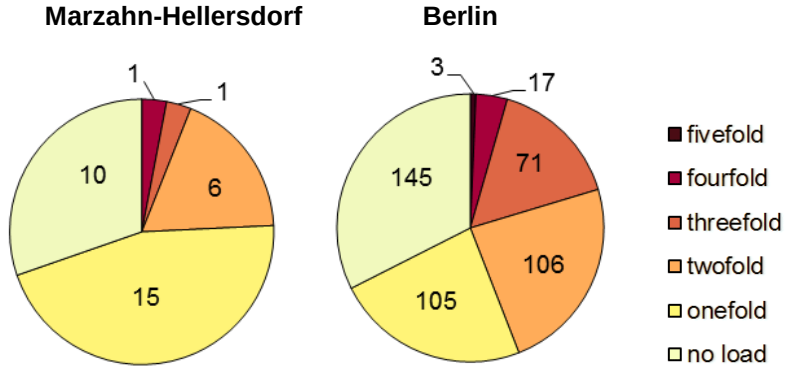

Fig. 28: Multiple load in the Marzahn-Hellersdorf borough due to the core indicators noise, air pollution, availability of green spaces, thermal load as well as status index (social issues) according to planning areas (Planergemeinschaft Kohlbrenner eG 2015c)

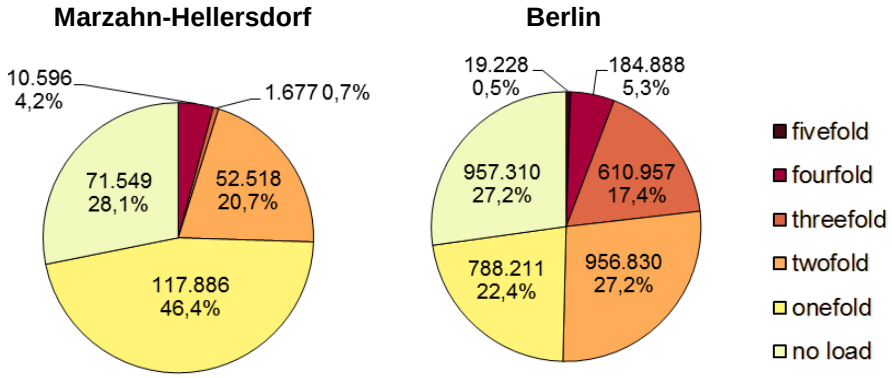

Fig. 29: Multiple load in the Marzahn-Hellersdorf borough due to the core indicators noise, air pollution, availability of green spaces, thermal load as well as status index (social issues) according to inhabitants affected in all planning areas (deviations are due to rounding) (Planergemeinschaft Kohlbrenner eG 2015c)

Overall assessment on the Berlin scale

In comparison to the entire city, the Marzahn-Hellersdorf borough does well, with few planning areas with multiple loads. This is also true for the distribution of the different load levels over the affected inhabitants.

Spatial focal points of the multiple load

There is a clear distinction between the planning areas that are not densely built-up and often characterised by areas with detached houses and the two areas with the large settlements Marzahn and Hellersdorf. In contrast to the detached houses, both large settlement areas include some planning areas with multiple loads (e.g. Marzahner Promenade, Helle Mitte).

Thematic focal points of the multiple load

The values for all core indicators are above the Berlin average in the Marzahn-Hellersdorf borough. This is especially true for the good or very good availability of green spaces.

Number of affected persons in the planning areas with a particularly high load

The comparatively small load in the planning areas is also reflected in the share of the population. 74.5% of the Marzahn-Hellersdorf inhabitants (189,435 inhabitants) live in planning areas with no load or with a onefold load (Berlin 49.6%).

Lichtenberg borough

Representation of the core indicators of the planning areas in comparison to the entire city

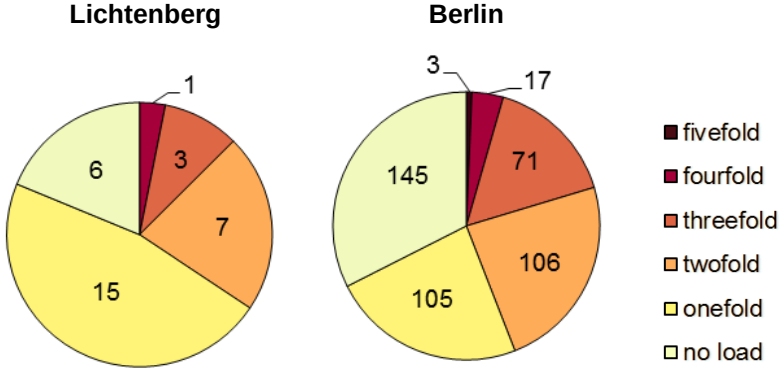

Fig. 30: Multiple load in the Lichtenberg borough due to the core indicators noise, air pollution, availability of green spaces, thermal load as well as status index (social issues) according to planning areas (Planergemeinschaft Kohlbrenner eG 2015c)

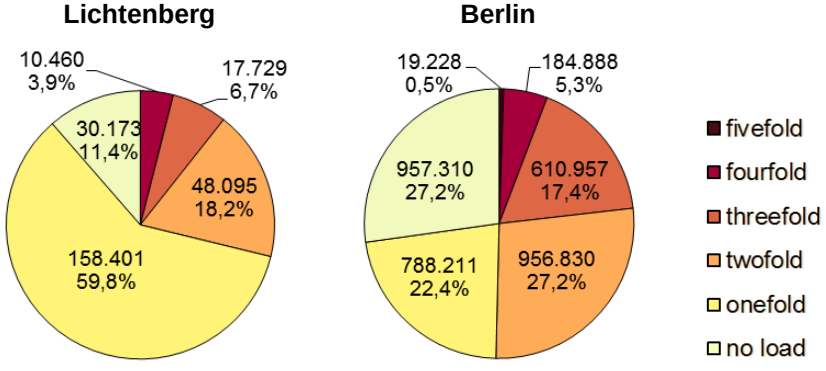

Fig 31: Multiple load in the Lichtenberg borough due to the core indicators noise, air pollution, availability of green spaces, thermal load as well as status index (social issues) according to inhabitants affected in all planning areas (deviations are due to rounding) (Planergemeinschaft Kohlbrenner eG 2015c)

Overall assessment on the Berlin scale

Due to the large share of 59.8% of planning areas with onefold load (and correspondingly a higher share in the population), the Lichtenberg borough cannot be classified as overall better than average. However, all in all, the degree of multiple loads is lower than in the Berlin average.

Spatial focal points of the multiple load

Areas with a greater and a smaller load are nearly evenly distributed across the borough. The reasons for this are to be found in small-scale factors.

Thematic focal points of the multiple load

Overall, Lichtenberg lies slightly below the Berlin average. Especially the higher share of planning areas with high noise load and thermal load are clearly evident. 22 PLAs in the borough (68.6%) have a high thermal load (Berlin 51.0%).

Number of affected persons in the planning areas with a particularly high load

Concerning the numbers of inhabitants in the different classifications, the borough is situated in the mid-range: Lichtenberg has fewer planning areas with no load, but at the same time also proportionally fewer planning areas or affected inhabitants with multiple loads than the entire city.

Reinickendorf borough

Representation of the core indicators of the planning areas in comparison to the entire city

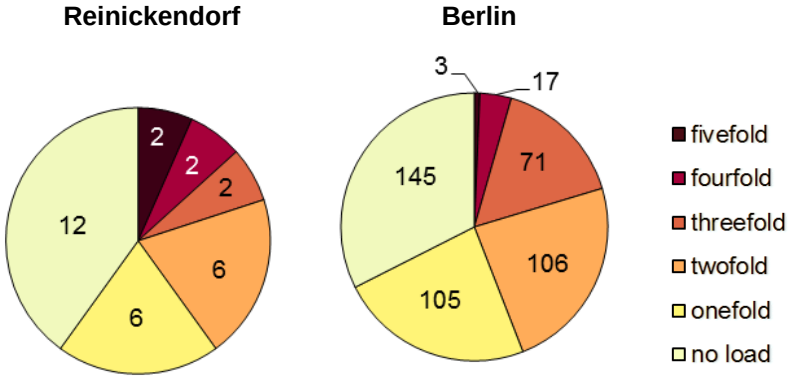

Fig. 32: Multiple load in the Reinickendorf borough due to the core indicators noise, air pollution, availability of green spaces, thermal load as well as status index (social issues) according to planning areas (Planergemeinschaft Kohlbrenner eG 2015c)

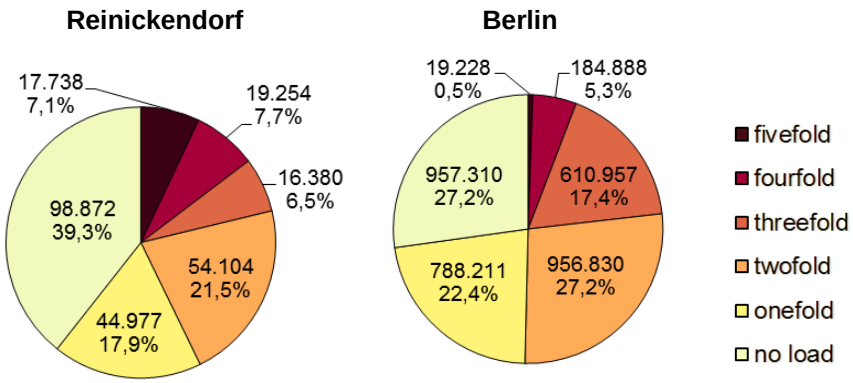

Fig. 33: Multiple load in the Reinickendorf borough due to the core indicators noise, air pollution, availability of green spaces, thermal load as well as status index (social issues) according to inhabitants affected in all planning areas (deviations are due to rounding) (Planergemeinschaft Kohlbrenner eG 2015c)

Overall assessment on the Berlin scale

Although the Reinickendorf borough has a disproportionate share of planning areas with fivefold load, the share of the population and the number of the planning areas with multiple load is smaller than in the Berlin average. The situation will presumably improve considerably after the closure of Tegel airport.

Spatial focal points of the multiple load

The south-east of the borough (in particular PLAs Letteplatz, Klixstraße, Scharnweberstraße, Dannenwalder Weg) is the spatial focal point of the planning areas with multiple load. More densely built-up structures with a Wilhelminian mixed character as well as the approach path for Tegel airport are located here.

Thematic focal points of the multiple load

Most of the factors are distributed according to the Berlin average, partly slightly better, but also partly worse. The share of planning areas with a high noise load is significantly worse (borough 36.7%, Berlin 19.2%).

Number of affected persons in the planning areas with a particularly high load

In comparison to the entire city, the distribution over the different load classifications is more favourable in Reinickendorf. Only in the segment of the highest loads, the share of fivefold loads stands out compared to the Berlin average (borough 6.7%, Berlin 0.7%). It is striking that 91.0% of all inhabitants affected by a fivefold load live in the borough of Reinickendorf (17,738 inhabitants out of altogether 19,228 inhabitants).

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