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Master thesis

To what extent do the exacerbating effects of air pollution on social inequality also occur in industrialised countries with a comparatively low level of social inequality?
– An analysis of the German case of Duisburg

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Sheila Heuer (3098303/502401)
Master Thesis, BMS (UT) & IfPol (University of Münster)
Degree: European Studies (M.Sc.) & Comparative Public Governance (M.A.)
First Supervisor: Dr. Le Anh Nguyen Long
Second Supervisor: Prof. Dr. Matthias Freise
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Content

Abbreviations

Term or acronym	Meaning of definition
AQI	Air Quality Index
EU	European Union
EC	European Commission
HLNUG	Hessian State Agency for Nature Conservation, Environment and Geology (original: Hessisches Landesamt für Naturschutz, Umwelt und Geologie)
HMUKLV	Hessian Ministry of Agriculture and Environment, Viticulture, Forestry, Hunting and Homeland (original: Hessisches Ministerium für Landwirtschaft und Umwelt, Weinbau, Forsten, Jagd und Heimat)
i.e.	That is (original: id est)
LANUV	North Rhine-Westphalia State Agency for Nature, Environment and Consumer Protection (original: Landesamt für Natur, Umwelt und Verbraucherschutz Nordrhein-Westfalen)
NRW	North Rhine-Westphalia
PM	Particulate matter
RP	Rhineland-Palatinate
WHO	World Health Organisation

Abstract

This empirical work aims to elaborate on the impact of air pollution on social inequality in terms of health, residential and income inequality. Despite the progress in reducing air pollution in the past few decades, there is still great potential for improvement as the World Health Organisation's (WHO) guideline values for air pollution are still not met.

Particularly problematic about high air pollution is that disadvantaged people suffer most from the negative social consequences which further exacerbates social inequality. Due to the limited availability of qualitative literature on the research object as well as the lack of research about industrialised countries, a qualitative single case study of the German city Duisburg is carried out to test how air pollution influences the three central dimensions of social inequality (health, residential and income inequality) and what the interaction effects between the dimensions are. Data is triangulated through document-based desk research on air pollution mitigation policies, on the one hand, and the conduction of in-depth expert interviews, on the other hand, to increase the validity and robustness of the qualitative data.

Thereby this thesis makes an important contribution to explaining the effects of air pollution on multi-dimensional social inequality in industrialised countries. It reveals the patterns and mechanisms behind the influence of air pollution and proves that they favour the emergence of an environmental health-poverty trap. The findings of this thesis demonstrate that, despite the existence of a welfare state, air pollution has negative effects on social inequality in the German city of Duisburg, which particularly affects the more disadvantaged groups of people. Nevertheless, the interviews have revealed that researchers from the municipal offices have started to realise the negative interconnection of air pollution and social inequality and are showing great ambition for improvement. They are trying to influence local policymakers through implementation-oriented policy recommendations following an integrated approach. The distinctive feature of their project's integrated approach not only facilitates a clear understanding of the interconnections between social and environmental problems but also creates optimal conditions for the overall improvement of air pollution and social inequality problems.

1. Introduction

Clean air cannot be taken for granted. The short and long-term effects of air pollution have been felt everywhere since the 1960s. Cardiovascular and respiratory diseases, as well as serious effects on mortality, resulting from air pollution, have become the norm (Katsouyanni, 2003). In Europe alone, about 500.000 premature deaths per year can be attributed to air pollution (WHO, 2016).

Given this, air pollution remains a pressing environmental challenge. Even if policymakers have shown great ambitions in improving air quality over the last three decades, legislation in the European Union (EU) on air pollution is far from meeting the WHO limits (Amann et al., 2020; Schubert et al., 2023; Berger, 2024; European Parliament Think Tank, 2024). Air pollution is conceptualised in this thesis as "the presence of harmful substances in the air that interfere with human health and ecosystems" (Roth, 2017, p. 4). In the European Union, the EU Directive 2008/50/European Commission (EC) specifies the emission ceilings and air quality standards that must be complied with in all member states (Hessian Ministry of Agriculture and Environment, Viticulture, Forestry, Hunting and Homeland (HMUKLV), n.d.). As compliance with particulate matter (PM_{10} and $PM_{2.5}$) and nitrogen oxide levels are the greatest challenges in Germany, the analysis of this research focuses particularly on these values (Roth, 2017).

Current research indicates that air pollution particularly causes disproportionate harm to disadvantaged people and thus exacerbates social inequality (Schraufnagel et al., 2019; Gómez & Iturra, 2021; Kampa & Castanas, 2008; Hill et al., 2018; Rosofsky et al., 2018; Slotje et al., 2001; Xue et al., 2022; Liu et al., 2020). In this thesis economically less advantaged citizens in society are referred to as 'disadvantaged people' for reasons of simplicity.

This effect is expected to be even aggravated by the different dimensions of social inequality: health, residential, and income inequality. While some studies have already confirmed this trend for developing or emerging countries (Gómez & Iturra; Xue et al., 2022; Liu et al., 2020), it is unclear, due to the lack of research, whether this also applies to cities in industrialised countries with a comparatively good welfare system.

The absence of literature on this topic in industrialised countries may be attributed to the assumption that countries with a welfare system no longer experience the negative social consequences associated with air pollution because they can reduce them through social safety nets and well-functioning healthcare systems (Schlosberg, 2013). In line with this, Sun et al. (2019) found that air quality has substantially improved in Germany and the European Union

in the last few decades due to a combination of emission mitigation policies. Additionally, the lack of knowledge in industrialised countries may be explained by the fact that the negative environmental effects on social inequality may be more visible and severe in developing countries (Rao et al., 2014).

However, even if the worst consequences of air pollution are mitigated, this does not imply that the conditions are satisfactory or even optimal. Instead, Germany is one of the European countries with the highest death rates concerning air pollution (Carvalho et al., 2019) and the selected case Duisburg particularly seems to suffer from both a considerable level of air pollution and social inequality (Duisburg Employment Agency, 2022; North Rhine-Westphalia State Agency for Nature, Environment and Consumer Protection (LANUV), 2024a).

All this further emphasises the necessity of closing this research gap and supplementing the perspective of industrialised countries with a strong welfare system on this topic. On the one hand, this knowledge can help to make urban planning and development strategies and policymaking more equitable and effective (Brulle & Pellow, 2006). On the other hand, it can also be used to conclude German welfare strategies and determine whether they are comprehensive enough to address air pollution-related health risks and their social implications (Boyce, 2018).

By researching the social inequality impacts of air pollution, this thesis addresses this demand for greater distributional justice by going beyond the environmental and economic impacts of poor air quality, to also consider its social impacts. The chosen research topic is of particular scientific relevance due to the high salience of air pollution and issues of social inequality, especially since the WHO guideline values for air quality are not yet met (Sofia et al., 2020; European Environment Agency, 2019).

Therefore, the research question is ‘To what extent do the exacerbating effects of air pollution on social inequality also occur in industrialised countries with a comparatively low level of social inequality?’. With the help of desk research on air mitigation policies and expert interviews, this paper attempts to find answers to this question.

To address the research question, several sub-research questions are considered:

1. What are the past and current air pollution problems in Duisburg?
2. To what extent does air pollution impact income, residential and health inequality in Duisburg?

3. What are the interaction effects between the different dimensions of social inequality in Duisburg concerning air pollution?
4. What are the ongoing projects, obstacles and further policy recommendations in Duisburg to mitigate air pollution and the negative effects on social inequality?

2. Scientific and societal relevance of the research

The concept of environmental justice is increasingly gaining recognition by scholars internationally, both in temporal and spatial terms (inter and intra-generational equity), and is now one of the socially recognised principles (Moreno-Jímenez et al., 2016; Fuchs et al., 2020). Particularly with the increase in tangible environmental impacts, questions of environmental justice are becoming ever more pressing and a stronger focus on the resilience of disadvantaged societies is becoming increasingly important. From an environmental justice perspective, air quality measures need to verify if they tackle disadvantages and must prevent a further increase in social inequality (Mitchell et al., 2015).

Scholars provided strong evidence that the most disadvantaged groups in particular experience the most harmful consequences of air pollution (Shen et al., 2019; Cushing et al., 2015; European Commission, 2021). It is referred to as the double burden due to two mechanisms: On the one hand, people of lower socio-economic status are highly exposed to air pollution since they live in more polluted areas (Lam & Chung, 2012; Chakraborty, 2009; Grineski et al., 2007), while, on the other hand, they suffer from differential susceptibility due to a lack of resources to protect themselves from the health effects (Deguen & Zmirou-Navier, 2010; Fairburn et al., 2019; Shen et al., 2019).

However, most of the evidence comes from less wealthy countries and metropolitan cities or even the country's capitals where social inequality is exacerbated by rising air pollution (Gómez & Iturra, 2021; Xue et al., 2022; Liu et al., 2020). Other studies have focused on the United States which does not have a strong social safety net either (Kampa & Castanas, 2008; Hill et al., 2018; Rosofsky et al., 2018; Slotje et al., 2001). The consequence of a research gap in important perspectives, such as those of industrialised countries with strong welfare systems, is that the problem may be perceived in a distorted way. It is therefore unclear whether air pollution exacerbates social inequality in industrialised countries with a comparatively well-functioning welfare system, even though a welfare system intends to minimise social inequality. Given that, this thesis tries to make a start in closing this research gap by analysing the effects of air pollution on social inequality in a deviant case, namely Duisburg, Germany. Thus, the

case of Germany can offer more nuances in the field of research by adding the perspective of an industrialised country.

This approach is also particularly relevant as so far mainly quantitative and comparative studies have been conducted (Fairburn et al., 2019; Deguen & Zmirou-Navier, 2010; Ferreira et al., 2013; Wu & Pu, 2020), which have only measured the impact in numbers and therefore could not capture social inequality as a complex issue with its many facets. Previous studies also missed hard to quantify dimensions of social inequality such as a lack of strong social networks promoting advancement in life and the subjective experiences of those individuals affected by environmental injustice. The qualitative approach of this thesis seeks to address this weakness by conducting a single case study and generating a deeper understanding of the context of the German city and the mechanisms and processes behind the impact which finally lead to environmental disparities.

The multidimensional perspective of social inequality (in terms of health, residential and income inequality) enables a holistic and integrated view, and also the investigation of the interactions between the various dimensions to promote a more comprehensive analysis of the hidden patterns and interrelationships. Consequently, a qualitative approach is necessary here to determine whether the dimensions interact with each other and in what form this influences the most disadvantaged people. This approach permits a more detailed analysis of whether air pollution leads to exacerbating effects on social inequality even in a country like Germany with a strong welfare system, offering a more comprehensive understanding that cannot be provided by quantitative data alone.

3. Theoretical framework

Air quality is one of the crucial environmental resources besides water and soil (Dike & Dike, 2012) which are necessary for the well-functioning of ecosystems. However, due to population growth, urbanisation, and industrialisation the pressure on these environmental resources is increasing immensely (Kattumuri, 2018). Since environmental resources are public goods from which no one can be excluded, it is difficult to prevent overexploitation (Dike & Dike, 2012). The possibility of free riders can lead to an increase in pollution if those responsible do not feel the consequences of their activities and are not held accountable (Yan et al., 2017; Konisky & Woods, 2009). As with other natural resources, air quality therefore also has an impact on people who are hardly responsible for the emergence of the pollutants, which is why the transnational regulation of limit values for air pollutants and making the polluters responsible for their actions is of immense importance.

In view of this, this thesis expects that air pollution has an impact on social inequality, defined here as "the relative position of individuals along several dimensions that measure achieved outcomes" (Binelli et al., 2015, p. 239). Social inequality includes the access of individuals to wealth, power, and good living conditions and thus reflects the disparities within the population to access a decent standard of living (Suleymanov et al., 2023; Alker & Russett, 1964). Scholars found that there is a negative impact of air quality in Europe on life satisfaction and well-being (Ferreira et al., 2013), especially for people being at risk for severe health effects (Luechinger, 2009) and people with lower income (Verbeek, 2019). For Germany specifically, scholars were able to confirm an association between lower social status, fewer green spaces (Braubach & Fairburn, 2010), and reduced air quality (Bolte & Kohlhuber, 2008).

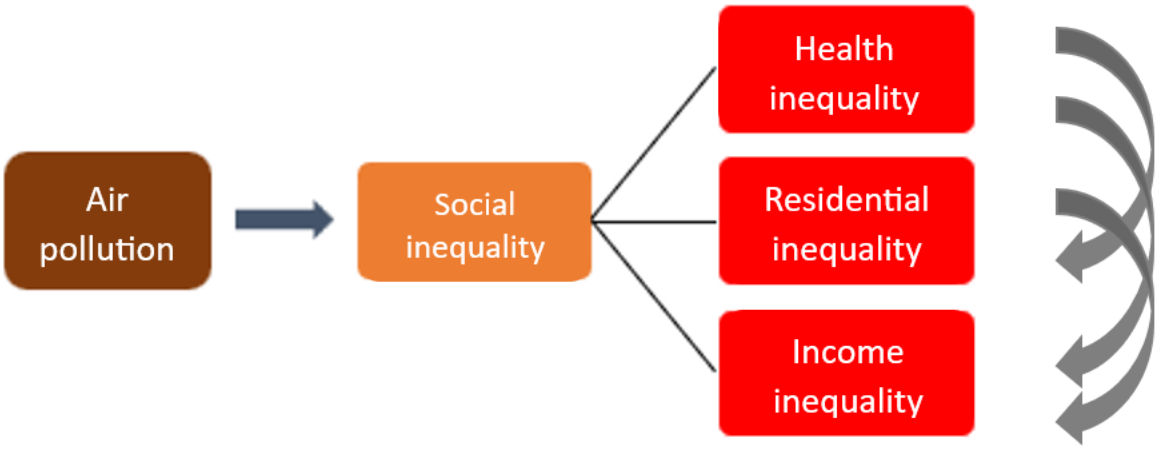
The "socially determined differences in environmental conditions" (Bolte et al., 2010, p. 14) are no new phenomena. Instead, the discussion about environmental injustice has its roots in the early 1990s and already exists in the fact that low-income households and other ethnicities suffer from a higher exposure to environmental hazards due to displacement into the more polluted districts (Banzhaf et al., 2019). Even though air quality has improved considerably in the last two decades, environmental inequality has increased to the benefit of the affluent (Mitchell et al., 2015).

Since social inequality has various dimensions and the effects cannot be measured generally, the dimensions for the research question have been selected with the help of the literature review. The literature has revealed that the impacts of air pollution are most relevant to health inequality, residential inequality and income inequality. Thus, these three aspects form the theoretical basis for this thesis.

Figure 1 illustrates the theoretical idea behind the effects of air pollution on the various dimensions of social inequality as well as the interaction effects between all the dimensions which reinforce the impact.

Figure 1

Illustration of the effects of air pollution on the various dimensions of social inequality and interaction effects



3.1 Health inequality

The first dimension of social inequality that has been defined is 'health inequality'. As Fairburn et al. (2019) stated, "outdoor air quality is one of the most important environmental factors affecting human health" (Fairburn et al., 2019, p. 1). Undoubtedly, air pollution leads to a significant increase in respiratory, mental, and cardiovascular diseases (Brunekreef & Holgate, 2002; Shen et al., 2019; Lelieveld et al., 2015). In Germany, for instance, air pollution is the greatest environmental risk to the health of people and contributes significantly to the development of chronic diseases such as cancer, heart attacks, and strokes (Berger, 2024).

The literature suggests that there is an indirect effect between the two variables air pollution and health inequality. Azimi et al. (2019) statistically analysed the effects of air pollution on health inequality in China with panel data from 31 Chinese provinces. Perinatal and tuberculosis mortality were hereby employed as dependent variables, as these diseases are very central to the Chinese context and largely connected to sulfur oxide and nitrogen oxide emissions. A statistically positive correlation was found, i.e. (that is) that high sulphur dioxide and nitrogen oxide levels are associated with increasing perinatal and tuberculosis mortality (Azimi et al., 2019). Yang and Liu (2018) analysed data from a national survey to test whether air pollution impacts the health status of citizens in China. The scholars also identified a statistically positive relationship between the two variables, meaning that disadvantaged people suffer most from worsening air quality due to other intervening factors. However, it should be critically noted here that the health problems and dominant pollutants in China are very different from those in

Europe, which is why the direct transferability of the two Chinese studies to the case of Duisburg is limited.

Other scholars analysed the effects of air pollution on health inequality in the European region (Fairburn et al., 2019; Deguen & Zmirou-Navuer, 2010) and found a statistically positive effect between the two variables as well. Richardson et al. (2013) were able to show with their statistical analysis of population distribution data and PM10 data for Europe that air pollution disproportionately negatively affects the health status of lower socioeconomic groups. Given this evidence, it can be assumed that there is a statistically positive influence of air pollution on health inequality for European cases.

It is worth considering what causes these health vulnerabilities. Yang and Liu (2018) found that the impact is due to insufficient access of low-income groups to health, medical resources and less polluted residential areas. In their words: "Air pollution mainly contributes to increased health inequality in low-income areas because the residents are unable to choose their conditions of life" (Yang & Liu, 2018, p. 51). Hence, economic factors play a role in the form of a mediator of the influence. The lack of financial resources also plays a central explanatory role for perinatal and tuberculosis mortality inequality, with a greater focus on the fact that lower socioeconomic households usually live in the more polluted regions and therefore carry a higher risk of disease (Azimi et al., 2019).

Fairburn et al. (2019) and Deguen & Zmirou-Navier (2010) investigated the mechanisms behind the influence in more detail. They concluded that health inequality is influenced by air pollution due to the existence of the following two mechanisms: On the one hand, the different exposure of disadvantaged groups than non disadvantaged groups causes environmental inequity. On the other hand, the differential susceptibility of disadvantaged groups to health risks from air pollution leads to health vulnerabilities (Fairburn et al., 2019). These factors, taken together, lead to the emergence of an environmental health-poverty-trap (Yang & Liu, 2018); thus "irrespective of exposure, subjects of low socioeconomic status experience greater health effects of air pollution" (Deguen Zmirou-Navier, 2010, p. 27).

Thus, Deguen and Zmirou-Navier (2010) argue in the same way as Fairburn et al. (2019) that there are two different mechanisms at work which lead to air pollution negatively influencing health inequalities. Both articles show that there are interacting variables of influence: while Deguen and Zmirou-Navier (2010) speak of vulnerability factors in European countries, Fairburn et al. (2019) recognise social factors (including ethnicity and economic position) in the WHO European region as mediators of the effect. Ultimately, the authors describe the

interacting variables differently, but they have a very similar significance and the centrality of the lower economic position as a vulnerability factor is evident in both journal articles.

When comparing the explanations of all those mentioned studies, it becomes clear that income plays a central role in the causes of health vulnerabilities due to air pollution. Access to health resources appears to be crucial in China (Yang & Liu, 2018), however, this effect cannot be assumed in this great extent for the selected case of Duisburg due to the existence of mandatory statutory health insurance in Germany. The influence of the residential environment found by Azimi et al. (2019) is also mentioned in the social and vulnerability factors of the other two studies (Deguen & Zmirou-Navier, 2010; Fairburn et al. 2019), but is only one part of these factors. It can therefore be assumed that the combination of different exposure (due to more polluted residential areas) and higher vulnerability of socio-economically disadvantaged groups explains the health inequalities of air pollution in Germany.

Taking all this into consideration, the predominant view is that the effect is statistically positive and indirect and that income inequality as well as residential inequality mediate the influence since they result in different exposure and higher vulnerability of disadvantaged groups. Therefore, based on these indications, I expect that air pollution has a positive influence on health inequality in Duisburg by affecting particularly disadvantaged population groups more severely and leading to a deepening of existing health inequality.

3.2 Residential inequality

As the literature review has revealed, residential inequality seems to be an important dimension of social inequality that is impacted by air pollution too. Residential inequality is not to be equated with housing inequality, as not only housing rental prices and housing quality are of interest, but also ambient factors such as access to green spaces, green volume, visual pollution, and noise pollution.

Two studies of particular relevance to this question were identified: one in Chile and one in China which can be indicative of residential inequality. In a quantitative analysis of fine particulate matter (PM 2.5) concentrations in China, Xue et al. (2022) analysed how these affect house prices. The authors have shown that there is a direct negative effect of air pollution on house prices; i.e. increasing air pollution leads to falling house prices (at least in highly polluted areas) and a devaluation of property. It could therefore be reasoned that the falling prices reduce housing inequality in terms of access since lower-income families might have better access to housing, as Zhang et al. (2021) also found out for China. Nevertheless, it is not possible to draw

any conclusions regarding the residential quality of the population based on this study since the housing prices are only one part of the dimension and other consequences of air pollution such as reduced availability of capital for the poorer sections of the population are not included.

Gómez and Iturra (2021) carried out a similar analysis for the development of housing rental prices in Chile, which is also based on $PM_{2.5}$ emissions. They also found a direct and negative correlation between the two variables in the South American country. Their "model suggests that a 1µg/m3 increase in $PM_{2.5}$ produces, on average, a reduction of 4.1 per cent in housing rental prices" (Gómez & Iturra, 2021, p. 377).

Even though these studies provide very interesting findings, the transferability to the German case appears to be limited, as it can be assumed that the conditions in China and Chile are very different to Germany such as the differences in public welfare systems. Moreover, only the development of rental and purchase prices was examined. Even when these factors must be considered, it is crucial to take into account residential inequality as a whole for the case study of the German city. The main reason for this is that this thesis is interested in how unequal living conditions are due to air pollution, which includes not only rental prices but also access to green spaces, as well as proximity to factories, main roads, and other strong emitters (Gómez & Iturra, 2021).

In contrast to the first two studies, Grineski et al. (2007) focused more on environmental factors by analysing how air pollution affects the population of Phoenix, Arizona, and who is particularly affected. Indeed, using multiple regression equations, a significant finding was that there is residential segregation due to air pollution, manifested in the fact that ethnic minorities and lower-income residents tend to live in the most polluted areas of the metropolitan area (see Grineski et al., 2007). As indicated in the previous section on health inequalities, Deguen and Zmirou-Navier (2010) also found an amplifying effect of air pollution on residential inequality in European countries. Bolte et al. (2010) specifically noted that “[d]ata from Germany indicated that parents with a lower socio-economic position felt more often impaired by a lack of accessible green space in their living environment in both urban and rural settings.” (Bolte et al., 2019, p. 16)

Having established that air pollution can have a statistically positive effect on residential inequality and that it tends to have a particular impact on disadvantaged groups, it is worth considering the mechanisms behind this effect.

Deguen and Zmirou-Navier (2010) found that socioeconomic status plays a decisive role by influencing the housing market in such a way that housing and rental prices rise in the less polluted regions and fall in the other highly polluted regions. Consequently, people with lower socioeconomic status are displaced by the lower prices to the regions where the air quality is worse, which favours residential inequality (Deguen & Zmirou-Navier, 2010).

In line with this, some other studies have found the following correlation: People of lower socioeconomic households are exposed to higher levels of air pollution in their residential area since they live closer to main roads, for instance (Lam & Chung, 2012; Chakraborty, 2009; Grineski et al., 2007). Winters and Heylen (2014) also found evidence for this mechanism of socioeconomic vulnerability of renters.

Although Grineski et al. (2007) confirmed the influence of socioeconomic disparities as well, they also found that ethnic disparities play a crucial role. In Phoenix, for example, specific minority ethnicities such as Latino immigrants are particularly affected by air pollution impacts. Chakraborty (2009) also recognised the connection in Florida that ethnic minorities suffer from higher exposure to air pollutants due to historical segregation which is still prevalent in many regions. In principle, it can be assumed that the extent of segregation in US cities is not comparable with German cities. Nevertheless, even if the level of ethnic segregation in Germany is rather low, there are strong differences between migrant groups (Buch et al., 2021). The case of Duisburg in particular, which is examined here, is known for its high proportion of people with a migrant background, but also ethnic disparities and underprivileged immigration in the Marxloh district with poor structural conditions and a lack of social and public infrastructure (Krauß, 2019).

Given these points, it can be assumed that there is an indirect statistically positive influence of air pollution on residential inequality with higher levels of air pollution being associated with higher residential inequality. The expected causes are not only socioeconomic factors but also ethnic inequalities, which ensure a geographically unequal distribution and place a greater burden on disadvantaged groups.

3.3 Income inequality

Finally, income inequality also seems to be a decisive factor in the effects of air pollution in particular, as several scholars have confirmed (Liu et al., 2020; Wu & Pu, 2020; Fairburn et al., 2019; Verbeek, 2019; Binelli et al., 2015). There is evidence suggesting a statistically positive relationship between air pollution and income inequality. Liu et al. (2020), for instance,

analysed how air pollution in China affects income inequality from a health perspective and found that there is a statistically positive influence of air pollution on income inequality through other intervening factors. Similarly, Wu and Pu (2020) analysed panel data from 156 countries worldwide and found a positive exacerbating effect.

Fairburn et al. (2019) examined the impact of air pollution on different social dimensions in the WHO European Region with data from 2010-2017 and among them economic position. Using a statistical analysis of data from 31 journal articles, they discovered that in all 27 European countries "between 2004 and 2008 PM_{10} levels are statistically significantly higher in households with the lowest income" (Fairburn et al., 2019, p. 10). Goodman et al. (2011) and Samoli et al. (2019) have also confirmed that mean air pollutant concentrations are higher where people of a lower socioeconomic status live or are socio-economically deprived or even unemployed. Considering all this, the literature consistently shows a statistically positive relationship between increased levels of air pollution and income inequality. Thus it would now be helpful to also consider the explanatory factors behind this impact.

Liu et al. (2020) found that air pollution negatively impacts income inequality through the so-called health burden. This means that air pollution makes people with a lower socioeconomic status even more precarious. Existing income inequality across socioeconomic status should therefore be expected to be further exacerbated by environmental problems such as air pollution.

Scholars have confirmed the existence of a so-called health burden for people with lower socioeconomic status (Fairburn et al., 2019; Liu et al., 2020), which harms income inequality due to lack of health insurance coverage for instance, in countries where there is no compulsory statutory health insurance (Atake, 2018). Nonetheless, it seems that, even in countries like Germany with a robust welfare system, the risk of exposure to the threat of poverty goes hand in hand with poor health (Calvo & Dercon, 2013). This is exacerbated by the fact that even statutory health insurance does not cover all health services. In the dental sector, for instance, the Financial Stabilisation Act for Statutory Health Insurance in Germany, which was passed in 2022, is accompanied by benefit cuts in the dental sector (Seifert, 2022; Federal Ministry of Health, 2024).

Wu and Pu (2020) do not attribute this effect to the socioeconomic status but to political consequences and decisions. They uncovered general government health expenditures as a mediator of the effect of air pollution on social inequality, i.e. the higher the air pollution, the higher the governmental expenditures, which leads to other governmental public projects being

cut. In other words: if air pollution is addressed by political countermeasures, this harms income inequality due to the lack of governmental funds for the health sector or, for instance, to provide transfer payments for low-income groups (Wu & Pu, 2020). In principle, it can be assumed that these are lagging effects that tend to take place at the national or federal level. Therefore, for the analysis of the German case, the argument of Liu et al. (2020) seems more appropriate that the health mediator of the effect is not due to a lack of governmental expenditures, but due to the health burden.

Taking all this into consideration, it can be assumed that air pollution has a statistically positive indirect impact on income inequality with health being a central mediator of the effect. Thus, it is expected that air pollution has a positive influence on income inequality in the case of Duisburg which leads to an exacerbation of income inequality with increasing air pollution.

3.4 Interaction effects

Apart from the effects of air pollution on the individual dimensions of social inequality, it can also be assumed that there are interaction effects between the individual dimensions that have reinforcing tendencies. This has already become clear during the elaboration of the individual dimensions.

On the one hand, scholars assume direct impacts of residential inequality on health (Matte & Jacobs, 2006; Bazyl, 2014), for example through "exposure to lead, exposure to allergens that may cause or worsen asthma [...], pesticide residues, and indoor air pollution" (Matte & Jacobs, 2006, p. 7). Conversely, residential inequality should also be influenced by external factors, especially income. It is expected that the less income people have, the less likely they are to have access to good housing quality, as this is often associated with higher prices (cf. Xue et al., 2022).

Interaction effects between income and health inequality are also expected. Income inequality is said to have a direct amplifying effect on health inequality (Bazyl, 2014; Fairburn et al, 2019; Liu et al, 2020; Yang & Liu, 2018). In the words of Yang and Liu (2018): "A high level of income inequality in a region may accordingly contribute to increased health inequality" (Yang & Liu, 2018, p. 51). Fairburn et al. (2019) found that in the WHO European Region, there is a "higher proportion of chronic diseases among the residents with low economic position and [...] [better] coping possibilities of the residents with a high economic position" (Fairburn et al., 2019, p. 13). This clarifies that a single consideration of the individual dimensions is insufficient, which is why in this thesis and the interviews the overlaps and interplay of the different dimensions are specifically addressed.

3.5 Case Background

3.5.1 Case Selection

Duisburg in North Rhine-Westphalia was selected for the analysis due to the high level of social inequality and a considerable level of air pollution (Duisburg Employment Agency, 2022; World Air Quality Index Project, 2024b; LANUV, 2024a; LANUV, 2024b). The unequal distribution of income, the high unemployment (Duisburg Employment Agency, 2022) and poverty rate as well as the unequal distribution of opportunities within society are particularly pronounced in Duisburg as well as in some other major cities of the Ruhr region (Abeck, 2023).

A considerable level of air pollution was confirmed by data from both the World Air Quality Index and the North Rhine-Westphalian (NRW) Environment Agency LANUV (see Chapter 3.5.2) (World Air Quality Index Project, 2024a; LANUV, 2024a). A further criterion for case selection was that the chosen city had to be a German city big enough to find sufficient evidence but not a metropolis since it would be difficult to identify the effects of air pollution in all the different urban areas.

Duisburg is a deviant case (Seawright & Gerring, 2008) due to the relatively strong welfare system in Germany (Yin, 2023) and the lower level of social inequality in a worldwide comparison. Nevertheless, there is a considerable level of social inequality in the inner-German comparison, which indicates that Duisburg is a problematic case in which both social inequality and air pollution are present. This way, it is aimed to explore if even in cases in industrialised countries air pollution comes at the expense of the already disadvantaged groups of the population and exacerbates social inequality.

3.5.2 Case description ‘Duisburg’

Duisburg is an independent German city with a high population density considering its 502.211 inhabitants on a surface area of 232,84 square kilometres (Federal and State Statistical Offices, 2022). The city is divided into seven districts: Walsum, Hamborn, Meiderich/Beeck, Homberg/Ruhrort/Baerl, Rheinhausen, Centre and South. Figure 2 shows the boundaries of the city area and the individual districts of Duisburg (City of Duisburg, n.d. a; City of Duisburg, n.d. b).

Figure 2

Map of Duisburg (Source: Geoportal Duisburg, n.d.)

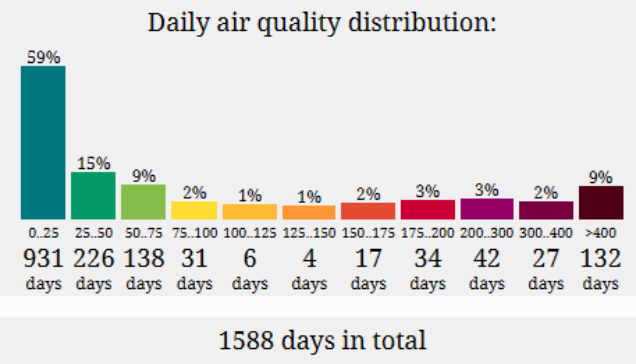
Duisburg is characterised by a high degree of industrialisation, particularly due to its several centuries of mining history, which explains the high population density and extensive road network (City of Duisburg, n.d. c; Geoportal Duisburg, n.d.). As a result, the city has developed into a very important transport hub in the region. Among other things, there are direct connections to the federal motorways A3, A57, A59, A40, and A42 as well as seven motorway junctions. Also, rail transport is well developed with over 800 daily train connections (City of Duisburg, n.d. d). Duisburg's inland port, which is the largest inland port in the world and an important hub for freight transport between Europe and China as part of China's new Silk Road, is also of great importance (Fuchs, 2021).

In principle, the LANUV is responsible for monitoring air quality in NRW and measures the ozone, sulphur dioxide, nitrogen dioxide, and PM_{10} values at seventeen different stations (LANUV, 2024d). Due to extensive air mitigation policies in the past two decades, such as the introduction of an environmental zone in Duisburg (LANUV, n.d. a), the annual average limit values for NO_2 and PM_{10} can now also be largely complied with, with a few exceptions for PM_{10}, sulphur dioxide and lead concentration, as shown in the annual report of 2022 (see also Table 3 appendix) (LANUV, n.d. b; LANUV, 2022; LANUV; 2023; LANUV 2024c). Nevertheless, very high levels of individual pollutants were also measured at times this year (see Figure 1 and 2 appendix): For example, a nitrogen dioxide value of 51 µg/m3 was measured in Duisburg-Bruckhausen on 18th April 2024, which is only a moderate level (LANUV, 2024c). The high sulphur dioxide value of 124 µg/m3 on that day is even more striking with its very

high value and falls into the third worst air quality category (LANUV, 2024b). According to the limit values specified in the 39th Federal Imission Control Act, such a high value may not be present more than three times in a calendar year and the annual average should be 20 µg/m³ (HMUKLV, n.d.). Given these values, it can be assumed that respiratory diseases arise, especially for sensitive groups of people such as children, the elderly, pregnant people with heart and lung conditions and that they should therefore limit outdoor exercises (IQ Air, 2018; World Air Quality Index project, 2024a).

Figure 3

Monitoring station 'Hummelpfad, Duisburg- Mitte', $PM_{2,5}$ values (Source: World Air Quality Index Project, 2024b)



A similar, if not even more worrying, picture emerges if you look at the values of the World Air Quality Index, which has 59 different measuring stations in Duisburg (World Air Quality Index Project, 2024a). On average, the measuring stations in Duisburg show a moderate or good air quality level; nevertheless, individual central stations such as station no. 56854 'Hummelpfad, Duisburg-Mitte' show quite alarming values where the PM_{10} values are exceeded on 60 days and the $PM_{2.5}$ values on 67 days per calendar year. Given the permitted limit values (HMUKLV, n.d) (see Table 1 appendix), this almost doubling of the number of exceedances is a matter of great concern (World Air Quality Index Project, 2024b).

In view of these numbers, it is undoubted that Duisburg has a considerable air pollution problem and enough room for optimising air quality. PM_{10} and NO_2 seem to be one of the main causes of concern but also the high $PM_{2,5}$ values.

4. Methodology

4.1 Research design & Analytical Approach

The objective of the analysis and planned interviews is to gain a more precise understanding of the causes and distribution of elevated air pollution levels. In order to find out how air pollution

affects the various dimensions of social inequality, a case study of the German city Duisburg is carried out. The focus on Germany is particularly interesting, as one would assume that a reasonably prosperous country would have few problems with air pollution and social injustice. Compared to many Asian (Hirota, 2010) or African countries (Ritchie & Roser, 2024), for instance, the level of air pollution seems to be better on average and yet Germany, together with Italy, France, Great Britain, and Poland, is one of the European countries with the highest death rates in connection with air pollution (Carvalho et al., 2019).

The chosen research question is X/Y centred which means that it aims at finding out how the independent variable (air pollution) influences the dependent variable (social inequality) in the German case. An explorative approach was employed to find an answer to whether the exacerbating effects of air pollution on social inequality also occur in small towns in industrialised countries. Due to the low level of social inequality in a worldwide comparison, it can be considered a high-residual case or outlier since the German case, Duisburg, is not typical but deviates from the cross-case relationship. Accordingly, the chosen case is a deviant one (Seawright & Gerring, 2008). Nevertheless, Duisburg has a high level of social inequality and air pollution compared to other German cities, which makes the case particularly interesting (see Chapter 3.5.1).

The determination of air pollution levels and pollutants in Duisburg was primarily based on official and daily updated values from the North Rhine-Westphalian State Agency for Nature, Environment and Consumer Protection. However, the values from IQ Air and the World Air Quality Index Project were also used for verification. The data from the World Air Quality Index Project was particularly helpful, as the many measuring stations provide data for all the individual districts (German Environment Agency, 2024b; IQ Air, 2024a, IQ Air, 2024b) and the values for the past three to four years are shown. Moreover, the index, based on the US Air Quality Index System (AQI) (IQ Air, 2018), is very helpful for assessing the overall air quality, taking into account the various pollutants. A combination of these different air quality data thus provides a very accurate picture of the actual air pollution in Duisburg with a distinction between the temporal and local dimensions and the presentation as an index, but also with the individual values in order to be able to identify the specific problematic pollutants.

In the appendix under Table 2, a table from the World Air Quality Index Project can be found which helps to interpret the air pollution levels and to recognise what behaviour is recommended at which level.

4.2 Methods of data collection

Data was triangulated by combining different data sources to increase the validity and robustness of the qualitative data. Two methods were employed to analyse the impact of air pollution on social inequality in terms of residential, health, and income inequality: document-based desk research and key informant in-depth interviews.

The document-based desk research was conducted to profile past and present air pollution policies for Germany and the city of Duisburg. Therefore, relevant policy documents were identified through a systematic online search of official government and city websites, scientific databases and relevant reports from environmental organisations. Criteria for document selection were timeliness, relevance to the research question, and authority of the source. Table 1 shows the policy documents employed with the reference.

Table 1

Employed policy documents in the document-based desk research

Type of document	Document description	Reference
Legislative documents	EU Directive on National Emission Ceilings (NEC Directive)	NEC Directive, 2016
	44th Ordinance on the Implementation of the Federal Emission Control Act	Federal Ministry for the Environment, n.d.
	39th Ordinance on Air Quality Standards and Emission Ceilings	Hessian State Agency for Nature Conservation, Environment and Geology (HLNUG), n.d.
	Federal Immission Control Act	Federal Immission Control Act, 1974
	Clean Air plan for Duisburg 'Ruhr Area West'- sub plan	City of Duisburg, n.d. g
	Clean Air Plan Ruhr Area 2011- Partial Plan West - City of Duisburg	District Government of Düsseldorf, 2022
Official reports	EU Commission on 'third outlook on the development of air quality'	EUR-LEX - 52022DC0673 - EN, 2022
	German Environment Agency on the national clean air programme	Schulte, 2020

	German Environment Agency on national air pollution control planning	Richter, 2017
	NRW State Office for the Environment on air pollutants	State Office for the Environment Rhineland-Palatinate (RP), 2024
	German Government on the clean air programme in Germany and the EU	The Federal Government, 2019
	LANUV on air quality plans in accordance with the EU Directive on ambient air quality and cleaner air for Europe	LANUV, n.d. a
	NRW Ministry of the Environment on environmental zones in NRW	NRW Ministry of the Environment, n.d.
	German Environment Agency on environmental zones in Germany	German Environment Agency, 2024b
	City of Duisburg on environmental zones	City of Duisburg, n.d. f
	City of Duisburg on Photovoltaic support in Duisburg	City of Duisburg, 2023
	LANUV on current air quality in NRW	LANUV, 2024c
Journal articles	'Decreasing trends of particle number and black carbon mass concentrations at 16 observational sites in Germany from 2009 to 2018.'	Sun et al., 2019
	'German climate change policy.'	Weidner & Mez, 2008
	'Ten years after Copenhagen: Reimagining climate change in urban areas'	Broto & Westman, 2020
Press releases & articles	Press realease of the NRW State Government on renewable energies in the year 2020	NRW State Government, 2020
	Press realese of the NRW Ministry of Economic Affairs on the 'progres.nrw-klimaschutztechnik' funding programme	NRW Ministry of Economic Affairs, 2024
	Press articles by WAZ on air pollution in Duisburg	Mohrs, 2011 & Wahl, 2023

This way, it is aimed to find out the priorities of air pollution policy and assess whether social justice is sufficiently considered. This analysis may make it possible to determine whether the air pollution control practices in Duisburg aim to reduce inequalities or even reinforce them because environmental policies often have a particularly negative impact on economically disadvantaged groups and thus may increase vulnerabilities (Shen et al., 2019; Berger, 2024).

By identifying any shortcomings in these policies, especially concerning social inequality, the research can provide a more nuanced understanding of how current strategies might fail to address or even exacerbate social inequalities. If the second part of the analysis of the in-depth interviews were to confirm that air pollution has an impact on social inequality, it might be possible to conclude from this background that air mitigation policies are not sufficient to address the specific needs of disadvantaged groups.

On the other hand, key informative in-depth interviews were conducted with experts in Duisburg. Interviews were held with five different experts to shed light on the different perspectives and dimensions of social inequality as well as the interaction effects between the dimensions. Thus, the following five people were interviewed: an environmental expert, an air pollution expert, a social expert, a construction professional and a social welfare professional. Table 2 visualises the key data on the interviews, the area of expertise of the interviewees and their relationship to the city of Duisburg. The five interviewees were assigned reference letters from A to E.

Table 2

Description of the interview partners

Reference letters	**Date and time of the interview**	**Area of expertise**	**Relationship to Duisburg**
Interviewee A	26th April, 2024, 1 pm	Air pollution expert: Expertise in the field of air quality management, air pollution causes and monitoring stations in Duisburg	Involved in Duisburg's air quality management through work
Interviewee B	2nd May, 2024, 1 pm	Construction professional: special insights into the urban planning and architectural situation in Duisburg as well as the pressing challenges	Works in Duisburg's private sector
Interviewee C	2nd May, 2024, 2 pm	Environmental expert: expertise in local environmental projects and problems in Duisburg, also involved in the intersections of sustainability and social issues,	Works in Duisburg's public sector

		direct influence on local policymakers	
Interviewee D	3rd May, 2024, 2:59 pm	Social expert: expertise in the social and residential situation and challenges in Duisburg, involved in interdisciplinary projects	Works in Duisburg's public sector
Interviewee E	16th May, 3:02 pm	Social welfare professional: Extensive socio-political knowledge of Duisburg through direct contact with and counselling for socio-economically weaker families in Duisburg	Works for a welfare organisation in Duisburg

The five interview partners were selected to ensure that as many different perspectives and types of expertise as possible are taken into account. On the one hand, stakeholders from the private, public, and welfare sectors were considered. On the other hand, with this broadly diversified expertise, the three different dimensions of social inequality as well as the overlaps between them can be well covered from diverse standpoints and all of the people interviewees also have direct or indirect contact with people of a lower socioeconomic status and thus may have specific insights into their concerns. The contact details of suitable interviewees were found through extensive internet research and they were contacted first by email, but then in some cases also by telephone, to enquire about their willingness to be interviewed.

Beforehand a standard question sheet was created to lead the interview, but the character of the questions was generally semi-structured. This combination of standardised with non-standardised open questions created some structure to the interview but still allowed concrete enquiries when necessary to ensure in-depth answers. The interviews were conducted via Microsoft Teams (Version 24137.2216.2931.2440) and recorded with the consent of the interviewees only for the purpose of transcription for the later evaluation of the data in this thesis.

4.3 Method of data analysis

After having identified key policy documents, the German and Duisburg documents were separately analysed to extract key information on air-related policies and measures. They were

subsequently critically analysed in terms of consideration of social inequalities that may be the result of those policies and whether countermeasures have been implemented with the air pollution policies to mitigate the negative effects on lower-income households.

The first step in the data analysis of the interviews was the transcription of all interviews. The qualitative and structuring content analysis according to Mayring was employed as an evaluation method, whereby a corresponding coding guide was created. With the help of this method, the relevant categories were worked out and related to each other to show connections (Mayring, 2022). The program ATLAS.ti (Version 24) was used for data processing.

A review of existing scientific literature has revealed that no existing coding scheme is currently suitable for this particular area of research. For this reason, a preliminary codebook was created before the start of the interviews based on the literature review in Chapter 3 and the sub-research questions. The codebook provided orientation for the data analysis, but was further adapted when new and unexpected findings emerged from the interviews. The preliminary codebook can be found in the appendix under Table 4.

In fact, during the coding of the interviews, new relevant topics were identified that were not included in the preliminary codebook and were therefore added as codes. During the coding process, the transcripts of the interviews were read thoroughly several times in succession and relevant text passages were identified. These passages were then labelled with the corresponding codes from the codebook or assigned new codes.

Therefore, the following codes were added during the analysis: air pollution (unproblematic locations), air pollution (legislation), air pollution (causes) and interaction effects (general). In addition, one completely new code category has been added: ‘Mitigation’ which specifies the current situation in Duisburg in terms of local policies and barriers in this area. The 'Social Report' is also mentioned in detail in the 'Mitigation' category as a current example of the city's actions and ambitions to reduce social inequality in Duisburg. With these changes, the codebook consists of a total of 23 codes divided into five categories. The final codebook including quantities, i.e. the number of codes identified, are visualised in Table 3.

Table 3

Developed codebook for the analysis

Air pollution: these are the codes describe the air pollution in Duisburg (total: 70 codes)

Code	When to use	Quantity
Air pollution (past situation)	Past situation of air pollution in Duisburg	5
Air pollution (current situation)	Current situation of air pollution in Duisburg	30
Air pollution (pollutants)	Relevant air pollutants in Duisburg	5
Air pollution (problematic locations)	Problematic locations and districts in Duisburg which suffer from high air pollution	11
Air pollution (unproblematic locations)	Unproblematic locations and districts in Duisburg which do not particularly suffer from high air pollution	6
Air pollution (causes)	Causes for air pollution in Duisburg	13

Impact: these are the codes which describe how air pollution impacts social inequality in Duisburg (total: 68 codes)

Code	When to use	Quantity
Impact (on residential inequality)	Air pollution impacts residential inequality	37
Impact (on health inequality)	Air pollution impacts health inequality	12
Impact (on income inequality)	Air pollution impacts income inequality	8
Impact (no impact on social inequality)	Air pollution does not impact social inequality	0
Impact (other intervening factors)	Other intervening factors that influence the effect of air pollution on social inequality	11

Interaction effects: these are the codes which describe how the different dimensions of social inequality interact (total: 43 codes)

Code	When to use	Quantity
Interaction effects (general)	Interconnection of the different dimensions in a general way	3
Interaction effect (residential & health inequality)	Residential & health inequality are interconnected, concerning air pollution	7
Interaction effect (residential & income inequality)	Residential & income inequality are interconnected, concerning air pollution	22
Interaction effect (health & income inequality)	Health & income inequality are interconnected, concerning air pollution	11
Interaction effect (no interaction effects)	There are no interaction effects between the dimensions of social inequality	0

Mitigation: these are the codes which describe ongoing projects, efforts and obstacles in Duisburg to mitigate air pollution (total: 94 codes)

Code	When to use	Quantity
Mitigation (local policies)	Policies implemented in Duisburg concerning mitigating air pollution	18
Mitigation (other legislation)	EU, national and federal legislation in respect to mitigating air pollution	2
Mitigation (social report)	Example of the social report project in Duisburg's municipality	29
Mitigation (obstacles)	Obstacles to mitigating air pollution and/ or social inequality	45

Policy recommendations: these are the codes which describe what recommendations the interviewees have given to improve the air quality and the negative effects of air quality on social inequality (total: 30 codes)

Code	When to use	Quantity
Policy recommendations (air pollution)	Recommendations & ideas on how to mitigate air pollution	21
Policy recommendations (social inequality)	Recommendations & ideas on how to reduce the effects of social inequality	9

Using the codes made it possible to systematically structure the data and extract the relevant statements on the research question. To ensure the consistency of the coding, the interviews were not only coded once in chronological order but also repeatedly checked in between to ensure that the coding was consistent across the five interviews. One example of the application of the codes is the code 'Local policies' in the category 'Mitigation'. This was used to mark interview passages that refer to current local policies in Duisburg in the area of air pollution mitigation in order to provide information about the ambitions and current projects of local policymakers in Duisburg. In the final part of the discussion, the data obtained was critically reflected in terms of the quality criterion of intersubjectivity (Strübing et al., 2018).

For better preparation, the author visited the city of Duisburg once in advance to get an own impression of the situation and identify the districts that suffer the most and least from air pollution. Additionally, this visit helped with establishing initial contacts with possible experts for the interviews.

5. Air pollution mitigation policies

This first chapter of the analysis provides important background information and can shed light on how the respective levels (national, city) deal with the problem of air pollution, what the best practices are and whether they consider social inequality.

5.1 Germany

Germany's air pollution is primarily based on EU regulations and directives, which contain legally binding standards for air quality and emission limits and must be implemented in national law by all EU member states (Miranda et al., 2015). The most important regulations in this area are the Directive 2008/50/EC on Ambient Air Quality and Cleaner Air for Europe and the EU Directive on National Emission Ceilings (NEC Directive) (EUR-LEX - 52022DC0673

- EN, 2022; NEC Directive, 2016; EUR-LEX - 2008/50/EC, 2008). The new NEC Directive (EU) 2016/2284 with even more ambitious particulate matter targets by 2030 (NEC Directive, 2016) has been transposed into German law via the Ordinance on National Obligations to Reduce Certain Air Pollutants (43rd BlmSchV) with specific national emission reduction obligations for most pollutants (Schulte, 2020).

Since June 2019, the 44th Ordinance on the Implementation of the Federal Emission Control Act has introduced higher emission limits for sulphur dioxide, nitrogen oxides, and total dust for large combustion plants (Federal Ministry for the Environment, n.d.). Additionally, industrial plants require a construction and operating licence (Sun et al., 2019). In the area of traffic emissions, the German Clean Air Plan has set up a "low emission zone (LEZ) in Germany to limit the emission of nitrogen oxide and aerosol particles from the traffic exhaust." (Sun et al., 2019, p. 2). The stricter emission limits and the environmental zone can have a positive impact on residential inequality by reducing the concentration of pollutants in problem areas, however, there is also a risk that housing costs in the regions and production costs will rise due to the environmental upgrading and the necessary industrial innovations.

The first systematic regulation for emissions was introduced in 1974 with the first Federal Immission Control Act (Federal Immission Control Act, 1974; HLNUG, n.d.), focussing on large industrial plants and power stations. In the next decade, the focus was on replacing emission sources in the new federal states with new plants with emission reduction facilities (Richter, 2017). While these industrial regulations are undoubtedly progressive in their aim to improve air quality, they can also be criticised for the fact that the introduction of new technologies to reduce emissions often results in higher costs, which are usually passed on to customers and place a disproportionate burden on low-income households if they are also dependent on the products, such as energy for instance.

Subsequent regulations have mandated technologies like catalytic converters in the early 2000s, significantly reducing particulate matter pollution from diesel vehicles. Similarly, there is a continuous tightening of the Euro standards for cars and lorries at the national level in Germany, particularly in the area of nitrogen oxides (State Office for the Environment RP, 2024). On the other hand, it is to be expected that these two measures will again be accompanied by negative social consequences for people with lower incomes if no targeted support measures for vulnerable groups are introduced during local implementation in the cities. Otherwise, vehicle owners from lower socioeconomic households would suffer greatly and unjustifiably from the negative effects.

Even though there has been a particularly high level of ambition in the area of air pollution since the 1980s, pollution issues appear to have been pushed more into the background in recent years due to the centrality of climate protection measures. Even if climate change has interfaces with pollution, this nevertheless leads to fewer specific ambitions in the area of reducing air pollution (Broto & Westman, 2020).

Despite significant progress in German air pollution mitigation policies, most of the measures are likely to harm social inequality. All this emphasises once more the need for local policymakers to consider social inequality in the implementation of those environmental policies to ensure that all population groups, especially the most vulnerable, benefit from the regulations.

5.2 Duisburg

Air pollution is generally recognised as a problem in Duisburg and the measures prescribed at the federal and state level (e.g. obligation designation of environmental zones and implementation of clean air and action plans) are taken if the limit values are exceeded.

There is not only a designated environmental zone in Duisburg but also clean air and action plans have been adopted (LANUV, n.d. a). The environmental zone has been in place in Duisburg, as in other cities in the Ruhr region, since October 2008 (NRW Ministry of the Environment, n.d.). Three years later, a large contiguous low-emission zone was even implemented in the Ruhr area, which intended to further reduce the high levels of particulate matter (see Figure 3 appendix) and increase the mitigating efforts by harmonising the emission zones of the different cities in the Ruhr area (City of Duisburg, n.d. e). The NRW Ministry for the Environment confirmed that particulate matter pollution has fallen continuously in recent years (NRW Ministry of the Environment, n.d.).

Since 2014, only vehicles with a green environmental badge have been allowed to enter the city (LANUV, n.d. a; City of Duisburg, n.d. f), which is only issued to vehicles with liquid gas, ethanol, or natural gas engines with regulated catalytic converters and petrol engines (TÜV North, n.d.). This measure successfully regulated traffic as one of the main polluters and tried to keep particularly polluting vehicles out of the city. It indeed reduced the negative environmental impact of traffic in the zones but to the disadvantage of the vulnerable, car-dependent groups who suffer from further social exclusion since they may not be able to afford new vehicles (NRW Ministry of the Environment, n.d.; Vrij & Vanoutrive, 2022). It is particularly problematic that the policymakers of these measures have not decided on any

special subsidies for the financial relief of these people and the benefits of the air pollution control measures are therefore unfairly distributed.

Other measures have related to the expansion of local public transport and the upgrading of public vehicle fleets, but urban planning measures have also been implemented. The first consequences of these ambitions are already visible, even if there is still a great need for improvement in the area of nitrogen dioxides (City of Duisburg, n.d. e). In the transport sector, there are also speed limits or bans on the passage of certain lorries, such as on Wiesenstraße in Marxloh. Moreover, the expansion of local public transport, traffic management, and the expansion of the local cycle path network in Duisburg also play a crucial role in reducing air pollution. In 2022, 45 kilometres of existing cycle paths were renovated and 4 kilometres of new cycle paths were constructed (District Government of Düsseldorf, 2022).

In addition to traffic-related measures, the Clean Air Plan also provides for industrial measures, as the causes of particulate matter and nitrogen dioxide pollution are primarily the result of industrial activities (City of Duisburg, n.d. g). Measures have been taken to contain air pollution, which have led to procedural changes in industrial operations, but have also reduced dust turbulence and dust drift. Training measures for employees of the large steelworks ThyssenKrupp Steel AG were also prescribed by the state of NRW, represented by the District Government of Düsseldorf so that further risks are minimised as far as possible in day-to-day work. Other industries were also addressed by targeted measures in the Ruhr Area West Clean Air Plan, such as DK Recycling by enclosing dusty goods or Sachtleben Chemie GmbH by constantly spraying the loading area with water to reduce dust during loading processes (District Government of Düsseldorf, 2022). These innovations are very welcome from an environmental perspective, even if it can be assumed that the technological advances and procedural changes in the companies are accompanied by increased costs that will presumably be passed on to consumers and thus further favour social inequality, as already described in the previous subchapter. Here, too, state subsidies must be considered where there is a risk of further disadvantaging already economically weaker households in particular.

The focus of air pollution mitigation policies in Duisburg appears to be in three areas: industry, urban transport, and road traffic, all of which disproportionately affect the urban poor. In the latter two areas, the focus is particularly on traffic control and regulation, as the high levels of particulate matter and nitrogen oxide are measured especially where the main traffic centres are located (LANUV, 2024c) (see Figure 4 appendix). However, there is also great potential for action and improvement in the industrial sector, which has also been recognised by political

decision-makers in Duisburg. The overarching objective is therefore to modernise industrial plants (Mohrs, 2011) and to prioritise the reduction of dust, given that loading generates excessive dust emissions. These, as well as dust emissions from construction sites, must therefore even be further reduced, which is also provided for in the Clean Air Plan through concrete measures (District Government of Düsseldorf, 2022). As measures in these three areas can have a strong impact on low-income households, it is particularly important to try to counteract the increased costs and reduced mobility for these populations, so that the gap and inequality of opportunity between high and low-income households in Duisburg does not increase further. According to published documents from the City of Duisburg, this problem and the corresponding countermeasures do not appear to have been addressed to date.

It is evident that the current air mitigation policies in Duisburg lack consideration of two crucial areas: public transport and the expansion of renewable energies and heating technology. It is estimated that approximately one-quarter of the population of Duisburg is dissatisfied with the public transport service and would like to see it expanded. The inadequate service appears to be particularly problematic for the population in the Homberg-Ruhrort-Baerl district (Wahl, 2023). During the visit to Duisburg, it was discovered that even the principal tram lines do not operate at regular intervals outside of peak hours, resulting in significant overcrowding. The indignation of the population indicates that they also desire enhanced and diversified local public transport options, particularly given the already considerable levels of car traffic and congestion caused by individual vehicles. 62% of the respondents indicated that the expansion of the bicycle network should be a priority to provide additional transportation options (Wahl, 2023).

The second area with considerable potential for reducing air pollution in Duisburg is the energy sector. The city of Duisburg has identified the high population density as a significant factor in the potential for generating electricity through photovoltaic systems on the roofs of houses. Despite this and the fact that NRW is a frontrunner in the expansion of wind energy (NRW Ministry of Economic Affairs, 2024; NRW State Government, 2024; Weidner & Mez, 2008), the current utilisation of PV in the city is still minimal (as of July 2023) (City of Duisburg, 2023; District Government of Düsseldorf, 2022). Furthermore, the prevailing heating technology remains largely dependent on high-emission stove heating systems which increases the risk of health problems and energy poverty due to the high financial costs which low-income households can barely afford. This also shows that the current heating situation in Duisburg exacerbates social inequality even further. An alternative solution would be to utilise Thyssen-

Krupp waste heat, which is a by-product of production and therefore does not generate any additional pollutants (Mohrs, 2011). The expansion of district heating is at least mentioned in the Clean Air Plan, even if no specific targets are set (District Government of Düsseldorf, 2022).

Wahl (2023) has identified another significant challenge: the considerable regional disparities observed in Duisburg, which have resulted in markedly disparate levels of social inequality. The extent to which this applies to the city of Duisburg and the effects of air pollution on the various dimensions of social inequality are examined in the following chapter.

6. Interviews

6.1 What are the past and current air pollution problems in Duisburg?

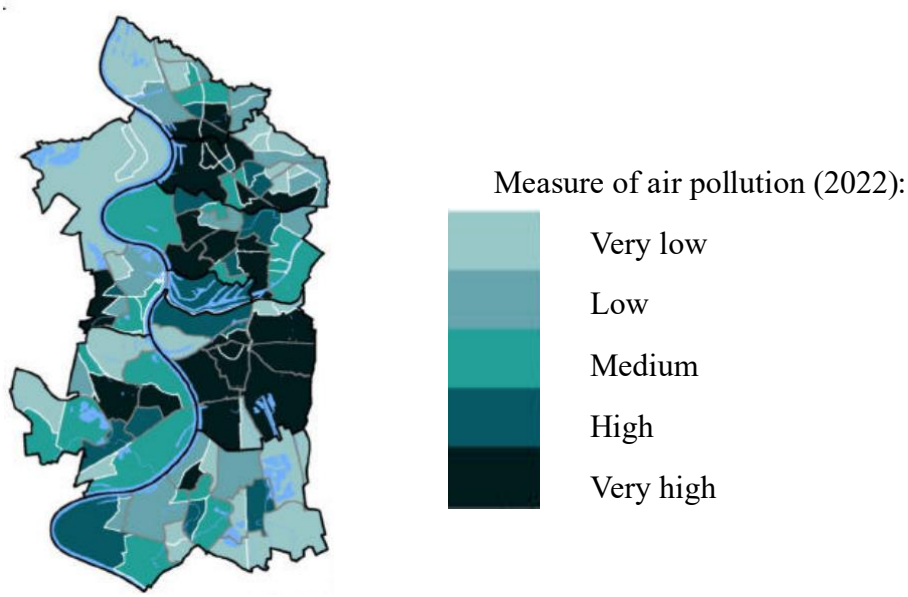
In this second chapter of the analysis, the results of the expert interviews are analysed and structured by the four sub-research questions. Despite relative improvements, air pollution in Duisburg remains a significant problem due to high industrial activities, an extensive road network, and high population density. Yet air pollution is less prioritized due to other dominating issues, even though its negative effects are unevenly distributed across the city.

Given the relative air quality improvement in Duisburg for the past few decades, “the overall importance of the discussion on air pollution control has naturally decreased”, as stated by interviewee C. It appears as if other problems are dominating now such as housing shortage, criminality, or the gap between rich and poor. Also, for environmental problems, the policy focus has switched more to climate change measures which still have positive effects on air pollution but lead to a decline in specific ambitions in addressing pollutants in Duisburg and establishing sufficient monitoring stations.

Figure 4 illustrates the spatial distribution of air pollution in Duisburg in 2022. Overall, there is a very high level of air pollution in many of the 108 areas. It is clear to see that the hotspots of air pollution are in the north, but also in the centre of the city, while the west and far south of the city are hardly polluted. In view of this data, it can be interpreted that the air quality in Duisburg is very unevenly distributed and the city has particularly serious problem areas.

Figure 4

Distribution of air pollution in Duisburg (Source: GEWOS, 2024, p. 119)



Even today, Duisburg stands out in comparison to other cities in the Ruhr region due to its comparatively high proportion of heavy industry. However, in the past, industrial sources in Duisburg have played an even bigger role and led to extremely high levels of air pollution which the people could feel and see everywhere. Even if the current situation is different since major parts of the industry have left Duisburg and thus "the industrial sources in Duisburg now only play a subordinate role among the absolute pollution hotspots.", as Interviewee A explained, few places in the city are still dominated by industrial sources. These are particularly due to the steel and iron industry, which is located mainly in the north of Duisburg. The resulting metallic substances, as well as particulate matter in the surrounding area, cause major pollution in these regions. On the one hand, the people who live near these industrial plants suffer from this greatly, but on the other hand, this also has an impact on the people who, for example, cultivate their allotment garden colony in the neighbourhood and are not allowed to harvest their vegetables due to the pollutants.

Nevertheless, the PM_{10} guideline values have been complied with since 2012, as Interviewee C confirmed that

> "in the past, up until 2012, we also had limit value exceedances for PM_{10} and these were the ones that were close to industry, in the industrial limit range. Since then, they no longer do, which means that because we comply with the limit values in the PM_{10} range, they were no longer the focus of attention".

As the previous analysis of the air pollution problem in Chapter 5.2 has already shown, industry is not the only cause of air pollution in Duisburg. Traffic also contributes to high levels of NO_2 pollution, particulate matter pollution, and noise pollution. Due to the high population density in Duisburg, the motorway and rail network is also heavily developed and trafficked. As a result, air pollution is particularly high in the vicinity of the A3, A59, A40, and A42 motorways and main roads. This is exacerbated by the logistics sector, which also causes increased traffic within the city (Fuchs, 2021).

However, a third reason for high air pollution in Duisburg is the individual activities of people, such as wood and coal firing, which is still widespread in the Ruhr region and leads to exceedances of emission limit values during periods of poor weather and low air exchange. The districts of Meiderich, Bruckhausen, and Marxloh in particular are considered hotspots, while Duisburg-Rumeln-Kaldenhausen, Huckingen, the green belt, the rural areas of Duisburg and the other side of the Rhine, including Rheinhausen, suffer much less from air pollution; as Interviewee E suggested "the Rhine also separates people very clearly". The high air pollution levels in the central areas can be explained by the fact that the dense population and tall buildings do not allow for ventilation but instead create a "canal inside [...] [where] these air pollutants [...] released from the traffic [are kept] [...] and cannot be blown away by the wind", as Interviewee A explained.

6.2 To what extent does air pollution impact income, residential and health inequality in Duisburg?

The analysis of the in-depth expert interviews has confirmed that air pollution in Duisburg exacerbates income, residential, and health inequality, leading to severe health problems and reinforcing socio-economic disparities.

Insights from the interviews indicate that air pollution in Duisburg affects social inequality among others in the form of health factors. Due to the unequal distribution of air pollution, the high levels of particulate matter and NO_2 emissions in Duisburg cause health problems. These include respiratory problems, as the lungs are affected by the pollutants and circulatory problems, but also stress-related reactions in the body, which can promote cardiovascular disease and mental health problems. Stress is particularly high in people who live by a major road and are constantly exposed to air and noise pollution. As Interviewee D stated: "[i]n this respect, where there are different problem areas such as noise and air pollution, health is [...] also endangered".

Since air pollution in Duisburg is very unevenly distributed, as the previous subchapter on air pollution has shown, the resulting health problems are also unevenly distributed. People living in regions with high levels of air pollution and low incomes are particularly affected by health inequality. The main problem here is that the implemented limit values in the EU are still below the current WHO health assessments and threshold values despite being tightened in recent years, which ultimately favours the development of diseases.

Analysing the interviews also revealed a negative influence of air pollution on income. Increasing air pollution requires more compensatory measures, such as installing air purifiers or relocating to less polluted areas, to prevent negative effects. These are largely influenced by financial resources. Those who have less income are usually more affected by the negative consequences of air pollution. Interviewee A expressed this in the following way: “people who are socially disadvantaged are forced to take these flats because they can't live elsewhere for financial reasons”. This also implies a connection between income inequality and the other two dimensions of social inequality, which are explicitly worked out in the next chapter.

In the same way, air pollution in Duisburg has been shown to have at least a partially reinforcing influence on residential inequality. As air pollution is a location factor, housing becomes cheaper in the hotspots and more expensive in the less polluted regions. The direct result is that “[t]he people who are disadvantaged live where air pollution is at its highest” due to the lower prices, as confirmed by Interviewee E. Adding to that, access to green spaces is unevenly distributed. The north and areas close to the centre of Duisburg are not only most affected by air pollution but also by the green space deficit. According to a study by the city of Duisburg, this is where most of the people live who receive social benefits or have a history of immigration (GEWOS, 2024) (see Figure 5 appendix). The land values in Duisburg's green belt are significantly higher in contrast to the north or centre, for instance, the nearby main roads in Bruckhausen where land values are much lower. Conversely, a reduction or prevention of residential inequality can lead to the disappearance of other social inequalities associated with it.

Nevertheless, the negative impact on residential inequality is at least partially mitigated by the housing shortage in Duisburg. Due to the high demand on the property market, factors such as the housing environment, access to green spaces, and air pollution in the area are becoming less important. As Interviewee B supposed, the flat itself seems to gain importance instead: “What I've noticed is that people no longer attach so much importance to where it is. The main thing is the flat.” In particular, elderly individuals, who are among the most vulnerable groups, would

also prefer to reside in proximity to major thoroughfares. This is because such areas tend to be more active and dynamic, which may influence their decision to reside in more polluted residential areas.

Another intervening factor is the visibility of the pollution. Since people perceive the living environment, it plays a bigger role in their decisions about housing. As stated by Interviewee C,

> "They don't see the PM_{10} pollution, they don't see the $[PM]_{2,5}$, they don't see the NO_2 pollution either. In other words, the concern and the effect on the individual works through experience and experience is the dust precipitation."

It is interesting to note that neither the land values as an important benchmark for housing prices are linked to air pollution but only to soil pollution, nor the environmental factors have played a role in housing market monitoring in Duisburg in the past. This implies that in Duisburg, air pollution has not historically influenced land values or housing market monitoring, despite its significant impact on living conditions. Nonetheless, the latter has been included in the housing report by Duisburg's municipal authorities for a few years now and is set to be included to an even greater extent in the future.

Interviewees A and B also indicated the importance of the relative comparison, i.e. for someone who previously lived in a region with higher air pollution, a slightly better situation is perceived as good, even if it is still accompanied by a high level of air pollution. In the same way, citizens compare themselves with each other and experience situations as unjust when differences are perceived to their disadvantage. For instance, the situation of people living in a heavily polluted residential area near industrial plants and/or main roads can be perceived as all the more serious if they know that no one is standing up for their concerns and improving the situation. In contrast to that people in Lüdenscheid have a strong lobby despite relatively minor problems and therefore have a better chance of improving the situation.

Finally, the level of education exerts an influence on residential inequality through the decision in which regions people look for housing. The higher the level of education, the greater the likelihood that environmental problems will interest people and influence their own decisions, as they are aware of the extent of the problems and their effects (cf. Meyer, 2015). Inadequate language skills, which correlate strongly with a migrant background, can also have a compounding effect on residential inequality. "[W]here there is a lot of poverty, the proportion

of migrants is also above average and [...] this also affects the areas of migrants more than average", as Interviewee D stated.

6.3 What are the interaction effects between the different dimensions of social inequality in Duisburg concerning air pollution?

The analysis of the interviews has revealed that the impact of air pollution on social inequality in Duisburg is not limited to a single dimension; rather, the interplay of factors (reciprocal and interaction effects) reinforces the overall negative effect on social inequality.

Interviewee E realised through their work that people who make use of educational counselling, for instance, often suffer from other problems too, such as debt problems or addiction. Disadvantages as a result of air pollution therefore tend not to occur in isolation, but in combination with other problems, which makes the initial situation more difficult. Interviewee D explained: "It's a cycle, so it's not the air pollution itself that affects people, but people are certainly affected by the other factors". Not all of these problems can be attributed exclusively to air pollution as a cause, also because there is no monocausality in reality. However, the uneven distribution of air pollution in Duisburg, which particularly affects groups that are already socio-economically disadvantaged, appears to be further exacerbated by the existing disadvantages.

Interviewee E gave a specific example of a person who lost their job through no fault of their own. However, the unemployment benefit was not enough to finance the original flat, which is why the person needed to move to a more polluted region of Duisburg to save costs. This favoured the start of a downward spiral from which it became almost impossible to escape without external support.

The analysis has shown that health inequality and income are linked. In Duisburg, income largely determines how well people can protect themselves from the health effects of air pollution. As Interviewee A confirmed: The "health factor, which is also another motivation to move away, is also there. But you have to be able to afford it and that's where the social component comes into play again." Financial resources also determine the ability to compensate for the stress caused by noise pollution, which usually goes hand in hand with air pollution, and whether food supplements and healthy food can be bought to lead a healthier life. Moreover, people with higher incomes can take more precautions, such as by participating in sports programs, and thus protect themselves from illnesses. People with lower incomes, on the other hand, usually have a higher susceptibility to health risks related to air pollution. As Interviewee

E stated: „So a family or even people who have a certain income can of course, conversely, act very differently if they have health restrictions than those who don't have them".

Residential inequality is also influenced by the income factor. Where there is a lot of air pollution and little green space in the neighbourhood, the prices per square metre in Duisburg are very favourable (see Figure 6 appendix). Even if people are aware of the problems of their living environment, a low income prevents them from moving to a better neighbourhood. Conversely, people who can afford to live somewhere else will not move there in the highly polluted areas or will move after a short time. Interviewee C indicated that "[t]here was […] a movement like that at one time, i.e. the desire [of young families] to live in a rural area or quasi-better neighbourhoods".

This double burden of high levels of air pollution and a lack of green spaces occurs partly in the poorer north, but also primarily in the centre of Duisburg. A housing policy analysis of the city of Duisburg, which was provided by one of the experts, shows that the highest values for this multiple burden were also determined in the regions where the lowest-income households live, Hamborn and Meiderich-Beeck (GEWOS, 2024). Many of these households have an immigrant background or receive minimum security benefits. This once again confirms the previously stated thesis that the most disadvantaged groups in Duisburg also feel the most harmful impacts of air pollution. Accordingly, in Duisburg, as a city in an industrialised country, there is also a higher differential susceptibility of people with a lower socioeconomic status due to the lack of resources thus leading to the so-called double burden (Shen et al., 2019; Fairburn et al., 2019; Deguen & Zmirou-Navier, 2010; Cushing et al., 2015).

Health and residential inequality are linked as well. As previously confirmed, residential inequality in Duisburg is characterised by unequal access to green spaces, but also by significantly higher air pollution levels in Hamborn and Meiderich-Beeck, where people with lower incomes live. Due to the higher concentration of air pollutants, residential inequality has an increasing influence on health inequality. Interviewee C reported on the results of a study conducted by the city's public health department with children from these neighbourhoods. They

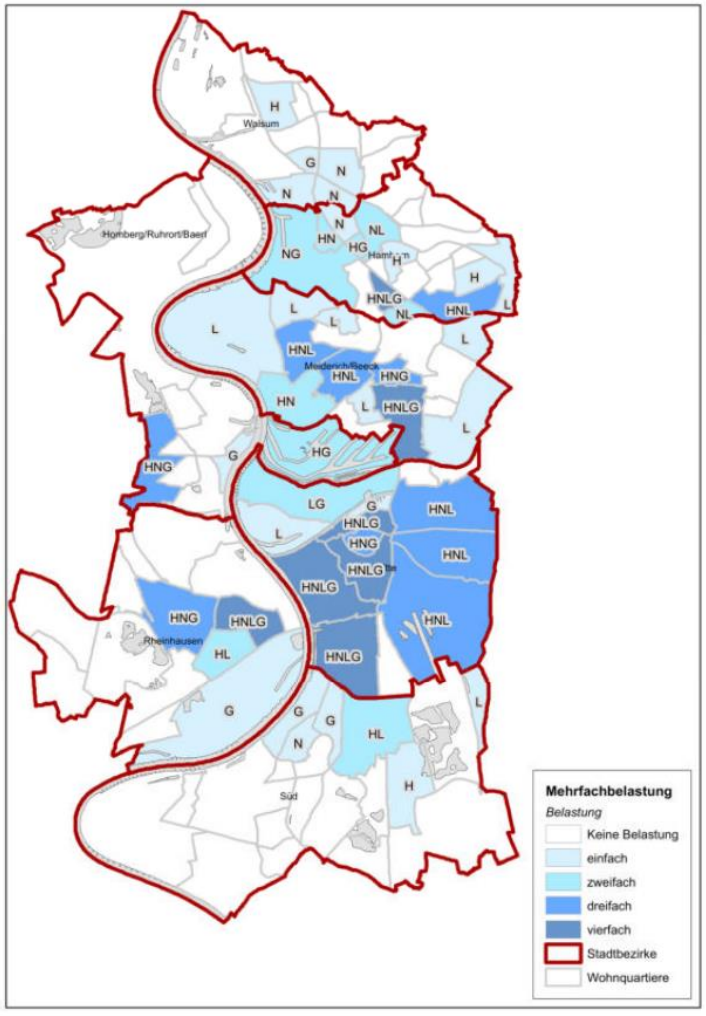
> "found that, on the one hand, the children had coordination disorders, i.e. they were above the average for Duisburg, and obesity was also significantly higher. [...] And the analysis is, of course, that the lack of green spaces, i.e. too few green areas, too little recreation close to home, promotes a lack of physical activity."

Interviewee D indicated that children under three are the most vulnerable group in terms of being affected by heat or the lack of green space. This emphasises that a highly air-polluted residential area with few green spaces creates health disadvantages for the people who live there.

Duisburg-Mitte and Wahnheimerort are particularly affected by the green space deficit, but also the north of the city and the south-west on the other side of the Rhine, as shown in Figure 5 under G. N stands for air pollution, H for heat pollution, and L for noise pollution; the last two are only of secondary importance in this analysis.

Figure 5

Distribution of multiple burdens in Duisburg (Source: Environmental agency of Duisburg, 2023)



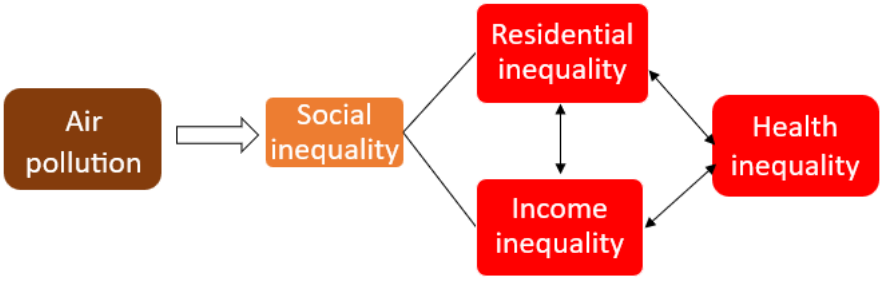
To summarise the findings of this chapter, it has been shown that there is a direct link between health and residential inequality in Duisburg, as income is a decisive factor in determining

people's capacities and circumstances, and financial resources are needed to protect themselves from the effects. As lower-income households are more likely to live near air pollution hotspots due to favourable rents, they suffer more from the health consequences, which in turn can only be better prevented with more financial resources. In this sense, residential inequality also influences health inequality. It is hardly possible for socio-economically disadvantaged people in Duisburg to move away from the region due to insufficient financial resources. They often have additional disadvantages and barriers due to a lack of language skills and insufficient access to information due to the higher frequency of having a migration background. The consequences of residential inequality are particularly evident in children at a very young age, as a lack of exercise significantly increases the risk of health problems such as obesity and respiratory problems. Additionally, many elderly people also suffer from the consequences, regardless of their income, as they often live on Duisburg's busy streets by choice. In this manner, residential inequality also exerts an influence on health inequality.

This has confirmed that social and ecological burdens are interrelated, at least for the part of air pollution in Duisburg, and cause multiple burdens (GEWOS, 2024). By analysing the interaction effects, it was, therefore, possible to confirm that traces of environmental injustice are present in the area and that people who are already disadvantaged suffer even more from the consequences of air pollution. Nevertheless, the effects on the three dimensions of social inequality are not at the same level, but health inequality is mainly a consequence of income and residential inequality, which were influenced by air pollution. Figure 6 shows a modified version of Figure 1 to show the interaction effects in line with the results of the analysis:

Figure 6

Illustration of the effects of air pollution on the various dimensions of social inequality and interaction effects



6.4 What are the ongoing projects, obstacles, and further policy recommendations in Duisburg to mitigate air pollution and the negative effects on social inequality?

6.4.1 Ongoing projects

Air pollution is not a novel phenomenon in Duisburg, and while several measures have been taken in the past two decades to address it, the focus was primarily on air pollution alone; however, a notable integrated project by city departments and local policymakers is now underway that addresses both air pollution and social inequality mutually.

According to the EU Directive 2008/50/EC (EUR-LEX - 2008/50/EC, 2008), there is an obligation "to measure where the worst pollution is suspected", as Interviewee A explained. Despite the introduction of the environmental zones, there have also been measures to reduce air pollution, such as changing the timing of traffic lights, regulating loading zones to reduce dust generation, and increasing public transport and cycle paths, although the latter is still criticised as being insufficient.

Another important practice is the inclusion of environmental factors in housing since 2017 and the inclusion of health as a factor in the action plan. Overall, however, the interviewees agreed that the best practice example for Duisburg is the introduction of the environmental zone in its current form since 2013, which has been by far the most successful of all measures.

Another very specific issue is currently being debated in Duisburg: the extension of the A59 motorway and whether it should be above or below ground. Interviewee E criticised the federal government for preferring the cheaper above-ground option without considering the other negative social and environmental consequences of such a decision:

> "The city wants the motorway to go underground in order to improve the quality for the citizens. But the state and also the federal government say: 'No, no, we'd rather have the cheap option'. But that also means that they are saying, 'We are not prepared to spend more money to accept the quality of life and the improvement in air quality that a tunnel system would bring'."

Accordingly, it is criticised that the government is often not thinking long-term and holistically enough.

Nevertheless, the interviews revealed that Duisburg pursues a very special project in the area of air pollution and social inequality which overcomes this critique by taking on an integrated approach and also considering the social consequences of air pollution mitigation policies. The various departments of the city have recognised the connection between these two factors in

Duisburg and wanted to document this by producing a comprehensive social report for the city, focusing on the social and climate-friendly development of Duisburg's housing landscape on the one hand, and making concrete policy recommendations on how to tackle the problems on the other. It remains unclear whether this project was inspired by the New European Bauhaus initiative. However, it does appear to follow a similar approach, which aims to restructure existing buildings to simultaneously strengthen the ecological and social dimensions and thus counteract environmental injustice (Dross, 2024; Schubert et al., 2023).

Many different stakeholders are involved in this process. The steering group consists of the Department of Social Affairs and Housing, the Environment Department, the Climate Protection Unit, and the Department of Urban Development and Project Management. However, representatives of the different city departments, the housing industry, social organisations, social initiatives, and tenant representatives were also involved in the development of feasible proposals for measures (City of Duisburg, 2024).

Due to the large scope of this project, it is not possible to go into detail on the exact content and actions. Nevertheless, a great deal of success was achieved through many meetings and workshops to exchange information between the different stakeholders and through many analyses of the relationship between environmental indicators (heat stress, lack of green spaces, air and noise pollution) and housing (social indicators, minimum income recipients, migration background). As Interviewees C and D explained, it was not always easy to reach a consensus, as all stakeholders approach the issue from very different perspectives and therefore have distinct interests. In retrospect, however, this can be seen more as a strength than a weakness given the great results of this collaboration project. Overall, it confirmed that environmental and social pressures in Duisburg overlap and cause multiple burdens.

The participants themselves are said to have realised how important it is to have come together in Duisburg for the first time in this way, to set up such a joint project. The report is expected to be published in summer or autumn of this year, and so far there has been positive feedback from all sides. This means that there is also the prospect of political decisions in support of these measures. It remains to be seen what the concrete consequences of these efforts will be, but it seems that a crucial step in the direction of counteracting the effects of air pollution social inequality has been taken. Contrary to the assumption in Chapter 5.2. that the social consequences of air pollution measures have not yet received any attention, it is now clear that

policymakers in Duisburg are indeed aware of the interaction of the two factors and are trying to counteract a further exacerbation of social inequality.

6.4.2 Obstacles

The five interviews also allowed to identify the barriers to further action and policies to reduce air pollution which are: overburdened authorities, conflicting objectives, lack of measuring points, a widening social divide, and housing shortages, as illustrated in Figure 7.

Figure 7

Obstacles to air mitigation policies in Duisburg

First of all, the interview participants claimed that high financial and personal resources are needed to implement such new air mitigation policies while most of the authorities already feel overloaded with other issues. Due to the dominance of other (environmental) problems, air pollution is less frequently addressed as otherwise the stakeholders would even feel more overwhelmed.

Moreover, the existence of multiple problems would also lead to conflicting objectives that make it difficult for the various stakeholders to work together. Interviewees C, D, and E criticised the fact that either there is no holistic view or that the tangible conflicts of interest make it difficult to find solutions since not all objectives can be given equal priority. One of these conflicts is between industrial and environmental actors in that economic efficiency is important to secure employment, but often leads to negative environmental consequences, including increased air pollution. Another concrete example is the aforementioned reconstruction of the A59. The federal government's preference for an above-ground construction method in order to save costs shows that those in power are usually not (yet) willing to bear higher costs for the benefit of society, especially the most disadvantaged people.

This emphasises once more the unwillingness of the decision-makers to minimise the negative social consequences of such policies if they increase the costs.

In terms of these conflicts of interest, Interviewee D proposed the wish for more guidance and prioritisation from policymakers so that one knows which issues should be prioritised in such situations. Interviewee D stated that

> "there are indeed tangible conflicts of interest and I sometimes have the impression that they are swept under the carpet in politics. I just can't do justice to everything and sometimes I have to be honest and say: that's just not possible".

Indirectly, however, this also leads to a desire to think in the longer-term and more holistically. Cutting costs in the short term usually makes no sense for the future if it creates new environmental and social problems.

Interviewees A and C also complained about the existing lack of monitoring stations in Duisburg, especially for particulate matter. While there is a good spatially differentiated picture of the city for NO_2 pollutants, there are mainly monitoring stations at hotspots, especially for $PM_{2.5}$, but also for PM_{10}. According to Interviewee C's explanation, if these are not expanded, this will become a problem, especially in the coming years when air quality standards will be tightened and further adapted to WHO recommendations.

Nevertheless, another problem was highlighted by the interviewees: the widening social divide is a complex social problem for which there are no simple solutions. How do we deal with the fact that certain groups of people have a strong lobby of recognised doctors and lawyers who can immediately defend their interests and set up pressure groups, while the concerns of other people are not even heard? Interviewees C and E indicated that the huge gaps in society are widening. As disadvantaged people are usually affected by multiple problems at the same time, they do not have the capacity to deal with environmental or political problems when struggling to meet other basic needs. This makes it almost impossible to arouse the interest and cognitive participation of highly socio-economically disadvantaged people in air pollution issues. While the middle class in Duisburg is quite concerned and active in air pollution activities, even the upper class hardly participates, as they are able to protect themselves from the negative consequences due to their wealthy economic situation. In view of this, civil society organisations, but also local politicians, need to focus on finding ways to minimise this social divide.

Finally, the housing shortage in Duisburg hampers efforts to reduce air pollution, as there is simply not much land left for restructuring or other urban planning measures. Many people are also reluctant to leave their homes for fear of not being able to find affordable alternatives elsewhere, making restructuring almost impossible. For instance, if social housing is not subsidised more by the state, there is no alternative but to locate social housing where land prices are low, as costs must be kept as low as possible. Even if the problem of housing shortage is partly mitigated by the visual appearance factor, this does not necessarily ensure that socio-economically disadvantaged people can live in the less polluted neighbourhoods. As confirmed by Interviewee A: "As long as there are these differences [in air pollution], there will be differences in the housing market and so these social aspects will manifest themselves".

6.4.3 Policy recommendations on air pollution

Efforts to mitigate air pollution in Duisburg requires a multifaceted approach, with substantial investments in public transport infrastructure and the promotion of technological innovations on the one hand, and encompassing urban planning strategies such as restructuring, traffic regulation, and the creation of more green-blue-infrastructure, on the other hand.

Traffic in Duisburg is to be changed in such a way that traffic flows are redirected, but care should also be taken to ensure that there is more than one alternative route, especially during periods of prolonged roadworks that result in road closures, in order to avoid extreme congestion. In addition, major investments should be made in public transport to reduce road congestion and pollution. The network of local and long-distance public transport routes urgently needs to be expanded so that trams and buses can run more frequently and faster. Interviewee E criticised that it currently takes an hour to get from one side of the city to the other by public transport. Strong investment in the expansion is the only way to ensure that people choose public transport as an alternative to the car.

Generally, the focus should be on developing environmentally friendly transport, with an emphasis on low-emission or even zero-emission technologies, electric mobility and bicycles. In extreme cases, consideration should be given to demolishing houses near major roads as a last resort to reduce the negative impact of traffic-generated pollutants that cannot be blown away if there are too many large buildings nearby. Even if I can understand the criticism on the one hand, I consider this measure to be very drastic, with major encroachments on people's individual freedom, which will again primarily affect disadvantaged people. In my opinion, this shows that prevention should be given much greater responsibility in urban planning. Therefore

there must be sufficient measuring points and air quality forecasts by experts to prevent such dramatic situations from arising in the first place.

In addition to traffic-related measures, the interviewees highlighted the need to increase the green spaces in the city and in problem areas, since these can absorb noise and pollutants Nonetheless, it is questionable how all this is to be achieved given the existing lack of space in the city. I agree that Duisburg should invest in green-blue infrastructure, i.e. water resources and green spaces, to alleviate the air pollution problem. However, it must be thought of in an urban and densely populated context where the alternatives mainly are the use of abandoned buildings for restructuring and besides that vertical gardening on buildings and rooftops is the only option. It is imperative to ensure that greening does not lead to green and environmental gentrification, but that social equity mechanisms ensure that disadvantaged neighbourhoods are prioritised to benefit from these measures (Jelks et al., 2021; Pearsall & Anguelovski, 2016).

Of course, industry continues to play an important role in Duisburg and as the city is economically dependent on it, ways should be sought to organise its activities in a way that less air pollution occurs. New technologies should play a greater role in optimising the impact of activities such as the loading of goods. Despite the promotion of technological innovation, concrete ideas for further air pollution measures needed in Duisburg are mainly in the area of urban planning and include restructuring, traffic regulation and creation of new green spaces.

Overall, a sequence of three conditions must be met for air pollution mitigation policies to be successfully implemented.

1. *Accurate measurement of pollutants*
2. *Improvement of technologies in factories*
3. *Issuance of new regulations and creation of obligatory rules which all involved stakeholders must comply with*

Interviewee A emphasised the importance of these steps with the following statement: “There is a curve where one can see exactly when the new regulations were introduced, and then there is always a downward bend in the line every time there are technical developments. The legislator must therefore follow suit or present them”.

6.4.4 Integrated policy recommendations for addressing social inequality and air pollution

Many of the measures mentioned to improve air quality in Duisburg have an interface with the reduction of social inequalities, making the two factors mutually compatible.

An example of mutual compatibility is traffic-related measures, which can not only reduce air pollution in the high traffic areas but also improve the living environment for disadvantaged people. A direct consequence of this is the reduced risk for respiratory diseases and other health problems.

The creation of new green spaces and vertical gardening in socially deprived areas can also contribute to reducing social inequalities and air pollution by improving the quality of life of people in deprived areas by providing recreational opportunities in the neighbourhood, while oxygen is produced and pollutants are filtered. Additionally, green spaces provide community spaces that can promote social interaction in these places and strengthen social cohesion within a diverse population (Ma et al., 2018; Diener & Mudu, 2021).

The interviewees mentioned that the primary focus should be on reducing air pollution rather than solely on social inequality, as lower levels of air pollution will inherently mitigate some aspects of social inequality. As interviewee D stated, a greater reduction of air pollution in Duisburg is crucial "so that the living conditions are better, and these spatial differences can also be reduced". Policies aimed at reducing air pollution thus can be of great benefit to the most disadvantaged people. As explained by interviewee C:

> "So the people on the ground who are affected by this benefit so much from policies that, let's say, increase environmental resources. And if you look at this in our canon, i.e. reducing noise, reducing air pollution, increasing the amount of green space and counteracting climate change and heat stress".

Even though I initially agree with this assumption, in my opinion one must be careful and not conclude that policies aiming at directly reducing social inequality are therefore less important (see Chapter 6.4.5).

The need to address the socio-environmental imbalance was emphasized by the interviewees while calling for air pollution reduction policies that can be implemented: "We have just said that these concepts usually disappear into a drawer. That's why we said we want to work in an implementation-oriented way", as stated by Interviewee C. Accordingly, the social report, which is being prepared by the various city departments with the help of other experts, seeks to go beyond the reporting function by proposing concrete measures and ideas for their implementation with an integrated view which also considers the social dimension.

Given this, it is evident that air pollution and social inequality mitigation are not necessarily conflicting objectives but can at least partly be pursued mutually with the implementation of

new policies. However, a basic prerequisite for this is that sufficient concrete data is available to monitor the situation and that crucial experts from different areas are involved in negotiation processes that work together on realisable implementation-oriented ideas for restructuring, of which the City of Duisburg's social report project is a very good example.

6.4.5 Policy recommendations on social inequality

Mitigating the complex interplay between social inequality and air pollution in Duisburg requires not only a targeted reduction of air pollutants but also structural reforms to directly address residential, income, and health inequalities.

As demonstrated in the preceding analysis chapters, the distribution of air pollution has become a social problem that is unlikely to be resolved. Indeed, combating social inequality is a significant challenge that people have been grappling with for a considerable period, due to the construct of social classes and the dynamics of privilege and power (Hurst et al., 2019; Tobin, 1970). Even if the interviewees indicated that the main focus should be on reducing air pollution as this would immediately result in a reduction of social inequality, I only partly agree with this. In my opinion, this alone will not be sufficient to mitigate the already massive negative impact on the disadvantaged people and the large gap to privileged groups of people in Duisburg.

Therefore, it will also be necessary to address the social inequality itself, that has already arisen in Duisburg, through targeted measures. Restructuring should be a central tenet in the counteraction of social inequality and the reduction of existing residential inequality, which is particularly detrimental to disadvantaged individuals. It is necessary to identify new methods for the distribution of living space.

The interviewees have not mentioned many concrete ideas on how to solely address social inequality in Duisburg. Nevertheless, the mentioned disadvantage of people with a lower education background or language barriers due to a migration background, imply that there is the need for policies aiming to empower them and reduce those barriers. Moreover, healthcare services subsidised by the state and offered in the mostly affected areas may be increased to mitigate the health impacts of air pollution.

However, as previously stated in the section on obstacles, the fact that those suffering most from residential inequality in Duisburg lack a strong lobby further complicates matters. Furthermore, those affected frequently lack knowledge about the system, which acts as a barrier to their ability to protect themselves from the negative consequences. Consequently, there is a necessity for the establishment of a more extensive network of support organisations, whose

objective is to bridge this gap and provide disadvantaged individuals with enhanced starting conditions. One concrete example could be the establishment of new community centres in the disadvantaged areas which not only offer the people educational workshops but also give the people an opportunity to raise their concerns.

7. Discussion

The objective of this thesis was to assess the impact of air pollution on social inequality in terms of health, residential and income inequality and reveal those mechanism behind this influence as well as the interplay of the different dimensions. Having analysed the air mitigation policies in Duisburg and having conducted five in-depth interviews with different experts and professionals, this thesis made a significant contribution to the understanding of the interaction effects between the dimensions of social inequality concerning air pollution and the extent to which these are influenced by air pollution in Duisburg. Moreover, the research on the precise issues, interaction effects, and solutions to environmental injustice is still in its infancy, with considerable potential for further growth.

It can be learned from the case of Duisburg that air pollution significantly impacts social inequality not only in developing countries but also in industrialised countries with a comparatively well-functioning welfare system. Existing air mitigation policies fail to adequately address the social inequalities and, due to the interplay of income, residential, and health inequality those negative social consequences are even exacerbated. Given this, policies must not only optimise the air quality but also specifically address those social disparities with targeted interventions in low-income neighbourhoods.

The example of Duisburg has emphasised that those social inequalities can successfully be addressed with an integrated approach and by involving many stakeholders with different kinds of expertise. This approach can also enhance the fairness and efficacy of urban planning strategies, while adapting German welfare strategies to mitigate the exacerbation of social disparities due to environmental consequences.

It is acknowledged that there is no single cause of social inequality in Duisburg, even if the focus were to be on the influence of air pollution on this phenomenon. Numerous other factors influence social inequality in Duisburg, as mentioned in passing in the analysis of heat and noise pollution (GEWOS, 2024). Nonetheless, air pollution represents a significant environmental concern that is often overlooked in favour of the more prominent issue of climate change. However, pollution is an equally crucial aspect of the broader triple crisis.

In order to ascertain whether the analysed impact of air pollution on social inequality for the German city Duisburg applies to Germany as a whole and other industrialised countries, further research should be conducted in the form of case studies in this area. This goal could well be pursued with broader cross-national comparative case studies which explore the effects of air pollution on social inequality for industrialised countries with robust welfare systems. This may help to achieve representativeness, identify common patterns, and unique national factors that influence the extent of social disparities resulting from air pollution or other environmental problems. Furthermore, quantitative studies can be employed to statistically ascertain the vulnerability factors, in addition to economic position and ethnicity, and to compare them between industrialised countries.

A unidirectional relationship between the social inequality and air pollution was employed for the purpose of the study, despite the possibility of a bidirectional or even reciprocal relationship. Further scientific investigation could be conducted to corroborate these findings. However, due to the limited scope and specific research interest, it was not possible to include all crucial aspects in this study. It could also be argued that education inequality is another important dimension of social inequality that should have been included. Individual scholars, such as Roth (2017) and Mohai et al. (2011), have confirmed that there is a strong correlation between education and air pollution. Nevertheless, no significant findings have been identified to date indicating that air pollution increases educational inequality for disadvantaged people. It can be assumed that there are strong correlations with income, which is why the effect is at least indirectly covered by this dimension, in a manner similar to the effect of migration background.

8. Conclusion

Despite the relative improvement, air pollution in Duisburg still reaches high levels and causes potential adverse effects on human health. The temporary high levels of NO_2 in the centre and the north of Duisburg are significant, while the levels of $PM_{2.5}$ and PM_{10} only just meet the current guidelines in average. The situation is likely to deteriorate further in the future since the current air pollution standards are not yet based on the WHO recommendations.

The analysis of the air mitigation policies for Duisburg in Chapter 5.3 has revealed that current strategies fail to address social inequalities. With the background of the analysis of the interviews that air pollution negatively impacts social inequality, it can be concluded that air mitigation policies in Duisburg are insufficient to address the specific needs of the disadvantaged groups. Moreover, it has demonstrated that there is a pressing need for action in the following areas:

1. Expansion of public transport, electric vehicles and the bicycle network, which is a significant concern for citizens and could significantly reduce traffic-related emissions
2. Further reduction of pollutants caused by industrial activities (particularly dust), through modernisation of industrial plants
3. Investment in green-blue-infrastructure
4. Expansion of renewable energies, which is considered a best practice example in North Rhine-Westphalia as a whole, but not in Duisburg; hereby the focus should lie on photovoltaics and installation of new heating technologies and the utilisation of Thyssen-Krupp waste heat as an alternative to wood and coal firing and other high-emission stove heating systems
5. Explicitly address social inequality through increasing subsidised healthcare services in the mostly affected areas, establishing a more extensive network of support organisations and reducing further language and education barriers
6. Combating regional disparities and reducing the social divide within the society through restructuring within the city and even greater support of state-supported welfare organisations
7. More guidance from federal and state stakeholders on prioritisation of issues to reduce the overburdening of local policymakers and facilitate collaboration processes in Duisburg
8. Adaptation of the EU Air Quality Directive to the WHO guidelines before 2035

The analysis of the five expert interviews proved the existence of regional disparities and confirmed that air pollution is indeed responsible for greater health, income, and residential inequality. Although it is not possible to make a definite statement regarding the strength of the effects observed through the qualitative approach of this work, it can be demonstrated that air pollution exerts a statistically positive, i.e. exacerbating, effect on social inequality. The interplay of various factors determines the extent of the negative consequences for disadvantaged individuals.

Another main finding of this thesis is that there is a direct correlation between income and health, as well as residential inequality, in Duisburg. Given that rents in Duisburg are relatively low, particularly in the heavily air-polluted regions such as the north of the city, many individuals with low income reside there and suffer from the long-term negative consequences of an increase in health problems for instance, and a lack of green spaces in the neighbourhood. However, two factors have been identified that mitigate partially against residential inequality

in Duisburg: the housing shortage, which ensures that environmental factors lose significance in the choice of housing, as well as the visibleness of air pollution which is more decisive for people's residential choices rather than the actual level of pollution.

The mutual reinforcement of the dimensions of social inequality is problematic, particularly given that the double victimisation process encourages downward spirals from which escape becomes increasingly difficult and is rarely possible without external help. The analysis also showed that other factors such as level of education and migration background correlate with the dimensions of social inequality, even if, for example, educational inequality per se is not increased through air pollution in Duisburg.

This evidence from Duisburg, a medium-sized city in Germany, demonstrates that air pollution is a significant contributor to social inequality and the emergence of an environmental health-poverty trap. Although Germany is a welfare state and has a comparatively robust welfare system, environmental issues such as air pollution result in the creation of additional disadvantages within society. These disadvantages serve to reinforce existing ones from which escape is barely possible without external help. This shows that even the existence of a comparatively well-functioning welfare system in Germany does not preclude the negative effects of air pollution on social inequality and that other aid organisations or support services are needed.

Nevertheless, an unexpected finding was that despite the unequal distribution of air pollution effects, Duisburg can be emphasised as a positive example of the ambitions in the interplay of air pollution and social inequality. Through the interviews, it was found that a social report is being prepared by different city departments on a very similar topic to this thesis and that the issue is receiving considerable attention. As described above, the various experts involved are not only interested in documenting the problems through a comprehensive report but also jointly develop implementation-orientated policy recommendations on how to further reduce air pollution and social inequality.

Although the report is scheduled for imminent publication, the direct political consequences remain uncertain. Nevertheless, the project participants have thus far received positive feedback, praise, and support from all quarters. Even the local policymakers appear to have recognized the urgency of taking action. Given this, it can be stated that this project, which has involved the collaboration of numerous stakeholders, represents a highly positive example of successful collaboration. It demonstrates that numerous obstacles and challenges can be overcome through lengthy and complex joint negotiation processes and that this is the first step

towards improving the situation. Should the requisite political action be forthcoming, the city of Duisburg could serve as a model for other municipalities facing similar challenges, demonstrating how to collectively overcome existing obstacles.

It is important to highlight the novelty of the integrated approach and the close cooperation of various stakeholders in the project, whereby environmental and social problems are considered together. The analysis has demonstrated that the objectives of reducing air pollution and combating social inequality are mutually reinforcing and that a joint approach yields great benefits even if they must also be considered separately. In the context of mounting environmental concerns and the growing prevalence of environmental injustice, a more comprehensive approach is becoming increasingly pivotal. This is exemplified by the European Bauhaus initiative, which represents a paradigm shift in the way we approach environmental issues. Furthermore, the aforementioned approach will facilitate the restructuring of existing building structures in a sustainable and socially just manner.

The fact that leading experts with close contact with local policymakers in Duisburg have already recognised this and are working with an integrated approach demonstrates that the initial crucial step towards reducing environmentally induced social inequalities has already been taken and that the potential for effectively reducing further social inequalities is high.

9. Literature

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Appendix

Table 1

Limit values, target values and threshold values in accordance with the 39th Federal Immission Control Act (Source: HMUKLV, n.d.; Translation from German)

Component	Characteristic	Value	Remarks
Sulfur dioxide	1-hour value	350 µg/m3 may not be exceeded more than 24 times in the calendar year	
	24-hour value	125 µg/m3 may not be exceeded more than 3 times in the calendar year	
	Annual average	20 µg/m³	Far from emissions sources
	Winter average	20 µg/m³	Far from emissions sources
Nitrogen dioxide	1-hour value	200 µg/m3 may not be exceeded more than 18 times in the calendar year	
	Annual average	40 µg/m³	
Nitrogen oxides	Annual average	30 µg/m³	Far from emission sources
PM10	24-hour value	50 µg/m3 may not be exceeded more than 35 times in the calendar year	
	Annual average	40 µg/m³	
PM 2,5	Annual average	25 µg/m³	
Benzene	Annual average	5 µg/m³	
Carbon monoxide	Max 8-hour value	10 mg/m³	
Ozone	1-hour value	180 µg/m³	Information threshold
	1-hour value	240 µg/m³	Alert threshold
	Max 8-hour value	120 µg/m3 may be exceeded on a maximum of 25 days in the calendar year, averaged over 3 years	Target value
	AOT40	18,000 µg/m3xh, Averaged over five years	Target value

Table 2

Explanation of the categories of the World Air Quality Index (Source: IQ Air, 2018; The World Air Quality Index project, 2024a)

Category	Air Quality Index	$PM_{2.5}$ (µg/m3)	Recommendations
Good	0-50	0-12,0	- Low or non-existing health risk; - All outdoor activities can be performed
Moderate	51-100	12,1-35,4	- Due to the risk of respiratory diseases, sensitive groups of people (children, the elderly, pregnant people with heart and lung conditions) should severely limit outdoor exercise when the air quality is moderate - Indoor spaces should be ventilated with outdoor air
Unhealthy for sensible groups	101-150	35,5-55,5	- Risk of eye, skin and throat irritation as well as respiratory problems - Restriction of outdoor activities - Sensitive groups should avoid all outdoor activities or wear masks outdoors - Use of an air purifier instead of ventilation
Unhealthy	151-200	55,6-150,4	- Increased likelihood of exacerbation of heart and lung disease and adverse health effects - Everyone should avoid spending time outdoors and wear a respirator - Use of an air purifier instead of ventilation
Very unhealthy	201-300	150,5-250,4	- Sensitive groups should stay indoors and limit their activities - Everyone should avoid outdoor sports and wear a mask when outdoors - Use of an air purifier instead of ventilation
Hazardous	301+	250,5+	- High risk of severe irritation and negative health effects for everyone (cardiovascular and respiratory diseases) - Sport and any outdoor exercises should be avoided - A respirator should be worn when outdoors

Table 3

Measured values from 2022 for nitrogen dioxide (NO2) and particulate matter (PM10) at the stations in Duisburg (Source: LANUV, 2022)

Messpunkt	NO2-Jahresmittel [µg/m3]	PM10-Jahresmittel [µg/m3]
Duisburg Asterlager Straße 122	29	--
Duisburg Bergstraße 48	--	20
Duisburg Friedrich-Wilhelm-Straße 25	31	--
Duisburg Kardinal-Galen-Straße	27	20
Duisburg Karl-Jarres-Straße 69	30	--
Duisburg Kiebitzmühlenstraße	--	24
Duisburg Meiderich Bahnhofstraße	31	--
Duisburg Moerser Straße 245	28	--
Duisburg-Bruckhausen	28	22
Duisburg-Buchholz	--	16
Duisburg-Ehingen	--	17
Duisburg-Walsum	21	17

Table 4

Developed preliminary codebook

Air pollution: these are the codes which describe the air pollution in Duisburg

Code	When to use
Air pollution (current level & situation)	Current level & situation of air pollution in Duisburg
Air pollution (past level & situation)	Past level & situation of air pollution in Duisburg
Air pollution (main pollutants)	Main pollutants in Duisburg
Air pollution (problematic locations)	Problematic locations and districts in Duisburg which suffer from high air pollution
Air pollution (political measures/ policies)	Political measures/ policies implemented in Duisburg concerning mitigating air pollution

Impact: these are the codes which describe how air pollution impacts the different dimensions of social inequality in Duisburg

Code	When to use
Impact (on residential inequality)	Air pollution impacts residential inequality (which districts)
Impact (on health inequality)	Air pollution impacts health inequality
Impact (on income inequality)	Air pollution impacts income inequality (which income groups)
Impact (no impact on social inequality)	Air pollution does not impact social inequality

Interaction effects: these are the codes which describe how the different dimensions of social inequality interact

Code	When to use
Interaction effect (between residential & health inequality)	Residential & health inequality are interconnected, concerning air pollution
Interaction effect (between residential & income inequality)	Residential & income inequality are interconnected, concerning air pollution

Interaction effect (between health & income inequality)	Health & income inequality are interconnected, concerning air pollution
Interaction effect (no interaction effects)	There are no interaction effects between the dimensions of social inequality

Policy recommendations: these are the codes which describe what recommendations the interviewees have given to improve the air quality and the negative effects of air quality on social inequality

Code	When to use
Policy recommendations (air pollution) on mitigating air pollution	Recommendations & ideas on how to mitigate air pollution
Policy recommendations (social inequality)	Recommendations & ideas of how to reduce the (negative) air pollution effects on social inequality
Policy recommendations (responsibilities)	Ideas about the distribution of responsibilities of all different stakeholders

Figure 1

Air pollution Duisburg on 16th April, 2024 (Source: LANUV, 2024a)

Messwerte am 16.04.2024 um 17:00 Uhr (MEZ)

Station	Kürzel	Ozon (1h) µg/m³	SO_2 (1h) µg/m³	NO_2 (1h) µg/m³	PM_{10} (24h) µg/m³
Aktive-Stationen					
Aachen Wilhelmstraße	VACW			36	<10
Aachen-Burtscheid	AABU	77		<10	<10
Bielefeld Detmolder Straße	VBID			38	<10
Bielefeld-Ost	BIEL	53		23	<10
Bonn-Auerberg	BONN			-	<10
Borken-Gemen	BORG	86		-	<10
Bottrop-Welheim	BOTT	75	<10	<10	<10
Datteln-Hagem	DATT		<10	<10	<10
Dortmund Brackeler Straße	VDOM			41	<10
Dortmund-Eving	DMD2	72		10	<10
Duisburg Kardinal-Galen Straße	VDUI			18	<10
Duisburg-Bruckhausen	DUB2		53	42	<10
Duisburg-Buchholz	BUCH		<10		<10
Duisburg-Walsum	WALS	84	<10	<10	<10

Figure 2

Air pollution Duisburg on 18th April, 2024 (Source: LANUV, 2024b)

Messwerte am 18.04.2024 um 10:00 Uhr (MEZ)

Station	Kürzel	Ozon (1h) µg/m³	SO_2 (1h) µg/m³	NO_2 (1h) µg/m³	PM_{10} (24h) µg/m³
Aktive-Stationen					
Aachen Wilhelmstraße	VACW			44	<10
Aachen-Burtscheid	AABU	67		<10	11
Bielefeld Detmolder Straße	VBID			41	<10
Bielefeld-Ost	BIEL	61		17	<10
Bonn-Auerberg	BONN			23	<10
Borken-Gemen	BORG	81		<10	-
Bottrop-Welheim	BOTT	69	<10	<10	<10
Datteln-Hagem	DATT		<10	<10	<10
Dortmund Brackeler Straße	VDOM			43	<10
Dortmund-Eving	DMD2	65		14	<10
Duisburg Kardinal-Galen Straße	VDUI			16	12
Duisburg-Bruckhausen	DUB2		124	51	13
Duisburg-Buchholz	BUCH		14		<10
Duisburg-Walsum	WALS	70	<10	<10	<10

Figure 3

Clean air plan Ruhr area (Source: Stadt Duisburg, n.d.)

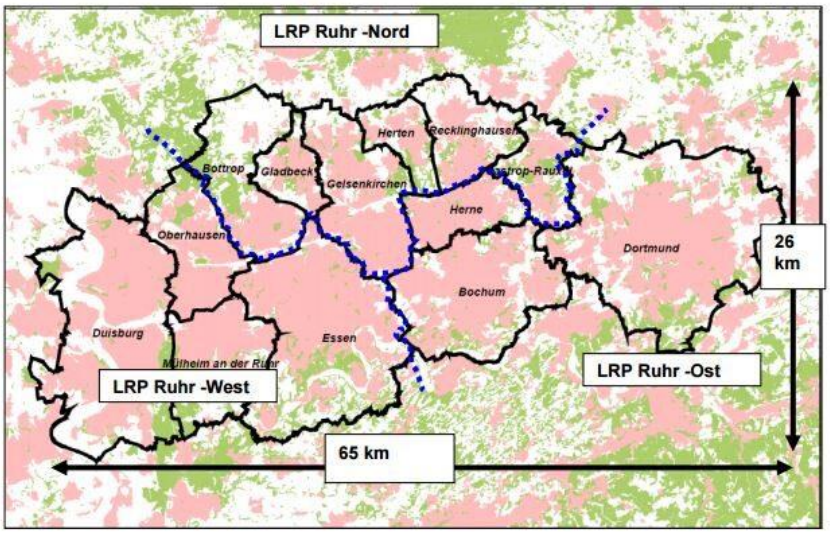


Abb. 1.8/1: Gebiet des Luftreinhalteplans Ruhrgebiet mit den Teilbereichen West, Nord und Ost und den betroffenen Städten Duisburg, Mülheim, Essen, Oberhausen, Bottrop, Gladbeck, Gelsenkirchen, Herten, Recklinghausen, Castrop-Rauxel, Bochum, Herne und Dortmund

Figure 4

Air pollution Duisburg on 8th May, 2024 (Source: LANUV, 2024c)

Messwerte am 08.05.2024 um 13:00 Uhr (MEZ)

Station	Kürzel	Ozon (1h) µg/m³	SO_2 (1h) µg/m³	NO_2 (1h) µg/m³	PM_{10} (24h) µg/m³
Aktive-Stationen					
Aachen Wilhelmstraße	VACW			48	18
Aachen-Burtscheid	AABU	75		<10	-
Bielefeld Detmolder Straße	VBID			24	18
Bielefeld-Ost	BIEL	82		13	12
Bonn-Auerberg	BONN			17	27
Borken-Gemen	BORG	75		<10	19
Bottrop-Welheim	BOTT	53	<10	<10	22
Datteln-Hagem	DATT		<10	<10	19
Dortmund Brackeler Straße	VDOM			43	31
Dortmund-Eving	DMD2	68		<10	25
Duisburg Kardinal-Galen Straße	VDUI			-	21
Duisburg-Bruckhausen	DUB2		16	25	29
Duisburg-Buchholz	BUCH		<10		25
Duisburg-Walsum	WALS	67	<10	<10	15

Figure 5

Multiple burdens, households with minimum income and immigrant population in the neighbourhoods (Source: GEWOS, 2024, p. 125)

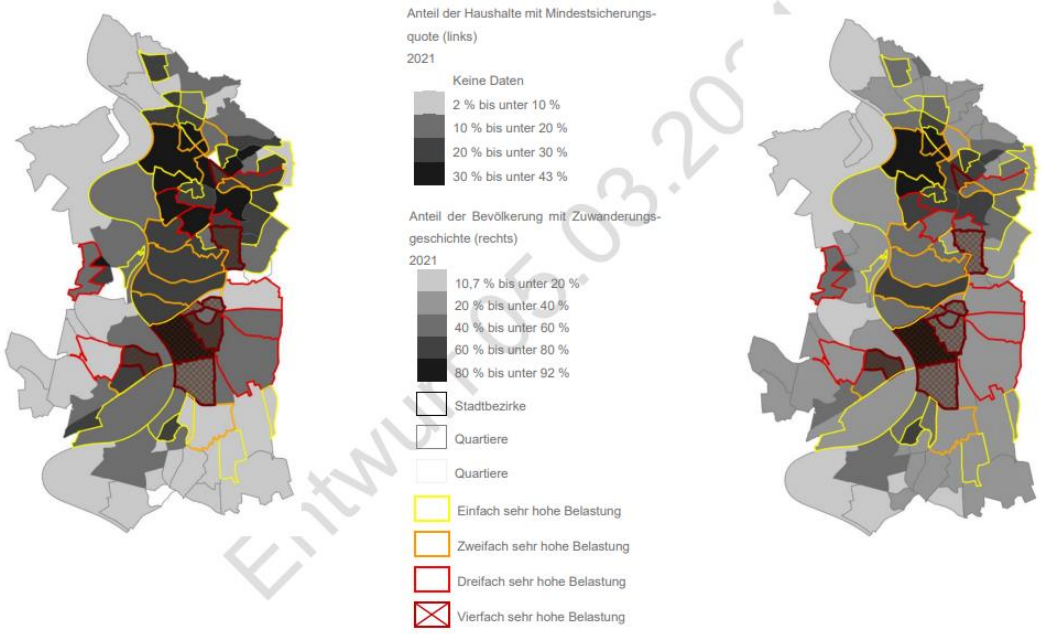
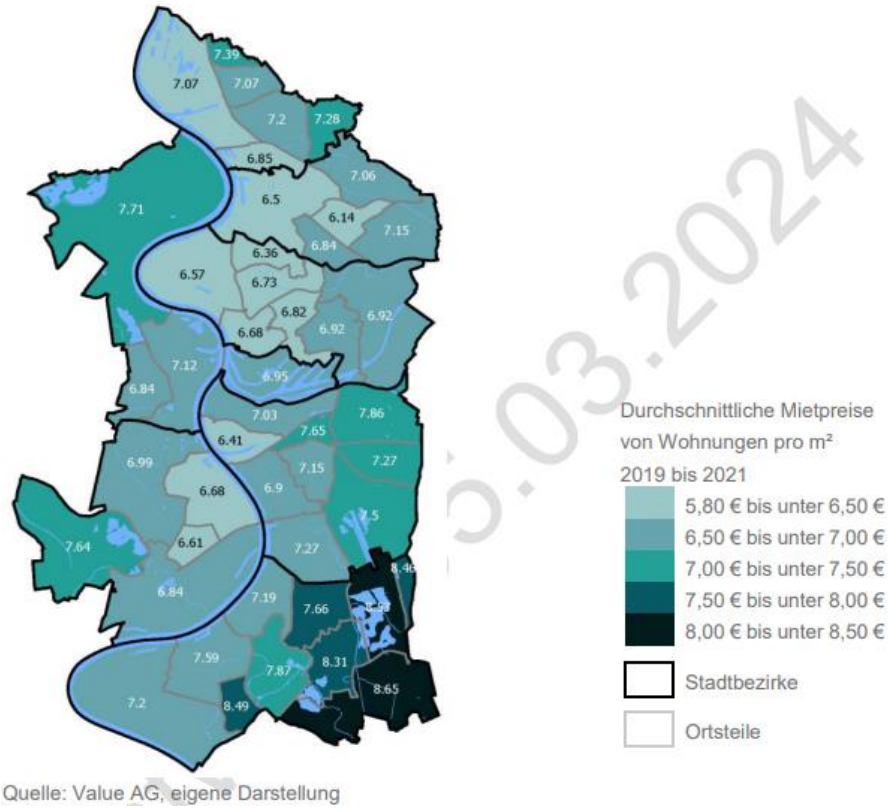


Figure 6

Rental prices for existing flats in the districts (mean value 2019 to 2021) (Source: GEWOS, 2024, p. 98; Value AG)

Die Zahlen in den Ortsteilen beschreiben die durchschnittlichen Angebotsmieten für 2021; die Farbeinteilung basiert auf dem jeweiligen Durchschnitt zwischen 2019 und 2021 gemäß Legende.



Quelle: Value AG, eigene Darstellung

Photo 1

North of Duisburg, Marxloh

Photo 2

Exemplary social housing in Marxloh

Photo 3

Centre of Duisburg

Photo 4

Motorway A59 in the centre of Duisburg

Photo 5

Green spaces in the south, Neudorf-Süd

Photo 6

Berthasee, Neudorf-Süd

Photo 7

Exemplary greened street in Neudorf-Süd

Trancript Interview 1

26th April, 2024, 1:00PM

I: Interviewer

E: Expert

0:04

I: Exactly. Yes, that should all work out. Right then, thank you once again for agreeing and for your willingness to support me. I'm Sheila Heuer, a Master's student at the University of Münster and in Enschede in Comparative Public Governance. And as you have already learned, I am conducting this research as part of my Master's thesis on the effects of air pollution on social inequality in Duisburg. And I would like to use various interviews to shed light on different perspectives. I would like to make a few points transparent to you in advance regarding the handling of the data.
You have already given me permission to record this interview. As I said, this is only for the purpose of transcription and subsequent data evaluation for my analysis. And only I have access to the data. They are backed up on a password-protected laptop, so there are no worries that anyone else could access them.
I will either leave out or anonymise all personal information and all my data processing practices comply with the applicable data protection laws and regulations as set out in the GDPR. Exactly and I will delete the recordings once the transcription is complete.
Do you agree with this?

1:23

E: Yes.

1:24

I: Okay, thank you very much. I was very pleased to hear back from you, because your work [as an air quality expert] [...] gives you exactly the kind of expertise I was looking for. And you have informed me in advance by e-mail that they [...] [also] had interesting experience in the area of drawing up clean air plans, which could be of interest for my work. I have added a few questions that also go in this direction, but otherwise also specifically on the effects on the various dimensions of social inequality. And I think that if there are no more questions from your side, we can start directly with the interview questions.

2:04

E: We can start. I'll just quickly close the door here. Then we won't be disturbed. Just a moment.

2:05

I: Very good.

2:13

E: So.

2:15

I: Very good.

2:16

E: So, [it] can start.

2:18
I: Yes, perhaps first of all: Can you introduce yourself, mention what position you hold and for how long?

2:27
E: I am [Interviewee A]. [...]
On the basis of air quality forecasts and assessments, the district governments and local authorities develop measures to improve air quality in their area of responsibility.

3:21
I: Okay, thank you very much. That definitely shows once again that you really do have many years of experience in this area and are exactly the right candidate. Are you aware of any problems with air pollution in Duisburg?
And if so, what kind of problems?

3:39
E: Duisburg is not an exceptional city in terms of air quality. We have the same problems in Duisburg that we have in all major cities and smaller towns. Wherever there is a lot of motorised traffic, the levels of particulate matter and nitrogen dioxide are generally higher than in the surrounding area.
Yes, the industrial sources in Duisburg now only play a subordinate role among the absolute pollution
hotspots.

4:14
I: Okay.

4:16
E: There are only a few spots in the city where they [the industrial sources] still play a bigger role. But these are other pollutants. These are the metallic substances contained in the stones near plants that work in the area. But overall, the traffic hotspots and in all other cities are also absolute hotspots of pollution.

4:27
I: In other words, do you see the greatest potential for further reducing air pollution in Duisburg in the transport sector? Or is there another area, perhaps also in the industrial sector, where you could learn from other cities where things are going better and these pollutants could be better regulated?

5:04
E: As I said, Duisburg joins the list of all cities, yes, the traffic-related measures are there. That's why it started in 2008, 2009 with the low emission zones, when they started to reduce dust pollution by banning vehicles from entering city centres that didn't have a particulate filter; that means above all diesel vehicles that only had this yellow environmental badge at the time, which at some point were no longer allowed to drive in.
That was since, so the environmental zone came gradually. In the summer of 2013, the measure was introduced: from now on, only green stickers. And that meant for these [vehicles] without particulate filters: they were no longer allowed to enter city centres. But that's not just the case in Duisburg, it's a general measure that has been implemented in all NRW environmental zones and we have complied with the limit values since 2014. In other words, this measure has also taken effect.

6:08
I: Yes, of course that's a huge step forward, which also says something at the same time. Of course, the lower the air pollution, the lower the negative effects on various population groups. Nevertheless, if you want to look at it again, there is a certain level of air pollution in Duisburg, as in other cities in the region, and also due to industrial sites and so on.
But what impact does air pollution actually have on social inequality? So what are the social consequences of air pollution?

6:43
E: Well, I can only summarise it by saying that, as far as I can see, the areas where these streets are located are particularly affected. People who can afford to live somewhere else don't live there.

7:01
I: Yes.

7:02
E: Yes. That's simply the case. And I can't back that up with data, but you can possibly prove it by simply looking at colleagues of mine in the Climate Atlas who did something like that. They actually took a look at Immobilienscout 24 and simply looked at flat adverts from different streets in different cities and compared them with each other; quite simply how the living conditions are, what the prices per square metre might be. And you can already see that if you want to move away from these poorly ventilated street sections, you have to spend money in order to be able to afford something more expensive. That would then be a task that can be proven on the basis of data that comes from such adverts alone, from such housing adverts. And Immobilien Scout or other online offers - I don't want to advertise this portal now, there are quite a few - often contain the clear addresses where the flat is located. You can clearly read the prices per square metre and you can see that: These are the flats that socially disadvantaged families can afford because the prices per square metre are lower. No, that's just my outlook, my thesis I would say, yes, in a scientific sense, but then perhaps it needs to be proven with data from these portals.

8:24
I: Yes, exactly.

8:38
E: It is of course also the case that - and this would be my second approach - it is a health problem. A few years ago, there was a paediatrician in Cologne who talked about the fine dust pollution and the incidence of lung diseases in his practice. I don't know if you can get in touch with paediatricians or something like that, so that you have one in the area or two or three preferably, who practice in an area where the air is worse and then one in Duisburg-Rumeln- Kaldenhausen, or somewhere outside where it is really green and well ventilated, so that this health factor, which is also another motivation to move away, is also there. But you have to be able to afford it and that's where the social component comes into play again.

9:35
I: Yes, that's right. That's a very interesting approach. I have actually also defined social inequality for myself in my work, not just in terms of income opportunities, but also the distribution of health risks and residential inequality, so that these different dimensions can be captured. And accordingly, interviews are also planned with a social and an environmental expert [...]. But I'm also looking for someone in the health sector because, as you said, it's

particularly exciting to see where there is a correlation between health and the role that income plays in being able to protect yourself from the possible effects. Or exactly what options you have or lack of options to take further precautions?

10:35
E: The advantage is that [one] [...] is obliged by the EU directive [...] to measure where the worst pollution is suspected [...]. This is determined by modelling. In other words, I can tell you where the worst points are, but we also have to determine so-called background values. This means that there are still measuring containers somewhere in the green surroundings, but also in the urban area, where you also have comparative values. I can put all this together for you.

11:05
I: Yes, that would be great. I would be very grateful for that. If I were to ask you in general terms, could you also tell me about neighbourhoods in Duisburg where you are aware that higher air pollution is an issue?
Or, sorry, not just higher air pollution, but also the people who live there who are socio-economically worse off; the neighbourhoods perhaps.

11:23
E: I can't do that off the top of my head. Yes, I can, as I said, let's use a map to show you where the road sections are, where the pollution is high, yes, there may be that I can then give you or lists somehow with addresses or something, I have to see how I can best find out, because I have to analyse according to the different pollutants. Yes, in the case of traffic, it's nitrogen dioxide and particulate matter. And for these industrial sites, it's also the dust, but there it's more the metallic components of the dust, where we then carry out extra analyses. So I can't make a generalised statement about air quality, I have to differentiate. Yes, but I can put something together for you on this question afterwards, where you can see exactly where the areas are where you still need to look with your analyses.

12:27
I: Yes, great, thank you. We've just touched on this a bit and the area of health [...]. How does air pollution influence the distribution of health risks and what role does income play in this?

12:51
E: Yes, we've basically already said that, right. So the individual health risks of the pollutants; what they all do is attack the lungs, the respiratory tract and then there's that. Yes, if I want to relate this to the social component, that if I lived in such a place, I would like to move away if I could afford it. For me, that's the social issue behind it, i.e. where the conditions are poor in terms of air quality or other criteria, yes, the rents are not so high. People who are socially disadvantaged are forced to take these flats because they can't live elsewhere for financial reasons. That's the social idea behind it.

13:48
I: Yes, thank you very much for explaining that again.

13:50
E: Unfortunately, that's the case. [I can also [give] you an interesting current example.] I don't know if we've already talked about it on the phone: Lüdenscheid.
You know this case with the bridge with the motorway bridge, which was blown up at the

moment because it was broken. And now they're all driving through a few places on the diversions route and people are understandably quite annoyed.
But if you put that into perspective: they otherwise live in the countryside with clean air, with the best conditions. For a window of two or three years or so, they have what people in these neighbourhoods in Duisburg, Essen, Düsseldorf, Cologne, everywhere in the cities, what they always have, what these people who are socially weaker, yes, and therefore have less of a lobby, have and they have to put up with it, perhaps for a lifetime. And in Lüdenscheid in the countryside, no, it's nice and cosy, they don't even have to put up with the same level of pollution, it's somehow in this order of magnitude, but no limits are exceeded. But this personal potential, this nervous potential, I say, is of course very high among the people in Lüdenscheid at the moment because they don't even know it. Someone in Duisburg might not even be upset about it, because in comparison to where they live now, it might even be an improvement.
Well, but it's just to see it socially, it's always relative from which side I look at it. When I look at the people in Lüdenscheid on Lennestraße, they've always had clean air and relative peace and quiet. And now they have the absolute disaster from their point of view. The people who live in Duisburg, in a street where it has always been catastrophically bad and is now slowly getting a little better, are happy about every improvement. They would be happy if things were as good as they are in Lüdenscheid. Yes, that's also a social component, this relativity, what level do I start from and what lobby do people have.
The people in that, that's also an important component there, because the people I don't know the neighbourhoods in Duisburg by name, who live in streets like that, they don't usually have such a strong lobby. In Lüdenscheid, of course, doctors and everyone else are immediately on the barricades, and they are also heard. There are citizens' initiatives and so on, that's also a social difference.
Some are heard, others are not, because they don't have prominent doctors in their neighbourhood or lawyers who take care of it and set
up a citizens' initiative.

17:00
I: Yes, that's actually the case. Access to resources has a significant impact on your own situation and whether you can see that something can change or whether your voice is heard at all and you have a chance of improvement, yes.

17:14
E: Yes.

17:19
I: Yes, it's very exciting to take this relative aspect into account again, which of course plays a very important role.
Exactly what do you think would be necessary then?
Well, that goes a bit too far, and perhaps that was already a partial answer. But what would be necessary to further reduce the impact of air pollution on social inequality?
I say, you can now also focus on
the transport sector with nitrogen and particulate matter emissions, which is perhaps easier to answer this question.

17:50
E: But that doesn't do justice to the city of Duisburg. Because it [Duisburg] simply has a

special history in terms of its past and the industrialisation of the industrial settlements, and certain production areas are still there.

18:08
I: Yes.

18:15
E: Yes, and that's why [...] [you're] still [busy] with these dust measurements and looking for metallic substances. So I would probably take a differentiated view, but it's rarely a residential environment. We can look, as I said, I'll send you the data and then you can think about it. It may well be that at these industrial locations, where we measure, it is not necessarily a residential environment. We're more likely to have an allotment garden colony there, but they're not allowed to harvest their vegetables and all that sort of thing. But if you want to refer specifically to the residential environment, then it may well be that NO_2 and particulate matter are sufficient. I'll send you everything; have a look, do it, no, you can see what comes out of it.

19:05
I: Yes, of course.

19:09
E: Yes.

19:09
I: Then I'll put that part of the question on hold for now. [...]

19:13
E: Yes, but what you can do is actually only one thing: you have to continue to reduce the air pollution itself so that it can no longer affect this environment, these social components, so that it can no longer have such an impact. According to the EU directive, it is a fact that everyone has the right to clean air, yes, and if I, well, we now have limit values in the EU, they are complied with. The World Health Organisation has already issued new recommendations. The EU directive is being adapted [and] the new limit values should be complied with by 2030. That means we have to take measures now and work towards achieving this by 2030, no. That means actually looking at the cities: Where are measures possible? Where can we perhaps switch traffic, whatever, or even close roads or take diversions? There are so many possibilities. Or more public transport services, cycle paths. These are all the measures that are included in such a catalogue, also in Duisburg. I would also be happy to send you the current clean air plan. It contains all the measures. It's a huge catalogue, but you can still take a look at it.

20:30
I: Yes.

20:34
E: Yes, so it doesn't help, I think. As long as there are these differences [in air pollution], there will also be differences in the housing market and so these social aspects are manifested. I can't get rid of that. Yes, it's just a market economy thing. As a city, as a country [...] you have to do everything you can to make transport in the city so environmentally friendly that there are fewer emissions and that the streets are also well ventilated.

In Essen, [...] it was once considered on one street that it would help to demolish houses in between. Because it always becomes dangerous when you imagine a road like that, with four or even six lanes and residential buildings three or four storeys high to the right and left, and then a ravine forms. That's why it is a canal inside and then there are these air pollutants in there that are released from the traffic and cannot be blown away by the wind. They are then simply in this street space and that is what causes the pollution to rise in these places. Basically, you have to start everywhere in terms of urban planning, urban development and traffic design, mixing with low-emission, emission-free technologies, bicycles, electromobility, public transport, so that the combustion of fossil fuels can no longer produce so many pollutants. That is the only way.

22:35
I: Yes. In other words, who else do you see as being responsible, apart from the local decision-makers and also the authorities and the organisations that provide the measurement data in order to provide information about the current situation? But what about the industry side?
Or other parties? I'd say architects, engineers, urban planners, who perhaps also need to be involved somehow in order to find an overall solution and bring together more stakeholders with different backgrounds.

23:12
E: At the moment, there is more of a focus on climate change, but that also has an impact on these issues, there is a new advice centre that has been set up at the NRW State Office for Nature, Environmental Protection and Consumer Protection for municipal advice, which brings together precisely these kinds of players. Engineering offices that have technical approaches, with the planners in the cities, so that people can be networked with each other, so networking is an important aspect, so that the decision-makers in the cities, but also at the district governments and perhaps even at the federal level, are always up to date: What is technically possible? What can be implemented and how do regulations have to change? Because it's actually just an illusion to believe that this will happen by itself, it won't happen that way.

24:02
I: Yes.

24:10
E: Yes and these, if you. You're far too young, but the Ruhr area used to look very different. I'm sure you've seen it in pictures. They didn't do that voluntarily either. Yes, there they are. You can look at the curves of air pollution. It's basically a triad. We have [a] level of air pollution, then there are people who are tinkering with new measuring devices to be able to detect it more and more precisely; at the same time, the technologies in the factories are being improved, for example filters on the chimneys back in the 70s, 80s, yes. And if I can improve something technically and I can also prove it metrologically, then I can also issue a regulation that says: Now you all have to do it.

24:58
I: That's right.

25:00
E: If that doesn't happen, then there won't be this technical development.
Yes, and you can see, as we did for sulphur dioxide back then, there's a curve where one can

see exactly when the new regulations were introduced and then there's always a downward bend in the line every time there are technical developments. The legislator must therefore follow suit or present them.
Yes, depending on the situation and then there is also the obligation [...] [to be able] to verify this by measurement [...]. It all has to work, otherwise there will be no improvement.

25:33
I: Yes, yes, that's right. Have you also noticed that people in Duisburg themselves are concerned about air pollution? I don't know if you work in Duisburg yourself now, but otherwise perhaps through your work.

25:51
E: [...] I observe, I grew up in the countryside myself and I always have the impression that people here in the city are particularly conscious of green spaces and balcony boxes and so on [...], whereas in the countryside, where I have experienced this, people tend to take it for granted and then plant a little flower and put a little pot there because it is simply important to them. I always find that very nice.

26:28
I: Yes, that's also the point of relative comparison that you have when you have little in comparison, that you then endeavour to create green spaces, flowers and so on in the places where you can, which then make the whole thing more pleasant and can improve the situation overall.

26:34
E: Yes. Yes.

26:46
I: Yes, that's all the questions I've thought about for now. I would now give you another opportunity if there is anything else that I haven't really asked that you would still consider interesting, which I won't clarify with you later with the data. I would give you space for that now.

27:07
E: I think I've actually covered everything that was floating around in my head.
I'll be happy to send you an email in the next few days, probably in the course of next week. Then I can break it down with the air pollution: Where in Duisburg do we have which substances? Because it really varies greatly from neighbourhood to neighbourhood. Where are the points?
And yes, if you think of anything else afterwards, just write to me. So no problem. I'm very happy to help.

27:40
I: Yes, yes, thank you very much for your willingness and also for the many interesting insights you were able to give me. That was really enriching. I've already learnt a lot myself and now have a much better overall picture in many different areas. And yes, I really appreciate your expertise. I'm looking forward to incorporating all this information into my work. If you like, I can send you a short summary of the results once I have completed my work. Just if you are interested.

28:13
E: That would be nice.

28:20
I: Yes, I'll make a note of that. It will be around the beginning or middle of July, until everything is finalised with the colloquium and so on. But then I'll get back to you by email so that you can perhaps get a little added value from my work, perhaps an interesting insight that could be of some use to you at work.
Right then I would just finish the transcripts, er the recording.

Changes:

- Slips of the tongue, like “um” smoothed for reading flow
- Word repetitions removed that were not repeated for emphasis, but only in the flow of thought
- Omissions marked with [...] and only made if this was personal identifiable data
- Marked in square brackets [X] if words have been added, in places where individual words are missing from the sentence but are necessary to understand the overall message

Transcript Interview 2

2nd May, 2024, 1:00PM

I: Interviewer

E: Expert

0:03

I: I'm studying international political science. Well, I tend to come from that field, but with a very international focus on many countries and these country comparisons. [I] still have my German topic, so to speak, because of course there is air pollution here too and it's interesting to take a look at it and I did an internship at the Federal Environment Agency in the last six months. As a result, this topic came up because I had a lot to do with the area of air pollution, also from a European level, and I was in the working group on the [Zero] Pollution Ambition, i.e. the EU's mission to have as little pollution as possible by 2050 that has negative effects, and that's exactly what I found very exciting to shed light on: What consequences does this really have, especially for people who are already disadvantaged, and what can perhaps be done to minimise these negative consequences as much as possible?
First of all, I would like to briefly explain a few more details regarding the handling of the data to you.
You have already given permission to record the interview. As I said, this is only for transcription and later data evaluation for my analysis of the Master's thesis and is stored on a password-protected laptop, which only I have access to and all personal information is either left out or anonymised. So don't worry, your name [...] will not be mentioned anywhere and all the data processing practices comply with the applicable data protection laws and regulations as set out in the GDPR.
I will also delete the recording after the transaction is completed.
Do you agree with this for now or do you have any concerns?

2:05

E: Yes, no, it's all good.

2:09

I: Okay good. Exactly, and I was very pleased that you were willing to conduct the interview with me, because through your work [...] [in the construction sector] you have exactly the kind of expertise that I was looking for, because I find this perspective very exciting. Exactly, and I had already informed you by email that I had thought about some specific questions on the effects of air pollution on social inequality. Especially in the case of residential inequality. And I think if there are no more questions from your side, we can start straight away?

2:42

E: Yes, we can do that.

2:43
I: Very good. Right, perhaps you could tell us in advance exactly what position you hold and for how long?

2:54
E: Well, I'm [...] [Interviewee B] [and I work in the construction sector in Duisburg].

3:24
I: That's amazing. Then you already have a lot of experience in this area.

3:28
E: Yes.

3:29
I: You could say that. And are you aware through your work [...] what air pollution measures are being taken in Duisburg, i.e. where, perhaps where the focus is?

3:43
E: In itself, little attention is paid to it. To be honest, I'd say that it's perhaps related to that. We don't have too many plots of land left that could be built on.
And if there really is a plot available? Nobody asks whether it's contaminated in any way. Unless the soil is contaminated. That is queried, but not air pollution.

4:15
I: Doesn't matter at all, because the living space is so limited and you don't have any room for it. Do you know what the city is doing or whether anything is being done?
There are also clean air plans that are in force for Duisburg, for example, that require certain measures to be adhered to.
In the area of traffic reduction, diversions, but also attempts to reduce the congestion problems caused by industry. Have you somehow realised what the priorities are, what Duisburg is perhaps particularly known for, what is perhaps already working quite well or where there is still a lot of potential?

5:05
E: Well, I would say that the fact that most of the heavy industry has left here and we practically only have Bruckhausen over in Duisburg means that it's no longer the main focus. It used to be much worse, I know, when Krupp was still based here in Rheinhausen. I know the time when the windowsills were black after a few days. That's all gone now, so a lot has already happened here in our area in terms of air pollution.

5:22
I: Yes. Yes, okay. And what do you think now?
So yes, air pollution has improved considerably compared to the last few decades and the time when heavy industry was still really well established here, but there is still, I checked this again, that's why I came up with the case of Duisburg, there is still quite a high level of air pollution, especially in comparison to the rest of Germany.

6:17
E: Yes. Above all particulate matter, I think so. The traffic load is relatively high.

6:25
I: Exactly, exactly, and also the metallic particles that are still a consequence of industrial activities. Exactly, but what do you think the specific effects are on people now? What are the social consequences and who is particularly affected?

6:43
E: So I would say for people it's of course respiration, circulation and all sorts of things that influence that. Of course, if I live on a main road, I have a higher level of stress than if I live somewhere on the edge of a green belt and that's where the boundaries are drawn.

7:07
I: Yes.

7:12
E: In the green belt, we have other standard land values that are much higher than the main roads that are now so predestined. And as a result, of course, we already have a two-tier situation here.

7:31
I: Yes, that means something.

7:31
E: Now the bows. Yes.

7:36
I: Sorry.

7:37
E: Yes, that the flats are practically cheaper in the main street traffic than they are now in a nice location.

7:47
I: Yes, that means you would say that income plays an important role in deciding whether you can protect yourself from the consequences of air pollution or whether you can afford more expensive houses, flats in the green areas and get away from these main roads.

8:07
E: Yes, yes, yes, definitely.

8:11
I: Yes, and if you take a look at the individual neighbourhoods in Duisburg. Where are the rental and purchase prices highest and lowest? I don't know if you can give a generalised answer.

8:21
E: So yes, yes, there are standard land values from the expert committee of the city of Duisburg.
So you can have a wonderful look inside and that runs under Borris NRW.

8:30
I: Yes. Okay, then I'll write it down.

8:35
E: You can have a look and you'll find all the standard land values across Duisburg. You can read them off very nicely there too.

8:43
I: Mhm okay, very good, then I'll have a look.
Are there still one or two neighbourhoods that you can think of, which you may have found out through your work, where people are really rather left behind in some respects or in some directions and, above all, are significantly worse off socio-economically and have to live in these areas?

8:54
E: Yes. Yes. [...] Of course there are the hotspots like Meiderich here. What else do we have? So practically, where the social hotspots are at the same time.

9:45
I: So more in the north, Bruckhausen, Marxloh?

9:48
E: Yes, exactly, exactly na. I think the stresses and strains are also higher there. Because actually, when you drive in, you kind of see this grey. And you immediately get the feeling that it's somehow not as nice here as it would be if I drove somewhere like Huckingen.

10:14
I: Yes. And how is it in Rheinhausen [...], also with the distribution of green spaces and noise pollution?

10:26
E: Rheinhausen is of course also in the core area [...] that's also a bit of a hotspot, the nationalities. And I would say that if someone has a bit of money, they would never move to the city centre. Well, there are many places here, Bergheim for example, [...], [the] Toeppersee, [...] [the] Kruppsee, [...] [there are] still relatively many green spaces [...]. But the main centre in Rheinhausen itself is also a bit questionable, not so nice.

11:20
I: Okay, so what exactly do you mean by questionable?

11:24
E: Yes, so you wouldn't necessarily want to live there, let's put it that way.
11:27
I: Okay, yes. Rather in the centre, then yes, because there too the, of course the population is denser, I suppose, and therefore more noise, more traffic, less space in parks and yes.

11:30
E: Yes, yes. [...] [There is] also a shopping area. But it's not nice to live there.

11:49
I: Yes, so not necessarily the highest quality of life, in terms of the housing situation.

11:56
E: Yes, yes, yes.

11:59
I: Yes, what do you think, how can [...] [structural] solutions contribute to equalising these social differences in the quality of the living space, but also the living environment?

12:10
E: Well, I would say [...] [the] flats in social housing [...] [are] now very well adapted to high-quality living. The last flats we built have underfloor heating, for example, are very well equipped, they are also completely finished, people need them, they move in. They don't need to put any more wallpaper on the walls, the top floor, everything is ready to go. So they really only have to move in with their kitchen and furniture. And that's why the quality of social housing is relatively high.

13:03
I: Mm yes and now in the.

13:05
E: Which I also think is basically good.

13:08
I: Yes, it's a bit like equal opportunities, which you can perhaps create and also ensure that people from different backgrounds can come together and are not separated geographically.

13:10
E: Yes, yes. Yes.

13:34
I: What about the living environment? Of course the furnishings and the overall quality of the flats play a big role, but also everything around them, including access to green spaces, which we've already mentioned. Have you noticed that something has changed there or that there is the will to bring about a change?

13:56
E: I don't think it [the living environment, including access to green spaces] really matters, it's really about the flat.

14:03
I: Yes.

14:04
E: If you fall into the area where you can get a council flat, you look for the right one for you, a two-room flat, a three-room flat, whatever. And what I've noticed is that people no longer attach so much importance to where it is. The main thing is the flat. And the only thing older people ask is: What about shopping facilities in the neighbourhood? Can I get
there on foot? Yes, they also like to live on the main street because it's much more interesting than somewhere like a small, subordinate street because there's always something going on.

14:39
I: Yes.

14:54
E: Yes, if a twelve-family house is built in the city centre, then 6 Wait, now I have to think. Ne 10, how many do we have then? 12 flats and 4 of them are at the back with a view over Rheinhausen. And the others face the street. I always wondered if that would work out. The ones facing the street were gone in no time at all, because people were looking to see what was going on in the streets. There's always something going on.

15:07
I: Yes. Okay, that means you also think that because the housing shortage is so great, there's no room at all to think about not making spatial distinctions between the different socio-economic groups.
That happens automatically because you don't have much chance and space for restructuring.

15:46
E: Yes, yes, then of course there's also the land value. If it's very high, I can't manage social housing. No, I have fixed things, the rent is calculated from the construction costs and so I have a certain commitment. Well, I can't suddenly set a price per square metre for land of over €300, no, I really have to make sure that I stay as low as possible. So in terms of location, I don't have the best situation.

16:10
I: Yes. Mhm okay, yes. And are you partly involved in urban development from the municipal side?
[...] [Are there] exchange formats in which we jointly consider what makes sense in terms of urban development?

16:46
E: Is not queried at all. No.
16:51
I: So you didn't have any contacts, not even in the past?

16:54
E: No, unless you look them up yourself because you have some questions. But otherwise, the city approaches you and says: Shouldn't we develop something or something, or I don't know if they might have something like that. I don't know. In any case, I've never been asked.

17:16
I: Okay, wow. And you haven't been asked by other actors for expertise, perhaps in relation to residential inequality, that you have contacts there?

17:23
E: Not at all, not at all.

17:26
I: Okay, that's exciting. That is of course also an important point that could also help to prevent these problems, because everyone in this area has different expertise.

17:31
E: Yes, yes, yes.

17:36
I: But now I keep realising that this is a very important point that is often neglected, that hasn't been given enough space so far. Yes, exactly. But, yes, maybe now a bit more in the direction of what could be done to further reduce air pollution, but also to minimise the negative effects on social inequalities? What do you think would be necessary from a political point of view? We may have already touched on one point, but perhaps you can think of something else?
I can repeat that again, I don't know if you've understood.

18:18
E: Yes, yes, I have understood.

18:20
I: Okay, yes, so you can also think about it for a moment, of course.

18:23
E: Yes.

18:26
I: Or it doesn't have to be, if not from the political side. What about industry or civil society organisations, environmental organisations or municipal authorities? What needs to happen so that we can somehow tackle this problem better, specifically in Duisburg, or what is perhaps already working well?

18:53
E: The bad thing is that the authorities don't talk to each other at all, as we see time and again. Everyone is muddling along and so it's difficult to reach a consensus somewhere, to get on the same page. Yes, that's incredibly difficult. And it's a shame, because it's a hindrance in the long run. That's not my internal query either. We always notice that at the building authority. [Sometimes you wonder what they're networked for.

19:38
I: Yes.

19:39
E: Yes, that's how I see it in that area a bit. It is the way it is and is accepted. Of course, measurements are taken, I think Duisburg even has a relatively large number of measuring points. But what is ultimately against it and then we also have at the moment, a colleague just said earlier. Today we have Thursday, Wednesday, Tuesday, [on] Tuesday was the worst, the traffic chaos here in our area, the motorways are closed everywhere, then Rheinhausen always becomes through traffic. All the lorries that drive around Duisburg drive through Rheinhausen and that causes emissions.

20:28
I: Oh, sure.

20:34
E: That's something that shouldn't happen.

20:38
I: So you would also wish that even if there are special situations and roads are closed, that not all lorries drive away from one another, of course, but that you can spread them out a bit and not drive away like that.

20:48
E: Yes. And find equalising corners somewhere where you can divert the traffic without having to manoeuvre through the cities. You always notice it in the evening when you want to get out of the driveway, then you stand and stand because the cars keep coming from there. [...] [There is] the connection over to Moers [...] and then right towards the centre of Duisburg. So you don't notice that much is being done about all these emissions.

21:32
I: Well, they are measured and documented, but the actual actions do not necessarily follow in the form they should.

21:36
E: Yes. Yes, yes, yes.

21:43
I: Have you noticed that people in Duisburg are also concerned about air pollution? So did you [... perhaps notice that] people [...] expressed these concerns or also [complained] about the situation?

21:55
E: No, not at all. But I think they [the citizens] are also overloaded with all the other requirements that are supposed to keep them clean. Whether it's thermal insulation, sound insulation or fire protection. They no longer voluntarily
ask about any burdens, no. I just see it that way. It's an immense amount, which also costs a lot of money, because experts have to be called in everywhere, who don't work for free, and their fees are relatively high. Unfortunately, you don't ask whether you can achieve anything else.

22:29
I: Yes, that's true and I've also looked: Of course there are a few environmental organisations in Duisburg, but in terms of air pollution, it looks rather poor in terms of what's on offer and the fact that people are perhaps more committed to the rights and interests of the population.

23:02
E: Yes, I agree. Yes.

23:04
I: Yes. There are, I think that was all the questions I had in mind. Exactly, that I had specifically for you. Is there anything else you can think of in terms of experiences from your work that might be interesting in this regard? What we haven't mentioned yet.

23:24
E: Now in this area?

23:26
I: Yes, exactly, so in the area of air pollution and also the effects on social inequality.

23:39
E: Yes, social inequality. You can't say it's quite so blatant anymore, because social housing is already relatively high in terms of income. So you can already draw a lot from pensions and so on or have an income. That the poorest of the poor don't fall into it.

24:06
I: Yes.

24:11
E: That's more the stratum, yes, initially the working class.
The actual former working class, the [...] I would say that concerns, no, social housing.

24:22
I: Yes.

24:30
E: Then we have our Hartz IV people. Well, we don't have any Hartz IV people in our building, not even anyone who has registered or anything.

24:43
I: Yes.

24:45
E: Sure, new-build rents, which are now already at €6 for social housing. So we were paying €5.20 back in 2017, but it has now risen to €6. You have to come up with that first.

24:52
I: Yes. Yes, that's right.

25:07
E: Plus utilities, so heating, everything that goes with it, right. And in the meantime, they are already, yes, calculate it at just under €3, which is better for the warm rent of €9, right.

25:14
I: Here too. Yes, you have to be able to manage that first.

25:27
E: Yes.

25:29
I: Yes.

25:30

E: So social housing as it used to be has been softened a lot. It used to be tougher, so the income was much tighter, what people were allowed to have. What always amazes me about the whole story is that nobody asks what I might have left in my savings account, nobody asks.

25:45
I: Yes.

25:59
E: If I've got a million lying around, that's fine. But that's probably down to the exam itself.

26:02
I: Yes, that's right.

26:11
E: I don't know. I don't say anything about it. I stay out of it, but basically: it's not quite right. If I want to build socially or rent out. I mean, they're not millionaires or anything like that who have moved in with us, they're all older people, I'd say over 75, but they live in them.
26:13
I: Yes. Yes.

26:46
E: But the flats are also designed to be suitable for the elderly, with large bathrooms.

26:51
I: Ah yes, yes.

26:53
E: They have a 10 square metre bathroom with a bathtub and shower and all the bells and whistles, right. In total, the flat is 62 square metres for a two-person household with a nice balcony, everything you need, right.

27:14
I: Yes.

27:19
E: [...] [personal anecdote].

28:37
They [the first social housing from the 1960s] were also simpler. So I would say you can't tell the difference from privately financed housing. I mean, there are no wasted taps, but I don't have them here in a normal privately financed flat either, right.

28:44
I: Yes, so you do notice that the differences become smaller overall?
And people will have a better chance of a minimum standard of good housing and equal opportunities as a result?

28:57
E: Yes. Yes, yes, yes, yes, yes, yes.

29:02
I: Yes, yes, that's a nice development, to realise that for a start, yes.

29:06
E: Yes, and I mean, they would also, well, at least I wouldn't want to work in such hotspots, so I wouldn't want to put a house there in social housing.

29:17
I: Yes.

29:22
E: That doesn't work, it's doomed to fail somewhere, because the clientele that goes in then simply puts the flat back into a state of horror.

29:39
I: Yes.

29:43
E: That doesn't help either. The state puts so much money into it.
No, so it has to be dealt with in a fiduciary manner.

29:48
I: Yes, but perhaps it could also be achieved by not having a lot of social housing in one neighbourhood, I don't know how it's handled exactly, but by integrating the different types of houses into the neighbourhood so that the different people come together.

30:15
E: They are like that. They are freely [...] distributed. They don't have any, it's a bit different from when I look at Atroper Street up there, where it's mainly Turkish residents, where you can feel the ghetto somewhere.

30:17
I: Okay.

30:35
E: Social housing is really quite free and spread across [...] [the city].

30:45
I: Okay, yes.

30:49
E: Partly due to the fact that the developers themselves live somewhere nearby, perhaps also have a plot of land. For example: Where it's possible to build so far, so it's handled really loosely, right?

31:03
I: Yes, okay, yes, that's nice, then there are some positive aspects that can be observed in the development. There are a few approaches that you can build on.

31:16
E: Yes, it is. You can no longer see that it's social housing, absolutely not.

31:22
I: And that was different before?

31:26
E: Yes, it was kept simpler. Well, it was just the. Yes, when the materials, the choice of materials wasn't that high either.

31:41
I: Yes.

31:42
E: Now the normal materials and that's why they didn't look so nice in the flat, right.

31:49
I: Yes. Yes, exciting, yes, I think that helps me enormously, so that's all I've thought about.

32:00
E: Yes, that would be nice.

32:03
I: It was very enriching to talk to you and to learn from your experiences. I am also very pleased to be able to incorporate this information into my work. I'm also conducting a few other interviews so that I can shed light on as many different perspectives as possible on this topic.

32:11
E: Yes.

32:18
I: I don't know: would you be interested in me sending you my Master's thesis afterwards, if you want to read through one or two things? I don't know if that would help you with your work?

32:25
E: Yes, with pleasure.

32:29
I: Okay, yes, then I'll write it down. Then you might also have the small benefit of this interview, but above all my gratitude that you were able to support me so well and took the time to do it.

32:25
E: Which university are you at?

32:44
I: I'm at two different universities. One is in Münster, where I'm currently studying, but I'm also in Enschede, in the Netherlands.

32:47
E: Oh yes.

32:53
I: It's an international programme. We also study in English, I actually have to write everything in English and that's why I was partly in Münster and partly in the Netherlands for my studies.

33:00
E: Wow. Nice.

33:07
I: Exactly, and now I'm finishing my Master's thesis and then I'm slowly moving towards starting my career.

33:13
E: Yes, and in which direction is it going then?

33:17
I: I can well imagine starting work at the Federal Environment Agency.

33:21
E: Yes.

33:22
I: I really enjoyed the internship and they were also very interested in offering me a suitable position, perhaps starting in autumn, when I'm done with everything. It's a huge institution with a total of 2000 employees, so if it's not in this area, there's bound to be a vacancy in another area.

33:28
E: All right. Yes, yes, yes, then I wish you good luck, all the best.

33:49
I: Thank you very much. I wish you the same. Have a nice day. And then I'll get back to you with the Master's thesis at the end. Thank you very much!

33:50
E: You as well. Okay, see you then. Bye bye.

Changes:

- Slips of the tongue, like “um” smoothed for reading flow
- Word repetitions removed that were not repeated for emphasis, but only in the flow of thought
- Omissions marked with [...] and only made if this was personal identifiable data
- Marked in square brackets [X] if words have been added, in places where individual words are missing from the sentence but are necessary to understand the overall message

Transcript Interview 3

2nd May, 2024, 14:00PM

I: Interviewer

E: Expert

0:08
E: So I'm in for a degree. No, that's the wrong thing to say.

0:09
I: In the meantime, I would like to briefly explain to you the handling of the data that I have recorded. You have already given me permission to record this interview. As I said, this is only for transcription and later data evaluation for my analysis of the Master's thesis and all data is stored on a password-protected laptop, to which only I have access. The personal information is either left out or anonymised so that you don't have to worry about it and all my data processing practices comply with the regulations in the GDPR.
I will also delete the recording once the transcription is complete.
Do you agree with this or do you have any concerns?

0:53
E: Yes, we can do that.

0:55
I: Very good, thank you very much.

0:57
E: So you see something there?

1:02
I: Yes, I can see it now.

1:03
E: Okay, so that's a PDF that's not quite there anymore. So this is a presentation or a PDF document where [...] the social report [...] [is presented] again. That's perhaps a bit of background that we can't necessarily go into, but you also mentioned cooperation and that's perhaps a bit clearer with this graphic. Social affairs and target groups, these are basically the representatives from the housing office and the social sector. And climate and environment, [these are colleagues from the environment department and who work in climate protection] [...]. [Then there is the third pillar, the colleagues from urban development]. [...]
And yes, and the people involved, that was also a group. We set it up in this form. And if you look at the project group on the left. They asked for measures and we basically mirrored that with the people who were also involved internally and externally in the preparation of the social report. And we worked on the measures together with them and received feedback.
In this respect, we had a relatively high level of participation and I don't think that's even all the external experts.
We contacted the health college in Bochum and tried that too. But what kind of organisation is that? I'll say something like a state health authority, they're also based in Bochum. However, they were not represented because the timing was not so favourable.
In any case, we involved external people again.

And if you look to the right again, it says Advisory Board, where the city's department heads and heads of office were represented and, very importantly, the interface between politics and administration, because the parliamentary groups are also there. So perhaps that's the background to the involvement of politicians and external parties and the like.
And these are workshops where we then put together the measures that we have, where we put them up for discussion and suggestions.
The workshops lasted a couple of hours, I think, and all project group members plus external parties were brought together in a professional manner. And so, these are perhaps the measures, but we won't go into that now.

3:47
I: Yes, exciting.

4:00
E: So yes, here. And the whole thing naturally had a focus on housing, in a much narrower sense, so that we have outsourced questions and cross-relationships relating to mobility, because that is also a very strong level of action, but we have also outsourced them here, because a mobility concept is being drawn up at the same time and I'll say our measures relating to traffic, accommodation, quality, street space and the like have been delegated, so to speak, in inverted commas, so that we can deal with them in this project.
Here you can see the type of evaluation and the indicators that we have included for multiple burdens and ultimately for the questions of environmental justice. The first is heat stress. As a proxy or on the basis of our urban climate analysis, climatopes are formed and we have defined the so-called urban and city centre climate as the areas where there is potentially a high heat load.
We then took another look at the groups that are particularly affected. These are under 3 and over 65. This is because they can be distributed differently in the urban area. Then we have the green space deficit, which is new compared to the report you received at the time. We chose a 300 metre radius for the accessibility of green spaces, which is about 500 metres walking distance, which is often assumed in other concepts or assessments for green spaces and accessibility.
And then we also included the volume of greenery. This is a completely new indicator that has hardly been used so far. As part of our research project, I'll say on the one hand, we are working on a research project called Urban Green Eye, where we are trying to evaluate satellite data in a simple way and add new information, and on this basis, together with aerial photographs that have been evaluated accordingly, the green volume, i.e. cubic metres per square metre, was determined. Practically as an indicator of a green and climatic equalising effect again.

6:57
I: Yes, okay.

6:59
E: And then we have the air pollution NO_2.
7:03
I: Only NO_2?

7:05
E: That's nitrogen dioxide.

7:07
I: So particulate matter was not included?

7:13
E: Nope, nope. Particulate matter. Perhaps we can now delve into the depths of air quality, so to speak. This [particulate matter] is certainly a relevant factor, but there is no good database. If you are dealing with air, I don't know to what extent you have analysed the data situation. Here in North Rhine-Westphalia, the State Environment Agency is analysing the emission levels for various air pollutants using different measuring points.

In Duisburg, for example, there is also a PM10 station for the 2.5 and various collectors for the NO_2 range. However, they are not spatially representative because they were generally set up at so-called hotspots. This means that you don't have any information for the whole area. And in the case of PM 10, the data has been roughly available since 2008. The various emission registers for industry, small businesses and traffic have been analysed and combined using dispersion calculations, and dispersion calculations have been carried out for roads in particular. Among other things, this was done for PM10 and then for NO_2 and the, I say, the accuracy was not very high for PM10, because due to the special industrial structure that we have, characterised by the iron and steel industry, we naturally also have very high emission loads from a spatial point of view, which I don't think are listed so precisely, or for my say, which ultimately led to the fact that in the vicinity of these plants, the emission loads are very high, that the emission calculations in the vicinity of these plants are too high, i.e. the values are not particularly valid and this has ultimately also had an impact on this load simulation in the road area and therefore we have not used the PM 10 load as a basis for determining the environmental zones, but the NO_2 load, because it is accurate.

And that is why we have also focussed on NO_2 pollution here, because there is a reliable database available. And the information is available on a line-by-line basis, i.e. in the road area, because road traffic is the main emitter of the pollutant in the area. The situation is different for PM 10 and 2.5. They have a very large emission contribution from air masses that come from outside, i.e. supra-regional and regional pollution. That makes up a large part of the measurements, the pollution, when they measure somewhere. And the local contribution, i.e. from road traffic and then I say house fires and the like, is certainly there, but it is there to a lesser extent and it has more of an effect when you look at certain weather periods. So where there are low exchange situations, these local emissions are more likely to have an impact and of course you can't compare that with annual averages.

10:50
I: Okay. Yes.

11:28
E: Yes, that's how it looks at first. And noise pollution, the municipalities were obliged to carry out appropriate noise mapping and this was also done in Duisburg and broken down according to the various emissions, differentiated according to day and night, and we then also took the total pollution in each case, at the moment, road traffic.
We took rail traffic and applied assessment criteria in each case in order to then say whether there is a high level of pollution or not.

11:58
I: Okay.

12:05
E: We did the whole thing at the statistical level of residential neighbourhoods. There are 108 of them in Duisburg, which is quite a large number, so we can actually give a very good description of the area. And, of course, you also have the corresponding figures in the social area in the population area, and you can overlay all of this very nicely, or even look at specific things. And we have statistically analysed these stress factors, because they are now assessed, because there are no objective criteria that we can use to say they are suitable. And so we have chosen assessment criteria for air pollution, where we have basically only taken the very poor conditions as a benchmark, so to speak. We said 30 micrograms, 40 is the limit value and the EU Commission's current proposals are 20 in this case. And we have set ourselves at 30 because we say ok, that's there, but then it starts to get a bit or relatively bad. And we have done something similar for noise pollution. We have also included 65 and 55 as exposure limits that are relevant to health.

13:30
I: Okay, yes.

13:33
E: So that's what we did, we analysed the results for each borough and put them in order. In other words, we analysed, what is it called? [We took a percentile order and said that the last 25%, i.e. everything above the 75% percentile, are the most heavily burdened. These are our areas with particularly high levels of stress, which we then somehow described again graphically afterwards.

14:07
I: Okay. Yes.

14:22
E: So these are the social indicators. They also had questions. We have minimum income recipients, so we have considered: what does poverty mean in this case? And these are the criteria that we have defined together with the housing office, or they have defined, we have adopted. These are the people who are recipients of minimum income support. And that is then fed by these four sources that you see there. And then we also looked at the migration background and analysed it again.
This is what it looks like. Here you can see the numbers, the individual residential areas and the colours indicate the residents affected. We have now expressed the percentiles differently, so to speak, in terms of the number of people affected. And we have also done this for the vulnerable groups.
Here we have characterised those particularly affected and the areas that now have a particularly high potential heat load, so that is only a certain part of it. And yes, you can take a look at the analyses in each case.

15:26
I: Yes.

15:43
E: Here are the green space deficits. So the darker the area, the greater the deficit. And you can see that here is the centre of Duisburg, so to speak, here is Ruhrort with the port and here is where the north of Hamborn Meiderich Hamborn begins. This is the Marxloh area and here is Rheinhausen.

16:01
I: Yes.

16:05
E: So that's practically converted again here at the level of residential neighbourhoods, the air pollution here and the noise pollution there. So there's a relatively large correlation, not everywhere, but relatively strong, although there tends to be more noise pollution here, because Duisburg is cut through by motorways: A3 at the back, A59 here, A40 here, A42 up here and then there are all the railway lines, so there's a large number of people affected, right.

16:13
I: Yes.

16:48
E: So, then we've superimposed the loads here, simply added them up, so quadruple load is the highest hit, so to speak. You can see these particularly dark areas up here. And then we have superimposed this with the proportion of households with a protection rate, which is here. Everything that is outlined means that these are the various multiple burdens. Here with this diamond, these are the quadruple burdens and simply outlined here in yellow is the single burden.
So we have relatively many or if we look at the colours, just red, we really have many areas where we have at least a triple burden and at the same time the darker the colour, the darker the colour, the higher the proportion of minimum income recipients. This doesn't apply everywhere here, for example, but at least for some recipients. Do we have good, what does good transfer mean, there is a strong overlap.
And there are people with a history of immigration here. The play of colours [is] exactly the same and that is also similar, this, this residential area also stands out again. I think that's a double burden, so there's actually a very strong correlation between the two factors.

18:30
I: Just a quick question to make sure I understand correctly: multiple stress is, how exactly is it defined?

18:37
E: You can see this quite clearly in the picture on the left: H is heat, N is nitrogen, L is noise and G is ground deficit. This means that if you have all 4, you have 4 letters here and can then simultaneously recognise what is actually decisive for the pollution in the living area.

18:40
I: Yes okay, yes very good.

18:59
E: And we've simply overlaid the same thing with the benefit communities here. So that's it so far, okay.

19:13
I: Yes, wow, so how much work is already behind it and what you have already achieved in

terms of concrete results, which of course also illustrates the message very, very well. Is there a possibility that you could send me these slides afterwards?

19:24
E: Exactly. Yes, the whole thing hasn't been published yet. 16th May is the advisory board. It will set the course. I would say we'll wait that long.

19:36
I: So from 16th May.

19:46
E: Yes, this advisory board is meeting on that day and is supposed to decide on this report and these findings. And yes, I think we'll have to wait and see before I go off into the distance, so to speak.

19:52
I: Yes, of course. But does that mean you can perhaps send it to me the week after? That's why I'm asking, I have to hand it in on 6 June.

20:09
E: Yes. Yes.

20:10
I: I've got a bit of a time frame in mind and I can totally understand that with 16 May. But would it work out sometime in the week from or I say until 24th May? Or should I then rather, because I have to think about whether I then look for alternative dates, create dates.

20:29
E: Yes, no, I assume that it will probably work. So far there haven't been any, so there haven't been any very, so there haven't been any known hurdles.

20:34
I: Okay. All right, yes. Otherwise I would get in touch with you and find out how it went and whether you could possibly send me this data?

20:47
E: Yes, exactly. So, I hope that worked out now with the cancelling. Yes, all right.

20:57
I: Perfect. Yes exactly yes, great.
Yes, now I have a whole range of information and a lot has actually already been explained, which is very nice, because I have realised that you really are a lot ahead of me and have put an incredible amount of work into a very similar topic. Just again for the record, so to speak: So you said that you were aware of air pollution problems in Duisburg, especially in the areas of transport and industry, or are there other main areas that you could think of? So now, independently of the pollutants, but first of all the causes of high air pollution.

21:42
E: Yes. Yes, well, I'll have to catch up again in part with regard to the assessment of air pollutants. Because of our urban structure, we naturally have a particular contribution to emissions from industry. That is the iron and steel industry, which we have in the north of Duisburg, and in the south we also have blast furnaces and steel production, and in the centre we have the port. This is the largest inland harbour in the world. This means that the entire supply of raw materials, including the steelworks, is essentially handled via the Rhine. Transport via lorry and rail traffic, so that we have the second component, namely the logistics sector, as a major emitter of air pollutants and noise.
And then, of course, there is domestic combustion. There is not a great deal of knowledge about the particularly relevant emission structures. These include wood firing and coal firing. This still tends to be a bit widespread in the Ruhr region. Basically, we can't really estimate the weight. As far as I know, the State Environment Agency is working on a new edition of the emissions register, where it is hoped that the house wall area in particular will be a little better equipped.
It is known from studies of specific parameters that wood firing systems also contribute to exceeding emission limit values, i.e. these daily average values, during periods of low exchange and poor weather.
In other words, this can certainly be relevant and in the vicinity of industry, as you can see at individual monitoring stations if you take a closer look, there is also a larger contribution for PM 10. And in the past, up until 2012, we also had limit value exceedances for PM 10 and these were the ones that were close to industry, in the industrial limit range. Since then, they no longer do, which means that because we comply with the limit values in the PM 10 range, they were no longer the focus of attention, but rather shifted to the no 2 problem, which we were then able to expand through further, let's say simple, investigation options. In this case, the relevant sources are largely local, i.e. road traffic, and of course the spatial situation, i.e. if I have buildings on both sides, then I have higher emissions than if I only have a one-sided or open location, right?
That's why it's also a problem in the cities, including Duisburg, and I think the last time it was exceeded was in 2017. Since then, the limit values have been undercut, which is why the overall importance of the discussion on air pollution control has naturally decreased.

25:12
I: Yes. Yes, of course.

25:21
E: No, and that's why then. They're, so to speak, going into different questions of what relevance does the whole thing have? That has eased, in any case, and is basically gaining a new dynamic. At the moment it is not yet directly noticeable, but it will certainly change a lot in the next few years or next year, the year after next, when the new limit values are decided and then the PM, 2.5 system will definitely pop up and then you will realise that we have no measuring points at all. So we have a single measuring point in Duisburg, which is again close to industry, and the next one is in Mülheim Styrum, so the knowledge situation there is more than meagre, so that we will become the new pollutant, I say, with regard to the problem of compliance.
Even before PM 10, it was the daily averages rather than the annual averages and now in the future I have, I say, I'm currently analysing and evaluating the emissions situation based on the new values and then getting an assessment: where are we and what can we expect? What can we expect by 2030?
Because we know that we also have the NO_2 values.

26:42
I: Yes.

26:46
E: We have statistically corrected the data that we have from 2008 or 2011, which I believe were the last official results from the State Environment Agency. We corrected them on the basis of the trend at other measuring stations, the time factor, so to speak, and made the deduction, and that's why we arrive at these NO_2 values, so in principle we estimated them ourselves, in what order of magnitude they are. So now we have another difference up to 2030 and we can still take this into account with a certain discount and this will then lead me to an assessment of how big our emissions problem will be.

26:57
I: Are you now referring to the new EU Air Quality Directive or actually to the WHO limits, which are still not met by the new Air Quality Directive?

27:41
E: Yes, I will do both. I will, of course, take the Commission proposal first, because it is to be expected that it will be adopted, perhaps compliance will be postponed a little until [20]34 or until [20]40?

27:43
I: Yes.

27:57
E: But exactly that and yes, apart from PM2.5, we have no knowledge about that. It's difficult for us to assess that. But for PM10 and NO_2, I will do this and then I will compare both the EU Commission's limit value proposal with the WHO guidelines from 2005 and 2010, because for some pollutants they follow the proposals from 2005. For NO_2 they have deviated from this and have tightened them again, I would say, but ultimately they are still below the current health assessments.

28:23
I: Okay, yes. And from your experience now in the area of reducing air pollution: what have you noticed, what measures have been particularly successful in Duisburg, perhaps in contrast to other cities, what has been particularly noticeable, where the priority lies in the city, or what examples of best practice are there?

29:13
E: Yes, if you look at the industrial emitter group, we [Duisburg] possibly stand out a little in comparison to other cities because they no longer have this heavy industry. They have more of a problem on the transport side. The clean air plan, which has been in place in Duisburg for many years, but especially since 2008, i.e. the end of the 2000s, the first decade and the continuation, i.e. after 2011 when the last clean air plan was drawn up, there have been a large number of measures that affect the main emitters. And they all actually had an effect. And the PM 10 concentrations, as I described at the beginning, have actually fallen and then of course there have also been other processes that have led to an overall reduction in particulate emissions at national level. And that's why background pollution has also fallen.
And yes, in this respect there were various political processes that provided principles for a fundamental reduction in emissions. At some point, this also affected the motor vehicle sector

through other European standards and then local situations, which also found starting points at certain plants, diffuse sources.
And in the transport sector, the environmental zone discussion and regulations have certainly helped. I think people were more optimistic for a while, but then, oops, the diesel scandal, I'll say, came in between. So the criminal energy, so to speak, of some car manufacturers or many car manufacturers, which then led to NO_2 emissions not falling as quickly. And yes, that was actually one of the biggest measures.
And then, of course, there were lots of small [measures], but I think their estimated impact was on the lower end of the scale, such as loading zones, changes to traffic light timings, i.e. to keep traffic flowing smoothly.
But let me put it this way, the technical renewal via the environmental zone regulation has certainly I would say already made the biggest contribution.

31:57
I: Okay, yes. You've already said that air pollution as a whole plays a much smaller role than it did in the past, but there are still problems, especially in the NO_2 area. What are the social consequences of this? Are certain groups of people affected more than others and if so, why?

32:21
E: Yes, you just can't say that now. I don't know who lives there.
So I, you're talking about groups of people, you should know who you mean by that.
I can only say, and the findings we have gained there, that there are certain areas where people live who are recipients of transfer payments and have a history of immigration, so to speak, who live in areas where we have a higher environmental impact. And if these are the groups of people you are referring to, then I would say that is largely the case and the areas of pollution are of course not to be found in this neighbourhood as a whole, but always close to the actual sources of pollution.
And I don't think that the rent index allows such a precise resolution of whether you can recognise that, say, on the main roads and in the vicinity of industry. The proximity of industry is an indirect indicator of pollution: optical noise, air pollutants, which could lead to lower overall rent levels or property prices.

33:33
I: Exactly.

33:43
E: But that's not the case. I would say that's not one hundred per cent true, I think it is. So the assessment of these things is purely subjective and if I have a pleasant living environment and still have a high emissions load? Pollution. There are cases in the south of Duisburg where the soil pollution is so high that they are not even allowed to cultivate normally in the allotment garden, so to speak. So we have a very high level of soil pollution there.
Then those who offer land prices are not lower, they are high, because in this case I would say the visual quality prevails. So that's a factor that they don't have.

34:22
I: Ah wow.

34:36
E: In this question of environmental justice, it doesn't play out like that either. You would have to give it, perhaps investigate whether you can make such small-scale analyses, where practically in areas that are actually, let's say, more difficult in terms of social structure. But if

they have a nice living environment, whether this is also to be found at the same time, i.e. the poor environmental conditions as such are partly visible. If I now go to the north of Duisburg, the Brockhausen steel industry area is the area par excellence. Urban development funds have been going in there for over 30 years and I would say that not much has changed.

35:11
I: Yes.

35:24
E: And when industry was still really to be found opposite the green belt, then of course only those people settled there who, I don't know, perhaps had a special connection with Thyssen as a former workers' housing estate, or simply because the living conditions, the cost of living, are significantly lower there, and there are also the areas where we have a very high proportion of migrants.

35:51
I: Yes. Yes, that means you would also assume a connection between income and residential inequality, at least if you are aware of the situation and are not just blinded by these visual factors.
But the higher the income, the more willing people are to spend more money to live in neighbourhoods that are far from industry, far from the main roads. And yes.

36:22
E: Exactly, exactly, and then we also have and that also plays a role, so to speak, with the visual quality, the visual quality of the living environment. In the Thyssen area, I think we had a housing estate movement in the 50s and 60s, with low-rise social housing, but also detached and semi-detached houses with large gardens. In the past and nowadays, this has a very high quality of living, but these are areas where there is really heavy dust precipitation from industry and we know from the monitoring measurements that the noise pollution there is also enormous.

And then when someone moves into this area, so to speak, no, and then maybe they've only looked at the things there during the day. And then he realises, oh, I've got all my children's toys, the garden, the patio is always covered in dust and then it's also noisy. Then he wonders where he's got to. So the visual impression plays a role here too, so to speak. I can't say whether the land prices are particularly low, that would just be a question of further evaluation, right.

37:46
I: Yes, yes, exactly, I am actually in contact with others from the construction sector. [...] Exactly, I can then look into it in more detail.
What about health inequality then? So to what extent is this also partly influenced by income inequality or residential inequality? It's a bit about that.

38:20
E: So health and income are certainly connected in a certain way, but I don't think we can go into that any further here. So that will mean that people who have money tend to take better care of themselves with food supplements or better food and therefore tend to be healthier or

have a different lifestyle and are therefore healthier. I think this has probably also been proven by other studies. There are no such small spatial statements.
But that is now the part from the health sector that I can perhaps refer to:
In principle, large parts of the city administration worked together on a specific project and evaluated the various analyses they had in mind on a spatial basis. And then it came out that for areas of Duisburg, that was a certain segment that was under discussion. And that's what came out. So we had, so to speak, compiled the analysis of the multiple exposures there and were able to localise the areas that were particularly affected. And the public health department then analysed the school entry examinations and found that, on the one hand, the children had coordination disorders, i.e. they were above the average for Duisburg, and obesity was also significantly higher. And these are even higher in migrant neighbourhoods than in other areas. And both factors were of course higher in the area.
And the analysis is, of course, that the lack of green spaces, i.e. too few green areas, too little recreation close to home, promotes a lack of physical activity. Certainly not just the cause, but the connections can certainly be drawn, that the interaction with the environment is not so pronounced in young children, so to speak, or the opportunities are not there, and then overall it is perhaps due to the poor quality of food or the fact that people eat other products and do not live or eat in a way that is, how should I put it, health-orientated, that there are these obesity abnormalities.

41:19
I: Yes, okay, yes, very interesting. I have another question now, which would also be more about health. It may be very specific, but I'll ask it anyway. Perhaps you have an idea: have you observed that certain population groups are more affected by physical health problems that can be attributed to air pollution? In other words, respiratory and lung diseases. I don't know if you have any insights from the other, from the health authority.

41:48
E: There are, there are no studies. Well, you would have to analyse the sickness absence figures. There is a code number for each illness. You could ask the health insurance companies about this, but of course you wouldn't have any more detailed background information. And you have described impact factors, which are only part of it. Overall, cardiovascular diseases are just one of them [the impact factors], due to the stress reaction. Again, it is very difficult to separate this from noise emissions and the effects. So you can basically take the air pollutants or the noise situation as an indicator that there is an increased health burden in their vicinity, i.e. around the road traffic line in a corridor of around 50 metres. You can say that and then you could also calculate how many people that is.

42:49
I: Yes, that's right. And can you give specific examples from your experience, perhaps through your work, that suggest that air pollution increases inequality in society? So just in case you can think of any situations off the top of your head?

43:11
E: Yes, certainly the situation. In other words, the neighbourhoods have changed over the decades. So those who can afford it move to other areas where there are fewer pollution factors, right. And you can't just blame that on the air pollution, but as I said, it's more of a, in addition to the, I think the living environment plays a very big role, because that's what people perceive. They don't see the PM 10 pollution, they don't see the [PM] 2.5, they don't see the No_2 pollution either. In other words, the concern and the effect on the individual works through experience and experience is the dust precipitation. But it doesn't have any particular,

let's say, harmful functions or effects, but it is the external characteristic that something is wrong with my environment, right. And together with the lack of green space, which is what's there, that leads to young families moving away from Duisburg altogether. There was at least a movement like that at one time, i.e. the desire to live in a rural area or in quasi better neighbourhoods. And then you can see where they are, you can see that in the land prices.

44:40
I: Yes, yes, yes, exactly.
So now I'm going to go a bit further in the direction of the social reports. I think you told me on the phone two weeks ago that you are also working on this current social report and I would be interested to know what the response to it was? You indicated that you don't really know directly what the concrete consequences are, what happens with such a social report. But what did you learn about what, in what form perhaps it was taken into account by political decision-makers or where not, where the weak points are?

45:27
E: Yes, perhaps you have to look at it on two levels: Politics and, so to speak, the overall impact of this issue, which we first spread out over three or four pages in the housing report in 2017, and a housing report like that usually has 150, 200 pages, I don't know. But in relation to this, there was a very strong reaction to it in this so-called professional world, which then, I'll say, responded positively to the fact that such an issue was being addressed. And it is precisely this regional housing market observation, where it is also anchored, that has basically made it more or less a kind of demand that other housing reports must also deal with such issues. I can't say to what extent this has now taken place. And the impact of this area, the 2017 report in Duisburg, I'd say I only noticed it indirectly. Not directly, actually. So there was praise from all sides, but I didn't notice any consequences from the political side. That doesn't rule out that it was there, but I didn't notice it. And on the other hand, I would say that, at least indirectly, the politicians have also said, yes, we should continue to deal with it or include it, because with this social and housing report we are not only taking up this old evaluation, but it is also being examined in much more detail, analysed in more spatial detail and also provided with a canon of measures from the areas of housing, social affairs, climate protection, environment and urban development. And that is certainly something completely new, something that tends to be new, I would say, because we have just said that these concepts usually disappear into a drawer. Everyone is glad that they don't bother with them. And then after 10 years you ask what it looks like?
And that's what we've done now and we've realised that, oh, not much is actually happening. And that's why we said we wanted to work in an implementation-orientated way and this train of thought, which of course we also communicated to politicians via a printed matter, so what do we want to do, so to speak, the joint development of this housing and social report from, let's say, the various disciplines and what do we want to do, we also want to work more precisely and we also want to somehow take care of this socio-ecological imbalance, no, to work through that. And that is perhaps also an indirect impulse, as the politicians, who also decided this, naturally supported it. So they could have said, yes, we don't care about them, they don't bring us anything, they just cost us something, no. But that didn't happen. But that's not what happened and in this respect, let's say, it can certainly be seen as a positive contribution, perhaps also a positive image on the part of politicians.

49:09
I: Yes. Yes, definitely.
49:15
E: And this 16.5, maybe we'll get some more impetus, no, like that, because now we've

described it relatively precisely, what needs to be done, no. And in the best case scenario, the politicians should decide that we want to implement these measures, and you'll get money and staff for it. Because, of course, we have also explained again that these measures have consequences.

49:26
I: Yes. That means they would.

49:44
E: So with the available budget, the resources, it can't be covered.

49:50
I: Yes, that means that you would perhaps now, looking to the future, wish for an exchange not only in relation to the, so also in the follow-up, so to speak, that you could perhaps stay in contact, perhaps also by talking again about the exact measures and how they are really implemented, would that be something where you would think, yes, that would, at least once, create a little more pressure and commitment, of course, but also establish even closer cooperation, which is not only designed for individual projects, but also for a longer period of time.

50:27
E: Who do you have in mind for the collaboration?

50:31
I: Yes, that's, well, I was thinking first of all of the policy makers who actually adopt the measures in Duisburg itself, i.e. from the municipal side exactly. Among the departments, of course, I've already heard that from you. There is a very close dialogue in some cases, but above all with the political decision-makers.

50:53
E: Well, the politicians were involved in this development process, whether it was through these advisory board meetings, they basically accompanied the various work steps and the products with the objectives, sub-objectives and measures and now is the last meeting of this kind, where you can take a closer look: What are they actually up to? And where do the experts see the starting points, so to speak?
And here I hope on the one hand for a critically positive accompaniment, no, in the best case scenario, which on the one hand sets priorities, no, in these and these areas, you should, let's say, do more or rather implement them accordingly or perhaps get another assessment of the measures, the objectives, how to deal with them.

51:25
I: Yes. Yes.

52:03
E: And ultimately, as I said, I would say that this meeting is a barometer of what will come out of it and it will enter the political process at the beginning of June, when we feed the printed matter and the report into the various committees and the district council, where these meetings will then ultimately take place from September and continue until October, when the concrete decisions will be made by the majority in the council. There will certainly be another exchange, consultations in the meetings. And this advisory board, there are representatives on

it, but of course they also feed this back into their parliamentary group and that's why I say that the barometer of opinion is whether they want to continue along this path.

53:02
I: Yes, are there any other actors that you can think of specifically where you would perhaps like to see more willingness to be involved, to perhaps also point out problems that could arise when implementing these measures and how they can be solved. And exactly what else would be necessary to further reduce the impact of air pollution on social inequality?

53:27
E: Yes, well, I don't just want to focus on the issue of air pollution, of course, but there's another side to the story.

53:34
I: That's right.

53:39
E: So the people on the ground who are affected by this naturally benefit so much from measures that, let's say, increase environmental resources. And if you look at this in our canon, i.e. reducing noise, reducing air pollution, increasing the proportion of green spaces and counteracting climate change and heat stress.
And then, when you look at it, you have to consider: who can do what? Take the building out of the equation, i.e. the landowner, the building owner or the landlord, because in many cases it's not owners we're dealing with, but tenants. They are afraid of a price increase because, from a climate protection perspective, there is of course a transformation task, which this project is also intended to highlight. So we have various conflicting objectives and then we have conflicting objectives with the planning, because they don't want to build on the outside, they want to build on the inside. They can build where there is nothing, so in case of doubt there is green space or a wasteland. And of course they want to have greenery in there, greenery and shade, so to speak.

54:25
I: Yes. Yes.

55:02
E: That's the living environment, so to speak, and the building owner, who has nothing to do with air pollution at first, but he can of course make sure that his tenants live in a building that has been renovated accordingly, so to speak, that has light-coloured surfaces and where the attic is specially developed again so that the tenants don't start to fry up there in the summer. So there is a certain structure of responsibility, so to speak.

55:20
I: Yes.

55:30
E: And what would I like to see in the participation: On the one hand, of course, you have to inform them about it first, no: how do you see the connections, no? What and then what could you do? And then, I'll just say, I hope that the money, subsidies, whatever it all comes together in such a way that an action is taken and ultimately brings about an improvement for the tenant.

55:53
I: Yes.

55:55
E: We have the same thing in the residential environment: who is responsible there? In principle, we say the city and individual property owners with regard to the spatial structure and utilisation. In other words: how do we get greenery in there? That's partly the Environment Agency, because they are the managers of green spaces.

56:05
I: Yes.

56:09
E: In other words, they have to organise their green spaces in such a way that something is done to combat lack of exercise. That there is shade, that there is drinking water, fountains, so that health concerns play a role. And then, of course, this competition for use, well, that's what we call double or triple inner development. In other words, if I build, I have to take compensatory measures at the same time. Of course, I think it would be better if we could invest more in green-blue infrastructure, because at the same time, indirectly, of course, this generally results in less air pollution. And my buildings are generally always aligned with roads. If I put a development there, I automatically create and worsen my air pollution, because road traffic leads to higher emissions. So here, too, less development is actually better for air quality, from a purely spatial perspective.

56:58
I: Yes, very exciting, in any case. What about, as a final question, environmental NGOs or activism in general in this area?
You said that the problem is being perceived less and less as a problem. I don't want to limit myself to air pollution, but perhaps environmental problems in general. Is enough happening, are people informed enough about it? Is it a concern or is it perhaps overshadowed by other social problems in Duisburg?
overshadowed by other social problems in Duisburg? And would you like to see more attention paid to it?
57:50
E: That's definitely the case, due to the waves of migration from south-east Europe since the 2010s, on the one hand Duisburg is growing, there are more inhabitants because we're getting a lot of people from Bulgaria and Romania. And we have a social problem in that they are congregating in certain neighbourhoods and are therefore experiencing difficulties due to the different cultural situation and way of life with the local residents. And I think that puts a strain on the neighbourhoods and the structure. And I don't think air pollution plays a major role here.
And the interest in such, let's say, environmental situations is also generally associated with, I would say, a higher level of education, because they are more likely to care about it, right? What is perhaps perceived as a problem here will have long since exploded in Münster, because people deal with it in a completely different way. And we don't have that kind of social structure and that's why it's not categorised accordingly, let's say, and other factors naturally overlap. And what was the core of the question again?

59:05
I: Yes. The core yes, whether more activism would be desirable, more, yes.

59:24
Oh yes, we have. So there are various initiatives that, due to the history, I would also like to say, deal specifically with air pollution. So one initiative and the environmental association BUND, they also have a great deal of expertise in this area and also comment on the relevant planning projects, such as urban land-use planning or according to the Federal Immission Control Act or road planning, and also bring these aspects into play in each case. So in that respect it is very active, I would say more so than in other cities, I would assume. Although of course this is always blurred, because they also deal with the issue in principle, while other concerns and agitations always arise from personal involvement. For example, when a development site is built at the end of the street and people are afraid that there will be too much road traffic and therefore the dog run or the open space will be lost. But that's basically, let's say, the personal concern that triggers his commitment rather than the endeavour to improve the quality of the environment. That is more likely to be the case with these institutional stakeholders or groups, and we certainly have them.

1:01:03
I: Yes, that's very nice to hear. These are somehow very optimistic points, that a lot of things are already going well and offer good starting points, especially with the sending of the social report, to show the right effect.
Yes, thank you very much.

1:01:23
E: So it will be very exciting to see what comes out of this and we actually want to give a status report every two or three years on how the measures are being implemented so that it becomes clear where there might be a problem.

1:01:34
I: Yes, that's exciting. Unfortunately, I can no longer include that in my report, but of course it's nice to see afterwards what exactly happens with it.

1:01:50
E: Perhaps you are still aiming for a doctorate and can evaluate such processes again for another time?

1:01:55
I: Yes. Yes, yes, I have to say I wouldn't rule it out. I'm not sure at the moment, but I'm doing one thing at a time, starting with my Master's thesis and then the rest will follow. But I definitely find the field very exciting, I have to say. And also the direction of sustainable urban planning, even though I have more of a political science background, but yes, I think it's a very interesting and increasingly important area in general. Exactly.

1:02:04
E: Are you also planning to address the politicians, i.e. the parliamentary groups?

1:02:30
I: Yes, now specifically for the Master's thesis, or what do you mean?

1:02:34
E: Yes, for example.

1:02:36
I: Yes, actually not, because I'm trying to keep it neutral and I wouldn't be able to do that if I was only in contact with two parties, so to speak. That would also go beyond the scope of this work, especially because I have to hand it in in a month's time, I can't manage that.

1:02:51
E: Yes.

1:02:52
I: But I now have a total of 5 interviews, each with different perspectives, and I believe that I can create a good overall picture for the time being.

1:02:59
E: Mhm, then you can suggest to your examiners that the next Master's student should deal directly with the political side, i.e. how politics takes up and perceives these processes perhaps.

1:03:19
I: That's right. Yes.

1:03:26
E: Then in a certain way this will be a continuation of your work and at the same time this perspective will still be in it, yes, how will it be dealt with now?
Because that is of course also a topic that is not quite old, no. So it tends to be old, of course, but it's not presented so offensively, let's say, and in this respect it's interesting that perhaps in two or three years' time it will be looked at again: how do they react, how do politicians react in the cities where this has already been addressed thematically, right?

1:03:59
I: Yes yes, very interesting. I'm very happy to pass that on. Exactly, yes, I think that's it for now. We've been talking for a really long time now.
1:04:09
E: Good.

1:04:10
I: Thank you very much for your insights. It was very enriching for me. I look forward to incorporating all the information into my work. If you like, I can send you a summary of my results or the Master's thesis itself as soon as it is finished.

1:04:23
E: In any case, the master's thesis, then you can also, let's say, take it to heart again and then perhaps you will bring together the different points of view again. You can certainly take something out of it or your assessment of it, no, the, the, the political influence, you won't be able to write much about that because you can't determine it, but at least how you deal with it in administrative practice, so to speak.

1:04:40
I: Exactly. Unfortunately, yes.
Yes, at least that's the hope. Yes, thank you for your time and have a nice day. You'll definitely hear from me and I'll check the dates again after the advisory board meeting.

1:05:06
E: Exactly. Mrs Heuer, I wish you every success and a good grade.

1:05:13
I: Thank you, that would be nice. Okay, bye.

1:05:19
E: Ciao.

Changes:

- Slips of the tongue, like “um” smoothed for reading flow
- Word repetitions removed that were not repeated for emphasis, but only in the flow of thought
- Omissions marked with [...] and only made if this was personal identifiable data
- Marked in square brackets [X] if words have been added, in places where individual words are missing from the sentence but are necessary to understand the overall message

Transcript Interview 4

3rd May, 2024, 2:59PM
I: Interviewer
E: Expert

0:08
I: No, that all fits. Exactly. Then thank you very much for your consent. I am Sheila Heuer, a Master's student at the University of Münster in Comparative Public Governance and the University of Enschede. Exactly, and as you have already learnt, I am conducting research on the effects of air pollution on social inequality in Duisburg as part of my Master's thesis. Exactly and because you are exactly the right expert, I found this very exciting and I was also very pleased that you were prepared to answer my questions. Exactly, very briefly about the handling of the data: I am only recording the interview via audio, and will only use it for my data analysis. It's all stored on a password-protected laptop that only I have access to and I will delete it immediately afterwards and I will anonymise or leave out all other personal data, as stipulated in the GDPR. Do you agree with this?

0:58
E: Yes, I agree with that.

1:00
I: Yes, thank you very much. Exactly, I have already given him a rough insight into the questions by e-mail. Now.

1:06
E: Yes, thank you very much, but I have another question about your degree programme. What is the content of the programme? I hadn't quite understood that yet.

1:14
I: Yes, it's a lot about political science from an international perspective. So I'm studying in English, I chose to focus on sustainability myself and I was interested in this research topic because I did an internship at the Federal Environment Agency in the last six months and had a lot to do with the EU's Zero Pollution Ambition. And that's exactly why I came across it.

1:41
E: And indeed, I just understood you correctly that only Duisburg is of interest to you now.

1:48

I: Exactly. So, I only chose Duisburg as a case and conducted a total of five interviews with different experts to shed light on different perspectives in order to understand these dynamics: how does air pollution affect social inequality and also, towards the end, what can perhaps be done, what would be desirable so that the effects can be reduced.

1:58

E: Yes, okay.

2:11

I: Exactly, yes. Perhaps you could introduce yourself first, tell us what position you hold and how long you've been working there.

2:14

E: Yes, with pleasure. So my name is [...] [Interviewee D]. I have been working since [...] [as a social expert] [...].

3:15

I: Yes, interesting.

3:15

E: [What is interesting is that environmental factors] have not [played a role] at all in housing market monitoring in the past. There is housing market monitoring at state and federal level and also regionally, and there is a non-binding table of indicators. However, the environmental component is not included anywhere, and in this respect the 2017 housing report, which was published in 2019, was actually a novelty. And that was a project within the framework of housing reporting to investigate precisely whether there are connections between poverty and the environment, justice. The factors air, noise and geoclimate were then analysed and combined with our data on poverty, which we filtered out from the transfer of benefit recipients under SGB 2.

And yes, perhaps first of all.

4:00

I: Yes, it's also very interesting that you've already indicated that there has been a development in recent years in the direction that environmental issues are becoming more and more involved. Are you aware of the air pollution measures being taken in Duisburg through

your work? Or rather, where is the focus, in terms of best practice examples, which perhaps distinguishes Duisburg from other cities?

4:29

E: Well, first of all, you have to say that it's no surprise that there's air pollution in Duisburg. In other words, I think it would be surprising [in the] Ruhr region if it wasn't. In this respect, it wasn't a surprise, but we were actually interested in the regional distribution and then the context of poverty. [...] [We obtained the necessary expertise on the subject of air pollution from other areas]. And perhaps also exciting for you, because these are different disciplines and different perspectives. It was actually exciting to agree on this topic, i.e. how to look at the whole thing and not talk past each other. Everyone has their own perspective and their own specialist jargon and we really had to get our heads together first in order to be able to create a joint project.

And we actually went in with a hypothesis. We surmised that there were correlations, but then we wanted to use objective data to check for the first time whether our assumption was correct. Because in the end, facts count and we wanted to verify our hypothesis. [...].

6:12

I: Yes.

6:13

E: In this respect, I can't say anything about air pollution, but as I said, as a former industrial location, it's not surprising, although I don't know what reductions we've already achieved in air pollution. I can't really make a statement on this, but we have looked at
the current situation and, regardless of whether it is a lot or a little, we have only looked at the spatial distribution. Yes, perhaps so far.

6:46

I: Yes, what have you perhaps already noticed? I assume you are also referring to the social report, which will be published soon.

6:55

E: Yes, exactly.

6:57

I: Nevertheless, I assume, I think the advisory board meeting is in a fortnight' time, when [...] [Interviewee B] already informed me that the first tendencies could already be determined

somehow, what these social consequences of air pollution really are and regardless of how one categorises the level now, but what effects it really has.

7:14

E: Well, the first effect was that we were able to confirm our thesis and publish it with the housing report. And that really caused a stir because it was the first time that these indicators were included and then the, I think it was the Technical University of Dortmund, which was involved in the ZUKUR [Zukunft Stadtregion Ruhr] project, actually analysed: who included these environmental factors in their housing reporting or in any other context? And in fact we were the only ones out there.

And [...] [the] social report, which at the same time has a dual function: [...] [firstly] social reporting [to analyse spatial inequalities] [...] [and] also the housing action plan, which sets out the political guidelines for housing, [whereby] [...] and environmental factors are included. [...] [It was] proposed to continue in this way and in this respect, the politicians also agreed that [...] these areas should be [...] [linked] with each other.

And perhaps something special about Duisburg: elsewhere, the topic of housing is usually part of urban planning and urban development. That's not the case in Duisburg. So there are other reasons for this here. We always try to avoid interfaces, and there are interfaces between housing and social issues, just as there are with urban development. And [...] [therefore the] Office for Social Affairs and Housing [...] looks at housing from a social perspective. And in this respect [...] [the Office for Social Affairs & Housing] works on the social report together with the area of urban development, which is separate in our organisation, and with the area of the environment, which in turn is separate. So these are three completely autonomous areas, and we are actually trying - and this is indeed a challenge - to bring these three sub-areas on board here in order to achieve an overall view of the topic of housing with its social facets, but also with the environmental facets. And it is indeed a challenge, as in the small housing report project, to find a common language and to understand where the sensitivities or the important points lie in the other areas, to bring it all together so that it does justice to everyone and, of course, ultimately also brings the city of Duisburg forward with the findings that can be drawn from it.

10:04

I: Yes, that really sounds like a big challenge.

10:08

E: Well, indeed. In fact, the task of the social report and the housing action plan is to provide implementation-orientated recommendations for action and proposals for measures so that we not only, yes, have the knowledge, but also think directly in terms of implementation. That is precisely what housing reporting cannot do. Housing reporting has a different function. It has an early warning function and informs and analyses, but it does not yet provide an option for action or legitimisation for measures. The so, the action plan continues the thread. So this is really also about action, and in this respect it is all the more important and this is important for

the areas of environment, social affairs and housing, and in this respect the interrelationships are important. Yes, it's difficult to get that across in so few words. It may sound easier than it is in practice, because there are actually a lot of conflicting goals. Because if you could say, of course, that it's not so good to live where there's air pollution, but people have to live somewhere, and if we're in the middle of the Ruhr area and there's a certain level of pollution everywhere, then the plan would be naive and would reach its limits. In this respect, you have to look at the root cause, you have to reduce air pollution. That would be my wish, as you also ask: what can be done or what would you like to see?

11:43

I: Yes.

11:44

E: Well, I would really like to see a reduction in air pollution so that the living conditions are better and these spatial differences can also be reduced. One thing is very clear: air pollution is a location factor. And in this respect it affects housing. This is a very important point, because the spatial differences, i.e. our thesis was confirmed: there are areas where there are overlapping factors.
I don't know how far [...] [Interviewee C] has already gone there. So we practically superimposed several areas and we found that air pollution often goes hand in hand with high levels of traffic pollution, i.e. that noise levels are also high. There are also exceptions where the noise is not present. There are always exceptions, but the rule is that where there is high air pollution, it tends to come from traffic and not just from industry and is also directly linked to noise. In
other words, we have two negative factors that sometimes overlap.

And then we also analysed the green space deficit, i.e. the bioclimate, and we layered that on top of each other and then again the layer that interests you, the poverty part.

13:03
I: Yes.

13:03

E: And there were actually areas with single, double, triple or quadruple pollution. So we have more and more layers on top of each other and where the overall conditions are poor, where many poor people live with high levels of noise and air pollution. These areas are simply there, there's no denying it. Yes.

13:03
I: Yes, you've just said that you would basically like us to simply try to reduce air pollution as much as possible so that we don't continue to have this negative social impact. What else

would you like to see? Apart from the cooperation, of course, which has probably already got off to a good start, including between the various specialist areas, that people don't work on their own, but bring the different perspectives together and apart from the measures that will hopefully be implemented as a result.
What else should other players do? What would you perhaps like to see from the industry side or should other experts from the construction sector be involved more? What about environmental NGOs? Is there more need for this in Duisburg? You don't
have to go into everything in
detail, but what perhaps comes to mind in particular.

14:15

E: Yes, of course there are many important players. Of course, we are now looking through our municipal glasses. The action plan focussed on: what can [the] [...] city do? What suggestions can we make as to where we can improve the framework conditions or where we can start as a municipality?

What we cannot do, for example, is to stop an industrial company from reducing its pollutants without a legal basis, if there is no legal basis. We could perhaps take action by incentivising them.
But I think the most important thing is to keep talking, to actually analyse the situation objectively, sit
down at a table and look for solutions together. But the city, the local authorities, are actually reaching their limits and this is where the federal or state legislator is also required to set appropriate guidelines.

But then, of course, there are other conflicting goals to consider, such as economic efficiency, because in the end, of course, it's the jobs that count, which is a very complex area.
But the most important thing, I think, is that what we are already doing is that the different areas do not think for themselves individually with blinkers on, but sit down together around a table. In the same way that we do with people with different problems, so to speak, we have case conferences where different disciplines sit together and talk about problems and solutions. That is important and desirable and the project has also shown, firstly, how challenging it is, but also how important and how right it is.

15:52

I: Yes, and what role should the population play in this?
So do you have the feeling that people are aware of the situation and would also be prepared to accept measures or will that also, I mean, there are enough other problems, will they tend to overshadow the whole dynamic and leave little room for environmental issues overall?

16:17

E: It's difficult, of course. [...] [What I can say is] that poor location criteria have an impact on prices, and on rents. And that, in turn, is our segment and that is also why there is this uneven spatial distribution. Where many poor location criteria apply and air pollution is just one of

them. People who can choose where they want to live and don't have to look at their wallet will move to a place where these factors don't coincide. Because it's no secret, well, the data is basically public. And sometimes you can see it, hear it, smell it, whatever. You can also determine it that way, but also on the basis of the data. And if I can choose, and I don't have to look at the cent, I move to where there are no stress factors. So in this respect, of course, it's a bit of a social problem, but one that we can't easily solve. So that's where it gets difficult.

17:18

I: Yes. Do you then also think that air pollution continues to have an impact on health inequality? So exactly: I'm a bit interested in shedding more light on this dynamic between the various dimensions of inequality. You've already said that the higher the air pollution, the higher the rents in the better areas, so to speak, where there is less air pollution. Exactly, but what about health problems?

17:18

E: So of course we have taken the factors as a basis, for once the project in the housing report, but also now, where the health risk begins.
So there are always limit values, certain limit values, which are based on where health effects occur. In this respect, where there are different problem areas, such as noise and air pollution, health is of course also endangered in this sense, or at least the conditions are worse.

I'm not a health expert, but it definitely has or can have an impact on health. In this respect, of course, it also contributes to social inequality in terms of health factors. So, that's [health] also a reason for the, for the, our action plan. We have actually brought together all the disciplines that have something to do with this. On the other hand, you also have to limit it. In the end, everything has something to do with everything else. That will be difficult, but the health department is also involved and has an interest in bringing about an improvement in the initial situation. It's just not always that easy. So in many cases, at least in Duisburg, if you look at the motorway, if you look at the motorway and rail network and so on, if you superimpose it on this map, you can of course see that a lot of air and noise pollution comes from the main roads.

19:21

I: Yes.

19:22

E: But we actually need the roads, they're full to bursting. I don't know how well you know Duisburg, but we are also a logistics centre and have the port here. The route to the airport also goes through here and so on and so forth. So it would be more of an effort to redirect the traffic flows, perhaps only shifting the problem, but perhaps organising it more intelligently [...]. [But that would be the job of urban development].

19:22
I: Yes, that's true. Of course, that makes it more and more complex, because in the end there are a multitude of aspects and a multitude of experts who have to be involved, which of course poses other challenges in terms of coordination.

20:11
E: Yes, that's [the coordination] not quite the problem. That could still be solved. But there are indeed tangible conflicts of interest and I sometimes have the impression that this is swept under the carpet in politics. I simply can't do justice to everything and then sometimes I have to be honest and say: that's just not possible.

Let me give you an example that is relatively close to home. Everyone wants to live in houses that are climate-friendly and well-equipped in terms of energy efficiency, but in the end it can't cost more because it comes at the expense of affordability. Yes, but how is that supposed to work? But that's just one example of many.
And if I only look at it from a social point of view, then of course the affordability of housing is important to me and I can't say that climate protection doesn't interest me. And colleagues from the environment and climate sector, who want to keep houses energy-efficient, but affordability is not their core concern or their responsibility. But you have to think about that together and it just doesn't fit.

21:14
I: Yes.

21:15
E: And then, as politicians, you actually have to set priorities, whether you set them selectively or thematically, whatever. But that is the political discourse: how do I deal with these conflicting goals? And that will indeed be the challenge. And it is no different at municipal level than at state, federal or EU level. There are these conflicting objectives, and if I do justice to one, I harm the other and how can it all be reconciled?
Then interests come into play again: economic interests too, of course. If the city were now to endeavour to reduce traffic and would now, I have no idea, close roads so that you can't get through Duisburg. Then, of course, industry and trade will howl, because how are they supposed to do their work if they can no longer get away from one and the goods can't be delivered? So these are really very complex problems and challenges. There are no simple solutions.

22:12
I: Yes, and that will probably be a long road over longer processes until you can find the best possible way to do it. I have.

22:21

E: Well, I would hope that many people don't look at their topic with blinkers on, but take a broader view. It doesn't help if I do something good for one topic.
But I'm harming another goal. It doesn't work like that and I think it's a shame that various interest groups, regardless of their nature, are really dogged and focussed on their goal, but ignore everything else and that simply doesn't work and that's the job of politics. Yes, basically to do justice to this and to see the big picture.

22:50

I: Yes, that's right. Yes, that's a very interesting point, especially with this interdisciplinarity, which is becoming increasingly important, that you want to keep an eye on that and then regulate it.

Yes, I have one last question. Perhaps, we've already touched on a few aspects, but maybe you have one or two new ideas? To what extent have you observed that air pollution affects different social groups in Duisburg unequally?
Now perhaps, we've already talked a lot about this income aspect, I don't know if there's anything else you can think of.

23:21

E: Yes, you're probably asking for a reason. The fact is that we have also seen and established the connection that where there is a lot of poverty, the proportion of migrants is also above average and that this also affects the areas of migrants more than average.
On the one hand, this is a poverty problem and perhaps also sometimes a matter of attitude, in that many or some foreigners also have second homes and are perhaps not prepared to spend so much money on housing in Germany, even if they perhaps could and then tend to live in this area.

So there are overlaps between poverty, migration background and various pressures caused by environmental factors of all kinds. So we can also see that and we can actually pinpoint it in certain areas.

24:18

I: And regardless of the migration background, that others, yes, no, I think that's done, no, it doesn't matter, you've actually already answered that, yes, I'll have a quick look.

24:18

E: So it was actually a different issue. It relates more to the area of heat and lack of green space. You could really see that children under three are more likely to be affected, but you can't transfer that to the area of air pollution, for example, but I'm not so deeply involved in the subject that I can say that.

24:52
I: Sure. Yes, [...] [Interviewee C] also wanted to send me some data, depending on how it goes with the advisory board meeting, where I could then also use your evaluation, where that was then overlaid with a reference.

25:03
E: Yes, that's a bit difficult, so the schedule gets in the way a bit.
In fact, we can't release anything until the report has been approved. And the advisory board meeting is an important point, but after that there is still no release for the submission. Because there is actually a formal procedure that requires approval from all of the city's departments before it can be released and that, after the final touches have been made to the report and we have planned to bring the report to the committee meeting in September, it will probably not be released until mid-August or early August.
That will not be the case before then, and that is probably too late for your work, yes.

25:45
I: Yes, unfortunately. No, that won't help any more. But well, I already have a lot of information about it.

25:49
E: So as a starting point, as a source, which is public, you can take the housing report in any case and maybe google the ZUKUR project again. I think it was the TU Dortmund, but I could be wrong, but you should find something under the keyword ZUKUR and the keyword environmental justice.
Perhaps you will find something public that you can utilise in a concrete way.

26:12

I: Yes okay, yes, I'll have another look then. Thank you very much. Exactly, I would otherwise give you the space again, maybe there's one more thing I haven't asked you about that you've thought about that could be interesting in this context.

26:28
E: Not from my point of view.

26:31
I: Yes, very good. Then I think everything important has been said. Yes, thank you in any case for all your different insights. I've been able to learn a lot myself and I'm really looking forward to incorporating your expertise into my work.
Yes, if you would like, I can send you my Master's thesis afterwards if you are interested.

26:47
E: Yes, I would love to.

26:48
I: I think that will be the case in July, until the colloquium and everything is finalised, but maybe it will be interesting for your work again. Yes, and thank you very much. Have a nice weekend now and thank you very much.

27:04
E: I wish you the same and every success in completing your degree. And all respect to you for doing it in English only. Hats off to you! Have a great weekend!

27:08
I: Yes, thank you. Okay, thank you very much! Bye bye!

27:13

E: Then have a nice weekend!

27:17

I: Thank you too.

Changes:

- Slips of the tongue, like “um” smoothed for reading flow
- Word repetitions removed that were not repeated for emphasis, but only in the flow of thought
- Omissions marked with [...] and only made if this was personal identifiable data
- Marked in square brackets [X] if words have been added, in places where individual words are missing from the sentence but are necessary to understand the overall message

Transcript Interview 5

16th May, 2024, 03:02PM

I: Interviewer
E: Expert

0:08
I: Right, that should work now. Very good. Exactly, thank you very much once again. I am Sheila Heuer, a Master's student at the University of Münster and in Enschede on the Comparative Public Governance programme. And as you've already heard, I'm doing this research as part of my Master's thesis on the effects of air pollution on social inequality in Duisburg.
Exactly, I came up with the topic because I did an internship at the Federal Environment Agency and had a lot to do with air pollution and found it very interesting, especially from this social justice perspective.
I would like to explain a few points to you regarding the handling of the data. You have already given me permission to record the interview. As I said, this is only used for transcription and later data evaluation for my analysis and is stored on a password-protected laptop, which only I have access to. And all personal information is either left out or anonymised and all my data processing practices comply with the laws and regulations as set out in the GDPR. I will then delete the recording after completion.
Do you agree with this?

1:18
E: Yes, I do.

1:19
I: Very good, thank you very much. Exactly, and I was very pleased with your feedback and your willingness to conduct the interview because your work [...] [in the social sector in a welfare organisation] means that you have exactly the kind of expertise I was looking for. I wanted to shed light on different perspectives, had contact with a wide variety of experts and conducted my interviews. And exactly, I think if there are no more questions from your side, I would also start directly with the questions.

1:48
E: Yes, do that.

1:50
I: Perhaps yes, could you introduce yourself and tell us exactly what position you hold and for how long?

1:57
E: My name is [...] [Interviewee E]. I [...] [have direct contact with disadvantaged groups of people through my work].

2:26
I: Okay, wow. Yes, that's definitely a wide range of backgrounds and experiences that you have there, yes, let's say with disadvantaged families or perhaps socio-economically disadvantaged groups of people. There will be a few more questions along these lines in a moment. Perhaps firstly, what do you think are the social consequences of air pollution? In other words, are certain groups of people particularly affected by air pollution in Duisburg?

2:59
E: Well, it's always the people who live in urban areas that simply have a high level of air pollution that are affected, and that often goes hand in hand with a low income or simply the social disadvantage that exists in the individual areas.
In other words, whenever I have little money at my disposal, perhaps at the same time in debt and insolvency counselling or addiction counselling. So all of this causes the situation to deteriorate and that is linked to housing. And that's always where the people who are disadvantaged live where air pollution is at its highest. For example, a large proportion of our clientele do not live in the countryside or near a parc or somewhere where air pollution is really not so high, but rather in close proximity to the city centre and in residential ghettos, you could almost say. So wherever housing is cheap, air pollution is often high. There are disadvantaged people in the area and of course that also puts them at a disadvantage in terms of health.

4:05
I: You've just mentioned that you recognise some patterns or regularities in where your clientele live? Are there certain neighbourhoods that come to mind? Well, apart from near the city centre and far from the car parc, of course, but really certain areas of Duisburg.

4:26
E: We are seeing that large parts of the north of Duisburg are sometimes affected, neighbourhoods like Marxloh and Hochfeld. These are definitely the areas of the city where it is sometimes difficult and where the air pollution is also quite high. Everything that is so close to industry, no, BBK Werd, where the heavy metal industry used to be, people are of course always more affected there than in the south of Duisburg, for example.
You can say that quite clearly, or also in the rural regions on the other side of the Rhine, so the Rhine also separates people very clearly and I do believe that there are differences.

4:58
I: Yes, okay, that's interesting. In your opinion, does air pollution also have an impact on income inequality in society? Well, you've already said that lower-income groups are more likely to suffer from it. But how does this perhaps change with increasing air pollution? Even if we now assume or know that things have improved significantly in

Duisburg over the past decades, but the problems are still there and what does that do to income inequality?

5:39
E: So we always have income inequality when air pollution results in illnesses of some kind, for example, i.e. when people are more susceptible to things. Then, of course, you end up with groups of people who don't have such high incomes and who don't take the same precautions for themselves.
So a family or even people who have a certain income can of course, conversely, act very differently if they have health restrictions than those who don't have them anyway.
From my point of view, it's a cycle, so it's not the air pollution itself that affects people, but people are certainly affected by the other factors, including this air pollution. So that's not the only reason, there's no monocausality, but they are connected.

6:26
I: Yes, so do you also see this connection that the increasing air pollution in Duisburg can also increase the health risks for those who have fewer economic resources to protect themselves?

6:41
E: Yes, absolutely.

6:42
I: Yes, exciting. Hang on, I'll just have a look here, we've already covered a few things. Do you also see the greatest need for support for families in the neighbourhoods you just mentioned, i.e. in the north of Marxloh and so on, or is there still a difference to be noticed in terms of who has a need and who is perhaps also looking for support?

7:09
E: Well, I think that's where the need for support is greatest. But that also simply depends on the proximity to these systems. So someone who has a detached house, for example, and also has difficulties organising their affairs, has completely different skills, right. So they look for other things, they end up in a different situation. And those who are in these neighbourhoods often have multi-professional problems. And that's also one of the reasons why it's much more likely to pop up. So it's not so shameful, no, people are used to it.
I can't manage anywhere anyway, so I somehow go into the support system with everything I have. I'd say it's different for the middle class or the upper class, who also have difficulties and problems. They're much more hesitant, they don't come out with you straight away, it's more shameful, because you also have something to lose socially.

8:03
E: Yes, you just said multi-professional problem situations. How, just so I understand correctly. What exactly do you mean by that? So the multi-professional part now.
8:21
I: Yes, what I mean by that is actually that we notice that people who, for example, are linked

to us in pregnancy counselling, can also be docked in educational counselling at some point in the course of time and perhaps also have debt problems at the same time or are perhaps also affected by addiction. So you realise that there are families or people who have a lot of problems in their lives where they need support and that this is increasing. So the gap is widening, isn't it? Yes, the fact is that people who are treated more unequally because of their income and perhaps also their language and things like that are much more likely to seek counselling from us. That's why they are statistically more likely to turn up with us.

9:18
I: Yes. Do you perhaps have any examples that come to mind where this has worked very successfully? That, although the situation is very serious, very problematic, this support has perhaps enabled much better opportunities for participation within society and so the leap to make up for all the disadvantages can work after all. If so, how exactly?

9:47
E: Yes, so we have indeed. There are cases where we join forces to find joint solutions through the help system and enable people to take action for themselves again. In other words, by saying exactly what needs to be done now, i.e. by taking organisational action: What needs to be done to improve the situation? What options do I have? What am I entitled to and what options are there?
And so it's also the case that families who perhaps lived in a hotspot and were also docked with us because of low income, questions or whatever, were then able to move to a neighbourhood where it was much better for them and that of course also included the air improvement, the housing improvement, no. So these are no longer flats that are mouldy to who knows where, but they really do get out. But that takes time and of course people have to be able to participate cognitively.

10:23
I: Yes, yes, and of course it's not quite so easy to always pick them up at the right point, to take them with you, to think about it for yourself.

10:56
E: Yes, because these people simply need a lot of knowledge in this social system. They have to be able to find their way around the system somehow and actually have to have information about what is possible and they have to have the prerequisites. So language is often also a barrier. That's also the case for people who have lived in Germany for a long, long time and come here. And even if they have certificates, that doesn't mean they can speak it well. And if you can't speak the language well, you have barriers at every point, and of course we also have limits somewhere, because we have to say quite clearly that counselling can only take place within a certain framework. So [...] [we] counsellors can't speak all the languages that come up. We had 69 nations in the last year of pregnancy counselling alone. Of course, there are limits, but for those who really want to, and the case I just described comes from this area, it can be done. It very much depends on the will of the people.

11:58
I: Yes. Can you perhaps think of an example from your work experience that suggests that air pollution further increases inequality in society? Whether it's income inequality, residential inequality or health inequality. Can you think of any specific examples?

12:19
E: Yes, well, we had a case where someone became unemployed through no fault of their own and ended up in this downward spiral.
So first they had an income, then unemployment benefit 1, then unemployment benefit 2 and as a result they couldn't continue to pay for and finance their flat as they had done. And then you have to look for a new flat in a price segment where the air pollution is much higher than in the previous one.

12:52
I: Yes.

12:52
E: Yes.

12:55
I: Yes, exciting. So that has already indicated that there really is a multitude of problems and that the connection between air pollution and social inequality is not far-fetched, but is actually present in many different dimensions. What do you think would be necessary to further reduce the impact of air pollution on social inequality?

13:18
E: You would actually have to look first: How do we distribute living space in the urban area? That would really be the first point to look at, not to simply plaster over the neighbourhoods, which are already so overburdened anyway, with new buildings that preferably shoot up who knows where and where you can accommodate a lot of people.
Of course, that's contrary to the housing situation, isn't it? We have a lot of people who don't have a flat, people no longer leave their flats because they can't afford it or because they're worried they won't get anything else, then there's no housing available, and that's the next spiral, isn't it? So that's where the cat bites its own tail. It's like this.
And people who move are many people who move away. We are seeing a tendency for people to move away from these urban centres if they are better off, to more rural areas, but also because they can afford it.
Someone who receives social welfare, basic benefits, SGB 2 benefits or is a low earner, for example, cannot afford to move to the Lower Rhine if they work here in Duisburg.
Because this person somehow needs a car, even if they only earn a small amount of money. They need a connection.
The public transport system is not so good that you can say you can reach everything here. It takes me an hour to get from one side of Duisburg to the other. Well, what can I tell you, I used to work in [...] [old place of residence], it takes me an hour there too. So that's crazy, no,

we can't guarantee that, no, we can't guarantee that and that means there's also a big problem area.

14:42
I: Yes. Yes, that's right.
That means, on the one hand, you would see the city, I suppose, as being responsible, especially in the area of urban planning.
Who else would be involved? So what would you perhaps like to see from other players in order to further reduce the effects of air pollution on social inequality or, first of all, the air? You said that air pollution should not continue to rise so that the corresponding negative effects are also reduced.

15:21
E: Yes, so in any case, I see the housing industry as having a responsibility, which is part of it. Of course as part of it, not solely in this area. And yes, the expansion or reconstruction of the A59 motorway is now very much under discussion. So there is a debate here in Duisburg: above ground or underground. The city wants the motorway to go underground in order to improve the quality for the citizens. But the state, no, and also the federal government say 'No, no, we'd rather have the cheap option'. But that also means that they say 'We are not prepared to spend more money in order to accept the quality of life and the improvement in air quality that a tunnel system would bring'. And that's where I ask myself in such a construct: What are we talking about? Do we want to improve things for people and do we want to take a holistic view or is it about what is most favourable at the moment? Because I think we're constantly renovating bridges here because it wasn't considered before.
So I would like to see a holistic view of the federal, state and city systems, as well as stakeholders such as those responsible for motorway expansion.

16:36
I: Yes.

16:40
E: And at the same time, and this should not be concealed, we as charitable organisations are just as much in demand when we strive for any projects. We also have to look at it to a certain extent: can we build in a more climate-neutral way, can we do something to reduce pollution or perhaps even help to promote it by greening roofs through some conceptual stories, through climate managers that we employ in companies?
That's where we as a society are called upon. It's not just the city, it's not just the state, it's not just the federal government, we all have to get involved.

17:08
I: Yes. Do you have contact with the city's departments, which would perhaps also go in this direction, or is there cooperation?

17:12
E: Oh. So not explicitly from me and my department. But as the Caritas Association, we naturally also have someone who works in climate management and I'm pretty sure that there are contacts there too, because I know that the Executive Board and staff departments are in dialogue with the city and the relevant department heads.

17:38
I: Okay, that means there is nothing where you perhaps realised that there would be a much greater need? It's probably difficult to answer now because they don't have the contact themselves. But where perhaps welfare organisations could also play a stronger role, could be given more consideration in order to defuse this problem?

17:58
E: Well, I think we can always do more in terms of cooperation. The question is: what other problems do we have in this socio-political segment?
And I think the city of Duisburg is actually trying very hard
in this area. But the organisations are also trying very hard. Sometimes certain things simply don't materialise due to scheduling difficulties or things overtaking each other.
That happens, but I would basically say that the desire and will of the individual players is there.

18:21
I: Okay. Yes, that's very nice to hear that there's a good basis for being able to defuse this problem further and exactly. Let me see, I think I've already covered all the questions I was thinking about. Not that I've forgotten anything.
Oh yes, exactly: Have you noticed that the people of Duisburg themselves are concerned about air pollution?

18:49
E: Yes, yes, from a certain level upwards, no. So I would say: everything that is represented in the middle class upwards. I think that then decreases again in the upper class, maybe even decreases again, because it's not an issue that affects people, because they have the chance to orientate themselves elsewhere. So I always believe that if the situation there was bad, people would have the chance to leave.
The people who don't have the chance in the first place don't bother with it because they're in such a state. Oh well, I can't change anything anyway. So this ostrich syndrome buries its head in the sand and let's keep looking.
But the middle class is very active, including at a political level.
The people of Duisburg are already committed to ensuring that things simply change.
19:40
I: And below the middle class, but that there are either language barriers or access to information is not guaranteed in such a way that people could really take care of it or because other problems simply dominate?

19:54
E: Yes, exactly, so that's, sometimes it's not a question of: 'Do I want this? But can I do it, right? If I have to make sure that I get the money together for my family, because the question is: Is there something to eat or do I pay for my living space? Do I have a chance of looking after myself here?
Then these political things, and that's something quite political,
are not on the table for them, no, that's not their regular everyday life, that the first thing they say is 'what can be changed here politically?

20:22
I: Yes, that makes total sense. Yes. Could civil society organisations perhaps play an even stronger role in picking people up there anyway and, where the capacities are at least somewhat available, involving them more in issues and standing up for their rights, and also having a chance of affordable and better living space with less air pollution?

20:54
E: I do believe that this is possible. Here, too, the question is always 'how do we get people on board, because I know that there are initiatives that already have this as a concern for themselves?
But if it's the middle classes, to
put it bluntly, who have this concern and say that we have to do something for the citizens. Then that is an honourable concern, but how do we take those with us who are affected?
I believe that this is a major difficulty in many areas of social services or other planning areas. We don't take people on board because they don't have an eye for it at the moment, because they are so burdened with other things, so if I were to ask people in disadvantaged neighbourhoods 'what do you think about air pollution here? Does it affect you very much? Then they
would say 'Air pollution? I have to go to work or I don't have any money or I have to go shopping or the NV has to work'.
In other words, everything that directly affects people. But whether air pollution is high or low. I don't think most citizens would necessarily be able to answer that.
And then we have no chance, no, that we, as people from civil society organisations, can make a big difference.

22:02
I: Yes yes, that's definitely true. Yes. Is there perhaps anything else you can think of that is important in this context, where you have experience through your work that we haven't covered yet?

22:14
E: No, your catalogue of questions was so broadly peppered with things that I think I've already somehow communicated everything that's possible, especially in the short time here in the city of Duisburg.

22:22
I: Yes. Yes, yes, very good yes, thank you. I'm very pleasantly surprised that you were able to answer all my questions so well. Even though it was all very spontaneous and, as you said, you haven't been in the position for long, which is not so easy to get such a good overview of everything. But thank you very much for going to so much trouble. I've already learnt a lot myself and I'm very pleased to be able to incorporate these different views into my work. I would like to ask you again whether you would be interested in me sending you my Master's thesis when I have finished it.

22:59
E: Yes, I would definitely love to, and thank you again for this detailed question. I think that makes it easy to answer the questions that are important to you with pinpoint accuracy. So thank you for the good preparation, I've had different experiences.

23:14
I: Okay, yes, I'm glad to hear that. You're very welcome. Exactly. Yes, then I'll send you an email, I think I should be through with everything in about two months' time in July, but then you'll hear from me again. And have a nice evening. Yes.

23:30
E: Yes, thank you. And all the best to you for your Master's thesis. I'll keep my fingers crossed that everything turns out as you imagined.

23:34
I: Thank you very much. That's kind, thank you very much, okay.

23:40
E: Have a nice evening then, Mrs Heuer.

23:42
I: Thank you, you as well. Bye.

Changes:

- Slips of the tongue, like “um” smoothed for reading flow
- Word repetitions removed that were not repeated for emphasis, but only in the flow of thought
- Omissions marked with [...] and only made if this was personal identifiable data
- Marked in square brackets [X] if words have been added, in places where individual words are missing from the sentence but are necessary to understand the overall message

Declaration of Academic Integrity

I hereby confirm that this thesis, entitled The impact of air pollution on social inequality in the German city of Duisburg is solely my own work and that I have used no sources or aids other than the ones stated. All passages in my thesis for which other sources, including electronic media, have been used, be it direct quotes or content references, have been acknowledged as such and the sources cited. I am aware that plagiarism is considered an act of deception which can result in sanction in accordance with the examination regulations.

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