AIR POLLUTION & ENVIRONMENTAL JUSTICE IN THE NETHERLANDS

Anneke Bulten I MSc Thesis

AIR POLLUTION & ENVIRONMENTAL JUSTICE IN THE NETHERLANDS

An environmental justice analysis based on air quality distribution and citizens' perceptions

MSc Thesis Health and Society

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Summary

Introduction and aim: Adverse health outcomes due to air pollution are unequally divided across the population, which means that vulnerable groups are exposed to higher levels of air pollution. The question can rise if this distribution is not only unequal, but also unjust. Although the attention for the adverse health effects of air pollution in risen in the Netherlands and other European countries, that does not count for environmental justice. Therefore, this study investigated to what extent there is environmental justice in the Netherlands in relation to air pollution, by taking a holistic approach to environmental justice, to investigate if there are more aspects of importance in environmental justice issues than the concern how environmental burdens are distributed. This study took also the environmental justice principles recognition, participation, responsibilities and capabilities into account.

Methodology: A regression analysis was carried out for the pollutants NO2, PM10, PM2.5 and EC to investigate if there is a relation between pollution levels and income. Furthermore, semi-structured interviews were carried out among citizens in Rotterdam to investigate their perception of air quality and their perception of environmental justice. In total, 19 interviews were held with an average duration of 23 minutes. The interviews were transcribed verbatim and the data was analysed using thematic analysis.

Results: A significant U-shaped relation was found between the levels of NO2, PM10, PM2.5, EC and annual average income. Participants perceived the air quality in the Netherlands as neither good nor bad. Participants did not perceive injustice related to the principles of distribution, recognition and responsibility. There was perceived injustice related to the principle of participation because lower-educated participants do not feel able to join the societal debate to the same extent as the higher-educated participants. There is also perceived injustice in the principle of capabilities, but only when people experience air pollution related health complaints.

Conclusion: Injustice was found related to the environmental justice principles of participation and capabilities. Further research should point out to judge if all environmental justice principles are of equal importance in tackling environmental justice concerns.

Personal Note

Running an MSc thesis project from begin to end is quite a journey. It's all about discovering and mastering a completely new topic, meeting interesting people, sharing new insights, running an administration and, unfortunately, also some boring stuff, like travelling, transcribing and analysing.

At the start of this journey, I couldn't imagine what this journey taught me and how I enjoyed the whole process. Environmental justice and air pollution were not very special topics to me at the start of this thesis. However, during the whole process, I got more and more excited about it. This thesis touches on several interesting elements like health inequalities, social justice and air quality. But what I especially liked is that it focusses on the difference between 'the real numbers' and the effect it has on people's lives.

By finishing this MSc thesis, my education related to public health and health promotion is almost completed. In the next year I will continue my journey in the field of nutritional sciences to accomplish my dream: doing research on the edge of nutritional sciences and health promotion.

Before ending this personal message, I would like to thank everyone who has played a role in this amazing journey. First and foremost, thanks to the Lord, the Creator of the universe, He gave me this opportunity and He gives me enough strength every day to accomplish my dreams. Second, my two supervisors, Carlijn and Michiel, who inspired me and gave a lot of suggestions to improve my work. Third, my family and best friends who supported me in every step of the way. And last but not least, everyone who played a role in this research, participants as well as connections that searched participants for me: I couldn't have done this without you!

Content

1. Introduction

1.1 Air pollution and health inequalities

It was Hippocrates who said: *'If you want to learn about the health of a population, look at the air they breathe, the water they drink, and the places where they live.'* (Gracia & Koh, 2011, p. 4). It is now widely recognised that Hippocrates was right with his statement, because there is renewed attention for the effect of the physical environment on population's health. *'The physical environment can harm health when it exposes individuals and communities to toxic substances, irritants, infectious agents, stress-producing factors and physical hazards.'* (Secretary's Advisory Committee on National Health Promotion and Disease Prevention Objectives for 2020, 2010, p. 4). One of the elements of the physical environment that causes adverse health outcomes is local air pollution (Cushing, Morello-Frosch, Wander, & Pastor, 2015).

Adverse health outcomes due to air pollution are unequally distributed between social classes and racial or ethnic groups (Mohai, Pellow, & Roberts, 2009). Many studies confirm that more vulnerable groups in society are exposed to higher levels of air pollution (Verine Deguen & Zmirou-Navier, n.d.). Most of this research is done in the USA, but there are also studies that investigated the situation in Europe. Research showed that concentrations of air pollution in cities in for example England, Sweden, Italy, France, Norway and Germany are higher in deprived areas or in places where people live from lower socioeconomic status or with a lower level of education (Brainard, Jones, Bateman, Lovett, & Fallon, 2002; Chaix, 2006; Forastiere et al., 2007; Havard et al., 2008; Næss, Piro, Nafstad, Smith, & Leyland, 2007; Schikowski et al., 2008).

1.2 Inequality, but also injustice?

The question can rise if such an unequal distribution of air pollution can not only be seen as unequal, but also as unjust (Walker, 2009). A British study found evidence for the assumption that people who are most affected by air pollution are also those who are least able to do anything about it (Mitchell & Dorling, 2003). Other research suggests that vulnerable groups bear the costs of pollution, which is disproportionately generated by the more advantaged groups in society (Mitchell & Dorling, 2003; Pearce, Kingham, & Zawar-Reza, 2006; Sider, Hatzopoulou, Eluru, Goulet-Langlois, & Manaugh, 2015). This does not imply that vulnerable groups do not contribute to a certain amount to the current levels of air pollution. However, this might indicate a certain level of injustice, because high levels of air pollution are disproportionately located in places where vulnerable groups live. In fact, these people face a so-called 'double burden' (Wakefield & Baxter, 2010), because they already live in disadvantaged areas, but also in areas where the levels of air pollution are highest (Crouse, Ross, & Goldberg, 2009; Mitchell & Dorling, 2003). High levels of air pollution cause adverse health outcomes, but living in a disadvantaged area is also associated with negative outcomes on health and well-being (Crouse et al., 2009; Livingston et al., 2011; Wakefield & Baxter, 2010).

1.3 Holistic view on the origin of health inequalities

Wakefield & Baxter (2010) developed an interesting framework (figure 1), in which they consider this compromised well-being ('double burden') as a consequence of disadvantages at the community level. These disadvantages can be very diverse, like racism, poverty or labour conditions, and these disadvantages operate as the underlying mechanism that contributes to the development of the 'double

burden' that disadvantaged groups face. When looking at the framework in figure 1, it becomes clear that Wakefield & Baxter (2010) regard the composition and structure of a society (social standing and identity) as the cause for the development of disadvantages at the community level (social/institutional arrangements). The disadvantages at the community level affect health outcomes (poor health status) as well as the places where people live (degraded physical & social environment) in an independent way, which is shown in the lower part of the figure. The effect can also intertwine, resulting in compromised well-being (Wakefield & Baxter, 2010). To make the framework more concrete, it is explained using air pollution as an example.

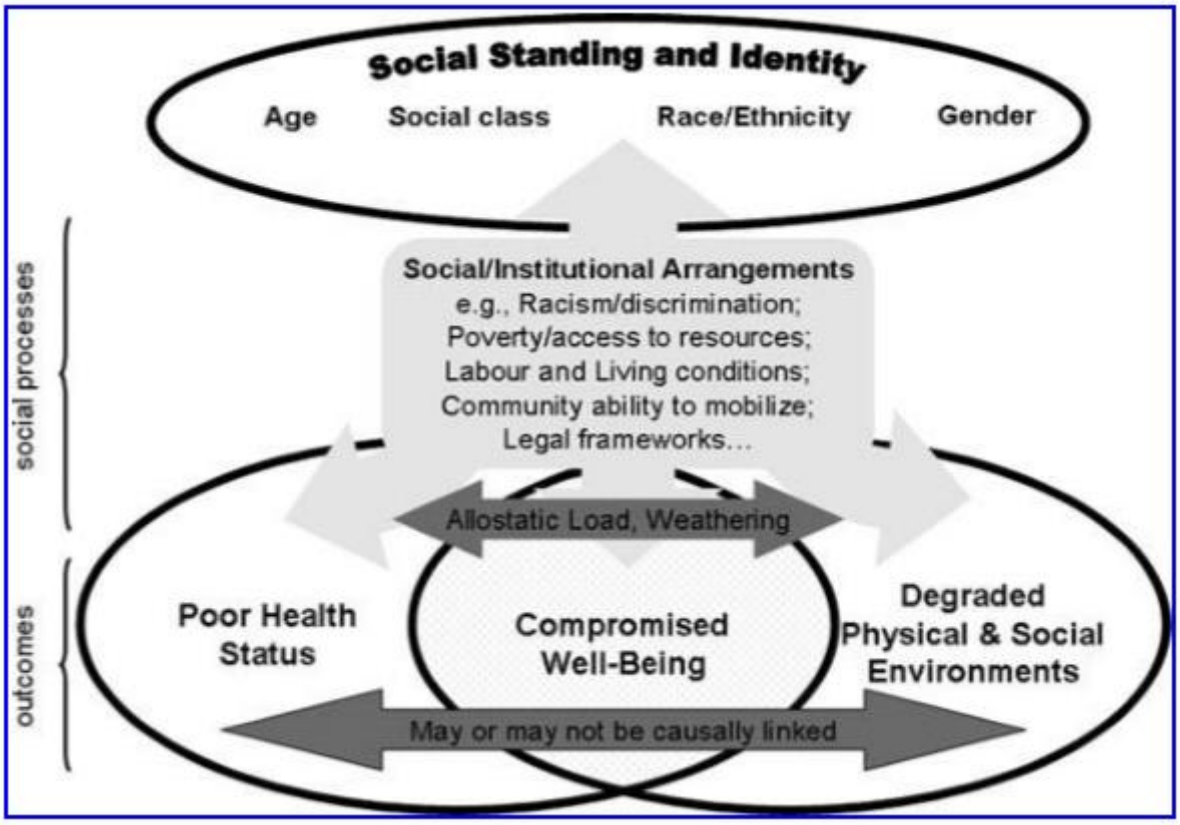

Figure 1: The framework developed by Wakefield & Baxter (2010).

Air pollution has a direct, negative effect on health, but air pollution is also more common in disadvantaged areas where vulnerable groups live. Furthermore, research showed that the effect of air pollution on health and the disadvantaged area cannot be divorced from the wider community context (Elliott et al., 1999). For example, the levels of air pollution are determined by the amount of traffic, the density of the industry, housing policies and spatial planning (social/institutional arrangements). These social and institutional arrangements are determined by the structure and composition of society (social standing and identity), like the amount of traffic depends on how many people can afford a car and how many of them have a driving license. In figure 2, the framework of Wakefield & Baxter (2010) is shown again, but now with examples on each level to apply the framework to air pollution.

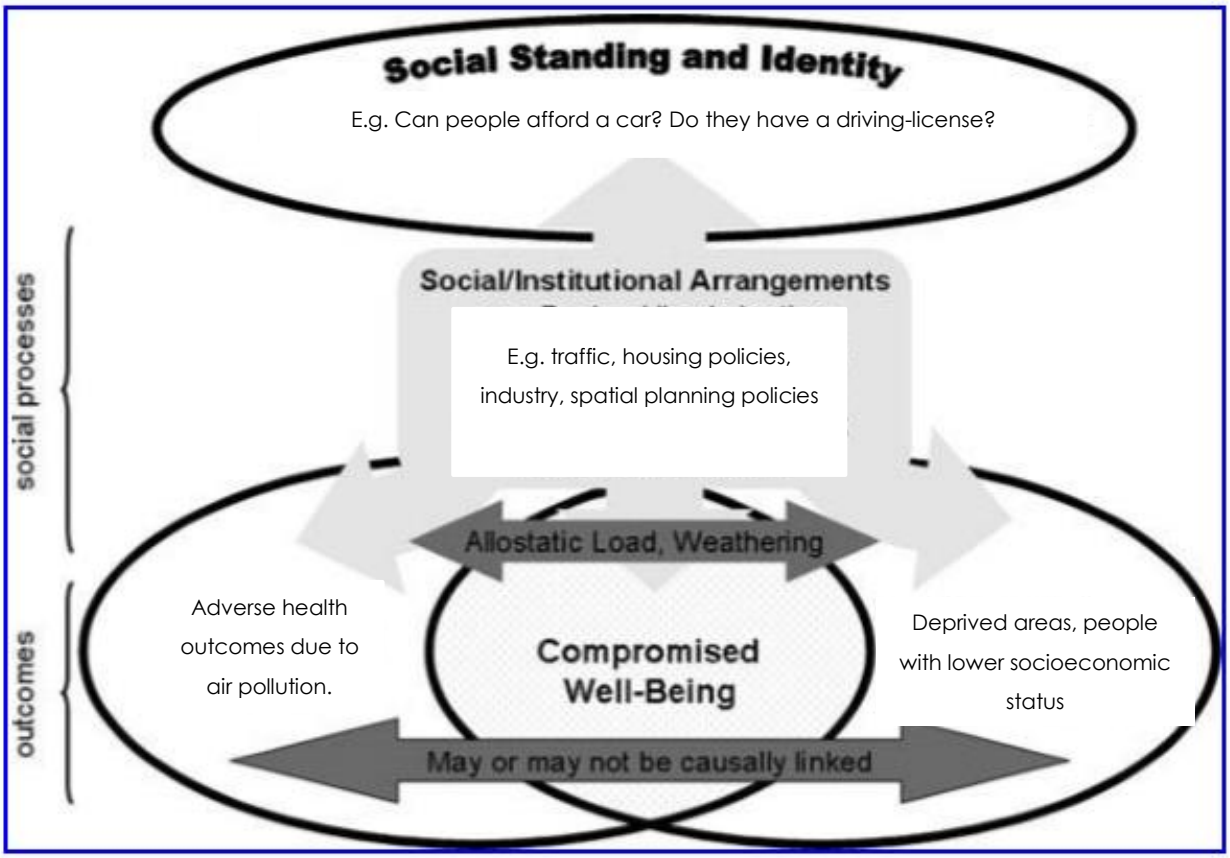

Figure 2: The framework of Wakefield & Baxter (2010) applied to air pollution.

A strong point of this framework is that it takes into account the diversity of issues that affect marginalised populations (Wakefield & Baxter, 2010). An advantage of such an approach is that the focus can be on multiple outcomes that exist on different levels and interact with each other. There is increasing attention in the literature for the importance of a holistic perspective on the effect of environmental exposures on vulnerable populations (Northridge, Sclar, & Biswas, 2003). Taking a holistic approach is in contrast to the linear way of doing health research in which a single exposure is linked to a single health outcome.

1.4 Holistic view on air pollution and environmental justice

The question was if an unequal distribution of air pollution can not only be seen as unequal, but also as unjust. The body of research that focus on the unfair distribution of environmental burdens, air pollution in this case, is called environmental justice (US EPA (United States Environmental Protection Agency), 2016). The traditional approach in environmental justice research on air pollution is investigating how levels of air pollution are distributed among the population and how that is associated with adverse health outcomes (§1.1). It might be worthwhile to look from a broader perspective at environmental justice and air pollution, because there are so many different elements that play a role (Wakefield & Baxter, 2010). When applying the framework of Wakefield & Baxter (2010) to air pollution, it was indicated that there are factors existing on different levels contributing to the current amount of air pollution, like housing policies and how many people can afford a car. Using the framework of Wakefield & Baxter will also enable to pay attention to the diversity of issues that marginalised populations face due to air pollution.

1.5 Problem statement

1.5.1 Increasing attention for air quality

Although most of the research on environmental justice and air pollution is done in the USA, it did also become a topic of interest in European research (see the studies listed in §1.1) and in European policies. In December 2013, the European Commission adopted a Clean Air Policy package aiming to reduce air pollution in Europe (European Commission - Environment, 2016). This policy package was adopted, because poor air quality in Europe is associated with a lot of health problems, premature death, lost working days and high health care costs (European Commission - Environment, 2016). It is expected that implementation of this policy package will be beneficial for public health in Europe.

The implementation of the clean air policy package will be done on a national level. It is calculated by the Netherlands Environmental Assessment Agency that the benefits of reducing the air pollution in the Netherlands according to the new European air quality standards are among other 1) an increase in life expectancy for all Dutch citizens with 4,6 months and 2) a decrease of 14% in lost working days (Planbureau voor de Leefomgeving, 2015). It will also lower the air pollution associated mortality rates in the Netherlands, like non-accidental mortality, mortality from respiratory diseases, lung cancer mortality and cardiovascular mortality (Fischer et al., 2015).

1.5.2 Environmental justice still not a priority

Although there is increasing attention in Europe and in the Netherlands for the adverse health outcomes of air pollution, environmental justice is hardly ever mentioned and is still not a priority in public policy (Kruize, Driessen, Glasbergen, & van Egmond, 2007). Attention to air quality is increasing nowadays, but attention for environmental justice is lacking behind. This can be illustrated by the recent policy of the Rotterdam municipal council, that focusses on reducing air pollution and making the city more healthy, liveable and sustainable (Gemeente Rotterdam, 2015), or by the initiatives of Dutch citizens aiming to improve the air quality. An example of such citizens initiatives are 1) the action of Milieudefensie to prosecute the Dutch state to claim healthy air for everyone in the Netherlands (Het Parool, 2016) and 2) an initiative of citizens in Rotterdam Noord, in close collaboration with Milieudefensie, to lower the levels of air pollution in Rotterdam (Facebook Community, n.d.). These examples show that the attention for air pollution is increasing, but environmental justice is not mentioned in any of these cases.

So, the attention for air quality is increasing in the scientific literature and in the societal debate. However, this attention is mainly focussed on the adverse health outcomes of air pollution and not that much on environmental justice. The studies that do focus on environmental justice are mainly based on statistical analyses investigating the distribution of air pollution across the population and most of them are executed in the United States. There is a need for a better understanding of the role of environmental justice in a European context. It could be interesting to focus on the Netherlands, because of the increasing attention for air quality in Dutch politics and among Dutch citizens. It might also be worthwhile to investigate if environmental justice in relation to air pollution is broader than investigating how it is distributed across the population. A way to investigate this is by using a holistic taking other aspects of environmental justice into account.

1.6 Research aim

This study aims to investigate to what extent there is environmental justice in the Netherlands in relation to air pollution. This study will do so by using a holistic approach to air pollution and environmental justice to investigate if environmental justice is broader than unequal distribution. This is scientifically relevant because the scientific literature does focus only on unequal distribution. Research which uses a holistic approach is lacking behind. The insights of this study can also serve as a basis for policy-making, because it will provide more insight into the relevance of taking a broader focus (than distribution and adverse health outcomes) in reducing air pollution and achieving environmental justice.

2. Theoretical framework

This study wants to explore to what extent there is environmental justice in the Netherlands in relation to air pollution. In order to embed this study in a wider context, this section will explain the environmental justice movement, relevant aspects of environmental justice and it will explain how environmental justice can be investigated using citizens' perceptions.

2.1 What is environmental justice?

The official definition of environmental justice is: '*Environmental Justice is the fair treatment and meaningful involvement of all people regardless of race, colour, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. (…) It will be achieved when everyone enjoys the same degree of protection from environmental and health hazards, and have equal access to the decision-making process to have a healthy environment in which to live, learn, and work.*' (US EPA (United States Environmental Protection Agency), 2016). The environmental justice movement originated in the USA in 1982, because civil rights activists organised to stop the state of North Carolina from dumping 120 million pounds of contaminated soil in the county with the highest proportion of African Americans (Mohai et al., 2009). People feared that their lives and health was being disproportionately put at risk, because of the colour of their skin or the sound of their accent (Mohai et al., 2009). This incident created the beginning of a new social movement in which it was recognised that people from poor or ethnic communities face greater environmental risks than white, middle-class people do. Environmental justice became an interdisciplinary research field in which many studies investigated the unequal impact of environmental risks on different social classes and racial/ethnic groups (Mohai et al., 2009). Today there is a substantial amount of literature which focuses on environmental inequalities and environmental justice in the US (Mohai et al., 2009).

2.2 Environmental justice and health promotion

There is a clear link between environmental justice and health promotion (Wakefield & Baxter, 2010). In fact, environmental justice touches on the same goals as the Ottawa Charter (WHO, 1986) does. The Ottawa Charter is an international agreement and was the result of the first international conference on health promotion organised by the World Health Organization in 1986 (WHO, 1986). In those days, there was a need for a new public health movement around the world (WHO, 1986). This new public health movement does not only focus on disease prevention but acknowledges that health education and promotion is also important in tackling diseases (Mcqueen & De Salazar, 2011). From that time, the aim of health promotion actions is reducing the differences in health status and ensuring equal opportunities and resources to enable all people to achieve their full health potential (WHO, 1986). In the Ottawa Charter, it is stated that '*health is created and lived by people within the settings of their everyday life; where they learn, work, play and love.*' (WHO, 1986, p. 5).

Since the creation of the Ottawa Charter in 1986, awareness is created for the importance of the conditions in which people live, work, play and go to school and also for the need to see health as a human right (World Health Organization Europe, 2013). In 2012, Healthy People 2020 was signed, a policy framework for the UN Member States (World Health Organization Europe, 2013). One of the main objectives is to reduce

health inequalities by focussing on the social and physical environment (Secretary's Advisory Committee on National Health Promotion and Disease Prevention Objectives for 2020, 2010). One of the topics of Healthy People 2020 is environmental health aiming to promote health for all through a healthy environment. One of the main themes is outdoor air quality (Healthy People, 2016).

Investigating to what extent there is environmental justice in relation to air pollution in the Netherlands touches right on the heart of the environmental justice principle, on the Ottawa Charter and on Healthy People 2020, because it looks at equity, the social and physical environment and the conditions in which people live, work, play and go to school. In this research a connection is made between environmental justice and health inequality research, which can deepen our understanding of the socio-spatial patterning of certain health outcomes (Pearce, 2013)

2.3 Environmental justice principles

There is a lot of discussion about the exact meaning of environmental justice. People use different concepts of environmental justice to strengthen their own position in the scientific and social debate (Davoudi & Brooks, 2014). This research will build on the existing work of Davoudi & Brooks (2014), because they look at environmental justice from different perspectives, resulting in a holistic and multivalent framework. They regard the following aspects of environmental justice:

- Distribution (Who gets what?)
- Recognition (Who counts?)
- Participation (Who gets heard?)
- Capabilities (What matters?)
- Responsibilities (Who does what?)

It is stated that these five aspects offer an obvious potential for research because there are only a few empirical studies that did include this broad conceptualization of environmental justice (Pearce, 2013). To know what every principle is about, Davoudi & Brooks (2014) developed some guiding questions for judging environmental justice concerns. These guiding questions can be found in table 1, together with a short description of what every principle entails.

Table 1: Guiding questions for judging environmental justice concerns (Davoudi & Brooks, 2014).

Justice dimension	What does it mean?	Examples of questions in relation to environmental burdens
Distribution	The distributional pattern of an environmental burden and benefits.	Does a deprived community suffer disproportionately from an environmental burden?
Recognition	Seeking measures that enhance a community by redistributing the burdens and beneficiaries, not resulting in stigmatisation of an area.	Does exposure to an environmental burden result in, or add to, misrecognition for a deprived community or stigmatisation of a deprived area? Is the area perceived as a 'natural' destination for other environmental burdens and does it suffer from their cumulative impact?
Participation	Equal opportunities to join the debate, share resources and equal access to environmental information.	Is a deprived community included in decisions about locating, or strategies to mitigate, an environmental burden?
Capabilities	The capacity to live the life that people want to live, the capability to function and flourish.	Does the environmental burden limit the freedom of a deprived community to pursue their valued goals?
Responsibilities	The responsibility people have towards fellow humans and nature.	Is a deprived community the least contributor to the cause of the environmental burden to which it is exposed? Is it compensated by the benefits that are attendant on the environmental burden? Can it contribute to mitigation measures?

2.4 Using citizens' perceptions by investigating environmental justice

Most of the evidence about environmental justice in relation to air pollution are based on statistical analyses, investigating the distribution of air pollution. However, this covers only the principle of distribution and not the principles of recognition, participation, capabilities and responsibilities. A way to investigate the relevance of these principles can be by using citizens' perceptions. Using citizens' perceptions could be a proper way to investigate environmental justice, because citizens do have a common understanding of what is fair and what is not (Schleich, Dütschke, Schwirplies, & Ziegler, 2016). Studying people's perception

of environmental justice was not a big issue in scientific research until now (Müller & Clayton, 2013), and measuring citizens' perceptions of environmental justice can be difficult. People's perceptions are a complex interplay of different processes and dimensions (Kasperson et al., 1988). People can, for example, perceive a big personal risk due to high levels of air pollution, while they are not concerned about the effects of air pollution on society as a whole (Van Der Linden, 2015). And, people who are more affected by air pollution, tend to perceive greater risks due to air pollution (Macias, 2016). They might consider more environmental injustice because they face the consequences of air pollution every day. So, the perception of air pollution might influence people's perception of environmental justice.

It is important to take the perception on air pollution into account because this can influence the perception of environmental justice. A useful way to explore the perception of air pollution is by exploring people's risk perception (Deguen, Ségala, Pédrono, & Mesbah, 2012). Therefore, Deguen et al. (2012) developed an air quality perception scale (AQP). The AQP is validated in France to measure the perception of air quality, but can also be used to assess the perception of air quality in other countries (Deguen et al., 2012).

2.5 Conclusion of first two chapters

To summarise the information so far, the aim of this research is to investigate to what extent there is environmental justice in the Netherlands in relation to air pollution. It is important to use a holistic approach to investigate different aspects of environmental justice. Using the environmental justice principles can lead to a more holistic perspective on environmental justice. A possible way to investigate the relevance of the environmental justice principles can be by using citizens' perceptions. However, measuring citizens' perceptions can be difficult and it can be that the perception on the environmental justice principles might be influenced by the perception of air pollution.

3. Research questions

Given the information in the previous chapters, the research question was identified and a few sub-questions were formulated.

The main research question is:

To what extent is there environmental justice in the Netherlands in relation to air pollution?

The identified sub-questions are:

1. What is the current distribution of air pollution in the Netherlands?
2. How do Dutch citizens perceive the air quality in the Netherlands?
3. What is the perception of Dutch citizens about environmental justice using the environmental justice principles?

The next chapter describes the methodology used in this study to answer the main research question.

4. Methodology

For this research, a cross-sectional study design was chosen. A cross-sectional design services '*to describe the frequency or level of a particular attribute in a defined population or sample at one point in time*' (Bowling & Ebrahim, 2005, p. 602). The attribute that was investigated in this study is the perception of Dutch citizens on environmental justice in relation to air pollution. This study consisted of both an analysis of the distribution of air pollution in the Netherlands and of semi-structured in-depth interviews. Table 2 shows the contribution of each method in answering the research sub-questions.

Table 2: Description of how each method contributes in answering the research sub-questions.

Sub-question	Distribution analysis	Semi-structured interviews
What is the current distribution of air pollution in the Netherlands?	X	
How do Dutch citizens perceive the air quality in the Netherlands?		X
What is the perception of Dutch citizens about environmental justice?		X

4.1 Place of study

The main research question focusses on the whole country of the Netherlands. However, this area might be too broad to investigate in this research. Until now, differences in distribution were mainly investigated in the urban environment. This underlines the argument to focus on one of the big cities in the Netherlands when narrowing the place of study to a more specific area. It was decided to do the data gathering in the municipality of Rotterdam and surrounding municipalities. This decision was made for three reasons: 1) In this city were several citizens' initiatives for clean air (§2.3), 2) tackling air pollution became a priority for the municipal council of Rotterdam (§2.3), and 3) the ability to approach participants in this area. The surrounding municipalities were included, because these are a kind of suburbs, build environment adjacent to Rotterdam and a few of these municipalities have interesting characteristics with regards to air pollution, like being close to port industry or being close to highways.

4.2 Analysis distribution air pollution

In order to answer the first sub-question about the current distribution of pollution, an analysis was made of the distribution of air pollution in Rotterdam and her surrounding municipalities. This was done for the pollutants NO2 (nitrogen dioxide), PM10 (particulate matter with a diameter of ≤10 µm), PM2.5 (particulate matter with a diameter of ≤2.5 µm) and EC (elemental carbon). These pollutants were chosen, because they are seen as a good indicator of the air pollution levels (Fischer et al., 2015; Van Der Zee & Walda, 2008). The background concentration of NO2, PM10, PM2.5 and EC in 2012, specified on 4-digit zip code level, was retrieved from the National Institute for Public Health and Environment via http://geodata.rivm.nl/gcn/. Data of annual average income level in 2012, specified on 4-digit zip code level, was retrieved from

Statistics Netherlands via https://www.cbs.nl/nl-nl/maatwerk/2015/38/gemiddeld-besteedbaar-huishoudinkomen-naar-postcodegebied-2012.

Data was analysed using IBM Statistics SPSS 24. All zip codes located in Rotterdam and those located in the surrounding municipalities (Albrandswaard, Barendrecht, Capelle aan den IJssel, Hellevoetsluis, Krimpen aan den IJssel, Lansingerland, Maassluis, Nissewaard, Ridderkerk, Schiedam, Vlaardingen en Westvoorne) were included in the data analysis. 13 zip codes were excluded from data analysis, because of missing data on average annual income, or because there were no people living in these zip code areas. The final analysis was based on 154 zip code areas. Regression analyses were executed to investigate a correlation between background concentration of NO2, PM10, PM2.5 and EC and average annual income. In addition, topographic maps were made using the Power Map tool in Microsoft Office Excel 2016.

4.3 Semi-structured interviews

After this, semi-structured interviews were carried out among Dutch citizens to investigate the perception of Dutch citizens on air quality and on environmental justice. In the first part of the semi-structured interview, the perception of Dutch citizens about air quality was investigated. The second part of the semi-structured interview contained questions on how Dutch citizens perceive environmental justice in relation to air pollution. A few fictional scenarios were included to provide in more detail how participants perceive environmental justice in more concrete situations.

4.3.1 Question on air quality perception

The air quality perception was investigated with the question how participants perceive the air quality in their own neighbourhood. The Air Quality Perception Scale was used to develop probing questions. The Air Quality Perception Scale consists of 22 items measuring the perception of air quality (see Appendix 1). These 22 items cover the following dimensions of air quality perception: health complaints, air quality inside the house, air quality outside the house and quality of life. The interview question and probing questions can be found in the interview guide (Appendix 2).

4.3.2 Questions on environmental justice

The questions to investigate the perception of environmental justice were based on the framework of Davoudi & Brooks (2014). The following questions were used as basis, but the exact interviews question were formulated in a clearer and better understandable way in Appendix (interview guide):

- How do you think that air pollution is distributed in the Netherlands? (distribution)
- Who do you think is mainly responsible for the current levels air pollution in the Netherlands? (participation)
- What are the responsibilities and capabilities of people in the Netherlands to improve the air quality in the Netherlands? (responsibility and capabilities)
- What are your responsibilities and capabilities to improve the air quality in the Netherlands? (responsibility and capabilities)
- Do you think that there are people who suffer disproportionately from air pollution? What do you think is the cause of it? (recognition)

Before the actual data collection was started, the interview questions were pre-tested among three persons with different gender and educational level. The results of these three interviews are not included in this research. It was only used to formulate the interview questions in a more understandable way and it pointed out that additional questions should not be included, because the duration of the interview was perceived as long enough.

4.4 Sampling procedure and execution semi-structured interviews

Participants were approached using convenience sampling. Convenience sampling is a sampling procedure that is usually used to found participants in a certain place, setting or source (Bowling & Ebrahim, 2005). Invitations for the research were sent via social media (Facebook and LinkedIn) to the social network of the researcher, to the network of the organisations 'Adem in Rotterdam', 'Samen voor Gezonde Lucht – Rotterdam Noord', 'Stadslab Luchtkwaliteit' and also via email to the network of Milieudefensie in Rotterdam. The criterion to include a participant in this research was that the participants' home is located in Rotterdam or surrounding municipalities.

19 interviews were held in total, after which data saturation was reached. The duration of the interviews varied from 12-64 minutes, with an average of around 23 minutes. Participants came all from different neighbourhoods in Rotterdam and there was diversity in age, gender and educational level. An overview of these characteristics is shown in table 3. As table 3 shows, the data include a duo-interview and a trio-interview. The results of this duo and trio interview are treated as if it was a single interview, because the answers of the participants in this duo- and trio-interview were in agreement with each other. The number of participants recruited via the environmental organisations was limited to 8 to ensure that not all participants were already interested in the topic beforehand and to ensure that they would not bias the results, because of their knowledge about air pollution.

Table 3: Participant's characteristics, including age, sex, educational level and zip code area

	Person	Age	Gender	Level of Education	Zip Code
1	AS	50-54	Female	WO	3621
2	BO	20-24	Female	HBO	3086
3	BZ	55-59	Female	MBO	3078
4	CR	70-74	Male	WO	3013
5	DD	55-59	Male	HBO	2907
6	DN	45-49	Female	HBO	3024
7	ED	20-24	Female	HBO	3676
8	EF	55-59	Female	HBO	3071
9	GE	20-24	Male	HBO	2903
10	GK	75-79	Male	VMBO	3083
11	HE	30-35	Male	MBO	2914
12	JE	25-29	Male	MBO	2912
13	KN	60-64	Female	MBO	2986
14	LA	25-29	Female	WO	3051
15	PN	65-69	Male	HBO	3068
16	RC	40-44	Male	VMBO	3076
		35-39	Female	MBO	3076
		35-39	Female	MBO	2904
17	RE	30-34	Female	WO	2922
18	SL	45-49	Female	MBO	3203
		18-19	Male	MBO	3203
19	WN	35-39	Male	WO	3043

4.5 Data analysis

The data from the interviews was analysed using thematic analysis. Thematic analysis is usually used to identify, analyse and report patterns within qualitative data (Braun & Clarke, 2006). It enables to describe data in rich detail (Braun & Clarke, 2006). The data analysis consisted of the following steps:

- Reading each interview transcript thoroughly to familiarise with the data.
- Generating initial codes based on the interview transcript.

- Comparing the initial codes of five randomly selected transcripts and searching for themes across and within these transcripts.
- Based on the themes that did arise in the previous step, all transcripts were reviewed and initial codes were clustered in themes. The primary themes were categorised, based on frequent words in the initial codes. These primary themes were: participants and neighbourhood; air quality; improvement air quality and justice. These primary themes were split, because of the size. The final themes are showed in appendix 3.
- Then all transcripts were checked to look for initial codes that were not clustered in a theme and to decide if an additional theme was necessary. There were only a few initial codes left and it was not possible to cluster these in the existing themes or in an additional theme.
- Deciding the final definitions of the themes.
- Writing down the results in the report.

4.6 Ethical considerations

Lastly, when doing research and designing the research methods, it is important to take research ethics in consideration. Research ethics is based on the five moral principles: beneficence, non-maleficence, respect for autonomy, respect for persons and justice (Sim, 2010). The most important principle of research ethics is beneficence: promoting the interests and welfare of others, through beneficial or protecting actions (Sim, 2010). The goal of this research was to explore the perception of Dutch citizens on environmental justice in relation to air pollution. As this may be a good goal in itself, it is important to take the other four moral principles into account.

First, the principle of non-maleficence, which means to cause no direct or indirect harm to others (Sim, 2010). This was especially of importance in this research, because asking people questions about their perception of air pollution and environmental justice could cause worries about their health. These people could also feel threatened by their personal situation. In order to acknowledge that such a situation could arise, participants were given contact details of the municipal health services (GGD Rotterdam Rijnmond) at the end of the interview to discuss their worries about their personal health or situation. The participants could also contact the researcher (or supervisor) if they have any questions related to the research (Appendix 4). At the end of this study, no one used the option to contact the researcher or supervisor.

Other ethical principles are respect for autonomy and respect for persons. A written invitation was provided to the participants with all relevant information about the research. All participants signed informed consent. The written information and informed consent form are shown in Appendix 5.

The respect for persons was safeguarded, using confidentiality. The identity of people was only known by the researcher and described in such a way in the final report that the identity of the participant could not be detected.

An ethical clearance was given by the Social Science Ethics Committee of Wageningen University. The ethical clearance letter is included in Appendix 6.

5. Results of air quality distribution

This section contains the results of the distribution in air quality. First, the distribution of air quality in the Netherlands will be showed, followed by the distribution in Rotterdam and a model that explains the association between income and pollution levels.

5.1 Distribution of air quality in the Netherlands

Figure 3 and 4 give a first impression of the distribution of the pollutants NO2 and PM2.5 in the Netherlands. These figures suggest that pollution levels are higher in and around big cities and around highways.

The WHO developed air quality guidelines in 2005. The lowest levels at which it is shown that air pollution related mortality increases are 10 µg/m^3 for PM2.5 and less than 40 µg/m^3 for NO2 (World Health Organization, 2005). When comparing these thresholds with the figures, it can be seen that the pollution levels are higher in the southern part of the Netherlands and around the Randstad. Therefore, it is likely that air pollution related mortality is existing in these part of the Netherlands.

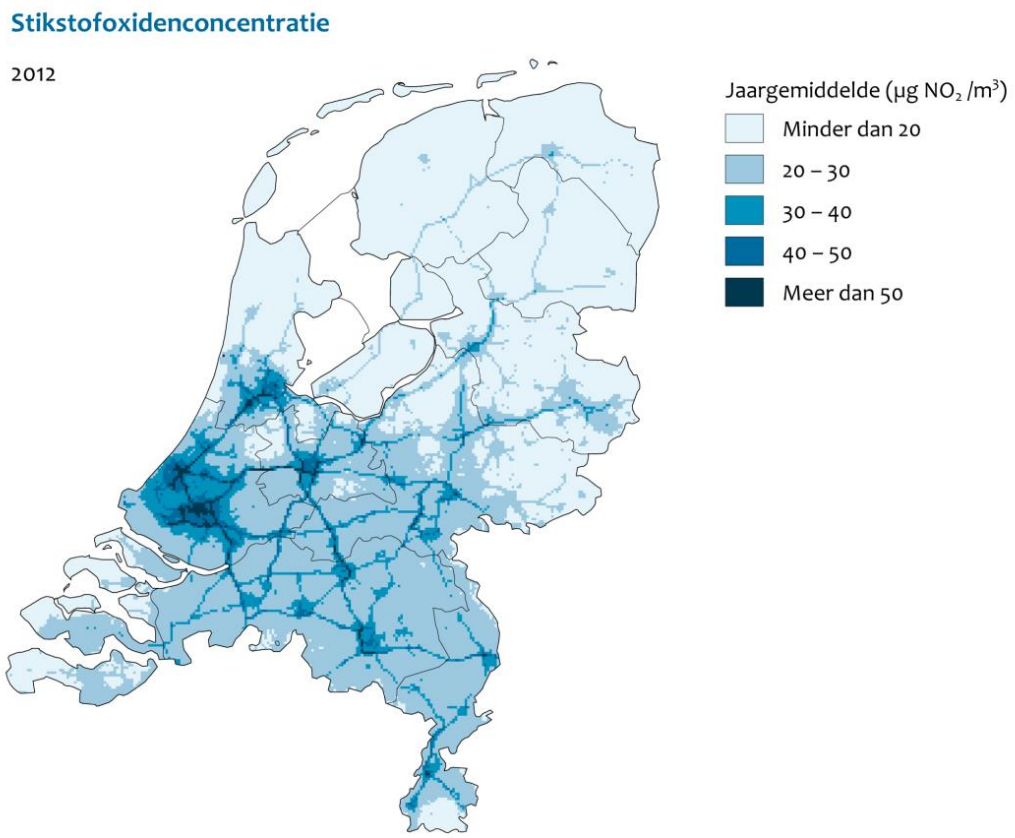

Figure 4: Distribution of NO2 in the Netherlands in 2012 indicated in microgram per cubic meters (Compendium voor de Leefomgeving, 2014b)

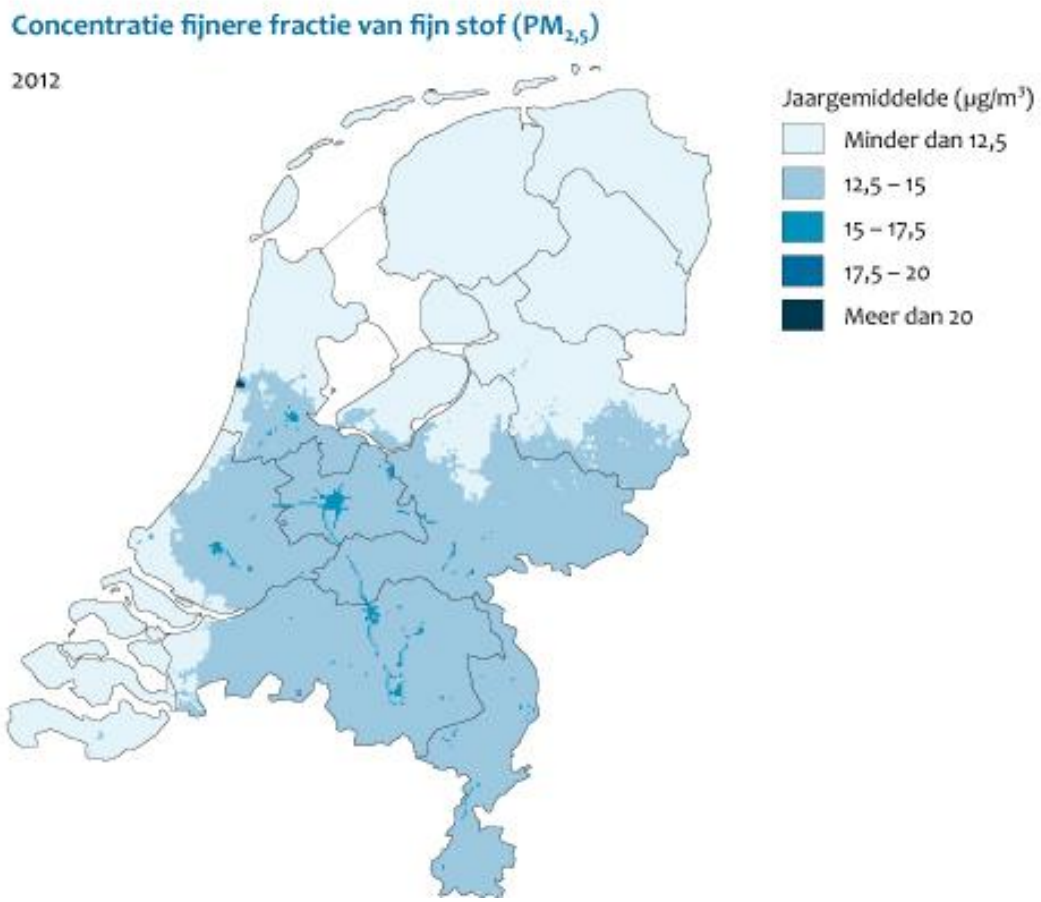

Figure 5: Distribution of PM2.5 in the Netherlands in 2012 indicated in microgram per cubic meters (Compendium voor de Leefomgeving, 2014a)

5.2 Distribution air quality in Rotterdam

After this general picture on the air quality distribution in the Netherlands, the focus will be on the air quality distribution in Rotterdam and surrounding municipalities. In figure 5 a map of Rotterdam is showed which contains information about the amount of households per zip code area. Figure 6 contains information about the average annual income per zip code area. Figure 7-10 show the levels of the pollutants NO2, PM10, PM2.5 and EC respectively. All pollution levels seem to be higher in the city centre, although this is more visible for the levels of PM10 and PM2.5 than for NO2 and EC. Different income levels exist in the city centre. At first sight, it seems plausible that income is associated with pollution. A statistical analysis is executed to test the plausible association between income and pollution levels, the results are shown in the next paragraph.

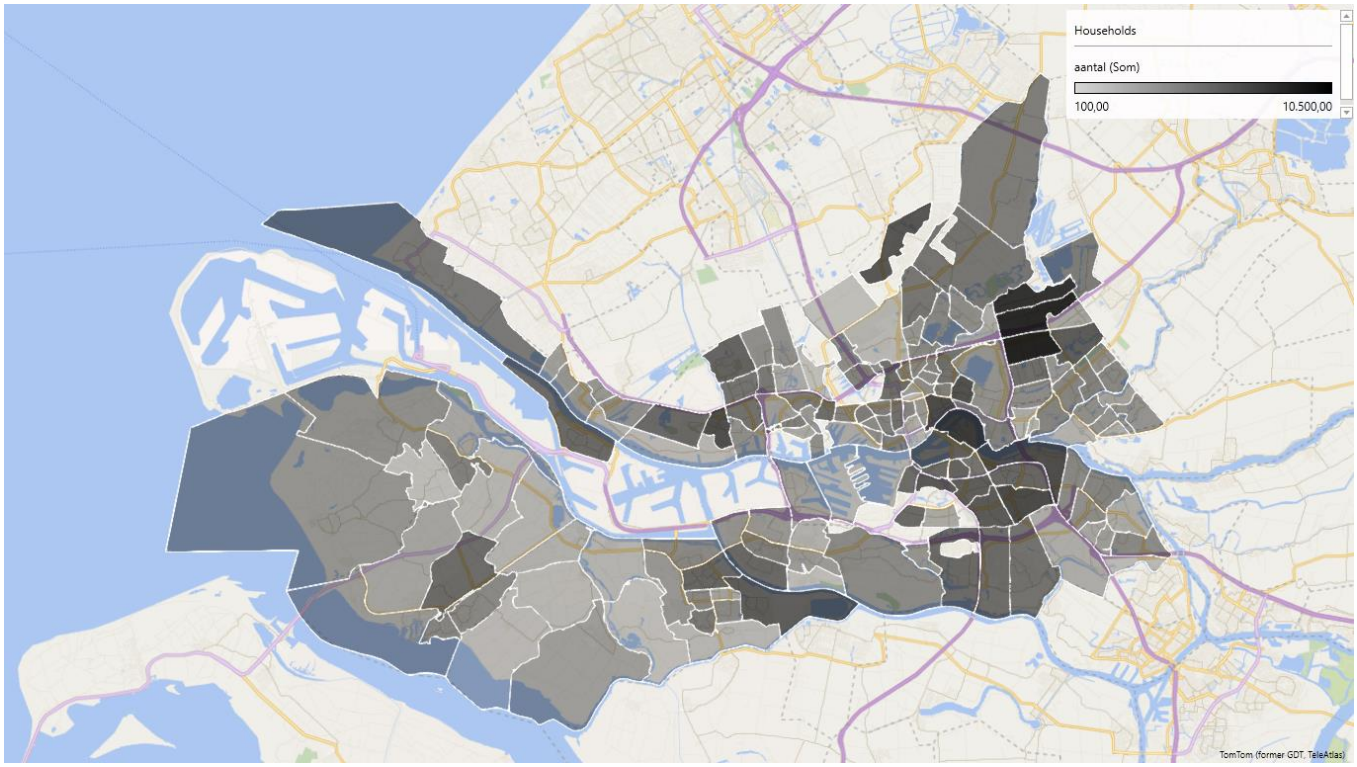

Figure 5: Amount of households per zip code area.

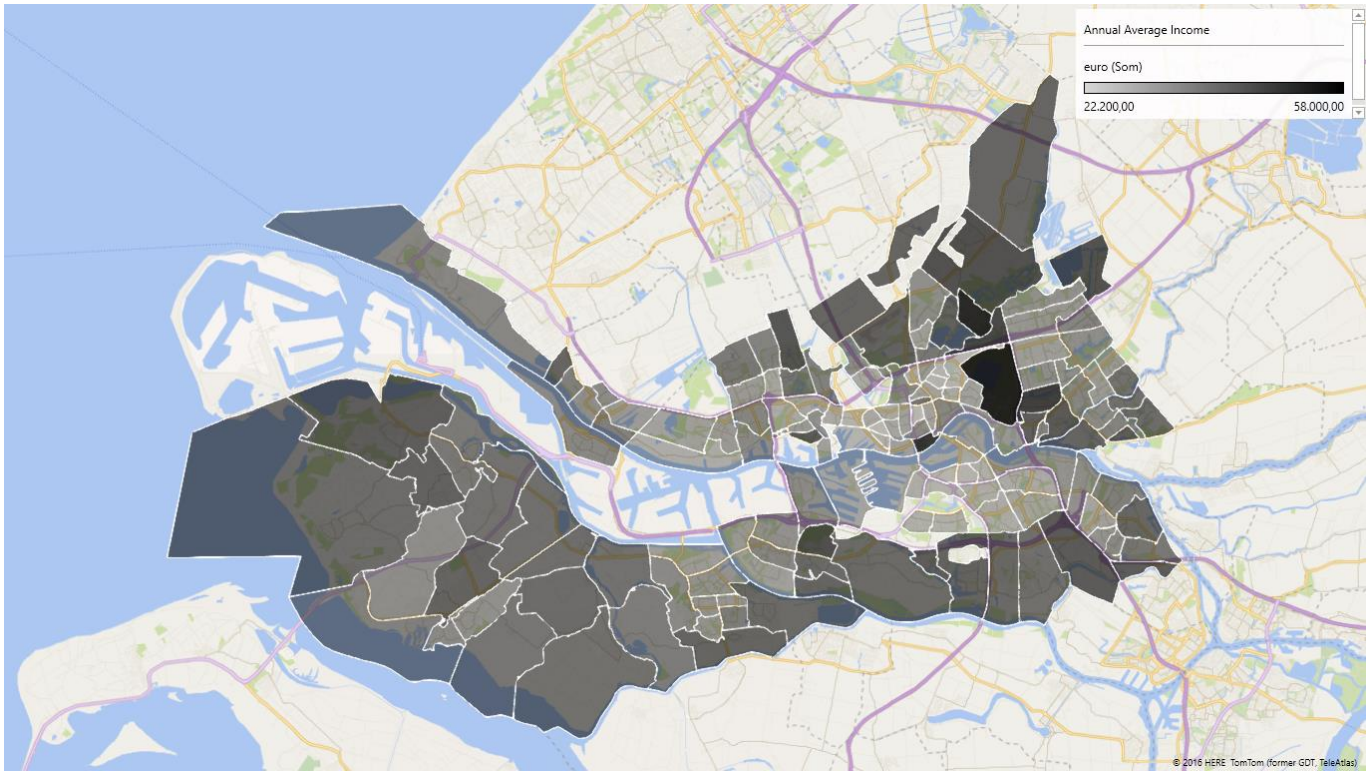

Figure 6: Average annual income per zip code area.

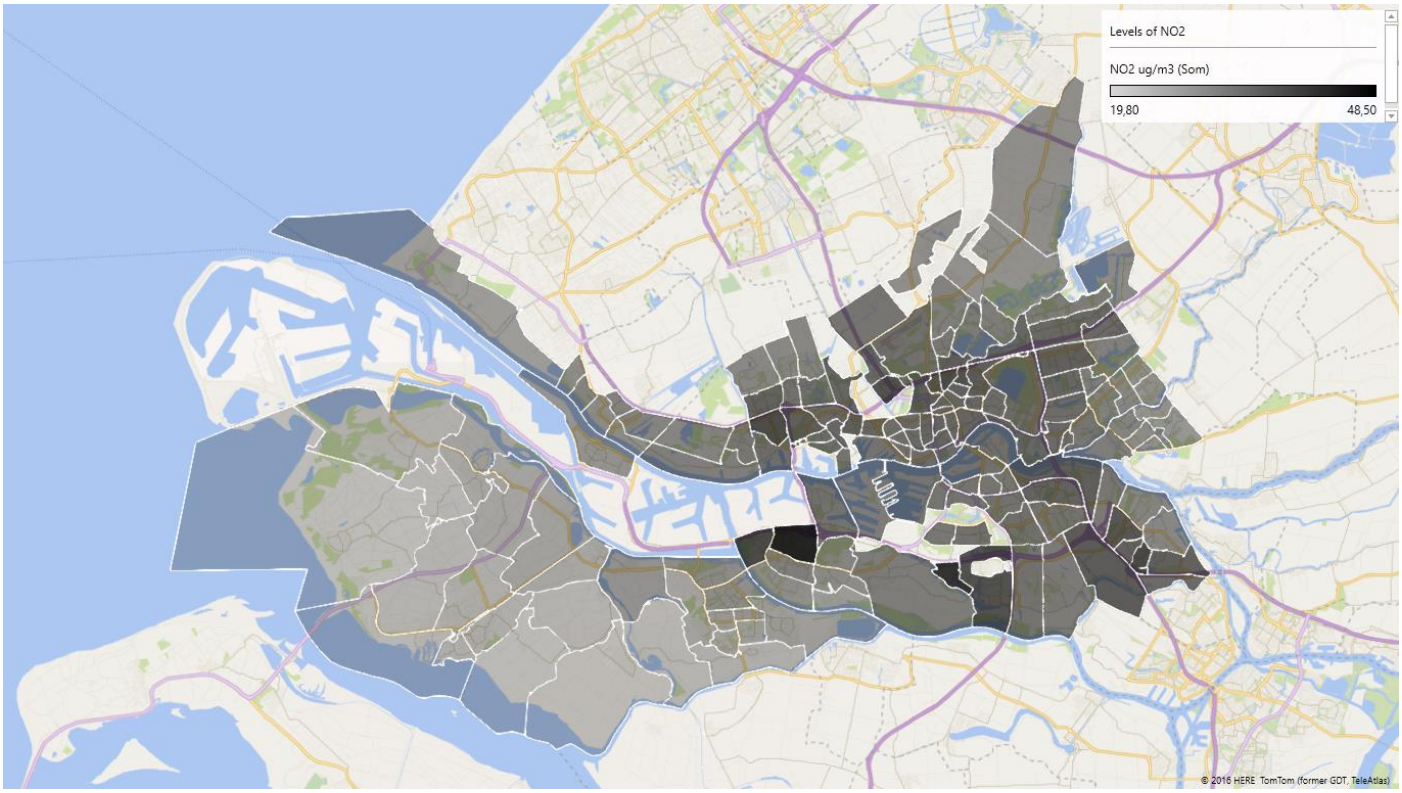

Figure 7: Levels of NO2 per zip code area.

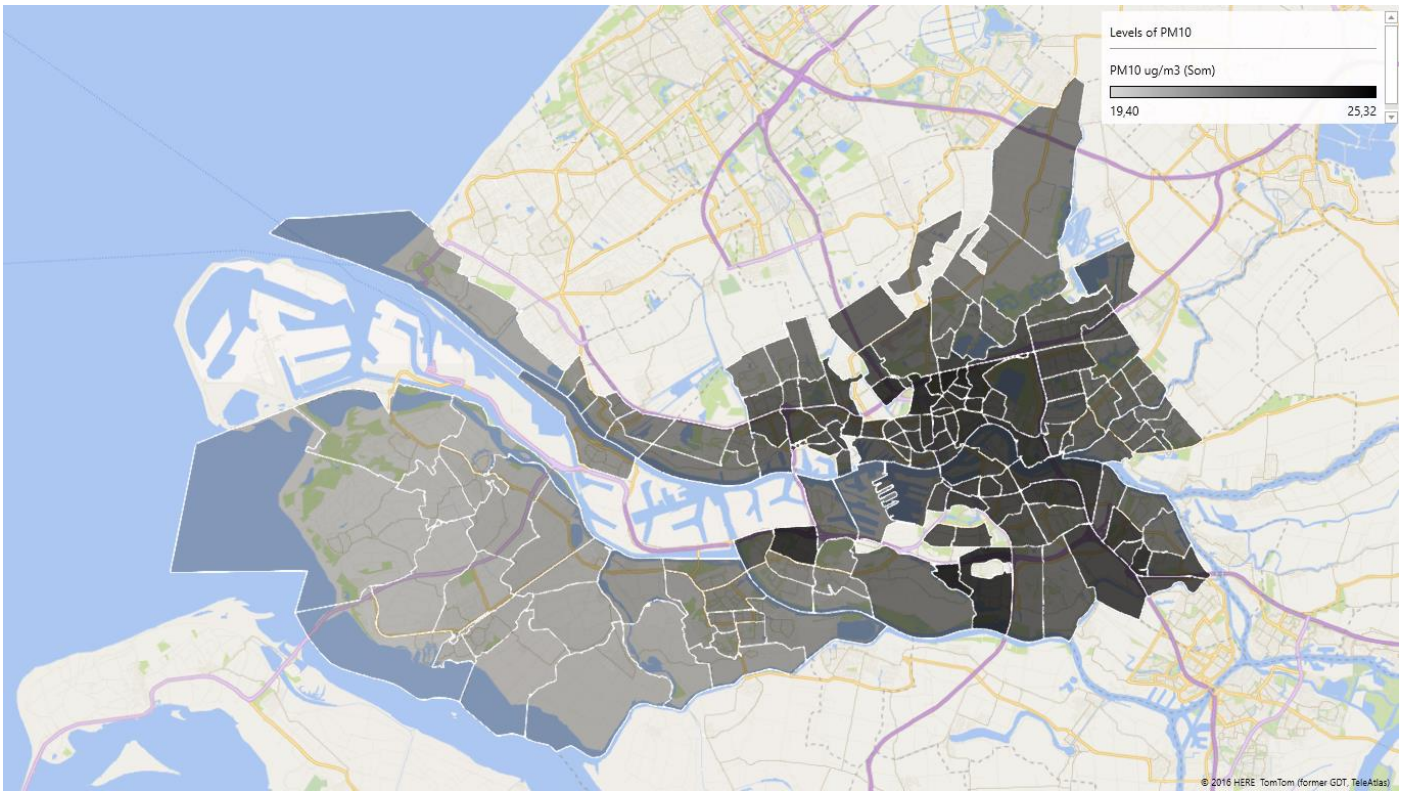

Figure 8: Levels of PM10 per zip code area.

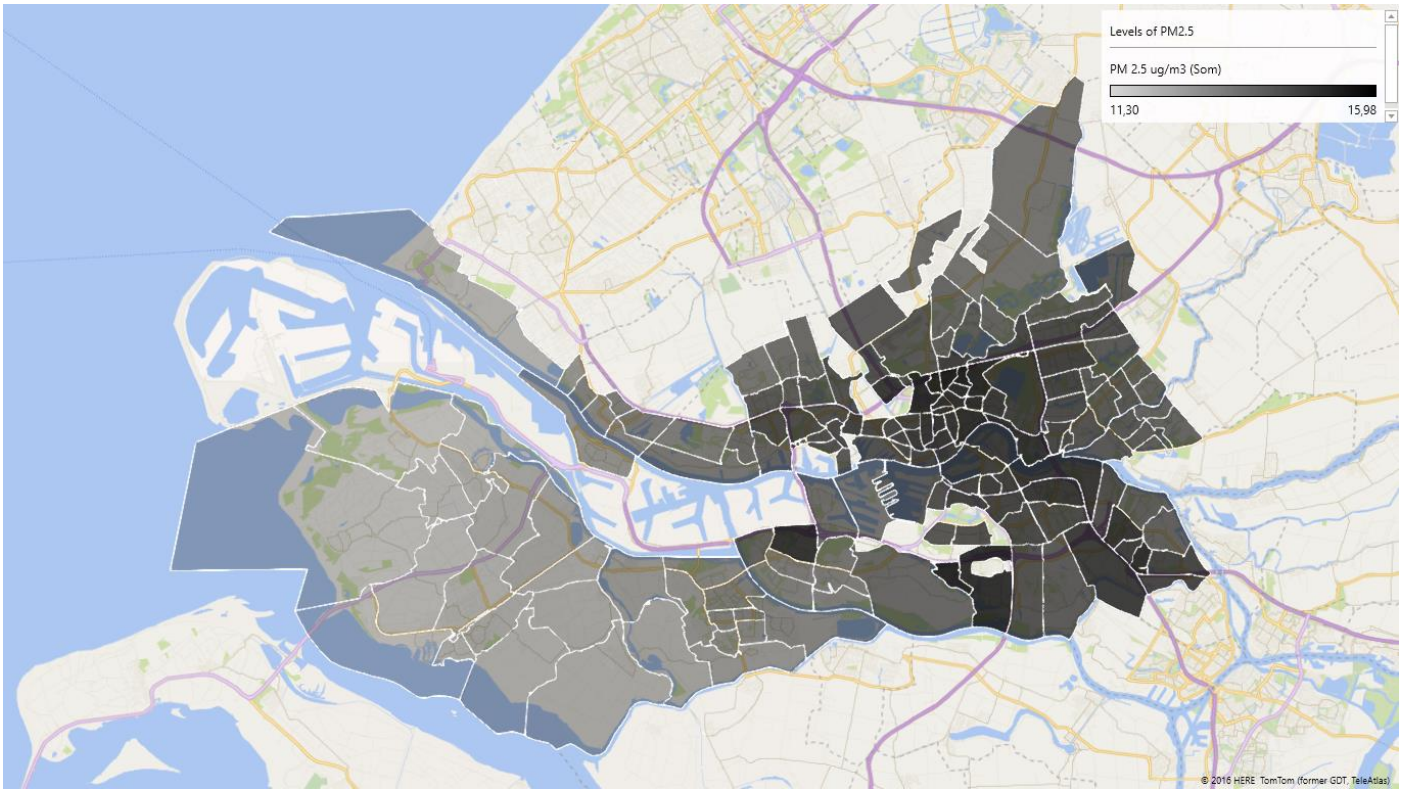

Figure 9: Levels of PM2.5 per zip code area.

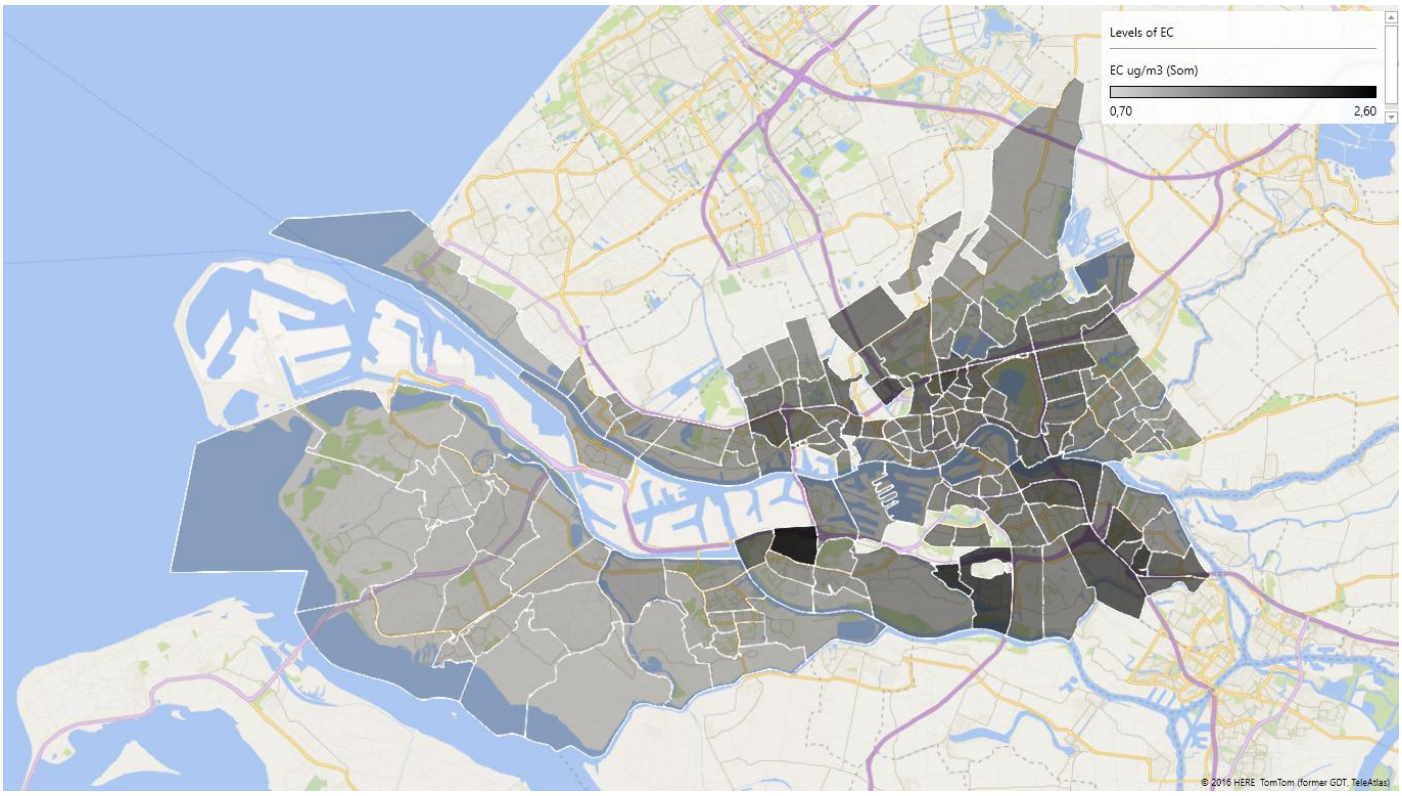

Figure 10: Levels of EC per zip code area.

5.3 Association between income and pollutants

To investigate if levels of NO2, PM10, PM2.5 and EC are associated with annual average income, several regression equations were calculated. Significant linear and quadratic regressions were found for NO2, PM10, PM2.5 and EC. The linear regression model explains 5-11% of the variability of the response data around the mean of the regression line, while the quadratic regression model explains 12-27% of this variability. A U-shaped associations is therefore more appropriate. The U-shaped associations of income-PM10 (27%) and income-PM2.5 (25%) explains more of the variability of the response data than the quadratic associations of income-NO2 (17%) and income-EC (12%). All regression lines were statistically significant, based on a p-value of 0.05. The exact data on R2, p-value and the regression equation can be seen in table 4. The regression models are plotted in graphs (figure 11).

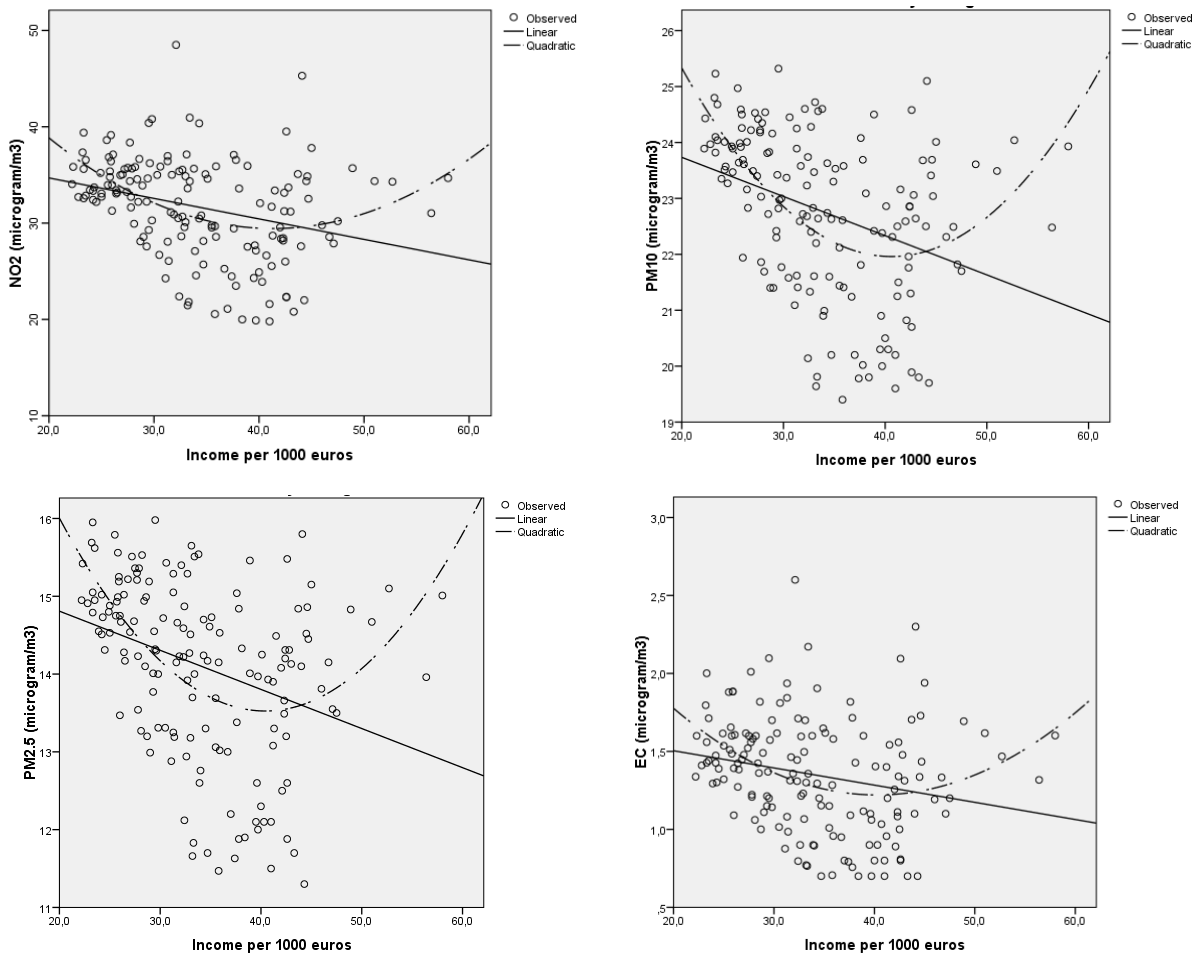

Figure 11: Graphs that represented the level of air pollution (NO2, PM10, PM2.5 and EC) in µg/m³ by annual average level of income in euros per zip code area in Rotterdam and surrounding municipalities.

Table 4: R-squared, p-value and regression equation specified by regression model for NO2, PM10, PM2.5 and EC.

	Linear Regression			Quadratic Regression		
	R2	**P-value**	**Regression equation**	**R2**	**P-value**	**Regression equation**
NO2	0.09	0.000	38.937-0.213x	0.17	0.000	$64.752-1.709x^2+0.021x$
PM10	0.13	0.000	25.135-0.07x	0.27	0.000	$35.041-0.644x^2+0.008x$
PM2.5	0.11	0.000	15.814-0.05x	0.25	0.000	$23.236-0.48x^2+0.006x$
EC	0.05	0.005	1.725-0.011x	0.12	0.000	$3.414-0.109x^2+0.001x$

5.4 Conclusion of this chapter

The air pollution levels in the Netherlands seems to be higher in big cities and around highways. Statistically significant linear and U-shaped associations of income and air pollution are found based on a p-value of 0.05. Using the U-shaped association is more appropriate than using the linear association, because it explains more of the variability of the response data (12-27% vs 5-11%). In other words: air pollution levels are higher in lower income and in higher income areas and air pollution levels are lower in middle-income areas.

6. Results of air quality perception

This section describes the neighbourhoods in which participants live, how they perceive the air quality in their own neighbourhood and how this perception is related to the actual levels of the pollutants NO2, PM10, PM2.5 and EC.

6.1 Living area of the participants

An overview of the participants including their sex, age, level of education and zip code area is already given in Table 3 (methodology). In the interview participants, were asked to describe the neighbourhood in which they live. Neighbourhoods in which participants lived ranged from those with heavy traffic roads to the city centre, worker's houses nearby the harbour, popular neighbourhoods with condominiums and quiet neighbourhoods with a lot of green areas. Figure 13 indicates where the neighbourhoods of the participants are located in Rotterdam or surrounding municipalities.

All of the participants talked positively about the place where they live, although some neighbourhoods were linked to criminality and nuisance from people or traffic. They mentioned frequently that there is good contact between the residents and that for example children were playing on the street. Common reasons to live in a specific area were the location, accessibility and the availability of green areas and good local facilities. There was variation in the cultural background of the inhabitants ranging from almost white, higher-educated people in the quiet and green neighbourhoods and city centre to multicultural and lower-educated people in the popular neighbourhoods. Between the neighbourhoods, there was variation in age, for example in some of the neighbourhoods primarily elderly live, while in others it is primarily young families and working people.

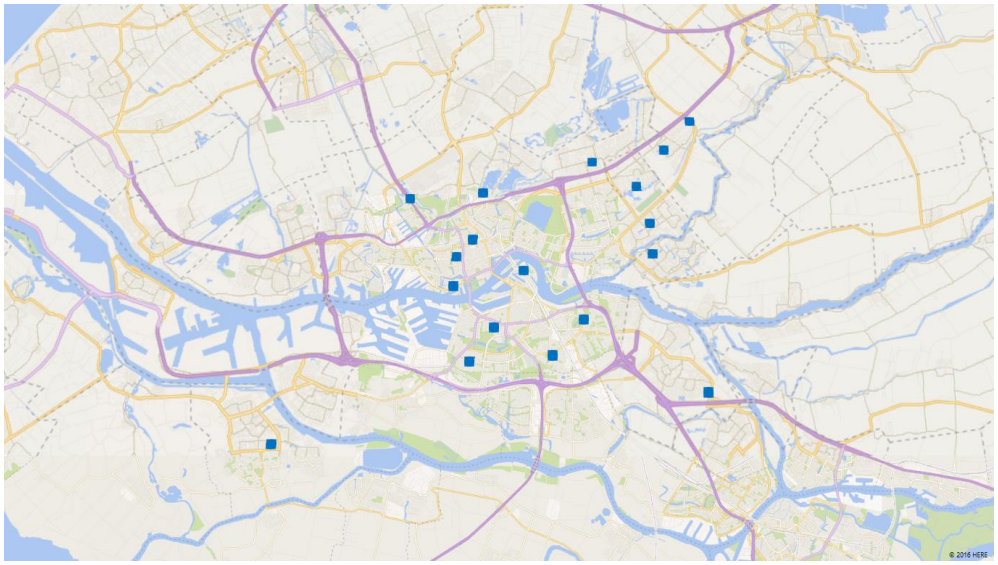

Figure 13: Location participants' houses

6.2 Perceived air quality

Participants were asked what air quality means to them. Air pollution was associated with traffic, industry, chemical odours and amount of micro-dust. The following quotes give an impression of the definitions of air quality:

"Clean air, yeah, free of um bad odours."(DD)

"I think of people who can breathe freely and well."(PN)

"Maybe, how clean the air is right here? (…) Well, substances in the air. Uh, ozone, things like that. From cars, exhausts, which comes from exhausts. That kind of things." (RC)

Participants indicated several places with bad air quality, like the harbour industry and heavy traffic roads. Participants indicated these areas as highly polluted, because they smell bad odours which they associated with oil, chemicals and exhaust gases or because they knew that there is pollution in an area (e.g. they read it in the local newspaper). The following quotes give an impression how participants perceive the bad odours associated with air pollution:

"It was a dirty, yea, what would it be? Fired oil or so, you know. Came then all from the, from the combustion things."(BZ)

"At the uh traffic lights, it is really unbearable. Then you are breathing that air. You smell that. From motorbikes and from cars." (DN)

Thereafter, the participants were asked how they perceive the air quality in their own neighbourhood. A summary of their reactions is shown in table 5 (p. 31-32). As can be seen in the table, most of the participants perceive the air quality in their own neighbourhood as neither good nor bad. It seemed like they are not really aware of the air quality and therefore perceive it as neither good nor bad, although some minor positive or negative remarks on the air quality were mentioned. Several participants indicated that they were not aware anymore of air pollution because they had lived there for so long and are used to it. This is illustrated by the following quotes:

"My brother lives in Rosenburg and when you were going there, you clearly smell the poison from the fabrics. And people who live there, they don't notice it anymore. But there is a clear difference if you are here or if you get there."(GK)

"And then I have to say, generally, you do not notice it. I'm a born Spijkenisser, so I really do not know better. You only notice it if you return from holiday or so. When you arrive in Spijkenisse, you notice it, you notice a certain odour and so, but yeah… if you live there for so long, uh yeah, you do not smell it. You do not notice it."(SL)

Participants perceive differences in air quality in the Netherlands. They indicated places in which they perceive better air quality compared with the air quality in their own neighbourhood in Rotterdam. Places which better air quality were in general characterised by less traffic and more nature. Participants did also indicate places with worse air quality compared to the air quality in their own neighbourhood. For example, a participant experienced smog on a vacation in Los Angeles and another participant saw a visible pollution layer during sunset at an industrial place.

6.3 Real air quality and perceived air quality

In table 5 is shown that participants who perceive the air quality as really good, really bad or as neither good nor bad. When combining this perception of good or bad air quality with the 'objective' levels of

pollutants in the air, there is no real association visible between the perception of the participants and the exact air quality. On places with lower air quality there were participants who perceive the air quality as neither good or bad, but also participants who perceive it as really good or really bad. This was also the case for places with better air quality, there were participants who perceive it as good, but also participants who perceive it as bad. This means that the perception of the participants on air pollution differs between the participants and that the perception is not related to the real levels of air quality.

6.4 Conclusion of this chapter

Participants' houses were located in different neighbourhoods of Rotterdam and some were located in the surrounding municipalities of Rotterdam. All participants were positive about the neighbourhood in which they live because of location, accessibility, social cohesion and availability of local facilities. Overall, the air quality in their neighbourhood was perceived as neither good nor bad. The perception of air quality seems not to be associated with the real levels of air quality. Air pollution was associated with traffic, industry, chemical odours and micro-dust and air quality was associated with less traffic and higher availability of nature.

Table 5: First impression on perceived air quality by participants and how this relates to the exact air quality.

Participant	Age	Zip Code	Number of Households	Average Income	PM10 ug/m3*	PM2.5 ug/m3*	NO2 ug/m3*	EC ug/m3	Perceived Air Quality and the arguments why participants perceive it this way.
1	50-54	3021	5 100	27 900	24,4	15,4	35,7	1,58	Bad, does associate bad air quality with several health problems, house located along a heavy traffic road.
2	20-24	3086	5 500	24 500	23,3	14,3	32,2	1,39	Neutral, have no positive or negative remarks regarding the air quality.
3	55-59	3078	5 800	25 900	24,3	15,3	36,4	1,88	Neutral, does not have complaints and does not recognise signs of air pollution in own neighbourhood.
4	70-74	3013	500	38 900	24,5	15,5	35,9	1,60	Neutral, does not have any complaints related to air pollution but is aware of the amount of traffic around the house.
5	55-59	2907	6 500	32 200	22,7	14,2	30,5	1,31	Difficult to describe, but participant perceived that air quality is better on greener places compared to own neighbourhood, is aware of the highway.
6	45-49	3024	4 000	28 400	23,8	14,9	34,6	1,42	Bad, cannot see the pollution at first sight but is shocked by the amount of carbon in the curtains.
7	20-24	3076	6 600	25 600	23,6	14,7	34,0	1,51	Neutral, does not have complaints related to air pollution but is aware of the amount of micro-dust in the house.
8	55-59	3071	8 800	28 900	24,2	15,2	33,9	1,49	Neutral, because the participant does not smell odours related to air pollution in the neighbourhood.
9	20-24	2903	3 900	29 500	22,8	14,3	29,3	1,20	Good, pleasant breathing in neighbourhood, no complaints related to air pollution.
10	75-79	3083	6 700	23 500	24,0	14,9	32,9	1,44	Neutral, doesn't notice it anymore, although participant knows that air quality is better in other places.
11	30-35	2914	6 500	32 200	22,7	14,2	30,5	1,31	Good, participant gets enough oxygen to execute daily activities.

12	25-29	2912	3 700	34 300	22,7	14,2	30,5	1,29	Pretty good, a lot of green available in neighbourhood that cleans the air.
13	60-64	2986	3 400	37 800	23,7	14,8	36,6	1,72	Bad, does have health complaints related to air pollution, feels healthier at their second house in the woods.
14	25-29	3051	3 500	37 600	24,1	15,0	37,1	1,82	Neutral, only noticeable with high temperatures, does not notice air pollution in daily life.
15	65-69	3068	10 100	30 300	23,4	14,7	35,0	1,62	Neutral, see some dust related to air pollution but does not have any health complaints.
16	40-44	3076	6 600	25 600	23,6	14,7	34,0	1,51	Good, does not have any health complaints and does not smell bad odours.
17	30-34	2922	2 900	32 900	22,8	14,3	29,6	1,23	Pretty good, is improved in the last years due to less traffic.
18	45-49	3203	1 700	30 500	21,6	13,3	26,7	1,02	Neutral, knows that there is a lot of industry in surroundings, but does not notice air pollution anymore.
19	35-39	3043	3 200	33 000	23,5	14,5	34,9	1,50	Good, does not have any complaints related to air pollution but did have complaints related to traffics' noise dust.

* Red numbers indicate that air pollution in a that particular neighbourhood is exceeding the thresholds of the WHO air quality guidelines, which are 20 µm/m^3 for PM10, 10 µm/m^3 for PM2.5 and 40 µm/m^3 for NO2 (World Health Organization, 2005). Green numbers indicate that the air pollution in a particular neighbourhood does not exceed the thresholds of the WHO air quality guidelines. No thresholds could be fine for EC.

7. Results of perceived causes and effects of air pollution

This section describes what were the causes of air pollution through the eyes of the participants, what they think is the effect of air pollution on neighbourhood's reputation, how they perceive the effect of air pollution on their health and psyche and how they think life in general will look like when there is good air quality.

7.1 Causes of air pollution

According to the participants most air pollution is located at places where people live and work and air pollution is therefore associated with population density. This would mean that the higher the population density, the higher the air pollution. The other two most common causes of air pollution mentioned by the participants were traffic and industry. However, also shipping, aviation and agriculture were mentioned as a likely source. Traffic was seen as the biggest polluter, because traffic is everywhere according to the participants, while industry and ships are located further away from residential areas. This is illustrated by the following quote (the original Dutch quotes are shown in appendix 7):

"I'm also very focused on traffic, because I, yeah, I think that I've the most trouble with it. Um... because the industry is still further away, not directly to homes. Of course, it is also not good, but yeah, I think on traffic first." (AS)

One of the participants stated that the air quality depends on the weather and another mentioned that pollution is higher among roads with tall trees next to it. The following quote is an example how the weather could influence air pollution:

"Because now, it did rain. So all the dirt in the air is a bit sink. And then you notice that it is better. But in the summer with an eastern wind, and when it is dry for a very long time… Then you will have amongst pollen and dirt from cars, you also get dry air and dirt." (KN)

Participants were asked what kind of people live in the proximity of high polluted areas. Many participants found it difficult to describe this because they did not know these places (and their inhabitants) very well. Those participants who were able to describe these areas were familiar with the place or the inhabitants and described these places as low-income areas with a lot of foreigners or as well-designed, high-income areas.

The participants stated that air pollution has negative impacts for all kind of people, lower as well as higher educated people and white people as well as foreigners. Participants shared the opinion that the air quality in the Netherlands is quite good compared with the air quality worldwide and that because of this, air pollution in the Netherlands did not have a bigger impact on vulnerable populations like lower-educated people. Participants could imagine that air pollution have a bigger impact on vulnerable populations in other parts of the world.

7.2 Effect of air pollution on neighbourhood's reputation

The participants were asked what the influence of air pollution is on the reputation of a neighbourhood. Some of them shared the opinion that air pollution leads to the stigmatisation of certain neighbourhoods in

the city. The following quotes illustrates that people relate this particular neighbourhood to air pollution immediately:

"Because most people ask for it. Where I live. Um like 'gosh, once again, are you not bothered by it'?" (AS)

However, the majority of the participants did not associate a certain neighbourhood immediately with air pollution. They thought that air pollution can play a role in the stigmatisation of a certain area, but that stigmatisation of an area is usually determined by the inhabitants and incidents in a certain neighbourhood like kids that hang around, criminality and bad housing facilities. The following quotes illustrate these findings:

"Certainly in the issue of 's Gravendijk. They have the image now… They caused it themselves first, when they went protesting. With the internet of course. And with consultation evenings, and so on. Gradually, everyone knows it, because it was in the newspaper. That it's the traffic sewer of Rotterdam. That's of course not good for your image. Because it has something to do with it. There are measures also. We were not allowed, at a certain time, to have diesel trucks on the shore. So, it helps then. But you also get a bad image." (CR)

"Um... I don't necessarily think that the neighbourhoods get a bad name. Um, but yeah, I think yeah, rather the whole environment. Yeah. Um, well, of course, it will not only be the pollution, but it does have certainly an um contributing …" (JE)

While the participants did not relate air pollution with stigmatisation of an area, but instead, thought that stigmatisation is determined by other factors, one of the participants described how air pollution can eventually lead to stigmatisation of a specific area. The following quote describes the process how a neighbourhood with air pollution can change in a stigmatised area:

"Mwah, I think you get really a shift in those people who have the possibility to leave, say the people with money. And that the people with um, with a low education level or with a lower income or just bad luck, that can't leave. And then get, you know, get, fall in housing prices and that does attract certain groups and therefore the whole neighbourhood gets a bad name, yeah." (RE)

7.3 Effect of air pollution on health and psyche

Participants were asked who are most vulnerable to the effects of air pollution. All participants mentioned that people most vulnerable to adverse health effects of air pollution are babies, young children, elderly, people with lung or heart diseases and other people with a weaker immune system. According to the participants, these people will develop the same symptoms that also arise in people who have smoked for a long time, like having difficulties with breathing and developing asthmatic symptoms. They stated that these vulnerable people need more energy to get enough oxygen, resulting in less energy for their daily activities and a lower quality of life. Development disorders, cancer and premature death were also mentioned, but only by the participants who acknowledged that they knew this, because they read a lot about air pollution and its effects on health and well-being.

The majority of participants didn't have physical health complaints themselves which they related to air pollution. However, those who experience physical health complaints due to air pollution mentioned the

following physical complaints: fatigue, stuffy nose, attack on vocal cords, dirty ears and irritation of the throat, the respiratory tract and skin. No association between health complaints and pollution was found after comparing the response of the participants with the actual amount of air pollution (table 5). Those participants who experienced these physical health complaints indicated that they feel restricted in their daily life due to these health complaints.

Besides physical health complaints related to air pollution, complaints related to mood, consciousness and feelings of disgust were also mentioned. The following quotes give an impression of these psychological complaints:

"Well, I'm very cranky. No, seriously, I was cycling, I always cycle. I really love cycling. But actually, I keep my breath half of the time. That's because of the scooters and motorbikes on the biking path." (AS)

*"Perhaps it is almost psychological now, "*** guys, all those cars". Hey. So it is just how you experience it." (CR)*

It was mentioned by the participants that they sometimes have to go to a more natural area, like the woods or the beach, to get some fresh air. When they are in a such a place, they have the tendency to take a deep breath and feeling more positive and relaxed. This is illustrated with the following quote:

"But when I'm walking on the beach or so, um, in Scheveningen or Hoek van Holland, then um, then at least you notice it in some way that the air you're breathing is better for you. I don't know how to explain it. But yeah, you notice a difference in air quality. It smells fresher. You go to the beach to get some fresh air, you know. There you have certainly some influence, yeah. You'll feel much better." (ED)

Even when participants know that the air pollution levels in a natural area are the same as in build areas, they still experience taking deeper breaths and feeling better when walking there.

"Because I notice it when I um, I um, I cycle through the Netherlands and when I come in other areas with more nature, than I know from personal knowledge that there's the same amount of micro-dust. Only you still breathe differently. If I breathe here along the way, then I breathe less deeply or so, I'm not sure how it works, but it certainly does something with you." (DN)

While participants experience the need of taking a deeper breath in more natural places, most of the participants acknowledged that they are unconscious about the air pollution and the need for cleaner air in their normal, everyday life. They only notice this need for cleaner air when they are in a cleaner area.

7.4 Effect of air quality on daily life

After asking the participants what they perceive as the consequences of air pollution, it was also asked what they think are the effects of good air quality. Participants were asked to describe how living in the Netherlands would change when there is good air quality everywhere. This resulted in a description of a sort of utopian world. The following quote was one of the most positive reactions:

"Fantastic. The best country on earth. Well, yeah. That would be lovely. (…) Anyway, spoken purely from me then, um, it seems like a paradise on earth." (AS)

But they mentioned also other positive effects, like more fresh air; more availability of and diversity in nature; life in general will be more relaxed and fair, because people will feel more tolerant and less aggressive; people will be healthier, feel active and are able to sport and cycle again; there will be less use of health care facilities, because people are healthier; there will be advertisements with a different focus and there will be less dust caused by air pollution.

However, there were also participants who thought that better air quality will not really make a difference in people's lives. They mentioned that quality of life will not change, because people who do not know that the air quality is better, will also not notice any differences related to air quality in their lives. Only people who have impaired quality of life due to real health problems related to air quality will notice a difference because they will have fewer health complaints due to an improvement in air quality.

"I'm really afraid that a lot of people will not notice the difference. Only the people who really suffer from it, because they are affected by physical conditions. Or those who live next to a factory and suffer from it. But I don't think that (…) it will have a big impact." (GE)

7.5 Conclusion of this chapter

Population density, traffic and industry were seen as the biggest causes of air pollution. The air quality in the Netherlands was perceived as quite good and participants thought that air pollution has negative impacts for all kind of people instead of only effecting people living in lower-income areas. Participants thought that air pollution can play a role in the stigmatisation in an area, but that stigmatisation is usually determined by the inhabitants and incidents in a certain neighbourhood.

Babies, young children, elderly and other people with (chronic) disease were perceived to be more vulnerable to the adverse health effects of air pollution. Some of the participants themselves did have air pollution related health complaints, merely complaints related to skin and the respiratory tract. Also, complaints related to mood, feelings of disgust and the need for taking a deep breath in more natural places were mentioned by the participants. According to the participants, good air quality would have numerous positive effects on living in the Netherlands.

8. Results of perceived needed efforts to improve air quality

In this section will be described what the participants think is necessary to improve the air quality in Rotterdam. First will be described what technical improvements are needed and the needed changes in the physical environment according to the participants. This is followed by the participants' perception of the responsibilities of the involved parties, mainly individual responsibilities and the responsibilities of authorities. The section will end with a description of the assets that are seen as necessary to make a real change.

8.1 Which improvements are needed?

8.1.1 Technical improvements

In the previous chapter is described that traffic and the industry were seen as the biggest source of air pollution. It is not surprising that part of the suggestions made by the participants to improve the air quality is related to restricting these sources of air pollution. Listed measures to restrict the traffic-related air pollution are lower speed limits, redirection of traffic out of town, promoting the use of bicycles, promoting the use of electric and public transport. A mentioned measure to restrict the industrial related pollution was placing filters to limit the emissions. However, participants pointed out very clearly, that they saw this last measure as the responsibility of the company owners.

The restriction measures mentioned in the paragraph above were not seen as the ultimate solution to improve air quality. Some of these measures include the use of electricity or other sustainable energy sources, but these sustainable energy sources do also have counter effects. The participants were doubting if the use of this sustainable energy sources will be really better for the air quality in the end.

Although the participants think that it is technically possible to lower the pollution levels, they stated that a bigger change is needed. A participant mentioned that the industry invested in their current resources and that they will not easily change to other resources (which are better for the air quality) because additional investments are needed. It was also mentioned that it will take years for all people can make use of electric transport, because electric cars are very expensive nowadays. Several participants thought that, besides the technical possibilities to lower the pollution level, cumulative measures have to be taken to have real impact and that the transition has to be more attractive to be implemented.

8.1.2 Needed improvements in the physical environment

Another suggestion made by the participants to improve air quality is related to the availability of green and the design of the physical urban environment. According to one of the participants, air quality depends on the design of the urban environment. It was mentioned that the city is currently designed for economic development and accessibility by vehicles. The participant meant that when the city council would pay more attention to air quality, they will also take the air quality into account in plans for the physical urban environment. For example, roads will be located in different places and more green will be planted in the city centre.

The majority of the participants associated the availability of green with better air quality. According to them, nature will filter the polluted air and thereby clean the air. They shared the opinion that planting more

green will enlarge nature's capacity to catch the polluted air. Some of the participants mentioned that they would like to see more nature in and around the industrial sides of the city.

8.2 Who is responsible?

8.2.1 Individual responsibilities

After asking what the participants saw as the possibilities to improve the air quality, they were questioned who they think is responsible for these improvements. It was stated that it is everybody's individual responsibility to take care of the environment (including improving air quality). The following individual possibilities were mentioned: voting on political parties that are dedicated to the environment; taking the environment into account when making choices related to travel and consumption; influencing close relatives by your lifestyle choices; sharing your opinions via social media; collaborating with the town council; putting pressure on the town council with a lawsuit and taking part in research and protests. This were primarily reactions of the higher educated participants. Among the lower-educated participants was mentioned that they should make different choices related to travel. Among the lower-educated participants, there were also people who indicated that they didn't know what they could do themselves to improve the air quality. Participants did not say why they did not know this.

Participants said that it is important to start individual initiatives and to share ideas with other people, because you get more done with more people. A person said that there are already many local initiatives in Rotterdam. However, a few others shared the opinion that people can do more to change the air quality and that it is important that individuals don't choose the easiest option, but take the long-term results of their actions into account. An example mentioned was that people are used to take their car for everything, while the travel time by bike or public transport is about the same. This last option will be better for air quality in the end.

8.2.2 Responsibilities of authorities

Many of the participants shared the opinion that global, national and local governmental bodies are mainly responsible for improving air quality. Governmental bodies are seen as the authorities that are responsible for the management of public and shared resources and the development and execution of laws and regulations. Governmental bodies are also seen as responsible for the well-being of the population. It was stated that one of the tasks of the governmental bodies is to listen to the people and to act upon it. The example was given that municipalities have to solve complaints of inhabitants about air pollution.

Some of the participants shared the opinion that the Dutch government should pay more attention to complying with the European standards for air pollution levels and that governmental bodies do not take enough action in tackling air pollution. They see that the government tries to change certain things, but they are not doing this in a consequent way. This is illustrated with the following quote:

"You have the environmental zone now. That's also a bit for the inhabitants. You have those big cruise ships. We have just the largest in the world now, which of course need millions liters of petrol to come to

Rotterdam and back. While people with old, classic cars are not longer allowed in the city. That reasoning is a bit double." (DD)

It was mentioned that the reason why governments did not take consequent measures is that governments are more concerned with the economy on the short term instead of with the well-being of the population on the long term. Another opinion was that governments have not so much knowledge about air quality and because of this, they are not able to act and to take good measures. A few people stated that the government should pay more attention to the effect of air pollution on low-income families. They explained that not everyone can afford a bicycle or have the money to travel with public transport. The government can promote the use of bicycles and public transport and thereby improve the air quality. Otherwise, these low-income families continue making use of their cars because this is cheaper and easier for them.

Nevertheless, people did recognise that governmental bodies are trying to change the current status of air pollution. Some people stated the importance of collaboration with other governments and lobbying organisations, because this will enable them to bundle their capacities in the battle against air pollution. In section 8.5 is described what participants saw as important assets to accelerate a change in the air quality status.

8.3 Needed assets to accelerate change to cleaner air

A lot of information was given by the participants about what could accelerate the change process. It was mentioned by the majority of the participants that awareness about the current situation and about the capabilities and responsibilities for change is necessary to trigger a real change in air quality status. This is illustrated by the following quotes that show that participants thought that other people will only change their behaviour or think about possible solutions when they have more knowledge about air pollution and its consequences.

"I joined some meetings of the municipal council. About air pollution. They are not informed. They don't know where they talk about. So it's difficult for them to do something with this kind of complaints… They don't know what it is. If we ask them what exactly is micro-dust, they don't know. What's in it? Yeah, we don't know. So, how can you come up with solutions if you don't know what it is." (DN)

"People are not aware of it. Um, until they wake up, because their child suddenly needs an inhaler." (PN)

It was mentioned that the current measures were not enough to make a significant improvement in air quality. Participants thought that people do not know how their behaviour impacts the air quality and that because of this more knowledge and awareness should be created. It was seen as the responsibility of action groups and the media and partly as the responsibility of the government to create more awareness amongst the people. However, it was also stated several times that awareness of the pollution problem does not automatically lead to improvements in air quality. When people become aware of the air quality and the necessary measures to improve the air quality, it can also lead to resistance towards these measures, because people are not willing to change their own behaviour. For example, when people have to limit their car use, but in reality, they did not do this.

It is seen as important that the population supports the governmental policies to improve the air quality because participants thought that in the end only this will contribute to significant improvements in air quality. They shared the opinion that the air quality will increase most when more and more people share the idea that the air quality needs to be improved and are willing to change their behaviour. Some participants mentioned that individuals can play a role by inspiring their social surrounding with their behaviour, because when more people become aware of the need for air quality improvement this will result in more taken measures.

It was mentioned by a few higher educated participants that there should be additional measures to create awareness about air pollution among low-income families. They thought that these low-income families are occupied by other worries, like how to earn enough money for their living. One participant stated that in Rotterdam measures against air pollution are only taken in higher-income neighbourhoods. Some of the lower-educated people mentioned that they did not know what they can do themselves to improve the air quality and that lower-income families in their social surrounding sometimes do not have the resources to change their use of transport (e.g. use of public transport for a family is far more expensive than using their car).

8.4 Conclusion of this chapter

Perceived necessary improvements were, among other things, restricting the emissions of traffic and industry, promoting the use of electric and public transport and more green available for filtering air pollution. It was seen as everyone's individual responsibility to take care of the environment. This means that people are responsible for their own lifestyle choices, for sharing their opinion and for taking part in the societal debate. Governmental bodies are mainly responsible for improving the air quality, because they are responsible for the well-being of the populations and for developments of laws and regulations. Participants perceived that governmental bodies could take more action in reducing air pollution, although they are aware that they have already taken some measures against air pollution.

Participants did mention that a bigger change in society is needed to improve the air quality. The following aspects mere mentioned: the need for more knowledge and awareness among the population, the need for more support to change the air quality and the need of additional actions among low-income families to create more knowledge and to provide them with the possibilities and resources to change (e.g. different choices related to traffic).

9. Results on environmental justice

In this section will be described what the participants perceive as just (or not) and the previous result sections will be summarised and related to the five principles of environmental justice.

9.1 Perceived environmental justice

A few fictional case descriptions were given to the participants to investigate their perception of justice in these particular situations. It was mentioned by the majority of the participants that everyone has the right to live in an area with good air quality. There was a common understanding among them that living in a polluted area is just when it was people's own choice to live there. It became injustice, when it was not their choice to live in a polluted area, because they did not have the money to live somewhere else; because they did not know that the area is highly polluted; because the pollution emerged when people were living their already or because people did not have the possibility to change their living area (e.g. lacking money, skills, social network).

It was also seen as injustice when voices were not heard and complaints from people who live in a polluted area are not taken seriously. It was seen as the municipalities' responsibility to listen to their residents and to act upon their complaints. Participants indicated a gradient in the level of righteousness. According to them, it became more just when a municipality did not take action immediately because they have good arguments to do so or they have proper plans to tackle the problem in the long term.

9.2 Summarising results according to justice principles

The five principles of environmental justice were explained in the theoretical framework. As these principles guided the interview questions and answers, this last section will explain how the findings of this study can be placed in the five principles: distribution, recognition, participation, responsibility and capabilities.

9.2.1 Distribution

As can be seen in the section on distribution, lower income area seems to have higher levels of pollutants, but also some high-income areas have high levels of air pollution. The air quality in the neighbourhood of the participants was perceived as neither good or bad. Participants were able to describe areas with high pollution, these were mainly located in the proximity of heavy traffic roads and at the industrial side of the city. They would like to see more green around these areas to filter the pollution.

Some participants did perceive that air pollution is higher in lower higher income areas. However, they thought that there is a bigger difference in pollutants between low- and high-income areas in other, mainly poorer parts of the world than it is in the Netherlands.

9.2.2 Recognition

The majority of the participants did not think that air pollution will lead to stigmatisation of a neighbourhood. They perceived that stigmatisation is usually determined by other factors like criminality and bad housing facilities. One of the participants explained the process how air pollution can lead to a stigmatised area with criminality and bad housing facilities.

Some streets in Rotterdam were well-known among the participants, because of the high emissions due to traffic. The participants indicated that this awareness is created by the residents living among these heavy traffic roads. They indicated that these people are only suffering from air pollution and not from other environmental burdens.

9.2.3 Participation

Many ideas to improve the air quality were mentioned (see results of perceived needed efforts to improve the air quality). The higher-educated participants mentioned a lot of opportunities to join the debate, for example by lifestyle choices and collaboration with the municipality. It was mentioned by some of those participants that there should be more awareness among low-income families about air pollution.

The lower-educated participants did not mention ways to join the societal debate, but they did know what that they could go to the municipality in case of air quality related complaints. They also indicated that lower-income families in their social surrounding did not have enough money to make more use of sustainable transport and the important role governments play in promoting this among low-income families.

9.2.4 Capabilities

The majority of the participants feel not restricted in their daily activities, because of air pollution and they were able to live the life they wanted. Some of the participants that did feel restricted, mentioned that their air pollution related health complaints were the reason for it.

Participants mentioned that their daily life would be different by good air quality. According to them, good air quality would be positive for health and well-being, mood and nature and there should be less use of health care facilities and less air pollution caused dust.

9.2.5 Responsibility

Participants shared the opinion that it is our individual responsibility to take care of the environment and therefore people should be aware of their contribution to air pollution and act upon it to lower the pollution levels.

It was not mentioned by participants that lower-income communities are the least contributor to the current levels of air pollution or that mitigation measures should be located more in lower-income communities. A reason for this might be that participants did not perceive environmental justice in the Netherlands meaning that pollution is not disproportionately located in lower-income areas.

9.3 Conclusion of this chapter

Participants did perceive injustice when people are forced to live in a polluted environment or when there is no action followed by governmental bodies to tackle serious complaints. There is no real injustice in distribution, because air pollution is higher in low-income as well as high-income areas and participants did not perceive injustice in distribution. There is no injustice in recognition, because the participants did perceive in general that air pollution did not lead to stigmatisation of an area. There might be injustice in participation, because higher educated participants perceived more ways for participation and act upon

it, while the lower educated participants did not mention ways to join the societal debate. Although participants did mention that life in general would be very different by good air quality, there is probably also not injustice in capability, because in general, participants feel not restricted in their daily activities due to air pollution. However, there can be an injustice for those who suffer from air pollution related health complaints. There is probably no injustice in responsibility because participants perceived that everybody is responsible for the environment and has to act on this responsibility.

10. Discussion

10.1 Major findings

The aim of this research was to investigate to what extent there is environmental justice in the Netherlands in relation to air pollution. This aim is accomplished by 1) investigating the distribution of air pollution, 2) investigating the perception of air pollution among Dutch citizens and 3) investigating how Dutch citizens perceive environmental justice in relation to air pollution. The major findings in this research are:

1. A significant U-shaped association is found between air pollution levels and income on zip code level in Rotterdam and surrounding municipalities, meaning that air pollution levels are higher in lower- and higher-income areas.
2. Participants perceived the air quality in their neighbourhood as neither good nor bad. The air quality in the Netherlands was perceived as quite good in comparison to other parts of the world. Air pollution was associated with traffic, industry, chemical odours and micro-dust and air quality was associated with less traffic and higher availability of nature.
3. Participants did perceive injustice in the fictional case descriptions when people are forced to live in a polluted environment or in cases when there is no action followed by governmental bodies on serious complaints of inhabitants.

   Participants did perceive injustice in participation because higher educated participants mentioned more ways for participation and took more action, while the lower educated participants did not mention ways to join the societal debate. Some of the participants might perceive injustice in capabilities, but only when they experience restrictions in their daily life, because they suffered from air pollution related health complaints. Participants did not perceive injustice in distribution, recognition and responsibility.

10.2 Relevance of findings

10.2.1 Significance of air quality distribution

The data on air quality distribution showed a small effect on income and air pollution levels. Only 5-27% of the variation in air pollution levels is associated with income. Although this relation is statistically significant, the practical relevance can be debated. It means that a large part of the variation in air pollution levels can be explained by other factors. This could depend on the kind of data used. The data of the RIVM are calculated based on the background concentrations of the pollutions combined with the data on actual emissions. According to the RIVM, an inaccuracy of 15% have to be taken into account. However, other explanations for this weak association between air pollution and income seems more logical.

The small effect could also be explained by the fact that the difference between higher income areas and lower income areas are not as big compared with other countries and therefore, no real injustice in distribution can be found. This in accordance with recent research that compared particulate matter in a European-wide study (Richardson et al., 2013). In this research no association for particulate matter and income was found in Western Europe and also no association was found in Eastern Europe. However, an

association between particulate matter and income was found when combining this data. This means that for Europe as a whole, particulate matter was higher in more low-income areas ((Richardson et al., 2013).

10.2.2 U-shaped correlation explained

A U-shaped correlation between particulates and income in Rotterdam is also found almost 10 years ago (Kruize et al., 2007). However, this U-shaped correlation is not found in other European studies. On the contrary, a review of Deguen & Zmirou-Navier (2010) included only studies with linear correlations. These studies shows that pollution is higher among lower-income areas in Europe (Briggs, Abellan, & Fecht, 2008; Havard, Deguen, Zmirou-Navier, Schillinger, & Bard, 2009; Mitchell, 2005; Namdeo & Stringer, 2008) or that pollution is higher in high-income areas in Europe (Forastiere et al., 2007; McLeod et al., 2000; Stroh et al., 2005; Tonne, Beevers, Armstrong, Kelly, & Wilkinson, 2008). And although a U-shaped correlation between pollutants and income in Rotterdam is confirmed by another study (Kruize et al., 2007), this does not mean that there is also a U-shaped correlation between pollution and income on national level in the Netherlands. Research shows that although certain areas might look the same at first sight, associations between pollutants and income in these areas can vary (Fecht et al., 2015). To make it more concrete: although the Netherlands and England might have similar geographical and population characteristics at first sight, associations between pollutants and income are not the same for these two countries. For example, higher pollution concentrations were found in the 20% of most deprived communities in England, but this same association was not found in the Netherlands (Fecht et al., 2015). The same counts when comparing the association between pollution and income in the city of Rotterdam with the association in other Dutch cities, because a U-shaped association is found for the Rotterdam region, but this association is not found in other big cities in the Netherlands (Fransen, 2016). Negative linear correlations were found between pollution and income in Amsterdam, Den Haag, Groningen and Tilburg, meaning that in these cities the pollution was higher in low-income areas, while positive linear correlations between pollution and income were found in Eindhoven and Utrecht (Fransen, 2016).

10.2.3 Air pollution levels and air quality perception

No association is found when comparing the data on air pollution levels to the air quality perception of the participants. Although there are just a few articles on air quality perception, finding no association between quality and the perception of air quality is confirmed by one other study (Gen, Shafer, & Nakagawa, 2012). Some scholars think that the air quality perception of people is not based on the real air quality, but on the setting in which these people live and on the socioeconomic characteristics of these people, like age and educational level (Brody, Peck, & Highfield, 2004; Geelen, Souren, Jans, & Ragas, 2013). For example, in this research, the people who did perceive bad air quality, did also have health complaints which they contributed to the air pollution. Having these air pollution related health complaints might be an explanation why they perceive the air quality as bad.

10.2.4 Environmental justice perception

There is no perceived injustice in this study related to the environmental justice principles distribution, recognition, and responsibility. There is perceived injustice related to the principle of participation, which means that participants did not have equal opportunities and resources to join the social debate. There

might be perceived injustice related to the principle of capabilities, but only when participants feel restricted in their daily life because of air pollution related health complaints. Finding no perceived injustice in some of the five environmental justice principles, can indicate that these justice principles are of relevance in scientific literature, but that the general public does not regard this of relevance in their everyday life.

10.2.5 Positive associations with good air quality

A remarkable result was that participants associated good air quality with all kind of positive aspects and they even thought that it can create a different society, because it will change the physical environment (nature and green), it is positive for public health and the interaction between people and it will create a different economic structure. It might be that people are overestimating the positive effects or that they have a deep desire to live in a utopian world. However, research showed that for example green spaces are associated with less crime and aggression (Kuo & Sullivan, 2001) and is beneficial for health and well-being (Lee & Maheswaran, 2011). So this shows that having less traffic and thereby more green available is (to some extent) beneficial for public health and the interaction between people. However, no explanation could be fined in the scientific literature for an overestimation by people of the positive effects of good air quality.

10.2.6 Explaining contradictory responsibilities

Another remarkable result was that participants thought that it's everybody's own responsibility to take care of the environment, while meanwhile they perceive it as the task of the government to take action and to promote good air quality. This can indicate a contradiction, because the idea can rise that individuals do not need to do anything that is good for the air quality when the government is already taking measures to promote good air quality. However, it can also be interpreted in a way that they see it as everybody's own responsibility, but that individual initiatives will not lead to big changes and that the government can take more actions that will have significant results, because of their power. It was also mentioned by a few participants that they government is mainly responsible, because they will have the power to change rules and regulations.

10.3 Linking findings to theory

10.3.1 Combining environmental justice and health promotion

This study is embedded in the environmental justice movement and in the field of health promotion. The importance of combining environmental justice and health promotion is stated in the theoretical framework. This study tried to connect the fields of health promotion and environmental justice by applying justice principles to air pollution. The results of these justice principles showed that citizens in Rotterdam and surrounding municipalities do not perceive environmental injustice in their region. While there may be adverse health outcomes in the Netherlands due to air pollution, the participants in this research did not think that this was unequally divided among the population. This might argue against the relevance of incorporating justice in improving air quality, however, a lot of studies in other cities did show injustice in distribution (e.g. Havard et al., 2009; Mitchell, 2005). In these cases, it will be highly relevant to incorporate justice in tackling the problem. Tackling this problem from both an health promotion perspective and an

environmental justice perspective is important, because it produces a more powerful approach to ensure that the whole population shares in the health benefits of environmental sustainability (Masuda, Poland, & Baxter, 2010).

10.3.2 Framework of Wakefield & Baxter (2014)

Combining the field of health promotion and environmental justice does also contribute to a more integrative and holistic perspective in tackling environmental health issues. While the movement of environmental justice might be more focused on social and institutional arrangements (§1.3 and Wakefield & Baxter, 2014), health promotion is focussed on improving people's health status and on the social and physical determinants of health (WHO, 1986). Combining these two fields gives more attention to the diversity of issues that affect marginalized populations. In this study questions were asked about the neighbourhood in which participants live, which would give more information about their social and physical environments. It was asked if the participants had air pollution related health complaints, which give more attention to their health status. By investigating the five environmental justice principles, the focus was on the social and institutional arrangements. It was argued in the theoretical framework that the environmental justice perception can be influenced by the air quality perception. This might also be visible in the results, because people did not really perceive the air as polluted, but they also did not perceive environmental injustice.

10.3.3 Relevance of environmental justice principles

Although this study found that people only perceive injustice in the participation principle, this does not imply that the other environmental justice principles are not of importance in tackling environmental justice concerns. Not only Davoudi & Brooks (2014) pointed out the importance of the other environmental justice principles, also other scholars think that it is of great importance to take recognition, responsibility, participation and capabilities into account in addition to distributive justice (Ballet, Koffi, & Pelenc, 2013; Clayton, 2000; Holifield, 2012). Articles found in the scientific literature that focusses on recognition, responsibility, participation or capabilities are all of philosophical nature. This might indicate a need for more research to judge the relevance of the principles recognition, responsibility, participation and capabilities.

10.4 Strengths and limitations

This study had several strengths and limitations. First the limitations of this study will be discussed:

- The used background concentrations of the pollutants NO2, PM10, PM2.5 and EC to investigate an association between pollution and income were determined for larger areas, like zip code areas. When concentration of the pollutants on street level was used, this could have led to different and more precise results. Pollutant concentrations can vary from street to street, while the background concentrations are an average of the whole zip code area.
- The results of the air quality perception could have been different when using the AQP questionnaire instead of the interview questions based on the AQP. The AQP is a validated questionnaire and might be more precise and sensitive to differences in air quality perception. This could have led to more precise results in air quality perception and therefore in more differences in air quality perception between participants and neighbourhoods.

It was expected beforehand that the air quality perception could have influenced the perception of environmental justice. Because no real differences in air quality perception are found, this might explain why participants did not perceive environmental injustice. Because the questions in the AQP are more detailed, the participants can show better reflections on the air quality. The AQP questionnaire could have made them more aware of several aspects of air quality. When they are more aware of these aspects, they could have shown slight different results in environmental justice perception because of this awareness. This difference will be strongest for the people who did not know much about air pollution yet.

- It was decided to limit the place of study to the city of Rotterdam and surrounding municipalities. However, incorporating more diverse places, like more natural areas, industrial areas, small towns or villages, could have led to a more detailed picture of the perception of air quality and environmental justice in the Netherlands. The findings for Rotterdam cannot be extrapolated to other places in the Netherlands. It could be that people living in more natural parts of the country do perceive environmental justice because they think that the air quality is really bad in the big cities. Or it could be the case that in other big cities people do perceive environmental justice because there the lower-income neighbourhoods are located in more polluted environments.
- The spread of the participants throughout Rotterdam and surrounding municipalities did create a rich picture of the complete situation, however, real differences between neighbourhoods could not be identified. Having two groups of participants from two different neighbourhoods could have led to a different perception of environmental justice. For example, when one group of participants live in a low-income neighbourhood and the other in a high-income neighbourhood. Using two groups can result in a detailed description of how lower-income communities perceive environmental justice and how higher-income communities perceive it. It enables to contrast the differences between the low-income and high-income groups.
- Several of the participants (8) were recruited through environmental action groups. Because air quality was a real priority for these people, they had a lot of knowledge about air pollution, its effects, needed efforts for improvement and so on. This resulted in detailed transcripts with a lot of examples. Part of the richness of the results can be attributed to these participants. Although the other participants sometimes give the same answers, but in less detail, this still could have biased the results.

Although there are quite some limitations mentioned, there are also some issues that contribute to the strength of this research. First some more general positive aspects of this research:

- The aim of this research is accomplished by giving a rich picture of the perception of different aspects of environmental justice. Furthermore, this research takes in integrative perspective, taking into account the perceived air quality, the characteristics of participant's neighbourhoods and the five principles of environmental justice.
- Focussing on a single aspect of the environment (the air) made the interview more concrete for the participants and gives them the opportunity to come with a lot of examples based on their own experiences.

- After the interviews, some participants mentioned that they did not expect that there are so many things related to air quality and that the interview questions forced them to think of some subjects they never thought of before. The interview could have led to more awareness among these people.

There are also some strengths related to the research set-up and methodology:

- A first strength related to this research is the use of semi-structured interviews to investigate the perception of air quality and environmental justice. This gave the opportunity for the participants to come up with their own answers, meanwhile maintaining that the important topics were covered.
- A second strength is the formulation of interview questions based on scientific literature. The questions from Davoudi & Brooks were used and formulated in a more understandable way. This ensured that participants were able to understand the meaning of the question and being able to answer them. Meanwhile, it did enable the researcher to investigate how the general public thinks about the scientific concepts of distribution, recognition, participation, capabilities and responsibility.
- The last strength was combining real data on air quality, the air quality perception and the perception of environmental justice principles. This did enable for investigating environmental justice based on different sources of data and combining this data to look for similarities and differences.

10.5 Implications for further research

As far as known, this is one of the first studies focussing on the perception of environmental justice among the general public. There are studies that investigated the perception of distribution in environmental justice, but not the perception of other environmental justice principles. This research did not find injustice in the perception of Dutch citizens, besides injustice in the principle of participation. Further research must point out if research on environmental justice should not only focus on distribution, but also on other principles of environmental justice. This could be done by interviews in other places or contrasting different places, to see if this makes a difference in the perception of environmental justice. Furthermore, a questionnaire can be developed based on the results of the interviews, to get a more quantitative perspective on the environmental justice principles. An advantage of such a questionnaire is that it is easier to extrapolate the finding to the whole Dutch population if the used sample is a reflection of the Dutch population.

If more knowledge is needed what participants perceive as just in relation to environmental issues, new research could contain more questions, like how important the environment is to the participants and what they, in general, perceive as just. This knowledge can give more insight into the reason why participants give certain answers, if they do it also for other environmental problems and if their perception of justice changes when it becomes clearer from the interview questions that environmental justice is the topic of research.

10.6 Implications for practice

This study did not only show the perception of environmental justice among Dutch citizens, but it also gave an impression of citizen's ideas to improve the air quality and to tackle the causes of air pollution. Furthermore, the citizens pointed out the importance of creating more awareness among people to

accelerate a transition in air quality. It might be worthwhile to take the ideas of citizens more into account. Doing so will create more support among the population towards measures that contribute to air quality improvement and it will create more active involvement of citizens in such initiatives.

11. Conclusion

This study found no environmental injustice in the distribution of air pollution in Rotterdam, although a significant U-shaped association was found between pollution levels and income. Participants perceived the air quality in the Netherlands as neither good nor bad. Participants did not perceive injustice related to the principles of distribution, recognition and responsibility. There was perceived injustice related to the principle of participation because lower-educated participants do not feel able to join the societal debate to the same extent as the higher-educated participants. There is also perceived injustice in the principle of capabilities, but only when people experience air pollution related health complaints. So, only injustice was found related to the environmental justice principles of participation and capabilities. Further research should point out to judge if all environmental justice principles are of equal importance in tackling environmental justice concerns.

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Appendix 1: Air Quality Perception (AQP) Scale

This questions are derived from the study of Deguen et al. (2012).

Over the past week, as a result of air pollution, did you:

	Never	Occasionally	Often	Always
Feel worried about your health?				
Have 'red' eyes?				
Suffer from nose irritation?				
Sneeze?				
Have a dry throat?				
Cough?				
Have difficulty breathing?				
Suffer from headaches?				
Change your leisure activities?				
Stay indoors?				
Air your home?				
Close the shutters in your home?				
Use an air freshener in your home?				
Avoid opening your windows?				
Feel the need to wash your hands or face?				
Drink more water than usual?				
Smell an unpleasant smell outdoors?				
Smell an unpleasant smell indoors?				
Notice that your curtains were dirty?				
Notice that the sky was cloudy?				
Think that your quality of life was being degraded?				
Think about moving home?				

Appendix 2: Interview guide

Introductie

- Mijzelf en het onderzoek introduceren (naam, studie, doel van het onderzoek: ervaringen van Nederlandse burgers met luchtkwaliteit)
- Toestemmingsformulier laten lezen, ondertekenen en eventuele vragen beantwoorden
- Vertrouwelijkheid verzekeren, opnemen interview
- Pauze of vragen mag tussendoor
- Duur is ongeveer een half uur

Deel I – Luchtkwaliteit, omgeving en gezondheid

1. Kunt u kort omschrijven in wat voor wijk u woont?
2. Hoe ervaart u het om in uw wijk te wonen?
3. Wat voor soort mensen wonen er in uw wijk?
4. Als ik zeg 'luchtkwaliteit', waar denkt u dan aan?
5. Hoe ervaart u de lucht(kwaliteit) in uw wijk?
    a. Gezondheidsklachten (rode ogen, niesen, zere keel, verkouden, moeilijk adem halen, hoofdpijn)
    b. Binnenshuis (luchten, luchtverfrisser, ramen, onplezierige geur, vieze gordijnen)?
    c. Buitenshuis (andere activiteiten, veel binnenblijven, onplezierige geur, wolken)?
    d. Kwaliteit van wonen (verhuizen)?
6. Denkt u dat er in uw NL verschillen zijn in luchtkwaliteit?
    a. Waar merkt u dat aan? (gezondheidsklachten, binnenshuis, buitenshuis)

Deel II – Verdeling, miskenning en mogelijkheden

7. U heeft net (gebied net omschreven door participant als gebied met slechte luchtkwaliteit) aangegeven als een gebied met luchtvervuiling. Kunt u dit gebieden omschrijven (inwoners, omgeving).
    a. Indien niet omschreven, vragen wat ze zien als een gebied met luchtvervuiling.
8. Het is bekend dat luchtvervuiling vooral nadelig is voor kwetsbare groepen. Waar denkt u aan als ik zeg 'kwetsbare groep'?
9. Wat voor effect denkt u dat luchtvervuiling heeft op hen (invullen kwetsbare groep genoemd door participant)?
10. Leidt veel luchtvervuiling in een buurt tot een buurt met een slechte naam? Zo ja, hoe is dat te zien? Zo nee, waarom niet?

Deel III – Mogelijkheden, verantwoordelijkheid en participatie

11. Wat moet er gebeuren om de luchtkwaliteit te verbeteren in gebieden waar veel vervuiling is?
12. Wie is er verantwoordelijk om de luchtkwaliteit verbeteren?
    a. Wat kunt u zelf doen?
    b. Wat moet de overheid doen?
    c. Zijn er nog meer mensen of organisaties die iets kunnen doen?
13. Stel dat u iets zou willen veranderen aan de luchtkwaliteit in Nederland, op welke manier kunt u uw stem laten horen?

Deel IV – Eerlijkheid

Nu wil ik u een paar scenario's voorleggen. Van elk scenario wil ik weten of u het eerlijk vind en waarom.

14. Iemand woont in een wijk met veel luchtvervuiling.
15. Iemand woont in een wijk met veel luchtvervuiling en heeft niet voldoende geld om te verhuizen naar een wijk met minder luchtvervuiling.
16. Iemand woont in een wijk met veel luchtvervuiling. Hij is hier erg bezorgd over en wil er graag iets aan doen. Hij kaart dit aan bij de gemeente en de milieudienst, maar hij heeft het gevoel dat er niemand naar hem luistert en dat er niets aan wordt gedaan.

Afsluiting

17. Heeft u het gevoel dat luchtvervuiling u beperkt in uw dagelijkse activiteiten?
    a. Kunt u een voorbeeld geven?
18. Kunt u beschrijven hoe het leven in Nederland er anders uit zou zijn als er in heel Nederland sprake is van een goede luchtkwaliteit?

a. Gezondheid Nederlanders
b. Kwaliteit van leven van Nederlanders
c. Het wonen in Nederland

19. Heeft u nog vragen over het interview of over iets anders?

Hartelijk dank voor uw deelname!

➔ Bedankbriefje en presentje

Appendix 3: List of final themes

- Participants characteristics
- Description of neighbourhood
- Definition of air quality
- Causes of air pollution
- Effect air quality on health or psyche
- Effect on daily life by good air quality
- Technical possibilities to improve air quality
- Improve air quality by physical environment + reputation neighbourhood (later split in improve air quality by physical environment and neighbourhood's reputation influenced by air pollution).
- Individual responsibilities for improvement
- Government responsibilities for improvement
- Change process
- Perceived justice

Appendix 4: Thank you letter

Heel erg bedankt dat u hebt deelgenomen aan mijn onderzoek!

Mocht u nog vragen hebben over het onderzoek zelf, dan kunt u mij bereiken via telefoon (06-10263011) of via e-mail (anneke.bulten@wur.nl). U kunt bij vragen ook contact opnemen met mijn begeleider Carlijn Wentink via telefoon (0317-481351) of via e-mail (carlijn.wentink@wur.nl).

Mocht u meer informatie willen over de luchtkwaliteit in uw buurt, dan kunt u een kijkje nemen op de website van de GGD: http://www.ggdrotterdamrijnmond.nl/milieu-en-leefomgeving/luchtkwaliteit.html. Ook kunt u contact opnemen met de afdeling Gezondheidsbevordering & Milieu van de GGD Rotterdam-Rijnmond via telefoon (010-4339894) of e-mail (gb&mggd@rotterdam.nl).

Dit onderzoek is onafhankelijk en niet in opdracht van de hierboven genoemde organisatie.

Appendix 5: Invitation and informed consent form

Beste meneer en/of mevrouw,

U gaat deelnemen aan een onderzoek naar de ervaringen die mensen hebben met de luchtkwaliteit in Nederland. In dit onderzoek zal ingegaan worden op verschillende onderwerpen, zoals de luchtkwaliteit zelf, maar ook welke mogelijkheden en verantwoordelijkheden er zijn om de luchtkwaliteit in Nederland te verbeteren.

Uw ervaringen zullen in kaart worden gebracht door middel van een interview. Dit interview zal ongeveer een half uur duren. Als u toestemt, wordt een geluidsopname van het interview gemaakt. Deze opname wordt gebruikt om het interview later uit te schrijven.

De informatie die u geeft zal vertrouwelijk behandeld worden om uw anonimiteit te garanderen. Uw naam en andere persoonlijke gegevens komen niet terug in het onderzoeksrapport. De informatie die verkregen wordt tijdens dit interview wordt alleen gebruikt voor dit onderzoek en bijbehorende publicaties. Aan het eind van het onderzoek zullen de geluidsopnames gewist worden.

Uw deelname is volledig vrijwillig. U kunt op elk moment beslissen om niet mee te doen aan het onderzoek. Hiervoor hoeft u geen reden aan te geven. Wanneer u behoefte heeft aan een pauze of een vraag wilt stellen, dan kan dat op elk moment.

Met vriendelijke groet,

Anneke Bulten

Door dit formulier te ondertekenen:

- Geef ik aan alle informatie op deze pagina gelezen te hebben en heb ik de mogelijkheid gehad om vragen te stellen. Ja/Nee
- Geef ik toestemming om het gesprek op te nemen. Ja/Nee
- Geef ik toestemming om anonieme citaten uit het interview op te nemen in het onderzoek. Ja/Nee

Datum: Handtekening deelnemer: Handtekening onderzoeker:

Dit formulier wordt tweemaal ingevuld: een exemplaar is voor de deelnemer, het andere exemplaar is voor de onderzoeker.

Appendix 6: Ethical clearance letter

WAGENINGEN UNIVERSITY
WAGENINGEN UR

For quality of life

Ethical Clearance

To whom it may concern

The following project proposal has been reviewed by the Social Sciences Ethics Committee (SEC):

Names applicants: Anneke Bulten
Title of the research project: The Perception of Dutch Citizens on Environmental Justice in Relation to Air Pollution (MSc Thesis)
Location: Wageningen/Rotterdam
Funding sources: None
Period: June 2016 – October 2016

The Committee has concluded that the proposal deals with ethical issues in a satisfactory way and that it complies with the Netherlands Code of Conduct for Scientific Practice.

With kind regards,

Prof. Dr Marcel Verweij
Chair Social Sciences Ethics Committee

26-05-2016

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Wageningen UR (Wageningen University and various research institutes) is specialised in the domain of healthy food and living environment.

Appendix 7: Original quotes in Dutch

Chapter 6

"Schone lucht, ja, vrij van euh nare geuren" (DN)

"Dan denk ik aan mensen die vrij en goed kunnen ademen." (PN)

"Hoe schoon de lucht is hier misschien? (…) Nou stoffen in de lucht. Euh ozon, dat soort dingen. Van auto, uitlaten, wat van uitlaten komt. Dat soort dingen." (RC)

"Het was een vieze, ja, wat is het? Verstookte olie of zo hè. Weet je. Kwam toen allemaal uit die, uit die verbrandingsdinge." (BZ)

"Bij de euh stoplichten is het echt niet te harden. Dan sta je de lucht in te ademen. Dat ruik je. Van brommers en van auto's." (DN)

"Mijn broer woont in Rosenburg en als je d'r naartoe ging, dan rook je toch duidelijk de gif dat er uit die fabrieken daar komt. En mensen die daar wonen die merken dat kennelijk ook niet meer. Maar het is dus duidelijk een verschil als je dus hier bent of je komt daar." (GK)

"En dan moet ik zeggen, over het algemeen merk je het niet. Ik ben een geboren Spijkenisse, dus ik weet eigenlijk niet beter. Je merkt het alleen maar als je vol terug komt van vakantie of zo. Als je dan in Spijkenisse aankomt, merk je wel, dan merk je wel zo een geur en zo, maar ja.. als je daar zolang onder leeft dan euh ja, dan ruik je dat niet. Dan merk je dat niet." (SL)

Chapter 7

"Ik ben zelf ook heel erg op verkeer gefocust omdat ik ja, daar denk ik het meeste last van heb. Eum, want die industrie die staat toch wat verderop zeg maar, niet direct bij woningen. Is natuurlijk ook niet best maar eum, maar ja, ik denk zelf eerst aan het verkeer." (AS)

"Want nu heeft het flink geregend. Dus dan is al dat vuil uit de lucht ongeveer een beetje weggezakt. En dan merk je wel dat het dan weer beter is. Maar als het in de zomer bijvoorbeeld een oostenwind is, en het is heel lang droog… Dan krijg je behalve stuifmeel en vuil van de auto's, krijg je ook nog droge lucht en stof."(KN)

"Want de meeste mensen vragen er wel gelijk naar. Als voor waar ik woon. Euh zo van "jeetje, al zoveelste keer, heb je daar geen last van?"." (AS)

"In die 's gravendijkskwestie zeker wel. Inmiddels hebben die het imago… In eerste instantie hebben ze dat zelf veroorzaakt dat ze zijn gaan protesteren. Hè met internet natuurlijk. En met inspraakavonden enzovoort. Langzamerhand weet ook iedereen het, dat het in de krant wel staat. Dat dat het verkeersriool van Rotterdam is. Dat is natuurlijk niet best voor je imago. Want het heeft er wel mee te maken. Er zijn ook maatregelen. We mochten, op een zeker moment, nu geen dieselvrachtwagens meer over die wal. Dus dat helpt dan wel. Maar je krijgt er ook een slecht imago van." (CR)

"Euh, ik denk niet persé dat de buurt een slechte naam krijgt. Heum, maar ja, ik denk ja, eerder de hele omgeving. Ja. Euh, nou dat zal niet alleen de vervuiling zijn, maar het heeft wel een euh meehelpend …"(JE)

"Mwah, ik denk dat je daar echt een schifting krijgt van mensen die de mogelijkheid hebben om weg te kunnen gaan, zeg maar mensen met geld. En dat de mensen met euh, met een laag opleidingsniveau of met een lager inkomen of gewoon bad luck, die dan niet wegkunnen. En dan krijgt, weet je, dan krijgt, dan dalen de huizenprijzen en dat heeft dan een aantrekkingskracht tot bepaalde groepen en daardoor krijgt een wijk wel een slechte naam, ja."(RE)

"Nou, ik word er heel chagrijnig van. Nee serieus, ik was aan het fietsen, ik fiets altijd alles. Ik hou ook heel erg van fietsen. Maar ik ben eigenlijk de helft van de tijd als ik fiets m'n adem in aan het houden. Dat komt dan vooral door alle scootertjes en brommertjes op het fietspad." (AS)

*"Het is inmiddels misschien bijna psychologisch, "jongens ***, al die auto's". Hé. Dus het is maar net hoe je dat ervaart." (CR)*

"Toch als ik op het strand loop of zo en euh in Scheveningen of de Hoek van Holland, dan eum, dan merk je toch wel op één of andere manier dat de lucht beter voor je is als je die inademt. Ik weet niet hoe ik moet uitleggen. Maar ja, dan merk je toch wel het verschil qua luchtkwaliteit. Het ruikt frisser. Je gaat aan het strand effe lekker uitwaaien. Weet je. Daar heb je zeker wel invloed, ja. Je voelt je er veel beter door." (ED)

"Want ik merk het euh als ik euh ik fiets door heel Nederland en als ik dan in andere gebieden kom waar meer natuur is, dan weet ik vanuit eigen kennis dat daar evenveel fijnstof is. Alleen je ademt toch anders. Als ik hier adem langs de weg, dan adem ik minder diep of ook ik weet niet goed hoe dat werkt, maar dat doet wel iets met je."(DN)

"Fantastisch. Het beste land op aarde. Nou ja, ja. Dat zou natuurlijk heerlijk zijn. (…) Maar goed, puur van uit mijzelf dan, eum, lijkt het mij een paradijs op aarde." (AS)

"Ik ben eigenlijk bang dat er heel veel mensen niet echt bij stil staan. Alleen echt die mensen die ermee te kampen hebben, last van hebben door lichamelijke omstandigheden. Of die pal naast een fabriek zitten en daar last van hebben. Maar verder denk ik niet dat het (…) een hele grote impact heeft."(GE)

Chapter 8

"Je zit nu met de milieuzone. Dat is ook een beetje voor de bewoners. Je hebt die grote cruiseschepen. Nu hebben we net de grootste van de wereld, die heeft natuurlijk heel veel miljoenen liters om naar Rotterdam te komen en weer terug. Terwijl mensen met klassieke auto's mogen de stad niet meer in. De redenering is een beetje dubbel."(DD)

"Ik heb eens bij de vergaderingen gezeten van de gemeente. Over luchtvervuiling. Ze zijn niet geïnformeerd. Ze weten niet waar ze het over hebben. Dus het is ook moeilijk voor hun om dit voor soort klachten te doen… Ze weten niet wat het is. Als wij doorvragen ook wat is fijnstof eigenlijk, weten ze dat niet. Wat zit er dan in? Ja, dat weten wij niet. Dus hoe kan je dan ook oplossingen bedenken als je niet weet wat het is."(DN)

"Mensen staan daar niet bij stil. Euh totdat ze wakker worden omdat het kind ineens aan een inhalator moet." (PN)