Effects of European Particulate Matter Policy on Municipal Spatial Planning

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Foreword

This thesis is the end product of the Master Urban Environmental Management. When I started my study at Wageningen University, I did not know I would end here. But I am very glad I did. In this research I looked at the ways municipalities implement particulate matter policies from other levels in their own policies. Especially the link between air quality and spatial planning found my interest. When I was looking at a subject to look into, I found a nice article about particulate matter issues in Europe. This reminded me of an issue in my hometown, where there was a school build next to a road where cars were allowed to go 80 km/h. This speed limit resulted in bad air quality at the school grounds. The municipality tried to solve the problem, by placing a 3 meter high wall around the school, which I found a bit weird. Why would the municipality put a wall around the school? The particulate matter is dispensed in the air and will easily go over the wall and reach the school grounds anyway. Hence, I decided to look more into the subject of how municipalities use municipal policies regarding particulate matter and regarding spatial planning, to improve the air quality at municipal level.

I would like to thank the interviewees for all their information and help in this research. It helped me to understand the situation better. Not only for the case study, but also for municipalities in the Netherlands in general. I would like to give special thanks to my thesis supervisor, who I admire for his patience and the strength to help me in my struggle to get this thesis structured. At last I want to thank all the people who supported me in my study and research and helped me in difficult times.

I hope you enjoy this research as much as I enjoyed making it.

Barbara de Visser

Summary

The research in this report aimed to investigate the effects of European particulate matter policy on spatial planning in municipalities in the Netherlands and the consequences of tightening the limit values. The effects and sources of particulate matter, the implementation of air policy regulations at municipal level and the consequences of air quality regulations to municipal spatial planning is researched.

Particulate matter has an effect on human health and different sizes of particles have different effects on the body. European legislation focus on the coarse fraction with the sizes till 10µm and fine fraction with sizes to 2.5µm. The effects of particulate matter on human health is linear and there is no threshold concentration of particulate matter that it has no effect on human health. Municipalities focus on complying with particulate matter norms, rather than focusing on the effects particulate matter has on human health. Due to compromises with other political issues, like NO_x, municipalities can have problems with complying to the particulate matter norms and creating effective particulate matter policies. Municipalities can implement symbolic policies that have little effect and satisfy the inhabitants to do something, or implement measures at areas that are most easy to solve the particulate matter issues.

Parameters for measuring particulate matter vary per municipality, making it difficult to compare results. Even though monitoring and models are used, errors can occur, due to large variations in particulate matter concentrations on a small area. At municipal level, the peaks are mainly contributed by high traffic concentrations on roads and by industrial and agricultural areas. Municipalities focus primarily on traffic and industry. Municipalities are mainly concerned about are sea salt and soot and think the National Government is responsible to reduce the particulate matter concentration. Municipalities use mainly models linked to the NSL, or methods relating to traffic volumes, to measure the process of projects regarding particulate matter. There are measuring stations for particulate matter, but it is unclear how the municipalities use the information gathered from these measuring stations.

Municipalities regard $pm_{2,5}$ to be included in pm_{10} and find no need to create extra policies for $pm_{2,5}$. Action groups for air quality regard the municipalities as not caring and generating data from models in which the best models are used to submit data to the Nationaal Samenwerkingsprogramma Luchtkwaliteit.

The Nationaal Samenwerkingsprogramma Luchtkwaliteit is a cooperation program from the Dutch Government and local governments to improve the air quality by providing a flexible link between spatial planning and air quality. Traffic policies can have contradicting effects, since the increase of the speed limit in the Netherlands improves the traffic flow, but probably will increase the background concentration of particulate matter as well.

Most spatial planning policies that have an effect on particulate matter concentrations are related to zoning. Placing measuring stations at areas where the concentration is lower, or recalculating the process of the particulate matter projects, municipalities can create a situation where construction projects can still proceed. Most municipalities do not have pre-arranged spatial plans for sensitive locations, but focus in the spatial plans more on traffic flows and volumes.

Abstract

Even though European norms and laws for particulate matter are stringent, the link between the norms and the use of these norms on municipal level in practice is unclear. There is insufficient information about the consequences European policies regarding particulate matter has on Dutch municipal policies regarding particulate matter and spatial planning. For this report literature study was used to gain knowledge about the situation of particulate matter and particulate matter policies on different policy levels.
Literature study was also used to gain knowledge about the situation of spatial planning and spatial planning policies on national level,
Using document study and interviews a case study of the municipality of Utrecht was realised, by which information was gained about municipal policies regarding particulate matter and the way municipalities deal with areas where the particulate matter concentrations exceed the norms.

The case study showed a difference in approach towards the issues related to particulate matter, than the literature study portrayed. In terms of importance of the issue, the relation to spatial planning and effects of policy on municipal level the interviewees differed in opinion.

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1. Introduction

Around the world, air quality poses a significant threat to human health. Although in Europe the status has improved, many countries in Europe have problems with the limit values for particulate matter, as are defined in the Air Quality Decree (Schaap et al., 2010). In the Netherlands the norms were exceeded for a long time on a big scale. Because of this exceedance, spatial planning projects were delayed or banned (Matthijsen and Koelemeijer, 2010). Today, there are still places in the Netherlands where particulate matter norms are exceeded.

1.1 Particulate matter

Pm_{10} is defined as particulate matter that is 10 micrometre or less in diameter. It is a part of air pollution and a mixture of several chemical substances (Buijsman et al., 2005; Priemus and Schutte-Postma, 2009; Matthijsen and Koelemeijer, 2010). Pm_{10} consists of different components from different sources (Hoogerbrugge et al., 2010) and can become embedded in the lungs which creates health damage (Priemus and Schutte-Postma, 2009).The sources are, among others, emissions from motorised vehicles, domestic heating, agriculture, ships and industry (Priemus and Schutte-Postma, 2009). Particulate matter exists of 1) a primary fraction, emissions by human actions like transport, industry, agriculture and natural processes like sea salt and soil dust; and 2) a secondary fraction, chemical reactions of gasses among which are ammonia, NOx, SO2 and volatile organic substances (Wesseling et al., 2007). It is difficult to determine the trend in pm_{10}, because it depends on emission dispersion, chemistry and removal of these components (Hoogerbrugge et al., 2010). Mixture of sources by wind dispersion makes it difficult to see whether a source of particulate matter has emitted more or less particles. Because of the composition and size of particulate matter, it is difficult to get a sample of the total amount of particulate matter. In this way pm_{10} trends have large uncertainties.

Currently, the focus has shifted more to $pm_{2.5}$,because the finer fraction has more impact on human health, then the coarse fraction. From May 2008 the European Union issued new guidelines regarding $pm_{2.5}$ [1]. Measuring results for $pm_{2.5}$ are limited and measurement results about the concentration levels are not verifiable yet (Compendium voor de leefomgeving[1]). There are limited measuring stations for $pm_{2,5}$ and because of the size of the particles, it is relatively difficult to get a sample that gives a general idea about the $pm_{2,5}$ composition. This creates a situation where results of measurements or research cannot be generalised, which makes it difficult to give verifiable conclusions about the status of the particulate matter situation.

1.2 European policy

European environmental policy is one of the most influential policies for its member countries in regard of land use planning (Ravesteyn and Evers, 2004). The directives of the European environmental policies are based on the fact that many environmental problems are not bound by borders. However, the outcomes of the generalised policies can have different effects on different locations, because the local situation affects the

[1]Compendium voor de leefomgeving: http://www.compendiumvoordeleefomgeving.nl/indicatoren/nl0243-Fijnstofconcentratie%2C-daggemiddelde.html?i=14-66

impact a policy has on the environmental problem (Ravesteyn and Evers, 2004). According to the Environmental Balance 2003 (Milieu- en Natuurplanbureau 2003: 122-125) about 80% of Dutch environmental policies are based upon European directives and work on the philosophy of the common market with the same environmental standards for all companies of the European Union (Ravesteyn and Evers, 2004). All member states have the goal to reduce the emission of particulate matter by 20% between 2010 and 2020 (Milieuloket).

To keep the goal clear and keep an eye on the process, every Member State of the European Union has to deliver an annual environmental policy review to ensure that sustainable development is integrated in all sectorial policies of the European Union (Ravesteyn and Evers, 2004; Priemus and Schutte-Postma, 2009). National implementation of particulate matter policies, local situations and the scale and nature of the problem make the measuring of the effects of EU policy difficult (Ravesteyn and Evers, 2004). For example, when norms for air quality are exceeded, this can prohibit the construction of building projects and other activities in the member country (Ravesteyn and Evers, 2004).

The European Union mainly uses quality standards, product standards, integrated prevention and control of industrial installations and emission ceilings to reduce impact of environmental problems. In the domain of air quality there has been a long tradition of research, policy making and standard regulations in the European Union. (Ravesteyn and Evers, 2004). The main policy instrument for air quality of the European Union is the Air Quality Framework Directive. The Air Quality Framework Directive (1996/62/ec) has a direct spatial relevance, since air pollution policy related to nitrogen oxides and particulates is based on tightening the limit values for a specific area (Priemus and Schutte-Postma, 2009; Matthijsen and Koelemeijer, 2010).
The Air Quality Framework Directive requires the member states to create plans to attain the norms for pm_{10} (Priemus and Schutte-Postma, 2009). The plans include measures aiming at the protection of vulnerable population groups (Priemus and Schutte-Postma, 2009). In the first daughter decree of the Air Quality Framework, the norms are set as in the table 1.1 below. The yearly average cannot exceed 40 microgram per square meter and on a daily basis the limit value is 50 microgram per square meter. The daily limit value can be exceeded for not more than 35 days a year (Compendium voor de leefomgeving[1]).
The European Union planned a tightening of the limit values for 2010. However, due to resistance of member states and difficulties to comply to the first limit values, the norms are not changed yet (Matthijsen and Koelemeijer, 2010).

[1]Compendium voor de leefomgeving, http://www.compendiumvoordeleefomgeving.nl/indicatoren/nl0243-Fijnstofconcentratie%2C-daggemiddelde.html?i=14-66

Table 1.1: European norms for particulate matter (from Compendium voor de leefomgeving[1])

	Per 1 January 2005	**Planned per January 2010**
Yearly average	40 microgram/m^3	20 microgram/m^3
Daily average	50 microgram/ m^3	40 microgram/m^3
Maximum number of exceedance per year	35 days	7 days

Exceptions with the norms are possible if natural sources have an influence that make the concentrations to exceed particulate matter background levels. In such cases the member state is relieved of the obligation to take action if the pollution is caused by resuspension of particulates in the air (Priemus and Schutte-Postma, 2009). For example, when dust from roads is resuspensed into the air by traffic movement, the member state can claim that it cannot create actions to prevent this and the member state is exempted from actions of this kind of particulate matter. Although the Air Quality Decree determines the location of sampling points and how to measure particulate matter, large variations in methods and models that are used among member states make it difficult to compare future trends (Priemus and Schutte-Postma, 2009). The interpretation of European legislation is done by the Commission, European Court of Justice and the legislators and courts of the member states. However, when translated into national legislation, uncertainties came up and there is currently no consistency in the role of the national court of the member states (Priemus and Schutte-Postma, 2009).
The general public has access to up-to-date information on air quality and member states are required to report their experience to the Commission of the Air Quality Framework Decree (Priemus and Schutte-Postma, 2009), making the actions of the member states regarding particulate matter more clear and accessible.

1.3 Dutch policy

As a member of the European Union, the Netherlands based its air quality policy on the European Air Quality Decree. When looking at the Netherlands, it shows that Dutch policy regarding air quality is one of the most stringent policy implementations in relation to other member countries. The Dutch Air Quality Degree came into force in 1996 and the implementation is accompanied by a high legal ambiguity (Priemus and Schutte-Postma, 2009; EU, 1996).
To define areas, the Netherlands is defined into zones and agglomerations. When it comes to pm_{10}, the country is divided by three zones and six agglomerations (van Breugel en Buijsman, 2001) as seen in figure 1,1 (Compendium voor de leefomgeving, 2011[1]).
The Dutch Air Quality Decree is worked out according to the European guidelines, which uses two exceedance norms: The yearly average concentration of pm_{10}, and the daily average concentration of pm_{10} (Buijsman et al., 2005).

[1]Compendium voor de leefomgeving, http://www.compendiumvoordeleefomgeving.nl/indicatoren/nl0243-Fijnstofconcentratie%2C-daggemiddelde.html?i=14-66

1.3.1 Particulate matter

In the Netherlands the emission norm is mainly exceeded in urban areas and areas with a lot of agricultural activities. Local sources mainly contribute to this exceedance (Compendium voor de leefomgeving[1]). Particulate matter from natural sources, like sea salt and soil dust, can be neglected according to the new Air Quality Decree. In the Netherlands this means the number of days the norm is exceeded is lowered by six days to claim for the sea salt contribution[1] (Matthijsen and Koelemeijer, 2010).

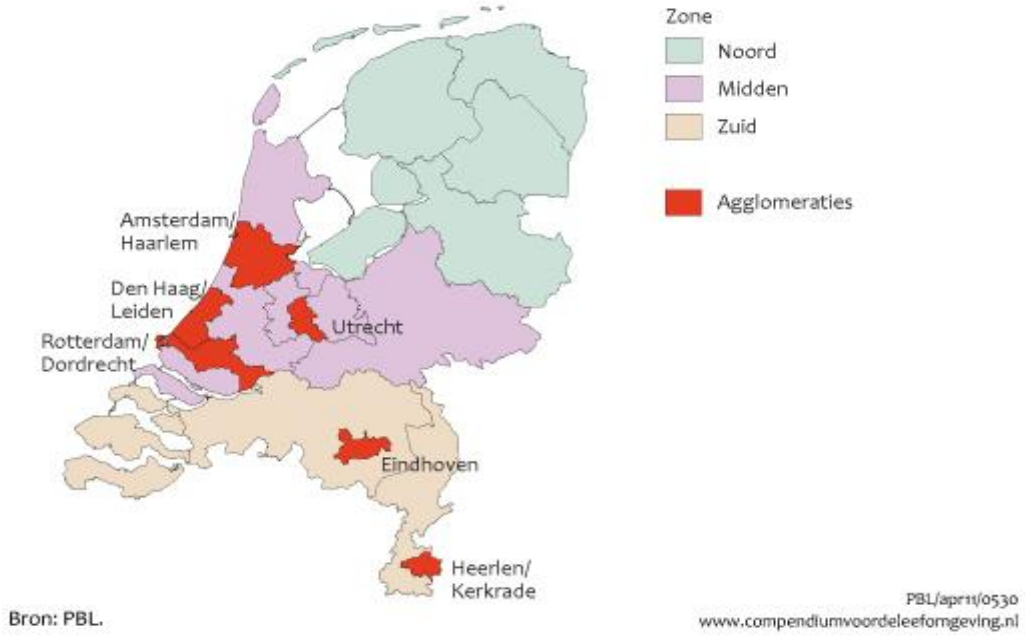

Figure 1.1: Agglomerations and zones for particulate matter in the Netherlands (Compendium voor de leefomgeving)

When for example, the norm is exceeded for 35 days in a year, the number is lowered to 29 days, to compensate for the sea salt concentration. When looking at figures 1,2 and 1,3 this can partly explain the big improvement of air quality status near the seaside. In figure 1,2 the yearly average was exceeded in the big cities like Rotterdam and Amsterdam and the number of days the concentration exceeded 50 microgram per square meter was exceeded almost everywhere, except the North-East of the country. In figure 1,3 it was a big difference, with only Amsterdam and Rotterdam having trouble with the number of days exceeding 50 micrograms per square meter and the yearly average.
On the other hand, while this sea salt reduction lowers the number of exceedance spots, it can also create areas where the limit values are filled with other particulates from other sources. The sea salt is 'replaced' with other particulates, which are more dangerous for the human health (Matthijsen and Koelemeijer, 2010).

The Dutch policy on particulate matter is divided into four elements (Compendium voor de leefomgeving[1]):

1) Policy at the source. To reduce the emission of particulates, the Dutch government focus on the source. This implies subsidies for coal filters for cars (dpf), measurements that focus on agriculture and industry. Moreover, regional and local governments are granted financial support.
2) Since 2008, the Dutch Government wants to make amendments of the Decree with the focus on: new norms for $pm_{2.5}$ and the request to the European Union to postpone the year that the Government meets the norms for pm_{10} and NO_2.
3) The Dutch government is committed in international concept to create stricter standards for emissions by cars, trucks and ships.
4) Provinces and municipalities take local measures, especially with traffic.

When comparing figure 1.2 with figure 1.3, the situation has improved, but there are still places where the norms are exceeded. From the measurements it becomes also clear, that when the tightening of the limit values would have continued, a large part of the Netherlands would be regarded as a problem area.

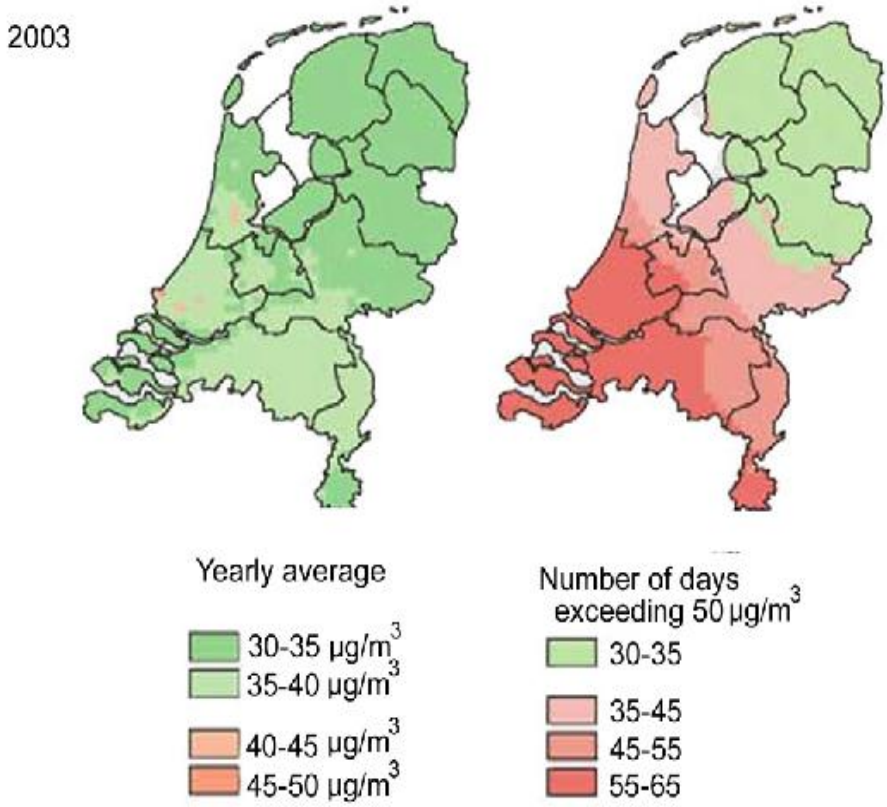

Figure 1.2: Particulate matter (pm10) concentrations at yearly average and number of daily exceedances for 2003 (Buijsman et al. 2005)

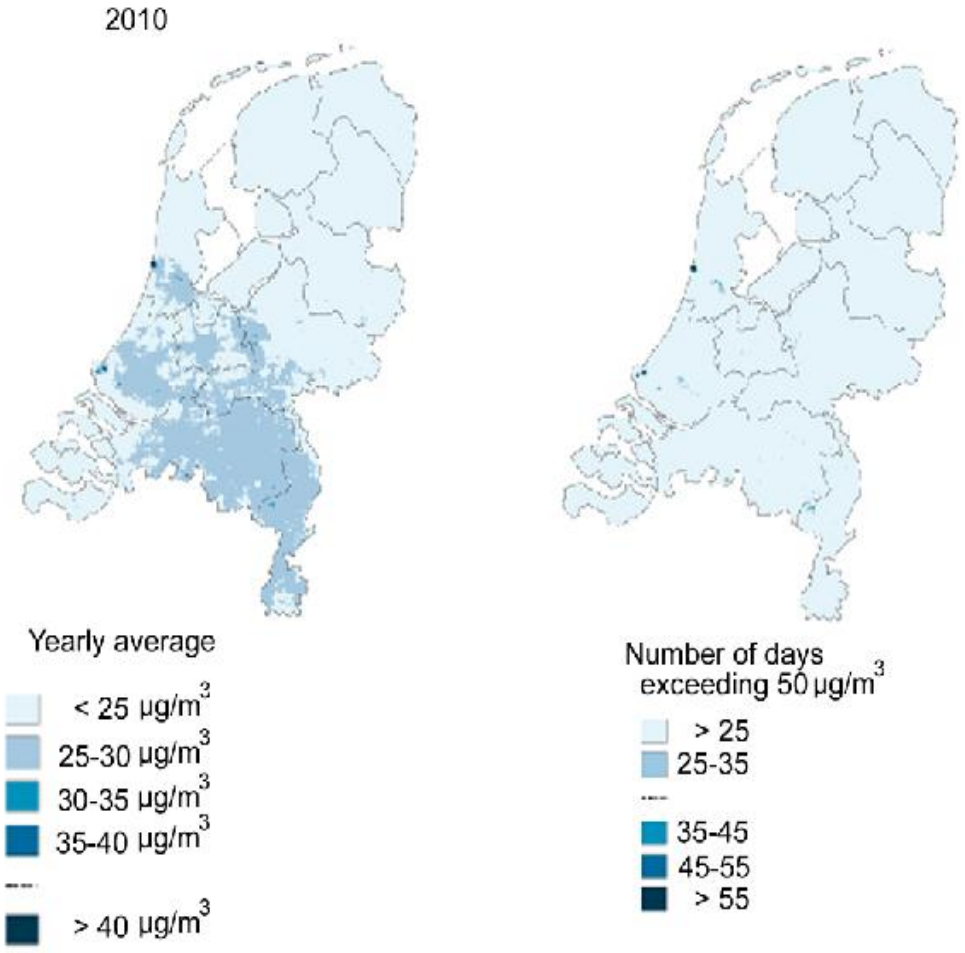

Figure 1.3: number of days where the norms are exceeded and the yearly average pm10 concentration in 2010 in the Netherlands (Velders et al., 2010)

1.3.2 Spatial Planning and pm_{10}

The European Air Quality regulations did not make any connection between the air quality guidelines and spatial planning on European level to 2004. After it became apparent that spatial planning needed to be involved to implement air quality regulations, the Dutch regulations for air quality were linked to spatial planning and all spatial decisions in the years 2004 to 2007 were tested against air quality standards (Priemus and Schutte-Postma, 2009).A direct effect of the stringent implementation of the directive is the delay and restriction on a number of house building schemes near motorways and other hot spots where the limits are exceeded (Priemus and Schutte-Postma, 2009; Ravesteyn and Evers, 2004). While Dutch national environmental policy intends to ensure that the limit values of the European Union are met in new situations, it prohibits building near busy main roads or requires converting the relevant stretch of the motorway into an underpass (Ministerie van VROM, 2002: 27). This prohibition of zoning due to exceedance of a limit value puts great pressure on research required during spatial planning preparations (Ravesteyn and Evers, 2004). Moreover,

“interesting legal questions could arise with respect to plans for the construction of new homes if, despite the fact that the limit value would be exceeded, a local authority grants permission because the relevant land use plan has not been updated to include the provisions of the Air Quality Decree.” (Ravesteyn and Evers, 2004: p94).

Because too many projects were cancelled this way, Dutch legislation made the regulations more flexible, which means that only large building plans are tested (Priemus and Schutte-Postma, 2009). One of the ways to make the regulations more flexible was the implementation of the Interim Law of City and Environment. The Interim law gave urban redevelopment a new impulse, by giving the opportunity to deviate from the prescribed norms (Ro Web, 2010).

Because the air quality regulations were made more flexible, the Dutch Government feared that enhanced standards for cars and industrial activities do not have the desired effect in time. In 2000 the Dutch Government notified the European Commission of the impossibility of meeting the standards for particulates. Moreover, the city councils do not have the intention to stop all building projects (Ravesteyn and Evers, 2004). When the directive will enhance the standards and norms, it will have consequences for the construction of new homes near roads (Ravesteyn and Evers, 2004) and other hotspots regarding particulate matter.

1.4 Problem description

The Netherlands is a country with a dense population. Due to the increase of the Dutch population, building projects are getting more difficult to start with, because the available land is protected or the norms for pm_{10} are exceeded. New projects, like new houses and infrastructure are affected by the Air Quality Decree (Buijsman et al., 2005; Ministerie van VROM, 2002). Trends in pm_{10} components and the emission sources show that the main decrease was in the nineties (see figure 1.4), while after 2000 the levels were about the same. In the period of 1993 to 2007 the concentration levels of pm_{10} in rural areas decreased with 0.7 to 1.0 $\mu g/m^3$ per year (Hoogerbrugge et al., 2010). However, weather conditions can create large year-to-year variations of around 2.5 $\mu g/m^3$ (Hoogerbrugge et al., 2010). The particle emissions from vehicles have decreased by around 50% since 1990. However, the particle emissions from brake -, road – and tyre wear and dust resuspension have increased (Hoogerbrugge et al., 2010). Recent measurement of pm_{10} compositions show that the anthropogenic contribution is 75 to 80% (Matthijsen and Koelemeijer, 2010), instead of the earlier estimated 45% (Buijsman et al.,2005). With respect to policy around particulate matter, this will mean that measurements can have a bigger impact on the concentration of particulate matter.

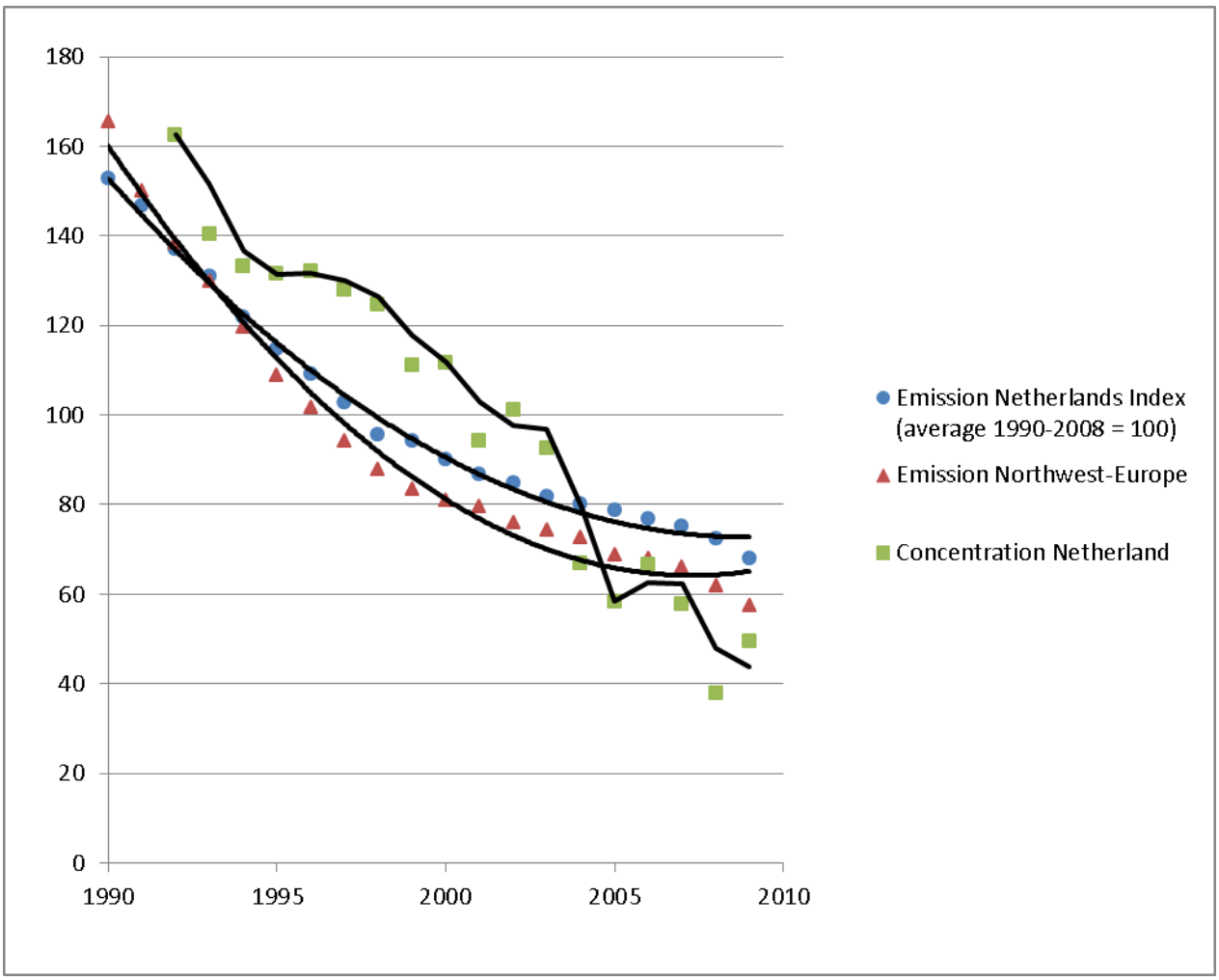

Figure 1,4: Average annual pm_{10} concentrations in the Netherlands (Hoogerbrugge et al., 2010; 23)

The uncertainty in the measurements creates discussion whether projects can be continued or not. These uncertainties are inherent to environmental and health problems caused by pm_{10} (Buijsman et al., 2005). From an inventory by the Association of Dutch Municipalities (VNG), half of the municipalities have problems with spatial consequences of the Air Quality Decree norms (VNG, 2005).
When looking at the research done about particulate matter, there is a gap between theory and practice regarding the implementation of European particulate matter policies at the municipality level.

When looking at literature about spatial planning and policy implementation, a lot of literature focuses on the health effects of particulate matter, the dispersion of particulate matter and the composition of particulate matter. Policy at national level is analysed and the general implementation of these policies is discussed. The link between municipalities and particulate matter policies is scarcely discussed and only briefly touched upon. In terms of spatial planning and particulate matter policies on municipal scale nothing to very few analyses are made in literature. Literature does not clarify the effects of particulate matter policy on municipal spatial planning. Therefore it is unclear what consequences will appear, when norms and limit values for particulate matter are tightened.

1.5 Research objective and research questions

The research aims to investigate the effects of European particulate matter policy on spatial planning in municipalities in the Netherlands and the consequences of tightening the limit values.

Main research question: What is the effect of European particulate matter policy on spatial planning by local municipalities in the Netherlands?

a) **What are the effects and sources of particulate matter?**
    a) What are the health effects of particulate matter?
    b) What is the composition of particulate matter in the Netherlands?
    c) What are the sources of particulate matter in the Netherlands?
b) **How are air quality regulations implemented at municipal levels?**
    a) What are the regulations of the European Union Air policy?
    b) How is the European Air Directive implemented and enforced in the Netherlands?
c) **What are the consequences of air quality regulations to municipal spatial planning?**
    a) How does particulate matter policy influence spatial planning?
    b) What are the measures municipalities use to deal with the consequences of particulate matter policy?
    c) What are the consequences if limit values will be tightened?

1.6 Methods

Based on Kumar (2005) a qualitative research design is chosen, with the focus on municipalities in general and a case study in the municipality of Utrecht. A qualitative research is preferred to a quantitative research, because most information will result from interviews. Hereby personal experience is the key for the research. Interviews with people, who have experience with how particulate matter policy is implemented at municipal level can give information focused on the subject of this report. The features of the qualitative research provides relevant data collection to answer the research questions as stated in the first chapter. Experiences and personal insights create the answers to how European particulate matter policy affects spatial planning at the level of municipalities (Kumar, 2005).

In this research a case study is conducted, because it can provide in-depth information about the subject. The case study is formed by the location and time of the case and can bring forward important aspects. The ways of data collection for this research was by interviews, literature study and the in-depth case study. To answer the research questions, this paper retrieved data from both primary and secondary sources, including policy documents, interviews and maps regarding spatial planning and particulate matter policies

1.6.1 Literature review

To obtain a framework for analysing the relationship between spatial planning and particulate matter and European policies, a literature review was conducted. Literature was found regarding particulate matter in relation to health, environment, spatial planning and policy. Relevant literature was found on health effects of particulate matter on the human body and the dispersion of particulate matter in the air. The impact of particulate matter on human health is widely discussed in literature. Literature on air policy implementation in the Netherlands is more limited. The effects of particulate matter on the environment and spatial planning overlaps with literature on composition and dispersion of particulate matter. Literature found on policy in regard to particulate matter, focuses on European level. Literature on spatial planning is mostly found in relation to European policy implementation.

1.6.2 Case study

For this research a case study is chosen to deepen the subject of how European particulate matter policy can influence the spatial planning of municipalities in the Netherlands. To select the case study, the case had to fulfil a set of preconditions and argumentation.

The preconditions for the case study are:

1) It is a municipality in the Netherlands
2) It should have ambitions to grow
3) The municipality needs to have experience with particulate matter policies

When looking at these conditions, a number of areas come up. Most big cities in the Netherlands have ambitions to grow and experience problems with particulate matter norms and policy implementation. For the selection of the cases, internet searches were conducted. In this research the municipality of Utrecht was chosen, because it lies in the middle of the Netherlands and therefore has a high background concentration, with contribution of sea salt from the West as well as pollution contribution of neighbouring countries from the East.

The case study focused at a local municipality which has problems or had problems with pm_{10} concentrations. In the Netherlands, there are still many local municipalities which have to deal with pm_{10} concentration problems. Utrecht is a defined as an agglomeration on the map, and it is expected that the concentrations are higher in the city than in the surrounding area. It is one of the fastest growing municipalities in the country. Also the city of Utrecht is a busy place with many different kinds of mobility and industry surrounded by intensive agriculture and busy roads. Still, Utrecht is increasing its city area as well as the municipalities within the province of Utrecht. For this research, Utrecht fulfils all the preconditions for the case study.

1.6.3 Interviews

For this thesis several interviews were conducted. The interviews were semi-structured, with open-ended questions. The semi-structure gives flexibility and allows the researcher to bring up new questions during the interview. For every interview a series of questions were brought up (see appendix), but when an interesting topic came up, more questions about the topic were made up. The interview had open-ended questions, so the answers could not be answered with a definite yes or no and the questions desired an explanation.

The interviews were also used to gain a better understanding of the meanings and opinions of individuals that worked on the subject of particulate matter and spatial planning. The interviews were done with people regarding the case study area. Two interviews were conducted with people who work at the municipality (Interview 1 and 2). The other two interviews were conducted with people, who are involved with action groups regarding air quality (interview 3 and 4).

The interviews started with a small introduction of the topic and questions about the person in particular to clarify the interview and to gain information about the person and the kind of experience that person has with the subject. The interviews were recorded and noted down by the researcher. The interviews were transcripted at a later time and interpreted by the researcher (see the annexes II to IV). The interviews were looked at in two different ways. On the first hand, the interview results were screened per question. The information gained was bundled together under the question to get an overview of the information gathered together with the other methods of data generation. On the second hand, the interviews were screened on the aspects. Every sentence that contained one or more aspects, which are based on the theoretical framework, was put together and created a framework of information for that aspect.

1.6.4 Document study

A document study was used to gain more data about politics in the Netherlands and at municipal level, regulations and the case study area. The data was drawn from articles, reports, government documents, websites and books. The search for literature was divided by the subjects where the research is focused on. Two kind of literate data is defined. Categories that were used to search were: air quality implementation by municipalities, particulate matter policies in the Netherlands, influence of particulate matter policies on spatial planning: and political influences on spatial planning.

1.7 Structure of the report

In this report the structure is as follows. In chapter 2 particulate matter and spatial planning is further defined. Health, particulate matter measurement methods and particulate matter in relation to spatial planning is discussed, together with the aspects to take into account for the case study. In chapter 3 policy is further defined. European policy on particulate matter, Dutch policy on particulate matter and policy on spatial planning is discussed, together with the aspects to take into account for the case study. In chapter 4 the analytical framework is composed from the aspects identified in chapters 2 and 3. In chapter 5 the case study is described. Chapter 6 presents the discussion, conclusion and recommendations for further research.

2. Particulate matter and spatial planning

Particulate matter is most referred to as having impact on human health. Chapter 2.1 describes the health effects of particulate matter, chapter 2.2 the methods to measure particulate matter. Chapter 2.3 describes the relationship between spatial planning in relation to particulate matter.

2.1 Health effects

Air pollution is a threat to human health, with a worldwide two million premature deaths as a consequence of inhaling pollution, dispersed by air (Amann et al., 2005). The health effects are caused by both gaseous and particulate pollutants (Akhtar et al. 2010). When looking at the effects of the different air pollution aspects, particulate matter is most dominant (Weijers et al., 2011). The size of the particle determines where the particle deposits in the body (Chang et al. 2011). Particulate matter is divided into a coarse fraction (pm_{10}), fine fraction ($pm_{2,5}$) and ultrafine ($pm_{0,1}$) and the physiochemical properties depend on the particle source (Akhtar et al. 2010). Fine and ultrafine particles are primarily inorganic ions, hydrocarbons and metals and produced mainly by combustion processes (Akhtar et al. 2010). Coarse particles consist mostly of crustal materials and are generated by mechanical processes mainly (Akhtar et al. 2010; Chang et al. 2011). Of the different size fractions, $pm_{2,5}$ is most affecting the body (Akhtar et al. 2010; Annesi-Maesano et al. 2007; Chang et al. 2011; Amann et al. 2005).

Ambient particles are composed of thousands of chemicals and constituents and it is unknown what element or combination of elements is responsible for the observed toxic effects (Akhtar et al. 2010). Most responses to particulate matter inhalation are: oxidative stress, inflammatory responses in the respiratory system along with consecutive systemic inflammatory responses, endothelial dysfunction, oxidation of lipids, vascular inflammation, induction of prothrombotic state and interactions with the autonomic function (Annesi-Maesano et al. 2007). There are variations in the levels of significant particulate matter concentrations, mainly due to differences in geographic location (Akhtar et al. 2010).

Particulate matter is studied in most cases for its intense effects on human health and economy (Akhtar et al. 2010). Epidemiological studies show correlations between the inhalation of particulate matter and respiratory and cardiovascular mortality (Brook et al. 2003; Kasouyanni et al. 2003). However, while the governments of countries try to decrease the concentrations of particulate matter by imposing policies, the decrease is slowly because of the worldwide combustion-based energy use which is still increasing (Valavanidis et al. 2008). Current research has shown that there are possible relationships between particulate matter concentrations and leukaemia, in addition to the already known coronary heart disease and lung disease.

The few studies that have been published on ultrafine particles give rise to the idea that the ultrafine particles are the real source of the morbidity and mortality increase of $pm_{2,5}$ (Amann et al. 2005). However, ultrafine particles are not investigated thoroughly enough and are left out of the rest of this work. Based on experimental studies the effects on human health are related to transition metals and organic compounds, which are part of the particulate matter composition (Akhtar et al. 2010). However it is difficult to demonstrate causality between those specific compound in particulate matter and human health and to eliminate the effects of other pollutants in the studies (Devlin et al. 2005).

According to Annesi-Maesano et al (2007), there is no threshold for the effects of particulate matter on human health to appear and the effects themselves are linear, even

at low concentration levels. The short term effects are relevant for all age groups and the cardiovascular system is most affected. Studies show that reduction in particulate matter concentrations reduces health effects. While more stringent air pollution legislation requires more resources, the health benefits outweigh the costs when particulate matter concentrations are reduced (Annesi-Maesano et al. 2007).

Particulate matter has the relatively the most effect on human health, when looking at air quality issues. When gaining data, it is expected to see consolidation to improve human health in spatial planning. Also, the effect of change in particulate matter concentration on human health in the surrounding areas is not clear. Literature states that health benefits of reducing particulate matter concentrations outweighs the costs.

2.2 Methods to measure particulate matter concentrations

The measurement principle for pm_{10} is based on the collection on a filter of the pm_{10} fraction of ambient particulate matter and the gravimetric mass determination (Council Directive (1999/30/EC)). Gravimetric mass determination is the analysis of the mass of the filter sample is determined by dissolving the sample, adding a precipitating reagent and filtering the sample. The residue is heated to remove most of the water, weighed and the composition is determined by the mass of the residue (Holler et al. 1996). The location of sampling points should be sited at a place representative of the area in terms of air quality, no less than 200 m^2 at traffic-orientated sites or several square kilometres for an urban-background site. For the sampler, the flow around the inlet should be unrestricted, the sampling point should be between 1,5 meters to 4 meters above the ground, not be positioned in the immediate vicinity of sources and the exhaust outlet should be positioned so that recirculation of air towards the inlet is avoided (Council Directive (1999/30/EC)).

A Member State may use any other method that can demonstratively give results equivalent to the filter with gravimetric mass determination method or any other method that gives a consistent relationship to the reference method. In that event the results achieved by that method must be corrected by a relevant factor to produce results equivalent to those that would have been achieved by using the reference method. Each Member State must inform the Commission of the method used to sample and measure pm_{10} (EN12341[2]). With these measuring methods, the member states can define the particulate matter concentration at that moment on that site. In Europe parameters like time resolution, type of monitoring site and samplers of particulate matter vary widely, making it difficult to compare results (Viana et al., 2008). Because member states use different types of filters, the comparability of the measurements and the levels of air quality is complicated (Matthijsen et al. 2009). To evaluate policy efficiency and trends in particulate matter concentrations, member states use models next to measuring methods.

[2] EN12341:Air Quality Field Test Procedure to Demonstrate Reference Equivalence of Sampling Methods for the pm_{10} fraction of particulate matter

2.2.1 Models used to measure particulate matter

The various models that are used in measuring particulate matter have different parts to play in the overall picture of the particulate matter concentrations. The most common used models are:

1. The LOTOS-EUROS model is a chemical transport model for Europe (Schaap et al. 2008). The model is the central investigation model and is validated with measurements. The model is further developed and the new routines for calculating contributions of sea salt, dust and biogene secondary organic aerosols are added. The model is coupled to the worldwide chemical transport model TM5, which creates the opportunity to calculate worldwide effects of air quality to Europe (Schaap et al. 2008).
2. The Operational Priority Substance model (OPS) is used to make concentration maps of , among others, particulate matter. These maps are used with reports of exceedances of the European air quality limit values, the defining of national and local policy and the testing of plans (van Jaarsveld, 2004). The results of the OPS model are limited to the air quality in the Netherlands (Matthijsen and Koelemeijer, 2010).
3. The Unified EMEP model is a chemical transport model for Europe. The results of this model are used as input for integrated assessment models of GAINS and used for European policy development regarding air quality and climate. Per European Union member state, the yearly air quality is based on EMEP model calculations (EMEP, 2009).
4. RAINS models are integrated assessment models that calculate air quality enforcements, including the costs of the measures, for Europe (Wagner et al. 2006). The models of RAINS generate integrated evaluations of emissions, from source to effect and reversed, and the scenarios. In the Netherlands a RAINS model is developed which focuses on the Netherlands (Aben et al. 2005).

Modelling particulate matter is necessary at different scales. Global scale models are needed because global transport is rapid. Models for particulate matter have a coarse spatial resolution. Local models are needed to evaluate variability in pollutant concentration per area (Koo et al., 2010). Viana et al. (2008) define three groups of modelling techniques: methods based on evaluation of monitoring data, methods based on emission inventories and dispersion models, and methods based on statistical evaluation of particulate matter chemical data that is acquired at receptor sites. Methods that are based on evaluating monitoring data are simple and the mathematical artefacts have low impact. Methods based on emission inventories and dispersion models are used in scenario studies to evaluate the impact of abatement strategies, but require detailed emission inventories, which are not always available. Moreover, they are limited by the accuracy of these emission inventories (Viana et al. 2008). The methods that are based on evaluating data at receptor sites assume mass and species conservation and mass balance can be used to identify sources of particulate matter (Hopke et al. 2006). Mass conservation is used to control whether all mass is accounted for in the sample. Mass balance is used to refer the mass of an element in particulate matter to the mass in the total sample. Of the last method, chemical mass balance can be regarded as the ideal receptor model. Chemical mass balance, appoints mass to chemical elements in the sample, but the requirements to have an perfect sample, where there is no part that

cannot be accounted for, are almost never fulfilled (Viana et al. 2008).

According to Chang et al. (2011) errors in measuring particulate matter concentrations can occur when pollution monitors are scarce and when pollution concentrations are highly variable within the community. Gulliver and Briggs (2011) state that in urban areas traffic can create variations in particulate matter concentrations. Monitoring devices are often not sufficient to capture these patterns of exposures. Because monitoring alone can create exposure misclassification, models are used to estimate concentrations of air pollution at any time and location. The type of models that are used depend on the availability of data and the exposure period. Land use regression techniques are used for long term exposures but are not suited for short term uses, because they do not implement the influence of meteorology. Dispersion models are suited for short term exposure modelling, but few models are capable to map air pollution in detail over large study areas. The limiting factors in applying models to exposure studies are data demand, costs and number of emission sources that the model can deal with (Gulliver and Briggs, 2011).

Most studies were focused on pm_{10}, but the focus is shifting towards measuring $pm_{2,5}$. However, there is limited data results for $pm_{2,5}$ and sources identified have different labels in different studies. Epidemiological studies that focus on associations between particulate matter and health effects relied on fixed site measurements of mass concentrations, but there is pressure to identify specific particulates responsible for the observed health effects. Identification of harmful constituents would lead to new legislation and mitigation policy (Viana et al. 2008). The full composition of the particulate mass is usually not analysable and a portion is unknown (Weijers et al. 2011). Chemical mass closure is usually used to estimate the major source contributions for particulate matter, but a total mass closure is most of the times not attained (Weijers et al. 2011). Particulate matter consists of different elements from different sources. Natural sources are uncertain, because they cannot be traced back easily. Air quality models need further study to refine the composition representations (Koo et al., 2010).

It is possible that a particulate matter concentration reduction is reached at one area, but this has no or even negative effect on the national particulate matter concentrations. While most areas are just below the particulate matter norms. It is possible the new sea salt deduction method creates an increase in the number of areas that exceed the norms (Beijk et al. 2011). Hence, it remains important to monitor the particulate matter concentrations and keep the models up-to-date (tweede monitoringsrapportage).

2.2.2 Particulate matter composition in the Netherlands

To estimate the particulate matter concentrations in the Netherlands, a combination of measurements and model calculations are used (Matthijsen and ten Brink, 2007). According to Weijers et al. (2011) the largest contribution of particulate matter in the Netherlands is nitrate. Other important components are sulphate, elemental carbon, organic carbon, ammonium, metals, chloride and sodium. The major parts of the inorganic components are in the fine fraction of $pm_{2,5}$, while metals and sea salt are more seen in the coarse fraction of pm_{10}. Constituents that are carbonaceous can contain other elements that react with the carbon. Elements reacting to carbon can contribute to the mass of the particulate matter sample. This can increase the unknown portion of the particulate matter sample.

When particulate matter concentrations are high, the unknown part increases as well,

while sea salt decreases. The atmospheric situation can contribute to the composition of the particulate matter sample. When there is slow atmospheric transport or stagnating conditions, the emissions are less diluted and removal is low. The sample shows a relatively high concentration of particulate matter in these conditions. During the winter period this effect strengthens due to a shallow boundary layer.

Since only the anthropogenic part can be targeted by abatement strategies, a first-order approximation of natural and anthropogenic contribution to particulate matter is important. The first-order approximation is a linear approximation method to create an impression of the composition of the sample. When looking at sulphate, 95% is anthropogenic, for nitrate it is 94%. Ammonia and mineral dust are 90% anthropogenic and elemental carbon and metals are exclusively anthropogenic, where organic matter is about 50% anthropogenic (see table 2.1). When adding all contributions, the estimated anthropogenic fraction of pm_{10} is 76% and for $pm_{2,5}$ 83% (Weijers et al. 2011).

Table 2.1: composition and source of particulate matter elements (based on Weijers et al. 2011)

Elements	Sulphate	Nitrate	Ammonia	Mineral dust	Elemental carbon	Metals	Organic matter
Anthropogenic	95%	94%	90%	90%	100%	100%	50%
Natural	5%	6%	10%	10%	0%	0%	50%

Most measured data were not obtained according to the measurement guidelines of the European Union and have no official status. When the measured levels are calibrated, the regional background for pm_{10} range about 12 to 16 µg/m³ . The urban background is a bit higher, ranging between 16 and 18 µg/m³. Streets will increase the concentration of pm_{10} with 2 to 6 µg/m^3 with average traffic conditions and on busy streets the increase in concentration can be between 7 and 14 µg/m^3**.** This will create a range of pm_{10} concentrations near streets of 14-32 µg/m^3 (Matthijsen and ten Brink, 2007).

As can be seen in figure 2.1 below, the particulate matter is composed of different sources from different backgrounds, where the main contribution sources are from Europe and the Netherlands. A large contribution of the particulate matter concentration is from other, not defined sources. The urban background in itself is a relatively small part of the total amount, where the exceedance peaks are mainly contributed by traffic.

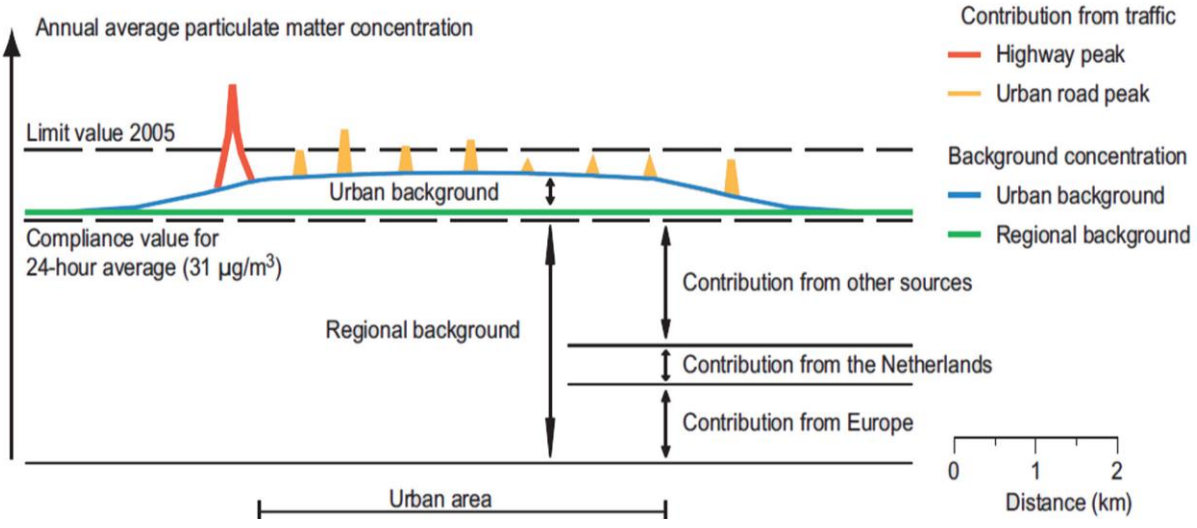

Figure 2,1: Example of composition of particulate matter in a cross section of a city (Matthijsen and Koelemeijer, 2010)

In the European Union the amount of data on $pm_{2,5}$ is scarce (Matthijsen and ten Brink, 2007). The exceedance occurs mainly along motorways, busy roads in the city centres and at locations close to industrial parks (Kruitwagen et al. 2009). Currently livestock farms are also taken into account as bottlenecks for particulate matter (Beijk et al. 2011).

According to Matthijsen et al (2009) the standards are based on the Average Exposure Index (AEI). This AEI is a three-year average that is based on measured urban background locations from each member state. The main reason for introducing the $pm_{2,5}$ AEI was that epidemiological research could not identify a level of concentrations of particulate matter where no effects are seen. The current knowledge on $pm_{2,5}$ is still limited. Because semi-volatile particulate matter fractions are predominantly in $pm_{2,5}$ routine measurements are less uncertain than pm_{10} measurements. In the Netherlands $pm_{2,5}$ is monitored in Amsterdam and Rotterdam from 2006 on. The concentrations at urban sites were used as input for the AEI (see table 2.3 below). The AEI itself is used to determine whether the Exposure Concentration Obligation (ECO) and Exposure Reduction Target (ERT) are met. Both ECO and ERT are three-year averages of the urban background concentrations, but they do not have to be met (Matthijsen et al. 2009).

Table 2.2: range of concentrations in different measurement sites (based on Matthijsen and ten Brink, 2007)

Pm sites	**Rural**	**Urban**	**Traffic**
Range $pm_{2,5}$	13-18 µg/m^3	15-21 µg/m^3	17-19 µg/m^3
Range pm_{10}	12-16 µg/m^3	16-18 µg/m^3	14-32 µg/m^3

2.3 Spatial planning in relation to particulate matter

Spatial planning is affected by particulate matter, by the fact that most chance of exceeding the limit values are along busy highways, busy roads leading to cities, nearby heavy industry areas, near intensive livestock farming, around the entrance of tunnels and along shipping ways and harbours[3][4]. Building in the vicinity of areas where the concentration of particulate matter is exceeding the limit values is very difficult. In some member states, like the Netherlands, it is prohibited by law. Spatial planning will have difficulties and have to be adjusted, or are obstructed by this[5]. On the other hand, solving particulate matter problems is possible by altering the spatial plan. The most common way to solve particulate matter bottlenecks is by zoning.

[3] Infomil: http://www.infomil.nl/onderwerpen/ruimte/ruimtelijke-ordening/handreiking/3-luchtkwaliteit/
[4] NSL monitoring: http://www.nsl-monitoring.nl/index.php
[5] Tweede monitorrapportage: http://www.rijksoverheid.nl/documenten-en-publicaties/kamerstukken/2011/12/20/tweede-monitoringsrapportage-voortgang-nationaal-samenwerkingsprogramma-lucktkwaliteit-nsl.html

2.3.1 Zoning

When looking at spatial planning there are some measures to influence particulate matter concentrations. By, for example, creating more distance between sources and vulnerable locations, severe effects can be reduced[3]. This does not decrease the total emissions of particulate matter, but creates more options to build.
Vulnerable locations have stricter norms than other building projects and therefore spatial planning has to keep in mind to create as much space as possible between vulnerable projects and particulate matter sources to have less problems to comply with the norms. Moreover, changing the function of the buildings and replacing vulnerable locations by less vulnerable groups, the situation can be improved. In developing spatial plans the municipality can create an optimal situation for future traffic volumes and flows[3]. In terms of zoning a municipality can create opportunities of buffer zones between sources and sensitive groups. This is also used in combination trade-offs on other environmental areas[3].

The European Union is rather rigid in the enforcement of the standards. This places problems for building projects, because permits are issued according to those standards. Environmental policy is justified by the principle of the common market and the resolving of issues at a high level of scale with clear standards (Evers, 2005). The use of zones to protect pollution sensitive areas is an established framework in the Netherlands and it has consequences for spatial planning (de Roo, 2003). According to Runhaar et al. (2009) urban planners recently got more freedom in formulating environmental ambitions that are related to the functions and characteristics of a specific area. Strict environmental norms impede spatial development, where spatial planning often misses opportunities to improve environmental quality. Urban planners struggle with how environmental indicators influence other aspects (Runhaar et al., 2009).
The combination of environmental policy and spatial planning is a mismatch between sectorial and territorial approaches. Where environmental policy is approached as separate sectors, spatial planning is mostly divided in territories. Sectors often exceed the borders of several territories. This can create problems in matching the different spatial territories to the environmental sectors. (Evers, 2005).

2.3.2 Tools to facilitate environmental value integration in spatial planning

There are a wide variety of tools developed to facilitate environmental values to integrate in spatial planning (Runhaar et al. 2009). Planning tools assist planners to accomplish planning tasks, which encompass elements like identifying and assessing spatial functions. Planning tools can provide guidelines for data collection, or facilitate decision making processes and have different grades of complexity. There are two main types of planning tools, the substance-oriented tools and analytical tools. Substance-oriented tools are used to create indicators for the state of the urban environment and are aimed to contribute to the improvement of the environment. Analytical tools produce knowledge about the aspects the planner wants to focus on. Tools that are more process oriented are aimed to achieve consensus on a joint course of action, but can have negative effects on environmental ambitions in spatial planning (Runhaar et al. 2009). In order to achieve consensus, environmental ambitions often are put opposite to economy or other interests.

[3] Infomil: http://www.infomil.nl/onderwerpen/ruimte/ruimtelijke-ordening/handreiking/3-luchtkwaliteit/

In this way, environmental ambitions need to be lowered in order to create full consensus on the joint course of action.

In the Netherlands planning tools have been developed that focus on integrating environmental and spatial planning, taking both content and process aspects into consideration. These tools are called hybrid tools. They help realizing environmental ambitions and action plans, by structuring part of the planning process and providing substance-orientated tools to support the tasks. The tools help to develop action plans for the area under consideration. Following the six steps as described below (Runhaar et al. 2009):

1. Analyse the current or future situation by describing spatial functions, environmental conditions and qualities. Various tools are layer models and check lists with indicators
2. Determine the desired area types by defining the main characteristics in terms of functions or qualities of the area. For this step guidelines are made about the area type.
3. Select and prioritise environmental aspects by check lists with indicators, environmental impact analysis, multi criteria analyses and other tools.
4. Formulate environmental ambitions.
5. Develop an action plan to implement the ambitions by using check lists of measures and best practices and guidelines.
6. Monitor, evaluate and give feedback.

The hybrid planning tools do not specify optimal outcomes, but take a more pragmatic approach and are based on cooperation of urban and environmental planners in defining area specific environmental ambitions. In this way, the environmental values can be taken into account in an relatively early planning phase. Hybrid tools are appropriate for areas that need to be restructured or developed (Runhaar et al. 2009). The tools combine elements of goal achievement and consensus and this makes them more flexible than just substance-oriented or analytical tools (van de Reit, 2003). Where substance-orientated tools only focus on consensus, the tools are flexible, but create low input of data needed for the planner to reach the goal. Analytical tools, on the other hand, only focus on gaining data, does not offer help when consensus is needed in reaching a fully cooperated plan. Hybrid tools are adequate in situations with many stakeholders that hold diverging interests. The tools require a context favourable for harmonization integration and allow for reflecting values at stake. Moreover it requires a fixation on political controversies, they should allow for flexible uses and assess financial implications (Runhaar et al. 2009).

Runhaar et al. (2009) state that tools can be assessed by the degree of contribution of integrating the environment and spatial planning. However, there is no general description of environmental policy integration. There are now three forms of environmental policy integration: Coordination, Harmonization and Priorization .

- Coordination is a limited form of integration and is aimed at avoiding contradiction in policies. Coordination is mainly used to abate end-of-pipe- measures .
- Harmonization brings environmental objectives as high on the agenda as sectorial objectives. Harmonization promotes synergy and tries to increase the effectiveness

of policy sectors.
- Prioritization favours environment above other subjects (Runhaar et al. 2009).

According to Runhaar et al (2009) the three types of environmental policy integration are not equally feasible or adequate in specific situations. Moreover, it is important that the environmental policy integration tools are supported by politics and society. Politicians can influence the level of environmental integration, which influences the way environmental values are integrated and the way environmental ambitions are viewed in the plan. Society controls critical resources (Runhaar et al., 2009). The influence of politicians and society creates different values or concerns, specific for the situation at hand. The strength of the integration of environmental policy differs therefore from situation to situation (Campbell, 1996).

2.4 Main aspects for case study

For the case study there are certain aspects that have to be taken into account.

Particulate matter has an impact on human health in many aspects. It is the most dominant part of air pollution that has an effect on human health. It is unknown what elements or combination of element are responsible for the observed effects. The concentration of particulate matter decreases slowly, and the way the impact of particulate matter on human health is viewed by municipalities should be analysed in detail for the case study.

To calculate the particulate matter concentration and define the composition of the particulate matter samples, different methods can be used. The European Union has a measurement principle, but member states can choose different methods and models to measure and model particulate matter. This can create different results for the same area. Analysing the methods used by municipalities in the Netherlands can create an insight into how measurement results are handled. The particulate matter composition in the Netherlands has a mainly anthropogenic source, with around 76% coming from human activities. When looking at the sources in total, a large part of the background concentration comes from sources at national and European level. On municipal level, the contribution is relatively small, but the peak loads are the main contribution for exceeding the particulate matter limit values and should be analysed in detail for the case study.

Zoning is one of the tools that integrate environmental values into spatial planning. It is an important tool to solve particulate matter bottlenecks. On the other hand, spatial planning is also affected by particulate matter policies and certain measures regarding particulate matter. The different ways to implement zoning tools, creates different levels of integration of environmental values, like particulate matter. The way spatial planning, and especially zoning affect the particulate matter concentration should be analysed in detail for the case study.

3. Policy

In this chapter the European and Dutch policy regarding particulate matter and spatial planning are described. First the European policy regarding particulate matter and spatial planning are presented and in 3.2 Dutch policy regarding particulate matter and spatial planning are represented.

3.1 European policy

All important air quality problems, among them is particulate matter, are interrelated and subject to long-range transport in the atmosphere (Amann et al. 2005). Effective strategies can therefore not be developed at local scale, or national scale even, but need cooperation on international scale (Amann et al. 2005). When looking at the types of policy that are implemented at international scale, Skjærseth et al. (2006) defines two different types: hard law and soft law.

Soft law policy is comprised of non-binding norms, like resolutions by international organizations. With soft law policy, domestic ratification is not required.

Hard law policy is comprised of norms that are binding to the member states who participate. These binding rules and norms are viewed as to have more credible commitments and have more stringent procedures. Soft law policies can be turned into hard law policies by making the non-binding norms binding for the participating member states and setting regulations for the participants.

Both types of policies can overlap. In these cases, soft law policies can strengthen institutions. Member states accept high ambitions more easily in soft law policies, than when it has to be negotiated in hard law policy. Moreover, soft law policies that are transformed into hard law policies has better implementation of the norms by participating member states (Skjærseth et al. 2006). The European Clean Air Directive is an example of hard law policy, since it has the strict binding legislation and member countries face financial penalties when they are not in compliance (Wolff and Perry, 2010).

3.1.1 Clean Air Directive

According to Wolff and Perry (2010) member countries are still in violation of the Directive, despite the financial penalties and European cities and local governments need to start implementing measures that are more effective to reduce particulate matter concentration levels to the binding norms (Wolff and Perry, 2010). There are concerns from scientists towards the limit values of pm_{10} and $pm_{2,5}$ in the European Air Quality Decree (Annesi-Maesano et al. 2007). The main concerns are that the limit values are still too high to adequately protect public health and the exclusion of natural particulate matter, like sea salt, reduces the public health protection as it would allow for higher concentration values than expressed in the existing legislation (Annesi-Measano et al. 2007). Moreover, the European Commission introduced the possibility to allow member states to have delay on reaching the limit values by 5 years (Annesi-Maesano et al. 2007).

In 1996 the Air Quality Framework Directive was established[6]. The Directive describes the basic technical principles for assessing and measuring the quality of the air and how member states can translate the framework into national law. In the first “daughter directive” the limit values for ambient levels of, among others, particulate matter are

[6] COUNCIL DIRECTIVE 96/62/EC

spelled out. In 2005 the European Commission enacted the Clean Air Directive, to mandate low levels of particulate matter for all member states. The Directive sets standards with respect to ambient air quality and demands from each member state to implement their own policies to reach the standards . Member states are also required to inform the European Commission of cases in which the air pollutant threshold are exceeded (Wolff and Perry, 2010). By 2005 the regulations for pm_{10} were such that the limit values for stations were 50 µg/m³ on daily average with no more than 35 days per year and the yearly average should not exceed 40 µg/m³ (Wolff and Perry, 2010). It was the intention of the European Air Quality Framework Directive to changed the thresholds in 2010 to that the daily average could not be exceeded for more than 7 days and the yearly average was to be tightened to 20 µg/m³ (see table 2.2) (Wolff and Perry, 2010; Matthijsen and ten Brink, 2007).

Table 3.1: norms for pm10 for 2005 and 2010

PM	**Norm pm_{10} 2005**	**Numbers of days a year (2005)**	**Norm pm_{10} 2010**	**Numbers of days a year (2010)**	**Norm $pm_{2,5}$**
Daily average	50 µg/m³	35	50 µg/m³	7	x
Annual average	40 µg/m³	x	20 µg/m³	x	20 µg/m³

However, due to foreseen difficulties the European Union abolished these tighter values in 2008 and replaced it by legislation for $pm_{2,5}$ (Wolff and Perry, 2010). An advantage for this was that $pm_{2,5}$ originates mainly from anthropogenic sources and therefore is, in principle, more manageable (Matthijsen and ten Brink, 2007). Hence, the norms for $pm_{2.5}$ were introduced.

For the measuring of $pm_{2.5}$ the Average Exposure Index was introduced as the Council Directive also required monitoring of $pm_{2,5}$ and reports of member states of daily concentrations of $pm_{2,5}$ (Wolff and Perry, 2010). The Average Exposure Indicator is the annual mean concentration averaged across targeted urban areas and is set at 20 µg/m³ for 2015. In 2020 this limit value has to met by all measuring stations across the countries (Wolff and Perry, 2010).For the fine fraction of particulate matter, member states must reduce the Average Exposure Indicator by 20% of 2000 levels in 2020 (Wolff and Perry, 2010).

3.1.2 Supervision and enforcement

Wolff and Perry (2010) state further that, due to low compliance by member states, the European Commission initiated more stringent supervision and enforcement of the standards. Violations of the standards were common and explanations varied significantly, so the Directive now allows a number of exceedances of the limits. The member states have to demonstrate that the exceedance occurs because of unusual circumstances. Extension to meet the standards can be achieved from the Commission if a member state can prove that it has made a strong attempt to meet the targets. Moreover, it must have a detailed strategy to meet the future air quality targets. If a country fails to comply with the limit values after receiving two warning letters from the Commission, the Commission can start an infringement procedure at the European Court of Justice. In 2009, 10 infringement procedures were initiated to Cyprus, Estonia, Germany, Italy, Poland, Portugal, Slovenia,

Spain, Sweden and the United Kingdom. The daily penalty a violating city has to pay is calculated like this:

$$Daily\ penalty = (Flat\ Rate * Seriousness * Duration)\ N$$

The flat rate is currently set at 600 euros for each member state. Seriousness is based on the impact of the violation on human health and the ecosystem. Duration is based on the amount of time the member state is in non-compliance and the responsiveness of the government of the member state. The duration of the infringement runs from the date of the first Court judgment. N is a country factor, which is based on the ability of the member state to pay the penalty, determined by the GDP of the member state, and the number of votes in the European Council. For the Netherland, for example, the N is 7,6. Under European law member countries can demand that local authorities develop action plans to address air pollution (Wolff and Perry, 2010). At the moment in densely populated areas, the urban background may be close or even exceed the limit values set by the European Air Quality Framework Directive. Moreover, based on extrapolation of the 2004 $pm_{2,5}$ levels, the Institute for European Environmental Policy concluded that the yearly average of 20 µg/m³ would not be reached in Europe in 2015 (Matthijsen and ten Brink, 2007).

According to Amann et al (2005) the European Union has established a legal framework called “Clean Air For Europe” (CAFE)[7]. This framework is created to protect European air quality. CAFE brings together information about air quality development in Europe, taking into account the effects of all legislation on emission control. The framework compiles a common knowledge base that can guide future policy development in air quality. Economic growth assumptions are a critical input to assessment of future air quality policy and how emission generating activities influence the future. Because it is difficult to accurately predict economic development, CAFE uses multiple projections to project the possible trends in future air quality in Europe. Anticipated decline in emissions will improve air quality, but is not sufficient to eliminate harmful impacts of air quality on human health. Present legislation needs to be tightened to reduce the health impact and priority is set on traffic emissions, small combustion sources that burn coal and wood and reduction in precursor emissions of particulate matter (Amann et al. 2005). To tighten emission concentrations policy makers require sound scientific knowledge of the sources of particulate matter (Viana et al. 2008), since many countries in Europe still have problems adhering to the daily limit value for pm_{10} (Weijers et al. 2011).

3.1.3 Influence of European policy on spatial planning

According to Evers (2005) the European Union policies do not only have effects on the policy sectors the European policies address, but the policies can change the European spatial development as well. The principles of the European policies are issued on the ground of a perceived community interest and they cross other aspects. In this way, European policies can have increasingly visible effects on the land use of its member states. Specific directives can bring new forms of development, or block them from occurring. In terms of spatial planning this means that the European Union, which has no formal authority for conducting spatial planning by its member states, can influence spatial planning through other means. Activities that affect spatial developments are internal market mechanisms and policies that target specific types of areas. The effects are most

[7] Clean Air For Europe 2005/0183 (COD): http://ec.europa.eu/environment/air/cafe/index.htm

visible when the aims or processes differ among member states. European sectorial policies are indirectly related to spatial planning and work generally on the scale of local government.

There are three different types of European policy that affect spatial planning:

- Subsidies stimulate development or behaviour. However, subsidies are subject to a variety of conditions. This creates differences among member states and have influence on spatial development, depending on the subsidy.
- Sanctions that are forced upon member states that violate standards of European policy, are indirectly affecting spatial developments. Sanctions are forced upon member states through legal action from third parties against non compliance of the norms and this financial measure can alter spatial developments by the difference in budget left for spatial plans
- Benchmarking influences spatial planning by the use of introducing new concepts or procedures. Competition among member states is enhanced, which can alter spatial planning.

The three approaches can have various effects on spatial development, as they interact with national policy. Moreover, since the policies in itself are not focusing on the spatial dimension, the policies can lead to unwanted and even contradictory results (Evers, 2005).

According to Evers (2005) the Netherlands is one of the largest net-payers to Europe. Next to the different approaches, the European policies have a relative high influence on Dutch spatial planning, for the country has a high population density and therefore a high concentration of pollution. Other important policies that influence the Dutch spatial planning are:

- The Common Agricultural Policy (CAP) has the most impact on land use in the Netherlands. The policy encourages production and aims to be self sufficient in food provision. The highly regulated market is successful but costly, as it absorbs around 88% of the EEC budget. Under this policy, the Netherlands is second in its level of exporting agricultural products. From 1990 the European Union agricultural policy shifted steadily away from this support towards rural development. The current reforms will not affect agricultural production as much as other member states, since only a quarter of the agricultural production falls under the price mechanism instead of the 59% with other member states. However, with the expanded markets it is probable that a lot of the Dutch rural areas will lose its agricultural function. When agriculture ceases to gain profit, the areas will be defined more by recreation, nature, commercial and residential uses. The Common Agricultural Policy affect spatial developments by altering the rural land market, while keeping agriculture profitable in the Netherlands (Evers, 2005).
- Regional policy is most explicit in influencing spatial planning (Evers, 2005). The European Regional Policy aims to reduce socio economic inequality and have a more level playing field in the common market. Moreover, the policy aims to restructure economy and society and employment. By funding infrastructural projects like roads, bridges etcetera, the European Union essentially conducts spatial policy under the name of regional development. The regional policies has changed the political arena, since the new member states are poorer. Therefore the core objectives are redefined. In the Netherlands is means that national government focus on increasing the status of the most competitive regions. This can create an

increase in economic disparities and migration to the urbanized West of the country. The European funding allows eligible projects to be completed ahead of schedule and the concepts influence spatial plans (Evers, 2005).

- The core business of the competition policy is to even out the economic playing field of Europe (Evers, 2005). The policy monitors and protects the European market to ensure that competition within the European Union is open and fair. Regulating the market is done by established standards to expedite trade between the member states. The policy protects the member states from actions that makes fair trading difficult, like monopoly formation and public-sector favouritism. Due to changes in opportunities of actors involved in urban development, the competition policy influences planning rules, which work by distorting the land market. The competition policy also makes it difficult for governments to choose which company they wish to do business with. However, since a lot of state companies are privatized, the Netherlands will hardly be affected by the competition policy. While the Netherlands profiles itself as a business-friendly tax environment, it could experience disadvantages of the actions taken by the European Union (Evers, 2005).

3.2 Dutch policy

Planners are stimulated by national policy, to have zones with environmental conditions as guidelines in urban areas. To implement environmental conditions in urban areas, ambitions regarding environment are integrated. However, integrating environmental ambitions and spatial planning often conflicts each other. At local scale policy integration is expected to reduce conflicts between spatial planning and environment and in this process, create more sustainable urban planning. However, urban planners struggle with how to implement environmental ambitions into spatial planning and how environmental indicators influence other aspects of spatial planning (Runhaar et al. 2009).
Municipalities form the lowest tier of government. They depend for 90% of their income from the central government. This fund can be spend as the municipality government sees fit. Grants can be used for specific purposes and municipalities are allowed to levy taxes. One of the municipalities' main responsibilities is to maintain the housing stock. To provide for the construction of new residential areas and to control development in existing urban areas and in the countryside, municipalities produce structure and development plans. The latter are especially important to local residents since they specify the uses to which land may be put. The municipality is also responsible for the roads and road safety and is able to control environmental nuisance[8] .

Evers (2005) state that European environmental policy is drawing most attention to spatial planning in the Netherlands. On the other hand environmental concepts are integrated into planning practices and plans on local scale. Due to this linkage, the European Environmental policies are increasingly important in the Netherlands in different fields of policy making. In terms of policies regarding air quality, particulate matter and nitrogen emission concentration norms are most difficult to comply with. The deadline for particulate matter pm_{10} was 2011 and for $pm_{2.5}$ the deadline is for 2015 and creates panic to comply with the norms. Moreover, it is difficult to reach the limit values and keep building at the same time (Evers, 2005). When looking at scales, the most of the background concentration stems from Europe and the Netherlands as a whole. Municipalities

[8] Overheid.nl: www.overheid.nl

contribute a relatively small part, but are responsible for most particulate matter reductions. In this part, the Dutch policies regarding particulate matter and regarding spatial planning is defined.

3.2.1 Environmental Policy in the Netherlands

Kruitwagen et al (2009) states that Dutch policy is aimed at closing the gap between the undesired situation and the preferred situation by adjusting the preference of the inhabitants or adjusting the situation towards the preferred situation itself. To adjust the preference of the inhabitants, other policy aspects are involved, in which interests related to the problem of the inhabitants are tried to be fulfilled. To adjust the situation towards the preferred situation different types of policy tools are used.
In the Netherlands the very high population density and high concentration of industrial activities make it difficult to comply with environmental policies, among them particulate matter. Therefore the Dutch government has to choose between stricter measures or a pragmatic approach. Policy actions can take the direction of source based emission reduction, or can use opportunities that are more flexible to reach the targets. In contrast with other European Union countries, which focus on reducing the emissions at source, the Netherlands uses the pragmatic approach. Sharp emission reductions can not always be reached in a cost effective way, because of the high level of economic activity and population density. When using the pragmatic approach national environmental targets can be reached in the light of European requirements. However, the approach could fail in terms of other policy function evaluation criteria and it is difficult to comply with the policy targets in a broader policy assessment.
Legitimacy is a key principle of policy making and consists of the goals that are set, the instruments that are used and the effects of those instruments. In terms of policy making, legitimacy is needed to create the framework for policy tools and ways of how to reach the goals. Policy making also requires knowledge of the causes and effects and has to be appropriate in the specific case the policy is used in terms of budgets, cultural habits and distribution of power. Knowledge about the causes and effects is needed to create policy tools that are focused on the appropriate aspect of the problem. When a policy tool or policy measure is specified for a specific case it is more efficient, than when the policy measure or tool is generalised. Most policy tools do not meet all conditions (Kruitwagen et al. 2009). In terms of policy tools and policy measures, it is important to use general policies and adjust them on local scale to the specific case, so the tool or measure is most efficient in terms of costs, fits in the behaviour patterns of the inhabitants and is supported by local power.

Kruitwagen et al (2009) also state that looking at Dutch air quality policies, air quality measures are formulated along three tracks:

1. traffic-related emissions. Emissions from traffic are reduced by filters and by promoting the purchase of cleaner vehicles. Moreover the speed limits are altered close to residential areas, to reduce traffic related emissions.
2. advocating additional European point source pollution policy. The general European policies regarding air quality is defined to Dutch cases for point source pollution.
3. introduction of a National Cooperation Program Air Quality (Nationaal Samenwerkingsprogramma Luchtkwaliteit) to put together national, regional and local measures to reduce the hampering of building activities. This program is further defined in chapter 3.2.2.

The challenge is to reduce the mismatch between what the policy needs to be effective and the provision of scientific knowledge. The air quality policies comply with European

targets and avoid costly emission reduction measures, but at the same time, it may delay restoration of environmental conditions (Kruitwagen et al. 2009).

The Netherlands is unique, because the Air Quality directives have been implemented in national legislation (Backes et al. 2005). Moreover, according to Velders and Diederen (2009) the directives are coupled with spatial planning, hence delays and postponements of a lot of building projects. Matthijsen and Koelemeijer (2010) state that to meet the standards for air quality in the Netherlands, the most effective policy means would be to decrease nitrogen oxides and ammonia emissions. This also affects the concentration of particulate matter (Matthijsen and Koelemeijer, 2010). When the Netherlands should exceed the air quality limit values at the deadline, given by the European Union, the European Union Directive requires that the Netherlands, as other countries which did not reach the limit values at the deadline, make plans and develop programmes to improve the air quality. Due to the uncertainties in the models and measurements, no absolute conclusions can be made whether the Netherlands will meet the limit values in time or not. Since sea salt contribution is less than was assumed, the sea salt reduction needs to be revised (Matthijsen and Koelemeijer, 2010).
One of the most used policy tools to reduce particulate matter concentrations is the Nationaal Samenwerkingsprogramma Luchtkwaliteit, which will be described in the next section.

3.2.2 Nationaal Samenwerkingsprogramma Luchtkwaliteit

The Nationaal Samenwerkingsprogramma Luchtkwaliteit (National Cooperation Program Air Quality) is a cooperation program from the National Government and local governments to improve the air quality[4]. The Nationaal Samenwerkingsprogramma Luchtkwaliteit provides a flexible link between spatial planning and air quality for the realization of building projects in the Netherlands(Kruitwagen et al. 2009). The norms for particulate matter concentrations can be limiting for the realisation and development of spatial plans. Not only does a spatial plan include prevention of nuisance and protection of vulnerable groups, it has to include a plan on how to keep the air pollution below the norms [4].
Because of this flexible link, all building plans can be put into effect. To do this compensation, measures like road-pricing and emission reduction in industry are used. Moreover, not all building activities are tested on their effect on the air quality. Only substantial projects are included in the assessment by the program. The program offered a way out in the dilemma of economy versus environment (Kruitwagen et al. 2009). One of the key focus points in the NSL is the reaching of the norms of particulate matter. The NSL takes up building projects where developments in terms of air quality norms are followed. Moreover, the measurements and projects are followed to see the outcome and communicate the state of the art measurements to municipalities in the Netherlands[4]. Since the European law only requires to meet the air quality standards, the program can reduce the restrictions for spatial planning. The National Cooperation Program Air Quality (short: NSL) requires detailed model calculations to see whether specific locations can be used for building projects and this makes building projects complex and expensive. Uncertainties in air quality models make it impossible to indicate whether the measures will meet the air quality standards at specific locations and hampers functionality and feasibility of the program measures (Kruitwagen et al. 2009).

[4] NSL monitoring: http://www.nsl-monitoring.nl/index.php

The NSL covers regional plans with spatial developments and municipalities have the opportunities to take extra measures. Most measures are aimed at traffic and industry. For traffic, the future traffic volumes are used to avoid bottlenecks and improve the flow of traffic. Not only does the general flow of traffic improve, but by this improvement the particulate matter build-up is less, which results in a decreased particulate matter concentration at those areas. In table 3.2 the most common measures to reduce particulate matter concentrations are given.

Table 3.2: measures to reduce particulate matter concentrations [5].

Traffic based measures	**Industry based measures**
Reducing traffic volume	Using environmental zones
Influencing composition of traffic	Limiting source emissions
Improving traffic flows	Replace emission points
Use of clean public transport	
Creating clean municipal car park	

The NSL program runs until August 2014, but in 2012 the risk factor of bottlenecks existing in 2015 is calculated[4]. In the NSL-monitoring of 2012 the increase of speed limits to 130 km/h will be taken into account[4].
National measures are general for the country and result in a reduced background concentration[4]. However, aiming at traffic and industrial sources creates results that are behaviour dependent and it is difficult to have a massive effect. When using the NSL regional spatial plans are covered and this gives municipalities the opportunity to take extra measures[4].The NSL monitoring tool is used to detect changes in air quality at the site of the project. Measurements and projects are put on the map and the background concentrations are measured.

Municipalities have to adjust their spatial plans to both the regional plans and their extra measures. These measures mostly have to do with traffic flows and placing of industrial sites. The most general measures taken are[4]:

1. Reducing traffic at places where there are bottlenecks. This can be done by stimulation of the use of public transport or working at home. However, this is behaviour dependent and the effect is coupled with the willingness of the inhabitants to use public transport or work at home.
2. Influencing composition of traffic. This is proven difficult, because a country can not ban cars with a high particulate matter emission. Moreover, the choice of cars and composition of cars depends on the consumer. Influence can only be done by advertising and subsidize clean cars.
3. Improving traffic flows. This can be done by steering traffic through other roads or create more lanes. This can have the effect, however, that the problem is replaced in another area. In other cases it can create a situation where at one place the concentrations go down and at another place the concentrations go up, but they both are just below the norms. When the European norms are adjusted, this will create bigger problems.
4. Create city rings and different routes for transport. This is also a replacing of

[5] Tweede monitoringsrapportage: http://www.rijksoverheid.nl/documenten-en-publicaties/kamerstukken/2011/12/20/tweede-monitoringsrapportage-voortgang-nationaal-samenwerkingsprogramma-luchtkwaliteit-nsl.html
[4] NSL monitoring: http://www.nsl-monitoring.nl/index.php

problems out of the project area, or trying to smoothen out the peaks by increasing concentrations of particulate matter elsewhere.

5. Use of clean public transport. This can solve the problem. Replacement of public transport that emits more particulate matter than the new versions will decrease the total concentration in the area. However, the decrease is just small and only helps when a large part of the inhabitants use public transport.
6. Create a clean municipal car park. The park is used to keep cars out of the city centre. The cars are parked in the car park and people travel further with public transport. This is an advantage for both the emissions of, among others, particulate matter, and the traffic flow in the city centre. Moreover, when there is a better flow of traffic, the emission of particulate matter will further decrease.
7. Use environmental zones. Environmental zones are designed to restrict the vehicles that emit the most particulate matter. This is possible for trucks, but because of European laws on economics it is not possible to ban certain cars from areas.
8. Limit source emissions and replace emission points. This is possible for industrial emissions. The limitation of source emissions can be done at source or by end-of-pipe measures. When the emission points are replaced, the concentrations are only lowered at that area, but the problem is not solved.

The monitoring is done by the Bureau Monitoring, which is a cooperation between the Rijksinstituut voor Volksgezondheid en Milieu (RIVM) and InfoMil from Agentschap NL[4]. Because the NSL is a cooperation of municipalities, provinces and the National Government, the partners are responsible for the measurements and projects. To monitor the process of the projects, the Bureau Monitoring gives information about the development of the projects, measurements and changes of the approaches. At the same time the partners deliver the recent data about air pollution under their responsibility[4]. This responsibility is based on measuring the air pollution by the municipalities. This is done by rules, but still there can be differences in measuring. Because of this, the results can vary. To create a more transparent underpinning of the data delivery by municipalities, the National Government wants to improve the quality of the data. The National Government also wants to check the differences and abnormalities in the data. In terms of traffic data and producing data ready for calculations, the municipalities have difficulties. When the process of calculations in the NSL is more transparent, it will help to eliminate the errors more easily. Moreover, to create a better picture of the situation on federal roads and with temporary situations, these areas have to monitored more strictly in terms to calculate the development of air quality at those areas. Because the number of projects can increase, by adjusting the way of modelling or calculating, or by adjustment of the limit values, municipalities will have to adjust their budgets to finance the projects[5].

[4] NSL monitoring: http://www.nsl-monitoring.nl/index.php

[5] Tweede monitoringsrapportage: http://www.rijksoverheid.nl/documenten-en-publicaties/kamerstukken/2011/12/20/tweede-monitoringsrapportage-voortgang-nationaal-samenwerkingsprogramma-luchtkwaliteit-nsl.html

Table 3.3: Tools used by the NSL[4]

NSL tools	Usage	Measures:
Monitoring tool	Calculation of developments of air quality projects	Pm_{10} and NO_2
Reorganization tool	Guidance of decisions of National Government about air quality	Particulate matter and NO_2
Calculation tool	Calculations of air quality along roads	Air quality

In table 3.3 the NSL tools are shown that are designed to monitor the projects. With the data provided by the municipalities the Monitoringtool can calculate the developments and conclusions can be made to continue with the project or to make changes, hence the results of the data is important for the project and can depend on the way of measuring. The monitoring tool is used to detect improvement in air quality. Measurements and projects are put on the map and the background concentrations are measured. The tool is based on data inputs from the municipalities. The Monitoringtool shows the concentrations of PM_{10} and NO_2 of that calculated year. Moreover, the tool has data about the achievement of projects and This puts the NSL as the most important policy tool to decrease particulate matter concentrations. With the use of the monitoring tool, the prognosis is that outdoor particulate matter concentrations will decline between 2010 and 2015 (Beijk et al. 2011). This expectation is for the urban areas and NSL projects. Municipalities will have to adjust their budgets too, if the number of projects increase. Another tool is the Reorganizationtool (Saneringstool). It is used to guide the decisions of the National Government on particulate matter and other air pollution matters. The Reorganizationtool shows the particulate matter and NO_2 concentrations with and without the effects of local measurements. In combination with the Monitoringtool, the Reorganizationtool can create models about the particulate matter concentrations in the areas, connected to NSL. The third tool is the Calculationtool (NSL-Rekentool). It calculates the air quality along roads[4]. In brief, the NSL models the concentration of particulate matter with project areas within municipalities and the concentration of particulate matter along roads. The difficulty to improve air quality of the inner city will bring increasing costs with the number of projects and the ways of solving the bottlenecks. Most exceedance will be around industrial areas and livestock farms. However, NSL assessment tool does not contain all sites relevant to human exposure, which leads to an underestimation of the amount of exceedance spots (Beijk et al. 2011). For example, agriculture is an important source of particulate matter, especially the intensive poultry farming[5], but is underrepresented in the NSL. A change in approach will be needed, especially with agricultural areas. Agriculture is an important source of particulate matter, especially the intensive poultry farming. Nowadays, the trend is to put all agricultural activities close together, to minimize the noise and odour from activities. When looking at particulate matter, the activities have to be spread over a large area, to decrease the concentration of particulate matter. A good number of poultry farms exceeds the limit value for particulate matter. In the NSL is also agreed that these overruns will be removed[5].

[5] Tweede monitoringsrapportage: http://www.rijksoverheid.nl/documenten-en-publicaties/kamerstukken/2011/12/20/tweede-monitoringsrapportage-voortgang-nationaal-samenwerkingsprogramma-luchtkwaliteit-nsl.html

The size of the problem for agricultural areas is identified in two phases:

1. the NSL analysed 330 companies as possible exceeders. These companies are passed on with specific data from the environmental permits. 70 companies emerged as actual exceeders.
2. after an update of the data files still 185 companies are recognized as possible exceeders. It is estimated that 50 – 100 companies will still yield to the previous group of 70 should be added. In total this delivers 100 – 150 companies that exceed the limit values. These exceedances are removed before mid-2011[5].

The companies that are not recognized as possible exceeders can fall just under the norm. When the norms for particulate matter change, it is possible that the number of exceeding farms increase rapidly.
At first instance, farms, which are subsidized are encouraged to take the necessary measures to eliminate the threat of compliances. This approach is strongly preferred, because it will keep the costs down. When necessary, the government can enforce this through updating of the environmental permit or partially withdrawing of the permit[8]. This will alter the spatial landscape in the way that farms that are not able to comply with the norms are shut down or taken over by other farms. In the figure below the exceeding farms are shown. The largest number of exceeding farms are in the Eastern and Southern part of the Netherlands. Hence, the most particulate matter problems have to be solved there. It is striking, that other parts of the Netherlands do not seem to have any exceeding farms at al. A lot of greenhouses are situated in the West part of the Netherlands and the North, like the provinces of Friesland and Groningen, have a relevant number of farms as well.

The approach of solving the bottlenecks is linked to the reconstruction of the animal husbandry in the five so-called reconstruction provinces. The reconstruction is based on discontinuation of farms in the extensification areas and moving them to sustainable locations in interlace and agricultural development areas[5]. Hence, the farms are spread and the particulate matter concentration decreases. At other places, however, the concentration of particulate matter will increase and with expansion of the farms the background concentration will probably also increase, because the total concentration over the country does not change with this approach. The National Government tries to strengthen this approach by setting up an innovation path along two tracks:

1. combined air cleaners. These also reduce the emission of ammonia and odour and can have a high return rate. The air cleaners are not used in poultry farms, because they get clogged by the large amount of dust.
2. other measures. This concerns technical measures such as spraying of small quantities of oil, electrostatic dust catchers, water scrubbers and others. Financial support techniques that the emission of fine dust limit are only subsidized if an emission factor for these techniques is published on the HOUSING site from VROM[5].

[5] Tweede monitoringsrapportage: http://www.rijksoverheid.nl/documenten-en-publicaties/kamerstukken/2011/12/20/tweede-monitoringsrapportage-voortgang-nationaal-samenwerkingsprogramma-luchtkwaliteit-nsl.html

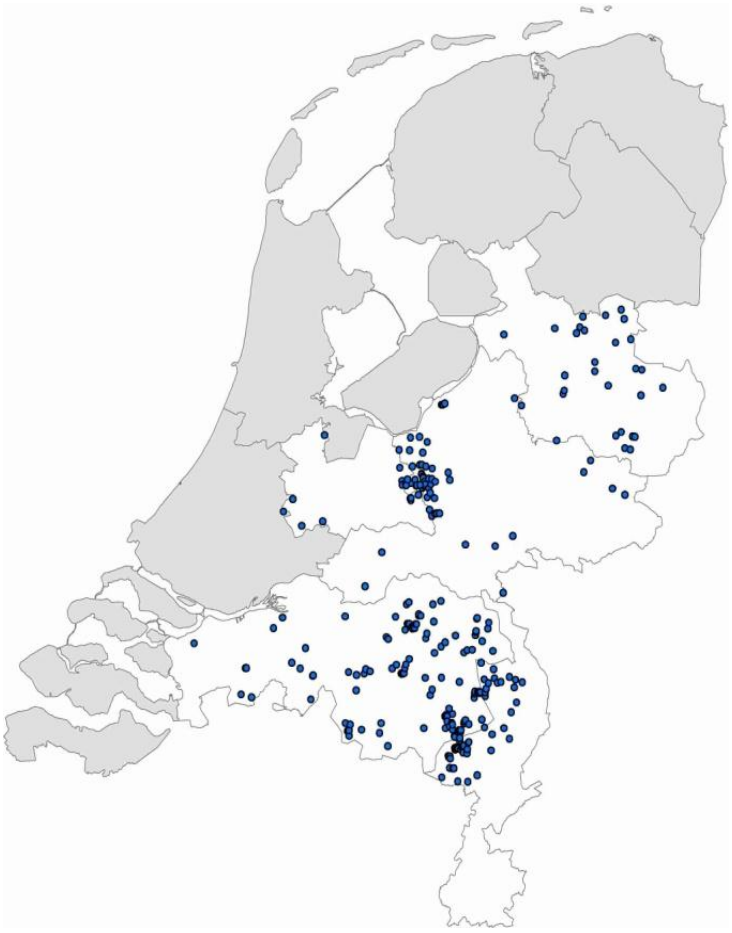

Figure 3.1 : Places where particulate matter limit values are exceeded, focusing on agriculture and livestock[5]

This can pose problems for new techniques that are more efficient, but are not published on the site. All measures that restrict the emission of fine dust fall under fiscal instruments of VAMIL. The National Government tries to enforce farms to use Best Available Techniques, however, it is proven unfeasibly at this time because there are not enough emission reduction techniques. Farms that voluntarily adjust to solve the particulate matter concentrations, can continue their business on the regular financial instruments. Any further responsibility lies with the municipalities. More efforts are needed, because the high local background concentrations of particulate matter make it difficult to comply to the norm. Municipalities prepared an area-based approach for this[5].

A number of projects have no signifying contribution to air quality and do not have to be tested to limit values. The Not in Signifying Degree boundary for the substances PM_{10} and NO_2 are set at 1.2 µg/m^3. To determine whether this is the case, the development of the project is compared with the spatial plan and what is possible within the existing land use plan[4]. When a project has a significant contribution of air pollution and does exceed the limit values inclusion of a project in the NSL is an obvious option. However, not all municipalities participate in the NSL. A Government may choose to work in those cases with project netting. In this case the limit value can exceed the particulate matter norms,

[4] NSL monitoring: http://www.nsl-monitoring.nl/indx.php

while at the project area the air quality improves because of the development[9]. When the spatial plan is in development, investigations have to start whether the development has any effect on air quality. The quality is divided in inventory investigations and expanded investigations with calculations as arguments. There are three kinds of calculation models: Method 1 is for urban areas, Method 2 is for roads and open fields and Method 3 is transport of polluted air by industry. The methods incalculate the background concentration[3]. The methods are not specified. However agriculture is possibly calculated with method 2. When measuring the air quality, the place of measuring has to be calculated to give a representative image of the status of air quality. Measurements are taken at places where people are exposed. For particulate matter the calculations of exposure are done for one person at a 24 hour scale. This is because most exceedances in the Netherlands are at the average daily scale, instead of the average yearly scale[5]

Financial stimulation measurements are made by the National Government and conclude: soot filters for existing vehicles, accelerated import of clean trucks, buses and cars, stimulating a clean municipal car park, green concession for public transport, environmental zones, stimulating natural gas pumps, creating different parking tariffs for different cars with a certain emission, more severe demands for the MOT of diesel cars. When looking at spatial planning there are some measurements to influence particulate matter concentrations[5].
The experience of the first year monitoring have led to improvements in the process. However, this year the planning was also under pressure because of the complexity around the software. The methods of measuring particulate matter can differ slightly and the data is contributed by the municipalities to the NSL. Due to tight schedules the NSL partners did not have the opportunity to clear all of the imperfections of the program. In the autumn it was decided to allow partners NSL-corrections, because it became apparent that there were many imperfections in the input data. This means that some projects are continued, while it is possible that the limit values are exceeded and the other way around. The program is partially corrected because a full correction would have led to far-reaching shortcomings or a delay[5]. This can affect the number of bottlenecks.

When necessary, the government can update of the environmental permit or partially withdraw the permit for farms[5]. This will alter the spatial landscape in the way that farms that are not able to comply with the norms are shut down or taken over by other farms. In this way the area can be redeveloped and cities will develop towards the rural areas.

3.2.3 Interim Law on City and Environment

The Dutch National Government states that the Interim Law on City and Environment is used to create a goal oriented and optimal use of space and quality of life. Until 2014 the municipalities can exceed some norms for pollution of soil, sound, air, and ammonia[9].

According to RO Web[10] the legislation of Air Quality in the Netherlands stressed spatial planning, making the Dutch Government introducing the Interim Law of City and

[3] Infomil: http://www.infomil.nl/onderwerpen/ruimte/ruimtelijke-ordening/handreiking/3-luchtkwaliteit/

[5] Tweede monitoringsrapportage: http://www.rijksoverheid.nl/documenten-en-publicaties/kamerstukken/2011/12/20/tweede-monitoringsrapportage-voortgang-nationaal-samenwerkingsprogramma-luchtkwaliteit-nsl.html

[9] Rijksoverheid: http://www.rijksoverheid.nl/onderwerpen/steden/stad-en-milieu

[10] Ro Web: http://www.ro-web.nl/2010/12/stad-en-milieu

Environment. This law was aimed to give urban redevelopment a new impulse. From 1997 till 2003 it was introduced as an experiment, with 25 Dutch municipalities cooperating to redesign complex urban areas. From 2006 the Interim law is embedded in the legislation for environment and spatial planning and gives municipalities the opportunity to deviate from the prescribed norms. The Interim law also helps to coordinate exemptions and permits of spatial project. The law was a project of VROM, Association of Dutch Municipalities (VNG), Interprovincial Deliberation (IPO), the ministries of Economics (EZ) Health Wellbeing and Sports (VWS) and Transport (VenW), Employers organisation VNO/NCW and the Nature and Environment foundation[10].

Before municipalities can use the Interim law, they need to take two steps:

1) Environmental issues are handled with as many measures aimed at the source.
2) The municipalities utilize the possibilities of existing legislation to solve the problem.

These two steps are combined in a plan where the spatial and environmental aspects are combined.

3) If after these steps the project still is not realisable, the third step is the exemption order[9].

To get this exemption order, the municipalities have to[10]:

a) Show that this exemption is needed to get the wanted spatial development and contributes to a sustainable spatial use with optimal quality of the living environment in the area.
b) Use this third step in combination with a development plan, because it is used for spatial development.
c) Show that stakeholders have participated with the preparations.
d) Limit the negative consequences of this third step. If this is not realisable, the municipalities have to compensate. This compensation needs to be executed within the area.

If the third step is approved, the municipality has to write a yearly report about the achievements and consequences of the step for five years by the Provincial Executive (Dutch: Provinciale Staten). If there are unforeseen consequences for the human health or the environment, the municipalities have to take measures to remove these problems. This Interim law helps with spatial planning in the way that it support building project, but can hamper policy measures regarding particulate matter. The Interim law can, for example, help in building in an area, where the particulate matter concentration is exceeding the limit value[10].

3.2.4 Zoning policy

Zoning policy is based on environmental standards. Environmental standards are limits that are implemented through policy to protect the environment. Conflicts in the area of environment and spatial planning is usually dealt with by converting environmental standards into areas with a distance, also called zones, which have to be maintained between the environmental sensitive areas and the source of the harmful function or activity. Environmental policy is used as a guideline setting for zoning policy. There is a possibility that friction occurs when different goals have to be reached. The friction often occurs at the cross of function, economy and society. As an effect oriented measure, zoning an area is very functional, but on an economical and social point of view it is almost impossible to implement these measures to the fullest (de Roo, 2003). The zone can

[10] Ro Web: http://www.ro-web.nl/2010/12/stad-en-milieu

hamper economic developments, for example.
The urban development in the Netherlands is mainly determined by the increasing demand for housing and commercial accommodation, which also increases traffic volumes. To handle the increase in traffic and the emissions that goes with it, the Dutch environmental policy uses a framework based on ambient standards. From this framework, zoning policy is regarded as an established way to protect pollution sensitive areas. However, it has consequences for spatial planning. Due to top-down implementation, the zoning policies usually transcend local authority boundaries. For area policy to be established at local level, the possibilities and disadvantages of the specific area should be steering. In terms of zoning, it gives room to smoothen out the conflicts and improve the use of the land. At local level, the balance would be established between source-based and effect-oriented policy (de Roo, 2003).

According to van den Brink et al. (2008) environmental zones, in particular environmental zones focused on particulate matter, makes it possible to reduce emissions by, for example, banning private cars with a certain emission certification from a part of a city, where air quality norms are exceeded. The primary goal of this environmental zone is to improve the air quality in the area. Moreover, the environmental zones improve liveability within the area because of a decrease in traffic intensity. The zoning has effect on people who live in the zone, who have a final destination in the zone and people who drive through the zone (van den Brink et al. 2008). In the Netherlands environmental zones that prohibit trucks in parts of cities, have been implemented from 2007. There are plans to implement environmental zones for cars, but when these environmental zones in the Netherlands are implemented, the zone has different types of cars to take into account.

For the implemented policy regarding trucks, the types and restrictions are:

1. Euro 0 and Euro 1 cars cannot enter the zone. As can be seen in table 2.4 Euro 0 and Euro 1 cars are older than 5 years and create relatively the most emissions. If these cars are banned from the zone, it will reduce the concentrations of pm_{10} in the area.
2. Euro 2 and Euro 3 cars which have a carbon filter certified by the European Union can enter the zone. Euro 2 and Euro 3 cars are maximal 5 years old. With the carbon filter, a part of the emissions are captured.
3. Euro 4 cars and younger can enter the zone. Euro 4 cars are the youngest cars, which have modern techniques installed. Usually this type of car has a carbon filter and emits relatively the least amount of pollution.

The effects of the environmental zone depend on the type of cars that can enter the area. For environmental zones that will use the banning of certain types of cars, the same types as described above will be used. When only Euro 0 and Euro 1 cars are banned from the zone, the reduction of particulate matter is maximum 2%. When also Euro 2 and Euro 3 cars are banned from the zone, the reduction of particulate matter is 24%. If the banning of cars would be implemented in 2015, all cars with Euro 3 and below will give a reduction of the pm_{10} concentration of 10%, while all cars with Euro 4 and below banned from the zone will give a reduction of 21%.

Table 3,4: Effects of environmental zone on particulate matter concentrations (van den Brink et al., 2008)

Effects	**2010**		**2015**	
Euro classes	Euro 0 and 1	Euro 3 and older	Euro 3 and older	Euro 4 and older
Maximal age car that is allowed in zone (years)	14	5	10	6
pm_{10} reduction in zone ($\mu g/m^3$)	0	0,3	0,1	0,2
pm_{10} reduction in zone (%)	2,00	24,00	10,00	21,00

When looking at the zones, different parties have different costs. Owners of cars that are not allowed in the zone have to buy a new car or travel differently in the area. The municipalities have to implement and maintain the zone. Communications about the new rules also go under the costs of the municipalities. The shops and industry that are positioned in the zone can have economical consequences in the way of fewer clients. Banning of cars older than 15 years decreases the traffic of cars with 2%. More effective will be the banning of cars older than 5 years. The decrease in car traffic in the zone is then 30%. As can be seen in table 2,4, the environmental zones reduce the emissions of cars, but the total emissions by traffic does not decrease much, because trucks and cargo cars are not affected by the zones. The efficiency of the zones depends on the level of cars that are banned from the area. When cars older than 5 years are banned, the pm_{10} emissions decrease by 20 to 25%. When cars older than 15 years are banned, the decrease is 1 to 2%. The zoning is most effective with busy roads with buildings at both sides. However, the effects differ per road and locally the effects can diverse strongly from the average. Traffic situations, compilation of traffic and the environment have to be taken into account in the decision for zoning (van den Brink et al. 2008).

3.3 Main aspects for case study

There are certain aspects to take into account for the case study.

In Europe local governments are stressed to implement measures which are more effective to reduce the particulate matter concentration. This to be in compliance to the European legislations for particulate matter. However, the measures can differ in effects on the composition, concentration and sources of particulate matter and can have an effect on spatial planning on municipal level. The way the municipality implements European legislation into municipal policies regarding particulate matter should be analysed in detail in the case study.

There are different rules and norms for pm_{10} and $pm_{2,5}$ on European level. The different norms and rules can affect local policy for particulate matter. In densely populated areas, the urban background can be close or even exceed the limit values of the European Air Quality Framework Directive, giving municipalities little to no room to reduce the particulate matter concentrations on local scale. The way the limit values are used in municipal policy

is analysed in detail for the case study.

To comply to the environmental legislation, set by European policies, the Netherlands uses a pragmatic approach to solve particulate matter problems. The way the general national policies are adjusted and used on local scale is analysed in detail for the case study.

The NSL provides a flexible link between spatial planning and air quality. Because of this link, most building plans can be put in effect. Also the Interim Law on City and Environment is used to make an optimal use of space and quality of life, by allowing a way to become more flexible. This has an impact on how municipalities use other policies to decrease particulate matter and this should be analysed in detail in the case study.

Planners are stimulated to create zones that imply environmental conditions as guidelines in urban areas. When a city is growing, the many aspects have to be implemented in the planning. Due to top-down implementation, the zoning policies usually transcend local authority boundaries. The way municipalities use zoning policies to influence the particulate matter concentrations at a certain area should be analysed in the case study.

4. Analytical framework for case study

To frame the results and gather information in a structured way, aspects are chosen for the analytical framework of the case study. In table 4.1 the research questions and focus for document study are linked to the aspects to be analysed in the case study. In each interview, general questions (as listed in Annex 1) were asked, as well as more specific questions to get a better insight into the views and opinions of the interviewees. In this chapter the aspects are described in terms of how the results were analysed and what kind of information was gained through these aspects.

Effect of particulate matter on human health:

For this aspect information was gathered about the view of the municipality on the importance of particulate matter in relation to human health. This view on particulate matter can change the way the municipality handles the issues around particulate matter concentrations and how the policies regarding particulate matter are formed. The information was gathered through interviews and policy documents of the policies and programs regarding air quality in Utrecht.

By asking the interviewees about the importance of reducing particulate matter concentrations on municipal level and the effect particulate matter has on human health, an impression was formed about the way the interviewee views the issue. Moreover, by asking the point of view of the interviewee about the effect of the implemented municipal policies on the particulate matter concentration at municipal level, an impression was formed about the point of view of the interviewee on how the municipality handles the issues regarding particulate matter. By asking the interviewees whether the policies regarding particulate matter have changed, since research has shown the anthropogenic contribution is 80% instead of the earlier idea of 45%, an impression was formed about the current knowledge on particulate matter research of the interviewees. Moreover, information was gathered about how new knowledge was implemented into policies.

By analysing the municipal policies regarding air quality and analysing the Action Plan Air Quality Utrecht on relations to human health and importance of reducing municipal particulate matter concentrations, information was gathered about the point of view of the municipality regarding particulate matter issues.

Composition and sources of particulate matter:

To gain an insight about the level of knowledge the municipality has about particulate matter in terms of the sources and composition, reveals the point of view of the municipality on whether policies on municipal level can have an impact on the particulate matter concentrations. The level of knowledge about the issue can alter the way, the municipality implements policies regarding particulate matter and spatial planning. Even though the contribution of particulate matter at municipal level to the total concentration is relatively small, the peak loads at municipal level are the main causes for exceedance of the particulate matter norms. The information was gathered through interviews and document study.

By asking the interviewees about what are considered to be the main contributors of particulate matter, information was gathered about the focus of policies and activities regarding particulate matter issues.

By analysing the Action Plan Air Quality Utrecht for information about what is seen as the main contributors of particulate matter emissions, an understanding was created about the focus of the action plan and municipal policies regarding the reduction of particulate matter concentrations.

Methods of measuring particulate matter:

How the municipality gains data of particulate matter concentrations and what methods and models are used to measure particulate matter and particulate matter concentrations can alter the view of the municipality towards the issue of particulate matter. To calculate the particulate matter concentrations and to define the composition of the samples of particulate matter, there are different methods that can be used. The difference in methods and models and can even give results that are more positive towards complying with the norms than it is in reality. The information was mainly gathered through document study. The interviews were used to next to the document study.

By asking the interviewees about the kind of measuring tools the municipality uses to determine the particulate matter concentrations, information was gathered about the way the municipality acquires and communicates information about the calculation method. Moreover, it creates an insight into how the municipality communicates measuring results to other parties.

By analysing the Action Plan Air Quality Utrecht about the methods and models of measuring particulate matter compositions and particulate matter concentrations, the methods can be compared to the European regulations regarding the type of methods to determine particulate matter.

Effects European policy on municipal policy regarding particulate matter:

For this aspect information was gathered about how the European policies regarding particulate matter have been translated into Dutch municipal policies for particulate matter. In Europe local governments are stressed to implement measures which are more effective to reduce the particulate matter concentration, in order to be in compliance with the European legislations for particulate matter. The way the European policy regarding particulate matter is interpreted, can have different effects on the composition, concentration and sources of particulate matter at municipal level. The information was gathered through interviews and document study.

Information was gathered about how the municipality views European policy regarding particulate matter. Insight was gained into how the municipality deals with the top-down approach and what difficulties appear when the rules and regulations have to be implemented in practice. By asking the interviewees about problems with the current particulate matter legislation for municipalities, information was gathered about difficulties of implementing European regulations regarding particulate matter on a municipal level. By asking the interviewees about the differences between the implementation of pm_{10} and $pm_{2.5}$ in practice, an insight was gained about the point of view of the municipality on the regulations for different particle sizes. Moreover, information was gathered about the differences in ways of implementing the different policies for both particulate matter fractions.

In the document study, both the policies for particulate matter on municipal level and the

Action Plan Air Quality Utrecht were analysed. By analysing the policies, information was found on how the municipality handles the different fractions of particulate matter. The analyses of the policies and the Action Plan Air Quality Utrecht also created an insight into how the municipality implemented the European regulations at municipal level.

Effects national policy on municipal policy regarding particulate matter:

Rules and regulations regarding particulate matter are handled through a top-down approach. Dutch policy is aimed at closing gaps between the undesired situation and the preferred situation. The municipality has to form its policies with the Dutch national policies in mind. The national policy tools regarding particulate matter can have an effect on how the municipality handles particulate matter issues. While on national level the main measures to reduce particulate matter concentrations are: traffic related emission reduction, advocating point source pollution policy and using the National Cooperation Program Air Quality, the municipality can have other measures. The information was gathered through interviews and document study.

By asking the interviewees about what kind of policy tools the municipality uses to reduce the particulate matter concentrations, information was gathered about which national policy tools are used by the municipality and what kind of policy tools are specific for the municipality regarding particulate matter. By asking the interviewees what kind of problems occur with the implementation of the particulate matter policies, information was gained about how policies relate to practice. Also the interviewees were asked whom they think is responsible for solving the bottlenecks for particulate matter in the Netherlands. This question was asked to gain insight into how the interviewees view the contribution of the municipality to solving problem areas in terms of exceeding the particulate matter concentration norms. By asking the interviewees what problems can occur when the norms for particulate matter concentrations are tightened, information was gained about how the municipality views the norms in terms of ambition and difficulty to comply with the norms.

By analysing the Action Plan Air Quality Utrecht, information was gathered about the kind of tools the municipality uses to regulate the particulate matter concentrations and reduce the particulate matter concentrations at areas where the concentrations exceed the norms. Moreover, in the Action Plan Air Quality Utrecht the relation between the municipal tools and the use of national policy tools to reduce particulate matter concentrations was analysed, to create an idea of the way the municipality views national tools in terms of usefulness.

Effects national policy on municipal policy regarding spatial planning:

For this aspect information was gathered about how national policy regarding particulate matter has an impact on municipal spatial planning. Information was also gathered about the impact of national spatial policies on municipal spatial planning and how these policies affect the concentration of particulate matter on municipal level. The different ways to implement zoning tools, create different levels of integration of environmental values. On municipal level, the level of integration shows the level of importance of environmental aspects for the municipality. Municipalities can use the different levels of integration of the environmental values, to implement policies regarding particulate matter or spatial planning. The level of integration creates a different combination of policies that can be

implemented to reduce particulate matter concentrations. The information was gathered through interviews and document study.

By asking the interviewees how the new $pm_{2.5}$ policies affect spatial planning compared to pm_{10} policies, information was gained about how the municipality anticipates on the rules and regulations regarding $pm_{2.5.}$ By asking the interviewees how the municipality can reduce particulate matter concentrations through spatial planning, information was gained about how the municipality uses spatial planning to reduce particulate matter and what aspects of spatial planning are used to get particulate matter concentrations at or below the norms. By asking the interviewees how national air quality regulations influence municipal spatial solutions to reduce the particulate matter concentrations, information is gained about how the municipality views spatial planning in relation to particulate matter and whether different rules and regulations at national level clash at municipal level.

By analysing the Action Plan Air Quality Utrecht, information was found on spatial planning solutions to overcome bottlenecks in terms of particulate matter concentrations.

Table 4.1: Analytical framework to use for case study

Research Question	**Aspect**	**Sources**	**Interview question and document study**
What are the effects and sources of particulate matter?	Municipal view on impact of particulate matter on human health	Amann et al., 2005 Akhtar et al. 2010 Weijers et al., 2011 Chang et al. 2011 Annesi-Maesano et al. 2007 Brook et al. 2003 Kasouyanni et al. 2003 Valavanidis et al. 2008	What is the effect of the implemented particulate matter policy on the health of citizens?
			How important is the reduction of particulate matter to interviewees' point of view?
			What effect do particulate matter policies have on the health of the citizens in the municipalities?
			What are the differences in policy approach, now investigation showed the anthropogenic contribution seems to be 80% instead of the earlier idea of 45%?
			Document study municipal policies
			Document study policy measures municipality

	Local composition and sources of particulate matter	Weijers et al. 2011 Matthijsen and ten Brink, 2007 Kruitwagen et al. 2009 Matthijsen et al. 2009	What are the main emitters of particulate matter in the municipality?
			Document study policy measures
	Methods of measuring particulate matter used by municipalities	Holler et al. 1996 Council Directive (1999/30/EC) Viana et al., 2008 Matthijsen et al. 2009 Matthijsen and Koelemeijer, 2010 Wagner et al. 2006 Koo et al. 2010 Chang et al. 2011 Gulliver and Briggs, 2011	What kind of measurement tools are used to determine the particulate matter concentrations?
			Document study municipal policies
			Document study policy measures municipality
How are air policy regulations implemented at municipal level?	Integration of European limit values and norms in municipal policies regarding particulate matter	Wolff and Perry, 2010 Annesi-Maesano et al. 2007 Matthijsen and ten Brink, 2007 Viana et al. 2008 Weijers et al. 2011 Evers, 2005	What are the differences between the implementation of pm_{10} and $pm_{2,5}$ policies in practice?
			Document study municipal policies
			Document study policy measures municipality
	Integration of national pragmatic approach in municipal	Runhaar et al. 2009 Evers, 2005 Kruitwagen et al. 2009	What problems can occur when limit values for particulate matter are tightened?

	policies regarding particulate matter	Beijk et al. 2011 Tweede monitoringsrapportage NSL monitoring Infomil de Roo, 2003 van den Brink et al. 2008	What kind of policy tools are used to reduce particulate matter concentrations?
			Who is responsible for solving the bottlenecks for particulate matter in the Netherlands?
			Document study municipal policies
			Document study policy measures municipality
What are the consequences of air quality regulations to municipal spatial planning?	Integration of particulate matter policies in municipal spatial planning policies	de Roo, 2003 Runhaar et al., 2009 Evers, 2005	How does the new $pm_{2,5}$ policies affect spatial planning compared to pm_{10} policies?
			How can the municipality reduce the particulate matter concentration through spatial planning?
			How do national air quality regulations influence municipal spatial solutions to reduce the particulate matter concentrations?
			Document study municipal policies
			Document study policy measures municipality

5. Case study: Utrecht

To find information about how European particulate matter policies are implemented in municipal spatial planning, the municipality of Utrecht is chosen as a case study. The case study focuses on the aspects mentioned in chapter 4.

Utrecht is one of the fastest growing municipalities in the Netherlands. It lies in the middle of the Netherlands and belongs to one of the big 4 biggest cities. The municipality of Utrecht is the same as the city of Utrecht and lies in the Randstad area. Utrecht is the centre of the network of roads, rails and waterways. The municipality has about 300,000 inhabitants and covers 99 km^2. The municipality has a population density of 3165 inhabitants per square kilometre [11].

Because of the construction of the residential areas Leidsche Rijn and Rijnenburg, city regeneration and development of the area around the train station, the housing stock increased. Furthermore, the municipality creates the opportunity to increase the amount of square meters of offices and industrial area between 2006 and 2020. This will lead to an increase of inhabitants of around 31% and an increase of jobs of around 30% (Actieplan Luchtkwaliteit Utrecht, 2009).

In this chapter the Action Plan Air Quality Utrecht is described and the interviews are analysed based on the aspects derived from chapters 2 and 3. The interviews were conducted with persons related to the municipality and persons related to action groups regarding air quality in Utrecht and the environment.

- Interviewee 1 works at the municipality as advisor environmental policy in Utrecht.
- Interviewee 2 works at the municipality as program manager air quality in Utrecht.
- Interviewee 3 is a member of an action group for clean air and human health. The action group advises the municipality about air quality and tries to get inhabitants involved as well.
- Interviewee 4 is the chairman of an action group related to human health and environment.

5.1 Utrecht municipal policy program for air quality

For solving air quality problems in the municipality, Utrecht has an Action Plan Air Quality. It is based on the NSL (Nationaal Samenwerkingsprogramma Luchtkwaliteit) and tries to solve the bottlenecks for the current situation and with the focus on future developments. The action program for spatial planning and air quality was created in 2009 (interview 1; Actieplan Luchtkwaliteit Utrecht, 2009). The Action Plan is created, because without these extra measures the municipality will not comply with the air quality norms in 2015. Because the municipality is one of the fastest growing municipalities in the Netherlands, it needs policies regarding spatial planning and policies regarding air quality to maintain or improve the air quality at urban areas. The policies regarding air quality are adjusted and checked to create a focus on the bottlenecks in the municipality. For the municipality of Utrecht the main problems are related to bottlenecks around particulate matter and

[11] Demografische kerncijfers per gemeente 2009: http://www.cbs.nl/NR/rdonlyres/0A28851B-BF48-4EDF-A5E6-1D464E73CD1D/0/2009b55pub.pdf

nitrogen dioxide. Measures that the municipality already implemented are, among others, an environmental zone for trucks, use of clean buses in the municipality, a raise of the parking tariffs, improving the flow of traffic and improving the municipal fleet in regard to emissions. The environmental zone for trucks is in the centre of Utrecht and is only accessible when the trucks have Euro 4 engines, or the trucks are younger than 8 years with Euro 3 engines with a soot filter. According to the Action Plan Air Quality Utrecht, the environmental zone reduces the particulate matter concentration with 0.3 µg/m^3.

The main bottlenecks for air quality that still remain are shown in figure 5.1.

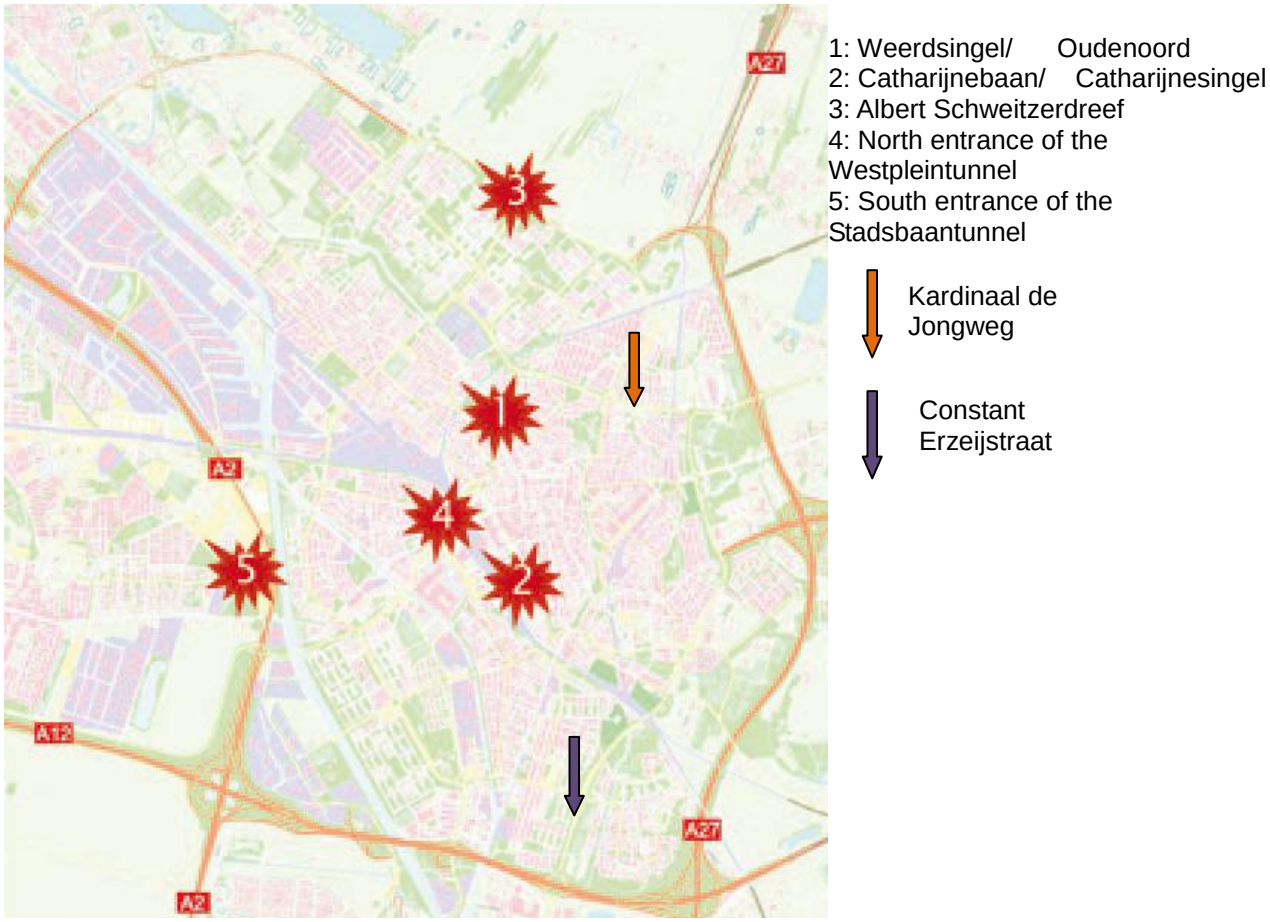

Figure 5.1: Bottlenecks of Utrecht air quality in 2015 and measuring points for particulate matter pm_{10} (Actieplan Luchtkwaliteit Utrecht, 2009)

The main focus of the Action Plan is on improving public transport in terms of increasing the use of public transport by citizens and travelling by bicycle. Because Utrecht is growing, the traffic volume is expected to increase with 30% in the year 2020. According to the Action Plan, the roads are with the current situation not able to support the increase of traffic, which leads to traffic jams and build up of emissions along roads. Figure 5.2 shows the number of days the concentration of particulate matter is exceeding the daily average of 50 µg/m^3 along the roads. According to the models and calculations, the number of days the norms of particulate matter are exceeded are maximal 30 days per year. Currently, the allowable number of days the daily average can exceed 50 µg/m^3 is 35 days.

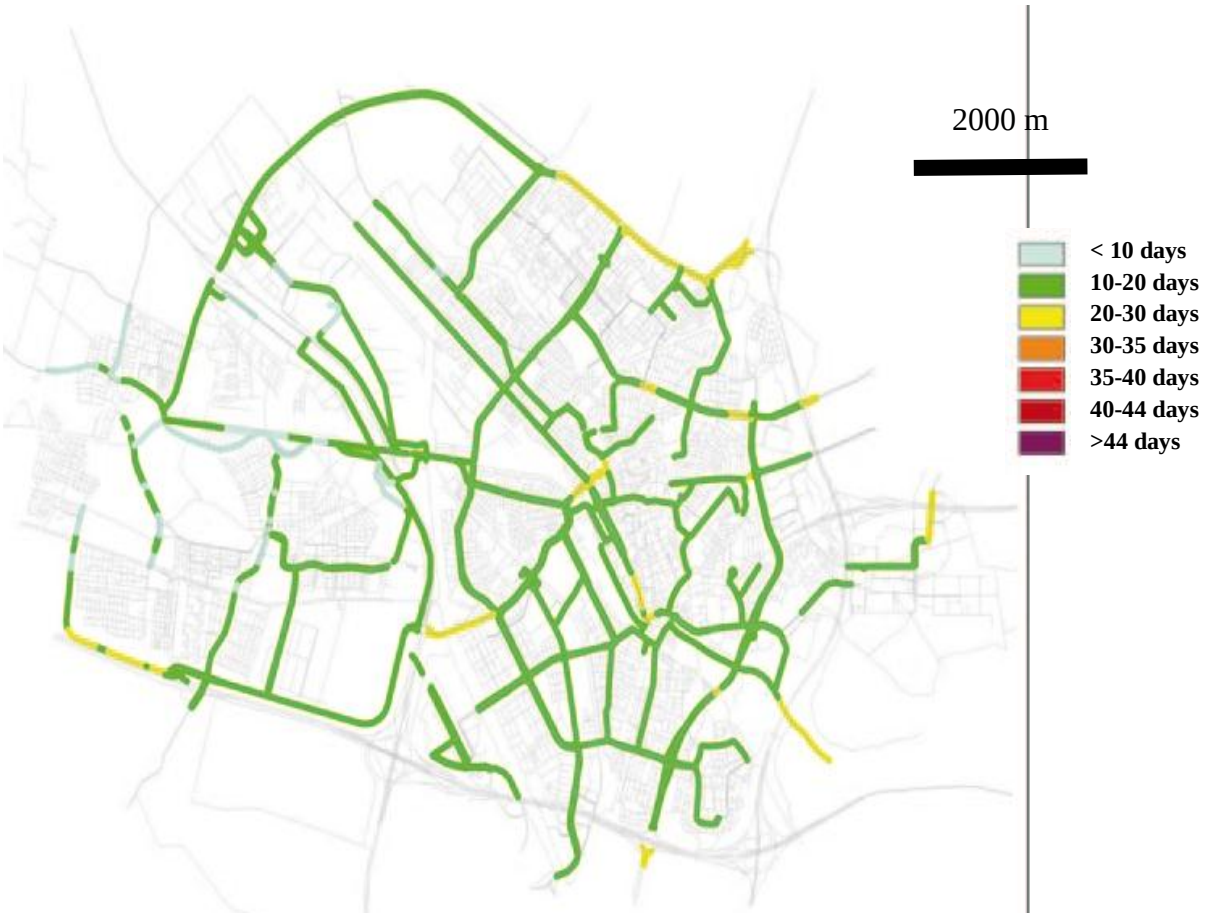

Figure 5.2: Number of days the daily average of particulate matter concentration is exceeded without measurements of the Action Plan Air Quality in the year 2010 (Actieplan Luchtkwaliteit Utrecht, 2009)

The Action Plan Air Quality Utrecht is based on 6 points regarding air quality (Actieplan Luchtkwaliteit Utrecht, 2009).

- Investing in public transport, bicycle tracks and park and ride spaces to provide an alternative for private car use in the city.
- To take measures to comply to air quality norms in 2015.
- Investing in accessibility of the inner city of Utrecht for cars by solving traffic bottlenecks.
- Investing in mobility management and change of behaviour of the inhabitants.
- Stimulation of innovative and sustainable forms of mobility.
- To take measures to improve the attractiveness of the municipality.

The effects of the measures are calculated with the CAR II 8.0 model, which is in compliance with the NSL. The CAR II 8.0 model is based on a class system for road sections. The roads in the municipality are divided into road sections, which have about the same characteristics. The traffic intensity of the road sections data are based on the VRU (Veiligheids Regio Utrecht), which uses visual 12-hour blocks in combination with the counting of traffic and data of traffic lights. With this information an annual average is calculated. The Action Plan also uses the reorganization tool from the NSL to calculate the

effects of traffic at the bottleneck areas. The municipality is obliged to give the ministry of VROM information about the execution of the air quality measures, data of the traffic and environmental characteristics of all relevant road sections. Based on these data, the ministry evaluates the development of the NSL. The monitoring of the development of the program is yearly.

The municipality of Utrecht has 4 measuring stations for air quality from the National Air Monitoring Network (Landelijk Meetnet Luchtkwaliteit) of the RIVM. Calculations of the air quality are based on the Air Quality assessment scheme (Regeling beoordeling luchtkwaliteit 2007) and the reorganisation tool of the NSL

In figure 5.3 is shown how many days the daily average of particulate matter concentrations are exceeded in the year 2015, when the measures are implemented and have the maximum effect. It is calculated that the number of days is reduced to maximum 20 days a year (Actieplan Luchtkwaliteit Utrecht, 2009).

Figure 5.3: Number of days the daily average of particulate matter concentrations are exceeded with the measures implemented from the Action Plan Air Quality in the year 2015 (Actieplan Luchtkwaliteit Utrecht, 2009).

The Air Quality Action Program Utrecht is a form of Coordination policy, where contradiction with other policies is avoided as much as possible. Moreover, this program not only focuses on air quality, but also has policies related to traffic control. In this way the municipality tries to get as much support as possible, while the concentrations of particulate matter are reduced to the level complying with the norms.

5.2 Effects of particulate matter on human health

The Action Plan Air Quality Utrecht states that the fact that bad air quality can form a serious risk for the health of elderly, children and people with breathing problems. The program finds an improved air quality of the municipality grounds is necessary for a healthy living environment. With the Action Plan the municipality tries to improve the air quality and in this way improve human health (Actieplan Luchtkwaliteit Utrecht, 2009). Interviewees 1 and 2 confirmed that it is important to take into account health risks. However, the municipality has its focus on fulfilling the norms. Health aspects are driven more to the background in this way. In most cases health and environment are put against economy in policy decisions. Moreover, the focus in relation to air quality has shifted towards nitrogen oxide emissions as most important air quality issue (interview 1; interview 2). Interviewees 3 and 4 regarded the municipal policies as symbolic, instead of having effects on the particulate matter concentrations (interview 3; interview 4).

> "There is little to nothing regarding particulate matter policy by the municipality. The main policies regarding particulate matter at municipal level is symbolic…. This symbolic policy has no effect or just a little effect on the particulate matter concentrations. This is not helping human health." (interview 3)

Moreover, the policy measures that are implemented are looked at in an opportunistic way. The municipal and national policy has become more flexible, making it possible to build at areas that used to be unsuitable. In this way, the building of houses is more important for the municipality, then protecting the inhabitants against high concentrations of particulate matter.

> "During the years, the policy for particulate matter has become increasingly flexible…. Current research has shown relations between particulate matter concentrations and leukaemia, next to the known diseases of heart, cardiac system and lungs. Moreover, there are relations between particulate matter concentrations and bee populations." (interview 4)

The policies that are in place reduce the particulate matter concentrations with the norms and this has its effect on the citizens of Utrecht (interview 2). There is a risk that particulate matter gets out of focus on municipal level, because the municipality is fulfilling the norms and views the problem as solved. It became apparent in this example:

> "A lot of buses came through this area and the municipality managed to get the particulate matter concentration down by using soot filters on buses. However, the NO_x concentration went up and exceeded the limit value. This problem was more steering and therefore the municipality decided to remove the soot filters again, so the NO_x concentration would go down. The particulate matter concentration hereby increased, but did not exceed the norms, so therefore it was regarded as a good solution" (interview 1).

The impact of particulate matter on health is regarded as being under control.

> "With help of the sea salt deduction, there are no or almost no problems in the municipality regarding particulate matter…. The GG&GD [Dutch Municipal Health Organization] thinks however, that the sea salt deduction does not comply with norms of human health." (interview 2)

When certain policies create an increase in other areas, for example by the use of zoning, the project is put with the NSL to monitor the progress (interview 1; interview 2). However, the projects are not located at areas where they are needed most, but where it is most easy to reduce the particulate matter concentrations. For example, a new building project has more opportunities to reduce particulate matter problems than an existing building block. In areas that have no or little building activity, measures are not, or less frequently taken to reduce particulate matter concentration exceedances. In this way, the municipality strategically helps certain areas, to comply with the norms, instead of reducing the particulate matter concentration where necessary.

> “Over the years, the policy greatly eased. The Netherlands is in a transition where many achievements are slowly being phased out. The projects regarding particulate matter are trying to show people more that something is done. It is more optical, than effective. For example, they plant some trees somewhere to capture particulate matter. With the current policy, the particulate matter standards are used in theory , but there is little enforcement of the standards” (interview 4).

The yearly average of particulate matter is well below the norms and only the daily average can be a problem for the municipality. This means that the municipality does very well and the effect on the health of the citizens is quite limited (interview 1). In municipalities in other provinces of the Netherlands, the problems with particulate matter are much worse. This is because of the representatives of those municipalities have different stakes and therefore make different policy choices (interview 2).
The fact that research has shown that the anthropogenic contribution is higher than previously was considered, was not known with everyone (interview 2) but does not change the way the municipality handles policies regarding bottlenecks. (interview 1; interview 2; interview 3; interview 4).

5.3 Composition and sources of particulate matter

The Action Plan Air Quality Utrecht does not contain information about the composition of particulate matter. The Action Plan recognises traffic as the main source for particulate matter and focuses the municipal policies on changing the traveling habits of the inhabitants of the municipality (Actieplan Luchtkwaliteit Utrecht, 2009).

The mentioned sources in the interviews are traffic and industry (interview 1; interview 2; interview 3; interview 4) and intensive farming (interview 2; interview 4). The municipality focuses the policies on traffic, since this is the most influential aspect to change the particulate matter concentrations. The focus of the municipality is on public transport and bicycle use (interview 1; interview 2). This is given as a substitute for driving a private car.

> “Driving with reduced speed limits gives less emissions, so the concentrations of particulate matter will go down then. The composition and concentration of particulate matter is mainly effected by the impact of different roads, way of constructing buildings and the flow of the traffic.”(interview 1)

However, whether or not the particulate matter policies will change the concentrations is up to the behaviour of the inhabitants (interview 1; interview 2). By increasing the speed limit for cars on highways, the concentration of particulate matter can increase up to 20%. This means that the background concentration of particulate matter will increase, and

municipalities will have more difficulty to comply with the norms(interview 2).

> “The problems (regarding particulate matter) are caused by behaviour, with the sources being traffic and industry…. Municipalities with a lot of intensive agriculture, like in Brabant, have more problems with particulate matter concentrations. “ (interview 2).

The most effective way to reduce the particulate matter concentrations is by source policy (interview 1; interview 2; interview 3; interview 4).

In terms of particulate matter compositions the interviewees mention soot and sea salt as important elements to take into mind (interview 1; interview 2; interview 3; interview 4). The change in policies around the deduction of sea salt from the particulate matter concentration can create a difference in the number of areas that exceed the norms. With the current legislation, the norms are reached by using sea salt deductions.

> “The new European legislation on sea salt deduction from the particulate matter concentrations should only be performed if it can be argued that on those days a certain amount of sea salt had occurred in the dust composition. This deduction has to be calculated.”(interview 3)

The old legislation around sea salt deduction allowed a standard deduction for the number of days the concentration of particulate matter exceeded the daily average. With the main contributors being traffic and industry, the sea salt deduction created a larger deduction rate then was proven in practice (interview 3).

There is a discussion around soot and whether or not soot should be regarded as an aspect of air quality that needs its own norms and regulations.

> “Another relation that is being researched, is the effect of soot on human health. Dutch national policies should have soot as an extra indicator with regard to particulate matter.” (interview 4)

Soot is now gaining importance in air quality regulations. It is proven by studies that soot has a direct effect on human health, instead of the insecurities around particulate matter, where it is not clear what causes the effects on human health (interview 1; Interview 2; interview 3; interview 4).

5.4 Methods of measuring particulate matter

In the Action Plan Air Quality Utrecht it is stated that the effectiveness of the particulate matter policies are calculated by the CAR II 8.0 model. The municipality uses data of the traffic and the characteristics of road sections in the areas. Another calculation method that is used is the Reorganization tool, which is from the NSL. The Air Quality Assessment Scheme (Regeling Beoordeling Luchtkwaliteit) is used to assess the air quality, with the results from the CAR II 8.0 model and the reorganization tool. The municipality has 4 measuring stations for air quality (Action Plan Air Quality Utrecht, 2009). Of these measuring stations, 2 stations measure pm_{10} concentrations. The other two stations are for other air quality aspects, like NO_x and sulphur. The daily concentration is measured at Kardinaal de Jongweg and Constant Erzeijstraat. In 2011 the number of days the daily average of 50 $\mu g/m^3$ was exceeded, was 44 days at Kardinaal de Jongweg and 26 days at Constant Erzeijstraat [12] (see figure 5.1) (Action Plan Air Quality Utrecht, 2009).

The interviewees mention that all data generated by the municipality is sent to the NSL (interview 1; interview 2; interview 3; interview 4), which calculates the outcome for the municipality. This means that the municipalities have the responsibility to deliver the data. Any mistake, accidentally or on purpose, can alter the outcome of the report.

> "The NSL is used for big constructing projects, where it is known that the air quality can be affected by the construction. The NSL decides whether a project can be continued based on the measures the municipality takes to improve the air quality….How do you register this improvement? This is stated in the NSL legal agreement. The monitoringtool checks the improvement in air quality. The measures and projects are mapped and every year the background concentrations are determined." (interview 1)

The outcome of all the data sent to the NSL is calculated for the municipality and this outcome decides whether the norms are reached or not. This outcome also steers municipal policies regarding air quality (interview 1; interview 2). However, problems can arise when one project is regarded as improving the air quality, while at other areas nearby the air quality gets worse. This is not calculated by the NSL. Moreover, the NSL is focused on only maintaining the norms (interview 2; interview 3). The National Institute for Measuring Air Quality (Landelijk Meetpunt Luchtkwaliteit) has around 50 measuring point spread across the country. Most of these measuring points, including some in Utrecht, show that the particulate matter concentration norms are exceeded (interview 3). The Netherlands should be complying with the norms in 2011, but:

> "…In the Netherlands the rules for calculating particulate matter are adjusted, making it possible to exclude sites where there is no significant human exposure to particulate matter concentrations. This is called the suitability principle [toepasbaarheidsbeginsel]. Because of this principle, a lot of areas are defined as not significant and the number of areas that exceed the norms are decreasing." (interview 3)

[12] RIVM: http://www.lml.rivm.nl/data/overschrijding/overschrijdingpm10.html

It is not clear what the effects are of the individual policy measures. The municipality does not think it is relevant to monitor the effects itself (interview 3). The effects of the policy measures are processed into traffic data that the municipality sends to the NSL (interview 3; interview 4). It is not clear what alteration in the traffic data is caused by what policy measure. It is also not clear where the numbers come from. Calculations are based on the emission factors and are determined each year. This is done for each type of vehicle, for the year of calculation and future years. The models are not evaluated and therefore there are no adjustments made to the calculations of the emissions (interview 3). It is impossible to see what the effects are of the policy measures and projects (interview 3; interview 4).

> "The emission factors are, simply put, based on European norms defined for car engines and the specifications of the manufacturers of the engines. The municipality assumes that the engines meet the standards. However, this is often not the case in practice."(interview 3)

To calculate the particulate matter concentration the municipality uses the NSL. The data the municipality delivers, are not checked (interview 3; interview 4).

> "From the RIVM [National Institute for Public Health and the Environment] monitoring report it is clear that the data that are delivered by the municipality are not checked. There is nobody who verifies the input. There are about 2 or 3 municipal officials, who have all knowledge about the input data for air quality. They decide which data regarding particulate matter is used that is sent to the NSL." (interview 3)

With the use of models, the municipality can give an underestimation of the number of areas that are exceeding the norm. Since the municipality tries to maintain just below the norms, the data of particulate matter concentration is altered by enlarging the area and put the measuring points on strategic places. This creates a more positive image of the status of the particulate matter issue in the municipality. Moreover, studies are not seen as autonomous. When comparing certain areas, it is possible that areas that are set as background concentration or viewed as a good example, are not in reality (interview 4).

5.5 Effects of policy on particulate matter concentrations

In the Action Plan Air Quality Utrecht, the effects of policy are not defined. The intention is to improve the air quality with the Action Plan Air Quality (Action Plan Air Quality Utrecht, 2009)

The municipality has little effect on particulate matter concentrations (interview 1; interview 2; interview 3; interview 4). The European legislation for air quality was the start of the Dutch air quality policy and the National Government is mostly responsible for solving bottlenecks. The view of the National Government is the same in this regard (interview 2). This makes that the most important tool for the municipality to reduce particulate matter is the NSL (interview 1; interview 2; interview 3; interview 4).

> "The National Government is responsible for solving bottlenecks regarding particulate matter. Most of all, because the National Government thinks this herself. There used to be a plan to give municipalities the responsibility to solve NO_x issues and the National Government would be responsible for reducing particulate matter concentrations. Eventually, both NO_x and particulate matter became shared

responsibilities.” (interview 2)

> “The most municipalities have the opinion the National Government is responsible for the particulate matter policy and the municipalities themselves only have to put the NSL measures into practice and give the NSL data so the NSL can monitor the projects.” (interview 3)

> “The NSL was created to make the complete coupling of European Air Quality and national air quality norms a more flexible process. The particulate matter legislation from 2005 was a direct translation from European particulate matter legislation. This was quite strict. Because of the NSL municipalities have a little more room to manoeuvre.” (interview 1)

The NSL creates a larger variety of ways to solve bottlenecks for particulate matter, than was the case with the strict coupling with European legislation regarding particulate matter (interview 1). The municipal policies are based on and guided by the NSL (interview 1; interview 2). Particulate matter policies are based on a top-down approach, where the National Government makes general policies and it works down to municipal levels. This gives less flexibility for municipalities to create measures that specifically solve the bottlenecks regarding particulate matter. The interaction between the different layers of government is mainly between the big cities and the National Government. This interaction goes mainly via the NSL (interview 1). The effects are incalculated into the NSL measures and traffic data (interview 3).

> “All the data generated by the municipality for the projects are sent to the NSL. The NSL will do the calculations and give the outcomes to the municipality. In this way, the municipal policies can be altered to improve the areas where the measures do not work or are not efficient enough.” (interview 1)

The measures to reduce particulate matter concentrations are compromised for what is politically feasible and what is economically feasible. Municipal policies regarding particulate matter are therefore compromised to costs and other political interests of the municipality. It is possible for municipalities to write down ambitions regarding air quality that are stricter than the national norms. For Utrecht, the ambitions regarding particulate matter concentrations are not stricter, because of the compromises (interview 1). Moreover, the focus for air quality norms has shifted to NO_x (interview 1; interview 2).

The most effective way to decrease particulate matter concentrations, is to create policies for the sources of particulate matter. Policies that focus on traffic and industry are most effective (interview 1; interview 2).

> “Mainly the busy roads near the city creates exceedance of the particulate matter norms. The VNG has sent a letter where questions are raised regarding the increase of the speed limits on most highways. The National Government has the idea to let people go faster where possible and only slow down were it is necessary. In the meantime, the effects on particulate matter norms are ignored.” (interview 1)

There is no difference in pm_{10} and $pm_{2.5}$ policies. While the European Union tries to shift the focus of particulate matter to the finer fraction, the introduced norms for $pm_{2.5}$ are the same as for pm_{10}. For the municipality, the introduction of $pm_{2.5}$ norms in the Netherlands,

did not impose any changes in the municipal particulate matter policies (interview 1; interview 2; interview 3; interview 4). For municipalities it becomes obligatory to measure $pm_{2.5}$ concentrations from 2015 on, but the municipality is not concerning the finer fraction in its municipal policies yet (interview 1).

> "The norms for $pm_{2.5}$ are just as strict as the norms for pm_{10}. Therefore it is not important to look at $pm_{2.5}$ separately. There is a new value for particulate matter, that is called the Average Exposure Index (Gemiddelde Blootstellings Index). This Average Exposure Index is a three year average of the background concentration of $pm_{2.5}$. The municipality does not have to deal with this Average Exposure Index."(interview 1)

> "There is no difference in policies regarding pm_{10} and $pm_{2.5}$. The municipality assumes that when the municipality complies with the pm_{10} norms, the $pm_{2.5}$ are also below the norms. The municipality does not monitor $pm_{2.5}$. This will only be done when the municipality needs to comply with the norms. Right now, the municipality does not take $pm_{2.5}$ into the calculations." (interview 3)

The NSL does not focus on agriculture and rural areas are less taken into account in the NSL, where the most bottlenecks regarding particulate matter are now occurring (interview 2).

> "Utrecht has no problems regarding particulate matter concentrations. Municipalities in Brabant have more problems around particulate matter. Those municipalities have a lot of agricultural activities and the municipal board has a high representation of people with a background in agriculture. Hence, particulate matter policies are compromised with other interests." (interview 2)

The policies will be most effective, when citizens cooperate and change their own behaviour. However, Dutch and European legislation can create problems around certain policy options the municipality wants to implement. Certain measures can not be implemented, because it will interfere with Dutch or European legislation (interview 2). The particulate matter policy did not become stricter to solve the bottlenecks. Municipal measures need to be more specific to gain results. Moreover, the reduction of the background concentration is only reached, when the effect is general, not at local scale only. This will cause problems, when the Dutch National Government declares that $pm_{2,5}$ has to be monitored separately from pm_{10} (interview 4).

> "For the background concentration, a large part of the contribution comes form cars. The Dutch National Government wants to increase the speed limit on most highways from 120 kilometres per hour to 130 kilometres per hour. This can increase the emission of particulate matter with 20%.This gives a higher background concentration, which makes it more difficult to comply with the norms for particulate matter…. Another example of the ways the background concentration can be increased, is the import of old cars into the Netherlands. It is not illegal to import old cars, which emit more, and cannot become illegal. It is therefore completely dependent on the people, whether they buy a car which emits less or not. Implementing zones in the municipality, where old cars are not allowed to drive is not permitted by national law either. In this way it is difficult to lower the particulate

matter emissions through source policy." (interview 2)

Therefore the main policies regarding particulate matter are focused on pm_{10}. Moreover, the health effects of $pm_{2.5}$ are not clear enough to have separate policies. This will probably change in the future (interview 2).

It is not clear what the effects are of European and National policy on particulate matter concentrations at municipal level. The municipality finds it not relevant enough to monitor the effects. Moreover, the municipality does not give specific data that defines which project has which effect (interview 3).

5.6 Effects of policy on spatial planning

In the Action Plan Air Quality Utrecht, the municipality uses environmental zoning for trucks, to improve the particulate matter concentrations in the city centre. Most measures to reduce the particulate matter concentrations are focused on traffic emissions, which will change the spatial development of the city (Action Plan Air Quality Utrecht, 2009).
The municipality is proposing to ban polluting cars from the centre as well, to improve the air quality. To the opinion of the city council:

"The traffic fleet is more polluting than the country average."

The zoning of the city centre will have an effect on the type of cars allowed into the centre. Diesel-fuelled cars older than 8 years and gasoline cars older than 12 years will be banned from the city centre[13]. This environmental zoning will be next to the zoning for trucks.

Interview 1 and 2 confirm the information from the Action Plan Air Quality Utrecht. Most particulate matter policy has most effects on spatial planning regarding sensitive locations (interview 1), city renewal and the spatial implications of this city renewal (interview 2).

> "There are some problems with sensitive locations. Sensitive locations are areas where people stay, who are part of a sensitive group. Think about children, elderly and the sick. In national legislation is written that construction at sensitive locations is prohibited when the particulate matter situation gets worse. Sensitive locations are defined on national level along national roads and provincial roads. Along municipal roads the municipality can decide for itself, because the autonomy of the municipality needs to be preserved. Because of this, municipalities do not have arranged spatial plans for sensitive locations." (interview 1)

Spatial planning is affected by the expected change in speed limits on highways. Because the increase in speed limits will increase the background concentrations of particulate matter the municipality will be faced with more areas that exceed the particulate matter norms(interview 1; interview 2). A change in spatial plans is needed to comply with the norms (interview 1). By the use of zoning, it is possible to keep the inhabitants as far as possible form the sources of particulate matter (interview 3). Also, when looking at zoning, environmental zones can have a positive effect on the area that is in the environmental zone, but the problem possibly is moved to another area, just outside this zone (interview 1; interview 2). Locally, it is possible to create zones that are not reachable by car.

[13] Utrecht weert oude auto's: http://www.nu.nl/binnenland/2846202/utrecht-weert-vervuilende-autos-centrum.html visited 28-06-2012

However, people will not accept these kinds of policies easily (interview 2). With creating traffic policies that changes the traffic fleet and creates possibilities to travel more by public transport, the municipality can build more compact and this has spatial advantages. By using public transport in the city centre, less use of cars creates opportunities to construct more buildings closer together (interview 1). However, from interview 4 it was disagreed upon creating compact cities.

> "A compact city is not at all useful in the case of particulate matter. In the case of a compact city, everything has to be closely built next to each other. In the passing of years, parts of the city will be uninhabited, giving companies the chance to settle there and these companies usually have an impact on the air quality again… Zoning is interesting, but the main problems with zoning and spatial planning is the competition for land. The municipality gives relatively large areas of land to industrial areas. At the same time inhabitants live relatively close together, due to high land expenses" (interview 4)

Since there are no differences in pm_{10} and $pm_{2.5}$ policies, there is no impact on spatial planning regarding $pm_{2.5}$ (interview 1; interview 2). Spatial planning has little to no effect on particulate matter concentrations and the municipality tries to influence the particulate matter concentrations mostly by traffic policies (interview 2).

Interview 3 and 4 disagree with the statements. The particulate matter policies have little to no effect on spatial planning (interview 3). Because there are no differences in pm_{10} and $pm_{2.5}$ policies, there is no impact on spatial planning. Because the municipal policies are mostly symbolic policies, there is no change in spatial planning policies. Moreover, the spatial plans will continue, even though it is clear that particulate matter norms in that area will not be met.

> "There is no effect on spatial planning. Even if it is clear that the limit value of particulate matter is exceeded, the municipality will sooner adjusts the calculations to below the limit values... Environmental zoning has little effect on particulate matter reduction" (interview 3)

Because of the policies regarding particulate matter getting more flexible, there are possibilities for the municipality to build in areas where the particulate matter concentrations will exceed the norms. The existing regulations regarding particulate matter make it possible to build in areas that create particulate matter bottlenecks, instead that it solves the bottlenecks and offers protection to citizens. An example is the construction of schools near busy roads. There are ways to protect citizens from particulate matter. It is possible to arrange the municipality in such a way that areas with a lot of industrial activity have separate roads from roads leading to living areas. This will create a situation where heavy traffic, like trucks will not have to be near houses. In terms of air quality, zoning along busy roads is most important (interview 4).

6. Discussion, conclusion and recommendations

In this chapter the results are discussed and the conclusions are described for municipalities in the Netherlands regarding particulate matter and spatial planning. Recommendations are given for further research.

6.1 Discussion

The discussion is divided in three parts. Every part is related to one research question. The differences and similarities between the literature study and the case study is presented here.

6.1.1 The effects and sources of particulate matter

Particulate matter has the most impact on human health, relative to other air quality aspects. Of the different size fractions, $pm_{2.5}$ affects the body the most. Governments try to decrease the concentrations of particulate matter, but this decrease is slowly, because of the increase by combustion based energy. There is no threshold for the effects of particulate matter on human health and literature states that the health benefits outweighs the costs when the particulate matter concentrations are reduced.
Literature provides a large variety of health effects aspects to focus on.
In this research the health effects have been taken into account as a minor aspect. The interviews created a different view on the importance of health effects than the literature. It appears that when it comes to policy, this is not always the case. When the focus shifts to another subject, or other interests are at stake, the fact to comply to the norm is the most important thing. All interviewees and documents consider particulate matter as an issue, but not on the same level. Where interviewees 1 and 2 consider particulate matter as important, but not problematic, interviewees 3 and 4 consider particulate matter as a big issue that needs to be solved.

The European Union defined a method principle to measure particulate matter, in which the sample is collected on a filter and the composition is determined with gravimetric mass determination. The location of the sampling points should be at sites representative of the area. However, parameters, like time resolution, type of monitoring site and type of particulate matter samples differ per member state and even per municipality. To evaluate policy efficiency and trends in particulate matter concentrations, member states use other models next to measuring methods. Literature state that in urban areas traffic can create variations in the concentrations of particulate matter on municipal level. Models for particulate matter are mostly limited by data demand, costs and the number of emission sources the model can deal with. Identification of the harmful constituents in particulate matter would lead to new legislation and mitigation policy. The data results for $pm_{2.5}$ are limited. It is possible that a particulate matter concentration reduction is reached at one area, but this has no or even negative effect on the national particulate matter concentrations.
In the interviews it became apparent that the municipality uses calculations based on traffic. Moreover, the process of data generation is unclear for some people. This can explain the differences in view on policy and the projects regarding particulate matter. In the literature is stated that the NSL has difficulties with the input data, gathered from the municipalities. The way of measuring the different criteria differs per municipality and can create errors in the results. Moreover, too little is known about $pm_{2.5}$ to measure this

fraction of particulate matter effectively. Some of the interviewees viewed the way the municipality measures the process of projects regarding particulate matter as unclear and inefficient.

The largest contributions of particulate matter in the Netherlands are nitrate, sulphate, elemental carbon, organic carbon, ammonium, metals, chloride and sodium. The major parts of the inorganic fraction contributes to $pm_{2.5}$, while metals and sea salt are mainly found in pm_{10}. The anthropogenic fraction of pm_{10} is 76% while $pm_{2.5}$ has 83% of anthropogenic contribution. The main sources of contribution are from Europe and the Netherlands, while the urban background creates the peaks, which are mainly contributed by traffic. Exceedance of particulate matter concentrations occur mainly along motorways, busy roads in city centres and at locations close to industrial parks. Currently livestock farms are also taken into account as bottlenecks for particulate matter.
Literature has the focus on the chemical composition and as sources the main contributors are regarded as: dust, traffic, construction, industry and agriculture.
The interviewees showed less knowledge about the composition and sources regarding particulate matter. The focus of the interviewees is on traffic and industry and sometimes agriculture. In the interviews industry, traffic and occasionally agriculture was mentioned as main sources of particulate matter. Moreover, the interviewees mentioned soot as an important element of particulate matter. Although literature regarded the research result, that showed that the composition of particulate matter is 76% and 83% instead of the earlier researched 45%, as important, the interviewees were less impressed. The information was not used to improve policies or was not known. Not all interviewees were up-to-date with the latest research regarding particulate matter. For interview 1, the information was a nice bonus for the effects of the policies, but saw this information as insignificant. For interview 2, the research was not known, but was convinced the policies would be more effective and therefore did not have to be changed. For interview 3 and 4, the information was known, but they saw no difference in policies regarding particulate matter. The research around soot is followed by all interviewees and considered an important aspect to take into mind as well. In interview 1 and 3, the interviewees do not consider agriculture as an main contributor, while in interview 2 and 4 it is stressed that agriculture is one of the main contributors of particulate matter as well.

6.1.2 Implementation of air quality regulations at municipal level

Literature states that effective particulate matter concentration reduction strategies need cooperation on international scale. In the interviews it became apparent, that also the municipality considers the higher levels of government responsible to reduce the particulate matter concentrations. The literature states, the main concerns of scientists are that the limit values are still too high to adequately protect public health and the exclusion of natural particulate matter, like sea salt, reduces the public health protection as it would allow for higher concentration values than expressed in the existing legislation. However, the municipality does not consider the limit values as too high. Moreover, the interviewees consider the municipality to focus on maintaining the norms, instead of the impact on the health of citizens.

In 2005 the European Commission enacted the Clean Air Directive, to mandate low levels of particulate matter for all member states. Due to foreseen difficulties the European Union abolished tighter values for pm_{10} in 2008 and replaced it by legislation for $pm_{2,5}$. For the measuring of $pm_{2.5}$ the Average Exposure Index was introduced and is set at 20 µg/m³ for 2015. The municipality does not consider $pm_{2.5}$ as a separate air quality indicator.

Measurements are scarce and the municipality considers to comply to the $pm_{2.5}$ when it also complies to the pm_{10} norms.

Literature states that at the moment, in densely populated areas the urban background may be close to or even exceed the limit values set by the European Air Quality Framework Directive. Anticipated decline in emissions will improve air quality, but is not sufficient to eliminate harmful impacts of air quality on human health. Present legislation needs to be tightened to reduce the health impact. The interviewees did not concern European particulate matter policies to be kept in mind, next to Dutch national particulate matter policies. The municipality tries to comply to the current particulate matter norms, and does not consider tightening the norms itself. When the norms are tightened, the municipality will have to use different policies to reduce the particulate matter concentrations.

Considering the high population density and high industrial activity concentration, literature states that the options of what municipalities can do to reduce the particulate matter concentration, are limited. In the Netherlands the background of particulate matter concentrations are fairly high and this can have consequences for implementation of policies and projects. The interviewees regard Dutch national policies regarding particulate matter as important for municipal particulate matter policies. Moreover, the responsibility is with the national government, in the view of the municipality. Interviewees 1 and 2 consider municipal policies as effective and improving the health of the citizens. Interviewees 3 and 4 consider municipal policies as not effective enough to have an effect on human health. From the interviews it became clear that the focus for particulate matter concentration reduction is on traffic and industry.

Literature states that the NSL is an important tool to reduce particulate matter concentrations on local level. Only substantial projects are included in the assessment by the program. To monitor the process of the projects, the Bureau Monitoring gives information about the development of the projects, measurements and changes of the approaches. At the same time the partners deliver the recent data about air pollution under their responsibility. The interviewees agreed with the NSL being the main policy tool the municipality uses to reduce particulate matter concentrations. The NSL is used to calculate the effects of the projects and measures regarding particulate matter. In the Action Plan Air Quality Utrecht, the main policy tools to reduce particulate matter concentrations are the NSL and traffic control. From the interviews it became clear that the calculations of particulate matter concentration and the effects of measures are done by the NSL. The municipality sends the data to the NSL, where the results are given back. The data is given as a change in traffic data. Data regarding particulate matter is defined by traffic volumes and characteristics of road sections. The data that is send to the NSL is not checked. This creates a situation where the number of areas that exceed the particulate matter norms are underestimated. The four interviewees do not agree about the difficulties of implementing particulate matter policies at municipal level. Interviewees 1 and 2 view the implementation as difficult or depending on peoples behaviour. Interviewees 3 and 4 consider that there is little to no implementation of particulate matter policies on municipal level.

6.1.3 The consequences of air quality regulations to municipal spatial planning

Literature states that European policies can have increasingly visible effects on the land use of its member states. Activities that affect spatial developments are internal market mechanisms and policies that target specific types of areas. The Netherlands is one of the largest net-payers to Europe. The municipality does not see this in this way. The interviewees saw little to no effect on spatial planning. Especially with the NSL in place, the effects on spatial planning were limited.

In the literature, spatial planning regarding particulate matter is mainly focused on zoning. The main solutions to reduce particulate matter concentrations through spatial planning are planning sources away from sensitive groups, creating detours for traffic or using environmental zones which ban certain types of trucks or cars. Zoning does help to reach the norms for air quality in the zoned areas, but it is not certain what the consequences are for the surrounding areas and what kind of effects this has on spatial planning. From the interviewees, the effects of Dutch national policies on municipal spatial planning are viewed as minor.

The interviewees were unified in the opinion about the impact of $pm_{2.5}$ on spatial planning. There are no effects on spatial planning regarding $pm_{2.5}$ policies. The opinions about whether spatial planning can have an impact on the particulate matter concentrations, are divided. Interviewee 1 is slightly positive, but thinks it has a small impact. Interviewee 2 thinks that there is no impact and spatial planning cannot contribute to reduce particulate matter concentrations. Interviewee 3 considers there is no impact of spatial planning on particulate matter concentrations and no impact of particulate matter policies on spatial planning. Interviewee 4 thinks that spatial planning influence particulate matter concentrations. In the Action Plan Air Quality Utrecht, the main spatial aspects concern traffic regulations. The municipality implemented an environmental zone and is planning to implement an environmental zone for private cars as well. Literature was clear about the stake of policies to reduce the particulate matter concentrations. However, the interviews showed a more scattered image, where not all interviewees regarded the policies to be effective.

6.2 Conclusions

European particulate matter policies have little effect on spatial planning at municipal level in the Netherlands. European particulate matter policies have its influence on particulate matter concentrations at Dutch national and municipal level. The composition of the particulate matter in the Netherlands is mainly anthropogenic. The anthropogenic contribution is 76% for pm_{10} and 83% for $pm_{2.5}$. The main sources of particulate matter in the Netherlands are traffic, sea salt, dust, industry and agriculture. The Clean Air Directive and CAFÉ are the most important air quality regulations and policies regarding particulate matter. The European Air Directive is quite strictly implemented in the Netherlands. However, the use of the Nationaal Samenwerkingsprogramma Luchtkwaliteit made the policies regarding particulate matter more flexible. Because of the NSL it is easier for municipalities to continue building projects. The health effects of particulate matter are varied and there is not threshold level, where the concentration of particulate matter does not have effect on human health. However, the way the municipalities generate the data required for the monitoring of creates uncertainty whether the impact of particulate matter on human health is regarded by the municipalities as important.

Because the flexible link and the way municipalities generate data of particulate matter concentrations, particulate matter policies do not affect spatial planning as much as previously thought. Most adjustments to the spatial planning are the use of zones, to reduce the particulate matter concentrations at certain areas. Other consequences of particulate matter policies are the different ways to guide traffic in the city. Municipalities try to influence the flow and volume of the traffic. Tightening of the limit values can have multiple consequences for the status in the Netherlands. The main consequence is the increase of number of places that exceed the new limit values of particulate matter. Because the concentrations are kept just below the norms, a slight adjustment can have major consequences. When $pm_{2.5}$ has to be measured as a separate aspect, it can influence the rate of success of municipalities to comply to the norms. At the moment there are no policies regarding $pm_{2.5}$ at municipal level.

6.3 Recommendations

6.3.1 Methodology

A qualitative research design was chosen, with the focus on municipalities in general and a case study in the municipality of Utrecht. The choice to use qualitative research helped with retrieving information that goes further into the subject and personal experience gained more insight into the answers.

To obtain a framework for analysing the relationship between spatial planning and particulate matter and European policies, a literature review was conducted. The literature found was helpful to gain insight into the problem. The amount of literature found on particulate matter and spatial planning, was less then expected.

For this research a case study was chosen to deepen the subject of how European particulate matter policy can influence the spatial planning of municipalities in the Netherlands. In this research the municipality of Utrecht was chosen, because it lies in the middle of the Netherlands and therefore has a high background concentration, with contribution of sea salt from the West as well as pollution contribution of neighbouring countries from the East. It is one of the fastest growing municipalities in the country. Also the city of Utrecht is a busy place with many different kinds of mobility and industry surrounded by intensive agriculture and busy roads. Utrecht also implemented environmental zoning for trucks and has the ambition to create an environmental zone for cars as well to enhance the air quality. With these aspects, Utrecht was an interesting case study, where both the history in particulate matter policies could be analysed as well as the future particulate matter policies and the effects on spatial planning at municipal level. The case study in Utrecht created results where most results can be generalised for municipalities in the Netherlands. It cannot be generalised to the level of municipalities of other countries as well, since the way the national policies are implemented can differ too much from the policies and implementation in the Netherlands.

For this thesis several interviews were conducted. The interviews were semi-structured, with open-ended questions. The interviews were done with people regarding the case study area. Two interviews were conducted with people who work at the municipality (Interviewee 1 and 2). The other two interviews were conducted with people, who are involved with action groups regarding air quality (interviewee 3 and 4). Although the amount of interviews were relatively low, the interviews were useful to gain information

about the way the municipality of Utrecht handles the issues around particulate matter. Moreover, next to specific answers about the situation in the municipality of Utrecht, the interviewees gave information about municipalities in general, making it easier to generalize the results for municipalities in the Netherlands.

A document study was used to gain more data about politics in the Netherlands and at municipal level, regulations and the case study area. The data was drawn from articles, reports, government documents, websites and books. The search for literature was divided by the subjects where the research is focused on. Two kind of literate data is defined. Categories that were used to search were: air quality implementation by municipalities, particulate matter policies in the Netherlands, influence of particulate matter policies on spatial planning: and political influences on spatial planning.

The analytical framework was used to structure the results and create focus on the aspects to look at in the interviews. It did limit the questions, but also gave a more clear representation of what to look for. Also the analytical framework gave the basis for the results to grow into subjects that meant more and can be said for municipalities in general.

6.3.2 Further research

Even though the analytical framework served as a basis to answer the research questions, some answers created further questions that could be researched to create a more complete image of the situation of particulate matter policy implementation in Dutch municipalities.

Even though the amount of literature about the impact of particulate matter on human health is fast, it is still not clear which constituents are responsible for most impact. Further research on the impact of the finer fraction on human health can help creating more effective policies to improve human health.

The methods to measure particulate matter concentrations vary per member state and even per municipality. Research about what is the best used method to measure particulate matter concentrations can help to create a better comparison of the results of member states. In this way the best practice policies can be shared with other member states, or at municipal level the municipalities can compare best practices.

It is unclear what the consequences are, when the norms are tightened to the earlier proposed norms of 20µg/m^3 as annual average and 7 days per year exceedance of the daily average of 50 µg/m^3. Not only at European or Dutch national level, but at municipal level as well. Further research into the consequences of tightening the norms can help to create policies on different levels that can cope with this and improve the air quality at the same time.

With the NSL the municipalities have to generate the data regarding air quality. This data is calculated into traffic volumes. The way the data is generated is unclear and not transparent. Further research into how municipalities generate data and how municipalities handle data submitting to the NSL is recommended to improve the NSL.

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Annex I Interview questions

Interview

Introductievragen

Naam:
Is het mogelijk om uw naam te gebruiken in mijn scriptie, of wilt u liever anoniem blijven?
Werk:
Hoelang bent u al bezig met dit onderwerp?
Wat vindt u zelf van fijnstof?
Ziet u het als een groot probleem in Nederland?
Wie is er verantwoordelijk, in uw mening, voor het oplossen van probleemgebieden (fijnstof) in Nederland?

1. **Wat voor beleidsinstrumenten worden er gebruikt door gemeentes om overschrijding van fijnstofconcentraties op te lossen?**
   a) Wat voor effecten hebben de beleidsinstrumenten op de ruimtelijke planning?
   b) Hoe wordt er besloten welke beleidsinstrumenten te gebruiken?
   c) Wat zijn de criteria waar beleidsinstrumenten aan moeten voldoen?
2. **Wat missen gemeentes om deze beleidsinstrumenten te implementeren?**
   a) Wat zijn de problemen bij het implementeren van de beleidsintstrumenten?
   b) Waar worden de normen overschreden?
3. **Hoe worden de regels voor fijnstof pm10 geïmplementeerd in gemeentelijk beleid?**
   a) Hoe zijn de interacties tussen verschillende lagen van bestuur?
   b) Wat zijn de problemen die voortkomen door de top-down implementatie van beleid van nationaal beleid naar gemeentelijk beleid?
   c) Wat voor voordelen zijn er door de top-down implementatie van beleid van nationaal beleid naar gemeentelijk beleid?
4. **Hoe worden de regels voor fijnstof pm2,5 geïmplementeerd in gemeentelijk beleid?**
   a) Wat is het verschil in implementatie tuseen pm10 en pm 2,5?
5. **Wat is er veranderd sinds het duidelijk is dat anthropogene contributie niet 45% is, maar 80%?**
   a) Wat zijn de verschillen in aanpak, nu de beleidsintstrumenten een grotere invloed hebben op de concentratie?
   b) Wat voor instrumenten zijn er nu wel mogelijk, wat met de lager contributie niet mogelijk of rendabel waren?
6. **Hoe kunnen gemeentes de huidige fijnstofconcentratie in hun gebied verminderen met behulp van ruimtelijke planning?**
   a) Wat zijn de voordelen van het verminderen van fijnstof door middel van ruimtelijke planning?
   b) Wat zijn de problemen omtrent het introduceren van fijnstofvermindering door middel van ruimtelijke planning?
7. **Wat zijn de problemen met het verminderen van de fijnstofconcentraties voor gemeentes?**
8. **Hoeveel frustreert de achtergrondconcentratie van fijnstof de ontwikkeling van gemeentes op ruimtelijke planningsgebied?**

9. **Hoe beïnvloeden andere beleidsregels de gemeentelijke ruimtelijke planning oplossingen?**
    a) Welke beleidsgebieden hebben de meeste invloed om ruimtelijke planning?
    b) Welke beleidsgebieden helpen bij het invoeren van oplossingen door middel van ruimtelijke planning?
    c) Welke beleidsgebieden werken het invoeren van oplossingen door middel van ruimtelijke planning tegen?

Afsluitvragen

Heeft u nog iets toe te voegen?
Wilt u de samenvatting van dit interview krijgen om in te zien?

Hartelijk dank voor uw antwoorden.

Annex II Interview 1

Interviewee 1 is werkzaam bij de gemeente Utrecht als Senior Adviseur Milieubeleid, gespecialiseerd in luchtkwaliteit. Hij doet dit al 10 jaar. Hij spreekt namens hemzelf in dit interview.

Het fijnstofbeleid ligt voornamelijk bij de Rijksoverheid in zijn opinie. Het Rijk heeft een redelijk goed pakket aan maatregelen om de concentraties naar beneden te brengen. Het is een compromis wat politiek en economisch haalbaar is en een compromis met wat voor invloed het heeft op de gezondheid. Het is een top-down benadering. Dit geeft minder flexibiliteit om te implementeren. Juridisch gezien kom je in een lastig pakket, als een gemeente hoge ambities heeft (hoger dan de wet voorschrijft). Dit komt omdat er altijd partijen zijn met andere belangen. In je gemeentelijk beleid kan je het vastleggen, maar ze zijn hier terughoudend in. In Utrecht zijn er op juridische gronden geen problemen met fijnstof. In praktijk zijn juridisch gezien meer problemen met stikstofdioxide. Het beleid voor stikstofdioxide is meer sturend voor ruimtelijke planning, dan van fijnstof. Jaargemiddelde fijnstofnorm is geen probleem tegenwoordig in Utrecht. Problemen kunnen zijn bij de daggemiddeldes voor fijnstof. Wel een discussie omdat ook naar de metingen worden gekeken. De monitoring van het RIVM geven discussies, maar het is nog niet aan de orde. De normen zijn strenger geworden en normen voor pm2,5 komen erbij. Pm10 is even streng als pm2,5 op dit moment en is daarom niet belangrijk om te kijken naar pm2,5. Als je ruimtelijke plannen moet gaan toetsen, heb je geen verplichting om naar pm2,5 te kijken. Dit is pas in januari 2015 om naar pm2,5 te kijken. Plannen die effect hebben op de fijnstof pm2,5 situatie, hoeven niet te worden gestopt. PM2,5 speelt juridisch nog geen rol bij het voldoen aan de normen in ruimtelijke planning. Het is niet beleidssturend. Er zijn geen probleemgebieden in het idee van fijnstof.

Van de beleidsinstrumenten die worden gebruikt is het meest bepalende het NSL (Nationaal samenwerkingsprogramma luchtkwaliteit). Discussie over het voldoen aan de normen in 2000. Wetgeving besluit luchtkwaliteit 2005 gaf een directe koppeling van wat mocht en wat kon. Door het NSL is er wat meer ruimte. In het programma zijn grote projecten opgenomen waarvan bekend is dat er veel luchtkwaliteitsproblemen kunnen opleveren. NSL zegt dat het door mag gaan, mits met de maatregelen die worden getroffen dat per saldo de luchtkwaliteit beter wordt. NSL gebieden zijn dus gebieden waar de luchtkwaliteit minder is, waar grote ontwikkelingen plaatsvinden. Hoe registreer je dat je per saldo vooruit gaat? Dat is geregeld in het NSL juridisch akkoord en er wordt gemonitored. Monitoringtool kijkt of er vooruitgang maakt in luchtkwaliteit. De maatregelen en projecten worden in kaart gebracht en elk jaar worden achtergrondconcentraties bepaalt. De data van maatregelen, projecten en achtergrondconcentraties worden opgestuurd, per jaar, naar het Rijk. De uitslag geeft het idee of gemeentes de grenswaarden hebben gehaald. Beleid van gemeentes wordt door NSL gestuurd. Andere beleidsinstrumenten zijn het ruimtelijk beleid.

In Utrecht is er een actieprogramma voor ruimtelijke planning en luchtkwaliteit. Dit heeft invloed op met name infrastructuur en verkeersbeleid. Bepaling of Utrecht aan de normen voldoet wordt via monitoring en rekenmodellen gedaan. Juridisch gezien zijn er dus geen problemen omtrent fijnstofbeleid. Wel zijn er soms problemen met gevoelige bestemmingen. Gevoelige bestemmingen zijn gebouwen waar mensen verblijven die een

gevoelige groep zijn, zoals kinderen en zieken en bejaarden. In de nationale wet staat dat op gevoelige bestemmingen niet mag worden gebouwd en of uitgebreid als de fijnstof situatie slechter wordt. Gevoelige bestemmingen zijn bepaald nationaal langs rijkwegen en provinciale wegen. Langs gemeentelijke wegen, mogen de gemeentes zelf beslissen, omdat de autonomie van de gemeente behouden moet blijven. Dit heeft tot gevolg dat er in sommige gemeenten weinig is geregeld voor gevoelige bestemmingen. Als er geen beleid voor is, kunnen interne belangen een rol spelen en wordt er minder op fijnstof gekeken.

De VNG heeft een brief opgesteld/ opgestuurd waarbij een vraagteken wordt gesteld bij de verhoging van de snelheidslimieten. De Rijksoverheid wil sneller waar het kan en langzamer rijden waar het moet is nu het devies, terwijl de fijnstof effecten van die verhoging niet worden meegenomen. Minder hard rijden geeft minder emissies, dus harder rijden geeft meer luchtverontreiniging. Ruimtelijke ontwikkeling wordt hierbij bemoeilijkt, omdat het harder rijden een deel van het fijnstof limiet opslokt. Het opvullen van de normen door harder rijden en meer bouwen, geeft moeilijkheden om aan de normen te voldoen en het kost daardoor meer geld om acties te ondernemen en onder de normen te blijven. Hiervoor moeten de ruimtelijke plannen worden aangepast.
Er is overleg tussen de verschillende lagen van bestuur. Voornamelijk met grote steden en het Rijk. Als je echt iets aan fijnstof wilt doen, is dat het meeste mogelijk via bronbeleid. Stedelijke achtergrond met verkeersbijdrage vult een groot deel van de normstelling. Speelruimte om iets aan de totale concentraties te doen is nogal beperkt. Grootste reductie kan via bronbeleid worden gehaald. Hierbij heeft het Rijk een grotere invloed. Als er wordt gekeken naar zonering, is het goed voor een gebied, maar wordt het probleem meer verplaatst naar andere gebieden.
Er komen grenswaarden aan voor pm2,5. PM10 waarden zijn strenger, dus er verandert weinig in het geval van beleid. De Gemiddelde Blootstellings Index (GBI) is een driejaarlijks gemiddelde achtergrond concentratie, als taak voor het Rijk. Gemeentes worden hiervoor niet op aangesproken. Vanwege de verschillen in stoffen kan je meer sturen op pm2,5 dan bij pm10 omdat het meer antropogene contributie bevat. Gemeentes hebben er nu nog weinig mee van doen.

In de dagelijkse praktijk maakt het niet uit, dat onderzoekers hebben uitgewezen dat fijnstof een grotere hoeveelheid antropogene stoffen bevat. Het is handiger om te weten dat beleid meer effect heeft, maar er is weinig van doen. Het onderzoeken van fijnstof is belangrijk om te weten welke stoffen welke effecten heeft. Studies hebben uitgevonden dat roet een belangrijke veroorzaker is van effecten op mensen. Er wordt gediscussieerd of er normen moeten worden gesteld voor roet.
Stedelijk bouwkundig beleid is belangrijk voor de ruimtelijke planning. Verkeersbeleid is voor ruimtelijke planning en voor fijnstof belangrijk. Knelpunten zijn blootstelling voor verschillende wegen, manier van bouwen en doorstroming van verkeer. Voldoen aan de grenswaarden is meestal de focus, in plaats van kijken naar de gezondheids effecten. Hierdoor kan het zijn dat door bij een knelpunt de concentratie minder te maken, de concentratie ergens anders hoger wordt, maar dat overal genomen de fijnstofconcentratie onder de norm is. De relatie tussen fijnstof en gezondheid is een lineare relatie. Dit betekent dat waar de concentratie hoger wordt, het slechter af is. Er is geen winst geboekt in het perspectief van gezondheid, maar juridisch is het goed. Het risico is hierdoor dat het onderwerp uit de belangstelling raakt, als er net onder de normen worden gewerkt.
Er zijn geen ontwikkelingen in de normstelling. Vanwege problemen met andere landen om aan de normstelling te voldoen, is het lastig om in de voorziene toekomst de

normstelling naar beneden bij te stellen. Het politieke klimaat is niet zo, dat ze staan te juichen om voor gezondheids redenen de normen naar beneden bij te stellen.

De Interimwet Stad en Milieu wordt in Utrecht niet gebruikt. Het speelt geen rol, omdat het NSL een meer dominante rol speelt. Utrecht is een groot Openbaar Vervoer kruispunt en heeft veel fietsers. Er zijn plannen in uitvoering voor Hoogwaardig Openbaar Vervoer Utrecht, die een deel is van het actieplan Luchtkwaliteit Utrecht. Door het vervangen van persoonlijk verkeer door openbaar vervoer, is het effect dat er compacter kan worden gebouwd en er is minder fijnstof. Het is ook dat er veel mogelijkheden zijn voor de automobilist om diep in de kern van de stad door te dringen. Dit heeft ervoor gezorgd dat er veel parkeerplaatsen in het centrum liggen en bereikbaar zijn. Utrecht is ook bezig met stedelijke distributie, waar vooral bij winkels minder energie en emissies bij de laatste schakels worden aangepakt. Organiseren van logistiek kan helpen om emissies te verminderen. Wanneer er wordt gekeken naar het openbaar vervoer, kunnen er criteria worden gesteld aan de bussen (onder andere) om de luchtkwaliteit te verbeteren. In sommige situaties is het moeilijk om bussen schoner te maken in het geval van fijnstof. Een roetfilter bij bussen geeft meer Nox, waar ook normen voor staan. Als de focus is op NO2, is het mogelijk dat het beleid aangeeft om geen roetfilter te gebruiken. Er zijn dus soms conflicten tussen juridische halen van de normen en gezondheid.

Annex III Interview 2

Interviewee 2 is Programmamanager Luchtkwaliteit in Utrecht. Ze doet dit werk vanaf 2009 en heeft een achtergrond in Luchtkwaliteit bij VROM.

Chronologisch gezien was de Europese regelgeving aangaande luchtkwaliteit de start van het Nederlandse nationale luchtkwaliteit beleid. In het investeringsbudget was er eerst te weinig om de problematiek te handhaven. Het is vooral van invloed op stedelijke vernieuwing. Er zijn normen opgesteld voor fijnstof, maar het is nauwelijks te beïnvloeden. Het is een gedragsprobleem waar de bronnen vooral liggen bij verkeer en industrie. Er wordt gewerkt aan het openbaar vervoer, om zo mensen minder met de auto te laten reizen, maar dat ligt aan de mensen zelf. Met de zeezoutaftrek zijn er geen of nauwelijks problemen in stedelijke gebieden betreffende fijnstof. De GGNGD vindt dat de zeezoutaftrek niet overeenstemt met de gezondheidsnormen. Als land is het al bijna niet te doen om fijnstof naar beneden te halen.
In Nederland is de Rijksoverheid verantwoordelijk voor het oplossen van problemen omtrent fijnstof. De rijksoverheid vindt dit ook. Er was een plan om de gemeentes problemen rond NOx te laten oplossen en de rijksoverheid zou de verantwoordelijkheid nemen over fijnstof. Dit is uiteindelijk een gedeelde verantwoordelijkheid geworden.

Het meest belangrijke beleidsinstrument is het Nationaal samenwerkingsprogramma Luchtkwaliteit (NSL). Maar het NSL is niet gericht op landbouw, waar nu de grootste problemen omtrent luchtkwaliteit zijn. Ook is het NSL gericht om aan de grenswaarden te voldoen. Voor Utrecht zijn er op dit moment geen problemen met fijnstof. Dit is anders bij gemeentes in Brabant bijvoorbeeld. Dit komt omdat er veel aan landbouw wordt gedaan en hierdoor is er een vermenging van belangen op politiek gebied.

De jaargemiddelden van fijnstof zijn goed. Het zijn de dagwaarden die soms worden overschreden en daar zijn er lokaal veel mogelijkheden om dit op te lossen. Brongerichte oplossingen zijn moeilijk, omdat het met gedrag te maken heeft. Een voorbeeld is het verhogen van de maximale snelheid op snelwegen. In sommige gevallen ontstaat hierdoor 20% meer uitstoot van fijnstof. Dit geeft een verslechtering van de achtergrondconcentraties, waardoor het moeilijker wordt om aan de dagwaarden te voldoen. Op dit moment zijn er geen fijnstof knelpunten, maar dit kan veranderen als de zeezoutaftrek wordt verandert. Een ander voorbeeld dat de achtergrondconcentraties verhogen kan, is de import van oude auto's. Het importeren van oude auto's, die meer emissies hebben, is niet verboden en kan ook niet verboden worden. Het implementeren van zones waar oude auto's niet worden toegelaten is ook niet toegestaan. Hierdoor is het moeilijk om de fijnstof emissies te verlagen via bronbeleid.

Terwijl onderzoek wordt verricht naar pm2,5, heeft het NSL pm2,5 gecorreleerd aan pm10. Hierdoor is er geen verschil in beleid tussen pm2,5 en pm10. Roet is nu meer belangrijk aan het worden, omdat het een 1 op 1 gevolg heeft op de gezondheid.

Bertien Oude Groote Beverborg wist niet dat onderzoek had uitgewezen dat fijnstof op dit moment voor 80% anthropogenisch is.

In haar mening is er geen rol voor ruimtelijke planning in het fijnstofprobleem. Het fijnstofprobleem kan beter worden verholpen op het gebied van verkeersbeleid. Het beste is gedrag te veranderen zodat mensen andere alternatieven zoeken voor het gebruik van auto's. Maar dit zal op landelijk niveau effectiever zijn. Lokaal is het mogelijk om gebieden voor de auto onbereikbaar te maken, maar dit zullen mensen niet snel accepteren.

Annex IV Interview 3

Interviewee 3 is lid van Adviesgroep Schone Lucht en Gezondheid.De adviesgroep in Utrecht is opgezet om de wethouders en de gemeenteraad van advies te dienen, maar wil daar bewoners langs drukke straten bij betrekken. Dit wordt gedaan door de bewoners van fijnstofknelpunten gewaar te maken van de hoeveelheid fijnstof in de lucht en de effecten hiervan op de gezondheid en door bewoners te betrekken bij acties die nodig zijn om de politiek van de urgentie van het probleem te betrekken. Kees van Oosten heeft lesgegeven in methodologie en verdiept zich voornamelijk in hoe de gemeente de concentraties berekent.

Wat voor effecten heeft het huidige fijnstofbeleid op de gezondheid van de inwoners van de gemeente Utrecht?
Er is in wezen weinig tot geen fijnstofbeleid door de gemeentes. De gemeentes voeren vooral symboolbeleid uit. Dit gaat om symbolische beleidsuitvoeringen van bijvoorbeeld het voorstellen van meer fietspaden of het reguleren van het fietsverkeer, of verkeersmanagement. Deze beleidsinstrumenten zijn relatief en kunnen moeilijk of niet gemeten worden in termen van fijnstof reductie en in sommige gevallen worden de effecten helemaal niet gemeten. Gemeentes schrijven rapporten waarin veel van dit soort symboolbeleid wordt uitgeschreven. De meeste gemeentes zijn van mening dat de Rijksoverheid verantwoordelijk is voor het fijnstofbeleid en dat ze alleen verantwoordelijk zijn voor het doorvoeren NSL-maatregelen en het verstrekken van gegevens voor de NSL-monitor.

Het Landelijk Meetpunt Luchtkwaliteit meet op ruim 50 meetpunten, op 14 meetlocaties is nog steeds sprake van overschrijdingen van de fijnstofnorm, terwijl daar in 2011 aan had moeten zijn voldaan (voor de derogatie in 2005). Daarentegen zijn in Nederland allerlei rekenregels aangepast waarbij het nu mogelijk is om op plaatsen waar geen sprake is van significante blootstelling geen fijnstof te berekenen [toepasbaarheidsbeginsel]. Dit heeft tot gevolg dat veel plekken als niet significant worden aangemerkt en daardoor de hoeveelheid overschrijdingen wordt gereduceerd.

De nieuwe Europese wetgeving omtrent zeezoutaftrek zegt dat de aftrek alleen mag worden uitgevoerd als kan worden beargumenteerd op hoeveel dagen hoeveel zeezout voorkomt in de fijnstof. Dit moet worden berekend. Volgens de Nederlandse regelgeving is een standaardaftrek toegestaan, die dus veel te groot is.

Wat voor effecten hebben IB-projecten en maatregelen die nu worden uitgevoerd op luchtkwaliteit?
Het is niet duidelijk wat de effecten zijn. In de meeste gemeenten vinden ze het niet relevant om de effecten te monitoren. De gemeentes geven geen specificatie van elk project apart van de gegevens en effecten. De gemeentes verwerken de effecten van hun NSL-maatregelen en NSL-projecten in de verkeersgegevens die ze voor de NSL-monitor aanleveren.

Berekeningen zijn mede gebaseerd op de emissiefactoren die elk jaar opnieuw worden bepaald. Dit gebeurd voor elk type voertuig, ook voor toekomstige jaren., Er wordt echter niet geëvalueerd of de voorspellingen correct waren en hierdoor worden geen

aanpassingen gemaakt aan de emissieberekeningen. De emissiefactoren zijn simpelweg gebaseerd op Europese normen voor motoren en specificaties van de fabrikanten. Ze gaan ervanuit dat de motoren voldoen aan deze normen. Dat blijkt in de praktijk echter vaak niet het geval te zijn.

Wat voor beleidsinstrumenten worden er in de gemeente gebruikt om fijnstof te berekenen?

De meeste gemeenten gebruiken nu het NSL voor het berekenen van de gegevens over fijnstof. Uit de RIVM-monitoringsrapportage wordt duidelijk dat de gegevens die worden ingeleverd door de gemeente niet worden gecontroleerd. Er is niemand die de gegevens controleert, die de gemeentes inleveren. Als voorbeeld: in de gemeente Utrecht zijn er 2 of 3 ambtenaren die alle kennis beheren over de invoergegevens. Zij maken uit welke gegevens worden gebruikt om door te spelen naar het NSL. Het uitrekenen van IB projecten wordt verwerkt in het verkeersmodel, wat betekent dat er geen directe gegevens openbaar zijn om te controleren wat er gebeurd. Het verkeersmodel dat wordt gebruikt en waar de gegevens van de effecten in worden verwerkt, wordt niet verantwoord. Het is daarom onmogelijk om te zien wat volgens de gemeente de effecten zijn van maatregelen en projecten..

Wat zijn de verschillen in het beleid van pm_{10} en $pm_{2,5}$ in praktijk?

Er is geen verschil in beleid t.a.v. pm10 en pm2,5. Gemeentes gaan er gemakshalve vanuit dat als er aan de pm10 waarde wordt voldaan, dat de pm2,5 waarde ook onder de norm zit. De pm2,5 waarden worden ook nog niet getoetst. Dit komt pas aan de orde als er aan de normen voldaan moeten worden. De gemeentes nemen het nu nog niet mee in hun berekeningen.

Wat zijn de problemen met het verminderen van de fijnstofconcentraties voor gemeentes?

Vroeger werden de gegevens voor fijnstof zelf door de gemeentes uitgerekend, maar dat wordt nu voornamelijk via de NSL-monitor gedaan. Een door de overheid goedgekeurd luchtkwaliteitsrekenmodel is het CAR model, dat de etmaalintensiteit, voertuigverdeling, snelheidstype en stagnatiefactor gebruikt om de fijnstof te berekenen. Deze gegevens worden niet door empirisch bewijs verkregen, maar zijn nattevingerwerk. Men noemt dat “expert judgement” Het enige gegeven dat wordt verkregen door modellen is de verkeersintensiteit, maar het verkeersmodel is ook weer van heel veel arbitraire aannames afhankelijk.

Een kritische blik van bewoners is waarschijnlijk het enige wapen tegen dit nattevingerwerk. Via procedures is het zeer moeilijk om veranderingen aan te brengen en dit levert meestal weinig op. De houding van de bewoners moet veranderen. Nu is het vooral de mening dat het teveel gedoe is om enigszins gehoord te worden. Ook wordt de publieke mening vooral bepaald door de berekeningen die door gemeentes worden gemaakt.

Wat voor effecten heeft de huidige aanpak van fijnstof op ruimtelijke planning?

Er is geen effect op de ruimtelijke planning. Zelfs als het duidelijk is dat de norm wordt overschreden, staat de planning voorop en worden berekeningen aangepast om onder de norm te komen. Milieuzonering heeft weinig effect op fijnstof reductie.

Annex V Interview 4

Interviewee 4 is de voorzitter van de Vereniging Leefmilieu. Het is een landelijke organisatie die zich bezighoudt met het milieu in relatie met mensen en gezondheid. Ze is docent en onderzoeker en gespecialiseerd in het toegankelijk maken van informatie op websites en documentsystemen. Gezondheid voor mens en dier staan voorop in de acties van vereniging Leefmilieu.

Wat voor effecten heeft het huidige fijnstofbeleid op de inwoners?
De huidige regelgeving maakt meer mogelijk voor gemeentes in relatie tot bouwen, in plaats van dat ze bescherming bieden aan mensen. In de loop der jaren is het beleid enorm versoepeld. Het wordt langzamerhand duidelijk dat in de focus verschoven moet worden naar de intensieve veehouderij. Luchtvervuiling door intensieve veehouderij geeft een ander beeld en andere symptomen dan luchtvervuiling door verkeer.

Het huidige fijnstofbeleid heeft de normstellingen staan, maar er is weinig handhaving van de normen. Bovendien is het voor de gemeentes een afweging van economie en gezondheid of economie en milieu. Meeste bewoners hebben het bewustzijn niet, maar ze verliezen langzamerhand het vertrouwen in hoe de gemeentes bepaalde onderwerpen behandelen. Nederland is in een transitie waar veel verworvenheden langzaam worden afgebouwd.

Huidig onderzoek heeft aangetoond dat er mogelijke relaties zijn tussen fijnstofconcentraties en leukemie, naast de al bekende hart en vaatziektes en longziektes. Ook worden er relaties gevonden tussen fijnstof en bijensterfte. Een andere relatie die momenteel wordt onderzocht is het effect van roet op de gezondheid. Het beleid zou roet als een extra indicator moeten wegen voor fijnstof.

Wat voor effecten hebben fijnstofprojecten die nu worden uitgevoerd op andere gebieden in de gemeente?
Door de versoepeling van het beleid en de geringe handhaving van de normen kan er gebouwd worden op de foute plekken. Dit kan gaan om scholen die langs drukke wegen worden gebouwd. Het is moeilijk om zulke projecten tegen te houden.

Fijnstofprojecten worden optisch benaderd door de meeste gemeenten. De meest gebruikte voorzieningen zijn planten en misschien een wal. Er wordt opportunistisch gekeken naar waar een project wordt geplaatst.

In onderzoeken die eerder zijn uitgevoerd, werd Nijmegen vergeleken met Vredepeel. Nu wordt langzamerhand duidelijk, dat dit niet per sé goed is, aangezien Vredepeel een hoge fijnstofconcentratie heeft door intensieve veeteelt.

Wat zijn de verschillen in het beleid van pm_{10} en $pm_{2,5}$ in praktijk?
Er is geen verschil in pm10 en pm2,5. In Nijmegen wordt pm2,5 wel gemeten bij het industrieterrein. Pm2,5 wordt nu gezien als een niet relevante norm, omdat de norm ervoor te hoog is.

Wat zijn de problemen met het verminderen van de fijnstofconcentraties voor gemeentes?
Gemeentes bekijken fijnstofproblemen door onder de normen te blijven. Ze doen dit door fijnstof te verrekenen in hun gegevens. Dit kan bijvoorbeeld door het gebied te vergroten en de meetpunten strategisch neer te zetten.

Hoe kunnen gemeentes de huidige fijnstofconcentratie in hun gebied verminderen met behulp van ruimtelijke planning?

In het geval van zonering is het mogelijk om de bewoners van een gemeente verder weg te houden van bronnen van luchtvervuiling. Ook is het mogelijk om een gemeente zo in te richten dat industrieterreinen hun eigen wegen krijgen en er minder (zwaar) verkeer is op wegen waar veel mensen wonen. In het geval van luchtkwaliteit is zonering langs drukke wegen het meest belangrijk.

Een compacte stad is niet handig in geval van fijnstof. In het geval van een compacte stad moet alles dicht op elkaar zitten. Over een tijd lopen delen van de stad leeg en dit geeft ruimte voor bedrijven om zich daar te vestigen. Meestal hebben deze bedrijven een impact op het milieu.

Het grootste probleem met zonering en ruimtelijke planning is de competitie om de grond. De grondpolitiek geeft bedrijven meestal grote stukken grond, (industrietterreinen) terwijl bewoners (denk aan woonvormen voor ouderen) heel dicht op elkaar wonen omdat de grond duurder is.