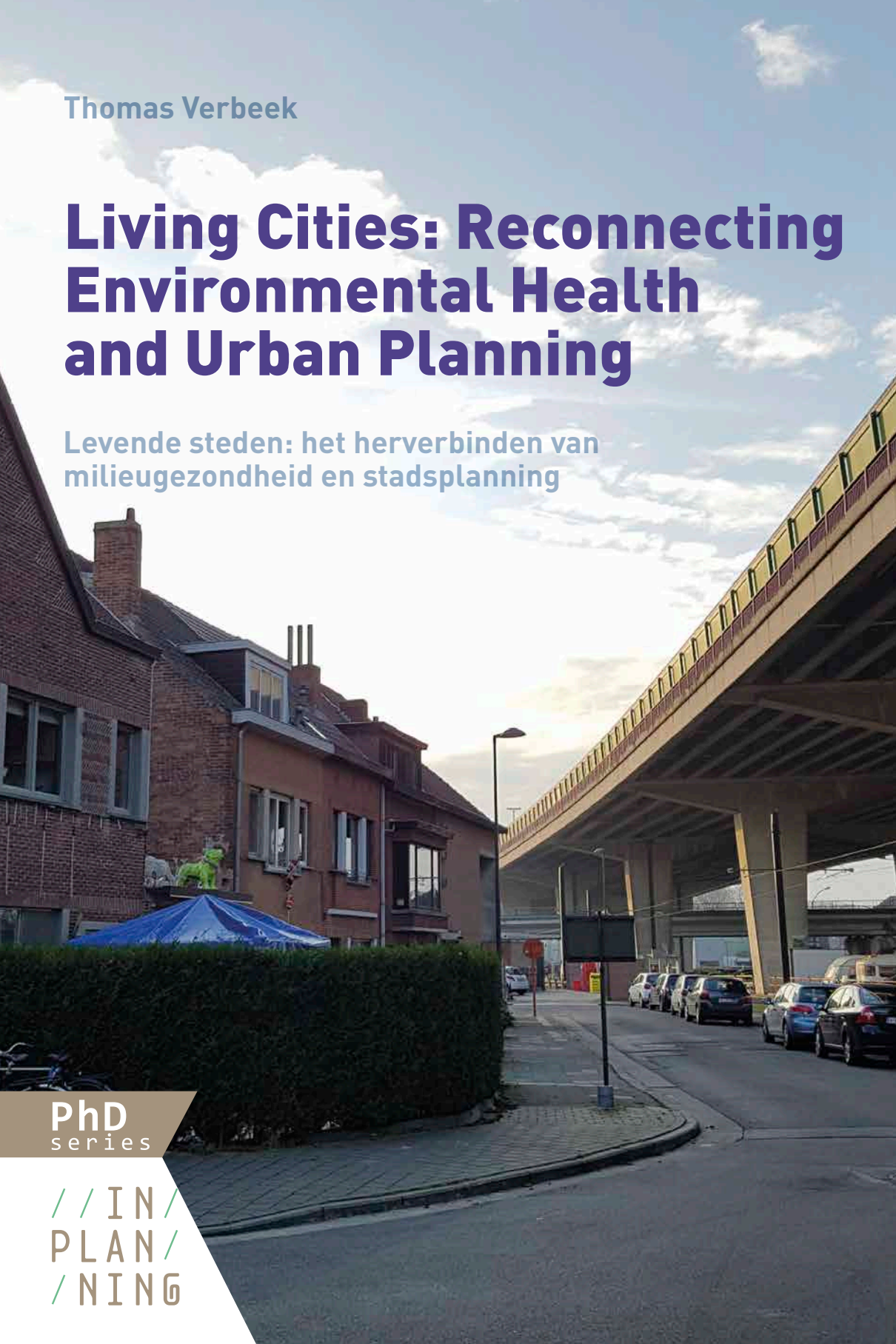
Thomas Verbeek

Living Cities: Reconnecting Environmental Health and Urban Planning

Levende steden: het herverbinden van milieugezondheid en stadsplanning



PhD series

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Living Cities: Reconnecting Environmental Health and Urban Planning

Thomas Verbeek

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Proefschrift ingediend tot het behalen van de graad van
Doctor in de stedenbouw en de ruimtelijke planning

UNIVERSITEIT
GENT

Vakgroep Civiele Techniek
Voorzitter: prof. dr. ir. P. Troch
Faculteit Ingenieurswetenschappen en Architectuur
Academiejaar 2016 - 2017

NUR 755
Wettelijk depot: D/2017/10.500/8

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Dankwoord

De meeste mensen die al eens aan een loopwedstrijd hebben meegedaan kennen het gevoel dat na de eerste kilometers soms opduikt, met de bijhorende vraag: “Waarom doe ik mijzelf dit toch aan?”. Ik heb het als loper verschillende keren meegemaakt bij een wedstrijd waaraan ik met veel enthousiasme begonnen was, maar die toch al snel iets zwaarder bleek dan gedacht. En ja, ook tijdens mijn eveneens met veel enthousiasme begonnen doctoraatstraject is mij dit gevoel weleens overvallen. Wat blijkt, hoewel beide soms leid(d)en tot wanhoop, voel(de) ik bij beide toch ook de eindeloze wil en energie om alles tot een goed einde te brengen, omdat je weet dat de beloning aan het einde groot gaat zijn. Na een lange en uitputtende wedstrijd met gelukkig ook veel momenten van intellectueel genot en collegiaal plezier is de finish eindelijk in zicht. In de laatste kilometers leek het alsof de aankomstlijn maar bleef opschuiven, maar nu ik dit schrijf zie ik de beloning vlak voor mij liggen.

De parallel tussen een doctoraatstraject en een loopwedstrijd trek ik niet zomaar. Wie mij een beetje kent weet dat mijn leven het laatste jaar voor een groot deel bestond uit mijn doctoraat en lopen. Bovendien zijn er nog heel wat andere gelijkenissen tussen de weg naar een doctoraatsverdediging en de weg naar de finish. Zo moet je bij beide zorgen dat je goed voorbereid aan de start komt. In de eerste plaats wil ik hiervoor mijn ouders bedanken, die mij steeds de mogelijkheid gaven om mijn interesses verder te ontplooien waardoor ik een geograaf annex ruimtelijk planner ben geworden.
Daarnaast wil ik prof. Georges Allaert bedanken. Georges, je hebt er niet enkel voor gezorgd dat ik na mijn master geografie nog ben begonnen aan een tweede master in stedenbouw en ruimtelijke planning. Je hebt me ook de kans gegeven om al tijdens die opleiding als jobstudent te komen werken bij de Afdeling Mobiliteit en Ruimtelijke Planning (AMRP) en me na mijn afstuderen meteen als wetenschappelijk medewerker aan te nemen. Ik kreeg de kans om onderzoek te doen naar de verstedelijking van de Vlaamse open ruimte, inclusief terreinwerk per fiets: op zoek naar tot de verbeelding sprekende fenomenen als ‘verlinting’, ‘vertuining’ en ‘verpaarding’. Er bestaat geen betere manier om het Vlaamse landschap écht te leren kennen.
Die eerste jaren hebben de basis gelegd voor de onderzoeker die ik vandaag ben. Wie daar ook toe bijgedragen hebben zijn Hans en Ann. Als senior onderzoekers hebben jullie mij toen begeleid en ondersteund in alle “eerste keren”: de eerste keer publiceren, de eerste keer naar een congres, de eerste keer lesgeven. Daarnaast

zorgden jullie voor een aangename werkomgeving waar ik als jongeling meteen werd gewaardeerd, waardoor de goesting om nog wat langer in de academische wereld te blijven hangen enkel groter werd. Hans en Ann, bedankt!

En plots, midden 2010, kondigde Georges een interessante wedstrijd aan. Met zijn steun was ik – voor ik het goed en wel besefte – vertrokken voor een loopje van zes jaar als assistent bij AMRP. Hiermee kon ik van alle aspecten van het universitaire leven een beetje proeven: lesgeven, studenten begeleiden, offertes schrijven, publiceren, congressen en studiedagen bijwonen en ellenlange vergaderingen uitzitten (de ene al nuttiger dan de andere). Maar daarnaast mocht ik een doctoraatsonderzoek uitvoeren en bovendien zélf het thema kiezen. Gezien in die jaren de discussie rond de gezondheidsimpact van de geplande Oosterweelverbinding voor het eerst brede media-aandacht kreeg, lag een prangend onderwerp voor het grijpen. Hoe kon het toch dat onze ruimtelijke planning zo weinig leek in te zitten met de gezondheid van de bevolking en hoe zou het anders kunnen? Ik had een ambitieus onderwerp gevonden dat zowel maatschappelijk relevant was, maar waar ik – met mijn geografische achtergrond – ook GIS-analyses en statistische tests op kon loslaten.

Tijdens een loopwedstrijd moet je uiteindelijk zelf elke stap zetten, niemand anders kan het voor jou doen. Ook bij een doctoraat is dit het geval. Gelukkig doe je beide meestal niet helemaal alleen. Als je een goede loper bent heb je misschien een coach, die af en toe even met de fiets naast je komt rijden, je even aanmoedigt, nuttige aanwijzingen probeert te geven en je dan weer alleen laat.
Als doctoraatsstudent had ik zelfs twee coaches. Waar Georges mij aan de start heeft gebracht, dook er tijdens de wedstrijd plots een nieuwe coach op, prof. Luuk Boelens. Dit gebeurt normaal niet tijdens een wedstrijd en de verandering is niet vanzelfsprekend. Eenmaal je aan het lopen bent, heb je een doel en ben je zo gefocust, dat je amper hoort wat men van aan de zijlijn tegen je roept. Bovendien heeft een nieuwe coach een andere methode en andere doelen.
Zo duurde het ook bij mijn doctoraat even voor ik de aanwijzingen juist interpreteerde en we overeenstemming vonden over het doel en de tactiek van mijn wedstrijd. Maar na afloop kan ik alleen maar tevreden zijn. Luuk, dankjewel om mij de weg te wijzen en me tegelijk uit te dagen. Het is mee door jouw kritische blik dat ik greep heb gekregen op mijn doctoraat en dat het resultaat er vandaag ligt.

Hoewel je een loopwedstrijd alleen zal moeten afmaken, heb je meestal een aantal collega-lopers die ook hun wedstrijd aan het lopen zijn en waar je je even bij kan aansluiten. Gedeelde inspanningen verzachten het leed, gedeeld plezier is dubbel plezier en van elkaars strategie kan je vaak nog iets bijleren.
Bij AMRP had ik het geluk om met veel aangename collega-lopers te mogen samenwerken, maar vooral ook dagelijks lief, leed en plezier te delen. Barbara, Griet, Giustino, Karel, Suzanne, Els en alle andere (ex-)AMRP'ers, jullie hebben ervoor gezorgd dat mijn werkplek de voorbije jaren een tweede thuis was waar ik ongetwijfeld nog vaak met een glimlach aan zal terugdenken.

Wat ook onontbeerlijk is bij een lange loopwedstrijd, is een goede praktische omkadering en de nodige bevoorrading. Voor praktische omkadering kon ik steeds rekenen op het AMRP-secretariaat. Van het helpen vertalen van enquêtes, het

voorzien van de juiste koffie en koekjes voor vergaderingen tot het altijd beschikbaar zijn voor een babbel. Anne Marie, Els en Maja, bedankt!
Voor de nodige bevoorrading zorgden dan weer de vele mensen waar ik tijdens mijn onderzoek mee in aanraking ben gekomen. De mensen die ik heb mogen interviewen, de deelnemers aan mijn verschillende klankbordgroepen, de proefpersonen die tijd maakten voor mijn test-enquête, de 399 respondenten van mijn enquête... maar ook alle collega-onderzoekers die ik op congressen en studiedagen heb mogen ontmoeten en die zorgden voor nieuwe inzichten en energie. Jullie hebben allemaal samen de voeding gegeven die onontbeerlijk was om dit onderzoek tot een goed einde te brengen.
In het bijzonder wil ik de dienst Data en Informatie van de stad Gent bedanken, waar Els V., Els B., Annelies en Eric op cruciale momenten in mijn onderzoek de nodige data, steekproeven en feedback hebben aangeleverd. Ook de mensen van bewonersgroep Viadukaduk wil ik extra bedanken om mijn case-onderzoek en enquête mee te doen slagen door praktische hulp en welgekomen feedback te bieden. Ik hoop van harte dat jullie ook iets aan de resultaten van mijn onderzoek hebben.
Ik vermeld ook graag de praktische hulp van mijn “naleescomité”, dat vlak voor de allerlaatste deadline tijd vrijmaakte om mijn teksten na te lezen en te corrigeren. Séb, Ineke, Suzanne, Timo, Matthias, Barbara, Giustino, Katrijn en Hannes, bedankt!
Finally, I would like to thank the Members of the Examination Committee for their feedback and cooperation. Due to your critical review of the first version of the dissertation, I could make some very useful final adjustments.

Een wedstrijd wordt meestal ook niet gelopen zonder supporters, en die waren gelukkig talrijk tijdens mijn doctoraatstraject. Ze allemaal met naam en toenaam bedanken is onmogelijk, maar samengevat gaat mijn dank vooral uit naar:
- De vrienden van PEW en PPP: voor de “Van Dun” avondjes, dansfeestjes en weekendjes, die mij met mijn twee voeten op de Kempense zandgrond hielden.
- De vrienden van Gent: voor de café-avondjes, Tour de Biérgique en andere weekendjes, barbecues en kerstfeestjes die steeds zeer welgekomen afleiding boden.
- Team Mercantour: voor de ontspannende wandelingen, reizen, brunches en lunches!
- Mijn ouders, zus en de rest van de familie: voor de gezellige familiebijeenkomsten die voor de nodige onthaasting zorgden in drukke tijden.
- Iedereen die het laatste jaar met regelmaat informeerde naar de stand van zaken; een simpel bericht betekent veel als je maanden op je doctoraatseiland zit.

Tot slot, sommige mensen supporteren niet alleen als ze er zijn, maar ook als ze er niet zijn. Hannes, je zat de afgelopen jaren altijd wel ergens in mijn hoofd, ook al lag je misschien onderaan een stapel to do’s of vond ik nog een extra pagina schrijven belangrijker dan even naar jou te luisteren. Ik kan je niet genoeg bedanken, zowel voor alle praktische hulp, je luisterend oor en het begrip voor mijn humeur en gebrek aan tijd. Nu deze wedstrijd is gelopen kijk ik er naar uit om met jou eindelijk aan een meer ontspannen tocht te beginnen.

Thomas Verbeek
Gent, 18 januari 2017

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List of acronyms and symbols

ANOVA	Analysis of Variance
AWV	Flemish Agency for Roads and Traffic (in Dutch: *Agentschap Wegen en Verkeer*)
BBL	Federation for a Better Environment (in Dutch: *Bond Beter Leefmilieu*)
Bral	Brussels Council for the Environment (in Dutch: *Brusselse Raad voor het Leefmilieu*)
CD&V	The Flemish christian-democratic party
CO	Carbon monoxide
DALY	Disability-adjusted life year
dB	Decibel (in this dissertation always interpreted as dB(A))
dB(A)	A-weighted decibels, expresses the relative loudness of sounds in air as perceived by the human ear
EIA	Environmental Impact Assessment
EMF	Electromagnetic fields
EU13	Bulgaria, Cyprus, Estonia, Hungary, Croatia, Latvia, Lithuania, Malta, Poland, Romania, Slovenia, Slovakia and Czech Republic
EU15	Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, United Kingdom and Sweden
GMF	Ghent Environmental Front (in Dutch: *Gents Milieufront*)
Groen	The Flemish green party
HIA	Health Impact Assessment
IVA	Intermunicipal Association for the Highway (in Dutch: *Intercommunale voor de Autoweg*)
L_{aeq}	The equivalent continuous sound level
L_{den}	The average equivalent sound level over a 24 hour period, with a 5 dB penalty added for noise during the evening hours of 19:00 to 23:00 and a 10 dB penalty for noise during the nighttime hours of 23:00 to 07:00
LNE	Department of Environment, Nature and Energy (in Dutch: *Departement Landbouw, Natuur en Energie*)
L_{ngt}	The average equivalent sound level during the night time hours of 23:00 to 07:00
LOGO	Local Health Council (in Dutch: *Lokaal Gezondheidsoverleg*)
MOW	Department of Mobility and Public Works (in Dutch: *Departement Mobiliteit en Openbare Werken*)
NIMBY	Not in my backyard

NO_2	Nitrogen dioxide
N-VA	The Flemish nationalist party
Open VLD	The Flemish liberal party
$PM_{2.5}$	Particulate matter with a diameter of 2.5 micrometers or less
SEA	Strategic Environmental Assessment
SHS	Secondhand smoke
sp.a	The Flemish social-democratic party
Spirit	The (former) Flemish social-liberal party
UNIZO	Union of Self-Employed Entrepreneurs (in Dutch: *Unie van Zelfstandige Ondernemers*)
UV	Ultra-Violet
VOKA	Flanders' Chamber of Commerce
WHO	World Health Organization

Summary

Today, citizens are getting increasingly aware that their health and well-being are inextricably linked to environmental conditions. Public opposition against environmental threats is rising due to higher living standards and the corresponding expectations of the residential environment. Many citizens no longer have confidence in generic environmental regulations and procedures. Instead, they adopt another view on the situation in which they focus on the specific local context and personal preferences. This growing public concern goes hand in hand with growing research on the different relationships between aspects of the built environment and impacts on health and well-being. Apart from getting a more detailed picture of the (context-specific) health effects of air pollution and noise, the scientific world has also investigated the health effects of green space, walkability and urban heat islands, among others. Despite the progress in environmental health research and growing distrust in the government with regard to environmental health, most public authorities (including the Flemish government) take a defensive position and continue to rely on generic regulations, established limit values for environmental impacts and fixed top-down procedures (such as the strategic environmental assessments). These are all static and only occasionally revised. Today, in most Western countries, health and environmental issues are the responsibility of their own specialized government departments with their own experts, while departments of planning, mobility and public works are still focused on geographical and engineering approaches to space and time. Despite its undeniable achievement in protecting a minimum environmental quality and preventing serious environmental conflict, this institutionalization of environmental health no longer works in our inherently dynamic, fragmented and volatile society. Generic standards, regulations and procedures no longer meet the increasingly unique and changing expectations or needs of places and populations, and cannot keep up with the progress in scientific knowledge. If we really care about the quality of life in our growing cities, we need to think of new strategies to reconnect environmental health and urban planning. Therefore, the research question was formulated as follows: **“How can urban planning and environmental health be reconnected to meet the increasingly unique and changing expectations or needs of places and populations?”**

To answer this question a research framework was devised with several sub-questions and a variety of research methods to answer them. The first two subquestions – “How did the current disconnect came into being” and “What are

its characteristics" – should be seen as exploratory questions to get a complete picture of the problem. They are answered by a combination of literature review and interviews with important actors. The third subquestion – "How to locate environmentally unhealthy situations and which planning strategies are needed to address them" – is a fundamental one and is theoretically answered by a literature review and the development of a theoretical framework. The fourth subquestion – "What is the relation between objective exposure to environmental impacts and variables of nuisance, vulnerability, responsibility or housing?" – is the first of three questions that structure the empirical research. It resulted in a spatial data analysis at statistical sector level and individual level for the selected case area, i.e. the municipality of Ghent. The fifth subquestion – "What do spatial, historical and actor context add to environmental justice debates" – was answered by a situational analysis of a micro case area around two highways in the south of Ghent, consisting of literature review, analysis of policy documents and spatial data analysis. The last subquestion – "What do citizens think about environmental health, environmental justice and appropriate planning strategies?" – led to developing and conducting a survey among residents in the micro case area. With 399 respondents on 1,003 sampled residents representative results were achieved. These were further evaluated by univariate and bivariate statistical analysis.
After introducing the topic, the research questions and the research framework in a first chapter, *Chapters 2* to *6* each report on one of the subquestions. *Chapter 7* and *8* are both dealing with the last subquestion and *Chapter 9* reports on the general conclusions.

To answer the first subquestion, a historical analysis of (the relation between) the disciplines of urban planning and public health is presented in *Chapter 2*. Both disciplines arose at the same time and initially evolved in close collaboration with each other. They became more segregated in the course of the twentieth century, as the public health paradigm started to focus on the individual instead of the environment and separate government departments were established. Environmental health is now largely institutionalized, assuring a minimum environmental quality for everyone by using generic standards and norms. At the same time, urban planners lost track of the health impact of their decisions.

In *Chapter 3* the characteristics of the current disconnect are further explored by focusing on three aspects: the growing research evidence on environmental health, the increasing citizen awareness and the command-and-control government policy. To get an idea of the current research evidence an exploratory analysis was carried out. It points to air pollution having the largest health impact, but noise causing the most annoyance. However, the more we know about both impacts, the more difficult it is to define general standards. For air pollution, no acceptable pollutant level or safe distance to a high-traffic road can be defined. For noise, contextual factors and personal sensitivity or perception play a fundamental role, and technical interventions to reduce sound levels may thus not have a proportionate effect on noise annoyance. In summary, environmental impacts lead to risks that might be linear and unambiguous at population level but cannot be easily translated to local situations.

To explore the increasing citizen awareness, several environmental pressure groups were interviewed that work on the topic of environmental health. These groups show a large potential for including more bottom-up knowledge and citizen engagement in policy making since most of them are professionally organized, take a critical but constructive position and focus on building collective expertise by combining expert and lay knowledge. The success of these pressure groups illustrates the citizens' distrust of the government in tackling urban environmental health issues.
To evaluate the command-and-control government policy, civil servants were interviewed and environmental regulations and procedures were analyzed. In general, environmental regulations and assessments are rigid, generic and missing a holistic perspective. The interviewed civil servants point to necessary improvements but are hesitant to give more room to bottom-up initiatives. They question citizens' intentions, the representativeness of pressure groups and their merely local perspective hindering a social balancing at a larger scale.
It is concluded that the institutionalization of environmental health is no longer sufficient in today's complex, fragmented and volatile society. Because we cannot "manipulate" a healthy living environment, nor take rational comprehensive decisions based on a full understanding of all impact-effect relationships that account for context and perception, additional planning strategies need to be developed.

In *Chapter 4* urban planning and environmental health are reconnected by developing a theoretical framework. The first half of the chapter discusses the literature, starting with some definitions and followed by an overview of different conceptual models of health determinants. An evolution is shown from simple deterministic models to advanced, complicated frameworks with multiple determinants, the built environment being one of them. But together with these theoretical advances the idea has emerged that no adequate framework can fully represent the complex web of dynamic processes through which the various determinants of health have their effects. Therefore, it is argued that both health and cities should be considered from a complexity perspective. This perspective does not disprove the rationalist, orderly paradigm or its antithesis of post-modern disorder, but tries to bridge both opposing positions. According to complexity theory, the physical and social reality are composed of a wide range of interacting orderly, complex and disorderly phenomena, necessitating a combination of quantitative and qualitative methods to get insight and to intervene. Some urban planning authors already recognized this complexity of environmental health and formulated general policy recommendations, but none offers sufficient guidance for contextualized spatial health policies in complex and complicated situations.
Two fundamental questions emerge: "How to locate environmentally unhealthy situations?" and "Which planning strategies are needed to address these situations?". To answer the first question, the environmental justice concepts of Walker (2012) were adopted and translated to a practical framework. Central to this framework are the distinction between the descriptive concept of inequality and the normative concept of injustice and the importance of the aspect of claim-making in environmental justice debates. To answer the second question is suggested that, depending on the complexity of an environmental health conflict, another planning strategy may be needed. Therefore, additional strategies should be devised,

complementing the environmental standards and regulations. Depending on actor context and spatio-temporal context four planning strategies are proposed and placed in a matrix: path-dependent, collaborative, adaptive and co-evolutionary. Apart from the co-evolutionary planning strategy as one of the four quadrants, the matrix also expresses an overarching co-evolutionary idea. This is illustrated by the mutual existence of the different planning strategies, which could not only be applied in specific cases or settings, but also refer to each other in the improvement towards more healthy cities or regions. Just as citizen initiatives are evolving in relation to existing rules, regulations, environmental impact assessments and environmental health models, the government's path-dependent strategy could over time and space co-evolve with the more open and complex strategies to these issues. This might include local participation, a shift of attention from predefined goals to process-related aspects, and abandoning logically deducted knowledge as the starting point.
In the next four chapters the proposed frameworks are tested through both quantitative and qualitative research methods, adhering to the complexity perspective, which equally values both scientific approaches.

Chapter 5 reports on an environmental justice data analysis for Ghent, focusing on the aspects of traffic noise and air pollution. Based on correlation analyses at statistical sector level and respondent level (of the 2014 Ghent Livability Monitor survey), four research questions are answered.
First, according to the analysis modeled noise exposure is only weakly related to subjective noise exposure. This can partly be explained by inconsistencies in the noise modeling, but personal characteristics and sensitivity might play a bigger role, as suggested by other research. This raises questions about only using modeled noise maps for assessing the health impacts of noise exposure.
Second, it was found that more vulnerable populations, with lower incomes, more unemployment, and foreign origin, are more exposed to modeled air pollution (but not to modeled traffic noise). This is in line with other research.
Third, the analysis showed that the more cars respondents own and the more they commute by car, the lower their modeled exposure to air pollution. However, correlations are rather weak. This inequality in distribution of responsibility and exposure to environmental pollution can provide an extra reason to call the situation not only unequal but also unjust.
Fourth, it was found that neighborhoods with more rental houses, more house moves, a shorter length of residence and lower house prices, bear a higher average exposure to air pollution, and to a much lesser degree to noise. This finding can be interpreted in two ways. On the one hand some people deliberately choose to live in these "more polluted" neighborhoods for some years, but others might get stuck in a rental situation, whether or not at the same location, with enduring exposure to environmental impacts.
While this data analysis is a good starting point to detect situations of environmental inequality, contextual information is needed to get a full picture, assess the (in)justice and make informed decisions. Therefore, based on the analysis and in consultation with the city of Ghent, the case of the E17 and B401 viaducts was selected for further research.

In *Chapter 6* the contextual aspects of the highway viaducts case are analyzed. The chapter starts with the evaluation of environmental pollution data, showing that limit values for air pollution and noise are exceeded in the area. A brief analysis of socio-economic and housing variables reveals a variety of neighborhood typologies along the highways and viaducts: from "urban" to "rural", from low to high incomes, from white to mixed origins and from young to old populations. The subsequent historical analysis shows that both highways were top-down planned and constructed in the 1960s and 1970s, when the idea prevailed that highways could help reorganize urban areas. However, the different history they have gone through demonstrates the importance of contextual knowledge to understand a situation of environmental inequality.
As for the E17 viaduct, the local resistance against the plans was vigorous but with no end. During its lifetime protest continued, primarily about the noise produced by the viaduct. This has led to several modifications: noise barriers, reduction of the speed limit and a section speed control system. Today, the pounding noise of the construction joints is the major source of annoyance and led to the emergence of a new pressure group, Viadukaduk. They could convince the city and local politicians to form a local front requesting change. The Flemish Agency for Roads and Traffic promised to alleviate noise exposure by maintenance works in 2020, but a long-term solution is still a long way off. Things are different for the B401 viaduct, or fly-over, which has no history of protest and pressure groups. It seems that environmental pollution plays less of a role here. However, today the future demolition of the viaduct is a symbol of the spatial and mobility policy of the current city council. The Flemish government, administering the road, has agreed with it on condition of a comprehensive city mobility plan.
For the case of the E17 viaduct, the main stakeholders and their claims are further analyzed through documentary analysis. The Ghent city council is merely a mediating actor, supporting their citizens in putting pressure on the Flemish Government. The positions of the Flemish government and the pressure group Viadukaduk illustrate the disconnect described in Chapter 3. The Flemish government adheres to a command-and-control policy. There exist many documents, plans and ideas on environmental health from different government departments, but with few concrete outcomes. Viadukaduk claims to take a constructive position by collecting information, consulting experts, networking with politicians and raising awareness among the citizens.
The chapter is concluded with the application of the two developed frameworks to the case. The environmental justice framework helps to understand the claims of different stakeholders and to gain new perspectives. It shows that there are different ways of how a situation could be judged and many "just" decisions. Applying the matrix of planning strategies shows that today the path-dependent approach is still dominant in the case area, together with attempts to collaborative strategies, individual examples of adaptive strategies and emerging opportunities of self-organizing, co-evolutionary strategies.

Since the opinion of the population living near the viaducts is of utmost importance, a survey among residents was developed and carried out. In *Chapter 7* the survey methodology is described, designed to gain citizen's ideas on the environmental justice of the situation and to assess their support for different planning strategies.

The survey dimensions were based on the two theoretical frameworks and the spatial scope was limited to the area within 500 meters of the two highways and viaducts. Through a survey campaign by mail enough respondents could be reached to make representative statements about the population in this case area. However, results are only indicative when comparing different zones within the case area.

As a final step in the empirical research the results of the residents' survey are reported in *Chapter 8*. Univariate and bivariate results are evaluated according to the dimensions of the two developed frameworks, leading to a summary of six remarkable results.
First, the survey results showed that the relation between perception of environmental impacts and modeled environmental impacts is weak, which means that for the same modeled noise or air pollution level the perception of people varies from low to high annoyance. For exposure to noise, it is known that personal sensitivity and contextual factors play a major role in defining subjective exposure, annoyance and several health effects. This puts the use of modeled noise maps to assess health impacts and take decisions into question. For air pollution, modeled data are more relevant, since the health effect is independent from annoyance.
Second, it was found that the relation with socio-economic and housing variables differs for objective and subjective exposure. While more vulnerable, less responsible populations and temporary residents experience the highest modeled exposures to air pollution and noise, socio-economically stronger groups and permanent residents are generally more annoyed. This gives reasons to discuss incorporating vulnerability and responsibility aspects in environmental health policy.
Third, the survey results suggest that the opinion on environmental justice is mainly determined by perceived annoyance and not by socio-economic variables. This lack of empathy for those who are annoyed makes it hard to intervene.
Fourth, only a specific group of people with sufficient time and knowledge, and with higher demands of their environment, seems to find its way to complaint procedures. This probably leaves certain problems underexposed.
Fifth, the majority of people does not question the role of the government, but advocates for additional collaborative and co-evolutionary approaches. However, most people also raise concerns about delay of the decision-making process, the neutrality of citizen initiatives and the attitude of the government towards participation.
Sixth, the population in the case area shows a high personal commitment to participate and adaptively protect their houses. However, socio-economic variables play an important role and especially people with a higher education, higher income, a job and a (semi-) detached house take additional protective measures and want to actively participate. It is the same group of people that rather knows Viadukaduk and can express its concerns in this way, questioning the unequivocal support of the city for such initiatives.

In the final *Chapter 9* first is reflected back on the applicability and merits of the theoretical framework. Next, the newly gained insights about processes behind environmental inequalities are presented. Thereafter, an answer is given to the main research question by formulating policy recommendations. These recommenda-

tions are all based on the idea that, notwithstanding the conclusive evidence on the health effects of environmental impacts, there is no objective and absolute truth on the environmental justice of a specific situation, and not one “right” policy decision. The developed frameworks rather help to understand what is going on, to gain new perspectives and to form new ideas. However, by applying the frameworks to a specific case, a lot was learned about the problematic relationship between urban planning and environmental health, and the potential of planning strategies. This led to developing a “roadmap” towards a better integration of planning and environmental health, consisting of five “aims” along the road, which together can support a longer process of system innovation.

First, the current regulatory framework should be revised and strengthened to better protect a minimum environmental quality for everyone. This can include adapting and reinforcing the instrument of environmental assessments, revising and differentiating the way of assessing environmental impacts, and giving the aspects of vulnerability and responsibility more attention in assessments and policymaking. Second, additional adaptive and collaborative planning strategies are needed to meet context-specific expectations and needs. Since perception plays a big role and because of the valuable local and contextual information citizens can provide, both strategies often go hand in hand, with a collaborative process helping to find adaptive solutions. Third, self-organizing strategies for environmental health can be fruitful, but government and research community remain necessary as a stabilizing factor, since otherwise a socio-economically fair outcome is not guaranteed. Fourth, to raise awareness, to have fair discussions on normative aspects and to let planners and citizens play an important role in reconnecting environmental health and urban planning, a shared knowledge base is needed with transparent and understandable dissemination of environmental health information. Finally, to support all these recommendations, planners should be trained to take strong entrepreneurial and mediating roles and to protect the public interest.

Samenvatting

We zien vandaag dat burgers zich steeds meer bewust worden van het verband tussen milieukwaliteit en hun gezondheid en welzijn. Het protest van burgers tegen milieubedreigingen neemt toe, deels ook als gevolg van de stijgende levensstandaard, waardoor men hogere eisen stelt aan de woonomgeving. Veel burgers hebben niet langer vertrouwen in de generieke milieuregelgeving en de bestaande procedures. Ze hebben een andere kijk op de situatie, die meer focust op de specifieke lokale context en persoonlijke voorkeuren. Dit groeiende maatschappelijke bewustzijn gaat samen met een toename van onderzoek naar de relaties tussen aspecten van de gebouwde omgeving en effecten op gezondheid en welzijn. Naast het verkrijgen van een meer gedetailleerd beeld van de (context-specifieke) gezondheidseffecten van luchtverontreiniging en lawaai, heeft de wetenschappelijke wereld ook onder meer de gezondheidseffecten van groene ruimte, bewandelbaarheid van buurten en stedelijke hitte-eilanden onderzocht. Ondanks de enorme vooruitgang in onderzoek en het groeiende wantrouwen in de overheid met betrekking tot milieugezondheid, nemen de meeste overheden (inclusief de Vlaamse) een defensieve positie aan, door te blijven focussen op generieke regelgeving, vastgelegde grenswaarden voor milieuimpacts en top-down procedures (zoals de milieueffectrapportering). Deze zijn allen statisch en worden slechts occasioneel herzien.

In de meeste westerse landen zijn gezondheid en leefmilieu de verantwoordelijkheid van aparte onafhankelijke overheidsdepartementen met eigen experten, terwijl de overheidsdepartementen van ruimtelijke planning, mobiliteit en openbare werken zich blijven richten op een geografische of ingenieursaanpak van dynamische ruimtelijke vraagstukken. Ondanks de onmiskenbare successen in het garanderen van een minimum aan milieukwaliteit en het voorkomen van ernstige milieuconflicten, werkt deze institutionalisering van milieugezondheid niet langer in onze inherent dynamische, gefragmenteerde en veranderlijke samenleving. Generieke standaarden, reguleringen en procedures zijn niet langer voldoende om tegemoet te komen aan de in toenemende mate unieke en veranderlijke verwachtingen of noden van plaatsen en bevolkingsgroepen, en kunnen daarnaast de vooruitgang in wetenschappelijke kennis niet volgen. Als we echt geven om de levenskwaliteit in onze groeiende steden, moeten we nadenken over nieuwe strategieën die milieugezondheid en stadsplanning herverbinden. Daarom werd de onderzoeksvraag als volgt geformuleerd: **“Hoe kunnen stadsplanning en milieugezondheid herverbonden worden om tegemoet te komen aan de in toenemende mate unieke en veranderlijke verwachtingen of noden van plaatsen en bevolkingsgroepen?”**.

Om deze vraag te beantwoorden werd een onderzoekskader opgesteld met verschillende deelvragen en een verscheidenheid aan onderzoeksmethoden om deze te beantwoorden. De eerste twee deelvragen – “Hoe is de huidige loskoppeling van planning en gezondheid ontstaan?” en “Hoe wordt deze gekenmerkt?” – moeten worden gezien als verkennende vragen om een compleet beeld van het probleem te verkrijgen. Ze worden beantwoord door een combinatie van literatuuronderzoek en interviews met belangrijke actoren. De derde deelvraag – “Hoe moeten problematische situaties van milieugezondheid gelokaliseerd worden en welke strategieën zijn nodig om deze aan te pakken?” – is fundamenteel voor dit onderzoek en wordt vooreerst theoretisch beantwoord door een combinatie van literatuuronderzoek en de ontwikkeling van een theoretisch kader. De vierde deelvraag – “Wat is de relatie tussen objectieve blootstelling aan milieuimpacts en variabelen van hinder, kwetsbaarheid, verantwoordelijkheid en huisvesting?” – is de eerste van drie vragen die het empirisch onderzoek structureren. Deze vraag leidde tot een ruimtelijke data-analyse op het niveau van statistische sectoren en op individueel niveau, voor het geselecteerde casegebied zijnde het grondgebied van Gent. De vijfde deelvraag – “Wat voegen ruimtelijke, historische en actor-context toe aan discussies over milieurechtvaardigheid?” – werd beantwoord door een situationele analyse van een micro-casegebied rondom twee snelwegen in het zuiden van Gent, bestaande uit literatuuronderzoek, analyse van beleidsdocumenten en ruimtelijke data-analyse. De laatste deelvraag – “Wat denken burgers over milieugezondheid, milieurechtvaardigheid en geschikte planningsstrategieën?” – leidde tot het ontwikkelen en afnemen van een bewonersenquête in het micro-casegebied. Met 399 respondenten op 1,003 uitgenodigde deelnemers werden representatieve resultaten bekomen. Deze werden verder geëvalueerd door univariate en bivariate statistische analyses.
Na het introduceren van het onderwerp, de onderzoeksvragen en het onderzoekskader in een eerste hoofdstuk, gaan *Hoofdstukken 2* tot *6* elk in op één van de deelvragen. *Hoofdstuk 7* en *8* gaan beide in op de laatste deelvraag en in *Hoofdstuk 9* worden algemene conclusies geformuleerd.

Om de eerste deelvraag te beantwoorden wordt in *Hoofdstuk 2* een historische analyse van (de relatie tussen) de disciplines van stadsplanning en volksgezondheid gepresenteerd. Beide disciplines zijn op hetzelfde moment ontstaan en in nauwe wisselwerking met elkaar geëvolueerd. Pas in de loop van de twintigste eeuw ontstonden er breuklijnen tussen beide disciplines, toen het volksgezondheidsparadigma zich meer begon te richten op individuele factoren in plaats van de omgeving en er aparte overheidsdepartementen werden opgericht. Milieugezondheid is nu grotendeels geïnstitutionaliseerd, gericht op het waarborgen van een minimum milieukwaliteit voor iedereen door middel van generieke standaarden en normen. Tegelijkertijd hebben stadsplanners de gezondheidsimpact van hun beslissingen uit het oog verloren.

In *Hoofdstuk 3* wordt de breuklijn tussen milieugezondheid en ruimtelijke planning verder geanalyseerd door te focussen op drie aspecten: het groeiende wetenschappelijk onderzoek over milieugezondheid, de toenemende bezorgdheid onder burgers en het hiërarchische, technocratische overheidsbeleid.

Om een idee te krijgen van de huidige wetenschappelijke kennis, werd een verkennende analyse van de literatuur uitgevoerd. Deze toont dat luchtverontreiniging de milieuimpact is met de grootste gezondheidsgevolgen, terwijl lawaai het meeste hinder veroorzaakt. Echter, hoe meer we weten over beide impacts, hoe moeilijker het wordt om algemene normen te definiëren. Voor luchtverontreiniging kan geen acceptabele concentratie aan polluenten worden gedefinieerd, noch een veilige afstand tot drukke verkeerswegen. Voor lawaai spelen contextuele factoren en persoonlijke gevoeligheid of perceptie een dermate fundamentele rol, dat technische maatregelen om geluidsniveaus naar beneden te brengen niet altijd een proportioneel effect hebben op de ervaring van lawaaihinder. Samengevat leiden milieuimpacts tot risico's die lineair en ondubbelzinnig zijn op populatieniveau, maar die niet eenvoudig vertaald kunnen worden naar lokale situaties.
Om de toenemende maatschappelijke bezorgdheid in beeld te brengen, werden verschillende milieuorganisaties en drukkingsgroepen geïnterviewd die aandacht hebben voor milieugezondheid. Deze groepen tonen allen een groot potentieel voor het opnemen van meer lokale bottom-up kennis en burgerinitiatief in het beleid. De meeste van deze groepen zijn professioneel georganiseerd, zijn kritisch maar tegelijk constructief, en richten zich op het opbouwen van collectieve expertise door het combineren van de specialistische kennis van experten en de lokale en contextuele kennis van leken. Het succes van deze groepen illustreert het wantrouwen van burgers tegenover de overheid met betrekking tot milieugezondheidsvraagstukken.
Om het huidige hiërarchische, technocratische overheidsbeleid te evalueren, werden overheidsambtenaren geïnterviewd en milieuregelgeving en –procedures geanalyseerd. In het algemeen zijn milieuregelgeving en milieueffectrapporteringen statisch en generiek en ontbreekt er een holistisch perspectief. De geïnterviewde ambtenaren wijzen allen op noodzakelijke verbeteringen maar zijn tegelijk aarzelend om meer ruimte te geven aan bottom-up initiatieven. Ze stellen vragen bij de intenties van burgers, de representativiteit van burgerinitiatieven en het hoofdzakelijk lokale perspectief van deze groepen wat een maatschappelijk evenwicht op een hoger schaalniveau belemmert.
Er wordt geconcludeerd dat de institutionalisering van milieugezondheid niet meer volstaat in de huidige complexe, gefragmenteerde en veranderlijke samenleving. Omdat een gezonde leefomgeving niet maakbaar is, en omdat we geen allesomvattende, rationele beslissingen kunnen nemen op basis van een volledig begrip van alle impact-effect relaties met inbegrip van context en perceptie, moeten er bijkomende planningsstrategieën ontwikkeld worden.

In *Hoofdstuk 4* worden stadsplanning en milieugezondheid herverbonden door middel van een theoretisch kader. Het eerste deel van dit hoofdstuk beschrijft de beschikbare literatuur, startend met een aantal definities gevolgd door een overzicht van verschillende conceptuele modellen van gezondheidsdeterminanten. Er wordt een evolutie aangetoond van eenvoudige deterministische modellen naar geavanceerde, gecompliceerde modellen met meerdere determinanten, waaronder de gebouwde omgeving. Samen met deze theoretische vooruitgang is echter het idee ontstaan dat geen enkel model het complexe web van dynamische processen adequaat in kaart kan brengen, waarmee de verschillende gezondheidsdeterminanten hun effect laten voelen. Daarom wordt betoogd dat zowel gezondheid

als steden moeten beschouwd worden vanuit een complexiteitsperspectief. Dit perspectief ontkracht het paradigma van rationele orde niet, noch haar antithesis van post-moderne wanorde, maar probeert beide tegenovergestelde standpunten te verbinden. Volgens de theorie van complexiteit bestaat de fysieke en sociale realiteit uit een breed scala van op elkaar ingrijpende geordende, complexe en chaotische fenomenen, wat een combinatie van kwalitatieve en kwantitatieve methoden noodzaakt om inzicht te verwerven en in te grijpen. Sommige auteurs in stadsplanning erkenden deze complexiteit van milieugezondheid al en formuleerden algemene beleidsaanbevelingen, doch geen enkele onder hen biedt een toepasbaar kader dat contextueel ruimtelijk gezondheidsbeleid in complexe en gecompliceerde situaties tot stand kan brengen.
Twee fundamentele vragen komen naar boven: “Hoe moeten situaties van ongezonde milieukwaliteit gelokaliseerd worden?” en “Welke planningsstrategieën zijn er nodig om dergelijke situaties aan te pakken?”. Om de eerste vraag te beantwoorden wordt een praktisch kader opgesteld, dat vertrekt van de concepten van milieurechtvaardigheid beschreven door Walker (2012). Centraal staan een onderscheid tussen het beschrijvende concept van ongelijkheid en het normatieve concept van onrechtvaardigheid, en het belang van het maken van claims in discussies over milieurechtvaardigheid. Als antwoord op de tweede vraag wordt voorgesteld om, afhankelijk van de complexiteit van een milieugezondheidsconflict, een andere planningsstrategie toe te passen. Daarom moeten nieuwe planningsstrategieën worden ontwikkeld, die een aanvulling vormen op de huidige milieustandaarden en reguleringen. Afhankelijk van de actorencontext en de ruimtelijk-temporele context, worden vier planningsstrategieën voorgesteld en gepositioneerd in een matrix: een padafhankelijke strategie, een collaboratieve strategie, een adaptieve strategie en een co-evolutionaire strategie. Naast de opname van een co-evolutionaire strategie als één van de vier kwadranten, geeft deze matrix ook uiting aan een overkoepelend co-evolutionair idee. Dit wordt geïllustreerd door het tegelijk voorkomen van de verschillende planningsstrategieën, die niet enkel in specifieke cases of situaties van toepassing zijn, maar ook naar mekaar refereren in een evolutie naar gezondere steden en regio’s. Net zoals burgerinitiatieven evolueren in relatie tot bestaande normen, regelgeving, milieueffectrapporteringen en milieugezondheidsmodellen, zo kan de padafhankelijke strategie van de overheid over tijd en ruimte co-evolueren met meer open en complexe strategieën voor deze thematiek. Dit kan betekenen dat binnen het overheidsbeleid lokale participatie een groter belang krijgt, dat de aandacht verschuift van vooropgestelde doelen naar procesgerelateerde aspecten en dat objectieve en gemodelleerde data niet langer als vertrekpunt wordt gezien.
In de volgende vier hoofdstukken worden de voorgestelde theoretische modellen getest door middel van kwantitatieve en kwalitatieve onderzoeksmethoden, vasthoudend aan het complexiteitsperspectief dat beide wetenschappelijke aanpakken als evenwaardig beschouwt.

Hoofdstuk 5 geeft de resultaten van een data-analyse van milieurechtvaardigheid in Gent weer, met een focus op verkeerslawaai en luchtverontreiniging. Door middel van correlatieanalyses op het niveau van statistische sectoren en individuen (respondenten van de Leefbaarheidsmonitor 2014 enquête), worden vier onderzoeksvragen beantwoord.

Ten eerste volgt uit de analyse dat gemodelleerde blootstelling aan lawaai slechts zwak geassocieerd is met subjectieve lawaaihinder. Dit kan gedeeltelijk verklaard worden door onvolkomenheden in de modellering van lawaai, maar mogelijk spelen persoonlijke kenmerken en gevoeligheid een grotere rol, zoals gesuggereerd door ander onderzoek. Dit werpt vragen op over het louter gebruiken van gemodelleerde geluidskaarten voor het in beeld brengen van de gezondheidsimpact van blootstelling aan lawaai.
Ten tweede bleek dat kwetsbaardere bevolkingsgroepen, met lagere inkomens, een hogere werkloosheid, en van buitenlandse origine, meer blootgesteld zijn aan gemodelleerde luchtverontreiniging (maar niet aan gemodelleerd verkeerslawaai). Dit ligt in lijn met de resultaten van ander onderzoek.
Ten derde toonde de analyse aan dat hoe meer auto's respondenten bezitten en hoe meer ze pendelen per auto, hoe lager de gemodelleerde blootstelling aan luchtverontreiniging. Correlaties zijn echter zwak. Deze ongelijkheid in de verdeling van verantwoordelijkheid voor en blootstelling aan luchtverontreiniging kan een extra argument vormen om de huidige situatie niet enkel ongelijk maar ook onrechtvaardig te noemen.
Ten vierde bleek dat buurten met meer huurhuizen, meer verhuisbewegingen, lagere woningprijzen en een kortere woonduur, gemiddeld hoger blootgesteld zijn aan luchtverontreiniging, en in veel mindere mate aan verkeerslawaai. Dit kan op twee manieren geïnterpreteerd worden. Enerzijds kiezen sommige mensen bewust om tijdelijk in een "meer vervuilde" buurt te wonen, terwijl anderen mogelijk vast zitten in een huursituatie, al dan niet op dezelfde locatie, met langdurige blootstelling aan milieuimpacts.
Hoewel deze data-analyse een goed startpunt is om situaties van milieuongelijkheid bloot te leggen, is ook contextuele informatie nodig om een volledig beeld te verkrijgen, de rechtvaardigheid te beoordelen en onderbouwde beslissingen te nemen. Gebaseerd op de data-analyse en in samenspraak met de stad Gent, werd daarom de case van de E17- en B401-viaducten geselecteerd voor verder onderzoek.

In *Hoofdstuk 6* worden de contextuele aspecten van de case van de twee snelwegviaducten geanalyseerd. Het hoofdstuk start met een evaluatie van milieukwaliteitsdata, die aantoont dat de grenswaarden voor luchtverontreiniging en lawaai worden overschreden in het casegebied. Een korte analyse van socio-economische en huisvestingsvariabelen legt een variatie aan buurttypologieën bloot langsheen de snelwegen en viaducten: van "stedelijk" tot "landelijk", van lage tot hoge inkomens, van blanke tot gemengde buurten en van jonge tot oude bevolkingsgroepen. De daaropvolgende historische analyse toont dat beide snelwegen top-down werden gepland en gebouwd in de jaren 1960 en 1970, toen het idee bestond dat snelwegen konden helpen om stedelijke gebieden herin te richten. Echter, de verschillende geschiedenissen die beide snelwegviaducten daarna hebben doorlopen, tonen het belang aan van contextuele informatie om een situatie van milieuongelijkheid te begrijpen.
Met betrekking tot het E17-viaduct was het lokale protest tegen de plannen hardnekkig maar tevergeefs. Het protest bleef aanhouden tijdens de levensduur van het viaduct, vooral over het lawaai geproduceerd door het viaduct. Dit heeft geleid tot verschillende aanpassingen: geluidsschermen, snelheidsbegrenzing en een trajectcontrolesysteem. Vandaag is het kloppende geluid van de voegen

de belangrijkste bron van hinder, en heeft dit geleid tot het ontstaan van een nieuwe actiegroep, Viadukaduk. Zij konden de stad en lokale politici overtuigen om een lokaal front te vormen met de eis voor aanpassingen aan de situatie. Het Agentschap Wegen en Verkeer beloofde om de lawaaihinder te verminderen door maatregelen te nemen bij de onderhoudswerken in 2020, maar een langetermijn-oplossing is nog steeds veraf. De kaarten liggen anders voor het B401-viaduct, of fly-over, dat geen geschiedenis kent van protest en actiegroepen. Het lijkt dat milieuverontreiniging hier minder een rol speelt. Echter, de toekomstige afbraak van het viaduct is een symbool geworden van het ruimtelijke en mobiliteitsbeleid van het huidige stadsbestuur. De Vlaamse overheid, die de weginfrastructuur beheert, is hiermee akkoord gegaan op voorwaarde dat de stad een allesomvattend mobiliteitsplan uitwerkt.
In het geval van het E17-viaduct werden de belangrijkste actoren en hun claims verder geanalyseerd door een analyse van documenten. Het Gentse stadsbestuur is slechts een mediërende actor, die de burgers ondersteunt in hun verzet tegen de Vlaamse overheid. De standpunten van de Vlaamse overheid en de actiegroep Viadukaduk illustreren de breuklijn die beschreven werd in hoofdstuk 3. De Vlaamse overheid blijft vasthouden aan een hiërarchische, technocratische aanpak. Er bestaan veel documenten, plannen en ideeën van verschillende overheidsdepartementen omtrent het aanpakken van milieuhinder, maar weinig concrete resultaten. Viadukaduk zegt een constructieve houding aan te nemen door het verzamelen van informatie, het consulteren van experts, het netwerken met politici en het vergroten van het lokaal maatschappelijk draagvlak.
Het hoofdstuk wordt afgesloten met het toepassen van de twee ontwikkelde theoretische kaders op de case. Het milieurechtvaardigheidsmodel helpt om de claims van de verschillende actoren te begrijpen en om nieuwe perspectieven te verkrijgen. Het toont dat er verschillende manieren zijn om een situatie te interpreteren en een veelvoud aan “rechtvaardige” beslissingen. Door de matrix van planningsstrategieën toe te passen op de case wordt aangetoond dat de pad-afhankelijke aanpak vandaag nog steeds dominant is, samen met pogingen tot collaboratieve strategieën, individuele voorbeelden van adaptieve strategieën en ontluikende mogelijkheden voor zelforganiserende, co-evolutionaire strategieën.

Omdat de opinie van de bevolking die vlakbij de viaducten woont van het grootste belang is, werd een bewonersenquête ontwikkeld en uitgevoerd. In *Hoofdstuk 7* wordt de enquêtemethodologie beschreven, die erop gericht is om de ideeën van burgers over milieurechtvaardigheid van de situatie te verkrijgen, alsook om hun steun voor verschillende planningsstrategieën in te schatten. De dimensies van de enquête werden gebaseerd op de twee theoretische kaders. Ruimtelijk beperkte de enquête zich tot de zone binnen 500 meter rondom de twee snelwegen en viaducten. Door een enquêtecampagne via e-mail konden voldoende respondenten bereikt worden om representatieve uitspraken te doen over de bevolking in het casegebied. Resultaten zijn echter enkel indicatief wanneer de verschillende zones in het casegebied met elkaar vergeleken worden.

Als laatste stap in het empirisch onderzoek worden de resultaten van de bewoners-enquête besproken in *Hoofdstuk 8*. Univariate en bivariate resultaten worden geëvalueerd door middel van de dimensies van de twee ontwikkelde kaders, wat leidt tot een overzicht van zes opmerkelijke resultaten.

Ten eerste tonen de enquêteresultaten aan dat de relatie tussen perceptie van milieuimpacts en gemodelleerde milieuimpacts zwak is, wat betekent dat voor hetzelfde gemodelleerde lawaainiveau of luchtverontreinigingsniveau de perceptie van mensen kan variëren van weinig tot veel hinder. Voor blootstelling aan lawaai is geweten dat persoonlijke gevoeligheid en contextuele factoren een grote rol kunnen spelen in het bepalen van subjectieve blootstelling, hinder en verschillende gezondheidseffecten. Dit plaatst vraagtekens bij het gebruik van gemodelleerde geluidskaarten om gezondheidsimpacts te beoordelen en beslissingen te nemen. Voor luchtverontreiniging zijn gemodelleerde data relevanter, omdat het gezondheidseffect los staat van de ervaren hinder.
Ten tweede bleek dat de relatie tussen socio-economische en huisvestingsvariabelen verschilt voor objectieve en subjectieve blootstelling. Terwijl meer kwetsbare en minder verantwoordelijke bevolkingsgroepen en tijdelijke bewoners de hoogste gemodelleerde blootstelling aan luchtverontreiniging en lawaai kennen, voelen socio-economisch sterkere groepen en permanente bewoners zich in het algemeen meer gehinderd. Dit geeft extra argumenten om kwetsbaarheid en verantwoordelijkheid mee in beschouwing te nemen in milieugezondheidsbeleid.
Ten derde suggereren de enquêteresultaten dat de mening over milieurechtvaardigheid grotendeels bepaald wordt door de ervaren hinder en niet door socio-economische variabelen. Dit gebrek aan empathie met wie wel gehinderd is bemoeilijkt het ingrijpen in de situatie.
Ten vierde bleek dat het een specifieke groep van mensen is, met voldoende tijd en kennis, en met hogere verwachtingen van de woonomgeving, die haar weg vindt naar klachtenprocedures. Hierdoor blijven er mogelijk een aantal problemen onderbelicht.
Ten vijfde stelt de meerderheid van de bevolking de rol van de overheid niet in vraag, maar pleit zij voor bijkomende collaboratieve en co-evolutionaire aanpakken. De meeste mensen zijn echter ook bezorgd over mogelijke vertraging in het beslissingsproces, de neutraliteit van burgerinitiatieven en de houding van de overheid tegenover participatie.
Ten zesde toont de bevolking in het casegebied een hoge persoonlijke bereidheid om te participeren en adaptief hun woning te beschermen. Socio-economische variabelen spelen echter een belangrijke rol. Het zijn voornamelijk mensen met een hogere opleiding, een hoger inkomen, een job en een (half-) vrijstaand huis die zelf bijkomende beschermingsmaatregelen nemen en actief willen participeren. Het is dezelfde groep mensen die zich eerder aansluit bij burgerinitiatieven zoals Viadukaduk, en die op die manier zijn bezorgdheden kan uiten. Dit stelt de onvoorwaardelijke steun van de stad voor dergelijke initiatieven in vraag.

In het afsluitende *Hoofdstuk 9* wordt eerst gereflecteerd op de bruikbaarheid en de kwaliteiten van het ontwikkelde theoretische kader. Daarna wordt samengevat wat dit doctoraatsonderzoek heeft geleerd over de maatschappelijke processen die een ongelijke blootstelling veroorzaken. Vervolgens wordt een antwoord gegeven op de hoofdonderzoeksvraag door het formuleren van beleidsaanbevelingen. Deze aanbevelingen zijn alle gebaseerd op het idee dat, ondanks de sluitende bewijslast over de gezondheidseffecten van milieuimpacts, er geen objectieve en absolute waarheid bestaat over de milieurechtvaardigheid van een specifieke situatie, en niet één “juiste” beslissing. De ontwikkelde kaders helpen eerder om te begrijpen

wat er speelt, nieuwe perspectieven te verkrijgen en nieuwe ideeën te vormen. Door deze kaders toe te passen op een specifieke case werd echter veel geleerd over de problematische relatie tussen stadsplanning en milieugezondheid en het potentieel van planningsstrategieën. Dit heeft geleid tot de ontwikkeling van een "stappenplan" naar een betere integratie van planning en milieugezondheid. Dit plan bestaat uit vijf concrete "stappen" die samen een langer proces van systeeminnovatie kunnen ondersteunen.

Ten eerste moet de huidige milieuregelgeving herzien en versterkt worden om nog beter een minimum aan milieukwaliteit te waarborgen voor iedereen. Dit kan door het aanpassen en versterken van het instrument van de milieueffectrapportering, het herzien en differentiëren van de manier hoe milieuimpacts worden beoordeeld, en het meer aandacht geven aan aspecten van kwetsbaarheid en verantwoordelijkheid in effectrapporteringen en beleidsvorming. Ten tweede zijn er bijkomende adaptieve en collaboratieve planningsstrategieën nodig die tegemoet kunnen komen aan context-specifieke verwachtingen en noden. Gezien perceptie een belangrijke rol speelt en gezien de waardevolle lokale en contextuele informatie die burgers kunnen aanleveren, gaan beide strategieën vaak hand in hand, waarbij een collaboratief proces helpt om adaptieve oplossingen te vinden. Ten derde kunnen zelforganiserende strategieën voor milieugezondheid vruchtbaar zijn, maar blijven overheid en wetenschappelijke wereld noodzakelijk als stabiliserende factor, omdat anders een sociaal-economisch rechtvaardig resultaat niet gegarandeerd is. Ten vierde is een gedeelde kennisbasis nodig met transparante en verstaanbare verspreiding van milieugezondheidsinformatie. Dit kan het bewustzijn vergroten, vormt een basis voor eerlijke discussies over normatieve aspecten en maakt het mogelijk voor planners en burgers om een belangrijke en geïnformeerde rol te spelen in het herverbinden van milieugezondheid en stadsplanning. Tot slot, om alle voorgaande aanbevelingen te ondersteunen, moeten planners worden opgeleid om sterke ondernemende en mediërende rollen op te nemen in het beschermen van het algemeen belang.

1

Introduction

1.1 Prelude

In March 2008 the Flemish newspaper *De Standaard* published an article with the headline “Oosterweel zal jaarlijks 56 levens eisen door fijn stof”, translated in English as “The Oosterweel project will cause 56 fatalities from air pollution a year”. This was one of the first times that the potential adverse health effects of an infrastructural project were covered widely in Flemish media, with contributions of environmental health researchers. It marked the beginning of years of struggle over this project, which was meant to complete the Ring Road around the city of Antwerp with a combination of viaducts and tunnels (Claeys, 2013; Van Brussel et al., 2016). The prospect of potential harm to public health raised awareness and empowerment among citizens. They started to organize, collect information, consult experts and design alternative solutions. An important pressure group that emerged was the citizen initiative Ademloos (“EN: Breathless”), which focused on collecting current scientific evidence and disseminating it to the public in an understandable and appealing way. They cooperated with Straten-Generaal, another community action group which was fighting the project by conducting studies and resorting to legal challenges. Straten-Generaal stressed the deficiencies in the planning process, which had not involved citizens and had left environmental health concerns to the environmental impact assessment. This assessment process was denounced for its narrow “specialist” view. It relied on norms and procedures that are generic and static, not taking into account the specific context of the project area. By their joint efforts, both groups raised concern about the potential environmental health effects of noise and air pollution and the fairness of the planning process. As such, they could enforce a non-binding referendum in which the project was voted down by a majority of the citizens. Another initiative, the Ringland citizen project, was born some years later and developed an alternative plan aiming to cover the whole Ring Road. By detailed and clever solutions and a professional campaign they soon gained support of a substantial part of the urban population, again putting pressure on the government to change plans. However, the government has always been hesitant and unsure in dealing with this new powerful activism and mostly sticks to the policy decisions that were taken. After years of discussions and delay, it is still unclear how and when the project will finally be realized.

This story is an illustration of the problematic relationship between spatial or infrastructure planning and environmental health, as well as the conflicting attitude of the principal actors. In Flanders, citizens are getting more and more aware and concerned about the relation between environmental conditions and possible effects on public health and well-being. Together with the higher demands of the residential environment, due to the rise of living standards, public opposition against environmental threats is rising (Brown, 2013). Moreover, many citizens no longer have confidence in generic environmental regulations and procedures, but instead adopt another view on the situation in which they focus on the specific local context and personal preferences. This growing public concern goes hand in hand with growing research on the different relationships between aspects of the built environment and impacts on health and well-being. Apart from getting a more detailed picture of the (context-specific) health effects of air pollution and noise, the scientific world has also investigated the health effects of green

space, walkability and urban heat islands, among others (Frumkin, 2003; Jackson, 2003a). This ever increasing evidence base causes the government's environmental norms and legislation to be always lagging behind the state-of-the-art knowledge. Moreover, a better dissemination of scientific knowledge on environmental pollution among the general public has contributed to citizens increasingly distrusting the government and its regulatory framework in protecting environmental quality.

However, despite growing scientific evidence and rising public awareness, most public authorities (including the Flemish) take a defensive position and continue to rely on generic regulations, established limit values for environmental impacts and fixed procedures (such as the strategic environmental assessments), which are all static and only occasionally revised. In spite of a series of reports by various governmental bodies (e.g. by the World Health Organization, United Nations and European Commission) highlighting the need to include health issues in planning and decision making and drawing on the support of legal requirements (e.g. the EU Directive 2001/42), the practical implementation is limited. Close working relationships between planners and public health practitioners remain scarce (Chapman, 2010). Today, in most Western countries, health and environmental issues are the responsibility of their own specialized government departments, while departments of planning, mobility and public works are still focused on geographical and engineering approaches to space and time. These specialized bureaucracies hinder constructive collaboration (Corburn, 2007; Kørnøv, 2009). Urban planners usually do not spontaneously involve environmental health experts in the planning process. They generally leave the aspect of health to the obligatory environmental assessments. These are carried out at the end of the planning process, when major decisions have already been taken and only mitigating measures can be proposed. Despite its undeniable achievement in protecting a minimum environmental quality and preventing serious environmental conflict, the institutionalization of environmental health no long works in our inherently dynamic, fragmented and volatile society. Generic standards, regulations and procedures no longer meet the increasingly unique and changing expectations or needs of places and populations, and cannot keep up with the progress in scientific knowledge. If we really care about the quality of life in our growing cities, we need to think of new strategies to reconnect environmental health and urban planning.

1.2 Research questions

The problematic relationship between urban planning and environmental health and the wide-ranging public debate brought forth the idea to carry out more thorough research about this matter. This research tries to give an answer to following main research question:

How can urban planning and environmental health be reconnected to meet the increasingly unique and changing expectations or needs of places and populations?

Within the aim of reconnecting urban planning and environmental health, and rethinking the planner's and citizen's involvement in urban environmental health issues, several interesting supplementary questions arise:

- How can environmental assessments be complemented with additional innovative planning strategies?
- What to do with the growing protest from environmental associations and grassroots movements?
- Who is best placed to decide what a healthy environment implies?
- What would this mean for the scope of urban planning and the role of the planner?

To answer these questions, a research framework was devised with several subquestions, relating to the different chapters of the dissertation (Figure 1). First, two explorative questions attempt to obtain a better understanding of the current situation:

A. How did the current disconnect came into being? (Chapter 2)

B. What are the characteristics of the current disconnect? (Chapter 3)

Next, a theoretical framework is constructed to give a theoretical answer to the main research question:

C. How to locate environmentally unhealthy situations and which planning strategies are needed to address them? (Chapter 4)

After that, the current disconnect, the challenges ahead and the proposed theoretical framework take more concrete form in a case study where discussions on environmental health are at stake. Three research questions structure this application and help find answers on the main research question above.

D. What is the relation between objective exposure to environmental impacts and variables of nuisance, vulnerability, responsibility or housing? (Chapter 5)

E. What do spatial, historical and actor context add to environmental justice debates? (Chapter 6)

F. What do citizens think about environmental health, environmental justice and appropriate planning strategies? (Chapter 7 and 8)

1.3 Research methods

To answer the different subquestions a variety of research methods were used, each with their strengths and weaknesses.

Subquestion A was answered by carrying out an exploratory literature review of the history of urban planning and public health. This research method was chosen because it could provide a general overview, sufficient for an introductory chapter, in a relatively short amount of time. While there was no need to be exhaustive, there is always the risk of leaving out important sources.

Subquestion B was assessed by a mixed approach. First, a literature review of the state of the art in empirical research on environmental health was carried out. This approach was used since this thesis does not focus on the empirical evidence of health effects, but rather builds on it as an element of fact that is not further discussed or examined. Because of practical reasons, some choices had to be made about the included impacts and studies. This means that the included information is not exhaustive. Second, the main actors in the Flemish environmental health debate and their perspectives were further analyzed by interviews. In the course of 2014 five representatives of Flemish environmental pressure groups and four civil servants of government administrations were interviewed in a semi-structured way. This method was preferred since it goes beyond a factual description and aims to get insight into motives and narratives. The results of the literature review, with an international scientific perspective, and the interviews, focusing on the Flemish situation, were evaluated by making reference to the theoretical literature. This made it possible to put the current disconnect and future challenges in a broader theoretical perspective.

Subquestion C was answered through a literature review of concepts and frameworks on health, environment and urban planning. These formed the basis for the development of a theoretical framework. As much relevant works as possible were taken into account to get a complete picture of the research field and its major knowledge gaps.

Subquestion D resulted in a spatial data analysis for the territory of the municipality of Ghent, which was selected as case area. This analysis used secondary data for the statistical sector level and the individual level. The data span over a period of two years, from 2012 until 2014. The statistical sector data were collected from various sources by the city of Ghent and are online available to the public, the individual data were collected from the Ghent Livability Monitor survey of 2014 with 2380 respondents. The goal of this analysis was to obtain an objective view on environmental justice and to locate inequalities. However, the analysis is heavily dependent on the quality of the data and there is also a risk of eliminating important differences at neighborhood level when the entire municipal territory is analyzed.

Subquestion E led to a situational analysis of a specific case area in the south of Ghent, around the highway viaducts of E17 and B401. The situational analysis consisted of literature review, analysis of policy documents and spatial data analysis. A large amount of information was collected and evaluated, but due to lack of time, a series of structured interviews with important stakeholders is missing.

Subquestion F was answered by developing and conducting a survey among residents in the case area in the south of Ghent. The survey dimensions of the eight page survey are based on the concepts of the theoretical framework, and questions were validated through expert workshops and a pilot study. In the survey campaign, people between 18 and 79 were sampled from the population register and invited by mail to complete the survey on paper or on the internet. Out of 1,003 potential respondents 399 participated, which makes the survey results representative for the target population in the case area. The survey results were further analyzed

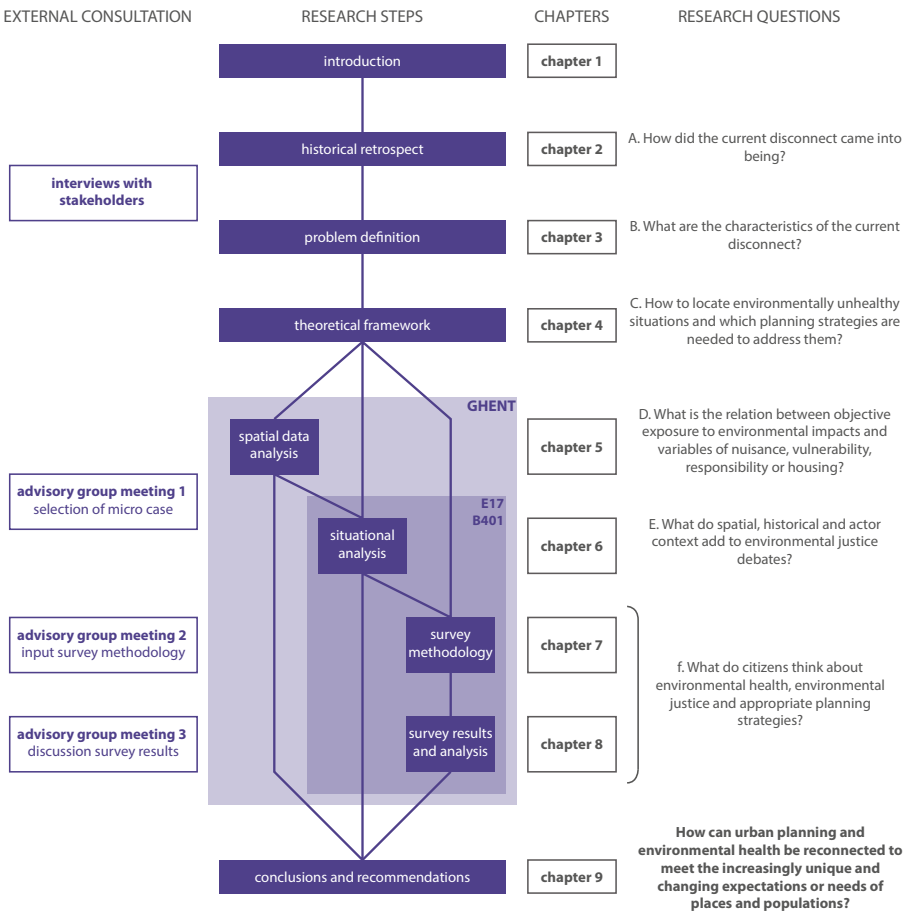
by univariate and bivariate statistical analyses. A massive amount of valuable empirical results gave insight into the perceptions and experiences of residents. The major weakness of this survey is the limitation to only one case study. Results might be different in other areas and therefore results should be interpreted with caution.

1.4 Outline

Following this introduction, *Chapter 2* explores the history of urban planning and public health to show how the two disciplines evolved from close cooperation into a segregated approach with separate government departments. In *Chapter 3* the current disconnect between urban planning and public health is further examined, paying attention to the growing empirical knowledge on environmental health, the rise of public awareness and citizen initiatives, and the standstill of current government policy. After thoroughly describing the lock-in today, in *Chapter 4* the (theoretical) literature is evaluated to find inspiration for the theoretical framework. A first framework is devised to locate environmentally unhealthy situations, based on concepts of environmental justice. Next to that, a second framework is drawn up with possible planning strategies for environmental health. Chapter 5 to 7 report on the results of an empirical case study analysis in which the ideas of the theoretical frameworks are applied. In *Chapter 5* a data analysis is carried out for Ghent to check for a relation between nuisance, socio-economic, housing and responsibility variables on the one hand and modeled environmental impact indicators of traffic noise and air pollution on the other. Based on this analysis a detailed case study area is selected in which an unequally high exposure to air pollution and traffic noise is at hand. Moreover, in this case debate on environmental health is currently ongoing. This case is the focus of the next three chapters. *Chapter 6* makes an in-depth analysis of the history of the case, recent evolutions and the most important actors. The two devised frameworks of chapter 4 are used to evaluate both the justice of the current situation and the possible future planning strategies. Since the opinion of citizens on the situation is missing, a survey is designed, of which the methodology is described in *Chapter 7* and the results in *Chapter 8*. By adding the citizens' opinion to the collected information, a complete picture is obtained of the situation and the feasibility of future strategies. In *Chapter 9* the case-specific conclusions are again linked to a broader perspective on planning and health, leading to the formulation of general policy recommendations.

The case study research was performed in close collaboration with the city of Ghent and the local citizen initiative Viadukaduk. Both partners were part of an external consultation group that gave advice at key moments in the research process (Figure 1). As such the case study connects to current discussions and might give useful input.

Figure 1 Research framework and structure of this dissertation



It should be acknowledged that this dissertation is written from a Western European, Anglo-Saxon point of view, with a major case study in Flanders. The general historical analysis and the description of the current disconnect do not apply to the situation in developing countries. However, the proposed new planning strategies and ideas on environmental justice can still be useful in these areas.

2

Historical retrospect

This chapter presents a historical analysis of the changing relationship between urban planning and public health. This is summarized in Table 1. The analysis relies primarily on secondary sources and thus does not aim to be exhaustive. It should be acknowledged that it is written from a Western European, Anglo-Saxon point of view. Since the empirical research of this dissertation focuses on Flanders and the city of Ghent, reference is made to the specific local context wherever possible.

Table 1 Historical overview of changing policies of public health, environment and urban planning

Era	Dominant public health paradigm	Public health and environmental policy	Urban planning policy
middle ages-1840s	– miasma theory – contagion theory		– unregulated and uncoordinated urban growth
1840s-1900s	– miasma theory – contagion theory	– removing hazards (contaminated air or people)	– engineering based sanitary reforms
1900s-1930s	– germ theory	– treatment and disease management	– Utopian city visions – garden city movement – birth of zoning
1930s-1960s	– biomedical model	– treatment and disease management	– Modernism – functionality and technological optimism – infrastructure and transportation projects
1960s-1990s	– biopsychosocial model	– treatment and disease management – growing focus on lifestyle and health promotion – birth of environmental legislation	– continuing suburban development – criticized urban renewal – new planning approaches focusing on social cohesion and justice
1990s-today	– biopsychosocial model	– treatment and disease management – focus on lifestyle and health promotion – growing focus on structural and environmental influences – institutionalization of environmental assess-ments	– comprehensive planning – neoliberal planning – local examples of New Urbanism, Transit Oriented Development, Eco-cities

2.1 Historical linkages

Historically, we have always been aware of the interrelation between the environment and our physical and mental health (Jackson, 2003b). The Greeks had the common view of the body as a vessel containing four basic fluids – black bile, yellow bile, phlegm and blood. They believed that diseases and disabilities resulted from an excess or deficit of one of these four substances, with the environment playing a key role determining the mix of fluids. Hence they advocated against climatic extremes and tried to settle their people in healthy and secure environments. This view is illustrated by Hippocrates in *Airs, Waters and Places*, in which he distinguishes unhealthy places (such as swamps) from healthy places (such as sunny, breezy hillsides) (Duhl & Sanchez, 1999; Frumkin, 2003). The Romans, built further on these insights. However, they tried to "fix" the environment with engineering instead of searching for the "right" environment. They were the first to introduce a public health system with a fresh water supply (through aqueducts), a network of sewers, and public baths and lavatories. Yet, in medieval society, these engineering solutions gave way to the notion that the medieval plague pandemics were a punishment from God, which had to be combatted by penance or witchcraft. Nevertheless, some natural philosophers – the predecessors of today's scientists – propagated a miasma or contagion theory (Slack, 1988). Adherents of the miasma theory believed that diseases were caused by bad air and advocated measures like burning tons with pitch and herbs in the streets to remove the contaminated air. Supporters of the contagion theory believed that diseases were caused by direct physical contact. They advocated establishing plague houses where infected people were put into quarantine, a practice that has lingered on until today (see, for instance, the quarantine facilities for tuberculosis, those in industrial harbors and those for the 2014 outbreak of the Ebola virus).

In the seventeenth century a renewed interest occurred in the relationship between health and the built environment, originating in the unhealthy conditions of the first pre-industrial cities. As population densities, numbers of marginalized populations, pollution and crime increased, also mortality rates rose (Galea & Vlahov, 2005). Large cities such as Paris, Antwerp, London or Amsterdam counted already more than a hundred thousand inhabitants around 1600 and were periodically challenged by infectious diseases like typhus and tuberculosis. At the same time, public hygiene was underdeveloped, with no facilities for safe drinking water nor closed sewerage systems (de Hollander & Staatsen, 2003). Urban planning was mostly a helter-skelter process, heavily determined by the market and private initiative, thus resulting in piecemeal, haphazard, unregulated and uncoordinated urban growth (Peterson, 1979). Under these circumstances, in 1662, the draper John Graunt carried out the first statistical health surveys by collecting numbers and causes of death to build the first life expectancy schemes. He was soon followed by Sir William Petty, who wrote his influential *Political Arithmetic* (1690) on the relationship between sanitary conditions and human mortality. These initiatives marked the seeds of a new approach to health and the built environment.

2.2 The emergence of urban planning

Despite the age old relationship between public health and the built environment, it was not until the massive congestion of early nineteenth-century cities that the discipline of urban planning took root (de Hollander & Staatsen, 2003). The key reason for this was the explosive economic growth of the industrial revolution in Western Europe, which led to a tremendous population drift from the countryside to the already highly populated cities. The overpopulation resulted in housing problems, crowding, poverty, pollution and devastating outbreaks of infectious diseases (Szreter, 1988). Also the city of Ghent experienced an important demographic explosion in the first half of the nineteenth century, when Flanders' textile industry became mechanized (Backs, 2001). It had considerable economic and social consequences. There was serious overcrowding in the rapidly built working-class housing and the many wells and small rivers in Ghent were used for water supply and as an open sewer. This led to a detrimental effect on public health, with the city being hit by cholera five times during the period 1832-1866 (Du Moulin, 1879).

In England, this unhealthy urban environment incited a public health revolution, starting with the efforts of the so-called hygienists – an alliance of physicians and civil engineers. They wrote a series of reports – of which the Chadwick's Report (1842) is the most known – on the abominable hygiene, moral degeneration and health consequences for the paupers living in the slums. With the purpose to increase labor productivity, Chadwick and the hygienists made proposals about healthy drinking water services, drainage systems and the removal of refuse (de Hollander & Staatsen, 2003). In spite of their efficiency, these engineering-based sanitary reforms were rooted in the still present belief in the miasma theory. In addition, the contagion theory continued to exist, with the corresponding policy action of separating out populations suspected of causing disease by large quarantines of immigrants (Corburn, 2007). This occurred especially in the United States, where the National Quarantine Act of 1893 mandated the screening of foreigners at state quarantine stations to prevent the admission of "insane persons, [...] persons likely to become a public charge [and] persons suffering from a loathsome or dangerous contagious disease" (Mullan, 1989: 41). Before that, and following the Chadwick reports, in 1848 the first Public Health Act was enacted in England. This act, still based on the miasma theory, effectuated a centrally controlled network of local boards of health and marks the first time in history that the British government made a commitment to safeguarding the health of its population (Lindheim & Syme, 1983). Later this was continued with the Sanitation Act of 1866, granting sanitary powers to local municipals (instead of the private sector) and modernizing drinking water services and sewerage. The rest of Europe followed these sanitary reforms, some nations immediately (e.g. France), others only after several decades (e.g. the Netherlands) (de Hollander & Staatsen, 2003). In Belgium (and Flanders) the French occupation around 1800 had reorganized local administration and already given municipalities a mandate to "take appropriate measures to prevent disasters and plagues, such as fire and epidemics". However, it was only in the second half of the nineteenth century – after severe cholera epidemics – that a number of big cities implemented far-reaching sanitation

campaigns. Polluted canals were systematically filled in and a sewage and water distribution network was laid (Despiegelaere et al., 2006). Also in the USA a transition took place from a night-watchman state to a welfare state, with the tasks of municipal administration shifting from the protection of individuals and the exclusive promotion and regulation of trade to a more general concern for resident's well-being. There was little doubt that a good sewer system and adequate water supplies meant investment in the present and future health of the citizenry, and thus should be put under municipal control (Schultz & McShane, 1978; Corburn, 2004).

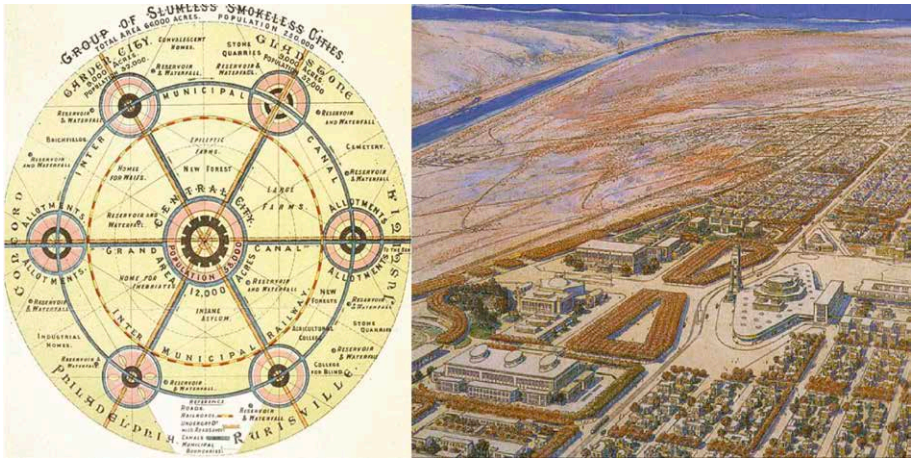
The proposed comprehensive solutions for the cities' unsanitary conditions demanded a fundamental restructuring of the physical basis of urban life. As the sanitary reformers pleaded for a systematic, large-scale reshaping of cities, they laid the foundation for a more systematic approach to urban planning (Peterson, 1979; Perdue et al., 2003). By leaving the matter to municipal engineers the concept of comprehensive city planning was accepted. In many respects the engineers' proposals surveyed the physical city more thoroughly and had a deeper understanding of the health needs of the populace than did the plans of the early-twentieth century (Schultz & McShane, 1978). However, often was opted for drastic *tabula rasa* solutions instead of adapting the existing pattern. Also in Ghent several crowded and unhealthy working-class neighborhoods were simply demolished in the second half of the nineteenth century. The largest of these projects was Zollikofer-De Vigne's plan from 1882, including the demolition of nearly a thousand homes (Boussauw, 2014). Moreover, Peterson (1979) argued that the comprehensive vision never became a reality and that actual authority over environmental change remained with many specialists who often worked in ignorance of one another. In this way, sanitary reform prefigured the fragmentary quality of much twentieth-century planning in practice.

2.3 Towards the rational city

Because of the sanitary awakening, in many cities the urban environment and the health of its residents improved enormously by the turn of the twentieth century (Galea & Vlahov, 2005). This sanitary awakening coincided with a conceptual shift in epidemiological theories, because miasma and contagion failed to explain certain aspects of population health (e.g. why epidemics occurred only sporadically). The focus turned to Louis Pasteur's germ theory of disease, which major premises are that every disease is caused by a specific microbe and that treatment is best achieved by removal or control of the offender (Corburn, 2004). Consequently, the public health focus shifted from investigating ways to improve urban infrastructure to laboratory investigations of microbes. Interventions began to focus more on specific immunization plans, with physicians, biologists and chemists emerging as the new class of public health professionals (Corburn, 2007). Although in the field of public health treatment and disease management soon superseded physical strategies of removing hazards, urban planners still attributed some attention to the impact of the built environment on health (Duhl & Sanchez, 1999). Two trends could be noticed: on the one hand visionary urban planners

promoted plans for the utopian city, on the other in practice a functional urban design perspective emerged.
The pioneering views of the Utopians originated at the end of the nineteenth century, with the work *Hygeia – A City of Health* of the British sanitarian Benjamin Ward Richardson (1876) as one of the first utopian schemes. He focused on elements of climate, site selection, water supply, sewerage, street layout, park system, and housing design that together would reduce mortality figures and transform the city into an ideal healthy environment. Following Richardson several other (social) Utopians made visionary plans of which notably Arturo Soria Y Mata with the *Ciudad Lineal* (1894), Ebenezer Howard with the *Garden City* (1898-1902), Le Corbusier with the *Ville Contemporaine* (1922) and Frank Lloyd Wright with the *Broadacre City Plan* (1935). While also paying attention to aspects of functionality, technology and social justice, all plans were concerned with public health. For example, the *Garden City* of Ebenezer Howard was founded on moderate decentralization and followed the prescriptions of Richardson's Hygeia. It was designed as a city with a low population density, wide avenues, a central park and houses within walking distance of the places of work. Also Le Corbusier explicitly wanted to reintroduce nature into people's lives. He was convinced that a rationally planned city with extensive green belts (*Ville Contemporaine*) or parkland (*Ville Radieuse*) offered a healthy, humane alternative for the chaotic and dark industrial cities (Fishman, 1982).

Figure 2 Utopian city plans of Ebenezer Howard (1898) and Tony Garnier (1904)



In practice, few cities were fully built according to the principles of the Utopians, but adapted versions had some success. Especially the garden city movement was quite strong, leading to the building of new towns and neighborhoods around big cities adopting some principles of Howard's Garden City model. To a lesser extent this also happened in Belgium, though only in the middle of the twentieth century, e.g. the garden-city neighborhood Malem in Ghent (Boussauw, 2014). At a general level, only the focus on functionality and a hierarchical ordering of land use found its way into practice (Corburn, 2004). This modernist approach was best described by another Utopian, Tony Garnier. In his work *Une Cité Industrielle* (published in 1918,

but already developed by 1904) he presented the basic idea of separating functional spaces with several categories of zoning: residential, industrial, public and agricultural. At the same time, these zones would be linked in a network of functional logistics and circulation routes (Duhl & Sanchez, 1999). The new professional class of city planners believed that this rational design would inspire functional, social and moral improvement, but also lead to healthy environments (Corburn, 2007).
The practice of zoning was first applied in Europe around 1900 by German, English and Swedish cities. In the 1910s and 1920s several other European countries, and also the United States, followed and started to adopt zoning. While European countries used zoning as a part of a comprehensive land-use planning that was ambitious and restrictive, the United States used it primarily as the major vehicle for regulation (Hirt, 2012). To an extent, the resulting zoning laws helped to separate homes and schools from odors and toxic emissions (Jackson, 2003b).
Yet, the experience with zoning in the US, described by Schilling and Linton (2005), illustrates the failure of its public health origins. Because the tables quickly turned and besides isolating industrial pollution also apartment buildings, businesses and retail stores were excluded from residential districts for health reasons, causing massive travel between zones, with an enormous impact on air quality and urban health.

2.4 Modernist planning at its peak

In the first half of the twentieth century, medicine was characterized by the progression of biology to the molecular level, and by the understanding of various biological phenomena at that level. Elaborating on the germ theory, the biomedical model became dominant, postulating that all disease can be explained in biological terms, disregarding psychological, environmental and social influences (Annandale, 1998). The emphasis of public health policy was thus on treatment, immunization and (childhood) vaccination. The original social model of public health, directed towards structural and environmental conditions, was definitively abandoned (Duhl & Sanchez, 1999; Corburn, 2007).
In policy and practice, separate areas of expertise and government departments were created, establishing distinctive disciplinary boundaries between urban planners and public health officials (Duhl & Sanchez, 1999). Also in Belgium a separate Ministry of Public Health was established in 1936, while before public health was spread over other Ministries such as Internal Affairs and Public Works (Velle & Strubbe, 2009). This evolution led to a condition whereby urban planning was cut off from its public health roots. Though public health officials may have been the first urban planners in the late nineteenth and early twentieth century, by the 1930s and 1940s others had taken over the field, creating new areas of expertise, such as environmental science, traffic engineering and building safety (Perdue et al., 2003). The focus shifted from attempting to restrain harmful “spill overs” from private market activities to promoting economic development through large infrastructure and transportation projects. The department of public works enabled a high involvement for the government in the planning and construction of the built environment, resulting in large-scale, low-density suburban developments (Perdue et al., 2003; Corburn, 2004; Gutmann & Leeming, 2011). The downside

of this economic efficiency was urban divestment, residential segregation and massive (auto)mobility, which partly evolved out of the zoned environmental conditions and had a profoundly negative impact on health (Corburn, 2004). Also urban development in Ghent in the middle of the twentieth century was strongly influenced by a modernist vision and a technological-optimistic perspective, for example reflected in large-scale social housing projects in the 1950s (Boussauw, 2014).
The links between urban planning and public health were not completely cut. A notable exception was the neighborhood unit design scheme of Clarence Perry (1929), which formed the basis for the famous publication *Planning the Neighborhood* (American Public Health Association – Committee on the Hygiene of Housing, 1948). This document described standards for building "healthy residential areas" and addressed site selection, sanitary infrastructure, planting and landscape design, street layout, lighting, residential density and amenities. Fischler (1998: 390) noted that these healthy design standards "represent the culmination of a search for scientific methods to secure collective well-being".

2.5 The birth of environmental legislation

During the second half of the twentieth century, the dominant medical paradigm gradually shifted from the biomedical model into the biopsychosocial model. According to this model, interactions between people's genetic makeup (biology), mental health and personality (psychology), and sociocultural environment (social world) contribute to their experience of health or illness (Engel, 1977). In public health policy this idea was already incorporated in the highly influential Canadian Lalonde Report (1974), the first significant government report to suggest that health care services were not the most important determinant of health (Hancock, 1986). Although Lalonde identified four major determinants of health (lifestyle, human biology, health care organization and environment), the report focused explicitly on health promotion, i.e. encouraging people to assume more responsibility for their own health. In later reports the emphasis changed from individual lifestyle to the role of an increasing number of interacting influences on health, like the social environment, power and control, housing, education, etc. The message of the reports was that government policy must balance its expenditures on medical care against the ones on health promotion, if it has health improvement as its goal (Glouberman, 2001).
It is in this era that public health policy evolved gradually from an effective medical discipline towards a politicized bureaucracy entwined with the state (Bennett & Di Lorenzo, 2000). This politicization of science and medicine made cooperation with urban planners even more difficult. At the same time, suburbs and metropolitan areas continued to grow, infused by the automobile and the accompanying state-supported highway infrastructure. Even subsidized mortgages took part in this process.

In Belgium, this was an important period for the discipline of urban planning. In 1962 the first law on urban planning was promulgated, which was the basis for a regulatory system that provided for the development of national zoning plans,

which eventually would cover the whole territory of Belgium. However, these plans have been known for their limited steering power and a too generous provision of residential areas in rural areas, further contributing to a dispersed settlement pattern (De Decker, 2011; Verbeek et al., 2014). This development was accompanied by the installation of various academic programs, the establishment of a number of specialized consultants and a significant growth in the number of competent civil servants at both regional and local levels (Boussauw & Boelens, 2015). In Ghent it led to the first comprehensive vision of the future development in 1964. It still adopted a technological-optimistic perspective, with the extensive planning of ring roads, suburban residential developments, peripheral shopping malls and highways (Boussauw, 2014).

In the late 1960s, the cores of many major European and American cities had lost their economic vitality and were left with declining neighborhoods and rising crime rates (Jackson, 2003b). The urban planning discipline grappled with widespread social unrest, and the field was hard-pressed to respond to activists' claims that large-scale public development projects, and their accompanying modernist designs for urban renewal, were not any better than the piecemeal changes of the past (Goodman 1971). As a result, new planning approaches received more attention, in which aspects of social cohesion and justice were deemed more important than economic efficiency and functionality. Jacob's *The Death and Life of Great American Cities* (1961), Davidoff's "advocacy movement" (1965), Lefebvre's *Right to the City* (1968) and Castells' work on grassroots movements (1983) are just a few examples of this change in the planning paradigm.

While public health faded into the background of the planning discipline in the 1960s and 1970s, the awareness on environmental issues started to grow. Both at a global level, illustrated by the Club of Rome think tank publishing the famous *Limits to Growth* report in 1972 (Meadows et al., 1972), and at a local level, illustrated by growing environmental activism and the establishment of environmental non-governmental organizations, such as the Federation for a Better Environment (BBL) in 1971 in Belgium (in Dutch: *Bond Beter Leefmilieu*) (Vets, 2008; Stassen, 2012). While activism was at first mainly directed to combatting local problems and finding a way to bridge economic growth and environmental sustainability, towards the 1980s a more general focus on combatting environmental nuisance and pollution was visible. This growing awareness encouraged environmental departments to reinforce their role in environmental health, building on the principles of public nuisance in common law (Schilling & Linton, 2005). Under the Nixon administration in the United States the Environmental Protection Agency was established and the National Environmental Policy Act (1969), the Clean Air Act (1970) and the Noise Control Act (1972) were passed. These acts effectuated the establishment and enforcement of air and noise standards. Also in Belgium, the Ministry of Public Health promulgated laws on the control of air pollution (1964), the protection of surface water (1971), and the prevention of noise annoyance (1973) in order to protect public health generally. These legislations were characterized by command and control environmental regulations with thresholds that should be met. To coordinate and maintain these regulations, within the Ministry of Public Health an environmental department was established in 1971 (Stassen, 2012).

In addition, the environmental impact assessment (EIA) came into practice in the United States in the 1970s, and in the European Union in the 1980s. It was developed to analyze and evaluate the ecological and human health effects of large (infrastructure) projects (Corburn, 2004). The assessment promised to catalyze healthier spatial planning (Kørnøv, 2009), accompanied by a new generation of social epidemiologists who would redirect attention towards structural and environmental influences on health (Fitzpatrick & LaGory, 2004).

2.6 Continuing disciplinary boundaries

Towards the end of the century, epidemiologists and academics tried to bridge the gap between environmental analysis and policy implementation (Voogd, 1994). At the same time architects and urban designers began to adopt sustainable (and healthy) principles of New Urbanism, Eco-cities, walkability and Transit Oriented Development (e.g. Tjallingii, 1995; Leccese et al., 2000). However, their ideas were not applied broadly. In practice and in institutional terms, the fields of urban planning and public health remained largely disconnected in most Western countries (Corburn, 2004). In Flanders, environment and health portfolios remained allocated to separate Ministries, which hampered the development of integrated policies in a coordinated way (Stassen, 2012). Urban planning centered on comprehensive and neoliberal planning approaches, such as strategic regional planning processes and public-private partnerships. Environmental health was further institutionalized, adding to the EIAs the establishment of the health impact assessment (HIA) for the United States and other countries in the 1990s and the strategic environmental assessment (SEA) for Europe in the 2000s. While the SEA analyzed environmental effects for plans, programs and policies, the goal of the HIA was to analyze the general direct and indirect health effects of public policy, including urban planning (Joffe & Mindell, 2002). Both assessments promised better collaborative ties among the health, transportation and urban planning sectors for mitigating the many negative effects of the environment on health (Dannenberg et al., 2006). Yet, in practice they serve as periodic interventions, typically focusing on individual projects, and regarded as obligatory evaluations by most planners. Moreover, in most countries the results are not legally binding, rather, they are merely considered policy recommendations (Kørnøv, 2009). How this institutionalization has its effect on the current situation, and how this relates to the opinion of academia and the public, will be the subject of the next chapter.

3

The current disconnect

As history shows, the domains of urban planning and public health arose at the same time, initially evolved in close collaboration with each other, and became structurally separate. Although the direct impact of the built environment on public health seems to have decreased today (de Hollander & Staatsen, 2003) – largely due to sanitary developments and improved housing – since the end of the twentieth century a renewed interest in the relationship between the built environment and public health has been evident (Dannenberg et al., 2003; Frumkin, 2003; Jackson, 2003b). This growing interest is visible at several stages.

In the first place, the impact of the built environment on health and well-being is receiving increasing interest from both public health and spatial planning researchers. Recent concerns about levels of physical activity, asthma, sleep disturbance and stress have put the aspect of spatial planning back on the public health agenda, and vice versa. From a public health point of view, the New Public Health Movement, originating at the end of the 20th century, opened up new perspectives (Baum, 2003). This movement challenged the escalating cost and limited focus of therapeutically based health provision. Instead it advocated that also the environment in which people live greatly affects their health and the ability to pursue healthy lifestyles (Galea & Vlahov, 2005). Spatial planning researchers also started to realize that the built environment in post-industrial culture is a tremendous unexamined resource for improving human health. They acknowledge that planning policies have facilitated if not fostered the powerful trend towards car-dependent, sedentary and privatized lifestyles, with their negative effects on health and well-being (Jackson, 2003a; Barton et al., 2009). This increased research interest has led to growing empirical evidence, which strongly identifies urban design and associated activity patterns as a public health issue (Frumkin, 2003; Jackson, 2003a).

In their turn, and partly because of the growing research evidence, citizens are getting increasingly aware that their health and well-being are inextricably linked with environmental conditions. Together with the higher demands of the residential environment, due to the rise of living standards, public opposition against environmental threats is rising (Brown, 2013). There exist numerous examples of citizen protest that stopped or obstructed the construction of cell towers, high tension lines, windmills, highways or incinerators on behalf of a healthy environment. The focus shift from life expectancy to health expectancy and quality of life can be explained by Maslow's theory, which postulates that human needs are organized in a hierarchical fashion (Maslow, 1962). In fact, modern post-industrial people have become very healthy people, thanks to public hygiene, vaccination programs, antibiotics, a general improvement in standards of living and a comprehensive system of health protection (de Hollander & Staatsen, 2003). But when primary health needs such as food, shelter, sanitation and medical care are fulfilled, other aspects become more salient. Since lifestyle is (at least partly) seen as a personal choice, environmental quality may now be looked upon as the next determinant that must be addressed.

However, despite growing scientific evidence and rising public awareness, planning professionals rarely include health in their planning processes. In spite of a series of reports by various governmental bodies (e.g. by the World Health Organization, United Nations and European Commission) highlighting the need to include

health issues in planning and drawing on the support of legal requirements (e.g. the EU Directive 2001/42), the practical implementation is limited. Close working relationships between planners and public health practitioners remain scarce (Chapman, 2010). Today, health and environmental issues are the responsibility of their own specialized departments, while planning departments still focus on geographical or architectural approaches to space and time (Kørnøv, 2009). This disconnection, resembling a political structure with its specialized bureaucracies, hinders including intersecting issues like health in spatial policy (Corburn, 2007). Only through more or less obligatory planning evaluations, like the environmental impact assessment (EIA), or restrictive environmental legislation, health issues enter the planning processes. This EIA process, under control of the environmental department, is based on a system of generic environmental norms and regulations, with limit values for an array of environmental risks. Because of this obligatory external assessment, urban planners seem to be only concerned with environmental health risks in last instance.

The current disconnect between urban planning and environmental health and the distrust between citizens and the government are further examined in the remainder of this chapter. First, an overview of the state of the art in empirical research on environmental health is presented, based on exploratory literature review. This will discuss the evidence on the interrelation between aspects of the built environment and associated effects on health and well-being. The evidence base is growing with unprecedented speed but much uncertainty remains about the details of the relationships. Second, the growing public awareness of environmental health is looked at by analyzing the recent trend of citizen activism on environmental health issues in Flanders. Several pressure groups active in the Flemish public debate on environment and health were interviewed to gather their ideas on environmental health and the role of urban planning. A summary of the results illustrates the growing distrust of society versus government. Third, the shortcomings of the current government policy are analyzed in more detail, by focusing in particular on the practice of the environmental impact assessment in Flanders and discussing the outcome of interviews with civil servants. To conclude, three dilemmas are described on the institutionalization of environmental health in the current networked society, showing the need for a different approach.

3.1 State of the art in empirical research on environmental health

To make an overview of the up-to-date knowledge on the relation between environmental impacts and health effects, a literature review was carried out. To guide this study, important choices were made about the range of impacts included and the spatial scale of the effects. First, to discern the environmental characteristics relevant for spatial planning, the focus was on impacts caused by the physical environment, and not the social environment. Second, the analysis was directed to impacts that generate differences at a local neighborhood level, and not the building or regional level (for an analysis of impacts on other scales, see Jackson, 2003a).

The literature study did not have the aim to be exhaustive and complete, but to get a broad view of the different impacts, their importance, the scope of their effects and the value of the existing empirical evidence. Mostly recent sources were selected that are cited regularly and that incorporate possible confounding variables. One of the main lacunas is the primary reliance on cross-sectional studies, because of the limited availability of longitudinal studies.
To analyze the different impacts a scheme consisting of three parts was used (Figure 3): spatial conditions (1), impacts (2) and effects on health and well-being (3). A simple example is the spatial configuration of a highway (1), generating traffic noise (2) with an effect on sleep quality of neighboring residents (3).

Figure 3 Framework for analysis of environmental impact empirical evidence

Based on the literature review, four important impacts with sufficient scientific evidence could be discerned. Two of them are direct environmental impacts: air pollution and noise. The two others are indirect impacts: the absence of green space as a restorative environment and the lack of physical activity caused by the environment.
For other impacts the effects on health and well-being have limited evidence, the spatial component is less pronounced or the spatial differentiation of the effect at a local scale is unsure. An interesting impact that is not included is the urban heat island effect, defined as an increase in urban air temperature as compared to surrounding suburban and rural temperature, leading to relatively higher urban mortality rates during heat waves. The effect is due to the combination of a high anthropogenic heat production, the lack of air flow and the retention of heat by buildings and other hard surfaces. It is expected to be exacerbated in the future as a result of further urban growth and climate change. However, this impact was not included in the analysis since the health effects have mainly been measured at regional level, with the city center being at high risk compared to the surrounding area (Tan et al., 2010; Dousset et al., 2011; Gabriel & Endlicher, 2011). In this developing field there is no conclusive evidence yet on significant differences in health impact at urban neighborhood level. Yet, since spatial and temporal modeling of urban temperature get a lot of attention in recent years (De Ridder et al., 2015) and health risk assessment methodologies are being developed (Tomlinson et al., 2011), more evidence is possibly coming our way. Among the other non-included impacts are the lack of social interaction in the neighborhood (e.g. Mohnen et al., 2011), soil pollution (Lu et al., 2015), electromagnetic fields (e.g. Teepen & van Dijck, 2012), and unhealthy food environments (e.g. Caspi et al., 2012).

3.1.1 Air pollution

Air pollution is definitely one of the most important environmental impacts at a local scale. The local differentiation is mainly due to the spatial organization of roads and the accompanying traffic. Industry can also contribute to local air pollution but little research focuses on this aspect.

Figure 4 Environmental impact scheme: air pollution

The relation between air pollution levels and roads has been investigated extensively. A lot of studies show that traffic intensity, upwind/downwind location and/or distance to major streets or highways are important predictors of differences in measured pollutant concentrations, for NO_2[1] (Roorda-Knape et al., 1998; McAdam et al., 2011), $PM_{2.5}$[2] (Fischer et al., 2000; Janssen et al., 2001), (ultra)fine particles (Hitchins et al., 2000; Zhu et al., 2002; Hagler et al., 2009), elemental carbon or "soot" (Roorda-Knape et al., 1998; Kinney et al., 2000), CO[3] (Zhu et al., 2002; Kaur & Nieuwenhuijsen, 2009), benzene (Fischer et al., 2000) and ozone (Kuhler et al., 1994). These findings indicate that the measured pollutants are related to vehicle exhaust emissions.
For most traffic volumes and pollutants, the major decrease in traffic-based pollutants occurs in the first 100 meters and then levels off somewhat after 150 meters (Zhu et al., 2002; McAdam et al., 2011). However, at a distance of 1,000 meters away from a highway a contribution of the road to local air pollution can still be measured (Fischer et al., 2007).

Today sufficient scientific evidence concludes that living alongside busy roads is less healthy than living with a bigger distance between the home and major roads. The most important and most described health effects are in the respiratory system, with increased respiratory symptoms, lung growth deficits and allergy development, all disproportionally affecting children (Health Effects Institute, 2010).
Many studies show an association between high vehicle traffic and chronic respiratory symptoms like cough and wheeze in children (e.g. Wjst et al., 1993; Oosterlee et al., 1996; Van Vliet et al., 1997; Hirsch et al., 1999; Venn et al., 2001; Nicolai et al., 2003; Shima et al., 2003; Andersen et al., 2008; Hoek et al., 2012), or asthmatic symptoms and/or asthma hospitalizations (e.g. English et al., 1999; Lin et al., 2002; Brauer et al., 2007; Morgenstern et al., 2008; Nordling et al., 2008; Gehring et al., 2010; Sinclair et al., 2014). A recent systematic review by Bowatte et al. (2015) provides further evidence that traffic-related air pollution exposure may contribute to the development of asthma in children, and not only aggravates existing symptoms.
Cross-sectional studies in Europe have shown that deficits in lung function growth in children – associated with morbidity and mortality in adulthood (e.g. Knuiman

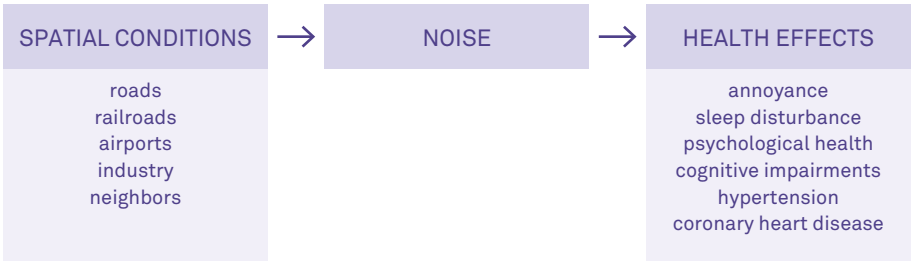
1 Nitrogen dioxide.
2 Particulate matter (PM) with a diameter of 2.5 micrometers or less.
3 Carbon monoxide.

et al., 1999) – are related to residential exposure to high (truck) traffic (Brunekreef et al., 1997; Sugiri et al., 2006). A highly cited research of Gauderman et al. (2007) showed that pronounced deficits in attained lung function at age 18 years were recorded for those living within 500 meters of a freeway, for both asthmatic and non-asthmatic children, thus giving evidence for adverse effects of traffic exposure on otherwise healthy children. This finding was confirmed in a cohort study by Schultz et al. (2015), who found that exposure to traffic-related air pollution has a negative effect on lung function at 16 years, leading to increased risk of clinically important deficits.
Associations between distance to the nearest main road and the risk of allergy development and exacerbation of allergic reactions have also been demonstrated (e.g. Krämer et al., 2000; Brauer et al., 2007; Morgenstern et al., 2008; Nordling et al., 2008; Bowatte et al., 2015).
Further, chronic exposure to air pollution from traffic is associated with increased mortality risks. Several studies show that individuals living close to major roads have an increased risk of mortality, although relative risks are small (e.g. Roemer & van Wijnen, 2001; Hoek et al., 2002; Finkelstein et al., 2004; Gehring et al., 2006; Beelen et al., 2008; Chen et al., 2013; Beelen et al., 2014).
The assumption that increased mortality is primarily associated with a higher prevalence of atherosclerosis (the hardening of arteries) and coronary disease is supported by the research of Hoffman et al. (2007), who found that long-term residential exposure to high traffic is associated with coronary atherosclerosis, and Gan et al. (2011), who observed an association between exposure to road traffic and adverse cardiovascular outcomes.

In terms of proximity, most studies use distances of 50 to 300 meters to indicate exposure to traffic-related air pollution, but adverse effects on health have been observed in people living up to 1000 meters from a busy road.
The closer to a road people live, the higher the concentration of pollutants and the higher the increase in adverse health effects. However, no studies are available that give evidence about an acceptable distance or concentration level at which there will be no adverse effects (Fischer et al., 2007; Beelen et al., 2014). Each choice for an “acceptable” distance between residential location and major roads or highways is not based on thresholds of health but on the societal acceptability.

3.1.2 Noise

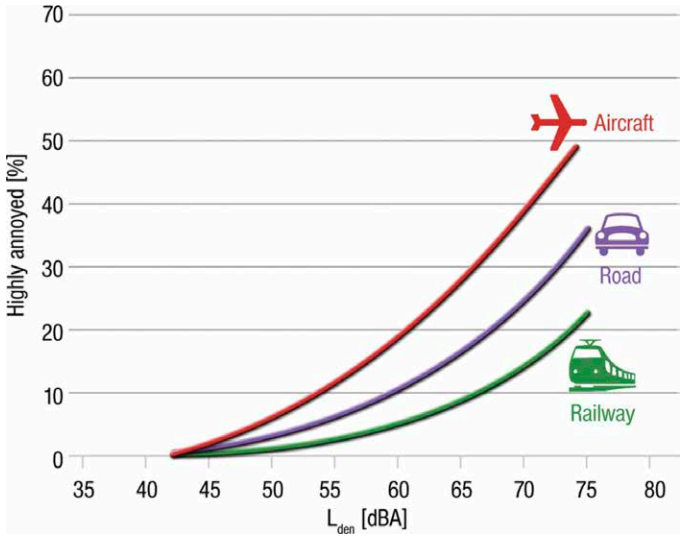
Figure 5 Environmental impact scheme: noise



Noise, defined as “unwanted sound”, is perceived as an environmental stressor and nuisance. It is an increasingly prominent feature of the urban environment and is being seen as an important environmental public health issue (Clark & Stansfeld, 2007). Noise is a phenomenon that is sensed and evaluated by everybody, and therefore noise exposure is one of the most frequent complaints of populations living in large cities (Muzet, 2007).

The direct auditory effects of noise on humans – like hearing loss – are well established. The corresponding sound levels and effects, however, do not occur in normal urban settings. Non-auditory effects cannot be explained as a consequence of sound energy, but result from noise as a general stressor (Clark & Stansfeld, 2007). Basner et al. (2014) give a good overview of all suggested health effects. Annoyance is the most reported problem caused by noise exposure and is often the primary outcome used to evaluate the effect of noise on communities (Ouis, 2001). Noise annoyance is a feeling of resentment, displeasure, discomfort, dissatisfaction, or offense when noise interferes with someone’s thoughts, feelings or actual activities (Passchier-Vermeer & Passchier, 2000). Of all health effects associated with noise, the dose-response relationship between community noise and annoyance is the most developed (Seto et al., 2007). However, the relation is not straightforward since the noise source plays an important role. Miedema & Oudshoorn (2001) showed that for the same noise levels aircraft noise causes more annoyance than road or railway noise (Figure 6). Moreover, in a systematic review Laszlo et al. (2012) note that annoyance as a reaction indicator should be evaluated with caution as non-acoustical factors play an important role in annoyance ratings. Technical interventions reducing noise may therefore not have impacts on annoyance proportionate to their impacts on sound levels.

Figure 6 Percentage of persons highly annoyed by aircraft, road, and rail traffic noises. The curves were derived for adults on the basis of surveys (26 for aircraft noise, 19 for road noise, and 8 for railway noise) distributed over 11 countries (Münzel et al., 2014; adapted from Miedema & Oudshoorn, 2001).



Associated with annoyance, both objective and subjective evidence suggest a relation between noise and sleep disturbance. Exposure to night-time noise might interfere with the ability to fall asleep, shorten sleep duration, cause awakenings and reduce quality of sleep (Michaud et al., 2007). Sleep disturbance can have an important impact on well-being, causing after-effects during the day: annoyance, irritation, low mood, fatigue, low vigilance and impaired task performance (Stansfeld & Matheson, 2003; Muzet, 2007). Community studies of traffic noise exposure have found consistent evidence for a direct effect on sleep disturbance (e.g. Öhrström, 2002; Miedema & Vos, 2007). Frei et al. (2014) recently found that nocturnal traffic noise has an effect on objective sleep quality, independent of perceived noise annoyance, while the association between self-reported sleep quality and noise is mediated by noise annoyance.
Given the effect of chronic noise exposure on annoyance responses, also psychological health might be affected. Studies of adults have confirmed that noise exposure relates to an increase in the number of reported psychological symptoms, such as anxiety and depression, higher levels of psychological distress and a higher prevalence of hyperactivity (e.g. Jones et al., 1981; Stansfeld et al., 1993; Haines et al., 2001a; Orban et al., 2016).
Further, strong evidence is available for a direct effect of noise on the cognitive development of children. Several studies have established that children exposed to noise experience cognitive impairments – especially impaired reading comprehension and sustained attention – with the suggestion that the children's further cognitive development may be affected (e.g. Haines et al., 2001a; Haines et al., 2001b; Stansfeld et al., 2005; Klatte et al., 2013). A highly cited field study was the naturally occurring longitudinal quasi-experiment reported by Evans and colleagues (Evans et al., 1998; Hygge et al., 2002). They examined the effect of the relocation of Munich airport on children's health and cognition, demonstrating a causal link between noise exposure and cognitive effects. A recent study of Clark et al. (2012) confirmed the effect for exposure to aircraft noise but did not find an association for road traffic noise.

There is also consistent and strengthening evidence for a small but significant effect of transport noise on hypertension and coronary heart disease (Babisch, 2006; Clark et al., 2007; Münzel et al., 2014). One of the most striking results comes from Jarup et al. (2008), who found an increased risk of hypertension related to long-term aircraft and road traffic noise exposure. Other studies showed an effect of transport noise exposure on the use of anti-hypertensive drugs (Greiser et al., 2007), self-reported hypertension (Rosenlund et al., 2001; Bluhm et al., 2007) and heart attack (Babisch et al., 2005; Selander et al., 2009). Following on from the discussion on confounding of air pollution effects, Gan et al. (2012) found independent effects of traffic-related noise and air pollution on cardiovascular disease and mortality. Also Halonen et al. (2015) adjusted their models for air pollution and found that long-term exposure to road traffic noise was associated with small increased risks of (cardiovascular) mortality, particularly for stroke in the elderly.

Despite the growing evidence for small effects on cardiovascular health, psychological health and cognitive development in children, this overview shows that effects of noise are strongest for annoyance and sleep disturbance. What these effects lack

in severity is made up for in numbers of people affected and the chronic nature of exposure. What complicates matters is that perceived annoyance and perceived sleep deprivation are not always corresponding to measured noise levels since they are also affected by the noise source, non-acoustical factors and personal characteristics.

3.1.3 Absence of green space as a restorative environment

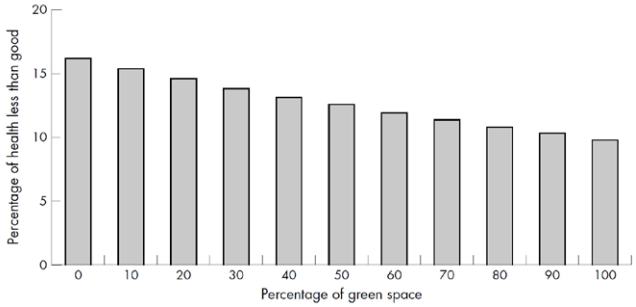
Figure 7 Environmental impact scheme: absence of a restorative environment

Since the start of the twenty-first century, a new research field has emerged on the relation between the availability of green space in a neighborhood, associations with several health outcomes and the restorative effect as the explanatory mechanism. In this point of view, green space is interpreted as “open, undeveloped land with natural vegetation”, including parks, forests, playing fields, and river corridors (Mitchell & Popham, 2008).

Today, evidence suggests a positive relation between the amount of green space in the neighborhood and self-perceived health (de Vries et al., 2003; Maas et al., 2006; Mitchell & Popham, 2007; Sugiyama et al., 2008; van Dillen et al., 2012) (Figure 8), a measure that coincides well with actual health and well-being (Jylhä, 2009). In these studies the relations are usually stronger for people with a lower socio-economic status and for youth and elderly. They also suggest that quality of green space plays an important role (Mitchell & Popham, 2007; van Dillen et al., 2012).
A study of Maas et al. (2009) showed that 15 of 24 assessed types of disease were less prevalent in living environments with more green space in a 1 kilometer radius. The relation between green space and physician-assessed morbidity was comparable with the relation between age and morbidity. The strongest association was found for anxiety disorder and depression, suggesting that mental health in particular might be affected by the amount of local green space. Also Nielsen and Hansen (2007) and Ward Thompson et al. (2012) found a relation between access to green space around the dwelling and prevalence of stress.

Further, the availability of green space has a moderating effect. It was demonstrated that income-related inequality in all-cause and circulatory mortality is lower in populations living in the greenest areas than in those having less exposure to green space (Mitchell & Popham, 2008). The relationship between

Figure 8 Relation between amount of green space (in a 3 km radius) and self-perceived health (Maas et al., 2006)



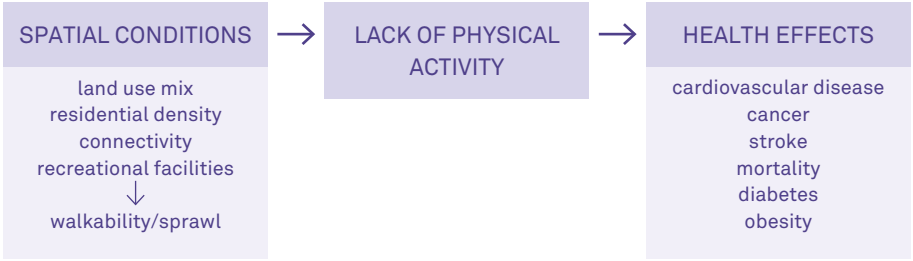
stressful life events and the number of health complaints was also significantly moderated by the amount of green space in the neighborhood (Wells & Evans, 2003; van den Berg et al., 2010). Other studies found a moderating effect of availability of green space on psychosocial effects of noise (Gidlöf-Gunnarsson & Öhrström, 2007; Dzhambov & Dimitrova, 2014) and on the damage of traffic stress on well-being (Song et al., 2007). These results support the notion that green space can provide a buffer against the negative health impacts of a lower social economic status, stressful life events or environmental stress factors.

Despite the growing empirical evidence on the relation between availability of green space and human (mental) health, it is still unclear how green space exerts a positive effect on health. However, strong scientific evidence has been found for the positive effects of nature on recovery from stress and attention fatigue, the so-called Attention Restoration Theory (Kaplan & Kaplan, 1989; Verheij et al., 2008). Most of the evidence for the restorative effect comes from laboratory experiments that exposed participants to photographic simulations of various types of natural environments (van den Berg et al., 2003; van den Berg et al., 2007), or controlled field studies that compared residents with natural elements in their view from the window to residents without such view (Kaplan, 2001). Several experimental studies suggest that exposure to green spaces (either physical or visual) can also reduce blood pressure (Hartig et al., 2003; Pretty et al., 2005). Recent research by de Vries et al. (2013) discerned both stress relief and social cohesion as mediators for the greenery-health relationship and found no evidence for physical activity as a mediator.

In summary, the absence of green space in residential neighborhoods might have an impact on the health and especially the well-being of people. Probably the restorative quality of these small nature areas is the most important mechanism for this effect. However, policy makers tend to view green space more as a luxury good than as a basic necessity, and appear to overlook its potentially important effects on health and well-being (Groenewegen et al., 2006).

3.1.4 Lack of physical activity

Figure 9 Environmental impact scheme: lack of physical activity



Since the turn of the century the relation between the built environment and physical activity has gained a lot of research interest. Low residential density, single-use zoning and low connectivity have been associated with less walking and cycling (Frank, 2000; Frumkin, 2002).

Low levels of physical activity threaten health both directly and indirectly. The direct effects of a sedentary lifestyle consist of a higher risk of cardiovascular disease, stroke and all-cause mortality (e.g. Wannamethee et al., 1998; Sesso et al., 1999; Wannamethee & Shaper, 1999; Wei et al., 1999; Lee et al., 2000; Lee et al., 2003; Schmidt-Trucksäss, 2016) and some cancers (e.g. Oliveria & Christos, 1997; Lee et al., 1999).
In addition, lack of physical activity contributes significantly to the risk of being overweight, which is a well-established risk factor for several diseases: heart disease, hypertension, stroke, osteoarthritis, gall bladder disease, some cancers and diabetes (e.g. Must et al., 1999; Mokdad et al., 2000; Vucenik & Stains, 2012). Mortality is also associated with obesity (e.g. Adams et al., 2006; Flegal et al., 2013). Obesity prevalence has risen steadily over the past decades. It is recognized as a major threat to public health, accounting for substantial disability and costs (e.g. Flegal et al., 2005; Olshansky et al., 2005; Caballero, 2007; Kohl 3rd et al., 2012). Research has recently expanded from a focus on individual determinants of obesity to investigating upstream influences in a social ecological model, including how the environment in which people live influences their lifestyle and weight. Urban design does not fully account for increasingly sedentary lives, and physical inactivity does not tell the entire story of the epidemic of being overweight, but today a growing consensus points to the environmental contribution to obesity (e.g. Hill et al., 2000; Frumkin, 2002; Witten & Pearce, 2016).

Empirical research into the effects of the built environment on physical activity and obesity has increased substantially since the start of the twenty-first century. Several review papers discuss the evidence to date (Saelens et al., 2003a; Booth et al., 2005; Duncan et al., 2005; Davison & Lawson, 2006; Kaczynski & Henderson, 2007; Papas et al., 2007; Wendel-Vos et al., 2007; Black & Macinko, 2008; Lee & Moudon, 2008; Feng et al., 2010; Renalds et al., 2010; Durand et al., 2011; Ding & Gebel, 2012). The concluding part of this subsection will look more deeply into the different measures that might be related to physical activity and obesity. The

focus is on spatial characteristics that can be modified through urban policies and planning initiatives, not on simple design interventions.

Many reviews approve the relation between physical activity and the concept of *walkability* of a neighborhood, a measure mostly based on residential density, street connectivity and land use mix (Saelens et al., 2003b; Frank et al., 2007). A large amount of studies show that adults who live in walkable neighborhoods walk and cycle more for transportation and are more physically active (e.g. Takano et al., 2002; Berke et al., 2007; Frank et al., 2007; Handy et al., 2008; Lee & Moudon, 2008; Carlson et al., 2015), but for children the same relation is not always found (D'Haese et al., 2014). Also the county *sprawl* index of Ewing et al. (2003), based on measures of low residential density and poor street accessibility, is related to physical activity, with residents of sprawling counties walking less.
The variables used to form these two measures are also individually associated with physical activity levels. *Land use mix*, notably mixed commercial-residential land use, is associated with higher levels of physical (walking) activity (e.g. Doyle et al., 2006; Frank et al., 2006; Li et al., 2008). The related characteristic of proximity to retail stores and commercial establishments also appear to increase physical activity levels (e.g. Berke et al., 2007; Nagel et al., 2008). Some studies confirm the association of *residential density* with physical activity, for example using measures based on population density (Frank et al., 2005) or compactness of urban settings (Frank et al., 2006). Also *connectivity* of the local transport network is associated with physical activity levels, with positive relations found for bike lane connectivity (Titze et al., 2008), intersection density (Frank et al., 2006) or size of neighborhood blocks (Wood et al., 2008).
Finally, substantial evidence exists for the association between proximity to a *variety of accessible recreational facilities* (such as parks, playgrounds, sports grounds, recreation areas) and higher physical activity levels. The relation has been found for all ages (e.g. Giles-Corti & Donovan, 2002; Wendel-Vos et al., 2004) and for specific target groups like children (Roemmich et al., 2006), adolescents (Babey et al., 2008), and elderly (Kemperman & Timmerman, 2009; Ranchod et al., 2013).

Concerning obesity, the available reviews point to an effect of the built environment, but leave much uncertainty about the specific associations and their magnitude. Given the large-range factors that affect weight status and potential time-lags between exposure and change in bodyweight, the lack of a strong association with weight outcomes found in cross-sectional studies is unsurprising (Durand et al., 2011). Nevertheless, in a recent research Ewing (2014) found that several compactness measures are negatively related to body mass index and obesity but not to physical activity, after controlling for observed confounding influences. He thinks that in his study personally assessed physical activity might underestimate actual physical activity levels, which should include active travel to work, shopping, and other destinations.
Based on the selected reviews obesity or increased body mass index can be linked to *walkability* (e.g. Frank et al., 2004; Frank et al., 2007; Rundle et al., 2008), *sprawl* (e.g. Kelly-Schwartz et al., 2004; Ewing et al., 2006; Joshu et al., 2008), *mixed land use* (e.g. Frank et al., 2004; Mobley et al., 2006; Bodea et al., 2008; Rundle et al., 2008), *population density* (e.g. Lopez-Zetina et al., 2006; Rundle et al., 2007;

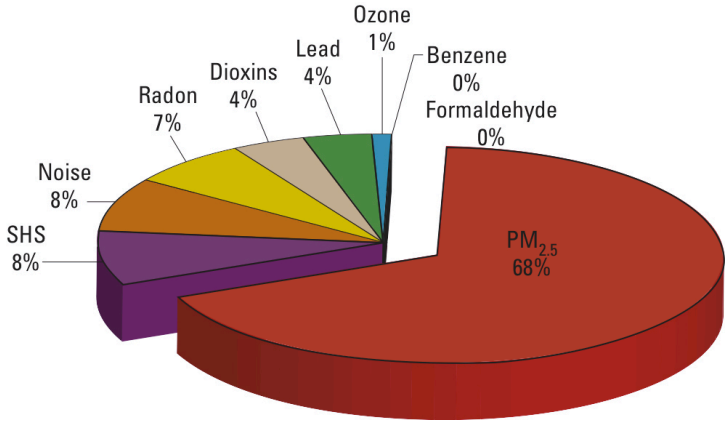
Stafford et al., 2007) and *access to recreational facilities* (e.g. Giles-Corti et al., 2003; Burdette & Whitaker, 2004).

Although the importance of several urban design measures is clear, no agreement exists about which factors would be the most effective or efficient targets for intervention. However, it is clear that (a combination of) the discussed measures can support urban design choices and evaluate neighborhood suitability for physical activity.

3.1.5 Environmental burden of disease

Based on the research evidence, for none of the impact-effect relations a clear quantification can be provided. There is no agreement on safe levels of noise or air pollution under which no adverse health consequences occur, neither on safe distances to a road or highway. For the indirect effects of green space and walkability, quantification is even harder, since different pathways exist that can explain the relation with health effects.
Nevertheless, for the direct impacts of air pollution and noise estimated quantifications of health effects are made. In a European research project comprising six countries, the included environmental risk factors accounted for about 3 to 7% of the total annual burden of disease (Hänninen et al., 2014). Airborne particulate matter ($PM_{2,5}$) was the leading risk factor associated with 6,000-10,000 DALYs[4] per million people per year. Together with secondhand smoke, traffic noise (including road, rail and air traffic noise) was second, with estimate ranges between 600 and 1,200 DALYs per million people per year – considerably lower than the health burdens of air pollution (Figure 10).

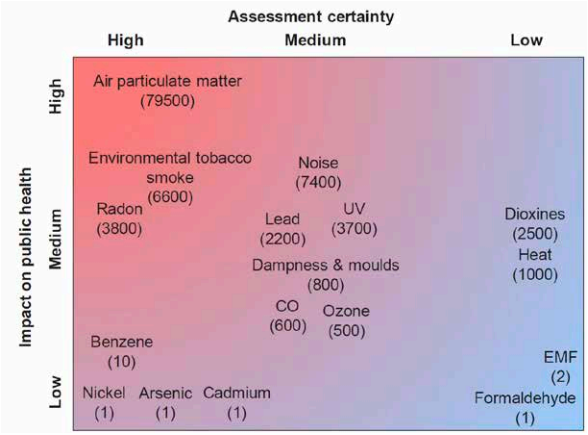
Figure 10 Relative contributions of nine targeted risk factors to the estimated burden of disease attributed to these risk factors, averaged over six participating countries (Hänninen et al., 2014)



4 DALY = disability-adjusted life year, a measure of overall disease burden, expressed as the number of years lost due to ill-health, disability or early death.

Research of the Flemish Institute of Technological Research (VITO), on behalf of the Flemish Government, gave similar results for Flanders (Buekers et al., 2012). Environmental impacts were found to be responsible for 8% of the overall disease burden in Flanders. This corresponds to a yearly loss of 100,000 DALYs, of which 79,500 DALYs are associated with air pollution (particulate matter), followed by noise pollution with 7,400 DALYs and environmental tobacco smoke with 6,600 DALYs (Figure 11). Following their estimation, the healthcare expenses of air pollution mount to 5.2 billion euro.
Regardless of the much greater health burden due to air pollution, citizens seem to be particularly worried about noise in their living environment, especially in Flanders. A series of surveys conducted every three years by the Department of Environment, Nature and Energy of the Flemish Government addresses the subjective evaluation of environmental impacts. This survey (called "Schriftelijk Leefomgevingsonderzoek") shows that (traffic) noise is the most important determinant of satisfaction with the living environment. A pleasant living environment thus largely depends on the sound environment (Botteldooren et al., 2011). However, in these surveys the impact of air pollution is only questioned by asking about odor nuisance. The growing awareness and concern about the health effect of air pollution might thus be missed.

Figure 11 Central estimate of the amount of Disability Adjusted Life Years (DALYs) per year in Flanders caused by different environmental stressors (Buekers et al., 2012)



3.1.6 Summary

Without having the ambition to give an exhaustive overview, the exploratory literature study in this paper shows that the relation between urban planning and health definitely needs our attention. The health relevance of the four described impacts is founded by a considerable amount of empirical evidence, of which only a part is mentioned in this paper.
Most empirical evidence is available on the negative health impacts of air and noise pollution from traffic. For air pollution, residential exposure to high traffic has been related to asthma, deficits in lung development and allergy development in

children; and a higher mortality and coronary disease risk for the whole population. For traffic-related noise exposure, conclusive associations have been found with annoyance, sleep disturbance, cognitive impairment of children and (slightly) increased risk of hypertension and coronary heart disease. Since the start of the twenty-first century a broader perspective is used and a lot of indirect relationships are proposed. Especially the associations between a green living environment and an improved mental health and between a walkable, mixed land use environment and physical activity levels have been extensively researched. However, for these relationships evidence is largely restricted to cross-sectional studies showing only correlation (not causality), the size of the effect remains unknown, and discussion on the specific pathways from environmental characteristics to health effects is still going on.

The four described impacts are of high relevance for urban planning since they can be acted on by planners and designers. The location of infrastructures like roads and railways and the traffic intensity can have an effect on exposure to air pollution and noise, the planning of green space in cities might create restorative environments and increase the mental health and well-being of nearby residents, the residential density and mixed land use of neighborhoods could contribute to higher levels of physical activity. These examples show the importance of incorporating the results from environmental research in urban planning policy and design. However, integrating these impacts in policy is not so clear-cut, as this analysis revealed several difficulties:

- The evidence is growing at unprecedented speed, making it impossible to grasp it in its entirety and quickly adapt policy accordingly.
- With regard to the two direct impacts (air pollution and noise) the harmful effect on health is not contested any longer, but uncertainty about the details of the relationship and the size of the effects remains. Generic distance rules for polluting infrastructures make little sense since local urban design and climate (e.g. wind) can significantly affect the local spatial distribution of impacts.
- With regard to the two indirect impacts only a part of the possible confounders is corrected for. Demonstrating causality and discerning the different pathways remain difficult (and maybe impossible) tasks.
- The environmental impacts lead to risks at the population level that cannot be easily translated to local situations. Certain populations and neighborhoods are more vulnerable than others.
- Perception does not always correspond to reality. This can complicate policy decisions but also allow for for creative solutions that influence perception.
- Impacts are often interfering with each other. For example, the higher the population density and mixed land use in a neighborhood, the more physically active people will be, but the more people will complain about noise as well.

The larger health burden and the stronger empirical evidence on health effects for air pollution and noise are the main reasons why these impacts will be the subject of the empirical research of this dissertation (Chapter 5 to 8). Especially for air pollution and noise, some impact-effect relations are linear and unambiguous. However, when different impacts are combined in a real world where no two places

and no two persons are alike, generic and linear regulations do not make much sense. In subchapter 3.3 will be analyzed how the current institutional environmental framework still interprets environmental impacts like air pollution and noise in a deterministic way. But first another recent evolution complicating the debate on environmental health is examined: the growth of public awareness and protest.

3.2 The growth of environmental pressure groups in Flanders

Because of growing research evidence, combined with highly educated citizens and today's open transfer of information, an increasing awareness of citizens about their health and well-being has emerged, inextricably linked with environmental conditions. A particular aspect, at least in Flanders and Brussels, is the recent growth of environmental associations and pressure groups that focus on topics of urban environmental health. After some successful actions, their strategies and functioning became more professional, leading to more support among citizens and a greater impact on urban planning processes.
To gain more insight into this emergent societal power, five actual environmental pressure groups were analyzed by qualitative interviews (Table 2). The interviews tried to reveal the background, aims, strategies, functioning and partnerships of these groups. In addition, the interviewees were asked for their opinion on the current inclusion of health in spatial planning processes and on possible beneficial adaptations. Hereafter, the main findings from the interviews are summarized. Copies of the transcribed interviews are available on request.

Table 2 Five representatives of Flemish environmental pressure groups were interviewed

Date	Organization	Interviewee
06/02/2014	Gents Milieufront (GMF)	Steven Geirnaert (coordinator)
06/02/2014	Straten-Generaal	Manu Claeys (chairman)
10/02/2014	Brusselse Raad voor het Leefmilieu (Bral)	An Descheemaeker (coordinator)
12/02/2014	Ademloos	Wim Van Hees (chairman)
19/02/2014	Bond Beter Leefmilieu (BBL)	Erik Grietens (policy advisor)

3.2.1 An analysis of five environmental pressure groups in Flanders

Gents Milieufront (GMF) (in English: Ghent Environmental Front) is an urban environmental association based in the city of Ghent, founded in 1998 by a group of volunteers committed to the environment. Today GMF has almost 1,500 individual members and except for three paid staff members, the organization works only with volunteers. They have an urban focus and are working on a broad range of topics like livability, environmental quality, energy, mobility, waste disposal, etc. Their strategies and tactics are diverse with the main activities being (protest) actions, networking/lobbying and communication in all kinds of media (website, press, news

agencies ...). Doing as much as possible is both their weakness and their strength. A weakness, because their focus is unclear and their efforts are never optimal, but also a strength, because the city often involves them in policy processes and debates for their broad expertise. Their general functioning regarding urban environmental conflicts can be described as action- and protest-driven to put pressure on urban policy. They have no formal representational function in advisory boards or commissions, nor do they perform studies themselves. Their lobbying strategy is focused on contacts with political parties and their networking on supporting all kinds of citizen initiatives in the city of Ghent and cooperating with similar groups from outside Ghent. They try to collaborate with scientists and researchers, but are not deliberately looking for these alliances.

The protest group *Straten-Generaal* (in English: States General for Streets) is a small community action group in the city of Antwerp, founded in 1999 and with a core of five to ten members. Their major ambition is to pursue a good local environmental quality (urban design, public space, green space ...) supported by participation and debate. However, in the last decade they particularly became known by their protest against the project of the Oosterweel connection in the city of Antwerp, deemed to complete the Ring Road through a combination of tunnels and viaducts. They see themselves as an "organic association", having almost no funding and working only with volunteers (no paid staff members). They strongly believe in the organic aspect because this puts them outside the political system. Although they occasionally perform legal challenges, their main activities are networking, own study work and communication. By networking they support and bring together many emerging protest groups and ally themselves with scientists, physicians and even managers or economists that strengthen their message. They have a strong belief in these – not always obvious – alliances. A second pillar of their strategy is substantive study of existing analyzes and reports, but also developing alternative solutions. Finally, they organize information evenings and go everywhere to speak at invitation, to disseminate knowledge, raise awareness among the population and encourage collective expertise.

The *Brusselse Raad voor het Leefmilieu (Bral)* (in English: Brussels Council for the Environment) is a Dutch-speaking environmental association in the city of Brussels, founded in 1973 out of several city protest movements, in the light of the struggle of the Dutch-speaking population to stand up for their own interests. They have about 60 members – individuals, grassroots movements and residents' associations – and focus on a livable city where residents can live, travel and recreate in a sustainable, affordable and pleasant way. They are a structural movement, with several paid staff members, and are officially recognized by the city and regional government. This is illustrated by their formal representation in several advisory boards like the environmental board or the mobility board. Apart from this representative function, their strategy is centered on lobbying, networking, building knowledge, press releases and giving support and advice to small local protest groups. Occasionally actions or pilot projects are set up. They get structural government funding, which makes it sometimes difficult to set up protest and pushes the association towards a constructive position and dialog.

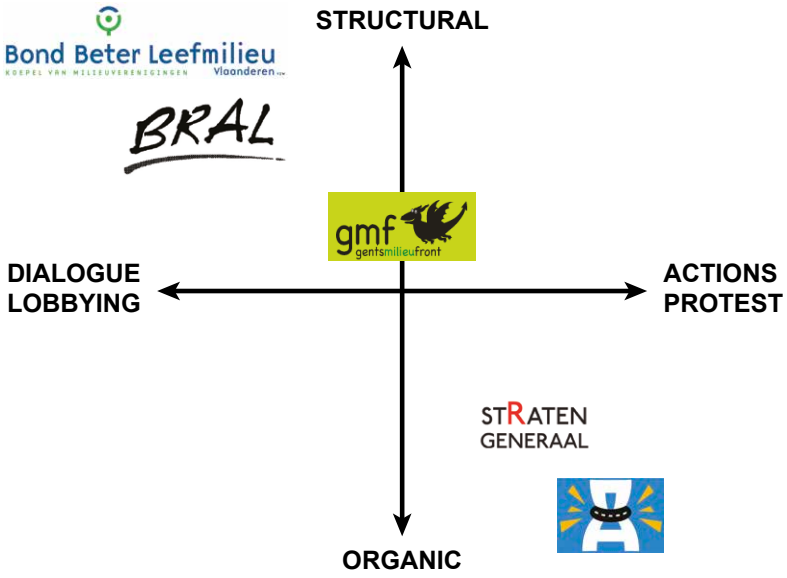
The protest group *Ademloos* (in English: “breathless”) is a small virtual community action group in the city of Antwerp with a loose structure, founded in 2007. It has a core of five members, supplemented with a contact list of experts, politicians and other like-minded people. It is a one issue group, focusing solely on the protest against the Oosterweel connection in Antwerp, a huge infrastructure project to complete the Antwerp Ring Road with a combination of viaducts and tunnels. Ademloos particularly focuses on the possible health impacts of the project, i.e. air pollution, and refers to this in its name. Because the existing technical resistance and political lobbying had yielded no results yet, the group adopted a professional marketing strategy. By a keen communication and advertising campaign (not least through social media) and controversial actions they could soon reach a large part of the citizens and force a referendum on the city council. This dynamic part is supported by a technical part in which all the public health arguments are documented, not by carrying out studies themselves, but by collecting study results, numbers and facts. In addition, they involved academic experts like environmental epidemiologists and urban planners, to gain credibility and to avoid the stigma of NIMBY protest.

Bond Beter Leefmilieu (BBL) (in English: Federation for a Better Environment) is the Flemish umbrella organization for the environment, founded in the wake of the May 1968 protests when concerns about the environment grew and several local environmental movements needed more structure and organization. Today the umbrella organization is a structural movement with about 150 members, mostly local environmental and nature associations. To support its operations, BBL has about 30 paid staff members and receives substantial structural government funding. Their primary aim is a better environment and so they focus on major long-term goals such as climate protection, sustainable mobility and air quality. Their man activities are setting up campaigns to raise awareness, supporting and advising the member associations, and influencing policy making. They do the latter mainly by formal representation in important advisory councils at the Flemish level, like the Mobility Council Flanders or the Environment and Nature Council Flanders. In addition, they try to influence policy making by classic lobbying (e.g. the ministerial cabinets) and are often spontaneously invited when a policy process is started. To support policy recommendations, they sometimes undertake studies or set up own actions. However, real protest actions are seldom organized in the name of BBL, since their formal policy advisory role commits them to consensus-seeking to realize their goals. But behind the scenes collaborations with local grassroots movements are often set up, to put pressure on the traditional formal policy consultations.

Although these five groups focus on comparable issues of urban livability and environmental quality, striking differences appear (Figure 12). The most important difference is between the groups with a structural organization that are recognized by the political system (BBL and Bral), the ones that are organic, non-structured, self-organizing initiatives that “attack” the political system (Ademloos and Straten-Generaal), and the ones that are somewhere in between, with a structured organization but without a fixed representative role in the political system (GMF). The used strategies differ accordingly: BBL and Bral are heavily funded by the government and stick largely to dialogue, lobbying and collection of data and

study results; Ademloos and Straten-Generaal at their turn are protest groups on the ground with a more offensive strategy; and GMF uses different ways to get into dialogue with the city but is often forced to sensational protest actions to stay relevant. Accordingly, the groups have a different scope: BBL and Bral focus on a variety of domains at a regional scale, GMF has a clearer focus at city-level, Straten-Generaal works in the city of Antwerp but focuses on a few particular cases and Ademloos is a one-issue movement, focusing solely on one infrastructure project.

Figure 12 Analysis of five Flemish environmental pressure groups



Both the structural organizations and the organic initiatives do not officially represent large numbers of people. BBL and Bral respectively represent 150 and 60 organizations, GMF has about 1,500 individual members and Ademloos and Straten-Generaal do not work with a membership policy but stick to occasional petitions to prove their support. However, all these groups have a powerful impact on the public debate and policymaking and reinforce each other. The structural organizations have good connections with politicians and government administrations, and can meet certain aims through dialog. But because of this position, they can never take too far-reaching viewpoints. The bottom-up, organic initiatives can complement this method by taking stronger positions and organizing protest. As such, they are more suited to raise awareness among citizens and build support. This bottom-up protest then in turn can be used by the structural organizations to set higher demands.

The diagram in Figure 12 shows the five discussed pressure groups only filling two quadrants. While these two quadrants represent the majority of environmental pressure groups, some recently formed Flemish groups can be placed in the two other quadrants. The Ringland initiative in the city of Antwerp, proposing an alternative solution for the completion of the Ring Road around the city, takes

up a top right position in the diagram. It evolved from a small, organic group of volunteers to a professionalized, structured organization with paid staff members and a substantial budget, but still challenging the political system (http://www.ringland.be/). A good example of an environmental group in the bottom left corner of the diagram is the "de Koep" citizen initiative in the town of Turnhout, aiming to make living and working in the region as pleasant, just and sustainable as possible. They adopt a cooperative spirit, a transparent way of working and strive to maximize commitment and self-responsibility of citizens. Instead of organizing media-friendly actions and protest to raise public awareness, they believe in open dialogue with all stakeholders to realize positive change (http://www.dekoep.be/).

3.2.2 Grassroots ideas on healthy urban planning

In the interviews with the different environmental pressure groups was also asked for ideas to improve the integration of public health in urban planning and policy, and what their role could be.

> *"Governmental power is overestimated. Actually the authorities have little room for maneuver but try to create an illusion of decision-making power. It would be closer to reality if the government would admit they are only a player in the field, albeit an important one, and stop trying to control everything. It is in in the interest of policy processes that the authorities proactively give room to citizen initiatives, otherwise these initiatives will continue to claim their place and delay policy decisions."*
>
> *- representative of environmental association*

All groups strive for a better inclusion of their movements in spatial policy. They think a government can only be ambitious and creative if bottom-up ideas and expertise can move up to the level of policymaking. If the authorities remain inadmissible, they will eventually be forced to reorganize the political decision-making. The pressure groups see no alternative, and point to a general sense that their movements will only gain more support, power and influence. At least in Flanders this evolution is partly due to the democratization of higher education, which has led to an educated and skilled population. Citizens increasingly stand up for their rights and criticize governments and policies. Environmental pressure groups also learn from each other's experiences and become more professional and efficient in their resistance. In their opinion, a government has to capture this evolution and insert the bottom-up expertise and ideas in a democratically functioning policymaking structure.

> *"The engaged and responsible citizen will only become more assertive, for example by social media that help citizens to connect, establish networks and organize protest actions. They increasingly learn from each other and bring in professional expertise – someone with good communication skills, someone with a technical background, etc. There is more coming together in these action groups, enhancing their impact."*
>
> *- representative of environmental association*

An interesting issue in this evolution, raised by the interviewees, is the value of collective expertise. In today's society the easy access to information (e.g. transparency of government, internet, a critical press) and many local networks lead to a high circulation of knowledge (e.g. grassroots movements that continue to inform themselves). Around specific spatial conflict situations a cloud of actively involved local experts is shaped, which each in their own way can offer valuable input. According to the interviewees, this expertise cannot replace the classical skilled expertise provided by the government but supplements it, leading to advanced knowledge and better substantiated solutions. They see scientists and medics as interesting partners in this formation of collective expertise, by supplying objective information, but also stress the pedagogical task of the government in feeding the collective expertise, i.e. by translating studies and policy documents to a large share of the population.

> *"By calling upon collective expertise not only more information is available, but also an assessment of interests takes place at an early stage in the policy process. This idea of involvement leads to a broader social consensus."*
>
> *- representative of environmental association*

The grassroots movements believe in self-organized, bottom-up initiatives to have a great chance of success, not only for local problems, but also for more abstract issues at city scale. They refer to several examples where a group of citizens conducts studies and collects information, in a participatory way, to address and solve environmental problems. However, in most cases the government is still not very receptive to this. If the authorities are not cooperative or in case of financial barriers, one of the final resources these movements are using is crowdfunding. This idea, where citizens organize fundraising to realize their ideas, illustrates again their persistence.

3.2.3 Summary

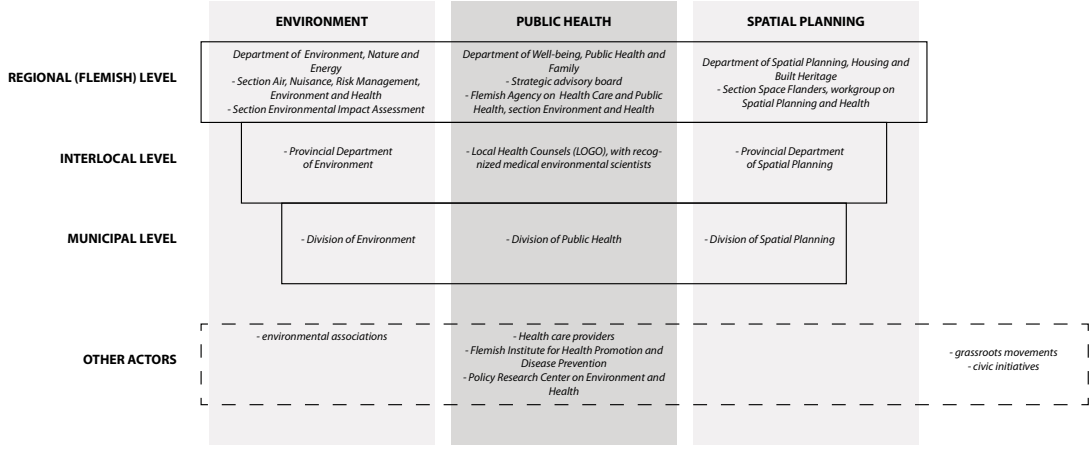
The discussed movements adopt different strategies and operate both as an "attacker" of the political system, and as a player within the political system. However, the groups find each other in (sometimes invisible) cooperation as they all strive for a more sustainable and healthy environment. They gain more and more citizen support for their initiatives by disseminating factual information, taking a critical but constructive position and combining expert and lay knowledge to build collective expertise.
The analysis shows that, supported by a growing public awareness, environmental movements are increasingly trying to influence spatial policy. There is a large potential and willingness to include more grassroots, organic initiatives in policy making. However, most authorities still have no answer to this evolution. This is understandable, since integrating their ideas in policy making is not always that straightforward. When more room is given to bottom-up initiatives, particularly the problems of a specific well-educated part of the population might be tackled. Although certain overarching environmental movements try to defend the rights and needs of all citizens, because of limited time and resources they often stick to guiding and supporting the spontaneous, self-organizing initiatives.

The success of these movements illustrates the citizens' distrust of the government. To fully understand this, first a clear picture should be obtained of the current spatial policy on environment and health.

3.3 Government policy on environmental health

The growing attention for environment and health among researchers and the public did not yet increase attention in planning practice, public works or spatial policy decisions. Although the aspect of public health is often included in governance agreements, concrete actions are not yet present. Urban design is still heavily influenced by archaic planning practices, partly because of the institutional separation of different policy domains, with a division of responsibility and foci (Jackson, 2003a; Kørnøv, 2009). Spatial planning, mobility planning and public works are, in most cases, undertaken in (separate) technical departments with professionals such as planners, engineers and architects, who are not familiar with "determinants of health" and other related terms. Health and environmental issues are the responsibility of health and environmental agencies, with other professions having the primary focus on providing service and treatment instead of prevention (Kørnøv, 2009). Also Corburn (2007) and Kidd (2007) point to this professionalism in the traditional government structure, and how it has created specialized bureaucracies hindering the inclusion of crosscutting issues like health in spatial planning. For Flanders, Figure 13 provides a scattered picture of all government administrations and stakeholders related to environment and health.

Figure 13 Overview of all administrations and other stakeholders related to the issue of environment and health in Flanders



Hereafter, the current spatial policy on environment and health is further discussed. First, a brief analysis of the Environmental Impact Assessment process illustrates the weaknesses of the current institutional structure and regulatory framework. Second, the outcome of interviews with civil servants is reported to give more insight in the current way of working and room for change.

3.3.1 The deficiencies of environmental impact assessments

Today, concerns about public health enter the planning process usually only in the final stages through an obligatory Strategic Environmental Assessment (SEA), or they are evaluated in connection with building permits through an Environmental Impact Assessment (EIA). In Flanders, the initiator of a plan or project – public or private – carries out the environmental assessment, but generally hires consulting companies that work with specialized experts in environmental science for different parts of the assessment report (e.g. environmental noise, air pollution, water pollution). The resulting report has to be approved by the government offices, often with advice from the environmental department, but in the whole process interdisciplinary collaboration with the planning department is generally lacking. Moreover, the environmental assessment process is based on generic environmental norms and regulations, with thresholds on an array of environmental risks. It results in at least five major deficiencies in tackling environmental health issues, listed below. This summary covers an analysis of the environmental assessment process in Flanders, based on desk research (mainly collecting information from the Flemish Government website on environmental assessment reports; http://www.lne.be/themas/milieueffectrapportage) and interviews with civil servants and environmental movements (see 3.2.1 and 3.3.2).

1 The environmental assessment framework has an environmental focus, not a public health focus.
   - The aspect of public health concerns only a tiny part of the environmental assessment process. Sometimes public health impact is a separate component that is evaluated, but often it is not.
   - There are no medical experts involved. Even if public health is separately evaluated, it is assessed by experts with a background in environmental science and not public health.
   - For the assessed health aspects the focus is often only on whether a project or plan will meet a health-based environmental regulatory standard. Chronic illnesses, the multiple and cumulative exposures that humans experience in their daily environment, and the broad social determinants of health are seldom considered.
   - Also the perception of people towards environmental nuisances is not taken into account. However, empirical research shows that perception does not always correspond to the objective reality. Ignoring this can be a breeding ground for citizens' distrust and protest.

2 The recommendations in the environmental assessment reports are only advisory, they are not legally binding.
   - An environmental assessment is an obligatory part of the approval process of the plan or the building permit but the outcome has no legal value.
   - In principle, the proposed mitigating measures in the environmental assessment report should be followed. However, in duly justified cases exceptions are possible.

3 The environmental assessment framework is too rigid, it cannot be easily modified.
   - The so-called “guideline books” offer generic research methods and assessment frameworks for the different environmental impacts and should be followed (unless motivated otherwise).
   - Due to this rigid framework, partly influenced by European legislation, environmental assessments are incredibly lagging behind the progress in scientific knowledge on the topic. Guideline books are only updated occasionally. For example, the Flemish environmental assessment guideline book on public health was updated in 2016, to replace the earlier version of 2002.
   - The whole process and all communication moments follow a strict schedule. There are no interim reports, few consultations of the public and no room for bottom-up lay expertise.

4 The environmental assessment framework is too complicated, a holistic perspective is missing.
   - The environmental assessment comprises several components (e.g. air pollution, noise, soil, nature, climate), each conducted and written by a separate recognized environmental expert.
   - During the process the different experts responsible for the specific issues to be assessed have little contact with each other. Although a coordinator officially takes care of the harmonization of the different parts, in practice each environmental expert has a lot of freedom in writing his/her part of the environmental assessment report.
   - This leads to a situation where impacts are mostly considered in isolation and worked out in a detailed specialist way, in most cases without exploring the linkages with other impacts. The opportunity of a holistic review is missed.
   - Because of the difficulty to understand an environmental assessment process in its entirety, at least in Flanders the independent character of the environmental assessment reports and the transparency of the process are called into question. The fact that developers have to pay the environmental assessment process and can choose themselves which experts are involved, adds to the distrust of the public.

5 The framework is too generic, the context is not taken into consideration.
   - Most environmental assessments are focused on the environmental impacts of a single project or plan. Rarely the relation with other already existent polluting facilities is taken into account. The general tone is that one project cannot be held responsible for the combined impact exceeding a certain threshold.
   - In the regular practice of environmental assessments all populations and neighborhoods are treated more or less the same, regardless their vulnerability or perception towards the environmental impact. Risks at population level are too easily translated to risks at neighborhood level.

These deficiencies are not only applicable to the Flemish context, also in other countries the process of environmental assessments is criticized. Corburn (2009), who describes the situation in the United States, denounces the process for treating all populations as similarly susceptible, restricting analyses to quantitative data, limiting the discourse and practice to experts and excluding lay knowledge.
While the first and second remark of the list specifically relate to the instrument of environmental impact assessment, the last three remarks are manifestations of a general problem in the current "command and control policy" of environmental health (and other policy fields). These deficiencies support the conclusion that we should rethink the role of public health in urban planning and spatial or environmental policy. In the next part will be examined whether civil servants join this idea.

3.3.2 Interviews with Flemish civil servants

To further explore the government's attitude, qualitative interviews with civil servants were conducted (Table 3). They were asked for their opinion on the current inclusion of health in spatial planning processes and possible beneficial adaptations. The main findings from the interviews are summarized here. Copies of the transcribed interviews are available on request.

Table 3 Four civil servants of government administrations were interviewed

Date	Organization	Interviewee
14/05/2014	Flemish Government – Department of Environment, Nature and Energy – Division of Environmental Impact Assessment	Jeroen Van Looy (process and quality manager)
19/05/2014	Ghent City Government – Division of Spatial Planning	Joost Aerts (spatial planner)
19/05/2014	Ghent City Government – Division of Environment	Anke Hermans (environmental impact assessment official)
23/05/2014	Local Health Council for Ghent and surroundings (LOGO Gezond+)	Nel Van Lent (medical environmental scientist)

The four civil servants from different policy areas largely defend the current way of working. They have confidence in the existing instruments, stress that participation is possible and emphasize that many gains have been made, because some decades ago environmental health was absolutely of no importance in spatial policy. In their opinion, citizens sometimes have too high expectations, while an environmental impact assessment is only an informative document included in the wider planning process without legal power. They also emphasize the limited influence of spatial planning in solving environmental health conflicts. In most cases a large infrastructure is the source of the nuisance, but other government departments administer these; so spatial planning is not to blame. At the same time, however, they admit that a city can start with considering health as a determinant when looking for a location for municipal functions like a school or a daycare.

"I understand the frustration of spatial planners about the environmental impact assessments because interaction is usually missing. The client often considers the assessment only an obligatory next step that is not always useful. Sometimes too many things are examined or expectations of the public are too high. Nevertheless, the idea itself is very useful."

- civil servant

However, they see ways of improvement. First, they advocate for a better collaboration and integration between the environmental, public health, planning and transport department, which is often not the case today, leading to delayed planning processes and discussions. It can, for example, be a good idea to invite an environmental health expert in a preparatory stage of a large planning process or infrastructure project. Second, the environmental impact assessment should have more power in adapting plans or projects with large negative environmental health impacts. Third, they believe the opportunities of consultation and participation of the public should be rethought. Paying more attention to this in an early stage of a planning process can prevent discussion afterwards.

"It is interesting to take the opinion of citizens into account and to inform them. If citizens know more about the risks and the alternatives they can be involved in the decisions. Of course this is time consuming and also easier for rather simple issues such as the construction of cell towers. But also for bigger projects it could work if the process is supported by the authorities and information is disseminated in an understandable way."

- civil servant

With regard to the growing civic engagement and power of grassroots movements on environmental health issues, the civil servants are very reserved. First, they question the intentions of these movements; is their aim to contribute constructively or to counterwork the project? Second, they feel that citizens often only react in a later stage of the process, when the plans are made concrete and major adaptations are not possible anymore. In an early phase, when the main concepts are decided, citizens are not always interested. Third, they see a conflict between local and regional/global thinking. A city or regional government mostly departs from an overall vision for the whole territory when a planning process or infrastructure project is started. Inevitably, this broader vision is often in conflict with local concerns. They stress that trying to solve the problem of some individuals is in most cases on the expense of others and a social balancing at a larger scale is then needed. When citizen protest groups only focus on the local scale, finding a solution becomes a difficult task.

"People are increasingly empowered and stand up for their rights, but also become more individualistic and sometimes overreact. They often only think of the problem on a local or neighborhood level. However, solving a local environmental problem usually causes problems elsewhere."

- civil servant

Despite their increasing power and influence, and the large societal potential of including more grassroots ideas in policy, most authorities still do not know how

to react to this evolution. In most cases their actions are redirected towards the official participation channels of the existing environmental policy framework. More innovative and creative incorporation of their ideas and commitment is rare.

3.3.3 Summary

While the evidence on environmental health risks is growing at unprecedented speed and citizen activism is highly dynamic and unpredictable, the government maintains an institutionalized approach for environmental health. This "command and control" policy of environmental health works with generic and linear frame-works, reducing the aspect of environmental health to obligatory assessments following strictly regulated pathways. Although different policy fields at all policy levels express the intention to integrate environmental health concerns in policy making, a proactive, coherent and effective policy approach is still lacking. It is difficult to break out of the institutional arrangements of a structuralist policy on environment and health, with a division of responsibilities and fixed procedures and regulations. This is confirmed by the views of civil servants, who admit the shortcomings in the current system, but rather see a solution in adapting the current system instead of seeking alternatives.

3.4 Conclusions: three dilemmas

The growing acknowledgement of environmental impacts on health has led to a lot of empirical research on the effects of air pollution, noise and other nuisances. At the same time the public awareness on these potential negative effects has risen, and culminated in many environmental pressure groups that focus on urban environment health issues (at least in Flanders). In contrast to this growing attention, the current policy on public health and urban planning remains very weak. Both disciplines are institutionally scattered across a tangle of administrations and policy levels, and the major connection between them is made through a generic regulatory framework with fixed environmental norms and a strictly organized environmental impact assessment.
Despite its undeniable achievement in preventing serious environmental conflict, this institutionalization of environmental health no longer works in today's complex, fragmented and volatile society (Boelens & de Roo, 2016). It has produced environmental assessments and regulations that are increasingly contested by involved citizens, experts and companies, resulting in the delay or even cancellation of planning processes. This situation demonstrates the discrepancy between the existing institutional order and the general practice of policy making (Hajer, 2003). In Hajer's opinion, our inherently dynamic and complex society challenges the legitimacy and efficacy of the institutional codified arrangements (e.g. the environmental assessments) with new and contingent developments, eroding the self-evidence of the classical-modernist institutes and policies. Furthermore, in this institutional void, public policy actors are caught between the demands of orderly, rational criteria – based on the generic idea of human welfare – and the messy, nonlinear reality of everyday local conditions and contradictions (Geyer &

Rihani, 2010). As such, there can be identified at least three major dilemmas on the interaction between environmental health issues and the current networked society. These dilemmas are coherent with the overall critique on modernism at large (Horkheimer & Adorno, 1947; Foucault, 1966; Lyotard, 1979): (1) the supposed "manipulability" of society, (2) the alleged "rational comprehensiveness" of the environmental regulatory framework, and (3) the naive best-for-everybody "paternalism" of the government.

3.4.1 Manipulability

First, the "manipulability" of a healthy living environment is disputed, since our society is dynamic, volatile and nonlinear. Due to ever-new insights and changing spatial settings, environmental assessments have often become obsolete by, or just after, their completion. This is especially true of assessments for large-scale, public development projects that take many years from planning to completion. Thus, legislation and environmental regulations are constantly lagging behind scientific knowledge on the topic and cannot deliver a convincing guarantee to the public. Not only does the knowledge on environmental impacts change during planning processes, but also the awareness and the societal importance given to health impacts constantly change and influence the involved actors. A good example is the planning process of the Oosterweel connection, trying to close the Ring Road around the city of Antwerp (Belgium) (Claeys, 2013). While the Oosterweel connection was initially planned in a very traditionalist, top-down framework involving minimal participation, during the planning process other players unexpectedly came into the field, being concerned about public health impacts. Citizens and entrepreneurs drew up alternative plans and attempted to either adapt or stop the government-led planning process. They delayed the project and its ultimate realization with protests and legal battles, thus extending the discussions until the present.
Scholars agree that these kinds of large-scale projects require a new kind of management to deal with their complex and changing settings (Geels & Schot, 2007). Because change occurs at random in a wide variety of dynamic multi-dimensional, multi-actor and multi-level settings, an evolutionary transition management should be adopted that does not seek to control or diminish uncertainties, but instead tries to influence or redirect developments towards improved health conditions (Innes & Booher, 1999; Healey, 2007).

3.4.2 Rational comprehensiveness

Environmental assessments are often considered black boxes, highly specialized and characterized by oblique language. This exacerbates the gap between academic and common understanding and contributes to distrust between citizens, experts and the government. In common spatial planning practice, and in the initial phase of planning processes, planners do not have the requisite technical expertise to truly understand environmental pollutant information and incorporate it into policy. This is invigorated by the enormous increase in research on the different relationships between the built environment and its impacts on health

and well-being, as shown in the first part of this chapter (Frumkin, 2003; Jackson, 2003a). This increasing specialization in research needs highly trained experts to perform the environmental assessments, burdening an integrated healthy planning approach and widening the gap with citizens. Moreover, much uncertainty remains about the details of relationships between environmental stressors and health effects, and the size of the effects, making a comprehensive decision framework an almost impossible dream.
And even if we could fully understand all impact-effect relationships, taking rational decisions is still an ambiguous task because in the real world impacts are interfering with each other. For example, the higher the population density and mixed land use in a neighborhood, the more physically active people will be, but the more people will complain about noise or be exposed to air pollution. In other words, the standard densification strategies often recommended for reducing the ecological footprints of cities are riddled with drawbacks when viewed from a local public health perspective (Næss, 2013).
To overcome this impossibility of rational comprehensive decisions, a governance perspective is needed, which brings together all experts and stakeholders across the entire urban health and planning spectrum, and loosens the old "silo" mentality within government agencies and between professionals (Vancutsem et al., 2009).

3.4.3 Paternalism

In company with the relationship between health and environment, the effect of an impact is dependent on its context. In our fragmented and complex society, generic standards for noise, water, soil and air pollution can no longer meet the increasingly unique expectations or specific needs of the population. As mentioned earlier, environmental impacts lead to risks at the population level that cannot be easily translated to local situations. Certain populations and neighborhoods are more vulnerable than others, and generic distance rules based on equal treatment and a "best-for-everybody" philosophy thus not always make sense.
In addition, perception not always corresponds to reality, further complicating the integration of environmental health concerns in spatial planning and policy. New research on environmental health even shows that sometimes personal disturbance caused by environmental impacts, as determined by personal susceptibility, is a greater indicator of health impacts than measured exposure. For example, a study on the health impact of noise pollution showed that physical and mental health variables were not associated with noise exposure, but rather with the subjective level of noise annoyance for the individual. This subjective noise annoyance was influenced by personal noise sensitivity, demonstrating the possible interweaving of vulnerability and perception (Schreckenberg et al., 2010).
Thus, an important divide exists between what is objectively regarded as (un) healthy, and how impacts are subjectively perceived. In response to this, de Roo (2011) rejects generic standards and advocates "net quality", which encompasses not only health, sustainability and quality of life, but also emotional states, such as a sense of security, belonging, social warmth and esteem. However, so far impact assessments include data on environmental problems that can affect health, but rarely consider subjective health and well-being issues in a systematic manner, or

recognize the complex interrelations between social and environmental factors and its repercussions on a person's health (Vancutsem et al., 2009).

3.4.4 Epilog

In spatial planning theory, these dilemmas have already resulted in approaches for more adaptive, actor-relational and co-evolutionary planning (Boelens, 2009; de Roo et al., 2012; Boelens & de Roo, 2016). These ideas are not yet applied in environmental health policy. There it would mean that standards and norms should not be seen as something that should be met or dealt with, but rather as specific factors of importance that play a reciprocal role in a process of undefined, heterogeneous (and if possible, collective) becoming. It would also mean a more dynamic approach for health assessments, since these assessments often deal with "wicked" problems, i.e. problems that are not only difficult to solve, but whose solutions again pose new (wicked) questions in and of themselves (Rittel, 1972).

In the ongoing settings of complexity, planners and politicians still need to take the aspects of public health and sustainability into account when deciding between urban alternatives. Because predictions will never be perfect and decisions will never encompass all the impacts and effects, we need approaches that deal sufficiently with those uncertainties and are able to adapt to changing circumstances. In other words, there is a need "to negotiate uncertainty" (Christley et al., 2013). Accordingly, a new planning paradigm is coming up, which recognizes that the essential principle of healthy urban planning is interdisciplinary collaboration, with shared recognition of the problems and shared will to address them (Vancutsem et al., 2009).

Therefore, we need to rethink the planner's and citizen's involvement in urban environmental health issues. How can environmental assessments be complemented with additional urban health considerations as an obvious and conditional item in urban plans and processes? What to do with the growing protest from environmental associations and grassroots movements? Can their expertise and commitment be usefully incorporated in a new spatial policy approach? Who decides what a healthy environment implies? Is it the government, by enacting general laws and regulations to protect public health? Or can people themselves decide about a healthy environment? What would this mean for urban planning?

In the next chapter, a part of the answer is given by first analyzing the theoretical ideas in academic literature and then presenting a new approach to public health in urban planning, by regarding (the integration of) planning and health as "complex adaptive systems" (Innes & Booher, 1999).

4

Building a planning framework for environmental health

To give an answer to the current "lock-in" and find new ways to integrate environmental health concerns in spatial policy, this chapter first discusses the existing theoretical ideas, after which it introduces a newly developed theoretical framework. The first half starts with briefly considering the definitions of "health", "environment" and "environmental health". This precedes an extensive analysis of the evolution in conceptual frameworks on health, in close relation to the history of public health discussed in chapter 2. Finally, a comprehensive review of existing frameworks on urban planning and health is presented. The second half starts from the observation that existing theoretical models are inadequate to respond to the challenges of an inherently dynamic and complex society. Defining the difference between "complex" and "complicated" systems clarifies that, while environment-health interactions involve some complicated and linear impact-effect relations, their simultaneous presence in a heterogeneous and volatile space makes up a complex tangle. For the two major questions that arise from this situation – how to locate environmentally unhealthy situations and which planning strategies to use – at the end of this chapter two theoretical frameworks are developed and explained[5].

4.1 Definitions

Prior to the analysis of health frameworks, an overview of some important concepts is presented to make explicit how these concepts are understood in the rest of this dissertation. This shows the difficulty of finding general definitions and thus asks for caution in using these concepts.

4.1.1 Health

The concept of health is interpreted in many ways and can be defined both narrowly or broadly. One of the most cited definitions of health is used in the Constitution of the World Health Organization as adopted by the International Health Conference of 1946: "Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (WHO, 1946). Although many value the explicit appreciation of the subjective experience of health and the inclusion of psychological and social dimensions (Melse & de Hollander, 2001), critics argue that a state of complete well-being corresponds more to happiness than to health (Saracci, 1997). Other definitions are more narrow, describing health as a "condition of being free of disease and infirmity and a basic and universal human right" (Saracci, 1997) or "just the absence of disease and other health problems of a physical or psychological nature" (Melse & de Hollander, 2001). In this dissertation, no strict definition is used. While objective health effects are obviously an important factor, also perception of impacts and subjective views on health are of concern, since urban planning and spatial policymaking involve interaction between different actors including citizens. Therefore, in the remainder

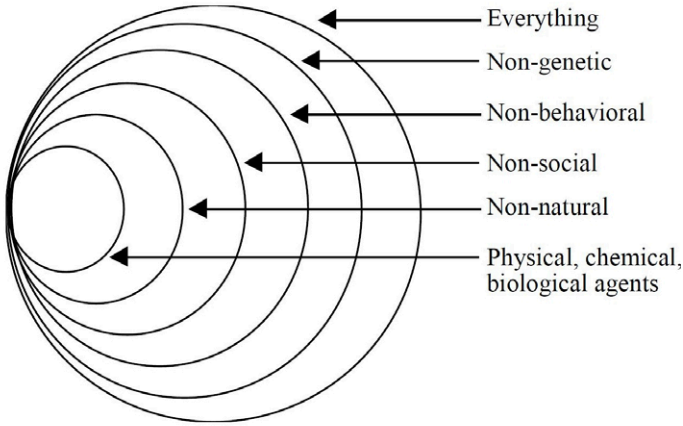
5 Parts of this chapter are based on Verbeek and Boelens (2016).

of this study will always be indicated whether health is understood in an objective or subjective way.

4.1.2 Environment

The concept of environment is even harder to define. Dubos (1965) described it as “everything that exists outside the body or mind of an individual or social group”, meaning both the physical and social surroundings. Afterwards, other (overlapping) interpretations arose (Smith et al., 1999; Melse & de Hollander, 2001), of which some are shown in Figure 14.

Figure 14 Different definitions of what constitutes “environmental factors” (Smith et al., 1999)



A seemingly straightforward approach is related to the human health perspective and the classic nature-nurture dichotomy. The according definition considers all factors that are not genetic as environmental. The problem with this definition is that, when time scale is large enough, and evolutionary mechanisms are taken into account, all diseases would be environmental.
A more common definition of environment starts from the extent to which exposure is voluntary and subject to personal action. In this view, behavioral and lifestyle factors are consequently not viewed as environmental, although the “social” environment and resulting pressure may question the voluntariness of these factors.
Finally, an economic perspective is possible (not in figure). Then, the externalities versus internalities approach defines environmental issues as those that occur to a group other than the decision-making group.
In this research, the focus is on the built environment, which can be acted on by urban planners and policymakers. For this purpose, a simple definition of the built environment is available, describing it as “that part of the physical environment made by people for people” (Northridge & Sclar, 2003).

4.1.3 Environmental health

The impact of the environment on health is captured in the concept of environmental health. The World Health Organization again uses a broad perspective, stating that the concept comprises “those aspects of human health, including quality of life, that are determined by physical, chemical, biological, social, and psychosocial factors in the environment” (WHO, 1996). However, according to an unstated presumption environmental health deals only with those aspects of the environment that are affected measurably by human activities and not those due to nature in the raw (Smith et al., 1999). Sometimes occupational health and safety, war and other circumstances of which the “environmentalness” is disputable are excluded (Melse & de Hollander, 2001). In a very strict view, also important life-style determinants of health such as smoking behavior and dietary patterns are excluded.
Throughout the remainder of this research a narrow concept of environmental health is used, in which the focus is on the environmental impacts that have a proven direct effect on health or well-being, be it physical or mediated by perception.

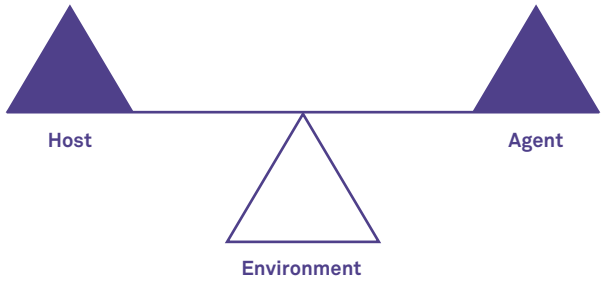
4.2 Conceptual frameworks on health

To develop a useful framework for healthy urban planning first a historical analysis of existing conceptual frameworks on health is presented. This historical overview does not give an exhaustive description of all available frameworks, but particularly wants to show the evolution in thinking. It corresponds to the changing views on public health and the growing scientific knowledge on its determinants, already touched upon in the second chapter.

4.2.1 Foundations

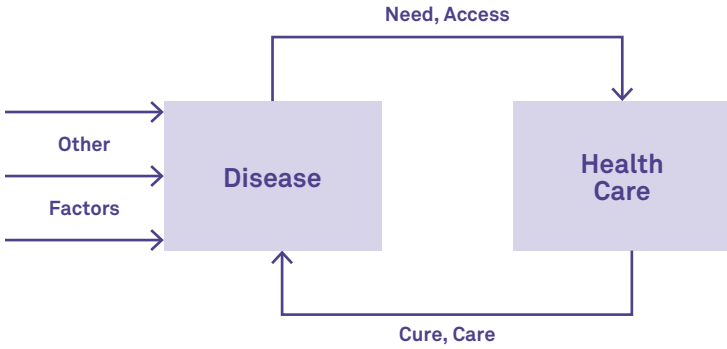
One of the first recorded descriptive models of human health was the ecological model or “health triad” in the late nineteenth century (see VanLeeuwen et al., 1999) (Figure 15). This model represents a dynamic equilibrium between the host, the environment and the agent of disease. A change in any of the three could upset the balance between the host and the agent, resulting in more or less exposure or disease, and conversely, less or more health. The corresponding germ theory – already discussed in chapter 2 – started from three assumptions: all agents cause one disease, all diseases have one causal agent and all exposed individuals become diseased. Although the idea of a dynamic equilibrium continues to be relevant, the current patterns of disease do not always correspond to these assumptions. Some agents are thought to cause more than one disease, many diseases have multiple causes, many diseases are noninfectious and exposure does not always mean you will experience unhealthy consequences (Levins et al., 1994).

Figure 15 The ecological model or health triad (late 19th century) (VanLeeuwen et al., 1999)



Towards the middle of the twentieth century the germ theory was abandoned in favor of the biomedical model of disease, in which the "hosts" are addressed instead of the "environment" (or the exposure to "agents"). The corresponding health care model, in which health is defined as the absence of disease or injury, is straightforward (Figure 16). It is a simple feedback model, with health care curing a disease that is generated by multiple unnamed determinants. Against expectations this model could not hold, because health care systems did not settle down to a stable equilibrium, but in contrast showed a progressive pressure to expansion.

Figure 16 Disease and health care: a (too) simple historical foundation (Evans & Stoddart, 1990)



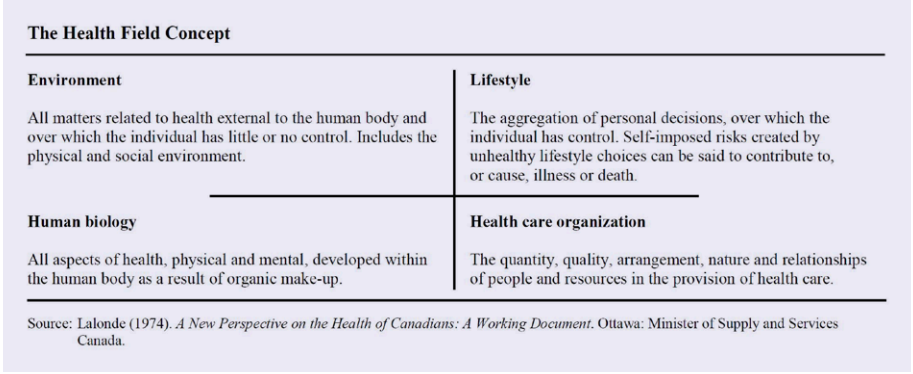
These two models correspond to outdated views on health. However, some useful ideas can be borrowed from them. First, the idea of a dynamic equilibrium between people and the environment still has its relevance. Second, the failure of the simple health care model has shown that public health policy must go wider than just providing care.

4.2.2 Biopsychosocial models

During the 1970s a conceptual shift took place from the biomedical view toward more holistic models, together with a growing recognition of the WHO-definition of health of 1946. Instead of focusing only on health care and disease, quality of life and well-being received increasing attention and different determining

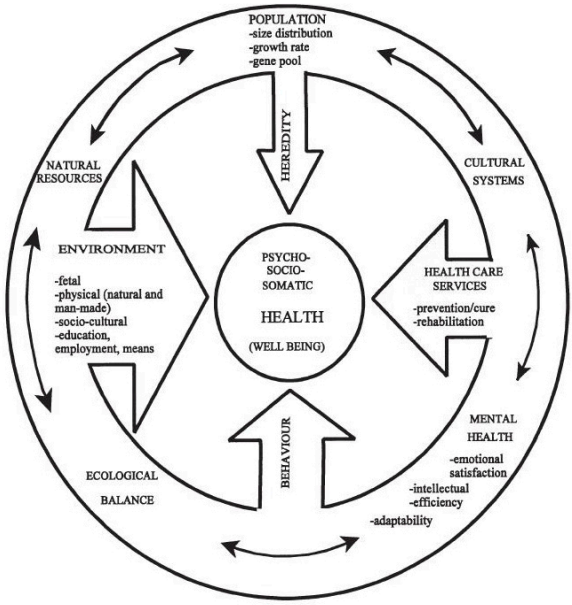
factors were discerned. In addition, the idea emerged that people could (and should) assume more responsibility for their own health, and that the expenditures on medical |care should be balanced against the ones on health promotion (Glouberman, 2001). The Canadian Lalonde Report (1974) was a milestone in this evolution and has had a major worldwide policy impact. Marc Lalonde, the Canadian Minister of National Health and Welfare, developed the Health Field Concept (figure 17), in which four determining factors are distinguished: environment, lifestyle, human biology and health care organization. He was influenced by Thomas McKeown (1971), one of the first to advocate that the major contributors to public health go beyond health care. McKeown criticized the biomedical model, which had "mistakenly reduced the concept of health to a mechanistic explanation of the state of the human organism", and universal health care coverage, which had not created a healthier society. Instead, he believed that healthy behavior and the social and physical environment have more influence. Lalonde put it less strong in his framework, by attributing an equal weight to the four inputs. However, in the accompanying documents he clearly stated an order of importance, with lifestyle first, followed by environment, human biology and health care organization.

Figure 17 The Health Field Concept (Lalonde Report) (Lalonde, 1974). Reprinted from Glouberman (2001)



At the same time Blum (1974) developed a similar classification, with (almost) the same four determining factors (Figure 18). He indicated the different importance of the factors by altering the size of the arrows. In addition, he identified five background influences: factors of population, culture, mental health, natural resources and ecological balance. Especially the involvement of "mental health" is remarkable, because the related concept of well-being is at the core of the model. Different from Lalonde, Blum considered environment the main factor, with behavior (lifestyle) only in third place. This is because his model is a general model for global population health. He explained that the contribution of the four factors to human health depends on the combination of the five background influences. So, the arrow sizes would be different for regions and countries where diseases are primarily related to the environment (e.g. in many developing countries), or where human behavior to a large extent dictates the health of the population (e.g. in Lalonde's Canadian context).

Figure 18 Environment of Health model (Blum, 1974)



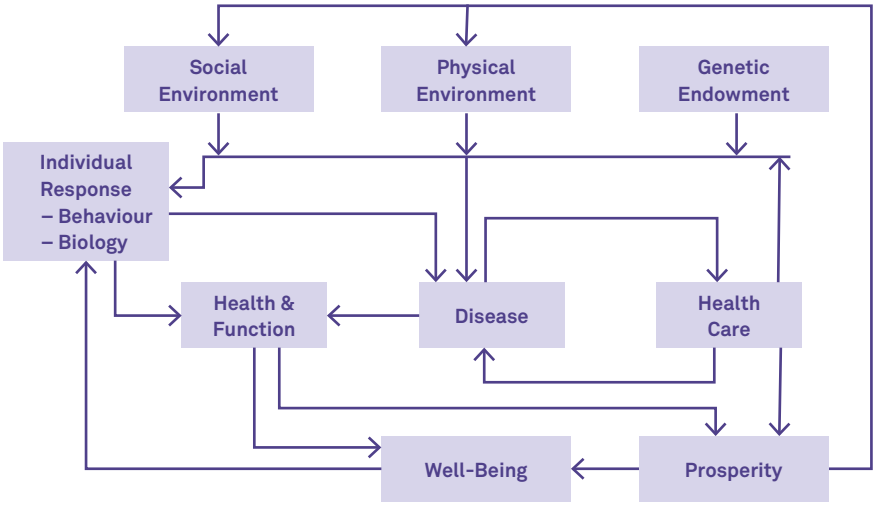
The main achievement of both Blum's and Lalonde's model is the appraisal of health as a complex concept that goes beyond medical care and incorporates lifestyle and the environment. This has contributed to the start of a health promotion and disease prevention movement, with profound impacts on public health policy.
However, the over-emphasis on lifestyle and the focus on the individual with a "blame the victim" mentality in Lalonde's policy model missed the importance of the physical and social environment and failed to grasp the interactions among the four quadrants. In summary, the health field concept was an attempt to capture the greater complexity of health in an expanded but still reductive model with more variables (Glouberman, 2001). Yet, the models marked the beginning of a change in the attitudes to health, quickly going beyond the lifestyle factor to incorporate the relative importance of socio-economic factors.

4.2.3 Health determinants frameworks

Building on the holistic models of Lalonde and Blum, since the 1990s some health determinants frameworks were established. Instead of only providing a conceptual model, these frameworks distinguish the different determinants of health and well-being, and how they are interrelated.
One of the first (and most famous) frameworks was established by Evans and Stoddart (1990) (figure 19). Remarkably, they distinguished between disease (a medical construct), health and function (experienced by the individual person), illness (the influence on well-being) and well-being (sense of life satisfaction). They introduced the concept of individual (or host) response, which can be unconscious (biological) or behavioral (lifestyle). Consequently, there are two ways of influence

on health from the physical environment, whether direct on disease, or indirect via host response. By including the determinant of prosperity, Evans and Stoddart tried to make a link with socio-economic variables. Finally, they included a particular feedback loop, stating that health care and health policy have economic costs that also affect well-being (through prosperity). An over-expansion of the health care system might have negative effects not only on the well-being of the population, but even on its health. Aggregated across all individuals, the interests of those who are ill are traded off against the interests of those who might become so.

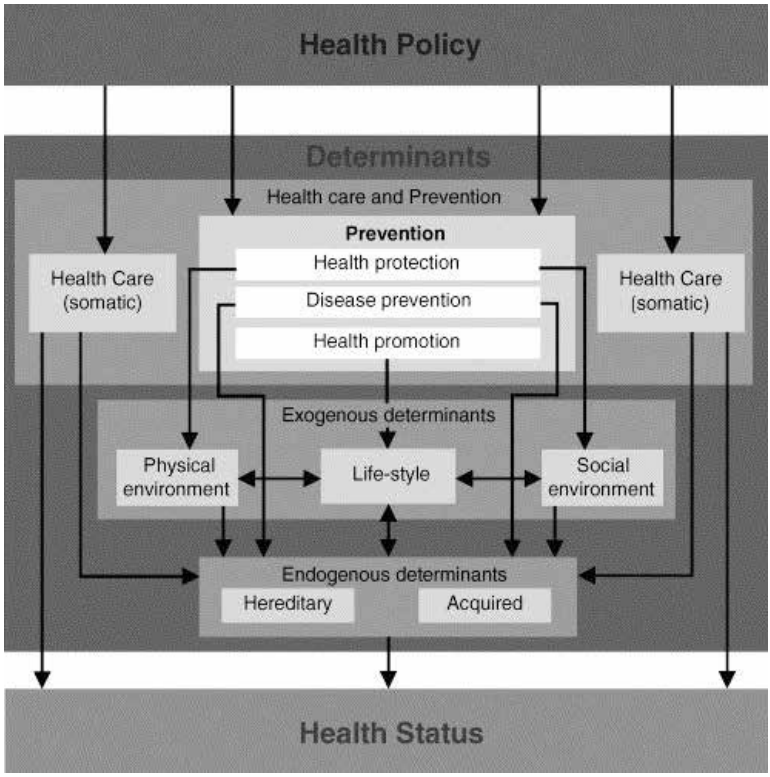
Figure 19 General health determinants framework (Evans & Stoddart, 1990)



Later, Evans and Stoddart made several adjustments to their initial framework (Evans & Stoddart, 2003). First, they changed their view of genetic endowment. In their first framework it was not only fixed at the moment of conception, but also unambiguous in its implications for health (genetic destiny). Later, they believed that the expression of endowment depends on interactions with both the physical and, particularly, the social environment. So there have to be lines of causality into the genetic box and out of it. Second, they realized that one factor is wholly missing in the initial framework: the role of time. Especially the impact of the social environment over the life course was considered important, but they could not imagine an adequate framework that represents the complex web of dynamic processes through which the various determinants of health have their effects over time. Third, they admitted that treating income or wealth as both a contributor to and a consequence of health status is not at all adequate. The link from income to health is not that simple, as if economic growth always leads to better population health. Evans and Stoddart acknowledged that the most plausible view to this point is that the relationship between income and health, or between inequality and health, depends largely on the social and cultural environment in which income differences are experienced.

Another health determinants framework was developed by de Hollander and Staatsen (2003) in the Dutch Public Health Status and Forecast Report (figure 20). In their view, health status is a function of exogenous determinants, endogenous determinants and health care. Within the group of exogenous determinants, they discern lifestyle, physical environment and social environment. The indicated interactions explain why the response to environmental exposures may vary substantially from one individual to the other. In addition to the interactions between exogenous determinants, they also clarified that endogenous determinants develop through interactions between genes and environmental factors.
A similar model made by Melse and de Hollander (2001) added an overarching box of influences, comprising demographic, social, cultural, economic and technological developments. Besides these frameworks some authors just tried to list all the determinants of health status, without indicating the interrelations (e.g. the 28 determinants of health status of Anderson and Armstead (1995)).

Figure 20 Framework of Dutch Public Health Status and Forecast Report (de Hollander & Staatsen, 2003)



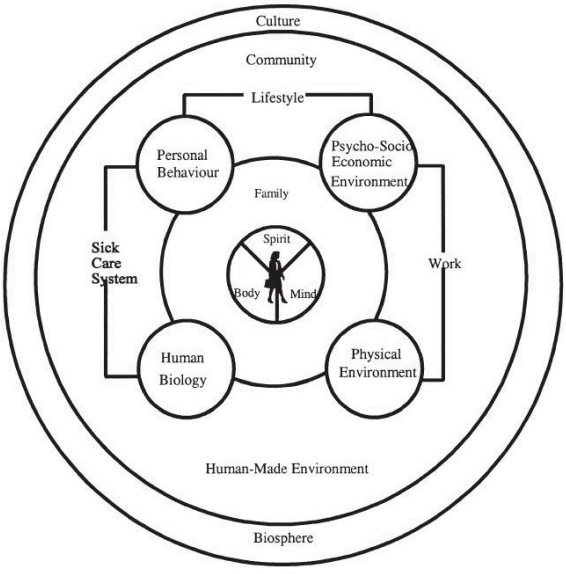
Already in the 1990s the deterministic nature of these frameworks was criticized (VanLeeuwen et al., 1999). Although the explicit introduction of specific determinants, interrelations and feedback loop relationships was appreciated, the identification of direct deterministic causal relationships among determinants of disease and health was considered problematic. VanLeeuwen et al. stated that

determinants of health are not the unconditional machinery parts that invariably lead to disease and hence a probabilistic interpretation of influences is preferred. From a spatial policy point of view, these models lacked specific elaboration on the environment-health interrelationship. While the concrete indication of physical environment as one of the health determinants definitely was a step forward towards a healthy planning framework, altogether these determinant models thus are not able to capture the overall complexity of public health.

4.2.4 Ecosystems frameworks

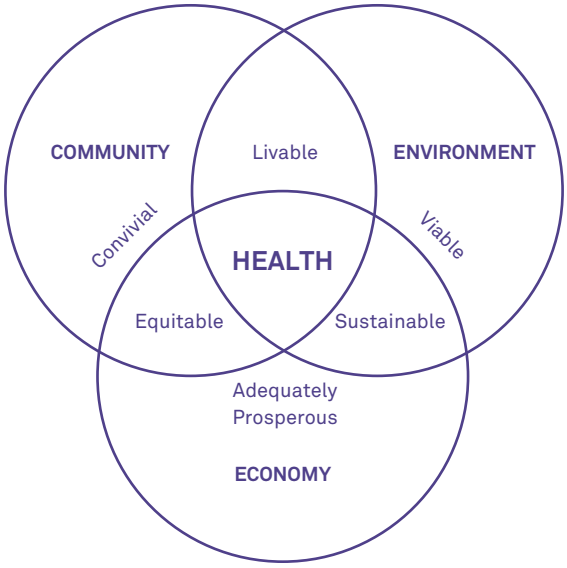
As an alternative to the health determinants frameworks, from the 1980s on, an ecological model of health gained interest. Its main idea is that an individual is part of larger systems, such as the community or the global ecosystem, whose characteristics influence the individual's life and its health.
Hancock and Perkins (1985) illustrate this in their Mandala of Health (Figure 21). Individual health is placed at the center of the model, with three components: mind, body and spirit. This core is influenced by three circles of nested systems around the individual: family; the community and the human-made environment; culture and biosphere. Within the family and community circles, four subgroups of health influences partly correspond to the holistic models of Blum and Lalonde: personal behavior, human biology, physical environment and psycho-socio-economic environment. In addition, an individual's health and family health are influenced by lifestyle, work and the health care system. There are remarkable differences in the positioning of concepts, compared to the biopsychosocial models (e.g. the place of lifestyle and the health care system). Most importantly, this model was the first to represent a nested hierarchy of influences on individual health.

Figure 21 Mandala of Health (Hancock & Perkins, 1985)



The later, more basic community ecosystem model of Hancock (1993), established a link between community health and the sustainable development of communities (Figure 22). By placing community health at the intersection of community, environment and economy, Hancock suggested that sustainable development and socio-economic variables are essential for sustaining human health. He discerned six qualities of healthy community ecosystems; they have to be convivial, livable, sustainable, viable and adequately prosperous with equitable wealth distribution.

Figure 22 Community ecosystem model (Hancock, 1993)



More recently, the human ecology model of a settlement of Barton (2005, 2009) can be placed within the ecosystems approach (Figure 23). His model discerns different outer spheres that affect the health and well-being of people, represented by the inmost sphere: natural environment, built environment, local economy, community ... He considers the built environment as the sphere of direct planning influence, affecting all the others to a greater or lesser extent. In this way the model can help understand the relationship between health and planning
The successive layers of the model relate people's health and well-being to different spheres and illustrate the hierarchical nature of the human ecosystem. Unfortunately, Barton is criticized for sticking to only show the different spheres and refraining to emphasize the interconnectedness within and across these layers (Rydin et al., 2012).

The Butterfly Model of Health of VanLeeuwen et al. (1999) is the most advanced model within the ecosystems approach (Figure 24). The model differentiates between the biophysical environment and the socioeconomic environment, with humans as intermediaries. Humans are characterized by a biological and a behavioral filter that enhance or reduce health, by governing the types of exposure that are encountered, along with the response and the degree to which the exposure

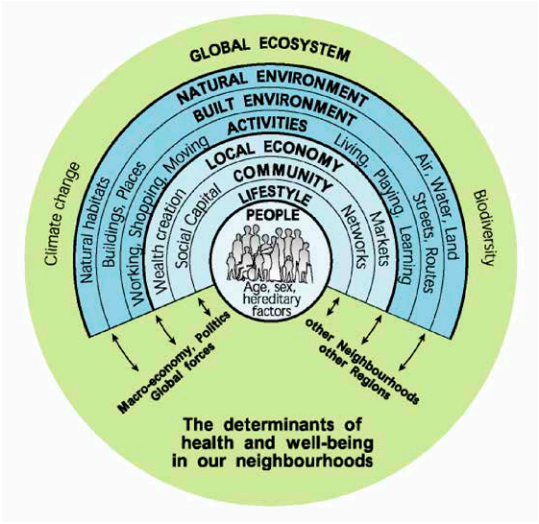


Figure 23 Ecosystem approach (Barton, 2005, 2009)

can cause damage. This corresponds to the individual response in the model of Evans & Stoddart (1990).
VanLeeuwen et al. illustrate the influence of neighboring ecosystems by linking the two “environments” to external “environments”. The nested hierarchical nature of ecosystems is not shown, but instead VanLeeuwen et al. argued that the model can be used for different scales and that always has to be stated to which scale one is referring.
Innovative in this model are the large double-headed arrows between the biophysical and socioeconomic environments, emphasizing bidirectional movement and feedback loops of energy, nutrients, and impacts. The arrows go right through individuals, showing that these effects are manifested through individuals by their behavioral and biological filters.
In summary, this model holds a more complex and multiscalar measurement of health, with respect to features of the biophysical and socioeconomic environment. Nevertheless, relations between the individual environmental components are not further specified.

The major contribution of the ecosystems approach is the recognition of different spheres of environmental influence, social and physical, ranging from the global ecosystem to the community and family level. The underlying idea is that a well-balanced ecosystem has positive health impacts. Although the models show the interrelatedness between these different levels, they do not show how they are interrelated. Also within one level the level of specificity is low, by not showing the full range of determinants and not considering the relations between the different components of a level. In summary, these models put an individual’s health into perspective, but they do not tell how we can act on this. Though more than in the holistic frameworks of Blum and Lalonde, the built environment is considered a separate factor affecting health and well-being, and a field on which action can be taken.

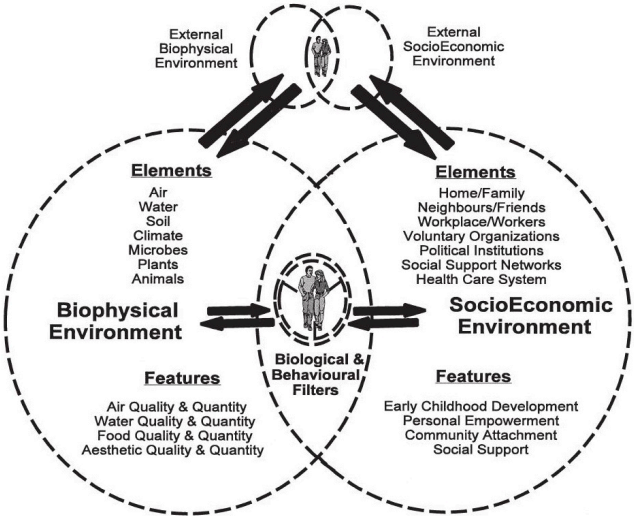


Figure 24 Butterfly model of health (VanLeeuwen et al., 1999)

4.2.5 An evaluation

This historical overview of conceptual frameworks of health shows an evolution from simple deterministic models to advanced, complicated frameworks. This reflects the evolution from the biomedical view where all attention goes to the individual, to the social epidemiology view where the environment is considered an important determinant (Glouberman, 2001; Corburn, 2005). Each of the three different approaches described above has added new perspectives:

1 Biopsychosocial models:
The acknowledgement of lifestyle and environmental factors (social, economic, cultural and physical) in explaining a person's health, at the same time putting the activities of health care systems in a more balanced perspective
2 Health determinants frameworks:
The indication of interactions and interrelations between a growing number of specific health determinants influencing a person's health.
3 Ecosystems frameworks:
The recognition of different spheres influencing a person's health instead of one sphere.

Together with these theoretical advances the idea emerged that no adequate framework can fully represent the complex web of dynamic processes through which the various determinants of health have their effects (Evans & Stoddart, 2003). Also the impact of the environment on a person's health is not so straightforward. The described models already show that environmental health effects are influenced by personal biological characteristics, lifestyle, behavior, and socioeconomic variables. However, in recent years several authors tried to further conceptualize this relationship, to better understand the dynamic and reciprocal ways the environment can act on health.

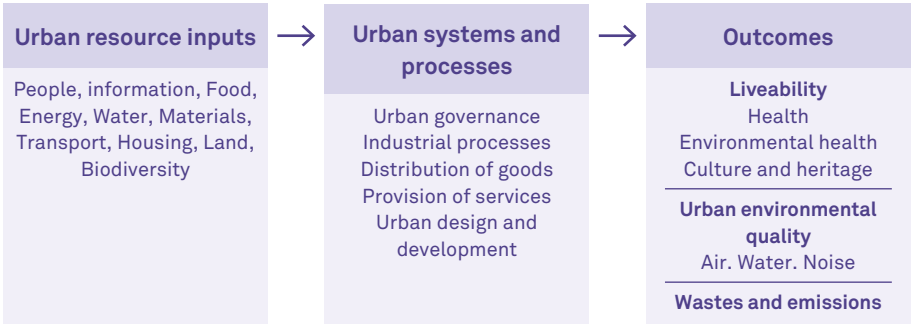
4.3 Conceptual frameworks on urban health

Because of the growing attention to environmental factors since the 2000s some frameworks were constructed that specifically focus on the urban environment. They try to transcend the deterministic nature of existing models, by providing conceptual and abstract frameworks that give an insight in the complex nature of cities and health. These models adopt a broad definition of environment and can be divided into two categories: socio-ecological urban health models and urban health inequality models.

4.3.1 Socio-ecological urban health models

Some frameworks focus on the urban environment and how its structures and processes have specific positive or negative effects on health and well-being. The extended urban metabolism model of Kearns et al. (2007) uses a social-ecological perspective on the complex nature of emerging public health problems in cities (Figure 25). They regard health as an expression of a complex web of interactions, all socially organized and mediated through changing cultural aspirations and norms. However, in their framework, they do not make these interrelations clear. Their urban ecosystems framework links the industrial production of urban resource inputs to the spatial patterns and organizational processes that characterize urban consumption. These resources, both physical and social, are then transformed, or "metabolized", and distributed through urban governance systems and infrastructure networks with emergent consequences for people and urban environments. This transformation of inputs through the network of urban systems and processes results in specific outcomes of livability, urban environmental quality and wastes and emissions. They attribute power to both governments and the market in creating more or less healthy cities. Their dynamic framework, in which they are reluctant to indicate specific interrelations, fits within the growing acknowledgement of complexity within cities. However, they have a rather deterministic view on intervention in the built environment to promote healthy behavior[6].

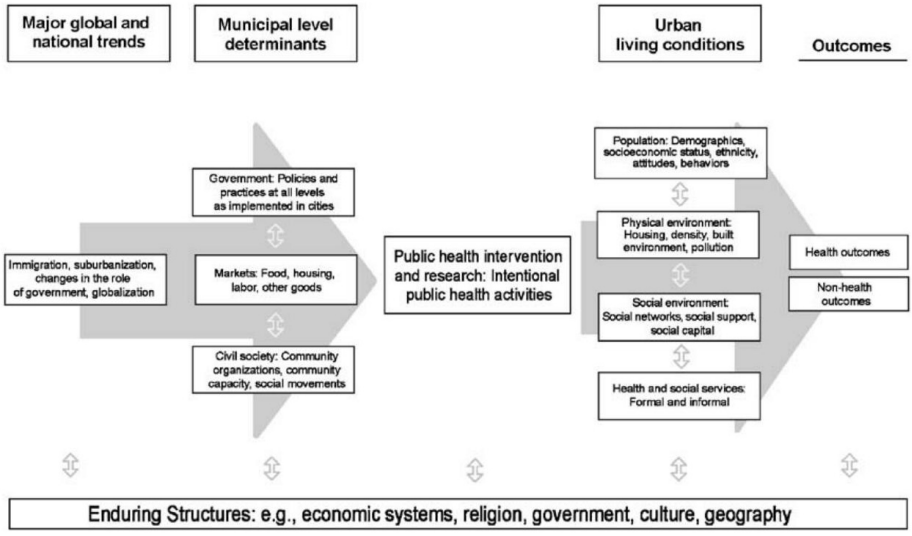
Figure 25 Extended urban metabolism model (Kearns et al., 2007)



6 "Our built form, the basic template in which we live out the majority of our lives and social interactions, must be planned, designed and constructed to encourage, not hinder, healthy behavioral changes in food availability, mobility options, workplace practices and lifestyle choices." (Kearns et al., 2007: 50)

Another dynamic framework focusing on the urban environment is the urban health conceptual framework established by Galea et al. (2005) (Figure 26). This comprehensive model incorporates and integrates the multiple levels of factors that affect health in cities and considers features of cities that may either promote or harm health. The core concept is that the social and physical environment defining the urban context are shaped by municipal factors such as government and civil society. The framework has much in common with the model of Kearns et al. (2007). However, Galea et al. put everything in a broader perspective, by adding national and global trends, and discerning enduring social structures and conditions – such as the economic and political system – overarching their framework. The framework itself thus consists of four levels. First, global and national social, economic, and political trends influence urbanization and determine the resources available to a particular city or region. They have an impact on the municipal level determinants of municipal government, markets and the civil society. These components have a direct impact on the urban living conditions, consisting of four primary determinants of the health of urban residents: population, physical environment, social environment, health and social services. In this step are the opportunities for urban public health interventions, which can relate to many policy fields ranging from housing to social services. Finally, the model measures both health and non-health outcomes, to get a more accurate and comprehensive picture of the costs and benefits of the various solutions.

Figure 26 Urban health conceptual framework (Galea et al., 2005)

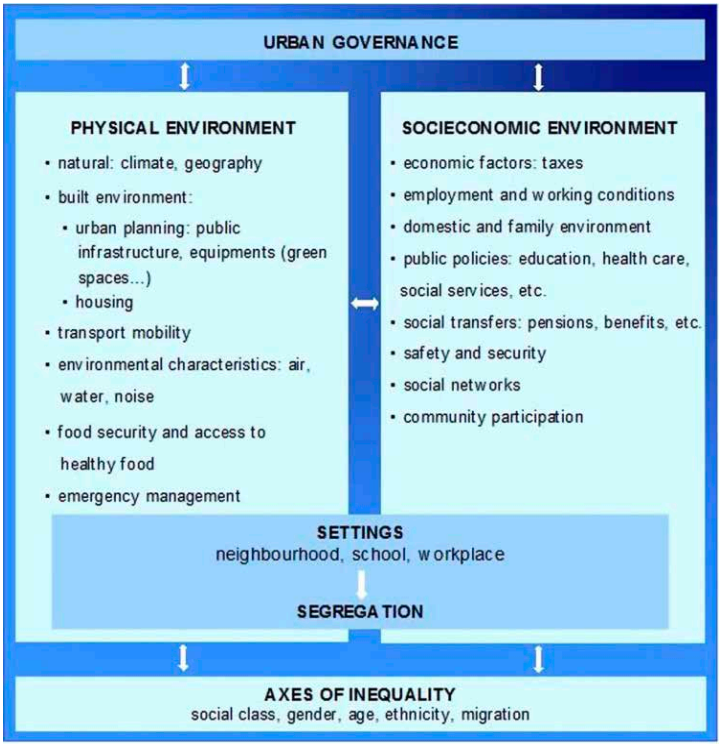


The principal contribution of both models is that they place the health of urban populations within a larger context and illustrate how it is shaped by enduring social structures and conditions, such as the political and economic system. They also show where and how can be acted on this relationship for greater urban health. However, both frameworks remain very general and do not propose concrete policy approaches.

4.3.2 Health inequality models

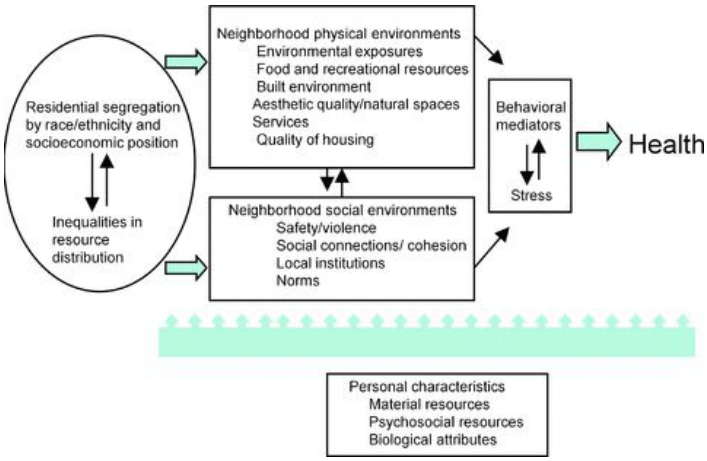
A second range of urban health models tries to define the different determinants that cause and maintain health inequalities. Borrell et al. (2013) made a conceptual framework that brings these factors and processes together (Figure 27). On top of their model is urban governance, which covers power both inside and outside governmental institutions. In this way political power of the government, economic power of the private sector and social power of community groups representing the civil society are included. The next level of their framework is divided into the interrelated domains of the physical environment and the socioeconomic environment, with their components. Next they discern settings, places where people actively use and shape the environment, and where they create or solve problems relating to health. Included in the framework are neighborhoods, schools and workplaces, but others can be imagined. In each of these settings, segregation may be an important concept (residential segregation, segregated schools ...), contributing to urban health inequalities. Finally, the model of Borrell et al. is underpinned by different social axes of inequalities, such as social class, gender, age or ethnicity/migration, which may be related to specific (combinations of) determinants in different settings. These axes of inequality are contextual and dynamic social constructs, involve relations of power and domination and are present at both the structural or macro (society) level and simultaneously at the micro-level (individual lives).

Figure 27 Determinants of health inequalities in cities in Europe (Borrell et al., 2013)



The model of Diez Roux and Mair (2010) is also based on a concern about health inequalities in cities, and focuses in particular on the processes through which neighborhood physical and social environments contribute to it (Figure 28). The model starts from residential segregation and inequalities in resources, mutually reinforcing each other and impacting neighborhood physical and social environments. These physical and social characteristics affect each other and, modified by the dynamic relation between behavioral mediators and stress processes, lead to health outcomes. The whole complex of interrelations depends on individual-level characteristics and although not illustrated in the figure, Diez Roux and Mair note that many of the processes are amenable to policy interventions.

Figure 28 Schematic representation of the contribution of neighborhood environments to health inequalities (Diez Roux & Mair, 2010)



Both frameworks try to explain how inequalities in urban health are related to segregation and inequalities in resource distribution. Also, the relation with urban policy and other forms of urban governance is established, showing the possibility to intervene in the interplay between spatial, socio-economic and health inequalities.
Both the socio-ecological models and the inequality models of urban health offer interesting perspectives to understand the environment-health relationship. Nevertheless, these models are limited to a general conceptual framework and do not make the interrelations concrete, nor suggest specific policy approaches. To further explore the ways how spatial policy and urban planning can contribute to the evolution towards healthier urban environments, in the next chapter specific frameworks on the urban planning and health interrelation will be evaluated.

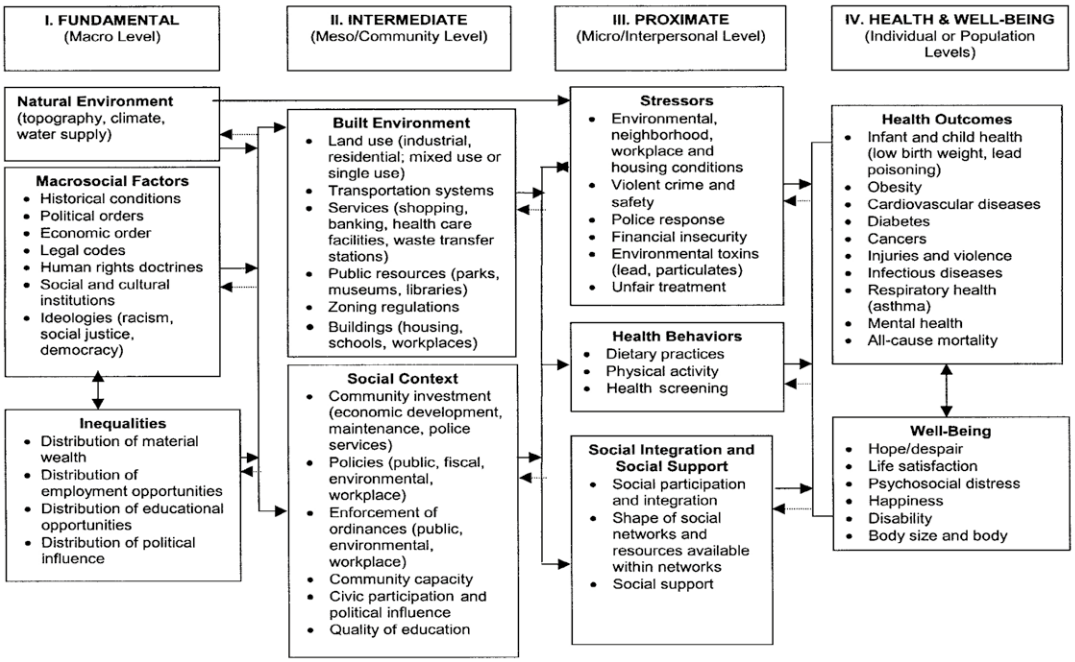
4.4 Conceptual frameworks on urban planning and health

The frameworks discussed above all try to reveal the different determinants and interrelations that make up an individual's health. However, they refrain

from making concrete recommendations towards spatial policy. Since the turn of the century though, new approaches arose that specifically focus on the health impacts of the built environment and recognize the complexity of the relationship between environmental health and urban development.

4.4.1 The Planning Healthy Cities Conceptual Framework of Northridge et al. (2003)

Figure 29 Planning Healthy Cities Conceptual Framework (Northridge et al., 2003)



One of the most well-known approaches for uncovering the complexity of the interrelationship between the built environment and health is the Planning Healthy Cities Conceptual Framework of Northridge et al. (2003) (Figure 29), which merges the ideas of several approaches. It adopts the multi-scalar and multi-dimensional idea of the ecosystems approach by building a framework of four interacting levels (Hancock & Perkins, 1985). By specifying the determinants of each part and detailing the relationships between the different parts, the framework follows the health determinants approach (Evans & Stoddart, 1990).
The level of fundamental factors consists of the natural environment, macrosocial factors and inequalities. These fundamental factors influence two domains of intermediate factors: the built environment and the social context. Northridge et al. emphasize the intermediate factors because that is where the impact of policy manipulation (e.g. of the built environment) has the greatest potential benefit for improved population health and well-being. Further they discern proximate factors at the interpersonal level and health and well-being at the individual scale. The

interactive relationships among the various levels are not further detailed and remain limited to the aggregate domains.
Besides not giving concrete policy recommendations, this framework is criticized for being deterministic and static, with each level affecting only the ones below or above it, instead of tracing more "complex" lineages (Rydin et al., 2012). The critique is part of the changing vision among academics who acknowledge that, in the past, the unique nature of cities and their impact on the health of their residents were addressed in fragmented and often narrow ways. Environmental dilemmas were traditionally taken care of by using a functional rationality approach, emphasizing direct causal relations between cause and effect, resulting in "predictable" outcomes (de Roo, 2000). Today the consensus grows that no adequate framework can represent the complex web of dynamic processes through which the physical and social environment have their effects (Evans & Stoddart, 2003; Glouberman et al., 2006).

4.4.2 Healthy city planning frameworks of Glouberman et al. (2006) and Corburn (2009)

Health and cities are increasingly understood as highly complex concepts, unable to be reduced to their component characteristics and shaped by numerous, perhaps even countless, forces in many spheres of influence, ranging from the molecular to the socio-economic (Glouberman, 2001). As a result, the ideas of stability, linearity and regularity that drive evidence-based policy are challenged, emphasizing the limited ability to predict, plan and control the behavior of social systems (Geyer & Rihani, 2010). In response, Glouberman et al. (2006) and Corburn (2009) presented two approaches that recognize the complexity of health and cities and adopt a relational view of places, with the mutually reinforcing and reciprocal relationship between an individual and his or her context as a major contributor to health. They did not develop a framework with determinants and relations, but rather formulated policy approaches.
Glouberman et al. (2006) advocate a "post-modern approach" to improve health in cities, considering cities and health as complex adaptive systems. Their "Health in Cities Framework" contains seven elements that can be seen as policy recommendations for intervention (Table 4).

Table 4 The Health in Cities Framework (adapted from Glouberman et al., 2006)

1	**Gather local information**: because understanding local strengths and assets is vital to intervening in complex systems.
2	**Respect history**: because adaptive systems are shaped by their past.
3	**Consider interaction**: because health is profoundly affected by complex and unpredic table interactions with the natural, built, and social environments.
4	**Promote variation**: because introducing many different, small-scale interventions for the same problem offers a greater hope of finding an appropriate and effective solution.

5 **Conduct selection**: because a beneficial strategy is needed to evaluate performance of potential solutions and selecting the best candidates.

6 **Fine-tune processes**: because the process of intervening in complex adaptive systems in any meaningful way will always be an iterative one, with issues gradually clarified and solutions refined.

7 **Encourage self-organization**: because complex adaptive systems often spontaneously generate solutions to problems without external input or formally organized interventions.

The first two recommendations concern the context-specificity of urban environmental health problems. There are no two problems alike, and we need to include local knowledge and appreciate history to solve them. The third recommendation relates to the relational view of places mentioned earlier. The fourth, fifth and sixth recommendation are process-related and advocate for an iterative trial-and-error attitude with many small-scale interventions and a dynamic evaluation mechanism, as the system is always changing and adapting. However, the recommendations give no advice on concrete implementation and specific strategies to be followed. The last recommendation stresses the aspect of self-organization, but is contradictory in arguing to encourage it but stating its absence of external input. In summary, these recommendations remain general and stick to rather obvious good advice.

A comparable approach was developed by Corburn (2009). In his book "Toward the Healthy City" he discusses five challenges in the evolution towards a healthy and equitable city-planning framework (Table 5). The two most remarkable ones are (2) the shift from overreliance on scientific rationality to the co-production of scientific knowledge and new measurement and monitoring networks; and (3) the shift from moral environmentalism and physical determinism to a relational view of place, in which meanings and interactions in urban spaces are crucial to understanding how place shapes human well-being.

Table 5 Five challenges toward a politics of healthy city planning (Corburn, 2009)

Toward a politics of healthy and equitable city planning		
Unhealthy city-planning frame		Healthy and equitable city-planning frame
Removal of hazards and people	→	Prevention and precaution
Overreliance on scientific rationality	→	Co-production of scientific knowledge New measurement and monitoring networks
Moral environmentalism and Physical determinism	→	Relational view of places
Laboratory view of city	→	Field site and laboratory view of population health and embodiment
Professionalization, fragmentation, and specialization	→	Cross-disciplinary collaborations and regional coalition building

Glouberman et al. (2006) and Corburn (2009) both recognize the complexity of environment and health and try to formulate policy recommendations. However, these are rather general and do not offer concrete policy advice to approach environmental health problems. Rydin et al. (2012) go one step further in trying to develop a more practical and detailed policy framework incorporating the alleged complexity.

4.4.3 Shaping Cities for Health Framework of Rydin et al. (2012)

One of the most recent contributions in urban planning and environmental health is the framework of Rydin et al. (2012). They point to the absence of a developed conceptual framework to support action on healthy urban environments and criticize the contributions to date to fill this gap.
Based on Batty's idea of cities as "the example par excellence of complex systems"[7] (Batty, 2008: 769) they propose a complex systems approach to the analysis and promotion of healthy cities, marked by the following characteristics: a recognition of the multiplicity of associations, nonlinear relations and multi-directional causation, feedback loops to maintain equilibrium, and inherent uncertainty about the prediction of effects. Their new framework describes urban health outcomes as the result of the mutual interconnections among four descriptors: (1) society and governance processes, (2) urban planning, policy making and management, (3) aspects of the built environment and its social use, and (4) how the built environment directly affects health (Figure 30). This simple framework indicates which factors have to be considered when building an urban health and planning strategy. Because of its simplicity it encounters little opposition, but it is insufficient to support an effective policy strategy.
Their ideas are made more explicit through a focused framework that identifies how interventions in the urban environment may affect health outcomes (Figure 31). Although they admit such a focused approach can never be fully comprehensive and is in danger of both leaving out specific aspects and failing to capture crucial interconnections, Rydin et al. promote it as a useful heuristic method of analysis and development. They explore this framework in greater depth by describing five case studies. These case studies focus on particular urban environmental problems (e.g. the urban mobility problem) and try to use the framework to better understand the factors that shape the tenuous connections between urban planning policy and health outcomes.

Following these frameworks, Rydin et al. (2012) describe a spatial planning approach that emphasizes three key elements (Table 6). These are broadly formulated to encompass almost the same ideas as those from Glouberman et al. (2006), to whom they refer (see Table 4).

7 "Emergent, far from equilibrium, requiring enormous energies to maintain themselves, displaying patterns of inequality and saturated flow systems that use capacity in what appear to be barely sustainable but paradoxically resilient networks".

Figure 30 Complex systems approach of urban planning and health (Rydin et al., 2012)

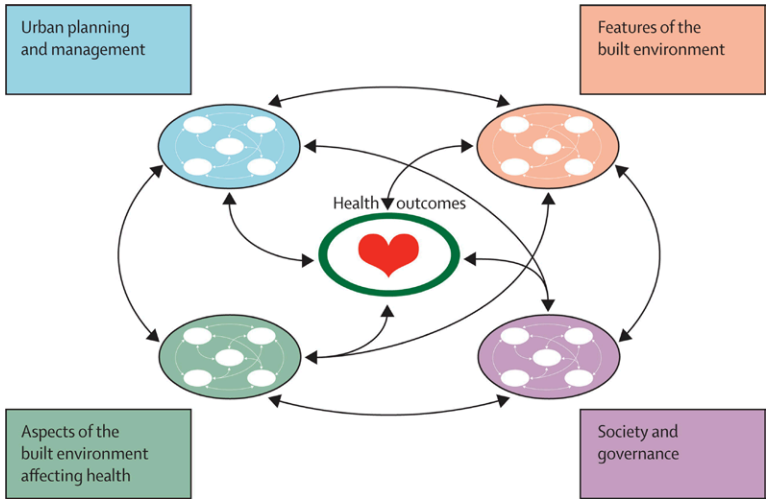
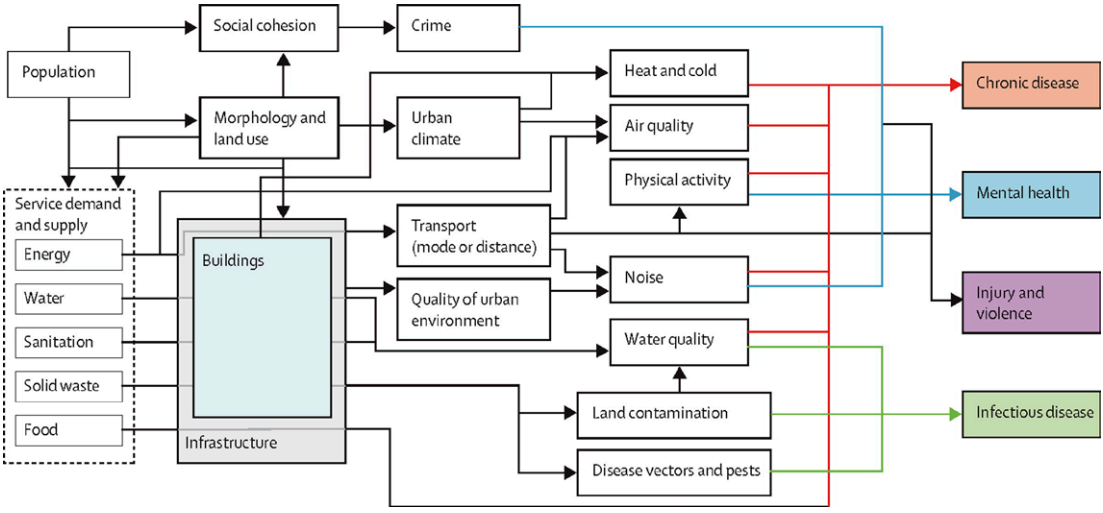


Figure 31 Urban connections between health outcomes and the urban environment (Rydin et al., 2012)



The first element reflects the context-specificity of urban environmental health problems, the need for experimentation with varied projects, and the facilitation of self-organization with the planner as “policy entrepreneur”. Second, the need to promote variation is again highlighted, as well as the aspect of local knowledge. They also put stress on an open process-orientated approach with reflexive social learning. The third element is a new one, advocating for debate and consultation about the moral and ethical aspects of policy interventions. The issue of environmental justice is strongly related to this.

Table 6 Shaping Cities for Health planning recommendations (adapted from Rydin et al., 2012)

1 **Focus on experimentation and trial-and-error**:
because the crucial component of potential failure should be regarded as attributable to the internal dynamics of societal subsystems. The new approach has to promote localized projects that are sensitive to specific circumstances, in which the policy practitioner is acting as a policy entrepreneur who searches for policy windows to effect change and in which opportunities might be community-based and representative of the self-organizing potential. Overall, the greater the diversity of the promoted projects, the greater the potential for the complex system to be steered towards urban health benefits.

2 **Assessments of various experiments needs to be strengthened**:
because reflexive social learning based on dialogue, deliberation and discussion has more chance of success than a modernist idea of reason, based on a technical exercise done by external experts. In this perspective, statistical data have to be combined with the insights of tacit and experiential knowledge held by practitioners and the lay knowledge and experience of local communities. The aim of this open, negotiated and process-orientated approach is creating a community of practice of all stakeholders to generate situated learning.

3 **Consideration of the value-laden nature of policy interventions**:
because there has to be a clear space for debate about the moral and ethical aspects of different approaches to urban health and city environments (in-depth consultation, mediation and deliberation).

Rydin et al. (2012) conclude that this strategy leads to a very different view of the process of planning. It can no longer be seen as a well-structured sequential process or policy cycle but rather as a series of events pursued over time, in which the public decision maker is not in control but is a participant. Instead of aiming at an impossible plan that anticipates future changes, we need to try and test incremental attempts to reach a goal.
These recommendations neatly fit within postmodern urban planning and the complexity planning approach, but are still broadly formulated and do not provide direct applications for actual planning practice. A further development of practical frameworks and strategies is still needed. But before this is discussed, first the difference between a complicated and a complex interpretation of the environment-health interrelationship is considered, since this has important repercussions on the development of a policy framework.

4.5 Adopting the paradigm of complexity

4.5.1 About complicated, complex and chaotic systems

For further clarification, and to draw up a new framework, we must first return to the distinction between complicated and complex systems, and between a paradigm of order and a paradigm of complexity.
A complicated system, such as a clock or turbo machine, can be sophisticated, consisting of several parts working together as one unit. But a specialist could break up the system, analyze its parts separately and then put them back together

again without a loss of information and with the same predictable outcome. The relationship between the parts would not change; instead, they would continue functioning in closed, static and rational ways. These systems are consistent with a linear perspective: causes lead to known effects in a predictable and repeatable manner (Geyer & Rihani, 2010; Boelens & de Roo, 2016).
This is not true for complex systems where each part influences the other parts reciprocally; all exchange (dissipate) information with each other and under specific circumstances or contexts, simultaneously maintaining massive internal variety and global stability. Their elements are constantly emerging and are different at various points in time (Bovaird, 2008). Deconstruction and reassembly would not work, as the conditional circumstances would change and, in the system, the parts and context would be in discontinuous flow. Complex systems can never be grasped as a whole, containing too many interactions, flows and movements. Those movements, flows and interactions make up a system; a complex system exists because of its relationships. By breaking up the system to find the basic principle that governs it, this relational information would be lost (Cilliers, 1998). Since the internal dynamics of these systems create complex outcomes that are not amenable to precise prediction, they can be deemed nonlinear. Their characteristics reflect the uncertainty and complexity of the majority of social phenomena and experiences (Geyer & Rihani, 2010).
To be complete it should be added that also disordered or chaotic systems exist, at least in the physical world. For example, some aspects of quantum mechanics and light happen completely at random. Therefore, Geyer and Rihani (2010) place all physical, biotic and social phenomena on a continuum with disorder and order at the ends and complex situations somewhere in between.

Following the Newtonian vision of an orderly, clockwork universe driven by observable and immutable laws, social phenomena – including public health and urban dynamics – were once considered complicated, ordered and predictable systems. From the 1950s onwards a traditional positivist approach permeated the social sciences and public policy thinking to a particularly high level. This approach was based on a paradigm of an orderly view of the world, characterized by four golden rules (Table 7). According to Geyer and Rihani (2010: 3) this paradigm led to "the pursuit of the perfection of greater order on messy societies" in the course of the twentieth century. The belief in the orderly nature and fundamental rationality and linearity of society and the ability of traditional scientific endeavor to understand and direct society is still prominent in public policy today. In chapter 3 it was argued that environmental policy is still based on a "command and control" framework with generic rules and regulations, as if orderly and linear solutions would work for the complex realities of environmental health.

Table 7 Four golden rules of a paradigm of order (Geyer & Rihani, 2010)

1. **Order**: given causes lead to known effects at all times and places.
2. **Reductionism:** the behavior of a system could be understood, clockwork fashion, by observing the behavior of its parts. There are no hidden surprises; the whole is the sum of the parts, no more or less.
3. **Predictability**: once global behavior is defined, the future course of events could be predicted by application of the appropriate inputs to the model.
4. **Determinism**: processes flow along orderly and predictable paths that have clear beginnings and rational ends.

The overall critique on modernism, discussed in 3.4, is in fact critique on the paradigm of order. Out of this emerged the extremely diverse, but significant challenge of a (disorderly) post-modern position in social science. According to post-modernism the world is understood as a chaotic, contingent, ungrounded, diverse, unstable and indeterminate system (Eagleton, 2013).
The paradigm of complexity takes a more moderate stance. It does not disprove the rationalist orderly paradigm or its antithesis of postmodern disorder, but tries to bridge both opposing positions. Complexity theory argues that physical and social reality is composed of a wide range of interacting orderly, complex and disorderly phenomena. When applied to social and conscious systems such as the society, urban dynamics or public health, six golden rules emerge (Table 8).

Table 8 Six golden rules of a paradigm of complexity (Geyer & Rihani, 2010)

1. **Partial order**: phenomena can exhibit both orderly and chaotic behaviors.
2. **Reductionism and holism**: some phenomena are reducible others are not.
3. **Predictability and uncertainty**: phenomena can be partially modeled, predicted and controlled.
4. **Probabilistic**: there are general boundaries to most phenomena, but within these boundaries exact outcomes are uncertain.
5. **Emergence**: they exhibit elements of adaptation and emergence.
6. **Interpretation**: the actors in the system can be aware of themselves, the system and their history and may strive to interpret and direct themselves and the system.

4.5.2 Applying the complexity paradigm to environmental health

When the paradigm of complexity is applied to the relationship between the built environment and health or to the way spatial policy and urban planning manage environmental health issues, in their entirety both issues can be considered complex phenomena or systems. However, these systems also contain certain linear and ordered elements, such as the proven health effect of air pollution at the population level. When this effect is considered at the individual level it might become even chaotic, since at equivalent pollutant concentrations some people get sick and others not. Because of this combination of ordered, complex and maybe even disordered phenomena, a combination of quantitative and qualitative methods should be adopted to get insight and to intervene. To quote from Richardson and Cilliers (2001: 12): “If we allow different methods, we should allow them without

granting a higher status to some of them. Thus, we need both mathematical equations and narrative descriptions. Perhaps one is more appropriate than the other under certain circumstances, but one should not be seen as more scientific than the other."

The discussed models of Glouberman et al. (2006), Corburn (2009) and Rydin et al. (2012) elaborate on the complex relationship between health and cities, originate from the (dissipative) idea of complex adaptivity and offer situational and innovative policy recommendations. But do they present a practical way for planners to approach environmental health issues in today's complex and nonlinear society? While Glouberman et al. (2006) give only general policy advice, both Corburn (2009) and Rydin et al. (2012) illustrate their ideas with interesting case studies characterized by a co-production of knowledge, a relational view of place, adaptive policy and feedback loops. However, the case studies are intended to show the complexity of urban environmental health issues rather than substantiating a practical policy framework. Moreover, the focused framework of Rydin et al. (2012) (Figure 31), encompassing all relationships and feedback loops between the built environment and health outcomes, gives the impression of control over the reciprocal and wicked problem[8] of health and the city. However, even highly sophisticated models of complex adaptive systems, elusive and ungraspable as they might be, collapse into simple, reduced structures when compared to the emerging complexity of reality (Allen, 2012: 82). In their article, Rydin et al. stated that "such an approach cannot be fully comprehensive and is in danger of both leaving out specific aspects and failing to capture crucial interconnections". Yet, they think it is "a useful heuristic method of analysis and policy development" (Rydin et al., 2012: 2086). On this point they fit in the paradigm of complexity, where these kinds of models can be useful tools together with other (qualitative) approaches. Prigogine and Stengers (1984) take a more explicit stance by stating that modeling complex adaptive systems – like the interaction between health and urban development – could never be used to plan or predict (proactively). Instead, they can only help analyze and explain (afterwards) and train stake- and shareholders to cope with uncertainty.

Despite the theoretical merits of the cited work, the available frameworks do not provide sufficient guidance for contextualized spatial health policies. They do not offer a practical framework that fully accounts for the co-existence of complicated and complex situations within society. Complexity has not overtaken or replaced complicated realities. Both co-evolve, just as clocks and turbo machines still exist in company with complex adaptive weather systems, or just as technical innovations in transport systems co-evolve with ever-changing mobility styles. To go one step further, one can imagine all realities and situations on a continuum from complicated to complex situations (and possibly even beyond towards chaotic situations). De Roo (2000) anticipated this by 15 years by taking a more moderate

8 A wicked problem is a problem that is difficult or impossible to solve because of incomplete, contradictory and changing requirements that are often difficult to recognize. Moreover, because of complex interdependencies, the effort to solve one aspect of a wicked problem may reveal or create other problems (Rittel & Webber, 1973).

view and suggesting that, depending on the complexity of an environmental conflict, another approach may be needed. For relatively simple yet complicated environmental conflicts, standard (modeling and framework) solutions will suffice, but for more complex environmental conflicts, another more open form of planning is needed, which would include greater local participation, a shift of attention from predefined goals to process-related aspects, and the abandonment of logically deduced knowledge as the starting point. He advocated a new approach, one that is not a substitute for environmental standards, but rather is an additional strategy that puts environmental conflicts into a wider perspective. His approach was an important inspiration for the new proposals for healthy planning to be described hereafter.

4.6 Theoretical framework: new proposals for a healthy planning approach

According to Geyer and Rihani (2010), adopting the paradigm of complexity does not provide a specific final "answer" to a particular policy, economic or social issue. Rather it enables decision-makers to interpret what goes on in the social, economic and political arenas in a new way that recognizes the limits of knowledge and prediction. The complexity perspective advocates a mixture of approaches and methods. In this sense, less orderly and traditional approaches and policy actors, often deemed soft and non-scientific, are just as scientific as traditional orderly approaches and provide the flexibility, adaptability and sustainability needed to manage the complex problems of today.
If this paradigm is applied to environment, health and planning, the current policy approaches for environmental health can seriously be questioned. These approaches are mostly restricted to generic regulations, deterministic solutions, (quantitative) evidence-based choices and a command and control policy of the government who sees itself as the key player. This failure already came up in the extensive description of the current disconnect between urban planning and environmental health in chapter 3. If a new healthy planning approach is developed from scratch with a complexity perspective in mind, also environmentally unhealthy situations have to be redefined. Given the complex interpretation of the concepts of health and urban dynamics, also at this point purely quantitative methods do not give a full picture. Two fundamental questions emerge:

1 **How to locate environmentally unhealthy situations?**
2 **Which planning strategies are needed to address these situations?**

To answer these questions, two theoretical frameworks are presented that combine traditional, quantitative, complicated approaches with novel, adaptive and flexible approaches that capture the complexity of cities and society.
To answer the first question, the interpretation of the concept of environmental justice by Walker (2012) provides an interesting perspective to build a theoretical framework. In his view, the identification of an unhealthy situation that needs intervention is not a straightforward task, because of the complexity of the environment-health relationship and the arbitrary definition of justice. According to Walker

(2010), justice and fairness are often at the center of conflict over decisions with significant environmental consequences. The proposed theoretical framework builds on this crucial aspect of claim-making.
To answer the second question, the ideas of de Roo (2000) are followed.
The proposed theoretical framework complements the current structuralist (complicated) planning strategies to environmental health conflicts with additional complexity approaches. Depending on the degree of complexity, other (combinations of) strategies come into view.
Both frameworks do not give a final "answer" to manage environment and health. What they do is suggest a tool to consider environmental health issues from a complexity perspective, to make more informed judgments and interventions.

4.6.1 An environmental justice assessment framework

The concept of environmental justice is thoroughly explained by Soja (2010) and Walker (2012). In his theoretical work on spatial justice, Soja (2010) states that the geographies in which we live can have both positive and negative effects on our lives. He argues that there will always be some unevenness in the geographies the society produces, and that we can never achieve perfect equality because of spatiality. This arises in the most basic way from the inequalities produced from the uneven geographical effects of everyday individual action and social processes. A location in space always has relative advantage or disadvantage, making choices about achieving spatial justice always a normative exercise. Following Soja (2010), environmental justice can then be seen as a subfield of spatial justice, focusing on geographical discrimination regarding negative environmental impacts.

Walker (2012) focuses on environmental justice and adopts a more practical approach. He analyzes multiple alternative definitions of the concept, and advocates to broaden the focus on distributive justice with other interpretations. Also other authors suggest to not only fight about the consequences of inequities in the siting of environmental goods and bads, but also the underlying decision-making processes and institutions that shape the distributions (Corburn, 2009; Anguelovski, 2013). Walker determines three basic interpretations:

1 **Distributive justice**: the distribution or sharing out of environmental goods and bads.
2 **Procedural justice**: the ways in which decisions are made, who is involved and has influence.
3 **Justice as recognition**: who is given respect and who is and isn't valued.

Within the concept of distributive justice, undoubtedly central to environmental justice claim-making, three dimensions are at stake: exposure, vulnerability and responsibility (Walker, 2012).

– The first dimension, **exposure**, considers the uneven distribution of environmental impacts across specific groups of the population.
– The second dimension, **vulnerability**, considers the health impact for a specific

person. Physiological, social, economic and cultural factors may mean that an entirely equal distribution of exposure to a burden may still have very unequal impacts. (When focusing on environmental resources, the dimension can be replaced by "need")
- The third dimension, **responsibility**, evaluates the justice of the dislocation of those creating environmental burdens (or enjoying the benefits of its pollution sources) and those suffering from harm or disbenefit. The importance of responsibility is also paid particular attention to in a recent paper by Davoudi and Brooks (2014). They make a plea for a pluralistic understanding of justice and expand the range of distributional concerns even with a fourth dimension of mitigation measures.

Further, Walker distinguishes between **inequality** and **injustice**, terms that are often confused with one another. He defines inequality as a descriptive term, describing a condition of difference or unevenness of something. It can be measured and described, although a description will never be an entirely neutral or unconstructed exercise. Injustice is a normative term and always involves a form of judgment or claim. An observed inequality (e.g. an uneven distribution of air pollution over a city) does not immediately imply a condition of injustice and the need for policy intervention. What is unequal will not be considered always and everywhere undesirable, bad, unfair or unjust (Walker, 2010). The normative character implies that no universal prescription exists of what is a fair distribution of environmental quality for any scale of analysis, and that questions of fairness are ethical and political, rather than empirical and statistical (Low & Gleeson, 1998). Environmental justice is always situated and contextual, grounded in the circumstances of time and place, hence defying universal definition (Walker, 2012).
In line with this, Davoudi and Brooks (2014) see the mapping of the distributional aspects and the detection of possible injustices only as a starting point in environmental justice research. The answers to questions as why injustice happens, lie in the underlying social structures and institutional contexts. They argue for a radically different take on environmental justice studies, in which the positivist, top-down, and expert-driven approaches are combined with the interpretative, bottom-up, and people-driven approaches. This situated view allows considering detailed narratives of a particular place, people's perceptions of the environment and the meaning and values they attach to it. The burdens, benefits and principles can then be fully understood in a relational way, priorities can be set and claims for environmental justice can be substantiated. This view corresponds to the complexity perspective outlined before and will guide the operational research framework presented later.

Here the crucial concept of claim-making should be introduced. Because no universal prescription of environmental justice exists, the concept is inevitably political. Since politics involves disagreement, competing perspectives and active work to persuade others, claim-making is central to Walker's environmental justice perspective. The basic combination in claim-making is to link evidence of a condition of inequality with a normative position on what is just or unjust. But the disputes on justice can extend to what constitutes reliable evidence and the degree to which injustice can be "proven" to exist. To bring some order into decomposing claims, Walker (2012) discerns three different forms, each applying to the three described concepts of justice.

1 **Claims about evidence**: about how things are.
This is not only about evidence of distributional patterns of burden and benefit, but also of inequality in procedures and in recognition or misrecognition of certain groups of people. Gathering evidence is seen as a claim for knowledge, authority and power, because evidence is always problematic, not a matter of simple fact and truth, but produced through social processes. Also, great scope exists for critique and disagreement about what makes up a "good" or sufficiently robust research design. In every quantitative analysis methodological choices are involved shaping the scope and form of the evidence claims that can be made and the knowledge that is generated and not generated. Walker indicates that the awareness of power relations in the production of evidence has led both activists and academics to call for and experiment with participatory, community-based research. Finally, claims about evidence do not have to stick to quantitative terms. Conceiving justice as procedure and recognition asks for other forms of evidence relying less on the analysis of large-scale data sets and more on particular cases, experiences and narratives.

2 **Claims about justice**: about how things ought to be.
These claims take a normative position on what is just or unjust. With regard to distributive justice these claims are about who gets what, about how the goods and bads should be distributed. Different distribution principles are possible, in which aspects of vulnerability and responsibility (e.g. polluter pays principle) can be taken into account. Today, for the distribution of environmental burdens often the principle of a right to a common minimum standard is used, to safeguard environmental quality for all citizens. This seems to make much sense and appeals in abstract logical terms, but Walker points to two significant deficiencies. First, the capacity of standards to take account of particular sensitivities and to protect the most vulnerable is at least uncertain, if not deeply constrained. Relying on the narrow and reductionist science of general standards would be insufficient. Second, using standards and data assumes good knowledge of the real world variation in exposure to environmental impacts, while the capacity to "fully know" is highly limited; e.g. it is impossible to know the air quality and sound quality for each location at any time, as every way of monitoring or modeling represents a distortion of reality.
Also concerning procedures and recognition claims about justice are made. As for procedural justice, claims can be made about the just functioning of the institutional framework that causes or influences a situation of environmental inequality. As for justice of recognition, claims are about the systematical, but not always intentional, lower valuation of certain social groups, by cultural or institutional processes that can be deeply rooted and difficult to reveal.

3 **Claims about process**: about why things are how they are.
While a few structural explanations exist (environmental discrimination, segregation, capitalism, political ecology ...), most cases of environmental inequality can be explained out of their spatial and temporal contexts. Snapshots of reality only reflect the current socio-spatial configuration, often traced back to historical processes. Gaining insight in these underlying causes is necessary to make a claim about the justice of a situation.

Table 9 Environmental justice claim-making framework, based on Walker (2012)

	claims about evidence	claims about justice	claims about process
distributive justice: exposure			
distributive justice: vulnerability			
distributive justice: responsibility			
procedural justice			
justice as recognition			

By combining the three kinds of claims with the different definitions of justice, a matrix arises, which can be used to analyze specific situations of environmental inequality (Table 9). It discerns the different dimensions of the justice of a situation, and can serve as a basis for claim-making or to understand and situate the claims of others. According to Walker, it is unnecessary that all three kinds of claims will be in place when environmental justice claims are being made, but often different claims are combined. Mostly claims about evidence are combined with claims about justice, e.g. a residents' association claims they are highly exposed to aircraft noise – a claim about evidence – and they consider it unfair – a claim about justice. Walker sees acts of justice claim-making as essentially open to all. In fact, all human beings routinely make claims about the justice or injustice of a situation. Also the opinions of those with particular professionalized roles and expertise must be seen as claims, rather than assertions of absolute truth based on their "better", "more expert" grasp of what is at stake. It then becomes interesting to think about on what grounds, in what circumstances and for what reasons some claims are advocated and given more authority and respect than others. To be clear, also the researcher or planner analyzing a situation is making claims; e.g. by analyzing the spatial distribution of air pollution a researcher is making claims about the evidence of distributive justice (in the dimension of exposure).

The main conclusion of the environmental justice framework is the absence of unique truth. Instead, different claims of how a situation should be seen and explained are connected to different actors involved in the case, influenced by spatial and temporal context. As a consequence there is not one right decision on the justice of a particular situation and the need to change it. The best choice is to take all stakeholders into consideration, try to understand their claims out of their specific background, and combine this with knowledge on the spatial and temporal context. While the developed framework provides guidance on assessing the desirability or justice of a specific situation, it does not tell how to manage situations of environmental (in)justice in urban planning or spatial policy. Therefore, a second framework is needed.

4.6.2 A matrix of healthy planning strategies

Building on the ideas of de Roo (2000) (see 4.5.2) is proposed to expand the current structuralist (complicated) planning strategies to environmental health conflicts with additional complexity approaches. The current strategies should not be completely abandoned because they still have their merits in solving simple or complicated issues and framing contextualized, dynamic and fuzzy issues of space and health. But these structuralist strategies are not sufficient in tackling all current urban environmental health problems, and cannot cope with the fragmented, volatile, contextual developments described earlier. Additional planning strategies are needed that come up with practical solutions that correspond to the everyday reality of contingency and volatility.
For this, inspiration can be found in the recent insights in complex management theories, which distinguish between the detail and the dynamics of complexity and propose corresponding management strategies. Hertogh and Westerveld (2010) use this approach to manage large infrastructure projects in various settings of social (un)certainty (Figure 32 and Figure 33). Detail complexity is defined as a situation with many components with a high interrelatedness; and dynamic complexity as a situation with the potential to evolve over time leading to limited understanding and predictability. For situations of detail complexity control is needed and for situations of dynamic complexity interaction is needed. In this framework they discern four different situations (simple, complicated, complex and complicated-complex) and suggest four corresponding management approaches.

Figure 32 Complexity in Large Infrastructure Projects (Hertogh & Westerveld, 2010)

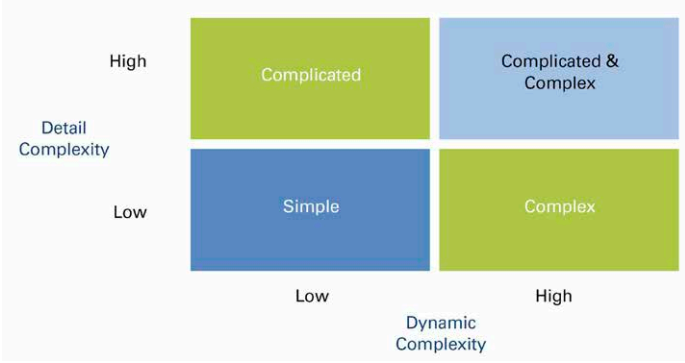
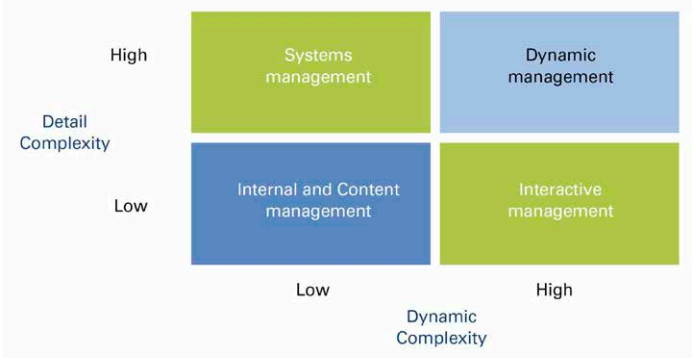
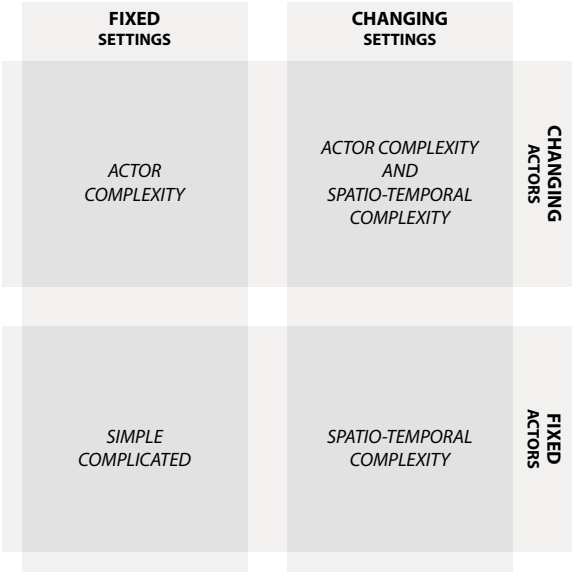


Figure 33 Four approaches on the management of complexity (Hertogh & Westerveld, 2010)



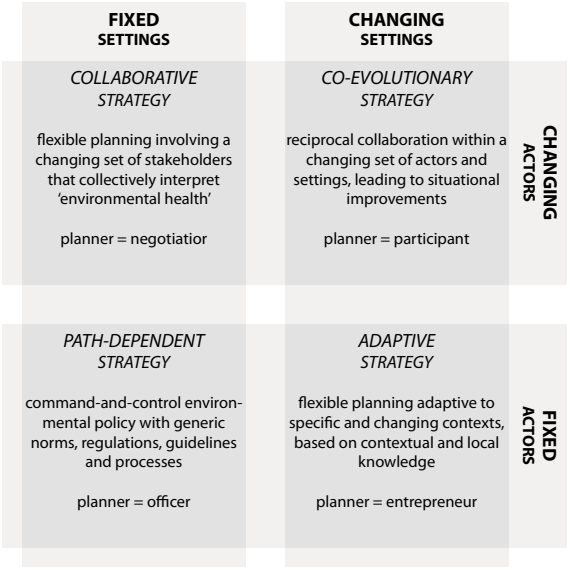
Following the discussed ideas on complexity in environmental health issues, situations of "detail complexity" without "dynamic complexity" are equivalent to (very) complicated situations. They are deterministic systems in which predictability would be possible if all information is at hand. Therefore, for the problem of environment and health a comparable matrix is developed with the axes defined somewhat differently (Figure 34). Static or fixed settings (on the left) are distinguished from dynamic, open or fuzzy settings (on the right). Another distinction is made between situations or problems that involve only a few fixed actors (at the bottom) and situations that involve many actors that possibly change over time (at the top). One could name the axes "spatio-temporal complexity" and "actor complexity". In a situation of "spatio-temporal complexity" the concept of environmental health is adaptive to specific spatial and temporal contexts, but with fixed actors defining environmental health. In a situation of "actor complexity" the concept of environmental health is adaptive to a specific actor context (including their perceptions, norms and values), but in a specific and controlled setting of space and time. Both situations of complexity have unpredictable outcomes and are nonlinear. If they come together the highest degree of complexity is reached, involving also higher degrees of uncertainty.

Figure 34 Complexity in environmental health issues



The corresponding matrix of healthy planning strategies (Figure 35) focuses particularly on the relationships among elements of the "complicated" schedules mentioned before, and could serve in addition to those schedules (e.g. Figure 31). Each of the quadrants determines how the relationship between the various elements of these schedules must be dealt with: path-dependent, collaborative, adaptive or co-evolutionary. For each urban environmental health issue, a specific combination of complicated models and different quadrants is needed; for some, a predominantly path-dependent strategy would suffice, but for more complex challenges, other strategies are more appropriate.

Figure 35 A matrix of planning strategies for environmental health



The left side of the matrix deals with fixed settings. When the actors are also fixed, this results in a **path-dependent** strategy in the lower left section. This strategy represents the established procedures of the environmental command-and-control policy and its associated generic norms, regulations and guidelines for environmental impacts with indisputable evidence (e.g. the EU air quality standards). It is supported by objective data collection (e.g. urban noise maps), empirical research on environmental impacts, and deterministic frameworks that try to uncover the environment health links in a holistic way. The environmental assessment processes can also be considered an example of a path-dependent strategy. In this strategy the environmental department takes the lead with its civil servants and appointed experts. The planning practitioner takes no concrete initiative concerning environmental health, but only follows the environmental norms and regulations. Such strategy could be sufficient for simple or complicated environmental health issues, e.g. the obligatory installation of an air purification system in polluting industrial facilities. For more complex environmental health issues, environmental assessments can be an important factor in taking decisions. Walker (2010) takes an even more radical position. He draws hope for more powerful strategic environmental assessments because in his view participatory processes cannot genuinely give equal access and influence to different public voices. He thinks environmental assessments should have a role in redressing the systematic environmental imbalances, explicitly recognizing that the public is not a homogenous group.

For most conflicts, however, and especially when more and ever-changing actors are involved, a more participatory or **collaborative** planning strategy is needed to deal with all the interests involved, albeit within strict and predefined objectives. This strategy includes bottom-up expertise and subjective aspects in policy processes. The involved actors can be ordinary citizens, but may also be civil society

organizations, such as environmental associations and neighborhood associations, environmental experts, public health workers, and many others (companies, landowners, automobile associations ...). Collaborative strategies are already used by urban planners in policy processes, but the aspect of environmental health is usually not really part of the discussion. In reference to the "complicated" holistic schemes illustrated by Figure 29 or Figure 31, it would mean that the characteristics of the relationships between the various elements, and the applicable norms and thresholds, would depend on the specific interests and actors involved. The concept of "environmental health" would thus be collectively interpreted and negotiated. In this strategy the planner guides the negotiations by caring for an equal representation of all stakeholders and protecting the public interest. An interesting example of this collaborative strategy relates to the Hemmes peninsula in Zaandam (Netherlands) (Example 1).

Example 1 Collaborative planning strategy: flexible application of noise thresholds in Zaandam (Netherlands)

The Hemmes peninsula in Zaandam would be a unique place for innovative residential developments close to the city center at the shore of the river Zaan. Unfortunately, this was impossible until recently because the activities of two industrial companies in the vicinity lead to exceedances of the countrywide noise thresholds for a residential environment. Therefore, the city tried to agree with the companies on relocating or reducing the exposure in the long term, but in the meantime already wanted to initiate residential development. Specifically, the city explored the option of concluding a contract with future residents, in which they would accept a few decibels higher noise exposure for some years. This means that stakeholders "negotiate" what level of noise exposure is acceptable and how "environmental health" is interpreted. While this creative solution first clashed with the strict environmental regulations, finally the city obtained a temporary derogation. It can develop a flexible zoning plan that, for the next ten years, should not comply to the regulations of the national Environmental Planning Bill. The plan should be approved by the end of 2016.

(Actieplan "Houdt het eenvoudig maak het beter". (n.d.) Verbeterdoel 3: Actieve aanpak. Retrieved from http://nualeenvoudigbetermagazine.nl/p4-verbeterdoel-3-actieve-aanpak.html)

Within more complex spatial settings, where volatile and changing objectives occur over time, this quadrant would not suffice. Therefore, in the lower right side of the matrix, an **adaptive** planning strategy can be found, able to cope with these changing settings in space and time. Depending on spatial and temporal context, interpreting the norms and thresholds of the path-dependent strategy can be more or less strict. For an adaptive planning strategy contextual and local knowledge is necessary. Although adaptive strategies can go together with collaborative strategies, they can also be truly government-led. In its pure form, this

strategy deals with a fixed number of actors with fixed and manageable interests and ambitions. In reference to the marked relationships in Figure 29 or Figure 31, specific adaptive translations to the problem and context in question would be necessary. In this strategy the planning practitioner can act as an entrepreneur, collecting contextual information and looking for customized solutions. An example of a government-led adaptive strategy in urban planning and health is the Directive on Sensitive Facilities adopted by the Amsterdam City Government (Netherlands) (Example 2).

Example 2 Adaptive planning strategy: distance rules for sensitive facilities in Amsterdam (Netherlands)

The Amsterdam City Government adopted a Directive on sensitive facilities in 2010. To reduce the exposure to air pollution among vulnerable social groups, this Directive imposes requirements on the minimal distance between high traffic roads and newly built sensitive facilities (schools, day care centers, hospitals and elderly homes). Supplementary to national administrative regulation, which makes it difficult to develop sensitive facilities within 300 meters from the edge of a highway and within 50 meters from the edge of a classified major road, the city administered that no new sensitive facilities can be constructed within 50 meters of a high traffic urban road. To discern these roads, the city uses the criterion of 10,000 motor vehicle passages per 24 hours. A motivated exemption of the guidelines in the Directive is only possible in case of exceptional circumstances or interests. Hence the measure is both adaptive to spatial context and to temporal context, in case the indication of high traffic roads is regularly revised. At the same time it shows that adaptive strategies (the local directive) can go together with path-dependent strategies (the "generic" countrywide regulation).

(Gemeente Amsterdam. (n.d.) Lokale Richtlijn gevoelige bestemmingen luchtkwaliteit Amsterdam. Retrieved from http://www.amsterdam.nl/parkeren-verkeer/luchtkwaliteit/beleid-regelgeving/lokale-richtlijn/)

Situations can become even more complex when both the objectives (or settings) and the interests (or actors), especially their number or character, change over time and space. For these situations, in theory a **co-evolutionary** planning strategy would be an option. In this case the objectives, procedures and even interests dissipatively co-evolve with changing settings and adaptively follow self-organizing pathways to facilitate improved environmental health resilience. This strategy starts on the outside and works in, beginning with collective experience and concern about a certain environmental health problem in real life. It is a reciprocal, co-evolving strategy between government, academics and the public, and between domains of environment, planning, health, mobility and others. It is a strategy without pre-set procedures, a fixed set of stakeholders or a static regulatory framework with norms and guidelines. Following the ideas on co-evolutionary, actor-relational planning the outcome is undefined, with many possible directions in changing actor-network settings, but which all move towards situational improvements for (unhealthy)

situations. It requires a very engaged and committed planner, one who is not the initiator of the process but merely a participant. Even then, successful outcomes and a smooth process are difficult to achieve. A spontaneous movement will often not be representative for the wishes of all residents in a neighborhood, causing local struggles. Also power relations between the different actors confine discussions and agreements and limit the paths of environmental improvement.
In reference to the "complicated" holistic schedules (e.g. Figure 31), this quadrant not only discusses the relations between the elements, but also the number and importance of the elements themselves, depending on the context, actors and issues at hand. In practice sometimes the seeds of a co-evolutionary strategy can be seen, when self-organizing initiatives suddenly point to new environmental health issues and start to raise awareness and collect expertise. A good example is "Lab van Troje" in Ghent (Belgium) (Example 3). However, these initiatives usually are quickly halted by the traditional government framework and local protest of opponents or receive sympathy and support as "test cases". Real reciprocal co-evolution in environmental health issues, with different stakeholders constantly adapting and reorganizing themselves on an ever evolving pathway of situational improvements, does not seem to happen yet.

Example 3 Seeds of a co-evolutionary strategy: "Lab van Troje" in Ghent (Belgium)

Lab van Troje (in English: the "Trojan Lab") is a living lab with different partners (citizens, businesses, organizations and government bodies). However, the initiative and the organization are with the civil society; the government is only one of the partners who facilitates. Through strategically chosen experiments, Lab van Troje aims to gain practical experience and to show that structural changes are possible. A successful project (called "Living Streets") is the temporary closing of city streets for motorized traffic, to create space for meeting, green and experiment and to contribute to local environmental health. In this case, citizens (or other societal actors) spontaneously come up with what they think are the environmental health needs for a specific (public) space and time and try to intervene. Although such experiments work well on street scale level, one can question the fairness and feasibility at the urban or regional scale.

(http://www.labvantroje.be/en/)

Essential to the co-evolutionary planning strategy is the self-organizing power of neighborhoods for environmental health issues. Glouberman et al. (2006) remarked that grassroots, self-funded groups often arise to address perceived environmental health issues and concluded that this self-organizing quality was a "free good" capable of producing novel approaches to spatial conflicts. However, Glouberman et al. did not make clear how these self-organizing elements fit within the overall vision of a robust and healthy society, with its standards, norms and environmental assessments. This is where the concept of co-evolution enters again. Although

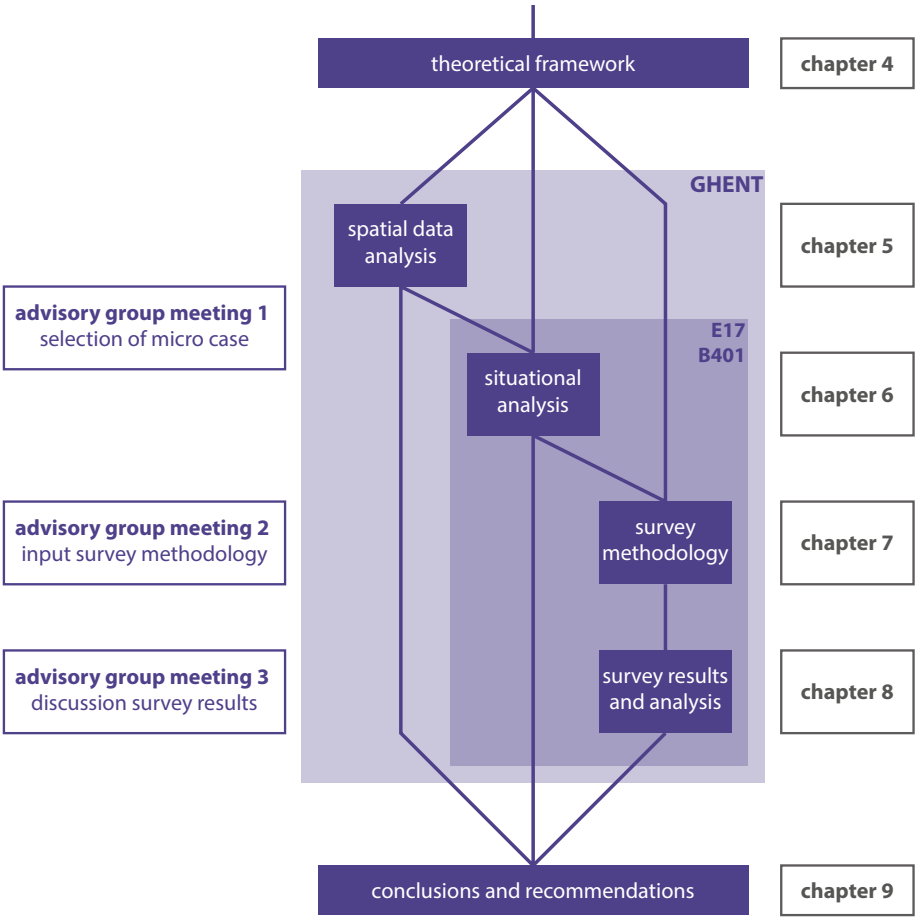
co-evolution is, like the evolutionary theory, rooted in Darwinism, with its notions of heritage, fitness, adaption, selection, mutation and variety, it also goes beyond that idea with the view that groups of organisms are evolving not only by themselves in specific biotic circumstances, but also in explicit circumstances through reciprocal selective interaction with other related organisms or systems (Ehrlich & Raven, 1964). Over time and space, subjects and objects dissipatively and continuously influence each other and co-evolve towards a new and, if possible, more resilient situation (Durrant & Ward, 2011).
The same goes for the matrix of planning strategies for planning and health-related questions. Although co-evolutionary theories of becoming – like general evolutionary theories – start from the species (for example the pro-active, grassroots activists themselves) it is acknowledged that activists are also evolving in relation to other actors, other initiatives and existing rules, regulations, environmental impact assessments and models regarding health outcomes of urban changes. As such, the idea of co-evolution could become more overarching. This is illustrated by the mutual existence of different planning strategies in Figure 35, which could not only be executed in specific cases or settings, but also refer to each other in the improvement towards more healthy cities or regions. The complicated models and standards for environmental health could over time and space co-evolve with the more open and complex strategies to these issues, including local participation, a shift of attention from predefined goals to process-related aspects, and abandoning logically deducted knowledge as the starting point. Planning and health expertise might again become two mutually acting and respected forces, operating interactively in an ocean of agents and agency within continuously changing settings. This view accepts that environmental health and planning processes unfold in time, without a clear beginning or, at least, without a clear and definite end, but still in reference to mutually set standards or norms. It could start with the uniqueness of every issue and urban health challenge and, considering the interaction of what is decided, and by whom, adapt planning to what is emerging. Thus, resilient translations of co-evolution for environmental health and urban development could be facilitated in an undefined, but possibly more resilient, becoming (Boelens & de Roo, 2016).

4.7 Case study research framework

To verify whether the presented analysis and policy frameworks could be useful in analyzing and solving actual environmental health conflicts, a research trajectory is devised in the city of Ghent (Belgium). This way of working is in line with a deductive research approach. A hypothesis (i.e. the two frameworks) is developed based on existing theory and a research strategy is designed to test the hypothesis. This research trajectory involves quantitative and qualitative methods since in a complexity perspective both are just as scientific. In the same way as traditional, structuralist planning strategies can frame contextualized and dynamic issues of environment and health, quantitative and objective analyzes can frame a qualitative and subjective research perspective of an environmental justice conflict.
The empirical research in Ghent consists out of four steps (Figure 36).

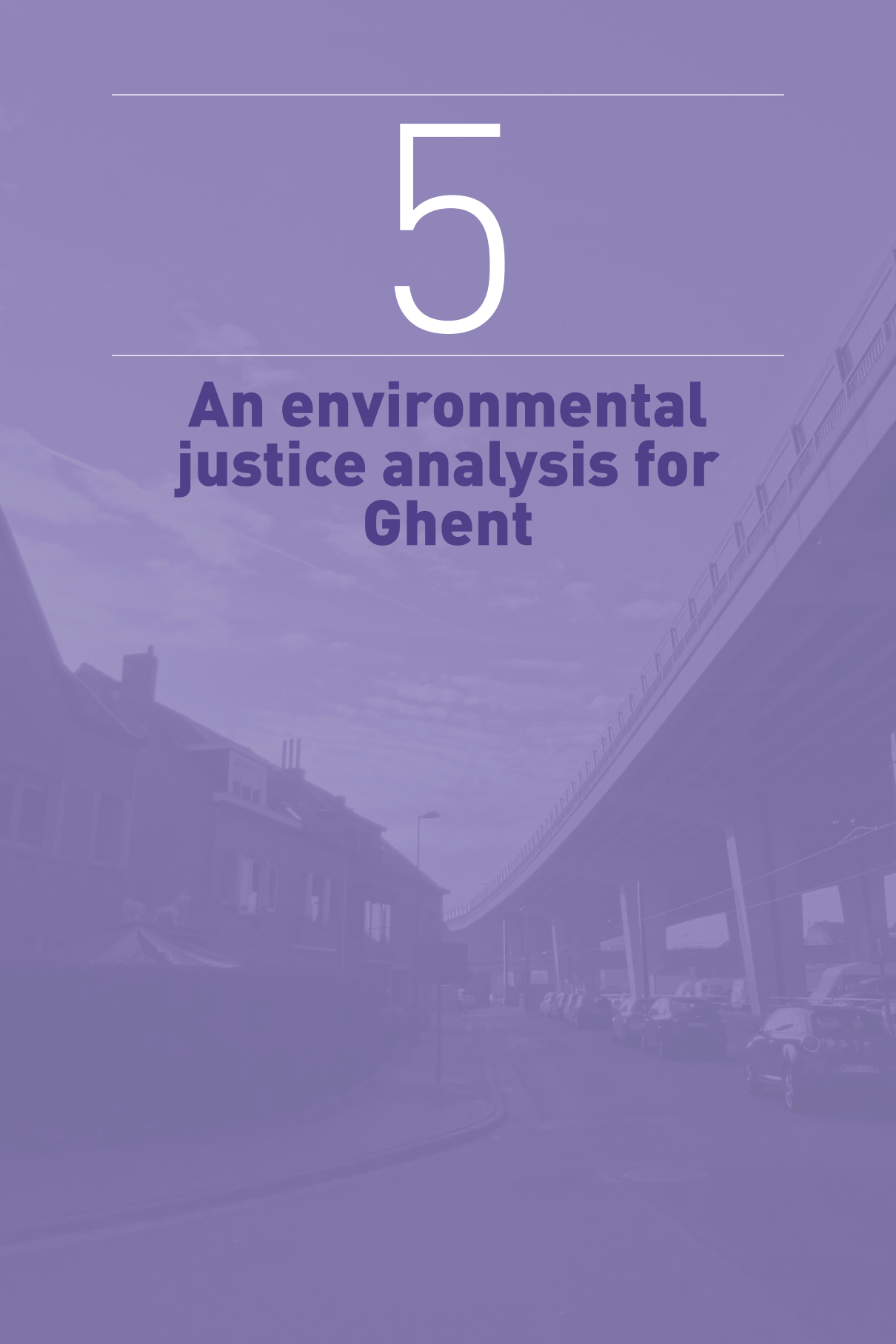
1 In a first step, a top-down, positivist approach will reveal citywide inequalities regarding environmental impacts. This analysis uses the discussed environmental justice concepts of Walker (2012), focusing on claims about evidence of distributive justice. The dimensions of exposure, vulnerability (e.g. relation with income) and responsibility (e.g. relation with car ownership) are addressed. Based on the analysis, and in consultation with an advisory group, a micro case is selected where spatial inequalities are present and (policy) debate is already going on.
2 As Walker (2012) noted, an observed inequality does not necessarily mean an injustice that asks for intervention. To evaluate that, more contextual and situational information is needed, both about underlying processes that produced this pattern and the perception of people living in this situation. Therefore, in a second step policy documents, newspaper articles, research reports, websites and spatial data are analyzed, to gain insight into the spatio-temporal context (history, socio-economic profile ...), the actor context (and its claims) and the current planning strategies. The environmental justice claim-making framework is used to understand the different claims about the situation, while the matrix of planning strategies is used to situate the current policies.
3 To further explore and contextualize the situation, and to get insight into future strategies to change the situation, the perception and opinion of the residents is of utmost importance. Therefore, in a third step a residents' survey is set up, using the environmental justice claim-making framework to get insight in the current situation, and the matrix of planning strategies to assess the feasibility of the different approaches.
4 After the survey campaign, results are listed and analyzed using the two mentioned frameworks. The results will clarify the environmental justice claims of the citizens and the potential of different planning strategies, which both can be added to future discussions.

Figure 36 Case study research framework



5

An environmental justice analysis for Ghent

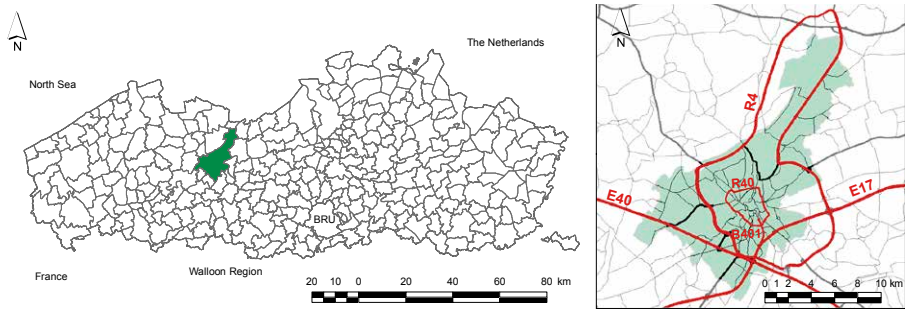


In this chapter a spatial environmental justice analysis for Ghent is presented to reveal citywide inequalities that can be further examined in the next research steps. First, the study area and the considered environmental impacts are presented and motivated. Second, the research questions are listed, followed by an overview of comparable existing research in the third part. The fourth part discusses the used data sources. Part five and six present the methods and results of two different analyses. Both analyses use the same environmental data, but combine these with other independent variables at statistical sector and individual level[9]. The seventh part critically discusses the methods and research outcomes, followed by the selection of a micro case in the final part of this chapter. This micro case is then further examined in the following three chapters.

5.1 Study area and choice of environmental impacts

The environmental justice analysis focuses on Ghent, a medium-sized city with a population of about 250,000 in the Flanders region (northern Belgium) (Figure 37). This study area was selected because of practical reasons: familiarity with the study area, close ties with the Ghent city departments, availability and accessibility of data. But apart from that the city is known for its debate on urban development, not in the least because of the active work of many civil society organizations and grassroots movements, also focusing on aspects such as quality of life and low-traffic environments (Boussauw, 2014).

Figure 37 Location of Ghent in Flanders; location of highways and major roads around Ghent



The environmental justice analysis for Ghent focuses on the impacts of air pollution and noise because of four reasons. The main reasons to limit the analysis to these impacts are the conclusive evidence of a direct relation to health and well-being (see 3.1.1 and 3.1.2) and the significant health burden on the Flemish population (see 3.1.5).

A third reason is the obvious spatial inequality of the distribution of these impacts across Ghent. The intersection of the southern city edge by two highways (E17 and E40), the busy urban ring road (R40) and suburban ring road (R4), the continuous port related traffic and several railways cause traffic noise and air pollution in their

9 A first version of the respondent level statistical analysis was published in Verbeek (2016).

surroundings (Figure 37). Furthermore, in the 1970s an exit ramp of the highway was built as a viaduct, just south of the city center (B401), and another viaduct was built further south as part of the E17 highway, cutting through the suburb of Gentbrugge. Ever since, the southern suburbs have faced a massive infrastructure that rises high above the houses and that is a source of traffic noise and air pollution (Boussauw, 2014).
A final argument to limit the research to the environmental impacts of air pollution and noise is data availability, since for both impacts detailed and full coverage modeled data exist. However, the available modeled air pollution data (further discussed in 5.4) are restricted to road traffic related pollution. Local variation in air pollution caused by industry, trains or other sources is thus not taken into account. Environmental noise data have less restrictions. Modeled data are available for road noise, rail noise and industry noise, and the combination of all sources.

5.2 Research questions

To reveal potential environmental inequalities regarding air pollution and noise in the city of Ghent, a spatial data analysis is carried out following the three dimensions described by Walker (2012): exposure, vulnerability and responsibility (see 4.6.1). In addition, the relation of modeled environmental impacts with the perception of these impacts by citizens, and with housing characteristics that might help explain possible inequalities, is evaluated. This leads to four research questions and according hypotheses. While all research questions want to make claims of evidence, their results can also substantiate claims of process.

RQ1. What is the association between objective and subjective exposure to air pollution or noise?

This is an interesting question, since measured or modeled data are most available, but especially perception of impacts (including subjective health) worries citizens and can mobilize them.

Hypothesis: There is a relation between modeled environmental quality and the subjective experience of it. This supports the use of modeled environmental quality as a proxy for subjective experience.

RQ2. What is the association between vulnerability and modeled exposure to air pollution or noise?

In this question the dimensions of “exposure” and “vulnerability” are assessed together, taking into account the possible interweaving and “triple jeopardy” of a low socio-economic status, a weaker health (and higher vulnerability) and a higher exposure to air pollution and noise. Socio-economic status can be measured by a combination of variables, including income, educational level, nationality, unemployment pressure, etc.

Hypothesis: The potentially most vulnerable and socio-economically weak people bear the highest burdens. In this case a situation of environmental inequality exists, which might be an environmental injustice.

RQ3. What is the association between responsibility and modeled exposure to air pollution or noise?

In this question the combination of the dimensions of "exposure" and "responsibility" is evaluated. The question is operationalized by evaluating the distribution of the benefits and burdens of motorized traffic. Potential proxy variables for responsibility are car ownership and car usage.

Hypothesis: People who contribute less to environmental pollution suffer disproportionally more from it. In this case a situation of environmental inequality exists, which might be an environmental injustice.

RQ4. What is the association between housing characteristics and modeled exposure to air pollution or noise?

In this question the relation with housing characteristics is examined, since the outcomes might explain possible environmental inequalities. Particularly house prices and the difference between temporary and permanent residents are interesting variables. Moreover, in Belgium renters more often have a weaker socio-economic status and thus this variable also relates to vulnerability (Winters & Heylen, 2014).

Hypothesis: People who are higher exposed are more often renters, who (plan to) live only temporarily at their current residence or who lack the resources to buy a house. House prices are also lower in neighborhoods with considerable environmental impacts.

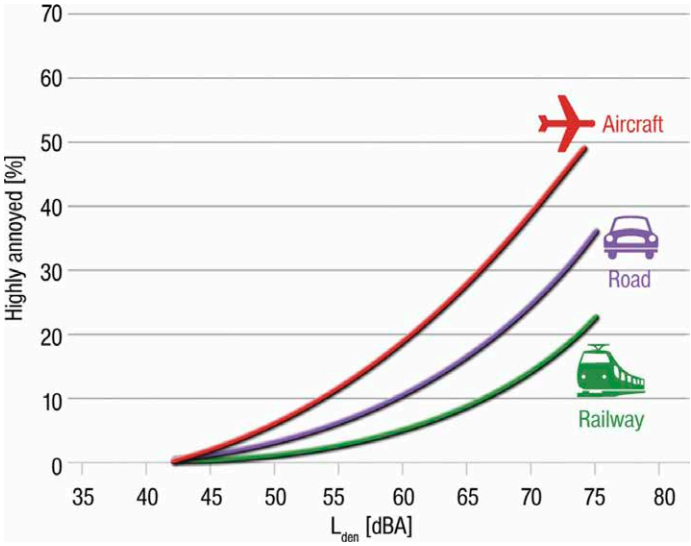
5.3 Existing research

Empirical research on environmental justice started in the United States in the 1980s and focused on the relationship between race and the spatial distribution of waste and industrial sites, pointing to situations of environmental racism (Walker, 2012). A large amount of United States-based empirical studies have confirmed that minority racial groups are more likely than white people to live in areas close to toxic waste facilities or with higher than average pollutant emissions (Brainard et al., 2002).
Since then, the scope of environmental justice research has expanded and diversified, with a focus on social class and other forms of socio-demographic difference, different scales, different time periods and different places. All over the world, the environmental justice frame has adapted itself flexibly and dynamically, to suit the issues at hand. In a European research context, since the turn of the century a lot of attention is paid to environmental justice issues concerning the impact of (traffic-related) air pollution and noise, the largest and second largest

environmental burdens on health in Europe (Hänninen et al., 2014). For both impacts, the spread out pattern with a lot of local variations and the mutual production by all of us add to the relevance of research.

In the first research question the association between objective and subjective exposure to environmental impacts is analyzed. Especially for environmental noise there is research available on this issue. The aspect of noise annoyance as important effect of noise exposure and possible mediator for effects ranging from sleep disturbance to increased blood pressure was already discussed in 3.1.2. The interesting graph of Miedema and Oudshoorn (2001) is recaptured in Figure 38. They developed much-referenced exposure-response equations and showed that for the same noise levels aircraft noise causes more annoyance than road or railway noise[10]. In addition, perception of noise has more impact on well-being than objective measures (Rehdanz & Maddison, 2008; Chasco & Gallo, 2013). Finally, also concerning the objective health effects of environmental noise, research suggests that individual noise perception (associated with individual noise sensitivity) explains these effects better than the actual and measured noise levels (Schreckenberg et al., 2010). Therefore, technical interventions reducing noise levels may not have impacts on annoyance and health proportionate to their impacts on sound levels (Laszlo et al., 2012).

Figure 38 Percentage of persons highly annoyed by levels of aircraft, road and railway noise. The curves were derived for adults on the basis of surveys (26 for aircraft noise, 19 for road noise, and 8 for railway noise) distributed over 11 countries (Münzel et al., 2014; adapted from Miedema & Oudshoorn, 2001).



10 Miedema and Oudshoorn's exposure-response equation for road noise is as follows:
$\%HA = 9.994 \times 10^{-4} (L_{den} - 42)^3 - 1.523 \times 10^{-2} (L_{den} - 42)^2 + 0.538(L_{den} - 42)$
[with %HA the percentage of highly annoyed people and L_{den} the average equivalent sound level over a 24 hour period, with a 5 dB penalty added for noise during the evening hours of 19:00 to 23:00 and a 10 dB penalty for noise during the nighttime hours of 23:00 to 07:00.]

In the second research question the combination of exposure and vulnerability is assessed. Some ten years ago, a highly cited review paper of Brulle and Pellow (2006) recognized that environmental hazards in urban areas still disproportionally affect low-income people and members of minority groups, followed by continued attention to the topic in recent years.
Today, empirical research suggests that exposure to air pollution is not evenly distributed and that individuals with a low socio-economic position or low income may generally be more exposed (Brainard et al., 2002; O'Neill et al., 2003; Chaix et al., 2006; Grineski et al., 2007; Braubach & Fairburn, 2010; Goodman et al., 2011). Sometimes there are exceptions, including reversed directions of associations in central city areas (Goodman et al., 2011). In contrast to air pollution, relatively few studies examine inequalities in environmental noise exposure and evidence is conflicting. Several studies show that individuals of low socio-economic position are more likely than others to report noise annoyance or are subjected to a higher modeled noise exposure (Brainard et al., 2004; Fyhri & Klæboe, 2006; Kohlhuber et al., 2006; Lam & Chung, 2012). Nonetheless, studies in the Netherlands and France report that environmental noise exposure levels are highest in middle-class neighborhoods (Kruize & Bouwman, 2004; Havard et al., 2011; Bocquier et al., 2013). The difference in outcome, to a lesser extent for air pollution, stresses the need for contextual and situational explanations. Unexpected findings may be attributable to historical, political, economic or social processes (Havard et al., 2011).
Exposure is considered to interact with vulnerability, producing a "triple jeopardy" of low socio-economic position, polluted environment and impaired health. This means that groups with a lower socio-economic position that already experience a compromised health status due to material deprivation and psychosocial stress, also receive the highest exposure; and this exposure then exerts larger effects on their health than it does on the average of reference population (O'Neill et al., 2003; Laurent et al., 2007; Pearce et al., 2010; Walker, 2012). Vice versa, well-off populations, regardless of their residential exposure to noise or air pollution, are likely to perceive less annoyance than their neighbors, because they can afford to protect themselves by equipping their dwelling with sound proofing or air purification and are often not at home during the day (Havard et al., 2011). In this way, air pollution and noise may contribute to social health inequalities.

In the third research question the combination of exposure and responsibility is assessed by evaluating the distribution of those creating air pollution and noise (or enjoying the benefits of its pollution sources) and those suffering from harm or disbenefit. The general hypothesis is that poor people are less likely to own a car than wealthier people, contribute less to environmental pollution but suffer disproportionally more often from it (Kohlhuber et al., 2006; Næss, 2013). There are some empirical analyses who prove that environmental injustice in distribution and production of poor air quality go hand in hand (Mitchell & Dorling, 2003; Davoudi & Brooks, 2014) but generally this relation is not yet so clear cut.

In the fourth research question the relation between housing characteristics and exposure variables is assessed, hypothesizing that neighborhoods with more rental houses and/or lower house prices bear higher exposures. Few research is available on this specific topic and results are varied and dependent on context. In a case

study in Phoenix, Grineski et al. (2007) found that neighborhoods with a higher proportion of renters are exposed to higher levels of air pollutants. In a case study in Hong Kong, Lam and Chung (2012) found that renters are generally exposed to higher levels of traffic noise. In a German population based sample, Pollack et al. (2004) found that people living in rented homes reported a higher air and noise pollution.
Some studies examined the association between house prices and environmental pollution. Two recent studies did not find a relation between house prices and objective measures of air pollution and noise, and only one of them found a negative effect of subjective exposure to air pollution and noise on house prices (Rehdanz & Maddison, 2008; Chasco & Gallo, 2013).

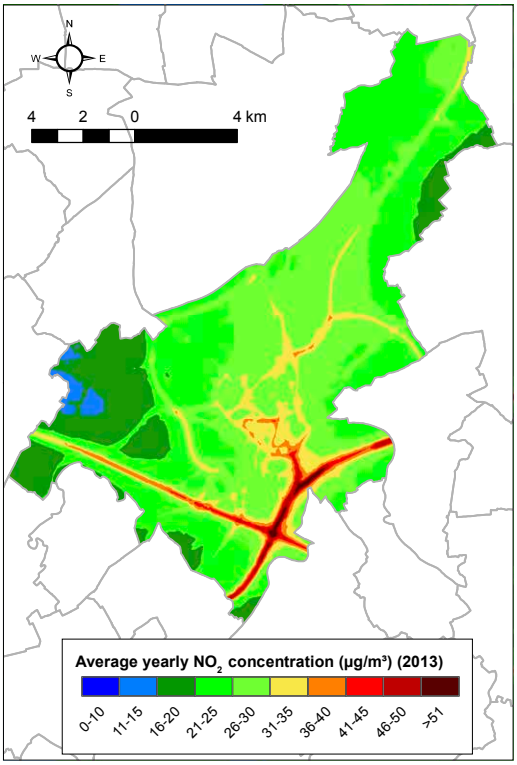
5.4 Data

5.4.1 Air pollution

To quantify the exposure to air pollution, data on air quality was derived from the ATMOSYS "annual air quality" maps for road traffic-related air pollution. ATMOSYS is a LIFE+ Environment Policy & Governance project co-financed by the European Commission, aimed at developing a generic web-based service to evaluate and analyze air pollution. On the project website (http://www.atmosys.eu) annual air quality maps are publicly available.
The ATMOSYS annual air quality maps result from the combination of two data sources: the spatial interpolation of air quality measurements (RIO-interpolation technique) and the calculation of air pollutant concentrations based on meteorological data and the emissions of air pollutants (IFDM-model) (Lefebvre et al., 2013). The RIO-interpolation technique primarily provides data on the background concentration, while the IFDM-model reveals local differences in air quality caused by traffic. Although validation tests gave reliable results, both data sources have limitations and uncertainties. A disadvantage of the IFDM-model is that it focuses on air pollution by road traffic and not includes other sources like industry or households. This can lead to underestimation of the actual concentrations and mitigation of local differences. Most importantly, the RIO-IFDM model is an "open street" model that does not take into account the effect of obstacles alongside roads (buildings, continuous urban fabric, trees) that can cause the so-called street canyon effect. This means that in narrow inner city streets with a lot of traffic, where the dispersion of polluted air goes slower, the model will probably underestimate the concentrations.
The ATMOSYS project provides rasterized georeferenced data on several pollutants, with a resolution of 10x10m. In further analysis, the average yearly concentration ($\mu g/m^3$) of NO_2 for the year 2013 is used as proxy indicator for traffic-related air pollution. Nitrogen dioxide is a gas that is a good indicator for urban traffic generated air pollution, showing more spatial variation than other modeled pollutants (Goodman et al., 2011). It is not likely that the health effects associated with NO_2 concentration are effectively caused by NO_2. Probably the occurrence of NO_2 is correlated with a specific mixture of particulate matter typical for traffic-related air pollution and the associated health effects (Health Effects Institute,

2010). Thus, NO_2 can be seen as a proxy indicator and accordingly limit values have been agreed on by the World Health Organization and the European Commission. Both bodies adopt a maximum limit value of 40 µg/m³ for the average annual NO_2 concentration. When this indicator is mapped (Figure 39) an uneven distribution across the city is visible, with higher values around the highways and just south of the city center. In a small area along the highways south of the city center, the limit value of 40 µg/m³ is exceeded.

Figure 39 Distribution of average yearly NO_2 concentration (2013) (Source: http://www.atmosys.eu)



5.4.2 Noise

To quantify noise exposure the urban noise maps of the city of Ghent were used, taking road, railway and industry noise into account. These were created for the first time in 2010 following the EU Environmental Noise Directive 2002/49/EC, which stated that for all agglomerations with more than 250,000 inhabitants detailed noise maps had to be made to get an idea of the total number of annoyed and sleep-disturbed people throughout Europe. In 2014, the noise maps were revised by the same consultants AIB-Vinçotte Environment nv and GIM nv (2014). They combined noise measurements with a 3D model containing topography and buildings. They also performed an extensive quality control with model validation on the field.

In further analysis, L_{den}[11] (2014) is used as the principal proxy variable for environmental noise. It is the most standard harmonized noise indicator for assessing annoyance and sleep disturbance. In the greater part of the analysis "L_{den} total" is used, the most general indicator combining road, railway and industry noise. In specific correlation analyses also "L_{den} road" (includes only road noise), "L_{den} industry" (includes only industry noise) and "L_{ngt}[12] total" are used. All data are in georeferenced raster format and have a resolution of 10x10m.
In Belgium and Europe no legally binding standards for road and railway noise exist, the main components of environmental noise. The World Health Organization (WHO) advocates a limit value of L_{den} = 55 dB[13] to indicate serious annoyance, while for new developments it recommends a limit value of L_{den} = 40 dB (WHO, 1999). For night noise, the WHO advocates a European guideline of L_{ngt} = 40 dB, which is the "Lowest Observed Adverse Effect Level" according to their review of evidence (WHO, 2009). In Figure 40 the distribution of "L_{den} total" across the city is shown, displaying a dispersed pattern around the municipal territory. In many parts of the city, especially along the major roads and railways, the limit value of L_{den} = 55 dB is largely exceeded.

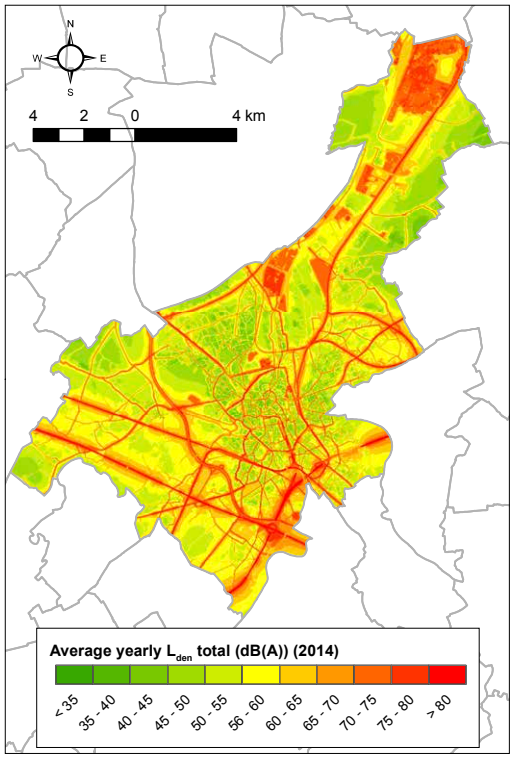


Figure 40 Distribution of average yearly L_{den} total (2014) (Source: AIB-Vinçotte Environment nv & GIM nv, 2014)

11 L_{den} is the average equivalent sound level over a 24 hour period, with a 5 dB penalty added for noise during the evening hours of 19:00 to 23:00 and a 10 dB penalty for noise during the nighttime hours of 23:00 to 07:00.
12 L_{ngt} is the average equivalent sound level during the nighttime hours of 23:00 to 07:00.
13 If dB is used throughout the text in fact dB(A) is meant. In the A-weighted system, the decibel values of sounds at low frequencies are reduced, compared with unweighted decibels, in which no correction is made for audio frequency. As such dB(A) expresses the relative loudness of sounds in air as perceived by the human ear.

5.4.3 Independent variables

To operationalize the other factors two different levels of analysis were used. First, data were collected at the level of statistical sectors. The city of Ghent counts 201 statistical sectors, which have been defined by sociological and spatial characteristics, with an average population of about 1,200 respondents (Figure 41, left). To calculate average exposure values per sector, a geographical data set with all residential addresses for the year 2013 was obtained from the Data & Information Department of the City of Ghent. Indicators on vulnerability and housing characteristics are publicly available on a website of the city of Ghent (http://gent.buurtmonitor.be/) but come from different sources. These indicators give an average value for each statistical sector. Unfortunately, no recent data for car ownership or car usage exist on the level of statistical sectors, nor data on perception of environmental impacts. Thus, only the second and fourth research questions are assessed at this level. Table 10 lists the data sets that were obtained.

Table 10 Used data sets at the level of statistical sectors, publicly available at http://gent.buurtmonitor.be/.

Research Question	Data set	Year	Source
2	Median household income	2012	Statistics Belgium
2	Unemployment pressure[1]	2012	Flanders Public Employment Service
2	% people of foreign origin[2]	2012	Crossroads Bank for Social Security
2	% EU15[3] origin	2012	Crossroads Bank for Social Security
2	% EU13[4] origin	2012	Crossroads Bank for Social Security
2	% Turkish/Maghreb[5] origin	2012	Crossroads Bank for Social Security
2	% other foreign origin	2012	Crossroads Bank for Social Security
4	% rental houses	2011	Census 2011 of Federal Government
4	Number of house moves per 1,000 inhabitants[6]	2012	Population Register Ghent
4	Average house price of sold houses	2012	Land Register Belgium
4	Relative house price of sold houses[7]	2012	Land Register Belgium

1 The share of non-working jobseekers between 18 and 64 years old relative to the total population between 18 and 64 years old.

2 An individual is attributed foreign origin when the father, the mother or the individual had a foreign nationality at birth.

3 EU15 = Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, United Kingdom and Sweden.

4 EU13 = accession to the EU after 2004 = Bulgaria, Cyprus, Estonia, Hungary, Croatia, Latvia, Lithuania, Malta, Poland, Romania, Slovenia, Slovakia and Czech Republic.

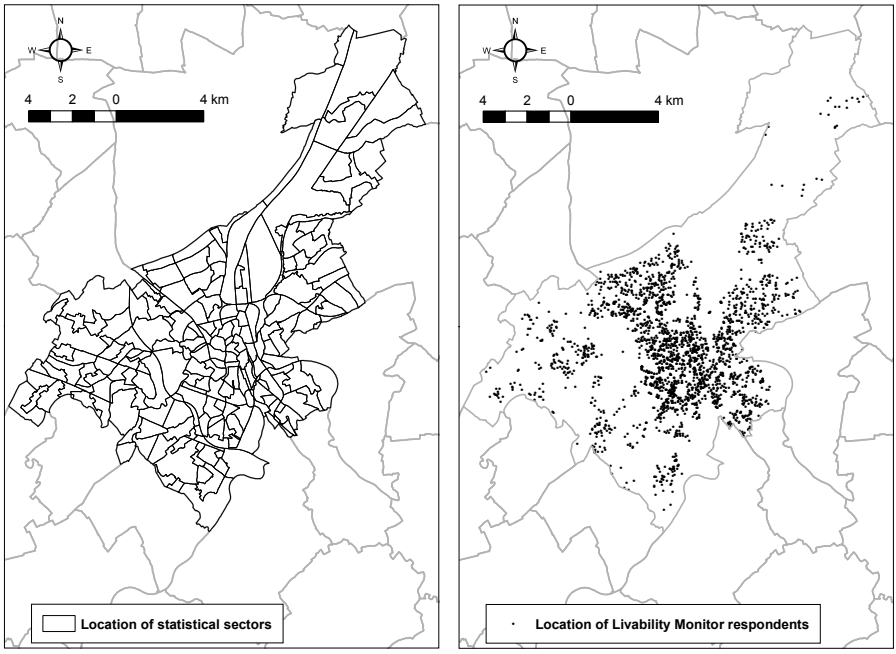
5 Maghreb = Algeria, Morocco and Tunisia.

6 The variable sums up all moves: inwards, outwards or within a sector (counted twice).

7 The difference between the real and expected price of sold houses, taking into account the housing typology in the sector and the average prices in Ghent for different types of houses (apartments, row houses, detached houses ...). The indicator thus better reflects the impact of the environment.

Second, the results of the 2014 Livability Monitor for Ghent were used, a survey conducted in 2013 with 2380 respondents, commissioned by the city council (WES vzw, 2014). Figure 41 (right) shows the location of the 2380 respondents, largely reflecting the concentrations of population across the municipal area. Both the vulnerability and the responsibility dimensions are included in the questions of this survey, as well as questions on noise annoyance, subjective health and housing characteristics. Most questions have ordinal answer categories and can be used in non-parametric correlation tests. Some questions have nominal answer categories and were recoded in binary variables for further analysis.

Figure 41 Location of statistical sectors (left) and Livability Monitor respondents (right)



In Table 11, Table 12, Table 13 and Table 14 the survey questions used to assess the different research questions are summarized, including answer frequencies. For some questions is indicated how nominal variables were recoded in binary variables. Because some respondents did not complete all survey questions sufficiently, no complete set of responses is available for the different questions. For most questions only a few respondents did not answer. When reporting the results, the number of respondents will be given for which each analysis was carried out.

Table 11 Summary of Livability Monitor 2014 survey questions used to analyze research question 1, with answer frequencies

Nr.	Short description	Question	Answer categories
66_4	Traffic noise nuisance	In the last 12 months, to what extent have you been troubled by traffic noise in your neighborhood?	Never (286) Rarely (698) Sometimes (685) Often (429) Always (250)
66_8	Industry noise nuisance	In the last 12 months, to what extent have you been troubled by noise from industry in your neighborhood?	Never (1753) Rarely (393) Sometimes (136) Often (41) Always (16)
66_9	Night noise nuisance	In the last 12 months, to what extent have you been troubled by night noise in your neighborhood?	Never (820) Rarely (889) Sometimes (441) Often (152) Always (42)
57	Subjective health	How is your health in general?	Very bad (8) Bad (57) Reasonably healthy (432) Good (1342) Very good (535)
58	Relation health problems with environmental factors	Do you think that your health problem is partly connected with environmental factors, such as air pollution, smell nuisance or noise?	Yes, certainly (102) Yes, maybe (219) No, certainly not (394) I don't know (198)
69_6	Impact air quality on health	Statement: "The bad air quality has an impact on my health"	Totally agree (1042) Rather agree (539) Neither agree/nor disagree (528) Rather disagree (88) Totally disagree (121)

Table 12 Summary of Livability Monitor 2014 survey questions used to analyze research question 2, with answer frequencies

Nr.	Short description	Question	Answer categories
82	Household income	To which amount does your family's total available monthly income correspond? By family we mean persons of one household living together under one roof. The total available income a month of your household consists of all real incomes from labor or wages/salaries, social allowances (such as child allowance, unemployment benefit, retirement pay, allowance for persons with a handicap, ...), additional allowances (such as interests, insurances, ...).	Less than 500 euro a month (8) 500 – 749 euro a month (25) 750 – 999 euro a month (50) 1,000 – 1,249 euro a month (147) 1,250 – 1,499 euro a month (169) 1,500 – 1,749 euro a month (165) 1,750 – 1,999 euro a month (198) 2,000 – 2,499 euro a month (329) 2,500 – 2,999 euro a month (251) 3,000 – 3,499 euro a month (282) 3,500 – 3,999 euro a month (188) 4,000 euro a month or more (342) I don't know (152) I have a replacement income (14)
81	Income adequacy	Can you get by on your family's total available monthly income as it is now?	Very difficultly (80) Difficultly (192) Rather difficultly (393) Rather easily (718) Easily (701) Very easily (270)
77	Educational level	What is the highest degree you have obtained?	None (81) Primary education (164) Lower secondary education (348) Higher secondary education (579) Non-university higher education (596) University (565)
73	Nationality	Which nationality did you have at birth?	Belgian (1975) [0] Western European (83) [1] Eastern European (85) [1] Southern European (28) [1] Moroccan (14) [1] Turkish (53) [1] Other (123) [1] I don't know (2)
73 bin	*Nationality*	*Which nationality did you have at birth?*	*[0] Belgian (1975)* *[1] non-Belgian (386)*
71	Year of birth	What is your year of birth?	- fill in a year -

Table 13 Summary of Livability Monitor 2014 survey questions used to analyze research question 3, with answer frequencies

Nr.	Short description	Question	Answer categories
46	Car ownership	How many cars does your family have? (also count leased cars and company cars that can be used by your family)	– fill in a number – 0 (282) 1 (1290) 2 (600) 3 or more (109)
48	Car use	In case you work, how do you usually travel to and from work? Indicate one means of transport, namely the means of transport used to cover the longest distance.	By car (680) [0] By motorbike or moped (33) [0] By bike (334) [1] By bus/tram (175) [1] By train (168) [1] On foot (92) [1] Other (12) Not applicable (799)
48 bin	*Car use*	*In case you work, how do you usually travel to and from work? Indicate one means of transport, namely the means of transport used to cover the longest distance.*	*[0] Car or motorbike/moped (713)* *[1] Public transport or bike/foot (769)*

Table 14 Summary of Livability Monitor 2014 survey questions used to analyze research question 4, with answer frequencies

Nr.	Short description	Question	Answer categories
15	Length of residence	For how many years have you (continuously) lived in the present neighborhood?	Less than 1 year (143) 1 – 5 years (627) 6 – 10 years (326) More than 10 years (1262)
17	Relocation intentions	Do you consider moving in the coming two years?	No (1540) [0] Possibly (380) [1] I would like to, but I don't find any house that meets my needs/ the needs of our family (62) [1] I would like to, but I don't have the necessary finances at my disposal (171) [1] Certainly (159) [1] I have already found a new house (57) [1]
17 bin	*Relocation intentions*	*Do you consider moving in the coming two years?*	*[0] No (1540)* *[1] Maybe, definitely or already planned (829)*
4	Ownership	Who is the owner of the house you are living in?	Yourself and/or partner (or your parents/ parent/guardian where you stay the most) (1541) [0] The social housing company (170) [1] The City or the Social Service Department (9) [1] Private landlord (592) [1] Other (39) I don't know (12)
4 bin	*Ownership*	*Are you owner or renter of the house you are living in?*	*[0] Owner (1541)* *[1] Renter (771)*

5.5 Analysis 1: statistical sector level

5.5.1 Methods

For the first analysis, which evaluates the associations between the statistical sector data and the environmental indicators, an average value for noise and air pollution per sector is needed. This value was obtained by combining the environmental impacts data with a spatial data set containing all residential addresses in Ghent (2013). Making use of ArcGIS9.3, to each address point the respective values were added of the rasterized air pollution and noise data. In this operation bilinear interpolation was used. This enabled the calculation of population-averaged concentrations for each statistical sector.
After combining these variables with the socio-economic data, correlation analyses were performed within the set of socio-economic and environmental variables and between both sets. Statistical analyses were carried out in SPSS (Version 22). For the most relevant correlations loess[14] plots are provided. Since the analysis contains the whole population of Ghent, p-values and significances are of no use and are thus not shown.

5.5.2 Results

Univariate analysis

Table 15 presents summary statistics at the statistical sector level for all variables used. Distributions are quite symmetrically, with skewness values largely between -2 and 2. For the vulnerability and housing variables a considerable amount of sectors does not have a value, in most cases because the population or housing supply in the sector is too small. All variables, including the air pollution and noise indicators, show a wide range of values, which means that the different sectors across the city have very diverse characteristics. For NO_2 concentration only very few sectors exceed the legal limit value of 40 µg/m³ for population-averaged yearly exposure. For noise exactly three quarters of the statistical sectors exceed the recommended limit value of L_{den} = 55 dB for population-averaged yearly exposure.

14 Locally weighted scatterplot smoothing.

Table 15 Summary statistics for vulnerability, housing and environmental variables, at statistical sector level

	N	Units	Mean	Skew-ness	Min	P5	P25	P50	P75	P95	Max
Median household income	171	€	18,842	-.08	10,154	13,210	16,358	19,040	21,206	24,400	27,303
Unemployment pressure	174	%	6.31	.98	.00	.98	3.18	5.50	9.18	14.53	23.40
% foreign origin	175	%	21.41	1.27	2.10	4.06	8.10	16.00	29.70	58.92	78.90
% EU15	169	%	4.65	3.92	.70	1.90	3.15	4.00	5.55	9.50	27.20
% EU13	148	%	3.64	1.89	.20	.40	1.00	2.30	4.73	12.70	18.50
% Turkish/ Maghreb	152	%	8.41	1.99	.30	.50	1.70	4.05	10.58	31.84	52.90
% other origin	165	%	6.94	1.55	.50	1.23	2.50	5.70	9.75	18.87	28.70
% rental houses	169	%	40.97	.47	5.60	12.35	23.25	37.90	55.40	78.05	96.30
Number of house moves per 1,000 inh.[8]	176	‰	249.51	1.01	29.41	68.18	144.49	221.93	331.28	486.71	846,15
Average house price of sold houses[9]	117	€	246,976	.62	120,016	157,277	199,329	232,193	284,614	374,670	428,500
Relative house price of sold houses[10]	117	%	-4.47	.78	-41.80	-32.35	-20.90	-9.10	9.00	37.99	55.90
Average yearly NO_2 concentration	194	µg/m³	26.22	.05	15.07	16.73	22.67	26.65	29.52	33.79	40.77
Average yearly L_{den} total	194	dB(A)	58.08	.30	45.83	51.45	55.00	58.12	61.03	66.11	74.23

8 Because this indicator is very sensitive to house moves in sectors with few inhabitants, outlying values over 1,000 were excluded from the dataset.

9 Because this indicator is very sensitive to extremely large transactions, especially in sectors with few sold houses, the 5% highest values were excluded.

10 Because this indicator is very sensitive to extremely large transactions, especially in sectors with few sold houses, the 5% highest values were excluded.

Associations between vulnerability variables

In Table 16 associations between the eleven different socio-economic variables are summarized. The most interesting correlations are found on the left side of the table. Median income and unemployment pressure per sector are strongly negatively associated ($r<-0.7$) and both show relatively strong correlations ($0.6<r<0.9$ or $-0.9<r<-0.6$) with % rental houses and % people of foreign origin (and the partial variables % EU13 origin, % Turkish/Maghreb origin and % other origin). Unsurprisingly, the correlation between % rental houses and number of house moves is quite strong ($r=0.671$), as well as the correlation between % rental houses and % foreign origin people ($r=0.642$). The associations between number of house moves and the vulnerability indicators (income, unemployment and % foreign origin) are moderate ($0.4<r<0.6$ or $-0.6<r<-0.4$); the association between house prices and vulnerability is weaker ($0.1<r<0.4$ or $-0.4<r<-0.1$).

In summary, it tends to be that some sectors combine a lower median household income with a higher unemployment pressure, a higher percentage of foreign origin people, more rental houses, more house moves and a lower average house price, and vice versa.

Table 16 Bivariate correlations between the socio-economic variables, at statistical sector level (Pearson correlation coefficients)

	Income	Unemployment	% foreign origin	% EU15	% EU13	% Turkish Maghreb	% other origin	% rental houses	House moves	Mean house price	Relative house price
Income	1	-	-	-	-	-	-	-	-	-	-
Unemployment	-.746	1	-	-	-	-	-	-	-	-	-
% foreign origin	-.769	.803	1	-	-	-	-	-	-	-	-
% EU15	-.102	.217	.213	1	-	-	-	-	-	-	-
% EU13	-.704	.640	.846	.075	1	-	-	-	-	-	-
% Turkish/ Maghreb	-.695	.717	.885	-.144	.811	1	-	-	-	-	-
% other origin	-.659	.707	.742	.315	.457	.394	1	-	-	-	-
% rental houses	-.668	.752	.642	.356	.368	.361	.774	1	-	-	-
House moves	-.465	.527	.551	.479	.436	.258	.537	.671	1	-	-
Mean house price	.358	-.383	-.401	.302	-.414	-.458	-.155	.000	.005	1	-
Relative house price	.213	-.183	-.238	.557	-.304	-.395	.043	.222	.255	.805	1

Association between environmental variables

The bivariate correlation between the two environmental variables (average yearly NO_2 concentration and average yearly L_{den} total) has a moderate correlation coefficient of r=0.365. This means there is a relation between the spatial distribution of L_{den} and NO_2 concentration, but their patterns are still clearly different.

Associations of environmental variables with socio-economic variables (RQ2)

Bivariate associations of the various environmental variables with the socio-economic variables are shown in Table 17. Since the associations might not have a linear shape, both Pearson product moment correlation and Spearman rank correlation are used to analyze bivariate associations. Spearman coefficients are often slightly higher than Pearson coefficients, markedly so for unemployment pressure and percentage of foreign origin people, reflecting nonlinearity in the associations.

For air pollution relatively high correlations can be noted, at least for sociological research. A higher exposure to modeled air pollution was found for statistical sectors with a lower median income (r=-0.371[15]), a higher unemployment rate (r=0.449) and a higher share of people of foreign origin (r=0.467). Remarkably the association with foreign origin is much stronger for the share of people with EU15 origin and the share of "others" than for the important groups of EU13 and Turkish/ Maghreb origins. For noise the correlation coefficients are much lower. There is almost no association with median income (r=-0.018), unemployment (r=-0.005), and the share of people of foreign origin (r=-0.020). There are weak associations

15 While both Pearson and Spearman correlation coefficients are shown in the tables, only Pearson correlation coefficients are mentioned in the text.

with the other variables. Remarkably there is a reverse correlation with percentage of people of EU13 and Turkish/Maghreb origins. This means that neighborhoods with a higher share of these populations will have a lower average noise exposure. Figure 42 depicts loess plots for the principal vulnerability variables and exposure to environmental impacts. The three plots for air pollution exposure on the left show very clear associations, in line with the correlation analysis. The loess curves show that for the three relations after a certain point the association weakens. The loess plots are the most pronounced for unemployment pressure and percentage of foreign origin, with the difference in average NO_2 exposure mounting up to more than 10 µg/m³. The three plots for noise exposure on the right show almost no relation, again indicating that the association between noise exposure and vulnerability indicators is much weaker than for air pollution exposure.

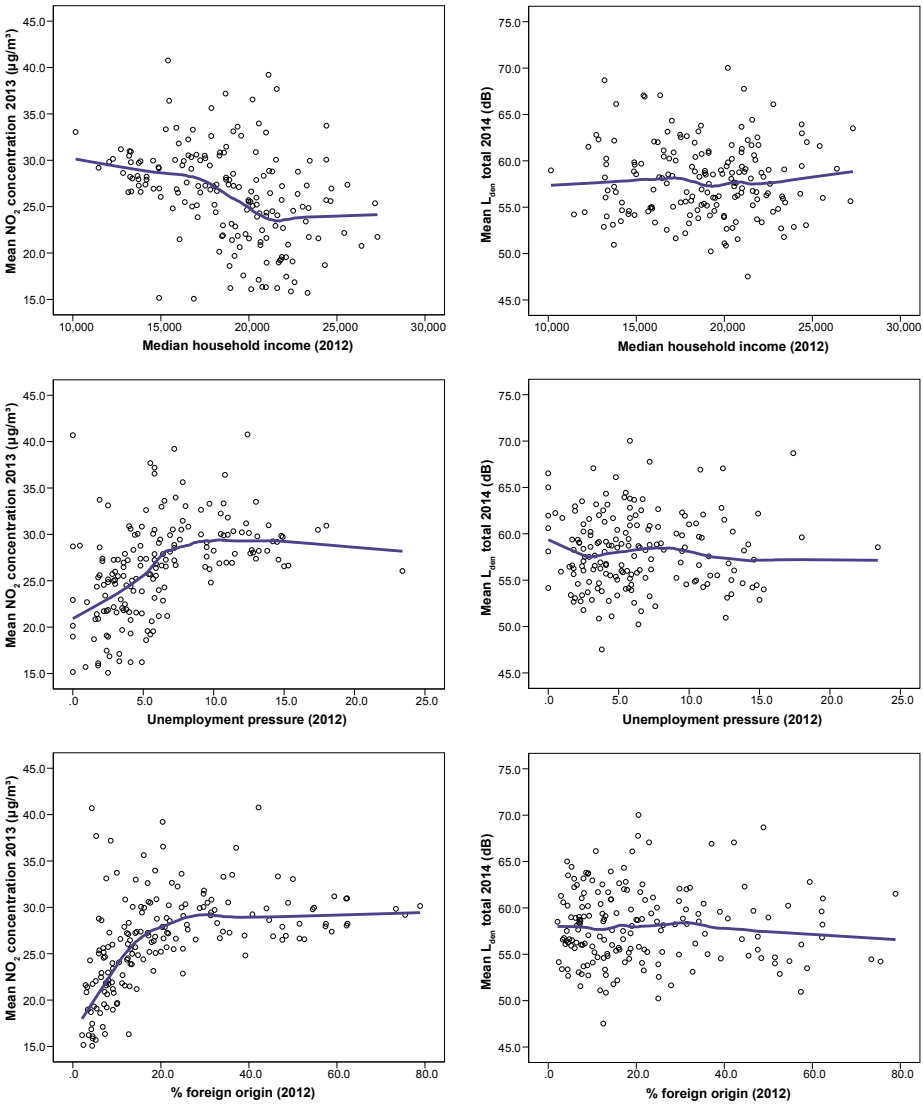
Table 17 Bivariate correlations between environmental exposure and vulnerability variables, at statistical sector level

	Average yearly NO_2 concentration		Average yearly L_{den} total	
	Pearson	**Spearman**	**Pearson**	**Spearman**
Income	-.371	-.436	-.018	-.001
Unemployment	.449	.557	-.005	-.014
% foreign origin	.467	.635	-.020	-.018
% EU15	.317	.392	.101	.069
% EU13	.323	.523	.027	.039
% Turkish/Maghreb	.255	.392	-.111	-.090
% other	.506	.660	.175	.101

Associations of environmental variables with housing characteristics (RQ4)

Table 18 shows the results of the correlation analysis between housing variables and environmental exposure. Both Pearson and Spearman correlation coefficients were calculated, since the association might not be linear and outliers are possible. In general, associations are much stronger for air pollution exposure, with the strongest correlations for percentage of rental houses (r=0.554) and number of house moves (r=0.557). The negative correlation between average house price and air pollution exposure is weaker but still considerable (r=-0.294). Relative house price shows no association with air pollution exposure. For noise exposure only the associations with percentage rental houses (r=0.141) and number of house moves (r=0.204) are worth mentioning, though much weaker than for air pollution exposure. Loess plots (Figure 43) give more insight in the associations. In general, clear trends can only be discerned in the loess plots for the association with air pollution exposure, and not in the ones for noise. The relation is most straightforward for percentage of rental houses and number of house moves associated with exposure to air pollution. Across the whole range of values for both indicators the average exposure to air pollution is increasing, whereby statistical sectors with a higher share of rental houses and more house moves bear a higher population-averaged exposure. For average house price a clear decreasing trend can be discerned, with lower average house prices associated with a higher exposure, though the slope

Figure 42 Loess plots for the associations of median household income, unemployment pressure and foreign origin with exposure to air pollution (left) and noise (right), at statistical sector level. Note that the y-axes do not start at zero.



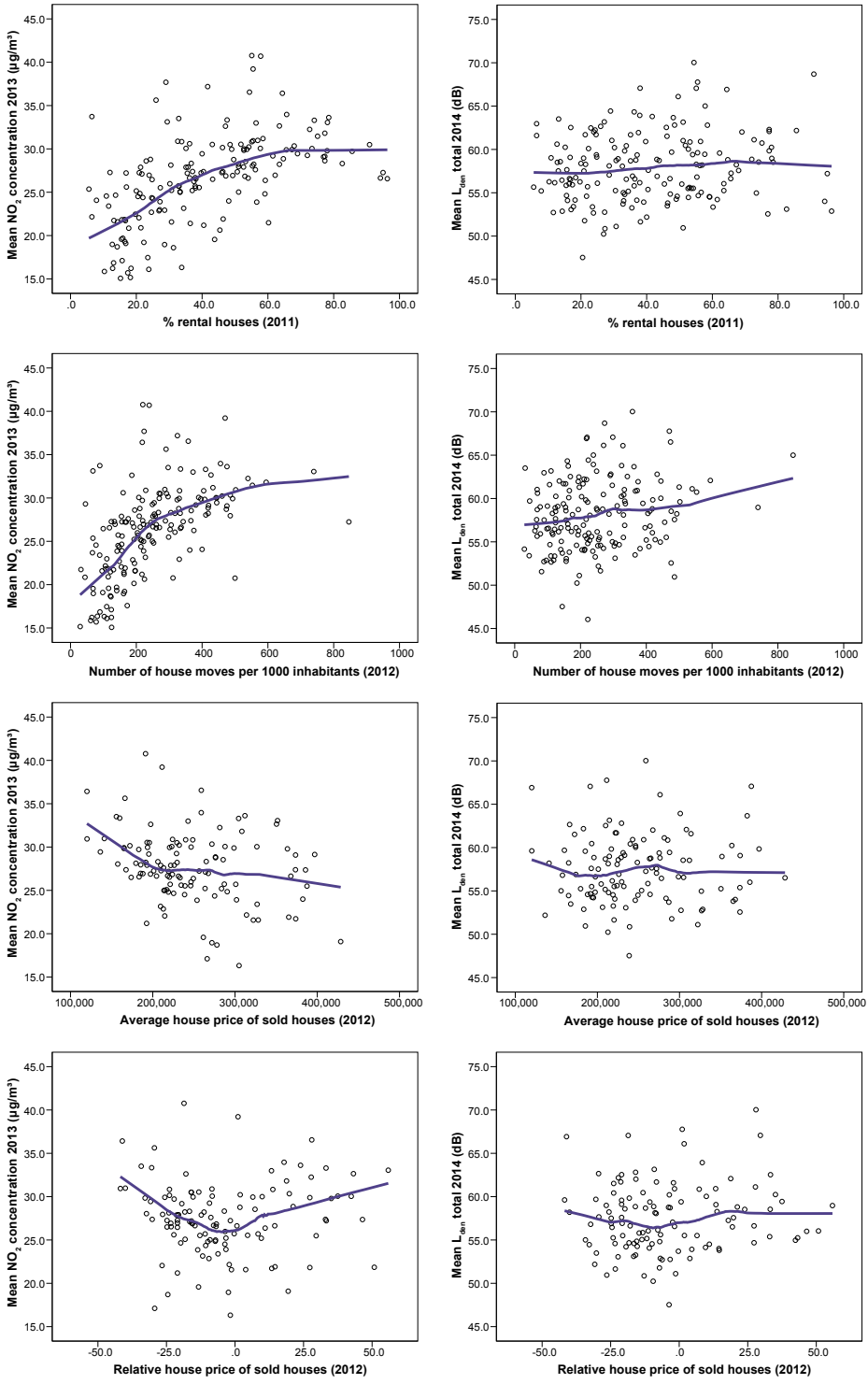
is not that steep. It is very likely that this association is influenced by housing typology. Neighborhoods with more expensive housing typologies (e.g. detached housing) are more often situated further away from the city center and major infrastructures, whereas neighborhoods with cheaper housing typologies (e.g. row houses) are more often situated close to the city center. The relative house price indicator makes abstraction of housing typologies by setting of house prices for specific typologies against the average values for this typology for the whole city. In this way the indicator gives more weight to the influence of environment on house prices. The graph for relative house prices at the bottom left is remarkable,

with higher exposure not only for statistical sectors where houses are undervalued compared to the city's average, but also for statistical sectors that are overvalued. A logical explanation is that the first group of sectors lie outside the city center and have a lower environmental quality, while the second group might lie in the city center, where impacts of air pollution are quite high but where other neighborhood characteristics compensate.

Table 18 Bivariate correlations between environmental exposure and housing variables, at statistical sector level

	Average yearly NO_2 concentration		Average yearly L_{den} total	
	Pearson	**Spearman**	**Pearson**	**Spearman**
% rental houses	.554	.631	.141	.119
House moves	.557	.649	.204	.182
Average house price	-.294	-.272	.004	.021
Relative house price	.040	-.025	.091	.063

Figure 43 Loess plots for the associations of percentage rental houses, number of house moves and average/relative house price with exposure to air pollution (left) and noise (right), at statistical sector level. Note that the y-axes do not start at zero.



5.6 Analysis 2: survey respondent level (Ghent Livability Monitor)

5.6.1 Methods

For the second analysis, to assess the association between the survey results (categorical variables) and the values of the air pollution and noise indicators, for every respondent both data have to be linked. Therefore, the environmental quality indicators were joined to the address-based survey results in ArcGIS9.3, using bilinear interpolation. Just as in method 1, SPSS (Version 22) was used for the correlation analyses. Next to correlation coefficients also error bar charts were made for significant associations, with 95% confidence intervals for the mean. These provide a better visual representation of the association and enable an estimation of the effect size (while a correlation coefficient only evaluates the extent to which a linear relationship is present and not the "slope" of the relationship). In addition, one loess plot was made for the continuous variable of "age". Since the analysis contains only a sample of the population of Ghent, significances of the calculated coefficients are given, using asterisks[16].

5.6.2 Results

Univariate analysis and correlation analysis of environmental variables

Table 19 presents summary statistics at the respondent level for the principal environmental variables NO_2 concentration and L_{den} total. The univariate analysis was not carried out for the independent variables at respondent level. These variables are mainly categorical, with answer frequencies indicated in Table 11, Table 12, Table 13 and Table 14.

The mean and median values for air pollution and noise are comparable to the respective mean and median at statistical sector level, with a difference of about 1 µg/m³ respectively 2 dB (Table 15). However, the range of values is much wider, since the values are not aggregated. This wide range of about 30 µg/m³ respectively 42 dB also means that there is a lot of diversity in noise and air pollution levels to which respondents are exposed. The table also shows that less than 5% of respondents is exposed to NO_2 concentration levels exceeding the legal limit value of 40 µg/m³, while a little bit more than half of the respondents is exposed to noise levels exceeding the recommended limit value of L_{den} = 55 dB.

The bivariate correlation between NO_2 concentration and L_{den} total has a weak to moderate correlation coefficient of r=0.293. This is slightly lower than the same coefficient at statistical sector level. While there is a clear association between the spatial distribution of L_{den} total and NO_2 concentration, their patterns are quite different, which could already be seen on the maps in Figure 39 and Figure 40.

16 One asterisk (*) means a significant result (P≤0.05), two asterisks (**) means a highly significant result (P≤0.01).

Table 19 Summary statistics for environmental variables, at survey respondent level

	N	Units	Mean	Skew-ness	Min	P5	P25	P50	P75	P95	Max
Yearly NO_2 concentration	2380	µg/m³	27.16	.165	14.9	19.54	24.68	27.06	29.69	34.74	45.3
Yearly L_{den} total	2380	dB(A)	56.65	.155	36.9	45.08	51.56	56.17	61.70	69.13	78.7

Associations between modeled impacts and perception (RQ1)

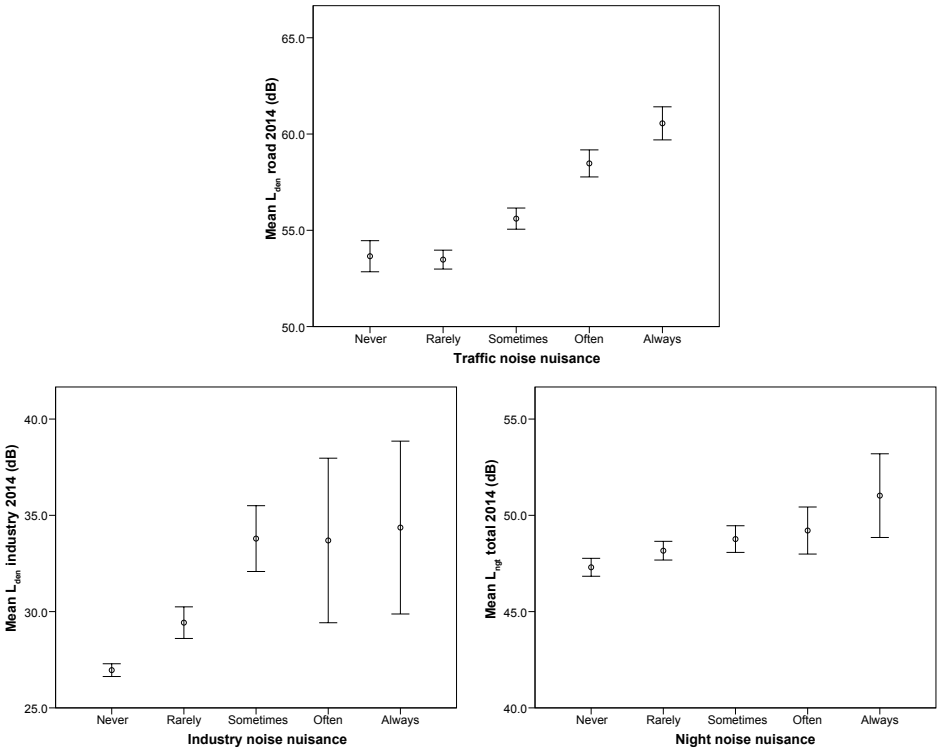
The first analysis assesses the association between modeled exposure to environmental impacts and nuisance of environmental impacts (Table 20). This is only possible for the aspect of environmental noise, since there are no survey questions on nuisance of air pollution. Because the three survey questions on noise nuisance focus on specific aspects of environmental noise, to each of these questions the most relevant noise indicator is related: for traffic noise nuisance this is "L_{den} road", for industry noise nuisance this is "L_{den} industry", for night noise nuisance this is "L_{ngt} total". Exact questions and answer categories are described in 5.4.3.
The calculated Spearman correlation coefficients show rather weak positive associations between the variables of subjective exposure and objective (modeled) exposure, with the strongest association for traffic noise (r=0.312**). All associations are highly significant (P<0.01). Respondents who feel more exposed to noise, are on average also higher exposed according to the models. However, the weak correlation coefficients show that this relation is not always true.
The error bar charts in Figure 44 confirm the results. In these graphs for all response categories on the survey questions the mean for the corresponding objective noise indicator is shown, including 95% confidence interval bars. The relation is the clearest for traffic noise, with a stepwise increase in mean L_{den} road from about 54 dB to 61 dB and few overlap between confidence intervals. The two other graphs show a less clear increase and lots of overlap between confidence intervals, hence representing the lower correlation coefficients.

Table 20 Bivariate correlations between questions on subjective noise exposure and modeled exposure, at survey respondent level (Spearman correlation coefficients)

Nr.	Short description	L_{den} road	L_{den} industry	L_{ngt} total
66_4	Traffic noise nuisance	.312** (n=2348)	-	-
66_8	Industry noise nuisance	-	.213** (n=2339)	-
66_9	Night noise nuisance	-	-	.100** (n=2344)

A second analysis (Table 21) evaluates the association of questions on subjective health and perceived health effects of environmental impacts with the principal environmental impact indicators of NO_2 concentration and L_{den} total. The only significant correlation is between the perception of environment-related health problems and modeled exposure to NO_2 concentration (r=-0.145**). This weak

Figure 44 Error bar charts for survey questions on traffic noise nuisance, industry noise nuisance and night noise nuisance and corresponding modeled noise indicators. Error bars represent 95% confidence intervals for the mean. Note that the y-axes do not start at zero.



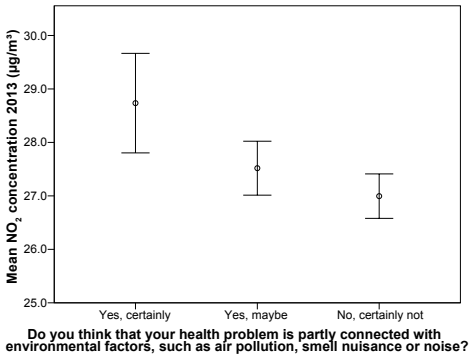
negative correlation shows that on average respondents who think they have environment-related health problems are also higher exposed to air pollution. When this relation is further explored in an error bar chart (Figure 45) the pattern is confirmed, with decreasing air pollution exposure when respondents are less worried. Only between the two extreme answer categories the confidence intervals do not overlap. With a value of about 2 µg/m³, the difference in mean NO_2 concentration, however, remains small.

Table 21 Bivariate correlations between questions on subjective health, environmental health impact and modeled environmental exposures, at survey respondent level (Spearman correlation coefficients)

Nr.	Short description	NO_2 concentration	L_{den} total
57	Subjective health	.000 (n=2374)	.008 (n=2374)
58	Relation health problems with environmental factors[11]	-.145** (n=715)	-.060 (n=715)
69_6	Impact air quality on health	.004 (n=2318)	-

11 To calculate the Spearman correlation coefficient the answer category "I don't know" was omitted, to construct an ordinal variable.

Figure 45 Error bar chart for the survey question on environment-related health problems and the air pollution indicator. Error bars represent 95% confidence intervals for the mean. Note that the y-axis does not start at zero.



Associations between modeled impacts and vulnerability variables (RQ2)

The second research question wants to assess whether more vulnerable people are more exposed to environmental impacts, a key question in environmental justice research. In the correlation analysis, vulnerability is operationalized through survey questions on household income, income adequacy, educational level, nationality and year of birth. Income adequacy was added next to household income, since it makes abstraction of the different needs of each household, but at the same time being more subjective. Exact questions and answer categories are described in 5.4.3. The association with the principal environmental impact indicators of NO_2 concentration and L_{den} total is shown in Table 22. All correlation coefficients for NO_2 concentration are highly significant ($P<0.01$), for L_{den} total only the point-biserial correlation coefficient for the association with nationality is significant. The relation between vulnerability indicators and environmental impacts is thus much more pronounced for air pollution. The directions of the associations do not all confirm the assumptions. While a higher income, better income adequacy and Belgian nationality correspond to lower exposure values, higher educated respondents and younger respondents are on average more exposed (at least to air pollution). The strongest associations exist between NO_2 concentration and household income ($r=-0.144^{**}$) or nationality ($r=0.196^{**}$). It should be taken in mind that in general correlation coefficients are very low.

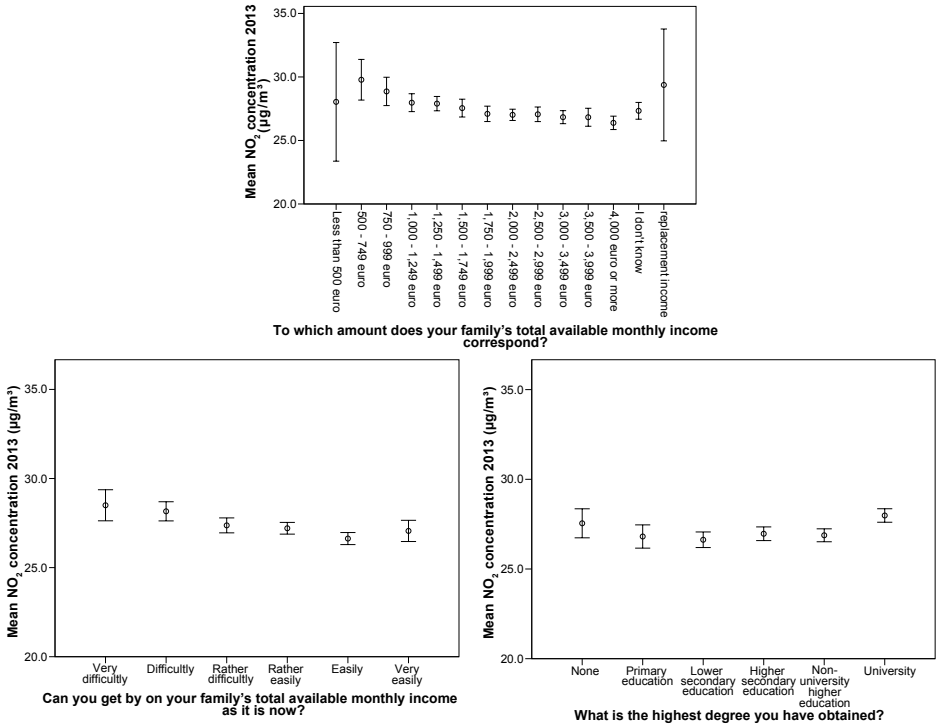
Table 22 Bivariate correlations between questions on income, education and modeled environmental exposures, at survey respondent level (Spearman correlation coefficients for questions 82, 81, 77; point-biserial correlation coefficient for question 73bin; Pearson correlation coefficient for question 71)

Nr.	Short description	NO_2 concentration	L_{den} total
82	Household income[12]	-.144** (n=2154)	-.021 (n=2154)
81	Income adequacy	-.102** (n=2354)	-.039 (n=2354)
77	Educational level	.082** (n=2333)	.040 (n=2333)
73bin	Nationality (binary)	.196** (n=2361)	.071** (n=2361)
71	Year of birth[13]	.093** (n=2351)	.017 (n=2351)

12 To calculate the Spearman correlation coefficient the answer categories "I don't know" and "I have a replacement income" were omitted, to construct an ordinal variable.

13 Only 'realistic' values between 1900 and 2005 were included.

Figure 46 Error bar charts for survey questions on household income, income adequacy and educational level. All error bars represent 95% confidence intervals for the mean for air pollution exposure. Note that the y-axes do not start at zero.



The significant associations are further explored in error bar charts for the mean (Figure 46). In the error bar chart for household income a stepwise decrease in mean air pollution exposure values can be determined. However, the differences are of an order of magnitude of about 2 to 3 µg/m³. The error bar chart for income adequacy shows the same decreasing pattern, with minor differences in exposure values. On the bottom right, the chart on the relation between educational level and air pollution exposure points to the remarkable fact that respondents with a university

education are significantly higher exposed than others. A possible explanation could be that these respondents are especially young people who just graduated and who live for some years in a more polluted neighborhood, until they move to a less polluted neighborhood. This idea is further confirmed in Figure 47, which shows the relation between year of birth of respondents and their modeled exposure to air pollution. While in general the distribution of air pollution seems to be quite evenly spread across all ages, the loess plot shows a small elevation between the years of birth of 1975 and 1985, these are respondents that were aged 28 to 38 at the time of the survey. Younger and older people tend to have a lower modeled exposure, but differences are small.

Figure 47 Loess plot for the association between year of birth and modeled air pollution exposure, at survey respondent level.

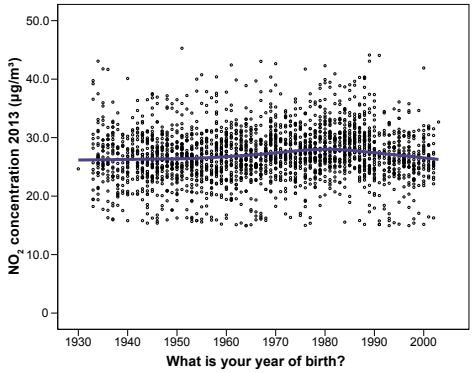
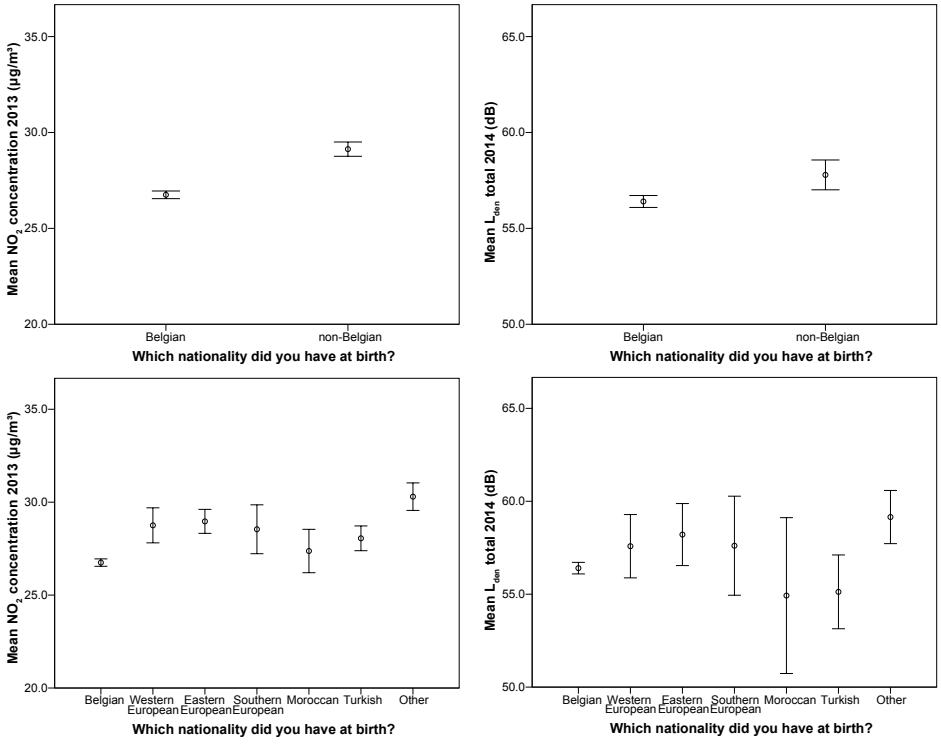


Figure 48 Error bar charts for the survey question on nationality, using binary and original answer categories. The error bar charts represent 95% confidence intervals for the mean for air pollution exposure (left) and noise exposure (right). Note that the y-axes do not start at zero.



The four charts in Figure 48 show the association between nationality and exposure (left: air pollution, right: noise). The two charts at the top use the binary variable and show a clear difference in mean exposure values, with non-Belgians being higher exposed, especially for air pollution. However, the differences remain small, about 2 µg/m³ for air pollution. The two charts at the bottom show error bars for the mean for the original categories of nationality. They indicate that it is foremost respondents from (non-Belgian) European origins and "Other" origins – respondents from Asia, Africa and the Americas – that bear the highest exposures, especially for air pollution. The important group of Turkish people in Ghent does only have a slightly higher air pollution exposure and a comparable noise exposure than Belgians. While interesting to get some more in-depth insights, the detailed graphs on nationality should be interpreted with caution, since the number of respondents for each region of origin is quite small.

Associations between modeled impacts and responsibility variables (RQ3)

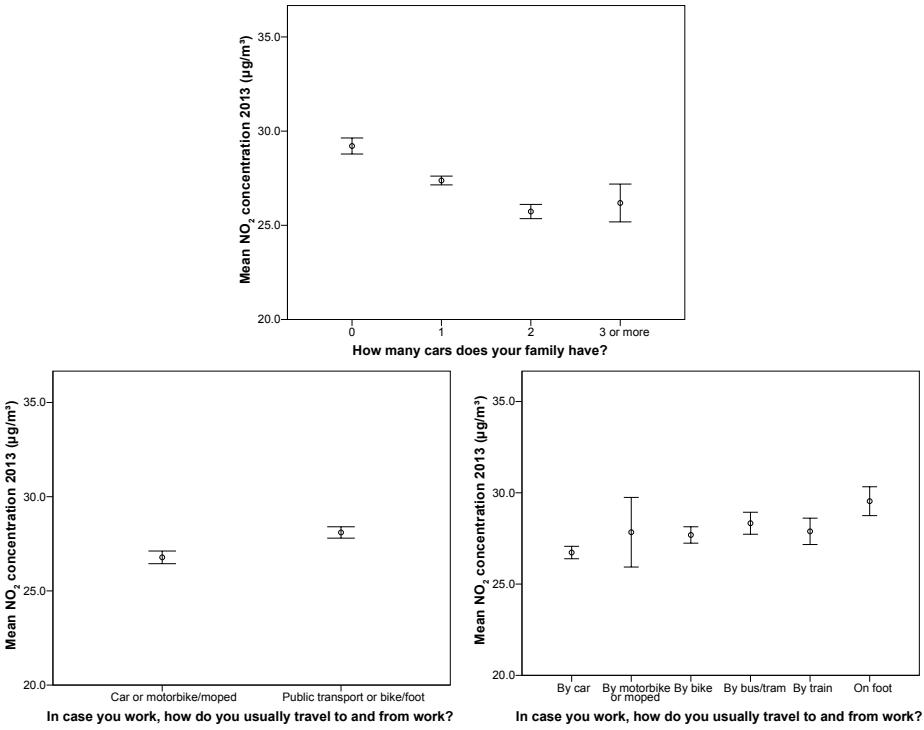
To assess whether there is an association between the distribution of responsibility for environmental impacts and exposure to these impacts, the Livability Monitor survey questions on car ownership and car use are used. Results of the correlation analysis are presented in Table 23. Exact questions and answer categories are described in 5.4.3. Both car ownership and car use only have a highly significant correlation coefficient for the relation with air pollution exposure ($P<0.01$), negative for car ownership (r=-0.257**), positive for car use (r=0.148**). Taking into account the order of the answer categories, this means that the more cars respondents own and the more they use private motorized transport for commuting, the lower the exposure to air pollution. Conversely, people without a car and who use public transport or walk or cycle to go to work, bear a higher exposure.

Table 23 Bivariate correlations between questions on car ownership, car use and modeled environmental exposures, at survey respondent level (Spearman correlation coefficients for question 46; point-biserial correlation coefficients for question 48bin)

Nr.	Short description	NO_2 concentration	L_{den} total
46	Car ownership	-.257** (n=2281)	.017 (n=2281)
48bin	Car use (binary)	.148** (n=1482)	.006 (n=1482)

The significant associations are further explored in error bar charts (Figure 49). The graph at the top not only shows that on average respondents with one car have a lower exposure than respondents without a car, but that also respondents with two cars have a significantly lower exposure than respondents with one car. The difference in mean exposure goes up to 3 µg/m³ for the highest versus the lowest category. This is still a quite small difference but shows unmistakenly a trend. For car use an error bar chart with the adapted binary variable is represented at the bottom left, and another one with the original answer categories at the bottom right. The differences in exposure to air pollution are less pronounced than for car ownership, but still an interesting trend is visible, especially in the graph on the right. Respondents who mainly use the car to go to work have on average the lowest exposure, followed by an intermediate category of respondents who use motorbike/moped, bike or public transport to go to work. Finally, respondents who go on foot on average bear the highest exposure to air pollution.

Figure 49 Error bar charts for survey questions on car ownership and car use (binary and original). Categories for car ownership are adapted by putting all answers above 3 in one category. The error bar charts all represent 95% confidence intervals for the mean for air pollution exposure. Note that the y-axes do not start at zero.



Associations between modeled impacts and housing characteristics (RQ4)

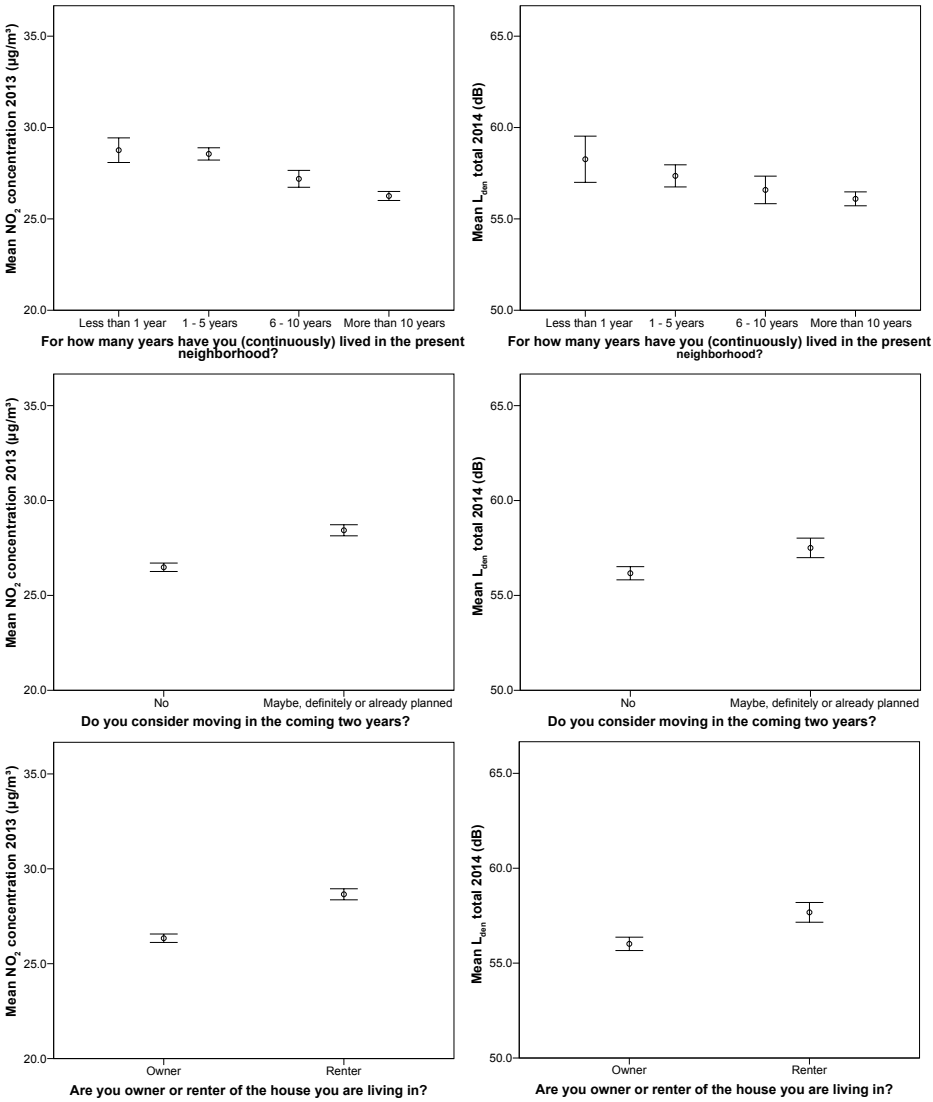
Finally, the association between modeled exposure to environmental impacts and housing characteristics is evaluated (Table 24). Exact questions and answer categories are described in 5.4.3. The calculated coefficients are for all associations highly significant (P<0.01). While the correlations are rather weak, especially for noise exposure, they point to a pattern. Respondents who live only for a few years in the neighborhood, who think about relocating and who rent their house on average have a higher exposure to air pollution and noise in their environment. This supports the hypothesis of the existence of "temporary housing" neighborhoods with a lower environmental quality.

All associations are further explored in error bar charts (Figure 50). Unambiguous patterns can be discerned, in line with the correlation analysis. Absolute differences between the mean of the answer categories range up to about 3 µg/m³ for NO_2 concentration and 3 dB for L_{den} total.

Table 24 Bivariate correlations between questions on length of residence, relocation intentions and ownership at survey respondent level (Spearman correlation coefficients for question 15; point-biserial correlation coefficients for question 17bin and 4bin)

Nr.	Description	NO_2 concentration	L_{den} total
15	Length of residence	-0.244** (n=2358)	-0.087** (n=2358)
17bin	Relocation intentions (binary)	0.207** (n=2369)	0.089** (n=2369)
4bin	Ownership (binary)	0.244** (n=2312)	0.109** (n=2312)

Figure 50 Error bar charts for survey questions on length of residence, relocation intentions (binary), and ownership (binary). The error bar charts represent 95% confidence intervals for the mean for air pollution exposure (left) and noise exposure (right). Note that the y-axes do not start at zero.



5.7 Conclusions and discussion

5.7.1 Research questions

The two analyses, the first on statistical sector level and the second on respondent level, give an answer on the research questions listed at the beginning of this chapter. They will be recaptured here.

RQ1. What is the association between objective and subjective exposure to air pollution or noise?

This question was only analyzed at the level of the respondents of the Livability Monitor for Ghent. The hypothesis can only be partially confirmed. ***In general, the association between modeled exposure and perception of environmental impacts or health effects is weak.***
A correlation analysis for the relation between subjective and objective exposure was only carried out for noise. Highly significant but rather weak associations were found between modeled noise exposure and perceived noise exposure (for traffic noise nuisance r=0.312**). This means that on average, across the whole population, there is a relation, but in a considerable amount of cases there is no relation at all. A second analysis assessed the perceived health effects due to environmental exposure. Only one significant but weak correlation was found, between modeled NO_2 concentration and a higher reporting of environment-related health problems (r=-0.145**). Remarkably, for subjective health no correlation with environmental variables could be found.

The weak association can partly be explained by inconsistencies in the modeled exposure data, which might not reflect the real exposure values for each address. However, it is more likely that personal characteristics and sensitivity play an important role, at least for subjective noise exposure (the first analysis). This is in line with findings in the literature. The much-referenced exposure-response equations of Miedema and Oudshoorn (2001) show that for increasing noise levels a growing percentage of people gets more annoyed, but there is always a group of people that does not feel annoyed (unless noise levels get extremely high). Also Schreckenberg et al. (2010) found that individual noise perception is associated with individual noise sensitivity, but not that much with objective exposure. Noise annoyance thus seems to be a very personal issue.
With regard to the perceived health effects, the literature review in 3.1 showed that air pollution has much worse health effects than noise, while people are much more annoyed by noise. Thus, a relation between subjective health and air pollution exposure would be plausible, but it could not be found. Only a very weak association was found between perceived health effects of environmental impacts and air pollution exposure. The absence of an association with noise exposure is in line with the literature findings, which attribute health impacts more to individual noise perception than to the actual and measured noise levels (Schreckenberg et al., 2010). At least for noise the clear absence of a relation between modeled exposure and health effects (and the weak association with perceived noise exposure) raises ***questions about using modeled noise maps for assessing the impacts of noise exposure.*** It is necessary to also consider personal variables of noise sensitivity.

RQ2. What is the association between vulnerability and modeled exposure to air pollution or noise?

To answer this research question, correlation analyses were carried out at the level of statistical sectors and the level of Livability Monitor survey respondents. The results point in the same direction and suggest some environmental inequalities. ***In general, more vulnerable people and neighborhoods in Ghent, with lower incomes, more unemployment and foreign origins, are more exposed to air pollution.*** Associations, however, are much stronger at the aggregated neighborhood level than at the respondent level. ***No clear association was found for noise exposure***, neither at statistical sector level nor at survey respondent level.

At the level of statistical sectors the strongest association was found between unemployment pressure and population-averaged air pollution exposure (r=0.449). The association between median household income and population-averaged air pollution exposure was a little bit weaker (r=-0.371). The association for percentage of people from foreign origin was somewhat stronger (r=0.467). However, this relation seems to be mainly determined by the percentage of specific foreign origin groups of EU13 (mainly Eastern Europe) and the "other" category (mainly Asia, Africa and the Americas). On the contrary, there is almost no association between vulnerability variables and population-averaged noise exposure levels at the statistical sector level. The exposure to environmental noise seems to be quite evenly distributed across all population groups.

At the level of respondents of the Livability Monitor for Ghent the associations were much weaker, but in line with the results at statistical sector level. A weak but significant association with air pollution exposure was found for income (r=-0.144**) and nationality (r=0.196**), with lower income respondents and non-Belgian respondents experiencing a little bit higher air pollution exposure levels on average. For nationality the association is again mainly determined by Eastern Europeans and the "other" category of Asians, Africans and Americans. For noise almost no association could be found. ***At the survey respondent level a remarkable but very weak association was found between higher educational level and higher air pollution exposure*** (r=0.082**), largely determined by the category of respondents with a university degree. The plausible explanation that this weak association is caused by young educated people who continue to live in the city for several years after graduation, in a "more polluted" neighborhood, was confirmed by an analysis of age versus air pollution exposure. This analysis showed that respondents between 25 and 40 years old on average have a little higher exposure to air pollution.

The results of the two analyses suggest some environmental inequalities and are in line with the current research evidence. The finding that people with a lower socio-economic position (lower income, higher unemployment, foreign origins) are generally exposed to higher air pollution levels, corresponds to earlier studies (Brainard et al., 2002; O'Neill et al., 2003; Chaix et al., 2006; Braubach & Fairburn, 2010; Goodman et al., 2011). The non-existent relationship for noise exposure does also fit the more varying research outcomes for this pollutant (Brainard et al., 2004;

Fyhri & Klæboe, 2006; Kohlhuber et al., 2006; Havard et al., 2011; Bocquier et al., 2013).

The ***much stronger association at statistical sector level then at respondent level*** seems to indicate that there is particularly a link at neighborhood level, whereby more polluted neighborhoods have a higher percentage of vulnerable people. The weaker link at respondent level might mean that, within a neighborhood, the more vulnerable people do not necessarily live at the most polluted places. This does not have to mean that they are not higher exposed in their daily lives, since exposure was calculated around the residential address and not in a wider range around the address, which might better reflect spatio-temporal exposure (Steinle et al., 2013). Moreover, it can be questioned whether the separate address-based exposure values reflect the real exposure, since the model is only intended for use at population level. Thus, both analyses have their strengths and weaknesses. The aggregated measure of exposure at statistical sector level better reflects reality, but then also the vulnerability indicators are aggregated. At the respondent level the exposure values might not reflect the real exposure, while the vulnerability indicators are more precise (but also subjective).

RQ3. What is the association between responsibility and modeled exposure to air pollution or noise?

Just like research question 1, this question was only analyzed at the level of the respondents of the Livability Monitor for Ghent. The hypothesis of less exposure to air pollution for people contributing to it, can be partially confirmed. ***In general, the more cars respondents own and the more they use the car for commuting, the lower their exposure, though only to air pollution. However, correlations are rather weak.*** The strongest correlation coefficient was found for the association between car ownership and NO_2 concentration (r=-0.257**), and also the corresponding error bar charts showed a clear trend, with a stepwise decrease of exposure to air pollution for a higher number of cars. The difference between mean exposure for respondents without a car and respondents with two cars rises up to 3 µg/m³, or about 10% (respectively 29 µg/m³ versus 26 µg/m³). The other significant correlation, between car use and exposure to air pollution (r=0.148**), was further explored in an error bar chart for the original answer categories. This chart showed that respondents who tend to use the car for commuting have the lowest exposure to air pollution, while respondents who go on foot have the highest exposure. All other transport modes have exposure values somewhere in between.

The observed inequality for exposure to air pollution, with people without a car or not using a car bearing a higher burden, is in line with earlier research (Mitchell & Dorling, 2003; Davoudi & Brooks, 2014). ***This inequality in distribution of responsibility and exposure to environmental pollution can provide an important environmental justice argument.***

RQ4. What is the association between housing characteristics and modeled exposure to air pollution or noise?

The association between housing characteristics and exposure to environmental pollution was assessed at the level of statistical sectors and the level of survey respondents. The hypothesis could be confirmed largely, however, associations for noise are very weak. ***In general, in neighborhoods with more rental houses, more house moves and lower house prices, the average exposure to air pollution is higher. To a much lesser degree this is also true for noise. At the same time, respondents who are renters, who have relocation plans and who have been living not that long yet in the neighborhood, on average bear a higher exposure, particularly to air pollution***.

At the statistical sector level rather strong correlations were found for the association of population-averaged exposure to air pollution with the share of rental houses (r=0.554) and the number of house moves with (r=0.557). For noise exposure these associations were also found, but the correlations were a lot weaker (0.1<r<0.3). This is in line with the outcome of the few existing studies in the literature (Pollack et al., 2004; Grineski et al., 2007; Lam & Chung, 2012). The corresponding loess plots showed a steady increase in average NO_2 concentrations with a rising number of house moves or higher share of rental houses, with the average difference rising up to 10 µg/m³. A moderate negative correlation was found between average house price and population-averaged air pollution exposure (r=-0.294). Since this association is not present for relative house price, this can probably be explained by the occurrence of cheaper housing typologies (apartments, row houses) next to polluting infrastructures. In this way it is in line with other studies that do not find a clear relation between objective measures of environmental pollution and house prices (Rehdanz & Maddison, 2008; Chasco & Gallo, 2013). While the loess plot for average house price showed a steady decrease of exposure with rising house prices, the plot for relative price showed a remarkable parabolic curve. This means that ***exposure levels are higher both for neighborhoods where house prices are undervalued and neighborhoods where house prices are overvalued***. The first category of neighborhoods might comprise the less attractive neighborhoods outside the city center, with a lower environmental quality. The last category might comprise the inner city neighborhoods, where the benefits of accessibility, abundance of facilities and urban vibe weigh up against the environmental pollution.

At the respondent level all assessed associations were significant, moderate for air pollution (0.2<r<0.3 or -0.3<r<-0.2) and weak for noise (0.0<r<0.2 or -0.2<r<0.0). The strongest correlations were found for the associations with ownership and length of residence. Renters and people who have been living less long in the neighborhood bear a higher exposure to environmental pollution, especially air pollution (r=0.244 and r=-0.244). Relocation intentions demonstrated a little weaker association, with people who tend to move house bearing a higher exposure, particularly to air pollution (r=0.207). The corresponding error bar charts illustrated these trends. The finding that exposure to air pollution, and to a lesser degree noise, is higher in rental neighborhoods with more temporary residents, can be interpreted in two

ways. ***On the one hand some people deliberately choose to live in these kinds of "more polluted" transit neighborhoods for some years***, are aware of the health consequences and might move to a less polluted neighborhood after some years. ***On the other hand a certain group of people might get stuck in a rental situation***, whether or not at the same location, but ***with enduring negative environmental impacts*** without the choice to move to a less polluted neighborhood. This example shows that the situation on the field is much more complex than a data analysis can reveal. It can be a good starting point, but other kinds of contextual and situational information are needed to get a full picture and take good decisions.

5.7.2 Other remarks

Both analyses, performed at different spatial levels, give consistent results that are in line with the literature and point to environmental inequalities. However, the data and methods have some weaknesses.

- Both the air pollution and noise data have limitations and are the result of modeling processes, starting from measurements. While the results were validated by tests on the field, the models remain an estimate of the real situation. For example, the effect of street canyons is not taken into account in the air pollution model, and low frequency impulse noise, which might be caused by pavement joints, is not taken into account in the noise model. Also, both air pollution and noise calculations are partially based on estimated traffic volumes. Finally, it should be noted that the noise indicator includes road traffic, railway traffic and industrial noise, while the air pollution indicator is mainly influenced by road traffic-related air pollution.
- The analyses used indicators for exposure around the residential address, rather than individual exposure to air pollution or noise during the day. This spatio-temporal exposure to air pollution and noise gets more attention in recent years, since measuring equipment is getting cheaper and more convenient to use. However, at the moment at least in Belgium no large scale data sets are available that take spatio-temporal exposure into account.
- The Livability Monitor survey contains the results of 2380 respondents, selected by stratified sampling on the level of the four city districts. A city district contains about 50 statistical sectors, thus it is possible that specific neighborhoods with a very high or low exposure are over- or underrepresented, distorting the results.
- The reference year of the used data varies slightly. For air pollution and noise exposure the most recent data sets were used, dating from respectively 2013 and 2014. The data to construct the independent variables vary in reference year. The respondent data collected from the Livability Monitor survey date from 2013. At the statistical sector level for most variables the most recent data were from 2012, which was chosen as base year. Only the variable for share of rental houses dates from 2011. The different reference years lie close together and it can be assumed that this has not distorted the results.
- The performed analyses are cross-sectional and not longitudinal. This means no statements about causal relations can be made. In other words, the analyses point to inequalities, but does not tell how these were produced.

- Only bivariate correlation analyses were performed. There is room for further exploration with multivariate research methods, taking into account interaction effects, and multilevel models, which account for different spatial levels (respondent and statistical sector). There was also no correction applied for spatial autocorrelation.
- Finally, the absolute differences in exposure, between different answer categories or values of the independent variable, are rather small in most cases. At population level it seems that there are no fundamental, big differences in environmental quality. However, the observed differences are still relevant. On the one hand because of health concerns, since the overview in 3.1 showed that there are no safe levels of exposure to air pollution and noise. Less exposure is always better, if only 1 dB or 1µg/m³ less. On the other hand, the differences at population level can indicate larger inequalities at more detailed spatial levels or between specific subpopulations.

Without minimalizing the weaknesses, the results of the analyses are clear and firm. However, and most importantly, the revealed inequalities do not automatically indicate injustices. To make an evaluation about that, more contextual and situational information is needed, both about underlying processes that produced this pattern and the perception of people living in this situation. Also Walker (2012) says that it is crucial to understand the interaction of pollutants and geographies in their spatial and temporal contexts. Although a possible explanation of inequalities is the interplay between personal preferences, personal behavior and forces operating in the public and private housing markets, also government departments can play a role. There is foremost a need to consider whether biases against certain social groups exist within the evident mechanisms driving changes in land use patterns, urbanization and development of transport corridors (Brainard et al., 2004). Regarding noise and local pollution, the location of developmental areas impacts the distribution of burdens and benefits among the city's inhabitants. If development takes place in the outer parts of the urban area, these neighborhoods will be safer from traffic and less polluted than the urban average, while inadvertently contributing to an increased overall amount of traffic and air pollution for residents living closer to downtown (Næss, 2013).

Assessing inequalities in the spatial and social distribution of environmental impacts is thus only the first step in an environmental justice analysis. Only by approaching (a neighborhood with) an environmental inequality from a pluralistic, interpretative, bottom-up and people-driven perspective, next to the top-down mapping of inequalities, environmental justice claims can be substantiated and possible trajectories for future development and improvement of the situation can be devised (Davoudi & Brooks, 2014). Therefore, based on the city-wide top-down analysis a micro case study was selected, in which underlying processes, detailed narratives and people's perceptions on both current situation and future strategies are examined.

5.8 Selection of micro case

To select a case study the demonstrated associations are an important starting point. The methodological choices to select a case area for further study are based on the gained insights in the analysis and the literature study on air pollution and noise. A double selection process is devised at the statistical sector level, with one selection method used to select areas that are interesting for air pollution exposure, and the other for areas where noise exposure might be an interesting issue.

For air pollution, the established association with vulnerability indicators is deemed highly relevant, since this points to the possible existence of a so called “triple jeopardy” of a lower socio-economic status, an impaired health and a polluted environment. As mentioned earlier, this means that socio-economically vulnerable groups that already have a weaker health status due to material deprivation and psychosocial stress, also receive the highest exposure, which exerts larger effects on their health than it does on the average population (Laurent et al., 2007; Pearce

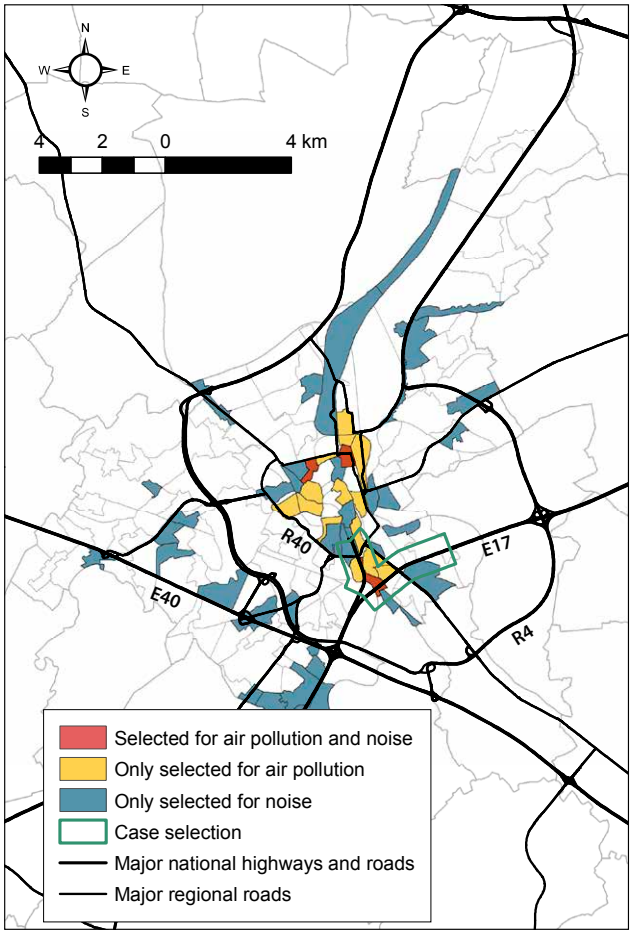


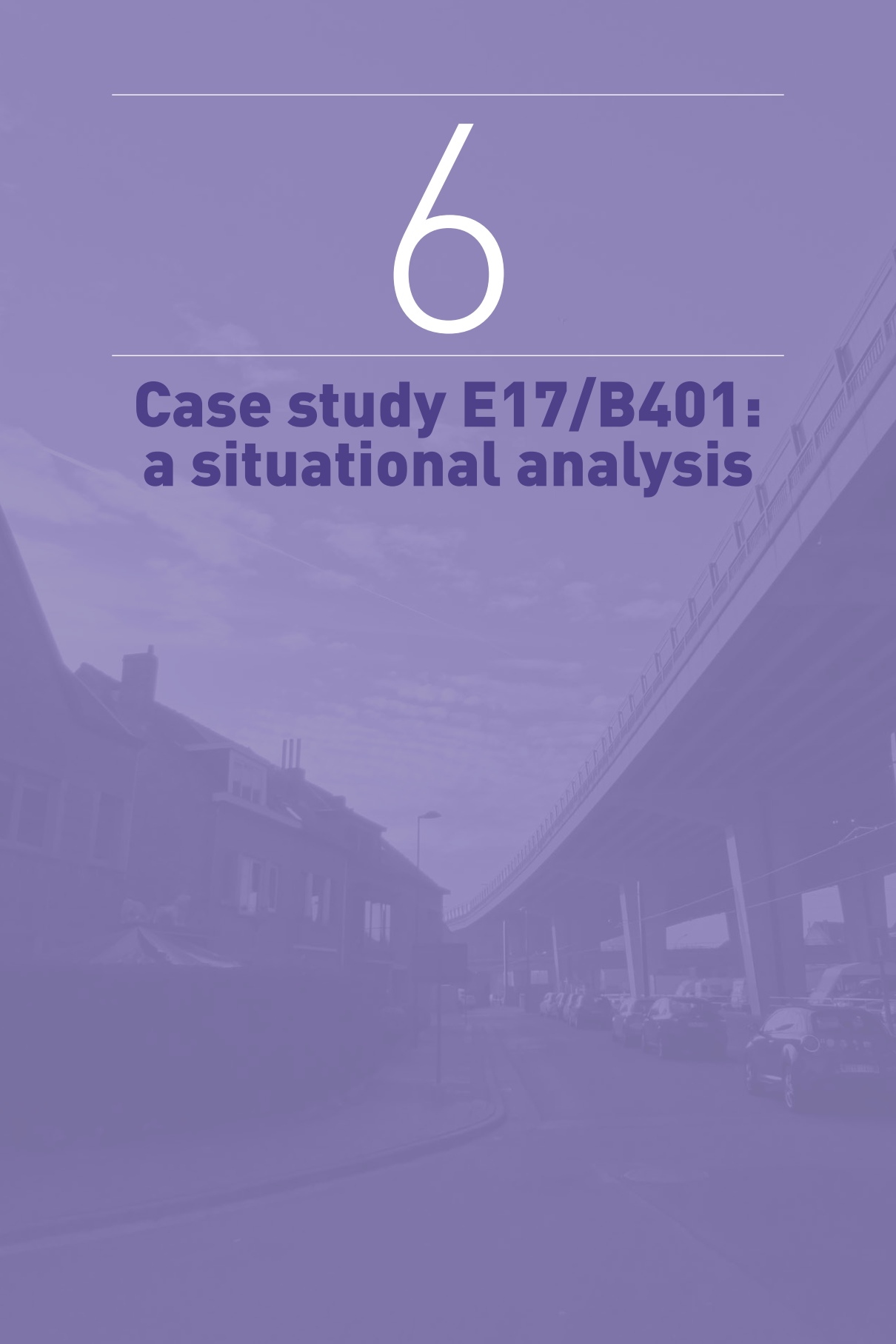
Figure 51 Selection of neighborhoods where environmental inequalities for air pollution and noise exposure are at stake; indication of the micro case for further research.

et al., 2010; Walker, 2012). O'Neill et al. (2003), among others, note that targeting exposure reduction among people with a lower socio-economic position would be justified on the grounds of maximizing public health benefits. Among the different vulnerability indicators at statistical sector level, the best correlation with air pollution exposure was found for unemployment pressure. As a selection method these sectors were marked that are in the highest quartile for both air pollution exposure and unemployment pressure (yellow and red in Figure 51).
For noise, the situation is different. As shown, the health effects of noise exposure have much more to do with personal sensitivity and perceived exposure than with measured noise levels. Consequently, Laszlo et al. (2012) noted that technical interventions reducing noise levels might miss the target and not have profound impacts on annoyance and health effects. Maybe other less technical measures can be devised for attenuating the perceived noise exposure. Therefore, to select these neighborhoods where noise exposure is at stake, subjective exposure is used as relevant variable. Since this measure does not exist at statistical sector level, the most relevant survey question is used, namely question 66_4 on traffic noise nuisance (the most important source of environmental nuisance). Thus, these sectors were marked that are in the highest quartile for subjective exposure to traffic noise (blue and red in Figure 51).

The statistical sectors selected for air pollution are all situated in the city center or along the major roads and highways that surround the city center. The statistical sectors selected for noise are more scattered across the city, with a lot of them located along major roads or highways. Based on this spatial data analysis and the outcome of a meeting with stakeholders, a micro case was selected in the south of Ghent, indicated with a green outline on the map. The micro case is characterized by two connected highway infrastructures cutting through the suburban fabric, causing elevated air pollution and noise levels in their surroundings. The long-standing protest movements in this area have recently led to policy debate and media coverage. The next three chapters will focus specifically on this area and further explore the environmental inequalities from a situational perspective, with major attention for the views of the citizens who live there.

6

Case study E17/B401: a situational analysis



In the previous chapter a spatial data analysis in Ghent was performed, which indicated environmental inequalities. According to the environmental justice claim-making framework, discussed in 4.6.1, primarily claims about evidence of distributive justice were made. The analysis led to the selection of a case area in the south of Ghent where different environmental inequalities are present. However, further research into contextual aspects is needed to judge the justice of this situation, to understand the opinions of the major stakeholders and to devise future policy strategies.
To get a full picture of the situation, in this chapter not only aspects of distributive justice, but also justice as procedure and recognition are considered. In addition, not only the evidence is analyzed, but also ideas about justice and processes behind inequalities. This information will inevitably be connected with claims made by different stakeholders. Thus, in addition to the researcher's perspective on the situation, their opinions and claims are analyzed to gain a holistic view on the situation. The environmental justice claim-making framework is used to evaluate all information. However, the picture will be incomplete, since the opinions of the citizens are not yet included. Therefore, in the subsequent two chapters a survey is carried out that goes into the perceptions and views of the people living in the area. Next to that in this chapter the practicability of the matrix of planning strategies is explored. By analyzing the recent history and the opinions and actions of today's main stakeholders the current planning strategies are discovered and positioned in the matrix. In the next two chapters the opinions of citizens on the different planning strategies are added to finally give policy recommendations.
To get insight in the spatio-temporal context of the situation and the current management approaches, a variety of sources is used: policy documents, newspaper articles, research reports, websites and spatial data. After introducing the case in a first section, the second part looks at the origin and history of the situation. In a third part the different stakeholders and their opinions are analyzed, followed by a summary of proposed solutions in the short and long term. Finally, the environmental justice framework and the matrix of planning strategies are used to structure and evaluate the gathered information.

6.1 Introduction to the case area

The case study concentrates on two highway routes south of the city center of Ghent: the E17 and the B401 (Figure 52). Both highways have a massive impact on the urban environment, because they consist of two huge viaducts that form a barrier in the suburban fabric and contrast with the predominantly low-rise neighborhoods (Figure 53).
The B401 highway is in fact a very large exit ramp that makes the connection between the main highway E17 (and E40) and the city center of Ghent. It brings traffic almost right into the historic center of the city, which is quite unique for Belgian highways. If you would enter the exit ramp just south of the city center, you would immediately gain height and start driving on a viaduct, which crosses the urban ring road R40 and the river Scheldt (twice) before connecting with the E17 highway at ground level. If from this point you would follow the E17 towards Antwerp, you immediately cross the river Scheldt again by a viaduct, followed by

a short section on an embankment. At the crossing of the major road “Brusselse-steenweg” you gain again some height to drive on a viaduct that arches over the suburban neighborhood of Gentbrugge. After passing the final houses of Gentbrugge, the viaduct takes the form of an embankment again until the next river Scheldt crossing. Two parts of the route draw the attention, the exit ramp or viaduct of B401 and the viaduct of E17. Their proportions sharply contrast with the surrounding neighborhoods that predominantly consist of low-rise buildings (except for some apartment blocks around the B401) and in recent years both viaducts were at the heart of political debate and the focus of environmental pressure groups. The maps also show the boundary of a 500 meter buffer zone at both sides of the highways, where the main environmental impacts have their effect, and which is at the core of further analysis.

Both highways handle a large amount of traffic. Detailed numbers on traffic intensities can be found on the website of the Flemish Traffic Control Center (http://www.verkeerscentrum.be). According to 2015 numbers, on working days about 120,000 vehicles (or 60,000 in either direction) use the E17 viaduct, of which some 28,000 heavy vehicles. On Saturdays and Sunday respectively 90,000 and 82,000 vehicles use the viaduct, of which respectively 9,000 and 5,500 heavy vehicles. The share of heavy vehicles varies from about 14% at rush hour to more than 60% at night. The intensities on the B401 are considerably lower, the highway ramp is used by about 60,000 vehicles on a working day (or 30,000 in each direction), of which only a few percent are heavy vehicles. On Saturdays about 55,000 vehicles use the B401, on Sundays about 45,000. With these high traffic intensities it is not surprising that along the infrastructure lines, the levels of environmental noise and air pollution are relatively high.

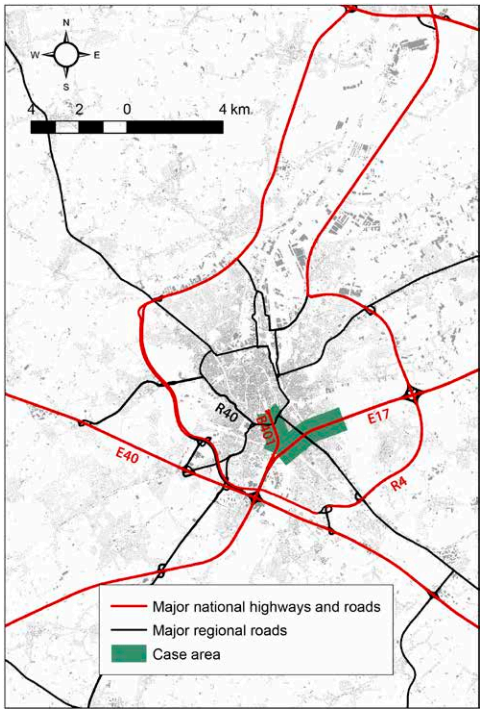
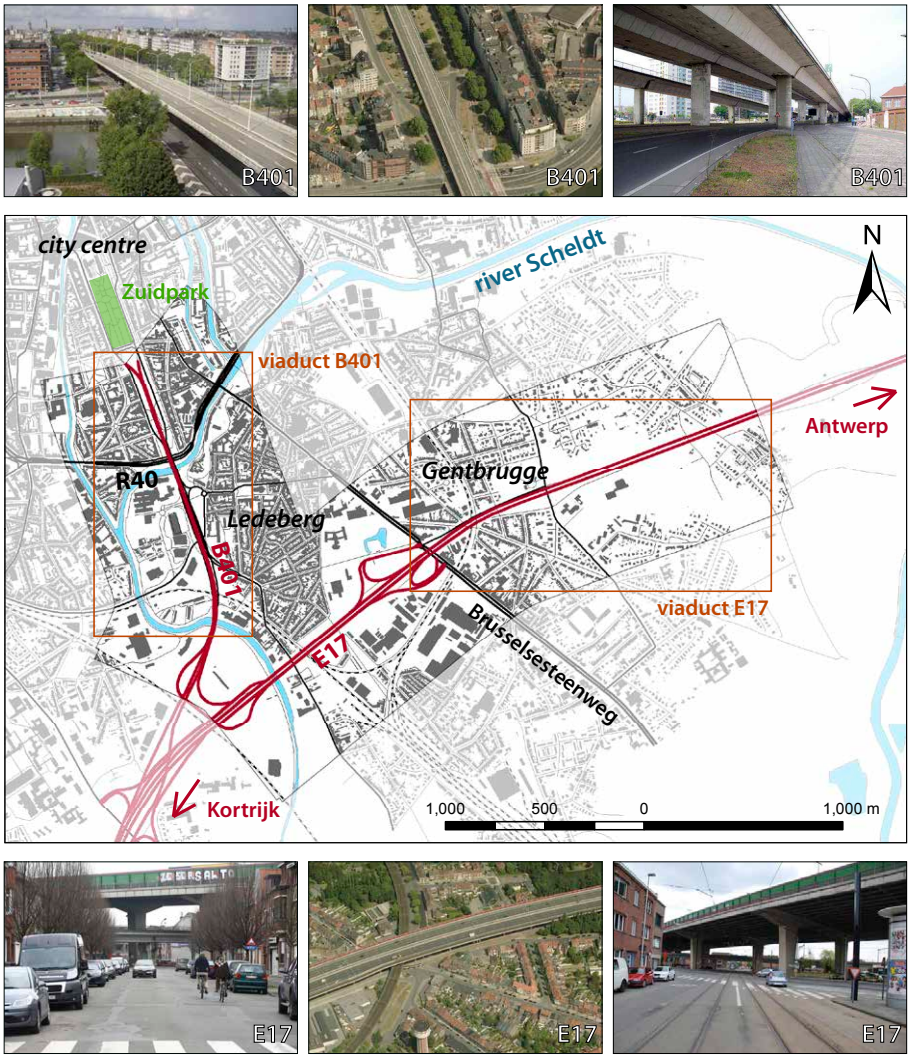


Figure 52 Location case area south of the city center of Ghent (Belgium), around the highways of E17 and B401

Figure 53 Map of E17/B401 case area with indication of viaduct location

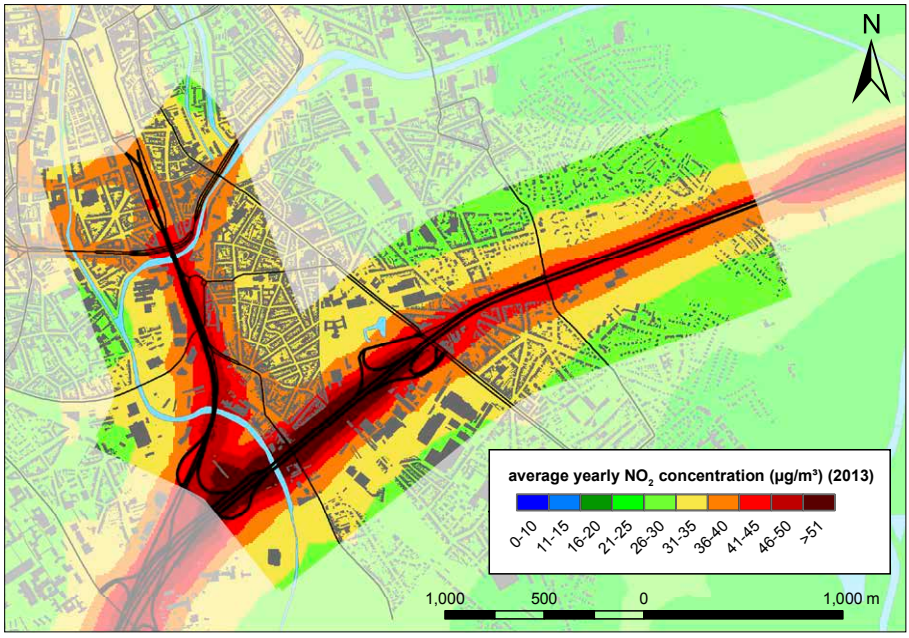


6.1.1 Air pollution

The air pollution map for this area uses the indicator of "average yearly NO_2 concentration" for 2013, based on the ATMOSYS RIO-IFDM model (see 5.4.1). It shows that the whole area alongside the two highways bears a high exposure (Figure 54). The highest values are modeled northeast of the junction of the two highways. In this neighborhood several houses are exposed to values that exceed 40 µg/m³, the EU and WHO limit value. Surprisingly the concentrations around the E17 viaduct seem to be lower than around other parts of the track. This can be explained by the characteristics of the model, which calculates concentration at a height of 1.5

meter above ground level[17]. If the highway lies on a slope, the concentration above the highway is measured, but if the highway lies on a viaduct, the concentration underneath the highway is measured, distorting the modeled concentrations along the highway. This distortion is less present at the B401 viaduct, since other roads pass under the viaduct and contribute to the local air pollution. This raises doubts about having too much confidence in these data.

Figure 54 Distribution of average yearly NO_2 concentration in the case area (Source: http://www.atmosys.eu)



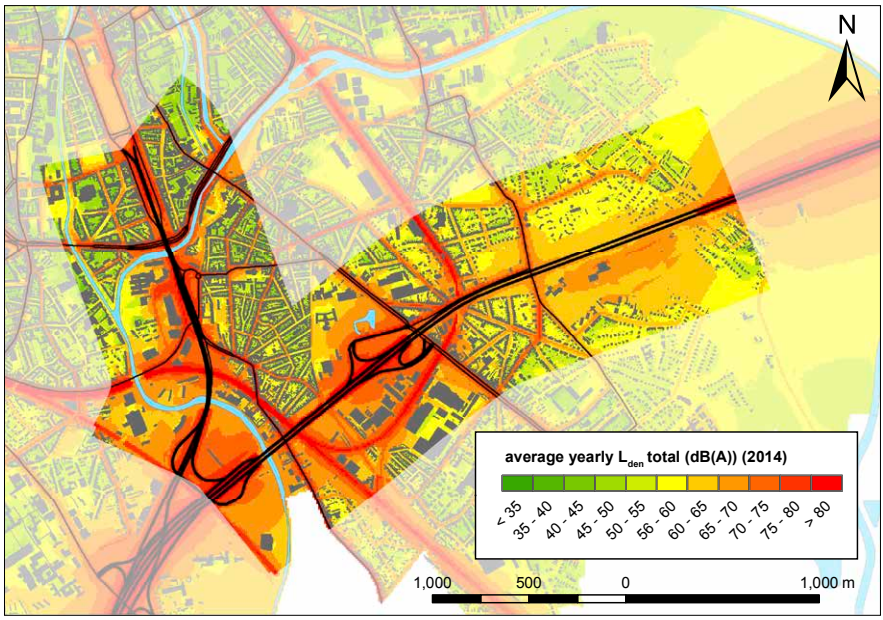
6.1.2 Noise

To analyze environmental noise in the case area, again the urban noise maps for Ghent are used, with the indicator L_{den} for the year 2014 (Figure 55). These urban noise maps include road, railway and industrial noise, but the map is dominated by road traffic noise, and to a lesser degree by railway noise. A large part of the area is exposed to very high noise levels, especially the immediate surroundings of the B401 viaduct and the western part of the E17 (where there is no viaduct). The area around the E17 viaduct remarkably shows lower exposure values. According to the residents group Viadukaduk in this neighborhood (http://www.viadukaduk.be) this is a distorted view, because the viaduct produces a lot of low-frequent impulse noise that is not included in the noise maps. The impulse noise is caused by 192 construction joints that connect 48 parts of the viaduct, a highly unusual

17 This was confirmed in e-mail communication by Wouter Lefebvre, environmental scientist working at the Flemish Institute of Technology.

construction method. Also the World Health Organization and noise researchers suggest to use separate indicators for impulse noise since the general measurement method underestimates this kind of noise (WHO, 1999; Leventhall, 2004).

Figure 55 Distribution of average yearly L_{den} total in the case area (Source: AIB-Vinçotte Environment nv & GIM nv, 2014)



6.1.3 Neighborhood characteristics

To get a full picture of the situation, the different neighborhoods that are dissected by the E17 and B401 are analyzed. The following data analysis gives some basic information on the characteristics of this area. Reference is made to the key city districts along the route: Ghent inner city, Ledeberg and Gentbrugge (indicated on the maps). These three districts comprise the major part of the 500 meter buffer zone around both highways and, as the analysis will show, have a very different profile.

The analysis focuses on demography, foreign origin citizens, economic situation and housing characteristics. The publicly available data of the data website of the city of Ghent are used (http://gent.buurtmonitor.be), on the level of statistical sectors. Only the data on number of house moves per sector (2012) were received by e-mail from the Ghent City Data Department. For every variable the most recently available data are used. To classify the values of the indicators Natural Breaks classification is used, since this gave the best representation. All sectors in the municipality of Ghent are taken into account in defining the class breaks, thus the categories reflect the distribution of values on city scale. For housing characteristics a few pictures are added of typical housing typologies in the three key districts.

6.1.3.1 Demography

First the demographic variables of age and household size are analyzed. Four indicators were selected:

- % of the population younger than 18 years (2015)
- % of the population between 18 and 65 years (2015)
- % of the population older than 65 years (2015)
- average household size (2015)

Figure 56 Percentage of the population younger than 18 years (2015), per statistical sector (Source: http://gent.buurtmonitor.be)

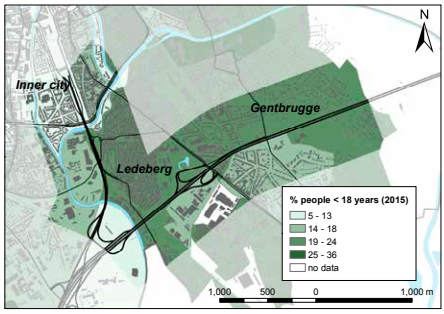


Figure 57 Percentage of the population between 18 and 65 years (2015), per statistical sector (Source: http://gent.buurtmonitor.be)

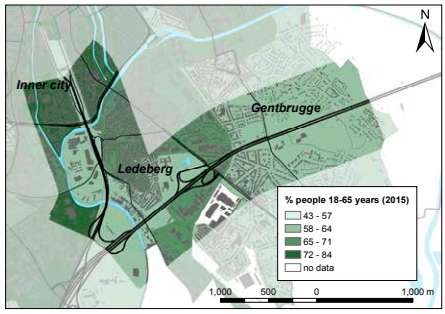


Figure 58 Percentage of the population older than 65 years (2015), per statistical sector (Source: http://gent.buurtmonitor.be)

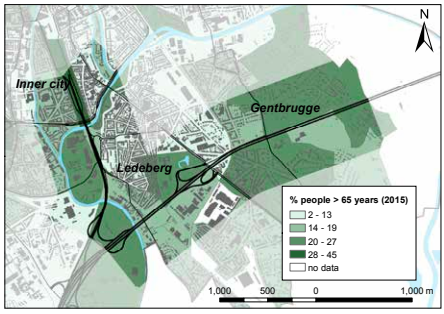
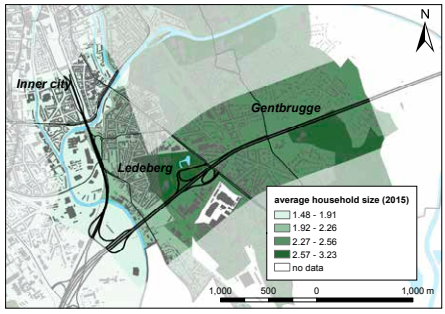


Figure 59 Average household size (2015), per statistical sector
(Source: http://gent.buurtmonitor.be



The maps (Figure 56 to Figure 59) show a diversity in demographic profile for the different neighborhoods along the highway.

- The neighborhoods in the north of the case area, which are part of Ghent inner city, have the most “urban” composition. They have a lower percentage of people younger than 18 years, very high percentages of “active population” between 18 and 65 years, and moderate percentages of retired people, except for the immediate surroundings of the B401, which have a very high share of retired citizens. Not surprisingly, this part of the case area has the lowest mean household size, with on average less than two persons per household.
- The area of Ledeberg has a quite young population, with higher shares of the under 18 and 18-65 population and in general lower shares of retired citizens. The average household size is quite average.

– The area of Gentbrugge has a relatively high share of young and old people. The active class is a little bit smaller compared to other parts of the case area, but considering the high average household size, these neighborhoods probably house the most families.

6.1.3.2 Origin

Second, the aspect of foreign origin is assessed. Therefore, the same indicators are used as in 5.4.3:

– % of the population of foreign origin (2012)
– % of the population of non-Belgian EU15 origin (2012)
– % of the population of EU13 origin (2012)
– % of the population of Turkish/Maghreb origin (2012)
– % of the population of "other" foreign origin (2012)

Figure 60 Percentage of the population of foreign origin (2012), per statistical sector (Source: http://gent.buurtmonitor.be)

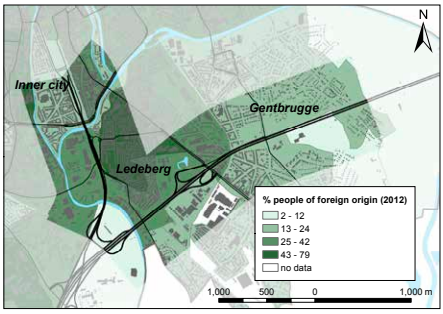


Figure 61 Percentage of the population of non-Belgian EU15 origin (2012), per statistical sector (Source: http://gent.buurtmonitor.be)

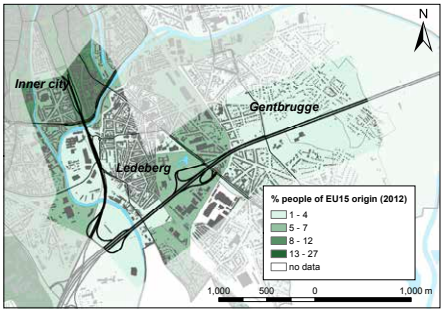


Figure 62 Percentage of the population of EU13 origin (2012), per statistical sector (Source: http://gent.buurtmonitor.be)

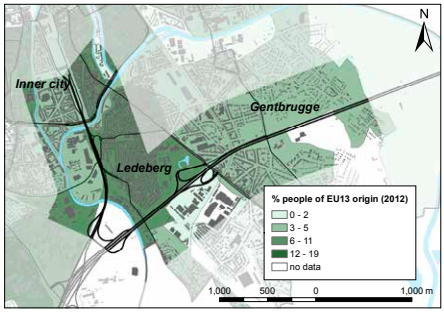


Figure 63 Percentage of the population of Turkish/Maghreb origin (2012), per statistical sector (Source: http://gent.buurtmonitor.be)

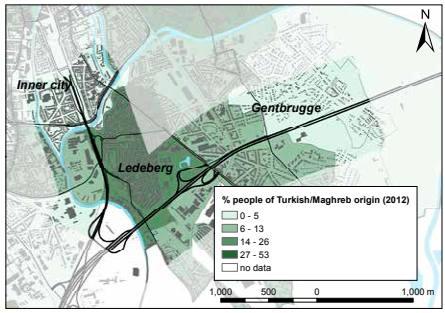


Figure 64 Percentage of the population of "other" foreign origin (2012), per statistical sector (Source: http://gent.buurtmonitor.be)

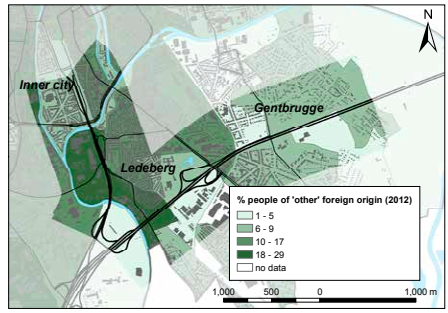


Figure 60 shows that Ledeberg has the highest share of people of foreign origin, followed by Ghent inner city. Gentbrugge has rather low shares of people of foreign origin. The different neighborhoods are further characterized by more detailed variables.

- The absence of the category with the highest shares for EU15 population (for the whole city) in the case area means that this population is concentrated in other areas of Ghent (Figure 61). Yet within the case area the highest percentages can be found in the southern part of Ghent inner city (which is the northern part of the case area).
- The highest shares of EU13 population are found in Ledeberg (Figure 62). These are especially citizens with origins in Eastern Europe. The neighborhoods in Gentbrugge and the inner city part of the case area have average shares.
- For shares of people of Turkish or Maghreb origin, the concentration in Ledeberg is even more striking, compared to the other parts of the case area (Figure 63).
- For shares of people of "other" origins (not EU and not Turkish/Maghreb) a more diverse picture emerges (Figure 64). The highest shares can be found in the western part of Ledeberg on the banks of the river Scheldt (where some high rise social apartment buildings are located).

6.1.3.3 Economic situation

To get a picture of the economic situation of the citizens living along the E17 and B401, the indicators of income and unemployment are analyzed. The selected indicators were already described in 5.4.3:

- median household income (2012)
- unemployment pressure (2015)

Particularly, the map with median household income shows clear differences between the neighborhoods along the highway (Figure 65). The inner city neighborhoods, as well as parts of the neighborhood of Gentbrugge, have a relatively high median household income, while the median household income in Ledeberg is considerably lower. The same goes for the map with unemployment pressure in Figure 66. The differences are less pronounced, but again Ledeberg is the most problematic district with the highest unemployment pressure.

Figure 65 Median household income (2012), per statistical sector
(Source: http://gent.buurtmonitor.be)

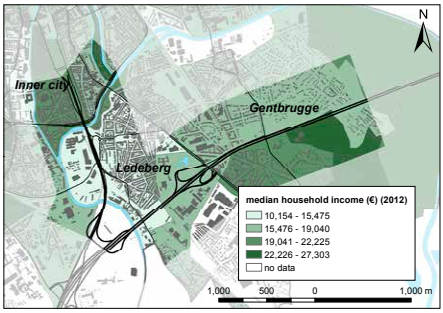
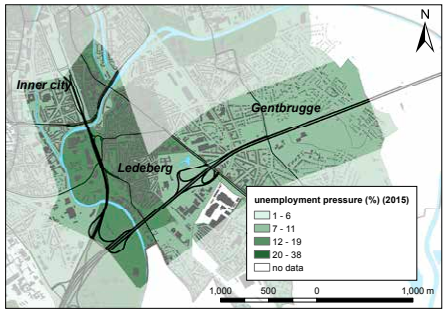


Figure 66 Unemployment pressure (2015), per statistical sector
(Source: http://gent.buurtmonitor.be)



6.1.3.4 Housing characteristics

Finally, a few indicators related to housing are evaluated. Except for population density, the indicators were already discussed in 5.4.3:

- population density (2015)
- share of rental houses (2011)
- number of house moves per 1,000 inhabitants (2012)
- average house price of sold houses (2013)
- relative house price of sold houses (2013)

Figure 67 Population density (2015), per statistical sector
(Source: http://gent.buurtmonitor.be)

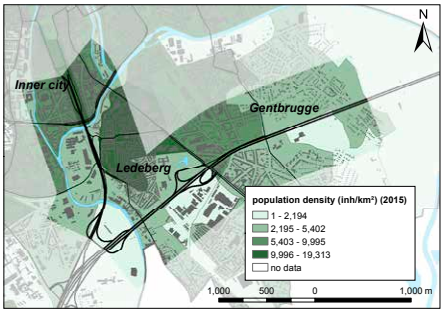


Figure 68 Share of rental houses (2011), per statistical sector
(Source: http://gent.buurtmonitor.be)

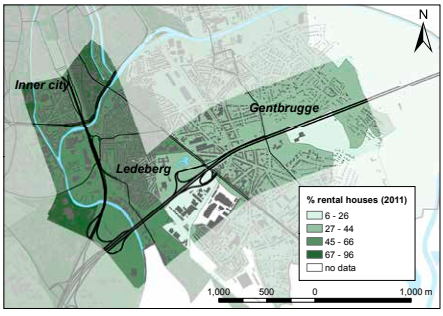


Figure 69 Number of house moves per 1,000 inhabitants (2012), per statistical sector
(Source: Ghent City Data Department)

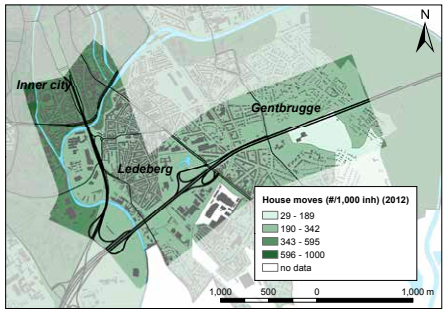


Figure 70 Average house price of sold houses (2013), per statistical sector (Source: http://gent.buurtmonitor.be)

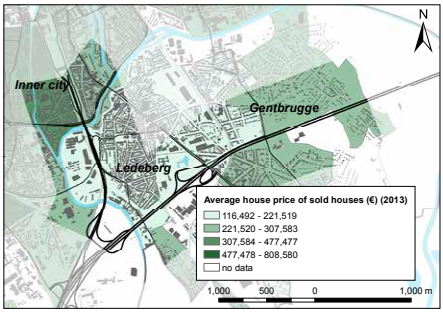
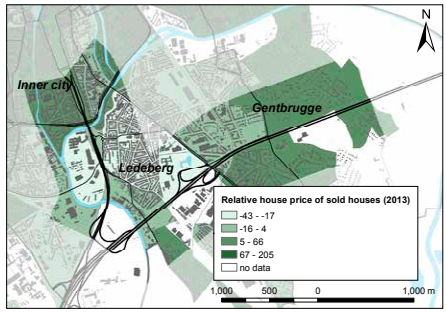


Figure 71 Relative house price of sold houses (2013), per statistical sector (Source: http://gent.buurtmonitor.be)



An evaluation of housing characteristics again points to remarkable differences between the neighborhoods along both highways (Figure 67 to Figure 71).

- The inner city part of the case area is the most “urban”, with a high population density, a high share of rental houses and a high relative number of moves. The two maps on house prices show that house prices in this part of the city are also relatively high.
- The suburb of Ledeberg has a different story. Its center shows a very high population density, but on the western and southern side densities are lower. Ledeberg also has a high share of rental houses, but relatively less moves per sector. It can be concluded that people tend to live longer in a rental house in this area. Finally, house prices are relatively low in this area.
- Lastly, the district of Gentbrugge has the lowest population densities of the case area, the lowest share of rental houses and an average number of house moves. The analysis of house prices shows that these are high in this city district, both in absolute and in relative terms. The nearby highway does not seem to affect the prices.

Although the building dots shown on the map in Figure 53 already give an idea of housing typologies, by way of illustration, a few typical images of housing typologies in the three key districts are added.
In the inner city part of the case area, apartment buildings and row houses are dominant (Figure 72). Apartment buildings are mainly located along the B401 or the urban ring road R40. The remainder of the area largely consists of row houses and town houses, from low to high quality, which are quite often divided into different apartments and/or used by students. In Ledeberg the two main typologies are single family row houses, whether or not renovated, and high rise apartment buildings (Figure 73). The row houses are mainly situated in the dense urban core of Ledeberg, while the high rises are located along the river Scheldt west of Ledeberg center. Gentbrugge is the only district that has a relatively high share of detached or semi-detached housing (Figure 74). In addition, also (refurbished) row houses are abundant.

Figure 72 Dominant housing typologies inner city (Source: Google Streetview)

Figure 73 Dominant housing typologies Ledeberg (Source: Google Streetview)

Figure 74 Dominant housing typologies Gentbrugge (Source: Google Streetview)

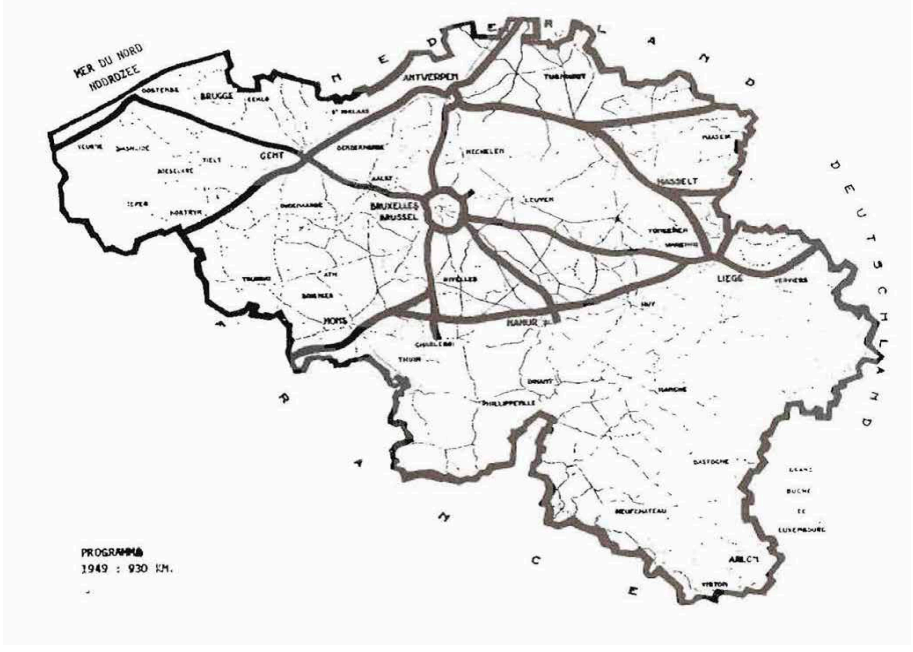
6.2 The construction phase

With this first impression of the case area and its environmental situation in mind, next the origins of both routes are examined. The E17 and B401 highway were built quite recently, with their completion only in the 1970s. The E17 was formerly called E3, and got his current name in 1985. Hereafter a few important moments and decisions in the design and construction phase are analyzed. Therefore, is largely relied on the master thesis “Monografie van een autoweg: de E3 tussen Kortrijk en Antwerpen” (in English: Monograph of a highway: the E3 between Kortrijk and Antwerp), in which Druwé and Lalush (2011) describe the history of this highway extensively.

6.2.1 The construction of E17 and B401: general overview

Until the middle of the twentieth century, a great skepticism towards the phenomenon of the highway prevailed in Belgium. The focus was on the repair and maintenance of existing national roads. For Ghent specifically this meant that all national and international traffic had to pass right through the historic city center. In 1949, a first Belgian highway plan was outlined by Hondermarcq, engineer at the "Dienst der Autosnelwegen" (in English: Belgian Highway Division) (Figure 75). The planned routes of the highways were already drawn in a very detailed way, with the E3 highway (later E17) located very close to the city center of Ghent. This plan came into being under the impetus of European cooperation. Shortly after, in 1950, the Declaration on the Construction of Main International Traffic Arteries was signed in Geneva, which defined the first E-road network and its technical requirements. The E3 was designated a major highway in this E-road network, also because of the defensive military importance. A few years later, in 1953, the European Ministers of Transport assembled and decided that E-roads were of national interest, and each country thus had to finance them themselves. Therefore, in 1955, a Belgian Road Fund was established to more quickly realize the highway plans in the period 1955-1965. However, the E3 highway was not included in these investment plans, and thus money and staff were not available.

Figure 75 First Belgian highway plan (1949) (Source: Gregoire J.M., Autosnelwegen in België. Ontstaan en verwezenlijking, Brussel, 1985, p. 27) (in: Druwé & Lalush, 2011)



For the E3 (now E17) an alternative funding system was conceived, the "Intercommunale voor de Autoweg (IVA) E3" (in English: intermunicipal association for the highway E3). The association was founded in 1963 and received a concession for thirty years. The IVA E3 had several shareholders: the Belgian State (the main

shareholder) and cities and provinces along the planned route. They wrote off loans at a fixed rate of return of 6.6 percent. The loans were almost immediately bought by major banks, which resold them at a profit to individuals. In return the citizen received a guaranteed interest. At his turn, the IVA E3 received a guarantee from the government: a refund of one franc per kilometer and per vehicle as soon as the highway was built. By this agreement, the government in fact would pay off the "debts" of the IVA E3 after its completion. It turned out to be a fruitful financial construction. As soon as the E3 was opened, the money flew in and after five years the loans of the citizens were completely repaid. The IVA E3 was responsible for the study, construction, equipment, maintenance and exploitation of the E3 highway, as well as for the valorization of real estate and the construction of connecting roads. By this intermunicipal process the initiative was moved to the regional and supra-local level, leading to a large number of entrances and exits.

In the design and construction phase a pragmatic and technical approach prevailed, even strengthened by the rise of the American paradigm of the "urban highway" in the 1960s. Its main idea was that the city could be reorganized and cleaned up by constructing highways into the heart of the city.
Concerning the E3 (or E17) cutting through Ghent's suburb Gentbrugge, the final route was approved in 1958 by Royal Decree. In 1963 preparation works and technical studies were carried out. In 1964 the works began and in 1973 the highway was completed. The E17 viaduct was built between 1967 and 1969. Finally, in 1985 the road numbering was revised and the E3 changed name to the E17.
Concerning the B401 expropriations were carried out and technical plans were drawn from 1967 till 1969. Works began in 1969 and were completed in 1972.
The adoption of the route through Gentbrugge, and the final choice for a viaduct and not a tunnel, were accompanied by extensive discussions. These are further described hereafter, along with a short explanation of the construction process of the B401 viaduct.

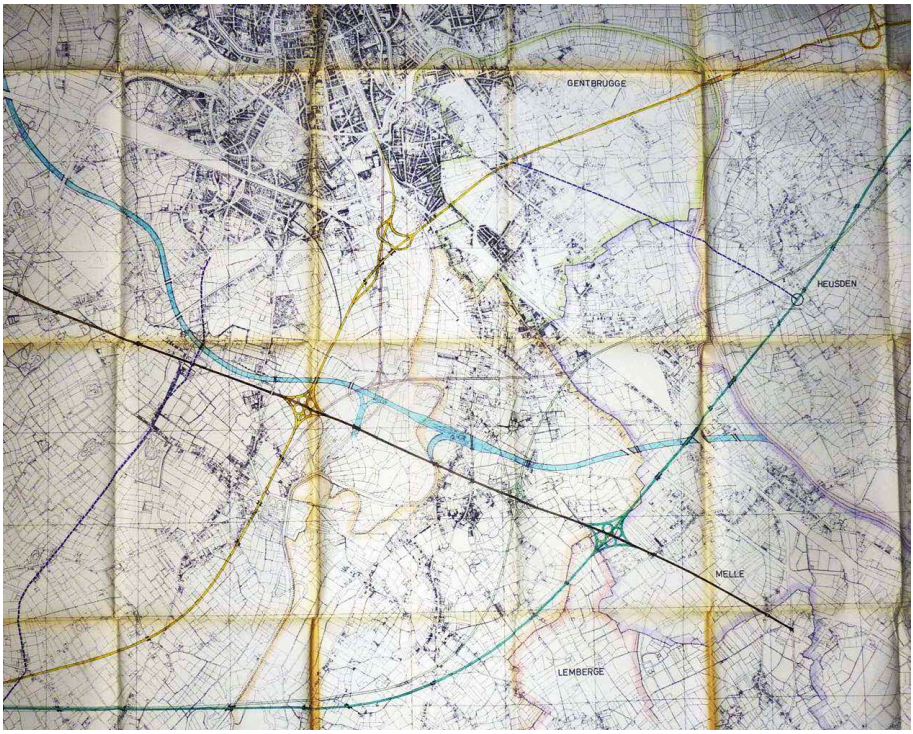
6.2.2 Construction of E17: the planned route discussion

The planned route for the passage of the E17 through the suburb of Gentbrugge was already sketched in 1949 on the preliminary drafts of the Belgian Highway Division (see yellow route on Figure 76). Between 1950 and the establishment of the IVA E3 in 1963, the former municipality of Gentbrugge[18] resisted vigorously against the plans, and the accompanying expropriations and infrastructural adjustments. Although there was continuing uncertainty about the exact route, all plans assumed that a tunnel would be constructed to avoid the densest parts of Gentbrugge, and not a viaduct.
In the beginning of the 1950s the municipality of Gentbrugge published a critical study of the planned route[19]. A fast connection to Ghent was named as the only

18 Until the fusion of the Belgian municipalities in 1977 Gentbrugge (and Ledeberg) were separate municipalities.
19 "De kritische studie met betrekking tot het tracé van de autosnelweg in de suburb Gent" (in English: the critical study concerning the planned route of the highway in the Ghent suburb) (Municipality of Gentbrugge, 1952)

advantage. On the other hand Gentbrugge formulated three objections. First, there were technical concerns, since the planned route through Gentbrugge had to overcome physical obstacles and the required visibility range for a driver might not be guaranteed. Second, there were downsides for urban development. The route would potentially become a barrier for the organic and harmonious development of the urban area. Moreover, during the construction phase land use planning was impossible, halting the further development of Gentbrugge. Third, there were strategic concerns about safety. In the post-war years a route through densely built urban fabric would possibly make an easy victim for a hostile air force. As a reaction, in 1952 the municipality of Gentbrugge sketched an alternative route, which was located further away from the city (see green route in Figure 76). This route would be less complex, would require less expropriations and had a lower cost. However, according to the Ministry of Public Works this route would be too far from the city.

Figure 76 Yellow route (Belgian Highway Division) versus alternative green route (municipality of Gentbrugge), in the year 1952. (Source: City Archives Ghent "Zwarte Doos", GAGB series, nr. 461, Prof. Ir. F. Vanderheyden, Study of planned routes in the Ghent Agglomeration, 1960) (in: Druwé & Lalush, 2011)



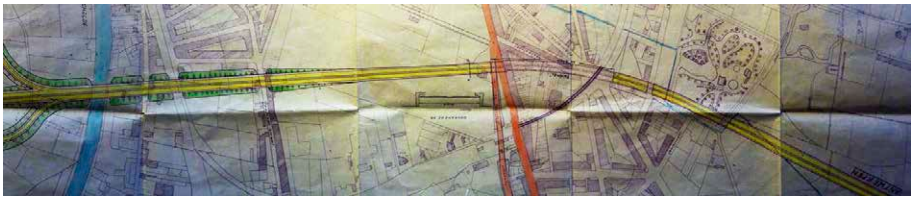
Because of this discussion in 1953 the Minister of Public Works visited Gentbrugge to explore the bottlenecks on the field. During this visit, the mayor of Gentbrugge spoke out against the plans, which would burden the future of his municipality. On the other hand, the Director-General Hondermarcq and the chief engineer of the Belgian Highway Division advocated the route through Gentbrugge. They stressed the national importance and the perfect location of the planned route to make a

swift connection with the center of Ghent (by the B401 exit ramp). The disadvantages of the counterproposal of the municipality of Gentbrugge were overemphasized. They pointed to costly expropriations and technical difficulties to construct a route through the rural areas of Merelbeke and Melle. In hindsight, both objections are far outweighed by the consequences of cutting through the dense urban fabric of Gentbrugge.
Thus, the higher authorities stuck to their plan and let national interests prevail. In 1958 the final route was approved by Royal Decree. However, since the works could not start immediately, the municipality of Gentbrugge continued in vain to put pressure on the authorities to change plans.

6.2.3 Construction of E17: the tunnel or viaduct discussion

Yet the main discussion took place just before the start of the works. In 1963 the detailed construction plans were handed over to the municipality of Gentbrugge and the IVA E3, who could make small adaptations where needed to start the works as soon as possible. In these plans a 150 meter long tunnel was provided to avoid the most densely built parts of Gentbrugge east of the Brusselsesteenweg, followed by a stretch of half open tunnel further east up to where the viaduct stops today (Figure 77).
In 1964, after some technical research by the leading engineering company, it turned out that the route had to be moved to the north for a few meters because of soil technical concerns. Further research called the financial feasibility of the tunnel option into question, since constructing it in the watery grounds of Gentbrugge would lead to very high drainage costs. In addition, an open tunnel had its disadvantages. It would be a wide and deep trench in the urban landscape, possibly functioning as a barrier. Therefore, the Ministry of Public Works quickly commissioned an alternative study for constructing a viaduct instead.

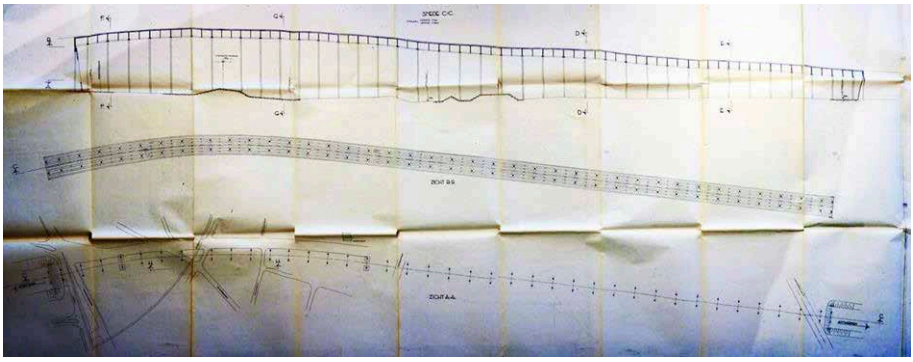
Figure 77 Preliminary plan of E3 route, including a tunnel east of the Brusselsesteenweg, 1963 (Source: City Archives Ghent "Zwarte Doos", GAGB series, nr. 461, Belgian Highway Divison, Preliminary plan on Gentbrugge territory, March 1963) (in: Druwé & Lalush, 2011)



After hearing of these plans, the municipality of Gentbrugge immediately tried to defend itself. In 1965 they wrote a critical note in which was stated that a viaduct could never be placed in the urban landscape in an orderly way and that its disruptive appearance would lead to a "virtual" separation of the territory. In addition, the municipality's plans to build a public administrative center, a swimming pool and recreation grounds next to the planned route would be compromised. Finally, the municipality put forth that there was too little attention

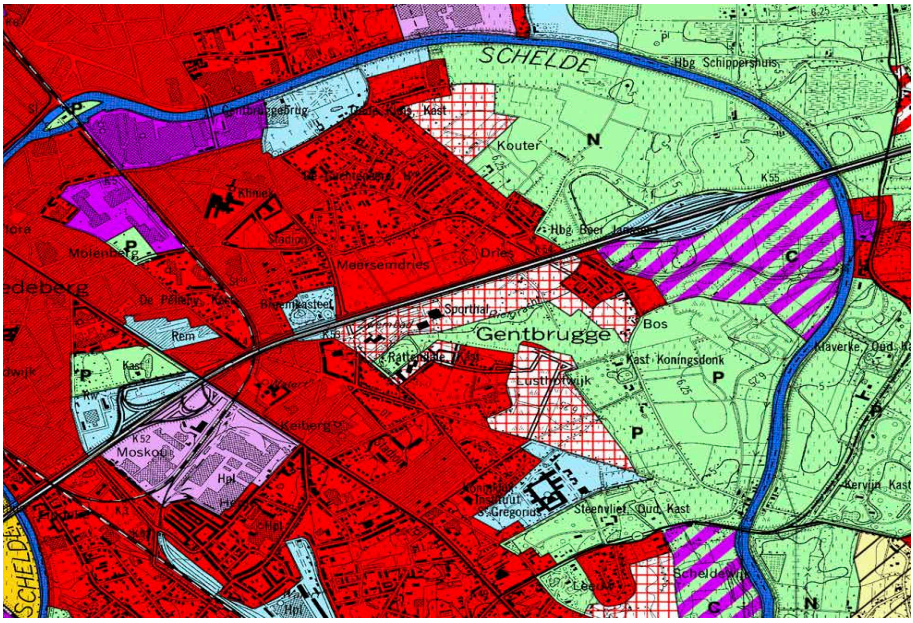
for the aspects of air pollution and noise in the viaduct study. This was the first time that environmental impact concerns entered the debate. But all efforts were to no avail, as in 1965 by Ministerial Decree the choice for a viaduct was approved. Financial concerns were the main argument, since a viaduct would cost 300 million francs less than a tunnel (which is about 7.5 million euro).

Figure 78 Preliminary design Gentbrugge viaduct, 1965 (Source: City Archives Ghent "Zwarte Doos", GAGB series, nr. 463, NMBS, Preliminary design Gentbrugge viaduct, Gentbrugge, 1965) (in: Druwé & Lalush, 2011)



Because the timely completion of the E3 highway could not be compromised, a modified preliminary plan for a viaduct was drawn on exactly the same place as the tunnel. An existing railway viaduct in Gentbrugge forced the designers to go to a local viaduct height of 14 meters, resulting in an asymmetrical shape of the longitudinal profile (Figure 78). Furthermore, on the planning documents of the viaduct (1965) all surrounding buildings and existing infrastructures were not shown, exemplifying the engineering ambitions of those times. There were almost no ideas for using the space under the viaduct, so it was all designated as parking space. Finally, the construction of the viaduct started in 1967 and was completed in 1969, except for the connector with the Brusselsesteenweg, which was completed only in 1972. This connector was not part of the initial plans but was added later by local pressure. To alleviate the burden on the municipality of Gentbrugge, the central government provided 75 meter of green buffer along the viaduct wherever possible. However, on the regional land use plan of 1972 ("Gewestplan") the green buffer was not formalized. Instead, the undeveloped land north and south of the viaduct was designated as monomorphic residential (development) area, which stressed the unclear vision (Figure 79).

Figure 79 Regional land use plan or “Gewestplan” 1977 (Source: http://www.agiv.be/)



6.2.4 Construction of B401: the Ledeberg viaduct

About the route and the construction of the B401, including the viaduct of Ledeberg, the debate was less intense. This can be partially explained by the fact that the route was planned at the same location as the old railway line leading to the railway station at the present Woodrow Wilsonplein. Consequently, a large part of the terrain was already possessed by the government (i.e. the railway company). The viaduct was deemed the backbone of the access complex Ghent-Centre and had to fit in the urban landscape as harmoniously as possible. However, the art of engineering prevailed on the landscape aspect leading to a gigantic transformation of this part of the city. In addition to the construction of the viaduct, which was completed between 1969 and 1972, and the readjustment of the connecting road network, other profound urban transformations took place in the surroundings. The most important were the construction of the UCO office building and three high rise towers to house the residents of expropriated houses.

Figure 80 Construction of B401 viaduct in Ledeberg (Source: City Archives Ghent "Zwarte Doos", GAGB series, nr. 462) (in: Druwé & Lalush, 2011)

6.3 Recent history and debate

Both highway routes, the E17 with the Gentbrugge viaduct and the B401 with the Ledeberg viaduct or fly-over, recently received a lot of attention in local politics and public debates. By analyzing newspaper articles from the press database Gopress (http://www.gopress.be/), a summary of recent history and debates is made to understand the current situation. It turns out that the E17 viaduct has a long history of nuisance and protest, while the attention for the B401 viaduct grew more recently and seems to be driven by local politics rather than neighboring residents.

6.3.1 E17 Gentbrugge: an eventful history of nuisance and protest

Ever since the construction of the E17 viaduct in the 1960s, some sort of protest has existed, primarily about the noise produced by the viaduct. An overview of recent history shows that residents and pressure groups, supported by local politicians, have always tried to put the issue on the agenda. This has led to several modifications of the situation.

In the 1980s and 1990s there was the "Werkgroep Milieuhinder E17" (in English: workgroup environmental nuisance E17), which could obtain the installation of noise barriers in 1989. Since the turn of the century the problems and protests accumulated. Particularly the renovation of the viaduct between 2002 and 2004, including a new road surface and new construction joints, has caused problems that

still exist today. A new pressure group “E17-lawaai” (in English: E17 noise) could obtain a reduction of the speed limit to 90 kilometers per hour in 2006. This was quickly followed by enforcement of the speed limit through speed cameras and a section speed control system in a later phase. A few years ago a new pressure group was set up that continues to strive for a long-term solution for the nuisance of the viaduct and encourages politicians to think about it. While the Flemish Agency for Roads and Traffic promised an alleviation of noise exposure by maintenance works in 2020, the pressure group is still not convinced. The following overview explains some events in a more detailed way.

Pressure group “E17-lawaai” and lawsuit

In the beginning of 2005 the pressure group “E17 lawaai” was set up, who advocated that environmental noise nuisance had worsened because of errors in the reconstruction of the viaduct. The construction joints would not fit well together causing an annoying, pounding noise. The group also denounced that for a length of 500 meters, at one side of the highway still no noise barriers were installed. The pressure group was set up after 14 months of fruitless communication with the Flemish Government, and was backed by the city of Ghent. The city agreed with the pressure group that the noise limits used by the Flemish Agency for Roads and Traffic (AWV) were too weak, with the Flemish Government bearing a part of the costs of buildings noise barriers only at very high noise levels (above 65 dB). The city and the pressure group “E17 lawaai” proposed to redesign the construction joints, divert heavy vehicles, lower the maximum speed limit and complete the noise barriers. In a newspaper reaction AWV minimalized the problem: “who lives next to a highway should take a higher noise exposure into account”, “60 decibels next to a highway viaduct is not that loud” and “the current situation is the best possible in the given circumstances”. However, AWV acknowledged that the new construction joints cause more noise annoyance (but are more durable), and promised to set up a new official noise measurement campaign to check whether the limit of 65 dB is exceeded. AWV did not follow the complaints about the missing part of the noise barriers, since the adjoining neighborhood was erected after the construction of the viaduct and residents thus could be aware of the possible nuisance.

Later on in 2015 the pressure group, representing 174 residents, sued the Flemish Government. The group asked the court to appoint an independent expert that could assess whether there was an increase of noise exposure attributable to the reconstruction works. The city of Ghent supported the writ. An objective measurement would also be in their favor, since parts of the construction costs of noise barriers would be borne by the city if the measured noise would be between 65 and 80 dB (stipulated in Module 5 of the Mobility Covenant Flanders, now Partnership Agreement IX of the Mobility Decree). The court appointed an independent expert, but it took years to complete the assessment. Consequently the judge completely agreed with the pressure group and confirmed that errors had been made in the reconstruction of the pavement joints. At the same time the judge ascertained that no enforceable noise standards for traffic noise existed. In lack of traffic noise legislation the complaints were finally rejected, the pressure group lost a lot of money and stopped all activities.

Reduction of speed limit to 70 km/h and introduction of speed cameras

In the meantime other actors entered the playing field. At the end of 2005, Jan Roegiers, a member of the Flemish Parliament for the social-liberal party Spirit, proposed to lower the speed limit on the viaduct to 90 km/h and for heavy vehicles to 70 km/h. He asked the Minister of Public Works, the Christian Democrat Kris Peeters (CD&V), to start a pilot project. By lowering the maximum speed the noise level would be able to decrease with about 5 dB, which meant that noise would be perceived half as strong (taking the logarithmic decibel scale and the sensitivity of the human ear into account). The pressure group E17-lawaai supported this proposal but besides continued advocating for the installment of better noise barriers and a quiet road surface. Soon also representatives of other parties became concerned about the traffic noise caused by the E17 viaduct. Among others, Helga Stevens of the Flemish nationalist party N-VA advocated for a quick reconstruction of the pavement joints, and the introduction of Flemish standards on traffic noise.

In the course of 2006 the majority parties (CD&V, N-VA, sp.a[20], Spirit and Open Vld[21]) came to an agreement on starting the proposed pilot case. Yet there was still discussion on the safety of lowering the maximum speed for heavy vehicles to 70 km/h, since this could cause traffic congestion and rear-end collisions. After a safety evaluation on behalf of the Parliamentary Mobility Commission, the 70 km/h speed limit for heavy vehicles was abolished and finally a pilot case with an overall speed limit of 90 km/h was approved. The pilot case would go together with noise measurements and speed enforcements and would become a permanent measure provided a successful evaluation by the Flemish Government and the neighboring residents. At the same time the Flemish Government promised to examine other structural measures. The pressure group “E17 lawaai” did not expect a lot of change and continued to strive for better pavement joints and supplementary noise barriers. The employers’ organization VOKA opposed the measure as it would lead to unnecessary traffic disruption and delays.
The pilot project on the E17 viaduct launched in October 2006, but because in the beginning no speed cameras were provided the speed limit had no effect. Therefore, the three-month project was extended in February 2007 and eight unmanned speed cameras were installed, which immediately slowed down the traffic. In the course of 2007 the neighboring residents reported that the speed limit had caused a significant decrease of the noise annoyance and without further discussion the pilot project became a permanent situation.

Towards a section speed control system

In 2008 the new Minister of Public Works Hilde Crevits (CD&V) proposed a more advanced system to enforce the speed limit, based on intelligent section speed control. Minister Crevits wanted to launch a pilot project on the E17 viaduct in Gentbrugge, as an experiment without fining drivers. In 2009 this pilot project effectively started for a period of six months. Provided a positive evaluation, it would be extended and become operational. The neighboring residents were not completely satisfied with the project that yet wanted to reduce their noise exposure.

20 The Flemish social-democratic party.
21 The Flemish liberal party.

Instead of investing 800,000 euro in the project, they would rather invest in the reconstruction of pavement joints and more or better sound barriers. They stated that the speed limit had changed the interval of the noise, but that the problem with the noisy pavement joints continued to exist. Moreover, the largest part of the noise is produced by heavy vehicles that already had to respect the 90 km/h speed limit on all highways throughout the country. Minister of Public Works Crevits reacted that acoustic research had proven that supplementary noise barriers would yield a very limited advantage for the neighboring residents. In 2009 she definitely decided not to invest in noise barriers, to the dismay of the pressure group.
The pilot project of the section speed control system was very successful. However, it was only in 2012 when the legal basis was in order to effectively fine drivers. From then on, the speed limit is respected by the majority of vehicles passing the viaduct. The pressure group "E17 lawaai" admitted the improvement of the situation by the section speed control system, but continued to ask for more measures.

A new pressure group "Viadukaduk" calls for a long-term solution

By getting tangled in court proceedings the pressure group "E17 lawaai" finally ended its activities around 2012 and thus protest was weak for some years. In the beginning of 2014 a new local pressure group asked for a quieter viaduct and adopted the name "Viadukaduk". Their main argument is that the speed limit only has a limited effect on noise production since the 70 km/h limit for heavy vehicles has not been realized, heavy vehicles produce eight times more noise than cars, and they constitute an ever growing share of traffic, particularly during the night. They also raised the problem of air pollution for the first time. Viadukaduk asked for additional solutions, such as moving freight traffic to the R4 (see Figure 52), lowering the speed limit for heavy vehicles, installing additional noise barriers and exploring the feasibility of a tunnel construction to let the E17 pass through Gentbrugge (see Figure 53). Ghent alderman of Mobility and Public Works Filip Watteeuw from the green party (Groen) quickly supported the newly formed group and its symbolic actions. In the short term he thought moving freight traffic to the R4 would be a good solution, in the long term a cover around the viaduct could be the best option. The Flemish Agency for Roads and Traffic (AWV) reacted understandingly and admitted that noise exposure had only decreased slightly after the introduction of the section speed control system. However, AWV was not very receptive to most of the proposed solutions and only stated to examine the possibility of moving freight traffic to the R4, which would necessitate costly adjustments to this road.
After a few months of symbolic actions and consultation with politicians, the Ghent city council officially supported Viadukaduk and put the problem on the political agenda. In July 2014 the city wrote a memorandum to the new Flemish government[22], which explicitly asked for a solution. The city council did not accept that the viaduct "will be reconstructed in the same way at the same location", and asked for a concrete timeframe in which fundamental change of the situation would be possible. The city estimated the remaining lifetime of the viaduct at 15 to 20

22 Memorandum of the Ghent city council to the new Flemish Government (2014) (https://stad.gent/sites/default/files/page/documents/Memorandum%20van%20het%20Gentse%20stadsbestuur%20aan%20de%20nieuwe%20Vlaamse%20regering.pdf)

years. Nevertheless, the new Flemish government agreement of July 2014 (N-VA, CD&V and Open VLD) and the policy paper of the new Flemish minister of Mobility and Public Works Ben Weyts (N-VA) did not mention the E17 viaduct, giving few hope for change.

Ghent Mobility Plan 2030 and discussion about responsibility

The next important step was taken by the city council of Ghent (sp.a-Groen, Open VLD), who launched a draft of the Ghent Mobility Plan 2030 at the end of 2014. In this document, the city council explicitly asked for an alternative for the E17 viaduct. The city claimed that the viaduct had to be renovated within 10 years and thus it would be a good idea to start thinking about an alternative that takes livability into account. Thus, the city council called for an immediate study. The Flemish Agency for Roads and Traffic (AWV) agreed with the contents of the Ghent Mobility Plan, but not with its timing. They stated the viaduct could survive for 25 to 30 years and had not planned major reconstruction works yet. Also the opposition parties in Ghent had some doubts about the feasibility of the plan, being dependent on other actors such as the Flemish government. The pressure group Viadukaduk did not accept the reaction of AWV and again asked the Flemish government to start a study on a future vision for the E17 viaduct, together with the city and in consultation with the citizens, regardless of the lifespan of the viaduct. Minister of Public Works Ben Weyts (N-VA) initially rejected this call, repeating that demolition or renovation were not on the agenda. Moreover, he said that moving freight traffic to the R4 or reducing the speed limit for heavy vehicles to 70 km/h would have little effect and would only create new problems, according to a feasibility study. In response, alderman Filip Watteeuw said that the city wanted to fully support a study of alternatives, but could not take the initiative nor pay the costs, since the E17 highway is administered and managed by the Flemish level. Further, he would continue trying to convince minister Weyts of thinking about a structural long-term solution for the nuisance within 10 to 15 years, despite the technical lifespan. Finally, in September 2015 the Ghent Mobility plan was approved, with mention of the responsibility of AWV to start up a study, though without details on timing or budget.

Flemish government promises quiet construction joints

In the beginning of 2015 the problem again got some attention in the Flemish parliament. Flemish social-democratic representative Joris Vandenbroucke (sp.a) asked a parliamentary question on the future of the E17 viaduct. Minister Weyts (N-VA) replied that the viaduct would certainly remain until 2045 and that an early demolition would be irresponsible. Yet, the minister wanted to try to reduce the noise exposure by starting up an experiment with a new kind of pavement joints, which if evaluated positively would be introduced as a general measure when major maintenance takes place in 2020. Further, Vandenbroucke regretted that there is no money to construct the missing part of noise barriers, while the maintenance of the viaduct costs double as much a year.
In reply to a new question of Flemish representative Joris Vandenbroucke in September 2015, minister Weyts said that the conducted experiments suggested a significant reduction of noise exposure by pavement smoothing and gluing the joints. The experiments showed a potential decrease with 11 dB. The minister

promised to apply this method in the planned major maintenance works of 2020. Viadukaduk welcomed the measures but since the air pollution would continue to exist and the effect of the maintenance works is still unsure, they kept striving for a long-term solution.

Viadukaduk and the city council continue to press the Flemish government

Since the beginning of 2015 debate flared up from time to time, the city council openly supporting the residents' group Viadukaduk.

In March 2015 Viadukaduk started a local research on environmental quality. Together with Ghent University two fixed sensors were installed at 320 meter from the viaduct, being able to measure both noise exposure and soot (as indicator for air pollution). The idea is to gain insight in the long-term fluctuations, including day-night patterns. The first results showed peaks up to 65 dB and a deflection of the noise by the noise barriers at high wind speeds. Through this action Viadukaduk wanted to keep the problem on the political agenda, until a thorough study of possible solutions is performed and the promise is made that the situation will be tackled. The city council of Ghent immediately supported this action and again addressed the Flemish government. Minister Weyts was now more acceptable and stated that the Flemish government would like to conduct a study on alternatives, but first asked Ghent to draw an overall mobility plan for the city.

In June 2015, at the start of the public inquiry on the Noise Action Plan for the Ghent agglomeration, alderman of Environment Tine Heyse (Groen) called as many Ghent citizens as possible to file an official complaint. Since this plan is administered by the Flemish government, as such the citizens would send out the message that the current situation could not continue to exist.

In January 2016, following a question of local politician Sara Matthieu (Groen) on the current state of affairs, alderman of Moblity Watteeuw (Groen) replied that he requested a meeting with minister Weyts. It is not clear whether this meeting has taken place, yet the spokesman of minister Weyts declared in the media that demolition was very unlikely, referring to the lifespan of the viaduct. He added that there were much more important projects to study and finance. So far, no concrete steps had been taken to start up a study.

In February 2016 Viadukaduk organized a well-attended information evening for residents' living along the viaduct. In that context Ghent University professor in medicine Dirk Avonts warned in the newspapers for the health effects of living close to the viaduct. He thought the only quick solution is to decrease the speed limit to 70 km/h, since the installation of noise barriers would only lead to the diffusion of transport pollutants and noise further away from the viaduct.

In May 2016, Viadukaduk organized a big street party that was covered in local (online) media. The Ghent Mayor Daniel Termont (sp.a) attended the event and addressed the citizens. He expressed his full support for the actions of Viadukaduk and only mentioned two efficient long-term solutions, being a tunnel or a viaduct cover.

Today it is still unclear who will take further initiative, since the city council of Ghent and the Minister of Public Works Ben Weyts (N-VA) point to each other. To make the situation even more complex, also the local N-VA party in Ghent supports the pressure group. Thus, the local front that requests change is almost unanimous, across party lines, against a Flemish government adopting a wait-and-see policy.

6.3.2 B401 Ledeberg-Ghent: a symbolic urban redevelopment project

The B401 viaduct, or fly-over, has no history of widespread protest and pressure groups. During its lifetime the protest of neighboring residents was very limited so far. It seems that the problems of environmental noise and air pollution play less of a role, although noise and air quality maps point to equally high exposures in the area.
However, a few years ago the B401 was at the center of political debate. Future plans for the viaduct were devised by environmental associations (such as GMF) and local parties (such as Groen and Open VLD). For a while the demolition of the B401 became a symbolic project and future proposals were not all that realistic, partly because the Flemish government, administering the road, was a little hesitant at first. Today the project is a symbol of the spatial and mobility policy of the current city council, which will do everything in its power to have a definitive decision on the redevelopment of the viaduct by the end of the government term. The Flemish government has officially agreed with a future demolition, on condition of the drawing of a comprehensive mobility plan. An overview of the recent history gives some more detail.

First ideas

The first official plans to reconsider the viaduct of B401 (see Figure 53) appeared in 2003. In the Spatial Structure Plan of Ghent the following passage is found: *"After partially demolishing the B401 viaduct, the park will be enlarged up to the city ring road, assuming the Flemish government eventually will revise the connection B401/R4"* (City of Ghent, 2003).
A few years later, in 2006, also the Ghent Environmental Front (GMF) started to focus on the viaduct, emphasizing the visual pollution. GMF wanted to demolish the viaduct and to let the B401 end at the urban ring road. Strikingly, at that time nobody talked about air pollution or noise. Yet, the first detailed urban noise maps for Ghent in 2010 show that the area around the B401 was an important bottleneck, with noise levels exceeding L_{den} = 75 dB(A). This was caused by a lot of traffic on a viaduct with outdated pavement joints and a noisy road surface.

Municipal elections 2012 and new city council

General attention for the B401 only started to grow in 2012, when several parties mentioned the demolition or redevelopment of the viaduct in their election manifesto for the municipal elections of October 2012. One of the protagonists was the liberal alderman Matthias De Clercq (Open VLD) who published a book in March 2012, titled "Dreams of Ghent" (De Clercq, 2012). In this book he ambitiously advocates for demolishing the viaduct to enlarge the Zuidpark, with the idea of New York's Central Park in mind, creating a public meeting space for employees of the surrounding offices and local residents. The traffic coming from the E17 would have to follow a long tunnel to reach the indoor parking lot Ghent Zuid at the northern end of the Zuidpark. The local liberal party Open VLD later adopted these ideas in the party's election manifesto. In a reaction, mayor Daniel Termont (sp.a) mentioned that the idea of demolishing the B401 viaduct was not a new idea, but something the mayor and aldermen were informally talking about for years, with sp.a and open VLD

sharing the same opinion. In the pre-election period the demolition of the viaduct did not seem that unlikely anymore, since at the same time the Flemish Agency for Roads and Traffic announced that the viaduct was in a deplorable state and had to be renovated urgently.

After the elections the social-democratic party (sp.a), the liberal party (Open VLD) and the green party (Groen) – all advocates of a demolition – formed a coalition. In the government agreement Termont II, the (partial) demolition of the viaduct is part of the political agenda for the government term. The idea is to develop a big Park&Ride parking at the crossing of the B401 with the urban ring road, where rental bikes and a direct tram connection to the city center would be available. There would only remain a single carriageway to drive into the city center, meant for local traffic and to reach the parking lot at Ghent Zuid.
The opposition parties criticized the city council for acting too hastily, since the B401 is a regional road administered by the Flemish government and there was no guarantee that Flanders wanted to cooperate in this. The new alderman for Mobility and Public Works Filip Watteeuw (Groen) declared to talk as soon as possible with the Flemish minister for Mobility and Public Works Hilde Crevits (CD&V). Since a budget was foreseen for an urgent renovation, Watteeuw thought this might be the momentum for drastic change and put forward to rather use the budget for demolishing the viaduct. Crevits replied that the renovation works would certainly start in 2013, including a new road surface and new pavement joints, for a total cost of 6 million euro. However, she was willing to listen to the plans of the city council, if they were part of a global mobility vision for the city of Ghent in which the demolition of the viaduct would be taken into account, and if they were affordable. It gradually became clear that before the end of the government period in 2018 a demolition would not be possible. Yet, alderman Watteeuw started to collect ideas and set up research, as he would like to take major decisions in this government period and reach the “point of no return”. The next city council then could effectively carry out the demolition.

At the end of 2013 the city announced that 200,000 euro would be budgeted for studies in 2015 and 2016. In the meantime, the Flemish Agency for Roads and Traffic (AWV) said to be willing to take part in a demolition scenario, but was worried also about the adverse consequences on traffic flow. Flemish minister Crevits would never take an official position, and left the question to her successor.

Flemish regional elections 2014 and new Flemish government
In the pre-election period of the May 2014 Flemish regional elections the question erupted again. The known architect Stéphane Beel advocated surprisingly for a more open attitude towards the car in the city. He thought the viaduct was one of the most beautiful entrances to the city, and even mentioned the possible construction of houses under the viaduct. The Ghent Environmental Front (GMF) repeated their call for a demolition of the viaduct. The Ghent city council at his turn organized a master class on the future of the B401, in which a draft future vision was drawn for the B401 space after demolition. The first aim was to prepare a master plan, which would make clear which studies would be needed.
In July 2014 a new Flemish government was formed by N-VA, CD&V and Open VLD.

The coalition agreement and the policy paper of the new minister of Mobility and Public Works Ben Weyts (N-VA) did not mention the B401 viaduct. Shortly after, Ghent launched its draft Mobility Plan in October 2014. The closure of the B401 was high on the wish list and the city indicated that a think-tank would be set up to explore all options. Afterwards further studies could be commissioned and design workshops organized. The local opposition parties again criticized the plans for being too much dependent on other actors, thus pulling the wool over the citizens' eyes.

In November 2014 minister Weyts took an official position about the B401 viaduct. He stated that a highway exit that directly ends into the city center "does not fit in a contemporary vision on mobility". Yet he considered it "unthinkable" to demolish the viaduct without other major infrastructure works (tram network, local road network, bicycle infrastructure, parking buildings) for which the city is at least partly responsible. He promised to cooperate in technical studies, but pointed to the responsibility of the city to work out an overall urban mobility concept. Different actors responded to this official position. The Union of Self-Employed Entrepreneurs UNIZO wanted to keep the viaduct, since it forms the access to the parking lot at Ghent Zuid, which is an important parking for shopping and city visits. Also Flanders' Chamber of Commerce VOKA was not convinced about the plans. They posited that the urban ring road R40 will be totally congested if the viaduct would be closed, as it is necessary for local traffic flow. Also architects and discussions on social media called the closure of the viaduct into question and thought it would be a useless investment. The Flemish Agency for Roads and Traffic (AWV) called for proper research and to not take hasty decisions, since the viaduct still has a lifespan of some 30 years.

Start of study on alternatives

After more than a year of calm, in January 2016, Flemish parliamentarian Joris Vandenbroucke (sp.a) asked minister Ben Weyts for a current state of affairs. Weyts repeated that the initiative to start a study and develop an alternative is with the city, which had not contacted him for a long time. In the press, Watteeuw reported that there had been some design studios and that a study was planned, with the intention to have a concrete plan by the end of the government term.
In June 2016 at last an exploratory spatial study was commissioned. The aim of the study is to gain insight in the spatial and mobility conditions of the project and develop a number of scenarios. This would allow for a participation trajectory with sufficient knowledge and informed alternatives. The study can take up to one year and a budget of 200,000 € is provided.

6.4 Today: actors and policy documents

The story of the design and construction of both highways, and the overview of recent history, reveals a playing field with a few prominent actors that dominate the debate today.

– *Ghent city council and administrations:*
The Ghent city council, through the mayor and its aldermen, advocates for reviewing the present situation and exploring alternative options. The city does not administer both roads and thus can only put pressure on the Flemish government and care for a supporting urban planning and mobility policy. It has set up a research on alternatives for the B401, but thinks the Flemish government should do this for the E17.

– *Flemish government and administrations:*
The Flemish government administers both roads, through the Flemish Agency for Roads and Traffic (AWV). The mobility policy is determined by the department of Mobility and Public Works, with major decisions being taken by the responsible minister, Ben Weyts (N-VA). The overview of recent history shows that Flanders tries to stick to a "business as usual" policy for both viaducts, falling back on the lifespan of the viaducts again and again, and only hesitatingly taking steps towards redevelopment. Also at Flemish level, the Department of Environment, Nature and Energy plays a role. They convert the European policy on air quality and noise in Flemish regulations and observe the application. Just like the city, they rather stand on the sideline, since they can only try to steer the debate and have little say in the decisions.

– *Civil society:*
Civil society organizations, representing the interests and will of citizens, are also important actors. Concerning the E17 viaduct recently a new, active group emerged, called Viadukaduk. Concerning the B401 such group does not exist. The citizens' voice in this debate is represented by the Ghent Environmental Front, an environmental association whose scope covers the whole city.

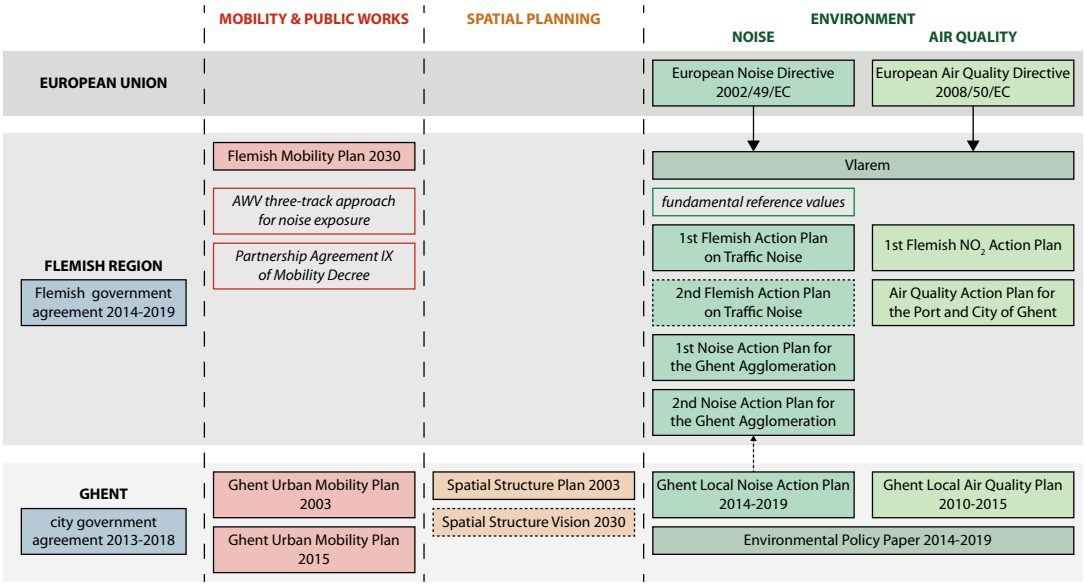
– *Politicians:*
In recent history some people's representatives from Ghent with a Flemish mandate played an important role in setting the political agenda. Among them Jan Roegiers (Spirit), Joris Vandenbroucke (sp.a), Sara Matthieu (Groen) and Helga Stevens (N-VA).

– *Other interest groups:*
Finally, if redevelopment plans will become more concrete, other actors probably want to be involved in the debate and have their say. Among them the transport federations (Febetra, TLV), the automobile associations (VTB-VAB, Touring), the Flanders' Chamber of Commerce (VOKA), the Union of Self-Employed Entrepreneurs (UNIZO) and the public transport company (De Lijn).

An important missing factor is the silent majority of the population. Since no participatory processes have been set up so far, an objective picture of the citizen's opinion is not available. This missing link is addressed by carrying out a representative survey, as described in chapter 7 and 8.
Hereafter the opinion of the three major actors at the moment is further examined: the city of Ghent, the Flemish government and the civil society group Viadukaduk. The analysis of the first two is based on relevant policy documents, for the last one

information on Viadukaduk's website and two other sources is used. The discussed policy documents are schematically placed in a diagram for better understanding (Figure 81).

Figure 81 Schematic representation of the different policy documents and policy levels related to the case E17/B401 (the dotted outlines point to policy documents that are not yet approved as of August 2016)



6.4.1 Ghent city council and administrations

The city of Ghent is obviously an important actor, representing the intermediary level between the Flemish government and the citizens (and other local actors). As such the city might have the best overview of the situation, but since it does not administer both highways, its decision power is rather weak and focus is on putting pressure on the Flemish government. This is shown in the **city's government agreement 2013-2018**, written and approved by a coalition of sp.a, Groen and Open VLD. The E17 viaduct is not explicitly mentioned, but the B401 viaduct gets full attention. One of the action points is to partially close the B401, which should end in a new Park&Ride building next to the R40, where (shared) bikes and a fast tram connection would be available. The traffic flows inward the city should use the urban ring road R40 or use a single carriageway at the current location of the B401. The city calls for action of the Flemish government to demolish the last part of the B401, giving room for an expansion of the Zuidpark.
To put more pressure on the Flemish Government, and to show their commitment to the citizens, the issues of the E17 and B401 are also mentioned in the city's policy documents on mobility, spatial planning and environment.

6.4.1.1 Policy domain of mobility

In the **Ghent Urban Mobility Plan of 2003** (City of Ghent & Tritel nv, 2003) the need for alternatives for the B401 or E17 is not yet mentioned. In the **new Urban Mobility Plan**, approved in September **2015**, the wind has changed (City of Ghent, 2015). Important to know is that the urban mobility plan, like all Flemish local mobility plans, is not drafted and approved by the city of Ghent alone. It is developed by a steering committee consisting of the City of Ghent, the Flemish Department of Public Works, the Flemish Agency for Roads and Traffic, the public transport company De Lijn, the railway company NMBS and the Port of Ghent. Associated with the plan, the different partners make commitments on future actions.
The mobility plan starts from the observation that different highways cut through or narrowly pass by densely populated areas. This burdens the air pollution and noise exposure of neighboring citizens. The mobility plan advocates a sustainably mobility policy that would also improve the local air and sound quality.

The route of the E17 through Gentbrugge is called “a gigantic barrier in the urban fabric with a very negative impact on the environment and public health”. The viaduct is called an example of “an outdated vision on a city-regional traffic organization”. The mobility plan does not accept that the E17 viaduct in Gentbrugge “will be reconstructed in the same shape at the same location, which does not mean that the route itself poses a problem”. Further on, the mobility plan states that the lifetime of the viaduct would come to an end in 2030, yielding the opportunity to opt for an alternative at that moment. The Flemish Agency for Roads and Traffic is held responsible to initiate a study on a future vision for the E17 viaduct, together with all relevant stakeholders (city, neighboring municipalities, others). Since the E17 is part of the international highway network, the city thinks the Flemish government has to take the lead in this.

The B401 is described as a dominant infrastructure with major implications on the livability and environmental quality of the surrounding neighborhoods. In addition, it is held responsible for an unbalanced traffic pressure in the southwestern part of the city. Literally, the mobility plan calls the B401 a remnant of the “outdated idea that cars should be able to drive right into the center of the city”, which is contrary to all current views on through traffic, selective accessibility and the impact of traffic on livability and the environment. The 2003 mobility plan already argued that the B401 as a major road should end at the urban ring road R40, without speaking about the rest of the route. The 2015 mobility plan repeats this strategic vision and adds that the last part of the viaduct cannot be used at all any longer, leaving only the lateral road next the Zuidpark for local circulation. The mobility plan admits that the scale and importance of the B401 impede a simple solution of diverting traffic flows. Instead there is a need for an integrated approach at the level of urban development, with a large scale innovative mobility concept. Therefore, in 2014 the city already started a research and planning process, aiming to find an integrated solution of a large urban Park&Ride parking and a strong public transport network. In the mobility plan, both the Flemish Agency for Roads and Traffic (AWV) and the city of Ghent make the commitment to further work on this, involving other partners like the public transport company.

6.4.1.2 Policy domain of spatial planning

In the city's **Spatial Structure Plan of 2003** the E17 and B401 viaducts get very little attention (City of Ghent, 2003). It seems both issues were not on the political agenda yet.
Concerning the E17 the only reference is, strikingly, about the reconstruction of transparent noise barriers, allowing the car drivers on the viaduct to have a clear view on the city. There is no mention of any environmental pollution caused by the viaduct.
Concerning the B401 a short passage lyrically describes the beautiful view when one enters Ghent by the viaduct. In addition, the partial closing of the B401 viaduct in the long term is mentioned, enabling an expansion of the Zuidpark. However, no sense of urgency is present.
At the moment the city is working on a new **Spatial Structure Vision 2030**. Details are not yet clear as of August 2016.

6.4.1.3 Policy domain of environment

In the local environmental policy of Ghent there is growing attention for noise annoyance and air pollution exposure. Several urban action plans were drawn up. As regards air quality, in 2010 a **Ghent Local Air Quality Plan 2010-2015** was developed, including 50 actions for a cleaner air (City of Ghent, 2010). The plan particularly includes measures to reduce the local traffic contribution to air pollution, as local traffic makes up to about 30% of NO_2 concentrations. Avoiding motorized transport as much as possible is described as the most effective measure. The only concrete measure for the E17/B401 study area is the proposal to divert heavy vehicles to the R4, as such reducing pollution around the E17 viaduct (see Figure 52). Also, the city advocates for a specific strategic "air quality" assessment on the basis of air quality limit values, which can be embedded in the existing environmental assessment framework for spatial planning and urban development projects.

As regards noise annoyance, in 2014 a **Ghent Local Noise Action Plan 2014-2019** was drawn up, as preparation for the new integral noise action plan for the Ghent agglomeration, developed together with the Flemish Department of Environment, Nature and Energy (LNE) (see 6.4.2.2). The plan starts from the observation that traffic noise is one of the most common forms of annoyance in Ghent (City of Ghent, 2014b). Based on the urban noise maps of 2014 it is calculated that 37,965 inhabitants, or about 15% of the city's population, are exposed to traffic noise levels exceeding L_{den} = 70 dB(A). A significant part of the highly exposed houses is located in the study area E17/B401 (see Figure 55). As a response, the city expresses the ambition to decrease the traffic noise level at all houses below 70 dB(A) by 2030. The city admits that this can only be achieved if European, Belgian and Flemish government care for enough supportive measures. The city of Ghent advocates a three-track approach, consisting of preventing new noise bottlenecks (e.g. smart mobility policy), combating existing noise bottlenecks (e.g. quiet road surfaces) and compensating existing noise bottlenecks (e.g. providing quiet zones). The plan lists concrete actions that mainly come from other policy fields. The need for a

sustainable and livable alternative for the E17 viaduct and the B401 viaduct is one of the “actions”. It illustrates that the proposed “actions” are rather “wishes” since most of them necessitate the cooperation of other policy levels.

Also in 2014 the **Environmental Policy Paper 2014-2019** was drawn up by the alderman for Environment Tine Heyse (Groen), with a focus on environmental nuisance and specifically on air pollution, noise annoyance and neatness (City of Ghent, 2014a). Concerning air quality the problem of high NO_2 concentrations is mentioned, partly caused by local traffic. The alderman advocates an integrated approach at a regional level, which takes form in an integrated air quality plan for the Ghent agglomeration and the port area (see 6.4.2.2). She also proposes a few local measures, like implementing air quality modeling in spatial planning processes, the creation of low emission zones and the setting up of participatory air quality measurement campaigns to map street level concentrations and change mobility behaviors. Concerning noise is referred to the draft integral noise action plan for the agglomeration of Ghent (see 6.4.2.2). One relevant action is preventing new traffic noise bottlenecks by drawing up guidelines for building at highly exposed locations. Throughout the policy paper the E17 and B401 viaduct are not specifically mentioned.

6.4.2 Flemish government and administrations

The Flemish government with its departments is a second important actor. Most importantly, the Flemish government administers both highways through the Flemish Agency for Roads and Traffic (AWV). Policymaking mainly happens within the Department of Mobility and Public Works (MOW) and at the cabinet of the minister of Mobility and Public Works. In addition, the European policy on environmental pollution is translated into Flemish policy by the Department of Environment, Nature and Energy (LNE). This department draws up Flemish action plans for noise and air quality and tries to have influence on the Flemish mobility and public works policy. Traditionally noise in particular gets a lot of attention, and also in the **Flemish government agreement 2014-2019** noise abatement measures are stressed. The aspect of air quality is mainly on the political agenda because of European pressure.

6.4.2.1 Department of Mobility and Public Works and Flemish Agency for Roads and Traffic

The Flemish Agency for Roads and Traffic (AWV) and the Department of Mobility and Public Works did not yet take an official position on the E17 and B401 in their policy plans. Their policy documents at Flemish level usually are very general and the issue of environmental pollution is almost untouched. At the moment the new **Flemish Mobility plan 2030** is developed. The draft version is yet available and refers largely to the action plans for air quality and noise for the aspect of environmental pollution (see further), without defining ambitions. Concerning the aspect of noise annoyance and the construction of noise barriers, the plan refers to the current way of working, which will be explained here.

The Flemish Agency for Roads and Traffic **(AWV)** adopts a **three-track approach** with regard to noise exposure along highways and major roads (http://wegenenverkeer.be/geluid-trillingen).

First, AWV has listed 26 priority bottlenecks, based on the first version of the Flemish noise maps for roads with more than 6 million vehicle passages a year (2011). Bottlenecks were selected based on the house facade noise levels, the number of houses that would experience an improvement of the situation if measures were taken and the physical possibility to construct noise barriers. AWV used an algorithm to rank them and on their initiative they are tackled one by one. Both the E17 viaduct and the B401 viaduct are not part of this priority list.

Second, based on citizens' complaints and occasional noise measurements by the Flemish government the construction of noise barriers or noise walls could be initiated. In this case the municipality and the Flemish government should sign the **Partnership Agreement IX of the Mobility Decree**. The project is always tendered and implemented by AWV. The measured noise level defines the distribution of the costs between the municipality and the Flemish region.

- Highest measured facade noise level of a dwelling L_{aeq}[23] > 80 dB(A): the Flemish region bears the full costs.
- Highest measured facade noise level of a hospital L_{aeq} > 65 dB(A): the Flemish region bears the full costs.
- Highest measured facade noise level of a dwelling L_{aeq} > 65 dB(A) and < 80 dB(A): the municipality bears a part of the costs, depending on the noise level and reduced by 10% when at least half of the dwellings within a distance of 250 meters from the road or highway were built before the road or highway was completed.
- Highest measured facade noise level of a dwelling L_{aeq} < 65 dB(A): the municipality bears the full costs.

These regulations were referred to earlier when the missing part of the noise barriers of the E17 viaduct was discussed. The problem in this case is that the measurements of AWV are just below 65 dB(A) at the houses close to the missing part of the noise barriers. However, recent local long-term measurements performed by Ghent University indicate peaks of up to 65 dB(A) at 350 meter distance from the viaduct, also at a house close to the missing part of the noise barriers. Possibly the weather and wind conditions play a role and thus a short-term measurement (like the one from AWV) does not always give a good picture of the situation. Moreover, concerning the E17 viaduct especially the low-frequency impulse noise, caused by the pavement joints, is most annoying. This noise is not taken into account in the measurements of AWV.

A third case when noise abatement measures are taken is in new large infrastructure projects, whether or not through the environmental impact assessment that proposes it as mitigating measure.

23 L_{aeq} is the equivalent continuous sound level.

6.4.2.2 Department of Environment, Nature and Energy

The Department of Environment, Nature and Energy (LNE), and more specifically the Division Air Quality, Nuisance, Risk Management, Environment and Health is responsible for the Flemish policy on environmental noise and air pollution. It is this division that translates European legislation into Flemish legislation, draws up action plans and maintains their execution.

Noise

Concerning environmental noise the **European Noise Directive 2002/49/EC** plays an important role, aiming at a coordinated approach to avoid, prevent or reduce the adverse consequences of noise exposure. The Directive was translated into the Flemish **Vlarem** legislation. The major tasks for the government are the drawing up of noise maps, the drawing up of action plans and informing the public, for noise associated with road, railways, airports and agglomerations. With regard to the noise exposure associated with the E17 and B401 particularly the Flemish action plan on road traffic noise is relevant, as well as the noise action plan for the Ghent agglomeration.

An important remark in this context is that, according to Vlarem, Flanders is able to determine general environmental quality norms for traffic noise exposure for more than ten years, but is still reluctant to do this. Instead Flanders developed a system with **fundamental reference values**: L_{den} = 65 dB for existing situations and L_{den} = 55 dB for new residential development. However, additional differentiated reference values were developed in which road category is taken into account. For major roads and highways, like the E17 and the B401, the limit value rises to L_{den} = 70 dB for existing situations and L_{den} = 55 dB for new residential development.[24] These ambitious norms, however, are not legally defined and are not accompanied by specific actions. They are only referred to as unofficial framework in environmental assessments, where they can also be adapted again to specific cases. The absence of a coherent legal framework has been addressed several times, for example in the 2014 annual report of the Flemish Ombudsman, which was discussed in a commission of the Flemish parliament. It was considered unfair that companies and citizens should comply with strict environmental norms, while the government gets an exemption for road traffic noise.

The **first Flemish Action Plan on Traffic Noise** (Flemish Government, 2010) was the first action plan drawn up following the European Directive. It describes the noise exposure, makes an inventory of existing measures and proposes new ones, focusing on all roads with more than 6 million passages a year. The plan first describes some obvious measures, like the quicker construction of noise barriers and quiet pavements at the most exposed locations, advocating for stronger European regulations on noise exposure, stimulating quieter vehicles and tires ... Interestingly, also the role of spatial planning is given attention. The department LNE wants to assess how it can guide local authorities in determining the desirability of spatial development. In the long term LNE wants to adopt a uniform

24 Also L_{ngt} values were defined, always 10 dB lower than the L_{den} values.

system with reference values to decide on spatial development at noise-affected locations. Finally, also the financing of new noise measures is addressed. The "polluter pays" principle is advocated for, by reforming the road tax and investing the revenues of road pricing in mitigating measures. In an additional study new measures are further explored, with the idea to include them in a second version of the action plan (Akron et al., 2010). The suggested measures can be divided in three groups:

- Measures at the source: especially the idea of constructing quiet pavements when redesigning a road is relevant for the case E17/B401. The measure was taken in the renovation of the B401 viaduct. For the E17, this might be at stake in the 2020 maintenance works, together with quieter pavement joints.
- Mitigating measures for bottlenecks: the idea of revising the financing mechanism of noise barriers is explored, in which more attention is given to the subjective noise exposure. Also the idea of subsidizing acoustic isolation of individual houses is discussed. Both measures could be relevant for the case area of E17 and B401.
- Precautionary measures: the establishment of an assessment framework for residential developments in noise exposed areas is proposed, either for planning purposes and for assessing building permits. It would, for example, be able to impose sound isolation measures above certain exposure values. Such an assessment framework would be useful for new residential development in the E17/B401 area, but would not contribute to a solution for the current residents.

In 2016 the draft of the **second Flemish Action Plan on Traffic Noise** was published and subjected to public inquiry (Flemish Government, 2016b). This plan builds on the first plan but expands its scope with all roads having more than 3 million vehicle passages a year. The general goals of the first plan are repeated, but this time a general threshold of L_{den} = 70 dB is defined to prioritize actions. Based on this threshold and the most recent noise maps a new list of 86 bottleneck situations was made up. Roads were selected when at least 50 dwellings are exposed to L_{den} > 70 dB(A), in a buffer of 250 meter around 100 m road parts, and this for at least 10 adjacent road parts making up 1 km of road. The E17 was not selected through this method, which again is based on noise maps that do not include low-frequency impulse noise, and for the B401 only the last part closest to the city center is selected. Further, in contrast to the first plan, concrete new measures are presented:

- Quiet pavements will be constructed when renovating roads with many highly exposed houses along, following a much less strict criterion than for selecting bottlenecks.
- The list of 26 priority bottlenecks where noise barriers can be a solution will be further addressed.
- The selected 86 new priority locations will be examined, from 2016 on.

Nevertheless, a spatial planning noise assessment framework is not yet developed, nor regulations for (subsidizing) acoustic isolation.

Also at the level of urban agglomerations noise action plans had to be drawn up. The **first Noise Action Plan for the Ghent Agglomeration** (Flemish Government, 2011) was developed by LNE and the city of Ghent. Its structure is comparable to the Flemish Action Plan for Traffic Noise, with an overview of existing or planned measures and an exploration of new or adapted measures. These measures will be concretely defined in a second version of the plan (see further). With regard to the noise effect of highways, the plan recaptures largely the measures described in the Flemish action plan on traffic noise, with some additions. It is suggested, for example, to differentiate a spatial planning noise assessment framework between urban and rural areas, since there are less alternative quiet locations in urban areas. Another relevant idea in the Ghent agglomeration action plan is the proposal to expand the financing possibilities for noise barriers to acoustic isolation for individual houses. Such a measure would also be applicable in the study area of E17/B401.

This plan was followed by the **second Noise Action Plan for the Ghent Agglomeration** (Flemish Government, 2016a). It was again developed by LNE together with the city of Ghent. The measures that the city will take correspond to what is listed in the Ghent Local Noise Action Plan (6.4.1), with the major ambition of decreasing the noise level at all residences under L_{den} = 70 dB(A) by 2030. For the case of the E17 and B401 especially the actions of the Flemish Region are interesting, as they add to the measures of the Flemish Action Plans on traffic noise. A brief summary:

- Study of a sustainable and livable alternative for the E17 viaduct: according to the plan, the remaining lifespan of the viaduct is estimated at 25 to 30 years, so in 2040-2045 it should be replaced. In the meantime the Flemish government promises to experiment with new sound abatement techniques and conduct a study of alternatives.
- Noise abatement measures for the B401: the plan refers to the 2014 major maintenance works carried out by the Flemish Agency for Roads and Traffic, including noise abatement measures. The speed limit was reduced from 120 to 70 km/h, a ban on heavy vehicles was introduced and new types of quiet pavement and construction joints were used.
- Study of further speed reduction on the E17: this has already been studied, but according to the Flemish Agency for Roads and Traffic this would have few effect because of the large share of freight traffic.

During the public inquiry phase of the plan, the alderman of Environment of Ghent Tine Heyse called the Ghent citizens to file an official complaint against the plan. As such a powerful signal could be given to the Flemish government that the proposed measures are inadequate. Apart from 76 individual complaints, several groups filed a complaint, including the environmental associations Ghent Environmental Front (GMF) and Federation for a Better Environment (BBL)[25]. Their arguments were comparable and can be summarized as follows:

25 The full versions of the BBL and GMF complaint can be found here: http://www.gentsmilieufront.be/images/downloads/bezwaarschriften_en_memoranda/bezwaarschriften/20150731_bezwaarschrift_geluidsactieplan.pdf (GMF)

- The noise action plan is deemed vague and unclear. There is no clear timing on the actions nor planned budgets.
- The continued absence of a framework with legally binding noise limit values is denounced, illustrating the weak ambition of the noise action plans.
- The policy limit value of L_{den} = 70 dB(A) is deemed arbitrary, since also below L_{den} = 70 dB(A) more than 20% of people can be highly annoyed (see Figure 38).
- With regard to the E17 viaduct, they both want to divert heavy vehicles to the R4 as a temporary solution, awaiting a structural solution in the long term.
- They also consider it insufficient and arbitrary to assess noises exposure solely on the basis of a model. Noise varies during the year, according to weather conditions and traffic composition. Moreover, the E17 viaduct is considered a "normal" viaduct in the urban noise maps, while in fact its pavement joints produce an annoying low-frequency impulse noise. This specific kind of noise is not included in the noise maps.
- To finance measures both groups suggest using the revenues of the road toll for freight traffic, introduced in Flanders in 2016. They also stress that the city can opt to invest in noise barriers without financial support of the Flemish government.

In general, both complaints attributed much attention to the situation of the E17 viaduct, while there are many other bottlenecks in Ghent. It seems the lobbying of the residents' pressure group Viadukaduk has had its effect.
The complaints did not lead to substantial adaptations of the plan, which was finally approved in May 2016. In reply to the remarks about the future of the E17 viaduct, the plan keeps sticking to the lifespan of 25-30 years of the viaduct. The Flemish region stresses the maintenance works of 2018-2020, which should alleviate the nuisance of the construction joints significantly. The Flemish region also promises that, next to the existing procedures and priority lists, it will discuss an additional priority list together with the city of Ghent. Remarkably, the passage about conducting a study of alternatives was adapted, specifying that this is a long-term action.

Air quality

Regarding air quality, European legislation is also guiding Flemish policy, with the European Framework Directive on Air Quality (1996) and the more recent **Air Quality Directive 2008/50/EC**, updating the air quality limit values. These regulations oblige the member states to model and monitor air quality, draw up action plans and inform the population. The obligations were translated into the Flemish **Vlarem** legislation with limit values, alarm thresholds and action plans.

The **first Flemish NO_2 Air Quality plan** (Flemish Government, 2012) was part of the Flemish request for postponement to meet the European NO_2 standards. At that time in some measurement stations this standard was not yet met. The plan focuses particularly on mobility measures to reduce emissions, but also explores a few measures to reduce direct exposure along major roads. The construction of noise barriers is deemed a possible local solution to decrease exposure, as they would

dilute the exhaust gases at a greater height.[26] An integrated approach is advocated for, in which the policy domains of mobility and spatial planning take the aspect of air quality into account throughout all planning and project procedures.

While most air quality action plans focus on general measures at Flemish level or adaptation of the environmental regulations, the **Air Quality Action Plan for the Port and City of Ghent** (Flemish Government et al., 2016) is more relevant for the case area. It was devised because the European standards for PM_{10} are still not fully met at the measurement stations and because mobile measurements also indicate exceedences of NO_2 and elemental carbon values at specific locations. While most actions in the plan repeat actions from other policy fields (e.g. the Flemish noise action plans) and are related to mobility management in general, one specific action is new. The department of Environment, Nature and Energy LNE, together with the Flemish Agency for Roads and Traffic, promises to study optimization scenarios for speed limits along the E17 and R4 as a function of air quality and traffic flow. Studies will be carried out in the period 2016-2018 and a budget of 200,000 € is provided.
In general, the Flemish policy on air quality is mainly driven by European legislation and concentrates especially on achieving the European Standards. The existing action plans focus on general mobility measures and have few attention for location-specific bottlenecks and solutions.

6.4.3 Viadukaduk

An important third actor in the case of the E17 viaduct is the residents' pressure group "Viadukaduk", which emerged in 2013 and strives for a long-term solution for the nuisance caused by the E17 viaduct. The profile that is outlined hereafter is largely based on three sources:

- the Viadukaduk website: http://www.viadukaduk.be
- the inspiration paper "Participatie, de wol bij al het geblaat", published on the occasion of the inspiration day on Participation in the Flemish parliament on 9 December 2014 (Kortom et al., 2014)
- an interview with Viadukaduk's chairman Hans Verbeeck in the Ghent magazine "Dzjoef" (http://www.dzjoef.be/zon-viaduct-zou-niemand-nog-aanleggen)

In general
Viadukaduk does not call itself a protest group, but rather a residents' group that constructively wants to look for positive solutions, independently of political parties. The focus is always on dialogue, persuasion and well-founded ideas. They strive to be involved in the study and design process of a spatial alternative for the

26 Recent scientific research, however, suggests that noise barriers not always lead to a decrease of the air pollution exposure. Directly next to the road a reduction of pollution is likely, but at further distance pollutants settle out and air pollution levels increase again, compared to a situation without noise barriers (Ning et al., 2010).

E17 viaduct that will improve the livability of the neighborhood in the long term. They do not advocate for a specific solution, but adopt an open attitude. Viadukaduk claims to follow a triple approach. First, they inform themselves about the details of the situation (the construction joints, the noise exposure, technical difficulties, etc.), also by contacts with academics. Second, they engage with the political world. Third, they want to increase local support for an alternative.
The group is quite well organized, with a monthly meeting of a ten-person core group and a pool of about twenty volunteers that help set up actions. There are contacts with environmental associations, other residents' groups and also the experiences of former action groups in the neighborhood were incorporated. Since the end of 2015 they are a registered non-profit organization. However, they will continue to focus exclusively on the future of the viaduct.

History

Viadukaduk emerged in the course of 2013, when a few neighbors of the viaduct united to positively strive for a healthy environment. They started with a flyer, a Facebook page and a petition, and soon got some attention in local press. In 2014 contacts were being made with the city council and local politicians from all parties. The Ghent alderman for Mobility and Public Works Filip Watteeuw (Groen) was one of the first supporters. The city council of Ghent was soon in favor of the idea and in September 2014 the explicit request to study alternatives was included in a memorandum of the city council to the Flemish Government. In 2015 also contacts with Flemish representatives were made, such as Joris Vandenbroucke (sp.a), who brought the issue on the Flemish political agenda. Further in 2015 Viadukaduk set up a local measurement project with Ghent University, to monitor temporal variations in noise and air pollution exposure, and to raise local awareness.

Actions today

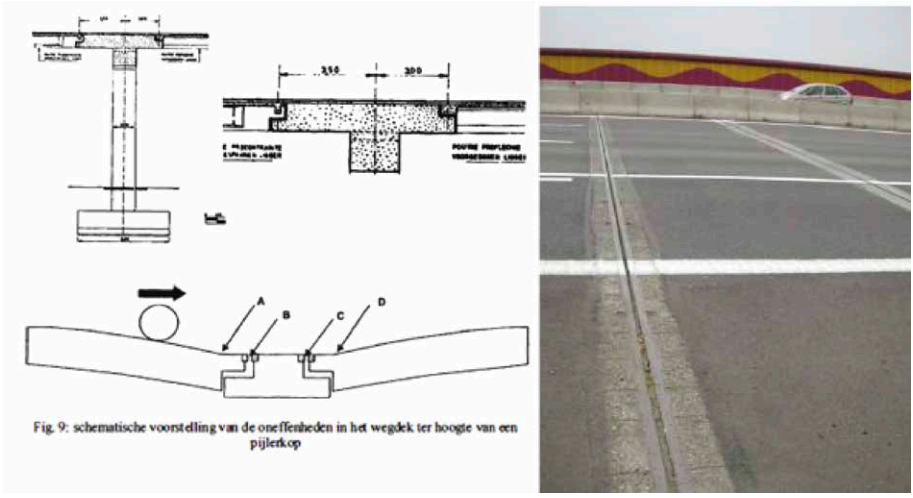
Until 2015 the focus was largely on making contacts with politicians and collecting information. The next step is creating broad public support in the neighborhood, which is not easy since there is a notable sense of resignation. According to Viadukaduk many residents are not aware of the negative impacts of air pollution and noise. Therefore, in the first half of 2016 a well-attended information evening and a successful street party – attended by the mayor – were organized.
The most difficult step, i.e. coming to an agreement with the Flemish government, is still ahead. Viadukaduk now focuses on the year 2020, when major maintenance works are planned. According to the Flemish Agency for Roads and Traffic, the viaduct can live for another 25 or 30 years if the works do not reveal major structural deficiencies. In contrast, Viadukaduk suggests to revise the future of the viaduct and to develop an alternative solution by 2020. However, they are aware of the tension between local politics and Flemish politics. The support from the Gent city council does not mean that much since the viaduct is administered by the Flemish region, with other political parties in charge. Moreover, the viaduct is part of a European connecting road that cannot easily be closed or diverted. The Flemish government will probably never transfer the authority to the city, in contrast to the case of the B401.

Analysis of the problem

On its website, Viadukaduk collects information and tries to focus on the problem by combining environmental data and European standards. According to Viadukaduk, in Gentbrugge and Ledeberg about 2,000 inhabitants are exposed to air pollution levels exceeding the European and WHO limit value of 40 µg/m³ (Figure 54). Moreover, they stress that this is not a safe limit and that also at lower concentrations adverse health effects have been found. Viadukaduk considers a risk area of 500 meters on both sides of the viaduct, in which about 7,500 citizens live, next to schools, daycare facilities, elderly homes, sports grounds, recreational grounds, and a newly designated urban green area.

With regard to air pollution, the urban noise maps for Ghent are addressed, which do not indicate a problem at the viaduct (Figure 55). However, the noise maps do not take low-frequency noise into account and it is this impulse noise – caused by the pavement joints – which is the major problem in Viadukaduk's opinion. They point to European documents that suggest to use different indicators for this kind of noise. The group also blames the absence of a legally binding framework for traffic noise exposure and looks to the Netherlands for inspiration, where a law on traffic noise has existed for more than 30 years, having a significant impact on urban planning.

Figure 82 Schemes and picture of the E17 viaduct construction joints (Source: website Viadukaduk, http://www.viadukaduk.be/)



Further, Viadukaduk describes the technical details of the construction joints of the E17 viaduct, which cause a large part of the annoyance (Figure 82). According to their information, the viaduct of Gentbrugge is in fact a girder bridge, with girders of 33 meter supporting a concrete plate, resting on abutments and piers. The "floating" concrete plates connect on the piers through expansion joints, which should be able to absorb motion and temperature variations. While this a very common way to build bridges, it is very uncommon for longer viaduct structures. In fact, the viaduct consists of a double row of 48 connected separate bridges. In addition, according to Viadukaduk the bridges bulge upwards, as the concrete would deform bearing the weight of the traffic. However, due to errors in the calculations this did not

happen, leaving a depression at every pier that produces a pounding noise when a wheel drives over a joint. Viadukaduk adds that when the construction joints were renovated in 2003, the old ones were replaced by iron joints, which are more durable but also produce more noise. Moreover, Viadukaduk thinks the opportunity was missed to remove half of the joints and only keep one joint for each pier. Thus, today there are still 192 iron construction joints (96 in each direction), which allow for a 5 to 10 dB increase of noise production, compared to a pavement without joints. Finally, the low-frequency pounding noise carries far because the viaduct construction radiates the noise underneath the noise walls.

Solutions

According to Viadukaduk, the actual speed restriction to 90 km/h only leads to a decrease in noise exposure of 1 to 2 decibels. Moreover, they regret that the 150,000 euros of annual revenues of the section speed control system are not invested in optimization of the viaduct. The current policy is thus deemed insufficient in tackling noise and air pollution exposure. The main question of Viadukaduk is to start up a study, which examines the exposure and annoyance, and explores different alternatives. They assume that by taking all costs and benefits into account, a renovation of the viaduct can never be the best possible solution.

Viadukaduk proposes three lines of thought:

- A first short-term idea is to divert freight transit traffic to the R4 (see Figure 52), by a system of intelligent traffic signs and dynamic steering to allocate vehicles based on their weight and destination.
- A second short-term idea is to reduce the noise by removing half of the construction joints and constructing new, quiet joints. On top of that a quiet pavement could be provided. Moreover, the missing part of the noise barriers could be completed to bring relief to the users of the neighboring allotment gardens and park area.
- In the long term a definitive solution could be to construct a tunnel or to cover the viaduct. This solution could be financed by smart road pricing for freight traffic, which was introduced on 1 January 2016 and would yield 250 to 500 million euros a year.

6.5 Today: possible solutions

In the review of recent events and the discussion of important stakeholders, several possible solutions were mentioned that can respond to the current environmental nuisance of the highways and viaducts of E17 and B401. Some solutions can be realized quite easily in the short term, while other solutions require years of study and negotiations. The following list tries to summarize the mentioned solutions.

E17 viaduct

Some solutions are at the infrastructural level and feasible in the short or medium term:

- Reconstruction of construction joints using a less noisy type (this is promised by AWV to be included in the 2020 maintenance works)

– Completion of noise barriers (there is still a missing part of about 500 meter)
– Construction of better noise barriers
– Construction of quiet pavement, at least in the right lane (this is promised by AWV to be included in the 2020 maintenance works)
– Acoustic isolation of individual houses, preferably with financial intervention of the government

A few solutions have a broader traffic management scope but are feasible in the medium term:
– Further speed reduction on the viaduct, e.g. to 70 km/h for heavy vehicles
– Diversion of freight traffic to the R4 ring road (see Figure 52). For this solution adaptations to the R4 are necessary and preferably also a new connection is realized north of the city.

Finally, some long-term solutions focus on radical change:
– Maintain the route, but construct a tunnel
– Maintain the route, but cover the viaduct
– Revise the route, possibly by upgrading the R4, which can make the E17 connection unnecessary

B401 viaduct

The viaduct was renovated recently and currently has a quiet pavement and pavement joints. The construction of noise barriers has never been proposed as a solution, possibly because of technical restrictions but reasons are unclear. Also mid-term traffic management solutions are not mentioned. All proposed solutions thus situate at the long term and reflect mainly the ambitions of the city, which considers the future of the viaduct almost a symbol of its sustainable urban and mobility policy.

A first concrete idea was suggested by Matthias De Clercq, currently first alderman of Ghent, in the 2012 pre-election period of the local elections. He proposed to close the final part of the B401 and to construct a tunnel to connect with the parking lot at Ghent Zuid, which had to be enlarged. The closed part of the B401 could then be demolished, or given a new destination as “infrastructural heritage”.

This car oriented solution was not adopted by the Ghent city council. Alderman for mobility Filip Watteeuw targets the efforts at halting the inward traffic at the urban ring road R40. As of 2015, three scenarios circulated:

– Scenario 1: the B401 ends in a new Park&Ride parking at the R40, the last part of the viaduct can be demolished facilitating an expansion of the Ghent Zuid park.
– Scenario 2: the viaduct remains but can only be used by outward traffic, inward traffic is directed to a Park&Ride building in Ledeberg.
– Scenario 3: only local traffic can continue using the B401, for visitors a new big Park&Ride parking will be built at the junction of the B401 with the E17.

6.6 Applying frameworks to case study

This chapter will be summarized by using the two theoretical frameworks described in 4.6. To analyze the environmental justice of the current situation, the

environmental justice claim-making framework is used. To analyze the current policy strategies, the matrix of planning strategies is applied to the case study.

6.6.1 Analysis of the current situation through an environmental justice framework

It was explained earlier that Walker (2012) adopts a practical approach to the concept of environmental justice by first of all decomposing it in three different definitions of justice, which can all be translated to the situation of the case E17/B401:

- First, there is *distributive justice*, the fair distribution of environmental goods and bads. In the case study this interpretation of justice is clearly at stake. One can question whether the particularly high exposure to air pollution and noise in the area is still just. In addition, also the aspects of vulnerability and responsibility can be taken into account.
- Second, there is *procedural justice*, the ways in which decisions are made, who is involved and has influence. In the case study this can be translated to issues like involvement of all actors in the policy processes, equal access to complaint procedures or the equal treatment of all citizens in the institutional or legal framework.
- Finally, there is *justice as recognition*, who is given respect and who is and isn't valued. Mostly this interpretation discusses the deeply rooted lower valuation of certain population groups. Translated to the case study, for example, lower socio-economic classes or renters could be given systematically (but not always intentionally) less attention, both by the government and by the citizen movements.

While all three interpretations are relevant and will be touched upon, it is foremost distributive justice which is at stake and which will receive most attention.

Further, Walker (2012) makes an important distinction between inequality and injustice, with inequality a descriptive term, describing a condition of difference or unevenness, and injustice a normative term, involving some form of judgment or claim. In the context of the case E17/B401, evidence on an unequal distribution of air pollution and noise in the area does not necessarily mean that this is an unjust situation that should be addressed. Therefore, underlying social structures, institutional context, histories, narratives and other situational factors have to be taken into account. In this chapter information was collected, but yet knowledge will always be incomplete and unanimous conclusions are unattainable. As said before, environmental justice is inevitably normative and political and thus everyone will make its own claim, linking evidence of a condition of inequality with a normative position on what is just or unjust. It then becomes interesting to analyze on what grounds, in what circumstances and for what reasons some claims are advocated and given more credit than others. This central aspect of claim-making is also clearly present when considering the history of protest and discussion about the

highways E17 and B401. Especially for the E17 viaduct citizen protest has had a big impact on the reduction of traffic noise, first by obtaining noise barriers, later by obtaining a reduction of the speed limit on the viaduct, and possibly in the future by reconstructing the pavement joints in the 2020 maintenance works. In the speed limit reduction, the local support of politicians was crucial. This poses the question why politicians followed the bottom-up voices at a certain point in time. The disputes on justice can even open up about both what constitutes reliable evidence and the degree to which injustice of some form can be "proven" to exist. Also this discussion on reliable evidence is at stake in the E17-case. The citizen movement Viadukaduk does not agree with the methodology of the noise and air pollution maps, and also contests the noise measurements of the Flemish government. This led to their decision to set up participatory local research to collect evidence themselves, which in turn is not considered valid by the Flemish government. Walker (2012) further explored the aspect of claim-making by discerning three different kinds of claims: claims about evidence, claims about justice and claims about process. By connecting them to the three different forms of justice, a claim-making matrix was developed that can be used as a framework to analyze situations of environmental quality (Table 9). On the one hand the statements of the different stakeholders can be placed in such a matrix, on the other hand also arguments and factual information put forward by the researcher (or planner) can be added. As they are at a different level, it is best to show a clear distinction between stakeholders' claims and the researcher's input when combining them in one matrix. Since at this point it is already clear that both highway contexts are totally different, they will be considered separately. Hereafter the developed matrix will be applied to the case of E17. Table 25 gives the summary of what will be discussed more extensively in the text. As for the case of B401 claim-making is not really at stake. There is no local pressure group working on it and environmental health is not really an issue in the discussions between city and region. However, in the next two chapters opinions of the neighboring citizens are gathered and then environmental health might come up again.

6.6.1.1 Case E17 – claims about evidence

In a concrete case study like the E17 there is a constantly evolving patchwork of pieces of evidence, a patchwork added to by a variety of actors for a diversity of reasons. Each of the actors has different motivations for committing resources to producing evidence and for focusing attention on particular dimensions of inequality. Also, there is great scope for critique and disagreement about what constitutes a "good" research design. In every quantitative analysis methodological choices are involved that shape the scope and form of the evidence claims that can be made and the knowledge that is generated. This is also visible in the case of the E17, where the road authorities defend themselves with noise measurements that show that there is no problem at all. Also the urban noise maps, which do not take low frequent, impulse noise into account, are a clear example of a claim about evidence by the Flemish Agency for Roads and Traffic, of representing reality in a certain way.

Walker indicates that the awareness of power relations in the production of evidence has led both activists and academics to call for and experiment with participatory, community-based research. This is exactly what the resident's pressure group Viadukaduk is focusing on today. They have started a measurement campaign themselves, to obtain a longitudinal image of the noise and air pollution, in contrast to the occasional measurements of the road authorities. As such this is a claim about evidence from the citizens.

From a researcher's (or planner's) perspective it can be confirmed that the models of air pollution and noise have some deficiencies. The air pollution maps are based on concentration levels at 1.5 meter above ground level, and thus underestimate the concentrations along the E17 viaduct. The noise maps do not take the low frequent impulse noise fully into account and thus undervalue the noise annoyance experienced by neighboring residents. In general, the models are only estimates of reality and do not take into account subjective aspects. It was discussed earlier that the health effects of air pollution and noise are far more complex than a simple standard or model can account for.
In their claims about evidence, all actors only focus on exposure in general, while also aspects of vulnerability and responsibility should be taken into account when setting policy priorities and whether or not recognizing citizen's protest as just. For example, the evaluation of neighborhood characteristics in 6.1.3 showed that some neighborhoods combine a high exposure with a high share of people of low socio-economic status (low income, unemployed, foreign origin) who are more vulnerable than others for the adverse effects. Same goes for the aspect of responsibility. Some make a deliberate choice to live in a highly exposed area, others end up in this neighborhood because it is the only option they can afford.

Finally, claims about evidence do not have to stick to quantitative terms. Conceiving justice as procedure and recognition asks for other forms of evidence that rely less on the analysis of large-scale data sets and more on particular cases, experiences and narratives. However, in the case there are not really separate claims on evidence of procedure, thus this box of the matrix is left empty. Also as a researcher there is nothing to add, the procedures and regulations itself are described in detail and publicly available. Concerning evidence in recognition the residents' group Viadukaduk and the city of Ghent sometimes complain to not be taken seriously by the Flemish government, which could be interpreted as a claim of evidence. Also in the construction phase claims about evidence of recognition were made, by the Gentbrugge politicians who felt largely disrespected by the national authorities that decided to construct a highway through their territory. While essentially claims about evidence, they inherently always involve a kind of judgment. Separating evidence and justice claims about recognition is not an easy task. From a researcher's perspective, it can be added that certain populations around the E17 might not be fully recognized, while exposure levels are at least as problematic. For example, the people living in Ledeberg bear the same exposure levels, but fall beyond the scope of Viadukaduk, which only focuses on the viaduct and not the other parts of the E17 route. Since the city supports Viadukaduk, they also indirectly fail to appreciate the situation in Ledeberg.

6.6.1.2 Case E17 – claims about justice

Today, for the distribution of air quality and noise often the principle of a right to a common minimum standard is used. This seems to make much sense and appeals in abstract logical terms, but Walker points to two significant deficiencies that also apply to the E17-case. First, the capacity of air quality and noise standards to take account of personal sensitivities and to protect the most vulnerable is a least uncertain, if not deeply constrained. Second, using standards and data assumes perfect knowledge of the real world variation in air quality and air pollution exposure. However, it is impossible to know the air quality and sound quality for each location at any time, as every way of monitoring or modeling represents a distortion of reality. These deficiencies are also applicable in the case study, where the government easily hides behind reductionist norms of noise and air quality, and therefore takes no action in case of the E17. At a more general level, the Flemish government even takes it one step further by refraining from defining general environmental quality norms for traffic noise. This demonstrates that these norms are rather based on political agreement then on evidence-based public health concern, which raises questions about their "justice". The residents' group Viadukaduk on the other hand uses another interpretation of justice of distribution, starting from their own subjective experience of exposure to noise and air pollution and collected information.
While the aspect of vulnerability is not touched upon in claims about distributive justice, the aspect of responsibility is. The Flemish government states that people who are living near the viaduct are at least partially responsible for their higher exposure. Their complaints are deemed invalid, because "who lives along a highway agrees to bear a higher exposure".

From a researcher's perspective the aspects of vulnerability and responsibility should be stressed. People with a weaker socio-economic status might have less choice of residence and are more susceptible to the impacts. It is an interesting question whether we should consider all people equally or give more priority to the more vulnerable ones. The same goes for the aspect of responsibility. Should we give priority to people who do not have a car and do not use the viaduct, or to people who do not have much choice of residence? Or should we treat all citizens equally? Also concerning procedures and recognition claims about justice are made. As for procedural justice, claims can be made about the just functioning of the institutional framework that causes or influences a situation of environmental pollution. As such, in the E17-case Viadukaduk together with the city claim that the financing procedures for installing noise barriers are not just. Viadukaduk and the city of Ghent also think they have not enough possibilities to engage in the planning and policy processes, which can be deemed a claim about justice of procedure. The researcher might add that other procedures used by the Flemish government are arbitrary as well e.g. the method to select priority zones for noise abatement measures. Finally, claims about justice of recognition are about the systematically, but not always intentionally, lower valuation of certain social groups. Both Viadukaduk and the city of Ghent do not feel fully recognized by the Flemish government. From a researcher's perspective the question can be added whether it is just that the city supports and recognizes the concerns of Viadukaduk, while there might be other much bigger problems that need recognition.

6.6.1.3 Case E17 – Claims about process

The Flemish government, the city of Ghent and the pressure group Viadukaduk do not make claims about process, about why the situation is like it is. This is particularly a field in which the researcher can provide factual information or valuable perspectives, for example by making an historical analysis of the situation.
When it comes to the origins of the higher exposure, the historical analysis showed that the viaduct was imposed by the Belgian government, in spite of vigorous local protest. The municipality even stressed the possible problems of noise and air pollution exposure, which was exceptional for that time. However, the urban fabric of Gentbrugge was disrupted by the construction of the viaduct and many expropriations were carried out. Concerning the aspects of vulnerability and responsibility, it does not seem to have been a deliberate choice to place a burden on certain weaker populations, but there is no clear information about that. Today at least, the different kinds of neighborhoods along the viaduct show that all socio-economic groups are affected.
When it is about the background of the current government policy, the analysis above shows that the Flemish government (and the city of Ghent to a lesser degree) sticks to path-dependent planning strategies. This will be further explained in 6.6.2.
Finally, to explain the (mis)recognition of certain populations and problems, in the E17-case the major explanation seems to be political. The city of Ghent might support Viadukaduk since it is not their responsibility to find a solution and can only gain credit by doing it. Moreover, it would not be politically productive to start recognizing a problem that is not yet recognized by the affected population (as might be the case in Ledeberg). As for the difficulties in the relation between the city and the region, again politics can explain a lot. Since different parties are in charge at city and regional level, the Flemish government might not like to hand out presents and keep its budget for other projects.

Figure 82 Schemes and picture of the E17 viaduct construction joints (Source: website Viadukaduk, http://www.viadukaduk.be/)

case E17	claims about evidence	claims about justice	claims about process
distributive justice: exposure	**Viadukaduk** "we are highly exposed to air pollution and noise, models and measurements do not represent the real situation" **Flemish government** "noise maps and measurements do not point to a very high exposure"	**Viadukaduk** "our high exposure is unfair and unjust, something has to change" **Flemish government** "there is no problem at all, the general air quality and noise standards protect every citizen equally"	
	Researcher *"the models are only estimates, they undervalue the exposure to air pollution and noise and do not take into account subjective aspects"*		***Researcher*** *"the viaduct was imposed by the Belgian government, in spite of vigorous local protest"*

case E17	claims about evidence	claims about justice	claims about process
distributive justice: vulnerability			
	Researcher *"weaker socio-economic groups are more vulnerable, it might be interesting to focus on their exposure"*	***Researcher*** *"weaker socio-economic groups are more vulnerable and might have less choice of residence, should we give them priority or should we treat all people equally?"*	***Researcher*** *"higher exposure of specific populations seems coincidental"*
distributive justice: responsibility		**Flemish government** "who lives along the viaduct is at least partially responsible for his or her own exposure"	
	Researcher *"people who don't drive a car are less responsible, it might be interesting to focus on their exposure"*	***Researcher*** *"people who don't drive a car might be less responsible for air pollution and noise, should we give them priority or should we treat all people equally?"*	***Researcher*** *"higher exposure of specific populations seems coincidental"*
procedural justice		**Viadukaduk and city** "the procedures of the Flemish government for installing noise barriers are not fair; we do not have enough possibilities to get involved in the decision process about the E17 viaduct"	
		Researcher *"also other procedures of the Flemish government are arbitrary, such as the selection method for noise abatement priority zones"*	***Researcher*** *"government sticks to path- dependent approach"*
justice as recognition	**Viadukaduk and city** "our complaints are not taken serious by the Flemish government"	**Viadukaduk and city** "we do not feel fully recognized by the Flemish government in our complaints and this is unfair"	
	Researcher *"are people from Ledeberg fully recognized?"*	***Researcher*** *"is it fair that this problem is recognized by the city, while there might be bigger problems that do not get attention?"*	***Researcher*** *"the playing field of politics defines which problems are recognized and which are not"*

The main conclusion of the environmental justice framework is that there is no unique truth, but different claims of how a situation could be seen and explained. These claims are connected to different actors involved in the case, influenced by spatial and temporal context. As a consequence there is not one right decision on the justice of a particular situation and the need to change it. Moreover, an important stakeholder is still missing in this framework: the citizen. In the next two chapters a survey will be carried out to gain representative citizens' claims on the environmental justice of the situation as well.
In addition to analyzing the environmental justice situation of the case also the used planning strategies are evaluated, which will be discussed next.

6.6.2 Analysis of planning strategies through the healthy planning matrix

By analyzing the case through the lens of the matrix of planning strategies, the currently used policy approaches can be assessed as well as the potential of other strategies for the future.

Path-dependent strategy
A large part of the current policy towards the E17/B401 highway infrastructure may be labeled as path-dependent. Especially the central government (the Flemish Region), driven by European legislation, adheres to this way of working. It focuses on generic regulations and standards, the writing of obligatory action plans for noise and air pollution, and procedures or algorithms to select priority zones without much flexibility. Some examples give an illustration:

- The Flemish road authorities use an algorithm with arbitrary limit values to select priority zones to invest for noise barriers or new road surfaces. Also the cost sharing between the Flemish Region and the municipality when a noise barrier is constructed is calculated by an algorithm. In both cases noise maps form the basis and subjective or contextual aspects are not included.
- By this financing mechanism of the road authorities, noise barriers can (partly) be financed, but other solutions like acoustic isolation of individual houses or using the spatial configuration of buildings as an acoustic barrier cannot receive any financial support.
- The European and the Flemish authorities try to turn the policy for air quality in a generic system with general thresholds. When these thresholds are met at all measurement stations a country passes the test, otherwise it can get a fine. Meeting the norms is thus seen as the aim, while a norm does not necessarily provide any health guarantee and the measurement stations might not be representative for the whole territory.
- Moreover, the drawing up of noise maps is conceived as generic. Contextual noise, such as the low frequent impulse noise caused by the joints of the E17 viaduct, is not taken into account.
- The city of Ghent adopts a generic policy target value of L_{den} = 70 dB(A) for all houses. This value is not based on health evidence, it does not leave room for specific adaptations according to spatial and social context and it does not allow

for setting priorities. It is rather a pragmatic, political benchmark instead of an illustration of true concern about the issue of noise exposure.
- The Flemish Region holds a very rigid vision on the lifetime of infrastructural constructions, while the further maintenance would probably cost more than investing in alternatives, even without taking possible public health costs into account.
- A lot of energy is put into the writing of action plans, announcing measures and research projects, but finally few of them come into effect. There is, for example, still no Flemish legislation on the maximum noise production of a highway, but only advisory reference values. It seems that some action plans are only written to meet the European standards, and not to effect practical change on the ground.

It can be concluded that this path-dependent strategy has positive aspects, such as the financing of noise walls when measurements point to a problem, but in general this planning strategy is insufficient and cannot keep up with the rapid developments in our urban society.

Collaborative strategy

Today collaborative planning strategies are not yet applied in the study area. However, with regard to the B401-viaduct the city of Ghent announced a participative process. But first the city will carry out a study into the spatial and mobility conditions and the different alternatives already formulated by them. With the outcome of the study in mind, the follow-up participative process would possibly leave few room for major adaptations to the preferred plan. At best already in the preparatory phase collaborative strategies are applied, involving all relevant stakeholders, among which independent experts and the citizens living near the highway (and not only the environmental movement). The collaborative process then should concentrate first on a common definition of the problem and the priority issues, also assessing the importance of environmental health. In the consequent exploration of future strategies can be negotiated about the level of environmental impacts that is acceptable, regardless of generic policy frameworks, norms and regulations, but with scientific input of experts in the field. With regard to the E17-viaduct collaborative strategies are not due to be introduced at the moment, but it might be a good idea to use this strategy when it is decided to carry out a study on alternatives.

Adaptive strategy

A good example of an adaptive planning strategy is the speed reduction that was introduced on the E17-viaduct. It is a local measure that was specifically taken because of the noise produced by the construction joints, departing from the usual speed limits on highways. There are not really other examples in the E17-case, even though it could provide opportunities. By using adaptive strategies special attention could be given to the specific pounding noise of the E17 viaduct, making it a priority in the Flemish noise policy plans. Also the acoustic isolation of individual houses or apartments, supported by the city or the Flemish government, would fit in an adaptive planning strategy. When the wider context of both highways is taken into account, more arguments pop up that ask for an urgent redevelopment of the area, before the viaducts' "lifetime" ends. Both viaducts put a barrier on further urban

development, and their surroundings do not only contain many residential dwellings but also recreational areas, schools and parks. Finally, the history of the viaduct reveals that most of the surrounding neighborhoods existed already when the viaducts were realized, which is one more environmental justice argument to search for adaptive solutions or an overall alternative.

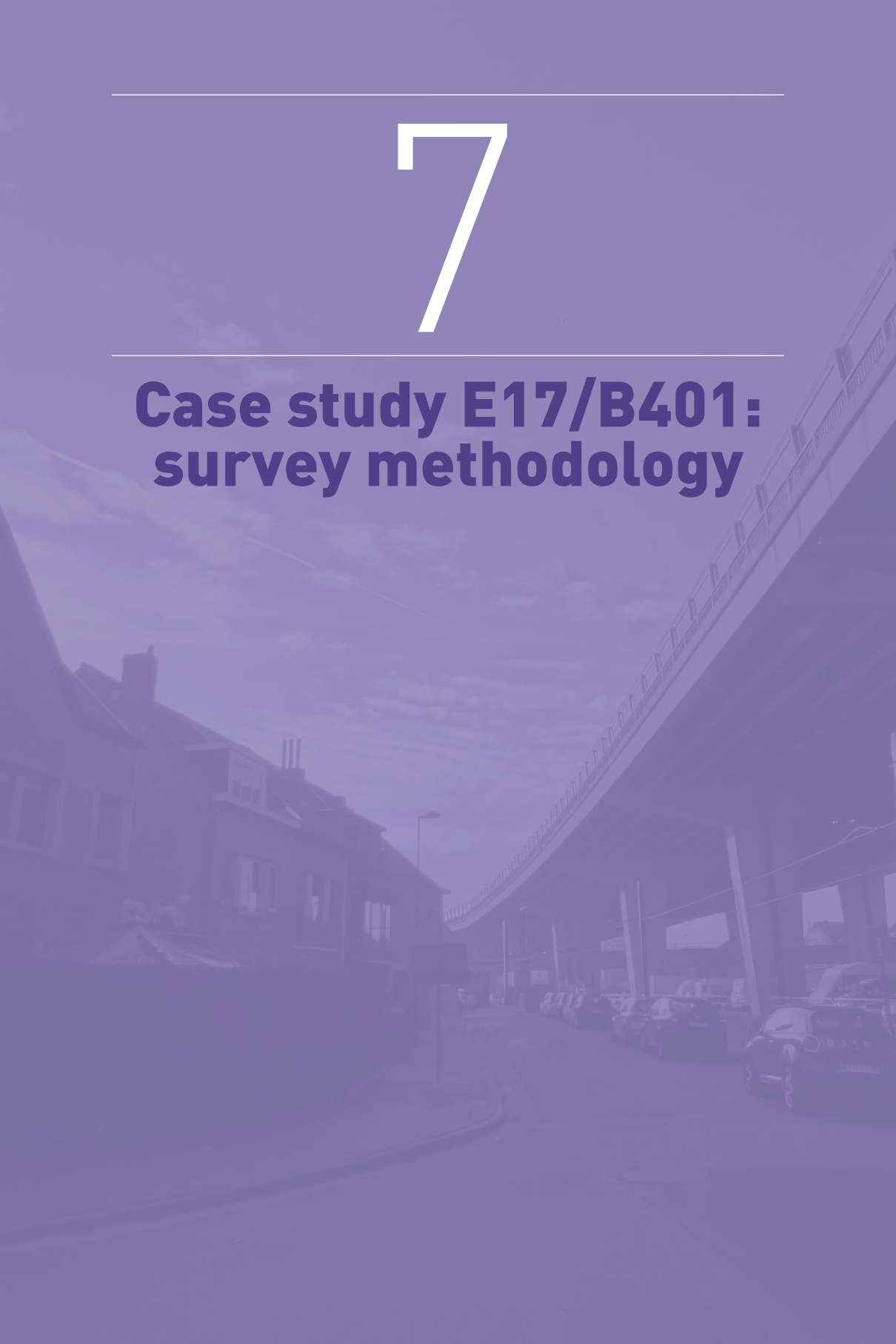
Co-evolutionary strategy

In the case, the actions of Viadukaduk can be seen as an attempt to co-evolutionary planning strategies. Viadukaduk is a group of citizens that spontaneously originated out of mutual concern about the living environment. They started to collect information, to contact politicians and to formulate new ideas because they felt a sense of urgency and considered the current policy framework inadequate. In the discussions, Viadukaduk takes a constructive position and does not have a specific solution in mind. They only want to put the problem on the policy agenda and to insist on research for alternatives. A group of citizens that collectively wants to take action can yield valuable input for the government. Today the city of Ghent is open to this citizens' initiative, but both parties are constrained by the Flemish government that sticks to fixed procedures, decided policy and the "lifetime" of its infrastructure works. The Flemish government has never been really open to constructive discussion on the issue, causing the citizens' initiative and the seeds of a co-evolutionary strategy to end in an impasse. There is need for further experiment to know whether a co-evolutionary strategy could contribute to a solution and whether the common interest and spatial justice would be safeguarded in this approach. It definitely also needs further exploration to check who feels represented by the limited group of citizens in these kind of residents' groups.

In summary, it seems path-dependent strategies are still dominant in the case area today, together with attempts to collaborative strategies, individual examples of adaptive strategies and emerging opportunities of co-evolutionary strategies. However, one of the most important actors has not been considered yet, the population living near both viaducts. To evaluate the environmental justice of the current situation and to assess the feasibility of planning strategies, their opinion is of utmost importance. Therefore, in the next chapter a survey methodology will be designed in order to gain their views and make a more accurate evaluation.

7

Case study E17/B401: survey methodology



To understand citizens' claims on the environmental justice of the situation and to assess their support for different planning strategies, a survey was carried out among residents living next to the highways and viaducts of E17 and B401. The aim was to obtain representative results on the scale of the whole case area. To compare the results of different neighborhoods within the case area (e.g. those around the E17 with those around the B401) or of different subpopulations, the survey yields only indicative results, because of logistical and organizational constraints.
Hereafter the survey methodology is described in detail, followed by a report of the survey campaign and an evaluation of the sample. In the next chapter the results of the survey are reported.
In the design of the survey important methodological decisions had to be made. Therefore, the different steps were used that Saris and Gallhofer described (2014). In addition, the methodology used by the city of Ghent to conduct the Livability Survey (see 5.4.3) guided the design of the survey (WES vzw, 2014).

7.1 Topic

The first step in designing a survey is defining the topic. The survey, which has both a descriptive and an explanatory purpose, wanted to collect information on two topics:

1. Current situation

The first part of the survey is about the perception of respondents on noise and air pollution exposure in their neighborhood, whether they think the distribution of exposure is just or not and how they feel about the existing procedures. While most questions target the specific situation of the respondents, some questions consider the general attitude towards environmental justice.

2. Planning strategies

The second part of the survey is about the opinion of respondents on different planning strategies to deal with the situation, and their personal engagement. Again most questions are on the current situation of the respondents, but some have a broader scope.

7.2 Most important variables

The second step in survey design is specifying the dimensions and variables that are used to assess the topic. The dimensions of the first topic follow the environmental justice framework, described in 4.6.1. The dimensions of the second topic follow the matrix of planning strategies, developed in 4.6.2. In addition, also general questions to collect background variables were included.

7.2.1 Current situation

The environmental justice framework defines three forms of justice: *distributive justice*, *procedural justice* and *justice as recognition*. In addition, three kinds of claims are discerned: *claims about evidence*, *claims about justice* and *claims about process.*
The survey focuses especially on distributive justice, since this is a key issue in environmental justice discussions and the simplest aspect to ask questions about to a diverse public. The survey tries to get insight in residents' claims about evidence and justice of distribution. For the aspect of claims about process information was gathered but it is the researcher who interprets this aspect.
For the dimensions of procedural justice and justice as recognition only claims about evidence were questioned. The justice and process related aspects of these dimensions are too difficult to enquire in an accessible survey. In summary, following dimensions remained, with a short description of the application in the survey:

1. Distributive justice – evidence
   - Main questions: What do respondents think about their exposure to air pollution and noise, and the effects on their health?
2. Distributive justice – justice
   - Main questions: What do respondents think about the justice of the unequally high exposure around both highways? And more generally, what is a fair distribution?
3. Distributive justice – process
   - Main questions: What are the reasons why some people are more exposed than others? Is it coincidental or do certain mechanisms play a role, such as house prices?
4. Procedural justice – evidence
   - Main question: How do respondents evaluate the access to procedures and the institutional framework?
5. Justice as recognition – evidence
   - Main questions: Do respondents feel recognized by the government, pressure groups or other societal actors?

7.2.2 Planning strategies

The second part of the survey focused on exploring the feasibility of and support for different planning strategies, related to the situation of the E17/B401 and in general. Also the role that respondents want to play in these strategies was assessed. The previously discussed strategies formed the dimensions: *path-dependent strategy*, *collaborative strategy*, *adaptive strategy* and *co-evolutionary strategy*. The aims and main questions of the different dimensions are as follows:

1. Path-dependent strategy
   - Main questions: Are respondents satisfied with the government policies and do they think it is just?

2. Collaborative strategy
   - Main questions: Do respondents think that more participation is needed, would this lead to fair outcomes and would they take up a role in this?
3. Adaptive strategy
   - Main questions: What kind of adaptive measures are favored by the respondents and would they take mitigating measures themselves?
4. Co-evolutionary strategy
   - Main questions: What do respondents think about spontaneous citizen initiatives and their fairness?

7.2.3 General questions

In addition to assessing the different key dimensions, some general questions were included in the survey. As such background information was gathered that can be used as explanatory variables, because different groups might have different opinions on the dimensions above. The explanatory variables are as follows:

- Demographic variables: sex, age, nationality and origin, language, household composition
- Socio-economic variables: educational level, employment status, income
- Health variables: subjective health
- Housing variables: housing typology, length of residence, ownership

7.2.4 External data

Finally, other available spatial data were used as explanatory variables. These data were linked with the respondents based on their residential address location. The used data include the air pollution and noise models mentioned in 5.4 and the calculated nearest distance to the highway.

7.3 Operationalization

In the next step the dimensions and variables were translated to survey questions. The design of the questionnaire tries to follow the different dimensions defined above as much as possible. In Appendix A1, Appendix A2 and Appendix A3 the full version of the ten page survey can be found in Dutch, English and French respectively. In Table 26 the composition of the questionnaire and the relation with the dimensions defined in 7.2 are briefly discussed. In addition to the questions on page 2 to 9, the first page of the survey describes some instructions to complete the survey, while the last page leaves room for extra comments and shows an application form for an additional interview.

Table 26 Relation of survey parts with dimensions defined in 7.2.

Part	Title	Content	Dimension (see 7.2)
1	Current situation: nuisance	Questions on perceived exposure of air pollution and noise and relation with health effects	Distributive justice: evidence
2	Current situation: justice	Questions on fairness of the unequal exposure to environmental impacts, in relation to the case study and in general	Distributive justice: justice
3	Current situation: housing and moving house	Questions on housing characteristics and trajectories (which might explain perceived inequalities)	Distributive justice: process
4	Current situation: complaints	Questions on making complaints, knowledge of institutional framework and recognition	Procedural justice Justice as recognition
5	Policy strategies: government	Questions on the fairness of the government (including recognition), trust in the government and knowledge on government policies	Justice as recognition Path-dependent strategy
6	Policy strategies: participation	Questions on appreciation and fairness of participation and personal engagement	Collaborative strategy
7	Policy strategies: mitigation measures	Questions on preferred adaptive solutions at neighborhood level and home level	Adaptive strategy
8	Policy strategies: societal actors	Questions on appreciation of different societal actors and the fairness to include them in policymaking	Justice as recognition Co-evolutionary strategy
9	General questions: you and your family	Questions on demography, nationality, origin and language	General questions
10	General questions: your education, employment and income	Questions on education, employment and income	General questions
11	General questions: your mobility and your health	Questions on mobility preferences and health	General questions

7.4 Test of the quality of the questionnaire

The final questionnaire is the result of a long process of getting feedback and adjusting the questions.

– On 9 October 2015 a first version of the questionnaire was presented to an advisory group consisting of Ms Els Bauwens (City of Ghent, Department of Data and Information), Mr Filip Van de Velde (City of Ghent, Department of Coordination, project officer B401 redevelopment), Ms Inge De Roose (City of Ghent, Department of Community, Welfare and Health), Mr Hans Verbeeck and Mr Jef Geldof (E17 resident's pressure group Viadukaduk) and Prof Luuk Boelens (supervisor).

- In the weeks after, more detailed feedback was received through e-mail from several Departments of the City of Ghent: the Environmental Department (Ms France Raulo), the Department of Coordination (Mr Filip Van de Velde), the Department of Data and Information (Ms Els Bauwens and colleagues) and the Department of Community, Welfare and Health (Ms Inge De Roose and Ms Jasmien Pauwels).
- After making adjustments based on the comments raised, in January 2016 a modified version of the questionnaire was tested in a pilot study with six residents living in the case area. Three of the six persons were selected from the researcher's network, three others were selected with help from residents' group Viadukaduk. All participants received the questionnaire through e-mail. Afterwards an individual evaluation interview was conducted, in which aspects of clarity, consistency, terminology and required time were discussed. The six interviews are listed in Table 27.

Table 27 Evaluation interviews survey pilot study

Interview date	Address	Birth year	Sex
5/01/2016	Jozef Vervaenestraat, Ledeberg	1986	V
6/01/2016	Jozef Wautersstraat, Gentbrugge	1952	V
6/01/2016	Henri Pirennelaan, Gentbrugge	1974	M
7/01/2016	Hubert Frère-Orbanlaan, Gent	1990	M
7/01/2016	Ledebergstraat, Ledeberg	1986	V
8/01/2016	Hippoliet Persoonsstraat, Gentbrugge	1963	M

- After conducting the evaluation interviews, the questions were adapted again. As a final check the questionnaire was evaluated by a colleague with expertise in survey research. The final questionnaire (and accompanying letter) was available at the end of January 2016.

7.5 Data collection method

The next step was the choice of a data collection method. The decisions made are loosely based on the methodology used in the Livability Survey carried out by the city of Ghent (WES vzw, 2014). It was decided to contact the respondents by mail with a printed survey, with the possibility to complete the survey online through LimeSurvey software. A translation of the survey in French, English or Turkish could be requested. To increase the response rate some non-response measures were taken.

7.5.1 Survey campaign

All sampled citizens received an envelope between 5 and 11 February 2016, containing four documents:

- A ten page questionnaire in Dutch (see Appendix A1)
- A two page accompanying letter (see Appendix B1)
- A free return envelope
- An application for receipt of the letter and questionnaire in English, French or Turkish (see Appendix C)

The questionnaires were anonymous. However, by putting a code on each printed survey, which could also be used for logging in on the online survey, the answers of each respondent could be linked with the sampled citizen and address. This allowed for keeping track of response rate and spatial analysis of responses afterwards. After three weeks, at the end of February 2016, all sampled citizens who did not reply received a reminder in Dutch and English (see Appendix D1).
In the beginning of April 2016 the target number of responses was not yet met. Thus, a second reminder in Dutch and English was sent to all sampled citizens between 18 and 35 years who did not reply, since the response rate in this age group was the lowest (see Appendix D2).

7.5.2 Translation of survey

The possibility was offered to the sampled citizens to request a French, English or Turkish version of the questionnaire, by filling in an application. Seven requests were received for a French version of the questionnaire, seven for an English version and one for a Turkish version. Because of financial constraints the questionnaire was only translated into French and English. The person who asked for a Turkish version was offered the possibility to fill in an English version. The translation of the questionnaire and accompanying letter into French and English was done by the researcher and proofread by colleagues.

7.5.3 Non-response measures

Almost inevitably, carrying out a survey leads to a certain non-response bias, an error occurring when some people included in the sample do not respond. This form of bias occurs when a sampled person cannot be reached (e.g. because he/she is not at home), when a sampled person does not want to participate, or when a sampled person is not capable to complete the survey (e.g. because of physical, intellectual or language constraints).
While almost impossible to eliminate completely, there are a few ways to ensure that non-response bias is avoided as much as possible. Based on the work of Dillman (1978) and the methodology used in the City of Ghent Livability Monitor survey (WES vzw, 2014), the following measures were taken to increase response rates:

- Providing the possibility of completing the survey online.
- Providing the possibility to request a translated version of the survey.
- Adding an official personalized persuasive letter with clear reference to Ghent University, including the contact details of the researcher.

– Offering an incentive, by way of raffling 10 Fnac vouchers of 20 € among the participants.
– Sending a reminder after three weeks and a targeted second reminder to the group of young adults (ages 18-35 years).
– Follow-up of potential respondents:
  • Sending a reminder to persons who requested a translated version of the questionnaire but did not return it.
  • Sending a reminder to persons who asked a question by email but did not participate afterwards.
  • Sending a reminder to respondents that only completed the online survey partially.

7.6 Population and sample design

An important step in setting up a survey is defining the population on which will be reported. After that, usually a form of sampling, based on a sampling frame, is used to describe this population. Since generally there is some non-response, the final group of respondents will differ again from the sample. In the different steps from defining the target population to obtaining the final group of respondents, important decisions are made, each causing some error. Below the choices in the sample design are explained.

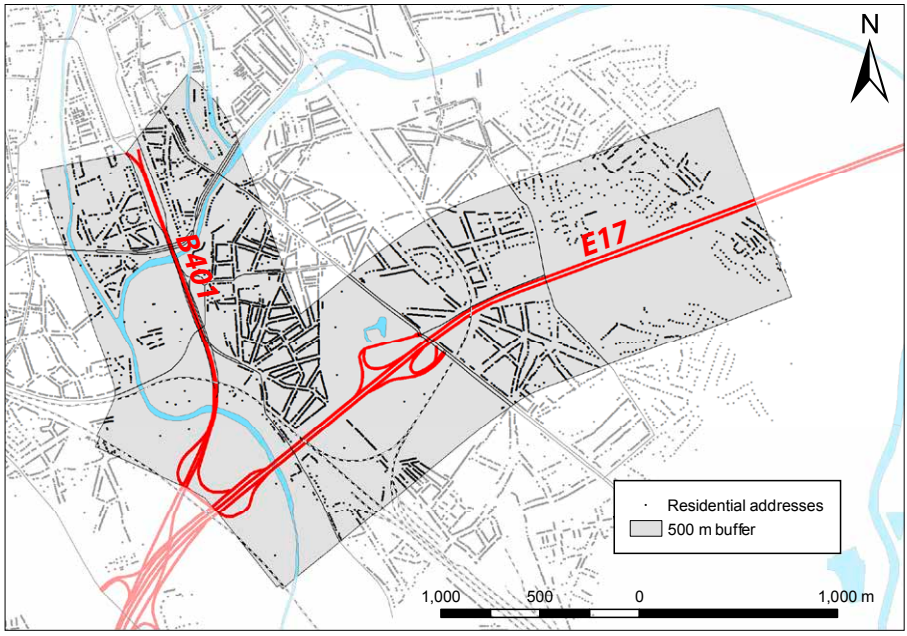
1. *Choice of target population*

– Definition: This is the population that will be reported on.
– Application to the survey: In the survey it was defined as *all citizens living within* **500 meters of two stretches of the highways E17 and B401** (Figure 83). The highway stretch of the B401 runs from the Zuidpark in the inner city up to the connection with the E17. The highway stretch of the E17 runs from this connector up to the end of the E17 viaduct. The two highway stretches contain the two viaducts, but also other parts.

2. *Choice of sampling frame*

– Definition: The sampling frame is a method to approach the target population as good as possible, for example by using a list of addresses or names.
– Application to the survey: In the survey the sampling frame was defined by using the population register, restricted to adults between 18 and 79 years old. Thus, only citizens who are officially registered as a resident in Ghent were included. The specific (large) group of students who are not officially registered was not taken into account.
– Error: The choice of a sampling frame presents a coverage error, since not the whole target population is part of the sampling frame.
– Numbers: Within the case area 20,328 citizens were officially registered at the moment of sampling (January 2016), among which 3,579 citizens younger than 18 years, 1,167 citizens of 80 years or older, and **15,582 citizens in the age group of 18 to 79 years**.

Figure 83 Location case area and residential addresses



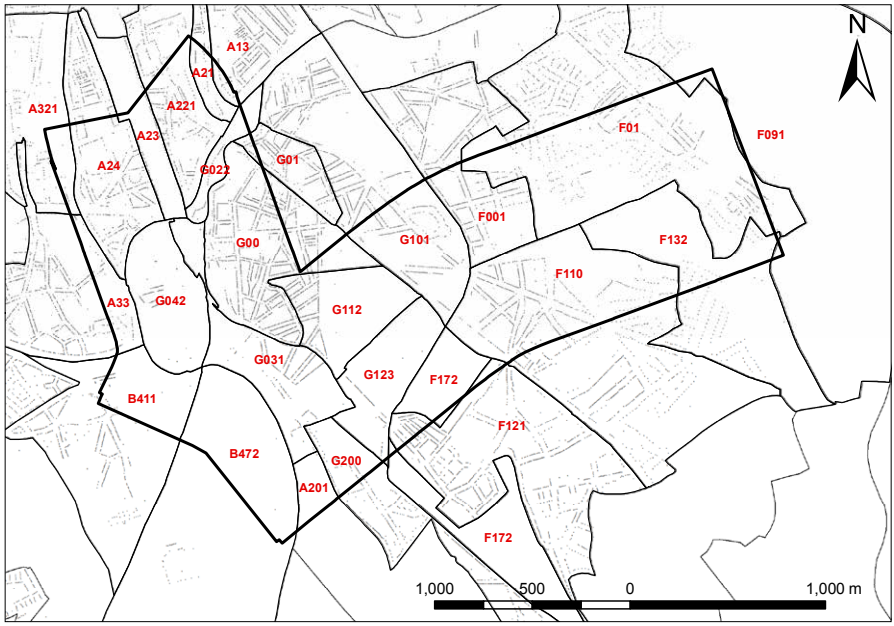
3. Choice of sampling procedure

- Definition: This is the way in which a sample is drawn from the population, using the sampling frame.
- Application to the survey: In the survey **stratified random sampling** was applied. The **strata were based on statistical sector and age**, to allow for a good spatial and social distribution of invited citizens (and thus respondents). In addition, only one person per household could be selected, in order to have maximum variation at the household level. Besides his own ideas, preferences and values, a person also represents the ideas, preferences and values of his family.
- Error: The choice of a sampling procedure presents a sampling error, since no form of sampling is neutral and unambiguous.
- Numbers: To reach the standard confidence level of 95% and confidence interval of 5%, **at least 375 respondents were needed**. As a response rate of about 30 to 40% was expected (based on the Ghent Livability Monitor survey campaign), it was decided to send 1,000 invitations to participate. Because of some rounding of numbers in the sampling for each stratum, the final number of invitations sent was 1,003. Concrete numbers of sampled persons for each stratum can be found in Table 28, with location of the statistical sectors represented in Figure 84. The stratified sampling took place in January 2016.

Table 28 Stratified sampling with strata based on statistical sector and age group, with the population register as sampling frame

Statistical sector		TOTAL (within 500 m buffer)							SAMPLE						
Code	Name	18-24	25-34	35-44	45-54	55-64	64-79	Total 18-79	18-24	25-34	35-44	45-54	55-64	65-79	Total 18-79
A13	HEERNIS	9	30	17	13	23	12	104	1	2	1	1	1	1	7
A201	FLORA	1	1	0	1	1	0	4	0	0	0	0	0	0	0
A21	VISSERIJ	23	69	28	46	44	42	252	1	4	2	3	3	3	16
A221	BRUSSELSE POORT	158	370	201	136	98	114	1,077	10	24	13	9	6	7	69
A23	ZUIDPARK	85	310	129	90	103	187	904	5	20	8	6	7	12	58
A24	DIERENTUIN	215	590	242	175	146	184	1,552	14	38	16	11	9	12	100
A321	SINT-PIETERS	155	334	50	12	9	2	562	10	21	3	1	1	0	36
A33	HEUVELPOORT	26	37	34	44	36	15	192	2	2	2	3	2	1	12
B411	OTTERGEMSE DRIES	8	20	13	15	16	11	83	1	1	1	1	1	1	6
B472	GROOT-HANDELS-MARKT	0	3	0	0	0	0	3	0	0	0	0	0	0	0
F001	GENTBRUGGE-CENTRUM	73	134	148	126	115	114	710	5	9	9	8	7	7	45
F01	DRIES	143	143	175	261	183	240	1,145	9	9	11	17	12	15	73
F091	ZWARTE FLES	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F110	SPORTPLEIN	176	269	293	263	283	256	1,540	11	17	19	17	18	16	98
F121	VOGELHOEK	20	71	53	40	22	30	236	1	5	3	3	1	2	15
F132	CONINX-DONK	10	0	15	19	12	9	65	1	0	1	1	1	1	5
F172	ARSENAAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G00	LEDEBERG-CENTRUM	343	894	643	483	386	351	3,100	22	57	41	31	25	23	199
G01	FLORA	10	28	8	13	9	12	80	1	2	1	1	1	1	7
G022	KEIZERS-PARK	13	77	40	26	38	49	243	1	5	3	2	2	3	16
G031	EINDEKE	99	269	174	161	126	113	942	6	17	11	10	8	7	59
G042	BELLE VUE	88	214	87	118	111	167	785	6	14	6	8	7	11	52
G101	L.VAN HOUTTE-BUURT (ST-ANTONIUS)	61	166	142	130	86	114	699	4	11	9	8	6	7	45
G112	DE NAEYER-DREEF	98	244	196	142	106	106	892	6	16	13	9	7	7	58
G123	MOSCOU	15	36	27	14	17	21	130	1	2	2	1	1	1	8
G200	MERELBEKE STATION	22	73	45	41	42	59	282	1	5	3	3	3	4	19
TOTALS								**15,582**	119	281	178	154	129	142	**1,003**

Figure 84 Location and code of statistical sectors falling at least partly within the 500 buffer area



4. Respondents

– Definition: These are the final participants in the survey.
– Numbers: After sending the first letter (with the questionnaire) a general reminder and a specific reminder to the young adults (ages 18-35 years), **a total response of 399 respondents** was reached, corresponding to a response rate of 39.8%. Thus, the scientific requirements of 95% confidence level and 5% confidence interval are met.
– Error: The step from sample to respondents presents a non-response error (see 7.5.3).

7.7 Processing of results and statistical analysis

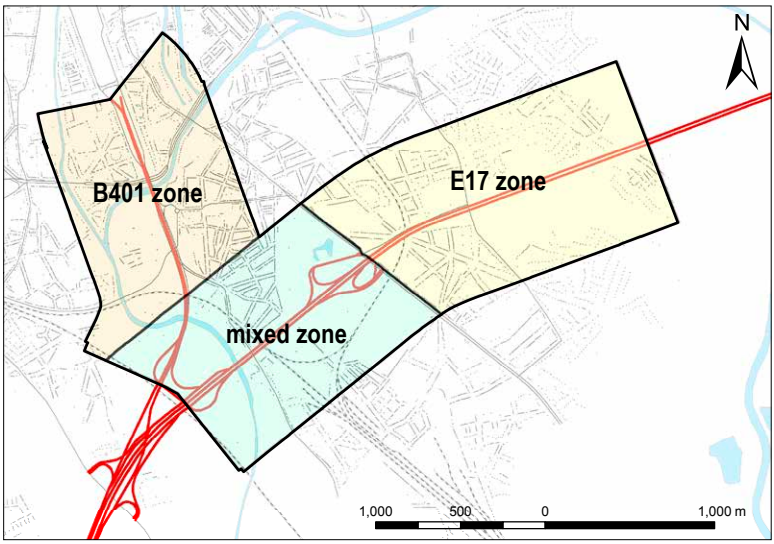
In the next chapter the results of the survey are reported, following the nine discussed dimensions. IBM SPSS Statistics 22 was used to carry out the statistical analysis.

First, univariate results were calculated for all survey questions, yielding representative findings for the case area as a whole. Since the previous chapter showed that the situation of the E17 is different from the situation of the B401, also separate results for three different zones were calculated (Figure 85):

1. E17 zone: a 500 m zone around the E17 viaduct, ending at the Brusselsesteenweg (beginning of the viaduct)
2. B401 zone: a 500 m zone around the B401 viaduct, which does not overlap with the 500 m zone around the E17
3. mixed zone: a 500 m zone around the less contested sections of the E17, partly within 500 m of the B401 as well

The presented results for the different zones are only indicative, since the statistical requirements for representativeness are not met at zone level. When relevant the significance of the differences between the zones was assessed, again only indicative for differences at population level.
For categorical questions the significance of a difference was assessed with cross tabulations and a Chi-Square test, followed by an evaluation of adjusted standardized residuals to find the abnormal values. By convention, this means that the standardized residual should be higher than 2.0 or lower than -2.0. These cells were marked in the cross tabulations. For questions with continuous answers a one way ANOVA was applied with Multiple Comparisons and post-hoc Tukey test to check for differences between the three zones.

Figure 85 Definition of three different zones in the case area



Second, bivariate analyses were carried out for following combinations of data:
- Combinations of different questions on the main dimensions of the survey
- Combinations of questions on the main dimensions of the survey with background variables collected in the general questions
- Combinations of questions on the main dimensions of the survey with linked spatial data (i.e. distance to nearest highway, exposure values for air pollution and noise)

Depending on the type of variables other statistical tests were carried out:
- If both variables are continuous or ordinal: Spearman's rank correlation
- If one of the two variables is ordinal/continuous and the other is binary: Mann Whitney U test
- If both variables are binary: Chi Square test

Correlations were evaluated following the convention in social research. This means a coefficient less than 0.1 is not considered relevant, a value of 0.1 is considered small, a value of 0.3 medium and a value of 0.5 large (Cohen, 1988).

7.8 Analysis of respondents

7.8.1 In general

1,003 citizens were invited to participate (Table 29), yielding 399 valid responses, representing a response rate of 39.8%.
604 invited persons did not complete the survey, or not in a valid way, and were defined as the non-response group. Twenty of them could not be reached because of several reasons: they no longer lived at the address, were deceased in the meantime or reported that they did not want to participate. Two persons requested a translated version but did not return it. Four persons completed the survey after the final deadline of May 1 and were excluded (of which one completed a translated version of the survey). Seven surveys were completed by a family member of the addressed person. For six of these cases the population register data in the sample were adapted accordingly (age, sex and nationality). In one of the seven cases the survey was completed by a family member with an age falling outside the sampling frame and this survey was therefore considered invalid. Of 577 of the invited persons no reaction at all was received.
Of the 399 valid respondents, 104 completed the survey online and 295 on paper. The high response on paper can be due to the fact that a paper version of the survey was included in the first mailing, as well as a free return envelope. Moreover, the stratified sampling leads to a large group of persons of older age who might feel more comfortable with a survey on paper.
The majority of respondents completed a Dutch version of the survey (388 respondents). Six people completed a French version and five an English version.

Table 29 Overview of response in survey campaign

	n	%
Total of invited citizens	1,003	100
Valid responses	**399**	**39.8**
of which		
completed online	*104*	*26.1*
completed on paper	*295*	*73.9*
of which		
Dutch version	*388*	*97.2*
French version	*6*	*1.5*
English version	*5*	*1.3*
Non-response	**604**	**60.2**
of which		
invited person could not be reached	*20*	*3.3*
survey was completed after the final deadline	*4*	*0.7*
translated version of the survey was not returned	*2*	*0.3*
respondent outside the sampling frame	*1*	*0.2*
no reaction	*577*	*95.5*

7.8.2 Response rate by sex, age, statistical sector and nationality

To get a better idea of the composition of the respondents, the response rates for specific subpopulations are analyzed. Therefore, the sample of 1,003 invited persons is considered. In 7.8.3 is looked into the representativeness of the group of respondents, compared to the target population.

Sex

The response rates for men and women are comparable, with a slightly higher response rate among women (Table 30). The table also shows that far more women than men were sampled. Since no stratification for sex was applied, it is unclear whether this uneven distribution is representative for the target population.

Table 30 Response rate by sex

Sex	Invited	Response	
	n	n	%
male	387	146	*37.7*
female	616	253	*41.1*
Total	1,003	399	*39.8*

Age

In relation to the age of the respondents there are more remarkable differences in response rate (Table 31). The highest response rate can be found among the groups of 55- to 64-year-olds and 65- to 79-year-olds, probably because this age group has more free time and because they may have a stronger connection with their neighborhood. The response rate in the groups of 35- to 44-year-olds and 45- to 54-year-olds are just below the average response rate and the response rate for 25- to 34-year-olds are only a few percentage points lower. Only for the 18- to 24-year-olds the response rate is considerably lower. Various elements can explain this. Some 18- to 24-year-olds might still live with their parents and have not made a choice of residence yet, leading to a lack of interest to participate. It is also possible that some only have their domicile at the address, but live somewhere else in a student's room.

Table 31 Response rate by age group

Age group	Invited	Response	
	n	n	%
18-24	119	26	*21.8*
25-34	281	103	*36.7*
35-44	178	69	*38.8*
45-54	154	60	*39.0*
55-64	129	67	*51.9*
64-79	142	74	*52.1*
Total	1,003	399	*39.8*

Statistical sector

If the spatial distribution of the response is analyzed, large differences appear between the neighborhoods (or statistical sectors) (Table 32). The response rate varies between 13.9% in the sector Sint-Pieters and 57.1% in the sectors Flora and Heernis.

The low response rate in the sector Sint-Pieters can be explained by the large group of foreign people among the 36 invited persons, who are official registered at student homes in this sector, but who actually no longer live there (which appeared after on-site verification). For the other two low response rates, in the sector Brusselse Poort and Vogelhoek, there is no obvious explanation, which might indicate a lack of interest.

The high response rate in the sectors Flora and Heernis is influenced by the very low number of invited persons in these sectors, seven in both cases, and the relatively big impact one respondent thus can have on the response rate. Among the sectors with more invited persons, particularly the sectors Gentbrugge-Centrum (25 respondents to 45 invitees) and Sportplein (53 respondents to 98 invitees) draw the attention, two sectors in Gentbrugge along the E17 viaduct.

A calculation of response rate by zone (Table 32 and Figure 85) also points to a much higher response rate around the E17 viaduct, even more than 50%. In the other two zones the response rate is similar at about 35%. This remarkable difference is in line with the situational analysis in chapter 6, which showed a much higher awareness and engagement of citizens living along the E17 viaduct compared to the B401.

A mapping of the response rate by statistical sector gives a clearer picture (Figure 86). The map shows the highest response rates on both sides of the E17 viaduct. Response rates along the B401 and the non-viaduct-section of the E17 are lower, yet with higher rates right next to the highway. The spatial differences in response rate can point to more or less engagement with or awareness about the environmental pollution caused by the highways.

Figure 86 Response rate by statistical sector, classification by Natural Breaks

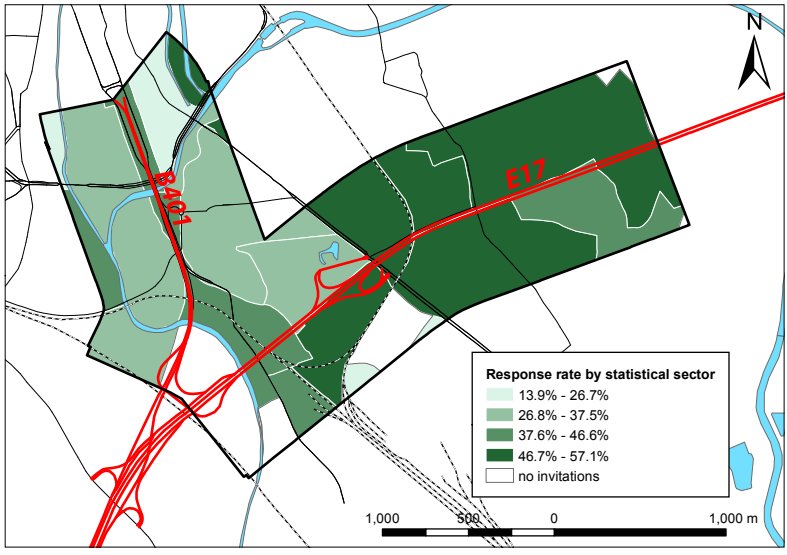


Table 32 Response rate by statistical sector (for location of statistical sectors, see Figure 84; for location of zones, see Figure 85)

Code	Name	Invited	Response	
		n	n	%
A13	HEERNIS	7	4	*57.1*
A201	FLORA	0	0	---
A21	VISSERIJ	16	8	*50.0*
A221	BRUSSELSEPOORT	69	17	*24.6*
A23	ZUIDPARK	58	27	*46.6*
A24	DIERENTUIN	100	34	*34.0*
A321	SINT-PIETERS	36	5	*13.9*
A33	HEUVELPOORT	12	5	*41.7*
B411	OTTERGEMSE DRIES	6	2	*33.3*
B472	GROOTHANDELSMARKT	0	0	---
F001	GENTBRUGGE-CENTRUM	45	25	*55.6*
F01	DRIES	73	36	*49.3*
F091	ZWARTE FLES	0	0	---
F110	SPORTPLEIN	98	53	*54.1*
F121	VOGELHOEK	15	4	*26.7*
F132	CONINXDONK	5	2	*40.0*
F172	ARSENAAL	0	0	---
G00	LEDEBERG-CENTRUM	199	73	*36.7*
G01	FLORA	7	4	*57.1*
G022	KEIZERSPARK	16	6	*37.6*
G031	EINDEKE	59	23	*39.0*
G042	BELLE VUE	52	17	*32.7*
G101	L.VAN HOUTTEBUURT(ST-ANTONIUS)	45	22	*48.9*
G112	DE NAEYERDREEF	58	20	*34.5*
G123	MOSCOU	8	4	*50.0*
G200	MERELBEKE STATION	19	8	*42.1*
	E17 zone	266	138	*51.9*
	B401 zone	531	187	*35.2*
	mixed zone	206	74	*35.9*
	Total	1,003	399	*39.8*

Nationality

When the response rate by nationality is analyzed, a much higher response rate appears for Belgians than for foreign nationalities (Table 33). Of 110 invitations to foreigners, only 20 persons participated, despite of the possibility to request a translated version of the survey. Apparently there are major barriers impeding their participation. Language will play an important role, since requesting a translation of the survey requires some effort, and translations were only provided in English,

French or Turkish. Furthermore, the online survey was only available in Dutch. Other reasons that might have had an impact are cultural differences (i.e. being not familiar with survey research), little connection to the neighborhood, illiteracy, and satisfaction with environmental quality because of former residence in worse conditions.
The 20 foreign participants in the survey have following nationalities:

- 2 persons: France, Netherlands, Spain, Turkey
- 1 person: Armenia, Brazil, Ethiopia, Finland, Ghana, Iceland, Poland, Portugal, Senegal, Serbia, Thailand, undefined (Palestine)

Table 33 Response rate by nationality (according to population register)

Nationality	Invited	Response	
	n	n	%
Belgian	893	379	*42.4*
foreign	110	20	*18.2*
Total	1,003	399	*39.8*

7.8.3 Representativeness and weighting adjustment

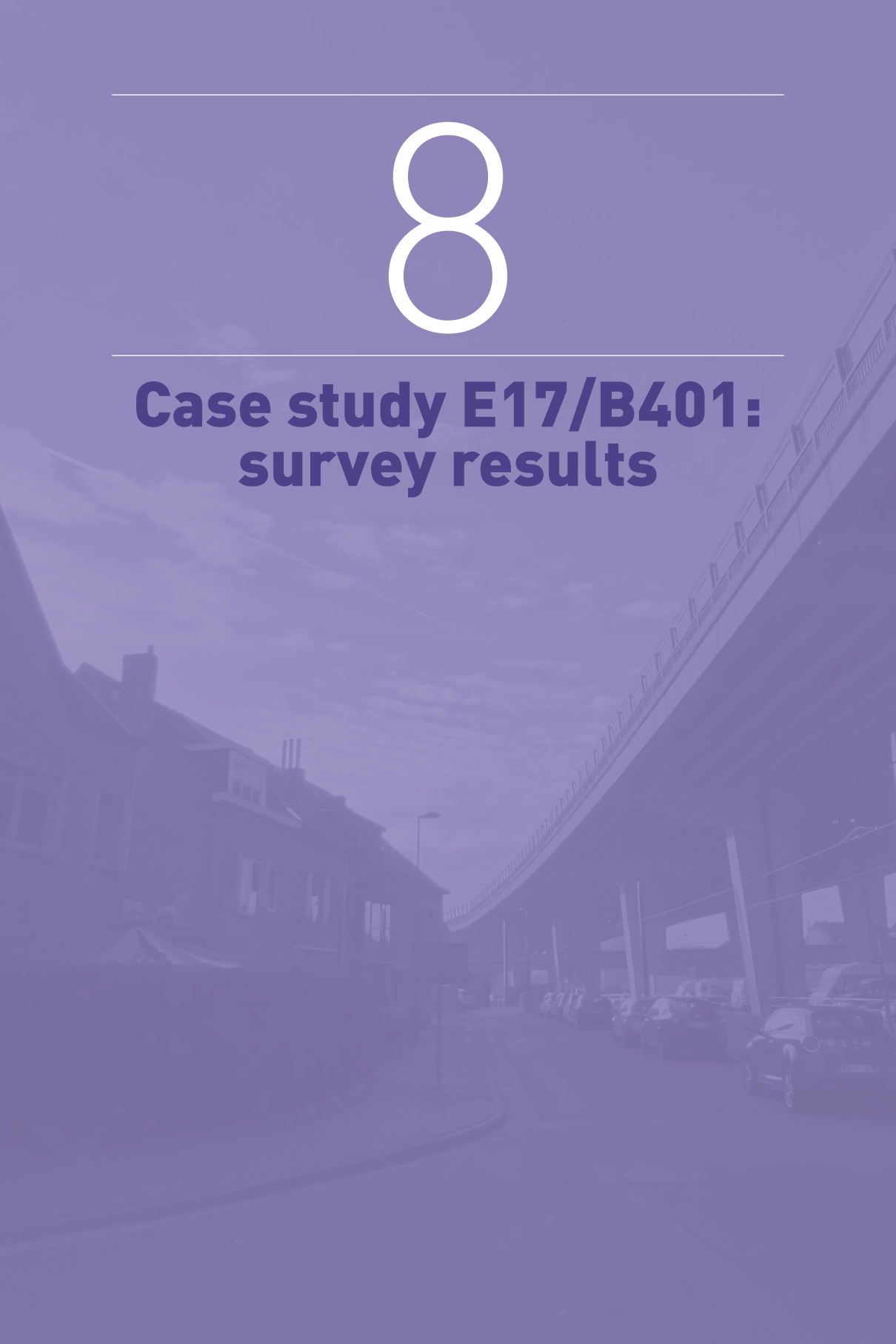
The sampling process aimed for a confidence level of 95% and a confidence interval of 5%. Therefore, at least 375 respondents were needed. Since 399 respondents were reached the requirements are met and thus representative statements can be made about the whole population in the case area. However, when different neighborhoods or subpopulations are compared with each other, the results will only be indicative.
To maximize representativeness the correction technique of weighting adjustment was applied. This is a conventional procedure in social research, in which every respondent is attributed a weight based on the response rate per strata. Because of non-response, the ratio between the number of respondents in each stratum does no longer correspond with the ratio at target population level. If no weighting was applied, certain statistical sectors or age categories would have relatively more impact on the results than others.
Unfortunately, it is not possible to correct for both age group and statistical sector, because some strata do not contain any respondent and this would make weighting impossible. Moreover, some weights would be excessively high, which can distort the results. Since the data could be adjusted for one variable, it was decided to only correct for statistical sector. Age group was considered less decisive for the results than location, since a large part of the questions is about the residential environment. Table 34 shows the calculation of the weight coefficients. These will be used to weight all cases when the univariate results of the whole population are analyzed and discussed. If subpopulations are analyzed, or bivariate analyses are carried out, weighting is not applied.

Table 34 Calculation of weight coefficients per statistical sector

		Population		Respondents		
Code	**Name**	**N**	**%**	**N**	**%**	**Weight**
A13	HEERNIS	104	*0.67*	4	*1.01*	0.67
A201	FLORA	4	*0.03*	0	*0.00*	---
A21	VISSERIJ	252	*1.62*	8	*2.03*	0.81
A221	BRUSSELSE POORT	1,077	*6.91*	17	*4.30*	1.62
A23	ZUIDPARK	904	*5.80*	27	*6.84*	0.86
A24	DIERENTUIN	1,552	*9.96*	34	*8.10*	1.17
A321	SINT-PIETERS	562	*3.61*	5	*1.27*	2.88
A33	HEUVELPOORT	192	*1.23*	5	*1.27*	0.98
B411	OTTERGEMSE DRIES	83	*0.53*	2	*0.51*	1.06
B472	GROOTHANDELSMARKT	3	*0.02*	0	*0.00*	---
F001	GENTBRUGGE-CENTRUM	710	*4.56*	25	*6.33*	0.73
F01	DRIES	1,145	*7.35*	36	*8.86*	0.81
F110	SPORTPLEIN	1,540	*9.88*	53	*13.42*	0.74
F121	VOGELHOEK	236	*1.51*	4	*1.01*	1.51
F132	CONINXDONK	65	*0.42*	2	*0.51*	0.83
G00	LEDEBERG-CENTRUM	3,100	*19.89*	73	*18.48*	1.09
G01	FLORA	80	*0.51*	4	*1.01*	0.51
G022	KEIZERSPARK	243	*1.56*	6	*1.52*	1.04
G031	EINDEKE	942	*6.05*	23	*5.57*	1.05
G042	BELLE VUE	785	*5.04*	17	*4.30*	1.18
G101	L.VAN HOUTTEBUURT(ST-ANTONIUS)	699	*4.49*	22	*5.57*	0.81
G112	DE NAEYERDREEF	892	*5.72*	20	*5.06*	1.14
G123	MOSCOU	130	*0.83*	4	*1.01*	0.83
G200	MERELBEKE STATION	282	*1.81*	8	*2.03*	0.90
		15,582	*100.00*	399	*100.00*	1.00

8

Case study E17/B401: survey results



This chapter details the results of the residents' survey. The most remarkable figures are mentioned in the text and the main findings are illustrated with some graphs. The full frequency tables and the results of the bivariate analyses are included in the appendices (Appendix E – univariate survey results and Appendix F – bivariate survey results).

8.1 Distributive justice: evidence

The residents in the case area make several claims about the evidence of exposure they are bearing. The results in Table 37 and Figure 87 show that the majority of the population is at least "sometimes" annoyed by traffic noise or air pollution, while for 35 to 40% of the population this is "often" or "always". The frequencies for traffic noise and air pollution are quite similar, if the "I don't know" category for air pollution exposure is ignored.
When looking into the separate frequencies for the three zones in the case area, only for traffic noise annoyance significant differences can be found. Residents in the B401 zone report significantly more often to be "never" or "rarely" annoyed by noise exposure, compared with residents in the E17 zone (Table 38 and Figure 88). Traffic noise annoyance is thus clearly more at stake around the E17 than around the B401.

Figure 87 Subjective exposure to traffic noise and air pollution (cases weighted)

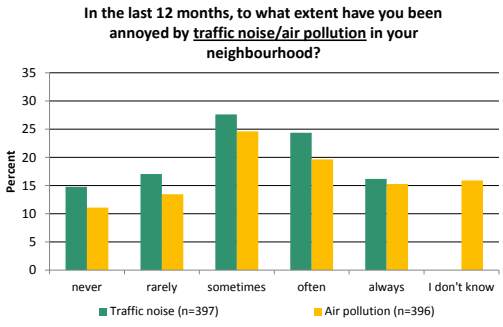
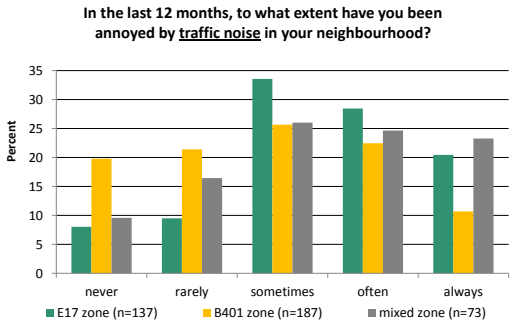


Figure 88 Traffic noise annoyance in the different zones of the case area (cases not weighted)



For traffic noise the answer frequencies were compared with the frequencies for exactly the same question in the Livability Monitor for Ghent 2014, representative for the Ghent population (Table 39 and Figure 89). This reveals a significant difference in subjective exposure; the population in the case area reports annoyance more often than an average Ghent citizen. This points to an inequality of perceived noise exposure. Figure 90 and Table 44 show how the population in the area assesses its relative exposure. For traffic noise, about 43% of the population thinks that their exposure is higher than for an average Ghent citizen. For air pollution, the population percentage mounts up to 48%. However, a considerable part of the population, about one in three residents, thinks to be equally exposed. The differences between the three different zones are not that pronounced. Only for traffic noise there is a significant difference, with the B401 standing out as a zone

where respondents do not feel higher exposed (Table 45).
In Table 100 the subjective exposure is compared with the modeled traffic noise and air pollution data. In general there is a correlation, but a very weak one (0.121* for traffic noise and 0.159** for air pollution). The modeled air pollution and noise data are thus not very good in predicting subjective exposure. According to a comparison of the results for the different zones, noise maps better predict subjective exposure in the B401 zone and in the mixed zone, compared to the E17 zone. This confirms the earlier mentioned idea that the noise annoyance caused by the E17 viaduct is not well represented by the noise maps.

Figure 89 Comparison for subjective exposure to traffic noise between survey and Ghent Livability Monitor (cases not weighted)

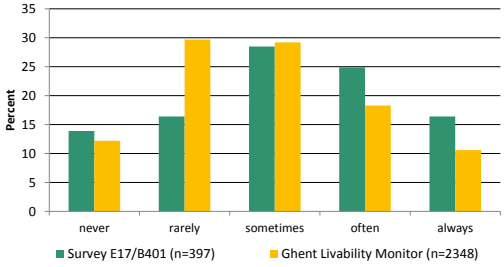
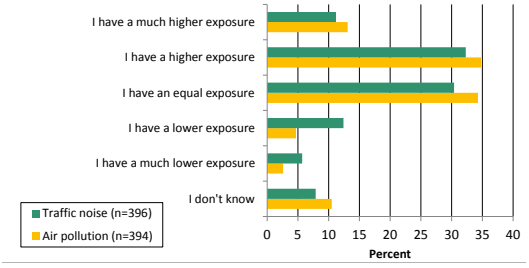


Figure 90 Relative exposure to traffic noise and air pollution (cases weighted)



About one in three residents in the case area points to the highway viaducts as major source of traffic noise and air pollution (Table 41). At the same time, almost 25% of the residents report no traffic noise annoyance at all related to the viaducts (and highways), while for air pollution annoyance only 5% of the population does not see any relation with the viaducts (and highways). This corresponds to the fact that traffic noise has more local street-level impact, while the impact of air pollution has a wider scope, as shown earlier in the modeled exposure maps (Figure 54 and Figure 55).
The relation with the viaducts is assessed significantly differently in the three zones of the case area (Table 42, Table 43, Figure 91 and Figure 92). In the E17 zone the highway is deemed the most important source of air pollution and traffic noise by more than half of the respondents, while in the B401 and mixed zone less than one third of the respondents considers the viaduct as the major source of air pollution and traffic noise. This analysis shows that the perceived effect of the viaduct on environmental quality is much larger in the E17 zone than in the other zones.
Table 101 shows the importance of the distance to the highway in predicting subjective exposure. The distance to the highway does not play a role in predicting noise annoyance, in any of the three zones. Only the relative exposure to traffic noise is estimated higher when living closer to the highway, especially in the B401 zone. For air pollution annoyance the distance to the highway plays a clear role. Except for the mixed zone, there is a clear relation between living closer to the highway and feeling more annoyed by air pollution. Probably the awareness about the problem of air pollution is higher when the viaduct is nearer.

Figure 91 Relation of traffic noise with the viaducts for different zones (cases not weighted)

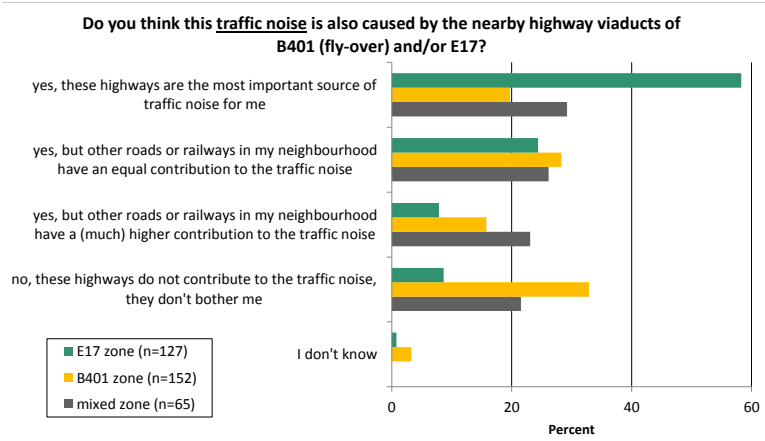
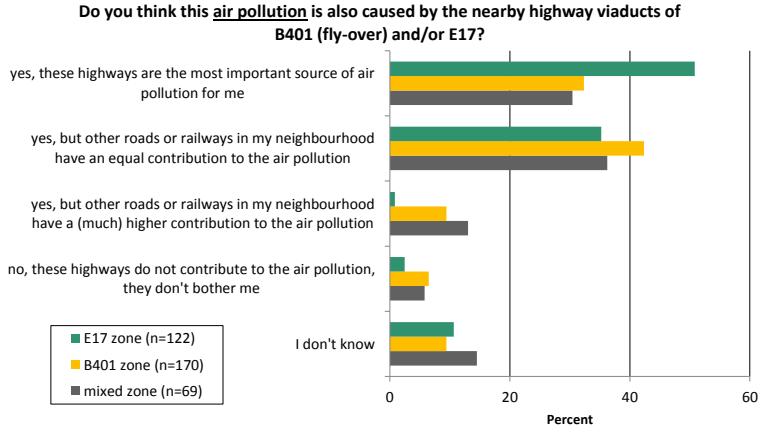


Figure 92 Relation of air pollution with the viaducts for different zones (cases not weighted)



While the subjective exposure to air pollution and noise in the case area is comparably assessed, people are much more worried about the health effects of air pollution (Table 46 and Figure 93). About two thirds of the target population is worried about air pollution, while for traffic noise this decreases to 42.5%. The awareness about the possible health impact of air pollution is remarkable.
The portion of the population reporting health problems related to air pollution or noise is considerably lower (Table 47 and Figure 94). Again air pollution related health problems are reported much more often than noise related health problems (38.8 versus 24.8%). Respondents in the B401 zone significantly more often report no traffic noise related health problems, compared to respondents in the E17 zone (Table 48).
In Table 100 is shown that both health concerns and health problems are not related to modeled exposure of traffic noise and air pollution.
A comparison of the general question on subjective health with the same question

in the Ghent Livability Monitor survey did not yield a significant difference. Thus, the population in the case area does not feel more or less healthy than an average Ghent citizen (Table 99).

Figure 93 Concerns about environmental impacts of traffic noise/air pollution and health effects (cases weighted)

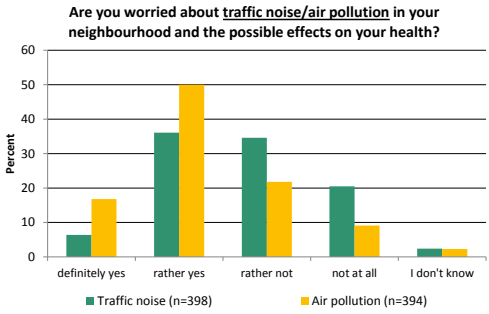
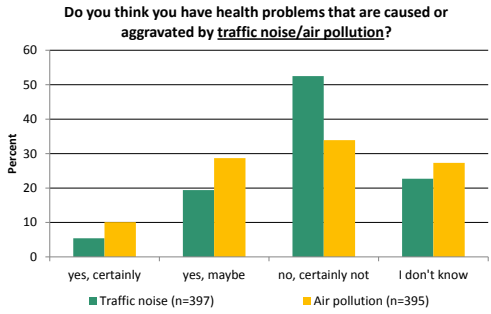


Figure 94 Occurrence of health problems caused or aggravated by traffic noise/air pollution (cases weighted)



Finally, there is looked into the aspects of vulnerability and responsibility, related to distribution of exposure, since this can give extra arguments in judging the justice of the situation. According to the reported results in Table 102, the socio-economic groups that are higher exposed by modeled exposure differ from those higher exposed by subjective exposure. Following the models, lower educated and lower income people are higher exposed to air pollution and traffic noise. However, this is not confirmed by the subjective exposure. For relative exposure to air pollution, even an inverse relationship is found, with higher educated and higher income people estimating their exposure to air pollution relatively higher. Also families with children, Belgians and people with a job estimate their relative exposure to air pollution higher. Awareness and information probably play a role in explaining this outcome. For traffic noise exposure, both modeled and subjective exposure point to higher exposures for older people and unemployed/retired people. Finally, people living alone would have a higher exposure to traffic noise according to the model, but do not report a higher subjective exposure.

For the aspect of responsibility a relation is found between higher modeled exposure to traffic noise or air pollution and a lower number of cars. However, for subjective exposure no relation can be found, except for people without a car feeling a bit more annoyed by traffic noise.

With regard to concerns about health effects, older, low educated people without a car are more worried about traffic noise, while women and families with children are more worried about the health effects of air pollution (Table 103).

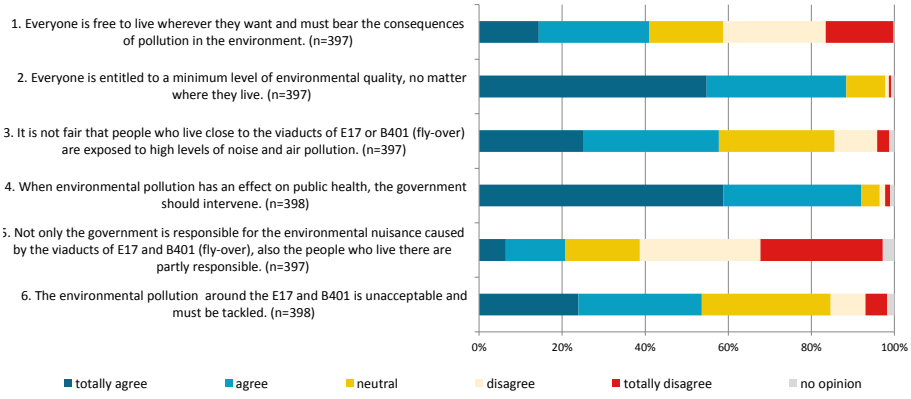
Summary

- The majority of the population in the case area is at least sometimes annoyed by noise or air pollution.
- The perceived exposure to noise in the case area is higher than the average perceived exposure in Ghent, and about 45% of the population thinks they are higher exposed than an average Ghent citizen (for both air pollution and noise).
- There is only a weak positive correlation between modeled exposure to traffic noise or air pollution and the subjective exposure to these impacts. The noise maps predict annoyance better in the B401 zone and the mixed zone, compared to the E17 zone.
- Air pollution is considered more related to the viaducts than traffic noise. In addition, there is a clear relation between shortest distance to the highway and annoyance by air pollution, which is not present for traffic noise (in any of the three zones).
- In the E17 zone the highway viaduct is considered the major source for both air pollution and traffic noise. In the B401 zone considerably less traffic noise annoyance is reported and the relation with the viaduct is less pronounced.
- According to modeled exposure, lower income and less educated people, without a car, are more exposed. This relation, however, was not reported for subjective exposure, except for people without a car that feel a little more annoyed by traffic noise.
- According to both modeled and subjective exposure to traffic noise, older people and unemployed/retired people are more exposed to traffic noise.
- According to (subjective) relative exposure to air pollution, higher educated and higher income people with children assess their exposure higher. This relation was not found for modeled exposure.
- People are far more worried about the possible health effects of air pollution than of traffic noise.
- Older, low-educated people without a car are more concerned about the health effects of traffic noise, whereas women and families with children are more worried about the health effects of air pollution.

8.2 Distributive justice: justice

The survey also contained questions on the fairness of the situation of the E17/B401 and environmental justice in general (Table 52 and Figure 95). A very large majority of the population (about 90%) agrees that everyone is entitled to a minimum level of environmental quality, and that the government should intervene when environmental pollution has an effect on public health. However, specific statements on the injustice of the situation of environmental nuisance around the E17 and B401 receive less support. Only slightly more than half of the population considers the high exposure to air pollution and noise around the viaducts unfair and asks for intervention. Thus, it seems that not everyone is convinced about the health effects of air pollution and noise caused by the viaduct. The first statement separates the population the most: about 40% believes that everyone is free to live wherever they want and should bear the consequences, while another 40% does not agree with it, the remaining part being neutral.

Figure 95 Statements on environmental justice (cases weighted)



A comparison of the opinion on the statements between the three zones in the case area did not yield any significant differences. A comparison with subjective exposure variables derived from the survey yields interesting results (Table 104). All statements are clearly correlated with the subjective exposure questions in the beginning of the survey (annoyance, relation with viaduct, relative exposure, health concerns, health problems). For the general environmental justice statements (nr. 2 and 4) the correlation is weak to medium. For the specific statements on the situation of the viaducts (nr. 3 and 6) correlations are medium to strong. Particularly the last statement, which speaks about “tackling” the situation, is very strongly correlated with all subjective exposure parameters, and the strongest with the variables on evolution of traffic noise and air pollution exposure. For the first statement the correlations are medium. Who feels more annoyed, who is concerned about health effects or who thinks that his/her exposure is high, more often does not agree with the idea that everyone is free to live wherever they want.

Table 104 also reveals some weaker correlations with socio-economic and housing variables. The two general statements on the right on environmental quality for

everyone are agreed on quite evenly across all variables, except for women and house owners who agree slightly more often. The two specific statements on the fairness of environmental pollution around the viaducts are more contested. Older people who have been living longer in the area, who have no car (or only one) and who think to be in poor health, more often agree that the situation is unfair and should be tackled. Owners and unemployed or retired people agree more often that the situation is unfair but not that it should be tackled, while people who commute by car think it should not be tackled. With regard to the first statement on the freedom to live wherever you want, people who live in a (semi)detached house, who are more educated and in poorer health slightly more often do not agree with the statement.

Summary

- In general, almost all people believe that everyone has the right on a minimum environmental quality and that the government should intervene when environmental impacts affect public health.
- Yet, when considering the specific –case of the E17/B401, only slightly more than half of the people thinks this situation is unjust and should be tackled.
- Who feels more annoyed, who thinks his/her exposure is relatively high, who has seen an increase in traffic noise/air pollution exposure, who is concerned about health effects or who thinks to already feel health effects much more often considers the situation unfair. The personal subjective exposure is much more decisive for the opinion on environmental justice statements than any of the socio-economic variables.
- Older people, who have been living longer in the neighborhood, who do not have a car, and who assess their health as poorer think more often that the situation is unfair and should be tackled.

8.3 Distributive justice: process

The third part of the survey contained questions on housing characteristics and trajectories. By answering these, the respondents do not make claims about process themselves. Yet their answers can be used by the researcher to make claims about the underlying mechanisms of the unequal exposure.
The analysis of general housing characteristics in Table 53 to Table 60 (and Figure 104) reveals interesting differences between the three different zones, which might help explain other answers. The most remarkable results are summarized in Table 35, characterizing the zones as follows:

- In the E17 zone 80% of respondents own the house where they live, which in most cases is a single-family row house or (semi-)detached house. Most

respondents have been living in their house for some years, 19 years on average.
- The B401 zone shows a more even distribution of owners (57%) and renters (43%). Most respondents live in an apartment or single-family row house, and moved to this neighborhood more recently, 11 years ago on average.
- The mixed zone has a majority of owners (75%), who mostly live in single-family row houses. On average respondents have been living in the neighborhood for 12 years.

Table 35 Housing characteristics for different zones (cases not weighted) (indication of significant deviations)

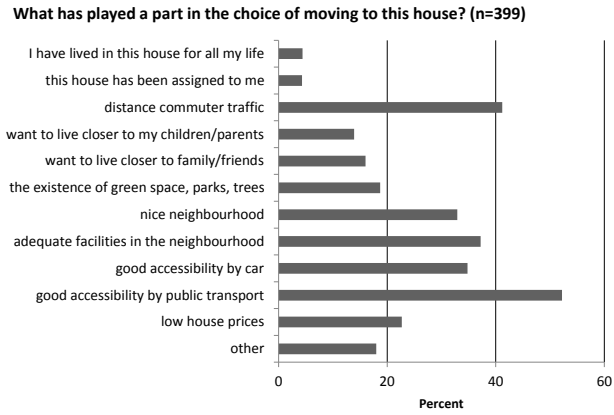
	E17 zone	B401 zone	mixed zone	TOTAL
% owner	80.4	56.7	75.3	68.3
% renter	19.6	43.3	24.7	31.7
% single-family (semi-)detached house	31.9	3.7	8.1	14.3
% single-family row house	53.6	36.9	74.3	49.6
% apartment or studio flat	14.5	59.4	17.6	36.1
Average year of settlement	1997.4	2005.2	2003.9	2003.2
Number of respondents	*138*	*187*	*73*	*398*

In Table 102 the relation between exposure variables and housing characteristics is evaluated. A medium to strong correlation is found between housing typology and modeled exposure to air pollution and noise, with apartments (and row houses) being higher exposed. However, for subjective exposure this relation is not present, and it shows even an inverse trend for traffic noise, with people living in a (semi-) detached house feeling higher exposed. For year of settlement and ownership remarkable differences are found between objective and subjective exposure. While according to the models, renters and people who arrived more recently in the neighborhood are more exposed, owners and people who have been living longer in the neighborhood report more annoyance. A comparable pattern is displayed for concerns about the health effects of traffic noise, with people that have been living longer in the neighborhood, in a detached house, being more concerned (Table 103).

The main reasons why people chose for their current place of residence are listed in Figure 96 (and Table 61). The most prominent ones are the good accessibility by public transport (52.2%), commuting distance (41.2%), the facilities in the neighborhood (37.2%), the good accessibility by car (34.8%) and the pleasantness of the neighborhood (32.9%).
Some reasons were significantly more or less chosen in the three zones (Table 63):
- In the E17 zone 10% of respondents answered they have lived in their house for their entire life, while in the B401 zone this option was significantly less chosen (3%). This is in line with the longer length of residence in the E17 zone.
- In the E17 zone for 37% of respondents the existence of green space, parks and trees played a role in the choice of residence, while this was of significantly less importance in the two other zones (B401 zone: 16%, mixed zone: 7%).
- Moreover, respondents from the E17 zone indicated more often that they moved to a nice neighborhood (44%) and indicated less often that low house prices played a role (only 10%).

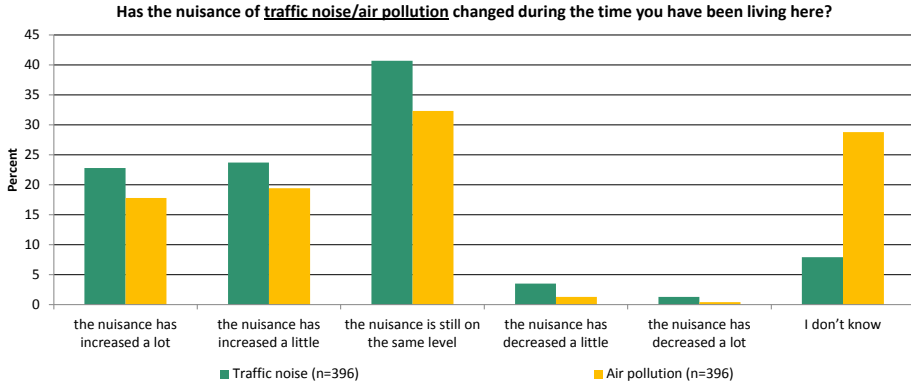
– In the mixed zone the reasons of a nice neighborhood (18%) and good accessibility by car were chosen significantly less often (23%), while the option of low house prices was a reason for 40% of residents.

Figure 96 Reasons for choice of residence in case area (cases weighted)



Most people were aware of traffic noise and air pollution when they moved to their current residence (Table 64). More than one third of the population (34%) thought the advantages outweighed the disadvantages, 38% thought it would be bearable and 16% answered they had little choice. In the mixed zone significantly more respondents ended up because of financial constraints or lack of adequate housing (Table 65).

Figure 97 Historical evolution of traffic noise and air pollution nuisance (cases weighted)

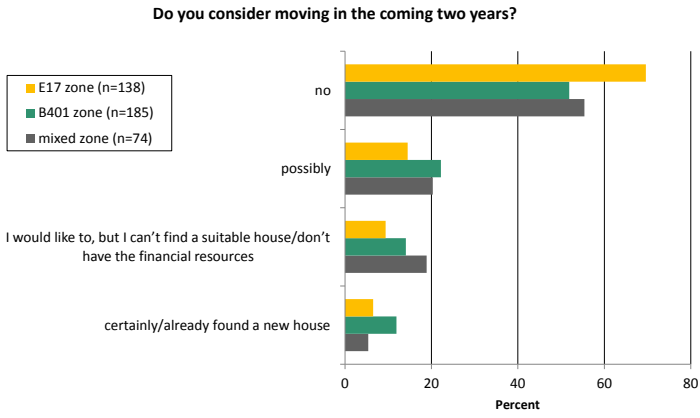


While the majority of the population in the case area made a deliberate choice to move to their current place of residence, things might have changed during the time they have been living here. Figure 97 and Table 66 show that for 46% of the population traffic noise has increased during this time, and 37% thinks the same for air pollution. Only a very small group thinks the nuisance has decreased. This change in nuisance might give extra arguments that it is not only the residents' responsibility and that they could not know this evolution was going to happen.

Another interesting aspect of housing is (the intention of) moving house. 56% of the population answers to definitely not move house in the coming two years, 9.6% will certainly move and the other 34% might move (Table 67). These numbers are not significantly different from the same numbers for Ghent, collected in the Livability Monitor survey (Table 68). However, there are interesting and significant differences between the three zones in the case area (Figure 98 and Table 69). In the E17 zone, 70% of respondents will definitely not move in the coming two years, while this drops to 52% in the B401 zone, where already 12% will definitely move.
The main reasons for moving are personal circumstances (32%), followed by environmental noise and air pollution in the current neighborhood (respectively 32% and 30%) (Table 70). There are no remarkable differences in mentioned reasons between the three zones, except for the mixed zone where people much more often are not satisfied with their neighborhood (Table 72).

Finally, the results of the general questions at the end of the survey revealed more interesting differences between the zones. In the B401 zone significantly less respondents have children living with them (14%), while in the mixed zone significantly more respondents live in a household with children (31%) (Table 97). Also an analysis of educational level in the zones gives some interesting results (Table 98). While in general the distribution of educational level is similar in the zones, the mixed zone has particularly more people with no education or only primary education. The E17 zone has a remarkably large group of respondents with higher secondary education and in the B401 zone the group with university education is significantly larger compared to the other zones.

Figure 98 Intentions of moving for different zones (cases weighted)



Summary

- The three zones are significantly different in housing characteristics, which might explain the opinion of the respective residents on (the importance of) environmental quality.
  - In the **E17 zone** most respondents are house owners who have been living already for a long period of time in the neighborhood in a comfortable house. The availability of green space, parks and trees and the pleasantness of the neighborhood were major reasons to settle there. 70% of residents definitely want to continue living in the neighborhood.
  - The **B401 zone** has a more even distribution of owners and renters, who have been living for a shorter period of time in the neighborhood and who are mostly living in row houses and apartments. Only 52% of people will definitely not move in the coming 2 years. It seems that many people plan to live here only for a certain period of time. In this neighborhood few respondents have children and people with university education are overrepresented.
  - In the **mixed zone** a large majority of respondents owns their house. On average, respondents have been living for about 12 years in the neighborhood, mostly in row houses. Low house prices were an important reason to move to this zone and a significant part of the respondents ended up here because of financial constraints. Respondents in this zone are less satisfied with their neighborhood than respondents from other zones. In this neighborhood live a lot of families and also people with low education are overrepresented.
- According to the models of traffic noise and air pollution, apartment renters who arrived more recently in the case area are more exposed. However, detached house owners who have been living longer in the case area report more annoyance. Along similar lines, people who have been living for a longer time in a detached house are more concerned about health effects of traffic noise.
- The good accessibility by public transport is the most mentioned reason why people settled in the area.
- Most people were aware of environmental pollution when they settled in the area and made a deliberate choice. However, according to 46% of the population traffic noise nuisance has increased during the time they have been living in the area. 37% of the population thinks the same for air pollution nuisance.
- People in the case area do not tend to move house significantly more often than the average Ghent citizen. However, when people want to move, air pollution or environmental noise are often indicated as a main reason.

8.4 Procedural justice

Some questions in the survey can give evidence on justice as procedure, with a focus on access to complaint procedures.
Table 74 shows that only 7% of the population has ever filed a formal complaint about air pollution or noise. Table 75 shows that this low number of complaints is very unevenly distributed. In the E17 zone a significantly higher percentage of 15% of the population has ever filed a formal complaint, while in the other zones this is around 5% of the population. Correlation analyses also show a relation with several explanatory variables (Table 105). People who feel more annoyed by traffic noise and air pollution, people who are older and have been living longer in the neighborhood, owners and retired or unemployed people all significantly more often filed a complaint.

Table 76 shows the reasons why people never filed a formal complaint. Almost half of the population (48.3%) thinks traffic noise and air pollution are acceptable. Another 25% does not know how to file a complaint and 22% does not really believe in the usefulness, because their voice is not heard or nothing is being done with their complaint. This last answer can be interpreted as thinking not being recognized by the government. For this question there is one significant (and striking) difference between the three zones. In the B401 zone respondents more often think traffic noise and air pollution are acceptable, compared to the other zones (55% in B401 zone versus 42% in E17 zone) (Table 78). In Table 105 the relations with other variables are reported. People who do not know the procedure are generally younger and have the intention to move house in the coming years. People who do not believe in the procedure and do not feel recognized are generally older, have been living longer in the neighborhood and are more often unemployed or retired. People who think the situation is acceptable more often live in an apartment, arrived more recently in the neighborhood, do not have the intention to move house, are better educated and think they are in good health.

Summary

- Only a minority of the population has ever filed a formal complaint about traffic noise and air pollution.
- Older people, who feel more annoyed by traffic noise and air pollution, who have been living for a long time in the E17 zone, who own their house and are retired or unemployed, more often filed a complaint than others.
- Almost half of the population thinks the environmental pollution is acceptable. In the B401 zone this rises to 55% of the population.
- Younger people who have the intention to move often do not know the procedure, older unemployed or retired people who have been living longer in the neighborhood more often do not believe in the procedure and do not feel recognized. People who arrived recently in the neighborhood, who are in good health, well-educated and living in an apartment more often think the situation is acceptable.

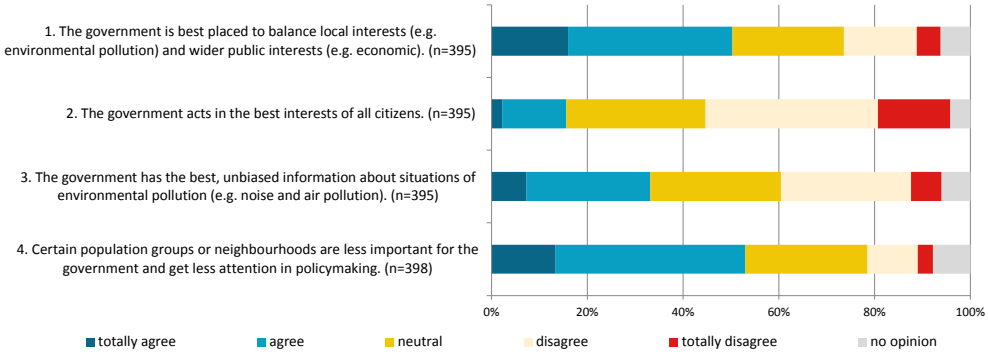
8.5 Justice as recognition

The aspect of justice as recognition is only indirectly addressed by questions on usefulness of complaint procedures, neutrality of the government and bias of citizen initiatives. These aspects and questions are evaluated in 8.4, 8.6 and 8.9. To avoid overlap is chosen to not describe this aspect separately but to make clear reference to justice as recognition in the concerned paragraphs.

8.6 Path-dependent strategy

The statements on the role of the government (Table 79 and Figure 99) reveal that half of the population (50.3%) believes that the government is best placed to balance local interests against wider public interests in a situation of local environmental pollution. With 29.5% of people being neutral or having no opinion, only a very small group of 6.2% of the population does not agree. Low educated people, renters, people who live in an apartment and people without children have significantly more belief in the role of the government (Table 106).

Figure 99 Statements on the role of the government (cases weighted)



While in theory the government level is considered the best level to deal with situations of local environmental pollution, a much smaller proportion of the population believes in its neutrality (Table 79 and Figure 99). 51.1% of the population does not believe that the government acts in the best interests of all citizens and a comparable share of 53.0% thinks that certain population groups or neighborhoods are less important for the government and get less attention in policymaking. With about one third of the population being neutral or having no opinion for both statements, this seemingly small majority is in fact a clear predominance. These statements touch upon justice as recognition (see 8.5). For these two statements significant differences are found in the answer frequencies for the three zones in the case (Table 80). Respondents from the mixed zone have significantly less confidence in the neutrality of the government and thus feel less recognized, while respondents from the B401 zone have significantly more confidence. Also respondents who feel more annoyed by traffic noise and air pollution, who have been living longer in the neighborhood and who think to be of

poor health have less confidence in the neutrality of the government and feel less recognized by the government (Table 106).
With regard to quality and neutrality of government data there is no consensus (Table 79 and Figure 99). About one third (33.2%) of the population believes the government has the best and unbiased information about situations of environmental pollution, while another third does not believe this (33.6%), the rest of the population being neutral or without opinion. Older people tend to have slightly more trust in government data (Table 106).

Surprisingly, only a minority of the population is familiar with the position and policy of the different government levels involved in the situation of the highway viaducts (Table 81). The knowledge on the city government position and policy is highest with 40.0% of the population being at least partly familiar with it. For the Flemish and European policy level only 21.4 and 18.9% of the population is familiar with their position and policy. In the E17 zone significantly more people are familiar with the Flemish government policy than in the B401 zone (Table 82). Since both viaducts are administered by the Flemish government, this difference probably points to more public awareness and engagement among citizens living around the E17 viaduct, compared to the citizens living around the B401 viaduct.

Figure 100 Statements on confidence in the government (cases weighted)

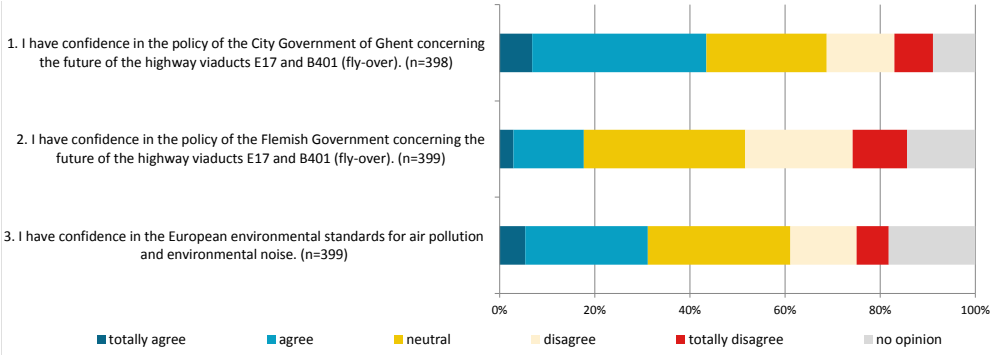


Figure 100 and Table 83 show how much confidence people have in different government levels concerning the highway viaducts. The city government of Ghent comes first with 43.4% of the population having confidence in it, compared to 22.4% having no confidence. The rest of the population is neutral or without opinion. The European environmental standards are a little less appreciated, with 31.2% of the population having confidence in them and 20.7% not. Confidence in the Flemish government is remarkably low, with 17.7% of the population having confidence and 34% not. There are remarkable socio-economic differences between the supporters of the city government and the Flemish government (Table 107). People who have more confidence in the city of Ghent are often younger, settled more recently in the neighborhood and more often have no car (or only one). People who have more confidence in the Flemish government are more often lower educated people, renters and people without children.

Summary

- People think the government is best placed to balance local interests (such as alleviating environmental pollution) against wider public interests, but its neutrality is disputed by the majority of the population.
- Low educated renters of an apartment, without children, are the most prominent believers in the role of the government. People who feel more annoyed by traffic noise and air pollution, who have been living for a long time in the neighborhood and who assess their health as poor, feel less recognized by the government.
- The majority of the population is not familiar with the position and policy of the different government levels involved in the situation of the viaducts.
- People have most confidence in the city government, followed by European laws and in last place the Flemish government.
- Younger people without a car, who settled recently in their neighborhood, have more confidence in the city government, while lower educated renters without children have the most confidence in the Flemish government.

8.7 Collaborative strategy

The majority of the population in the case area believes in participation (Figure 101 and Table 84). More than 81% is convinced that citizen participation can lead to better solutions, and a comparable 79.5% of the population thinks the citizens' interests are defended better when they participate in policy. With regard to the specific case of the viaducts E17 and B401, 80.4% of the population thinks it might be a good idea to involve citizens in finding a solution, while only 3.8% does not like this idea (Table 85). This support for policy participation is equally strong in all three zones of the case. The support for citizen participation is also quite evenly distributed across socio-economic groups. Table 108 does not show a relation with education or income. Yet women and people with a job believe a little bit more in participation than men and unemployed or retired people. Also people who feel annoyed by air pollution – and are aware of it – clearly are more supportive of citizen participation. Finally, a weak correlation was found for the intention to move house and participation. Surprisingly, people who think of moving have a slightly stronger belief in participation than others.

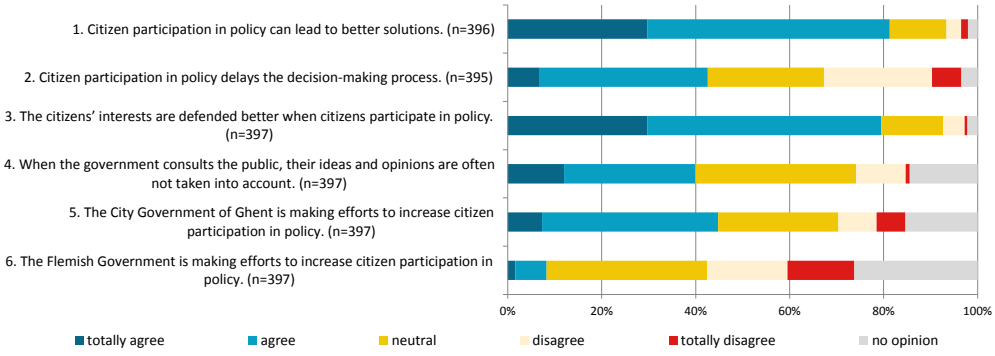
According to the respondents, the main benefits of participation are that citizens are most familiar with the local situation and bear the consequences, that citizens might have creative, smart and feasible ideas and that multiple perspectives and interaction between actors lead to better solutions.

Yet at the same time a big group of 42.5% of the population believes that participation delays the decision-making process, while 29.3% does not agree with this. The rest of the population is neutral or without opinion (Figure 101 and Table 84).

A comparable group of 39.9% of the population thinks the government does not

take their ideas and opinion into account, while only 11.1% thinks the government does. To summarize, while there is a big support for participation, in practice people have concerns about its correct implementation. In Table 108 is shown that people who feel less annoyed by environmental impacts are clearly more concerned about delays in the decision-making process. Men are also significantly more concerned about delay than women. With regard to the role of the government in participation, particularly older people, who are less educated and have been living longer in the neighborhood, have less confidence that the government will effectively consider the citizens' opinions.
A large part of the population thinks the city of Ghent is making efforts to increase citizen participation – 44.8% compared to 14.2% who does not agree – but only 8.3% of the population thinks the same about the Flemish government, with 31.3% that does not agree.

Figure 101 Statements on participation (cases weighted)



Regarding personal engagement in participation to find a solution for the situation of the viaducts, 40.8% of the population thinks to have sufficient knowledge and skills, while 38.0% thinks the opposite (Table 86). A larger part of 53.6% of the population effectively wants to be involved (Table 87). Since this group is bigger, a certain part of the population probably does not want to play a very active role in participation, but merely wants to gain information and judge on proposals from others.
Personal engagement in participation does not significantly differ between the three zones, but correlations with explanatory variables are numerous (Table 109). Who feels more annoyed by traffic noise or air pollution, who has a higher education, a higher income, a job and a family with children and who is male has more confidence in his (or her) knowledge and skills and wants to participate more often. Being of Belgian origin relates to more confidence in skills and knowledge but not in engagement to participate. Finally, younger people and house owners do not have significantly more confidence in their skills and expertise, but do want to participate more often.

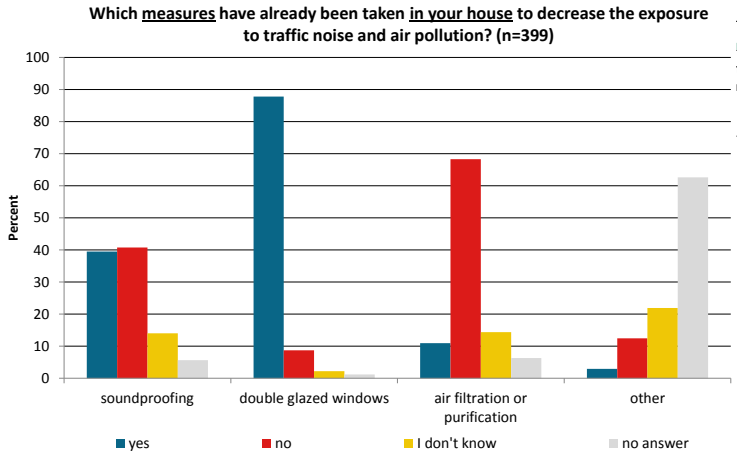
Summary

- A very large majority of the population believes in participation, also for the case of E17/B401, but most of them are also aware of the flaws, i.e. delay of the decision making process and a government that does not do anything with the outcome.
- Women and people with a job have significantly more confidence in participation. Less annoyed people and men are more concerned about delays in decision-making. Older, less educated people who have been living longer in the neighborhood have less confidence in the role of the government in participation.
- The city of Ghent is considered much more open to collaborative strategies than the Flemish government.
- More than half of the population in the case area wants to be involved in a participation process towards a solution for the E17 and B401 viaducts, however, not all of them think to have sufficient skills and knowledge.
- People who feel more annoyed, people with a higher socio-economic status (higher income, higher education, employed), people with children, men, younger people and house owners all want to be significantly more involved in participation than others.

8.8 Adaptive strategy

The majority of the population disposes of some protective measures in his or her house, which can be considered an adaptive strategy (Figure 102 and Table 88). Most of the people have double-glazed windows which, apart from giving insulation, also protect against traffic noise. Some 40% of the population disposes of soundproofing and 11% reports to have some form of air purification or filtration. However, numbers on the last measure might be distorted by respondents interpreting it more broadly as “ventilation”. Double-glazed windows are significantly more present with respondents in the E17 zone (95.6%) than in the B401 zone (87.4%) (Table 89). This is probably due to the higher presence of double-glazed windows in (semi-) detached houses (and row houses) (Table 110). Also owners and families with children more often have double-glazed windows, but these groups are more likely to live in (semi-) detached houses (Table 114). Surprisingly, in the mixed zone respondents report to have significantly more often air purification or filtration (22.7%) compared to the E17 zone (7.3%) (Table 89). This measure is generally more frequent with people who settled more recently in the neighborhood and live in an apartment (or row house) (Table 108). None of the protective measures in house is related to income or education, the most important indicators of socio-economic status.

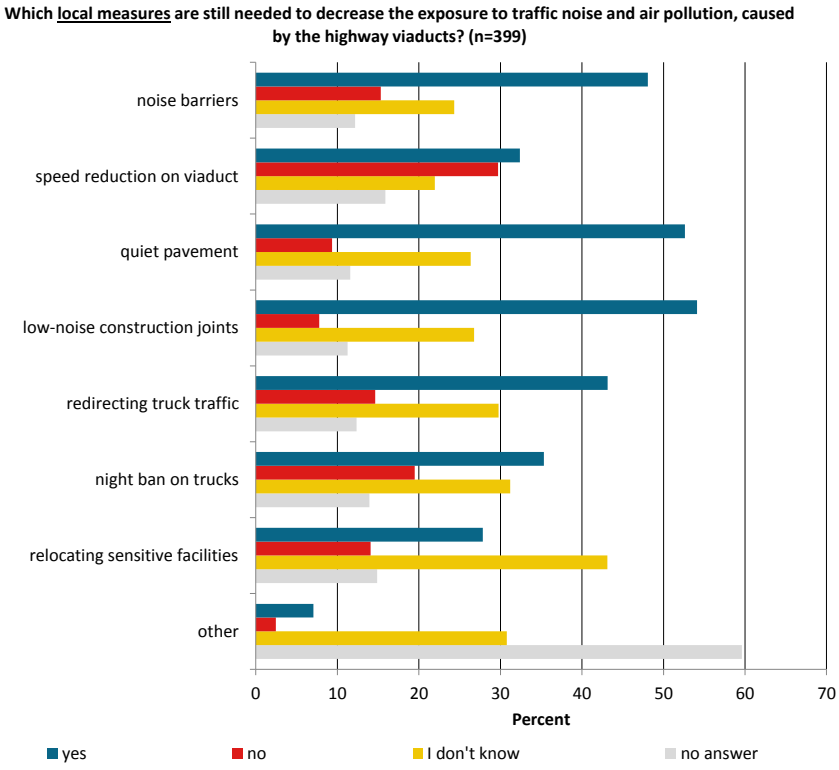
Figure 102 Adaptive measures already taken in house in case area (cases weighted)



According to the survey results, about 36% of the population needs (more) soundproofing, 34% needs (more) air filtration or purification and 20% needs (more) double-glazed windows (Table 88). Particularly for the measure of air filtration/ purification, and to a lesser degree for soundproofing, a very large part of the population does not know whether it is needed or gives no answer. Probably many people do not have enough knowledge about the availability and effect of protective measures.
Provided that the government subsidizes, a majority of 58% of the house owners would implement additional adaptive measures in his or her house (Table 90). If the government would pay the full cost, this rises to 74% of the owners. Younger people, who settled more recently in the case area, with a job and children, and with a higher education and income, are more willing to take additional protective measures in the house (Table 111).

Instead of residents taking protective measures also local adaptive solutions are possible, which do not remove all nuisance, but alleviate it (Figure 103 and Table 91). The support for new measures is the biggest for low-noise construction joints (54.2% supports it), quiet pavement (52.7%), noise barriers (48.1%) and redirecting truck traffic (43.2%). For a speed reduction on the viaduct, a night ban on trucks or the relocation of sensitive facilities the support is less strong (below 40%). For some measures the support differs significantly between the highway zones (Table 92). In the E17 zone there is significantly more support for quiet pavement and low-noise construction joints, compared to the B401 zone – where these measures have already been taken in the recent reconstruction works, as described in 6.3.2. In the B401 zone there is significantly more support for relocating sensitive facilities (73.4%), compared to the E17 zone (50.8%). This can be interpreted as finding a way to live together with the viaduct in the B401 zone, while in the E17 zone a majority of people does not want to adapt to the viaduct and just wants to remove it from their neighborhood.

Figure 103 Local adaptive measures still needed in case area (cases weighted)



Summary

- Most citizens living in the area have some form of protection against noise and/or air pollution. Double-glazed windows are most frequent, but a relatively large part of the population reports to have soundproofing or air filtration/purification.
- Double-glazed windows are more common with (semi-)detached houses while air filtration/purification is more common in apartments where people settled more recently. Socio-economic status does not play a big role.
- Most house owners would take additional protective measures in their house if the government would subsidize. Especially younger people, who settled more recently in the case area, with a job and children, and with a higher education and income, are willing to take additional measures.
- A quiet pavement, low noise construction joints, noise barriers and redirecting truck traffic are the most popular adaptive measures still needed at local level, with the first two measures particularly in the E17 zone.

8.9 Co-evolutionary strategy

Co-evolutionary strategies were assessed by asking on the opinion about groups of citizens that try to put a spatial problem on the agenda in a proactive and constructive way by collecting information, carrying out research, consulting experts and proposing solutions. In the case area the residents' group Viadukaduk is a good example.
It turns out that about 30% knows Viadukaduk, however, very unevenly distributed. In the E17 zone almost 60% of the respondents are familiar with Viadukaduk, while around 20% in the other zones (Table 94). Only about one in three respondents that know Viadukaduk also feels represented, but these numbers might be distorted by respondents skipping the detailed question (Table 93). It is not surprisingly that within the E17 zone Viadukaduk is more known by respondents who feel more annoyed by air pollution or noise (Table 113). In addition, respondents in the E17 zone who are familiar with Viadukaduk significantly more often have a higher education and own a (semi-) detached house (or in second instance a row house). Lower educated respondents who rent an apartment significantly more often do not know Viadukaduk.

The majority of the population in the case area (76%) thinks that "professionalized" residents' groups should be more involved in planning and policymaking (Table 95). Only 4% of the population absolutely does not like this idea. The most cited benefits are the idea that more information and different perspectives can lead to better, out-of-the-box solutions, that the members of such pressure group are engaged and well-informed, and that they live in the neighborhood and know the problem better than anyone else. When analyzing the relation with other variables, it is found that younger, higher educated people with children and a job are greater supporters of citizen initiatives (Table 112). Also people who feel more annoyed by air pollution are bigger advocates, while this correlation is not present for noise. A possible explanation is that air pollution annoyance is more related to awareness about and engagement with the problem, in contrast to noise annoyance.
While there are some concerns about the neutrality of such groups, a majority of 64% gives them the benefit of the doubt (Table 96). About 20% of the population thinks these groups are (too) biased. The belief in the neutrality of such groups is distributed quite evenly across socio-economic groups (Table 112). However, women tend to have more confidence in the neutrality than men and those who commute by car generally have less confidence in the neutrality. This group of car users can be considered feeling less recognized by citizen initiatives (see 8.5). Also people who feel more annoyed by air pollution and noise have more confidence in citizen initiatives.

Summary

- The majority of the population in the case area thinks that "professionalized" residents' groups should be more involved in planning and policymaking. Only one in five respondents has real doubts about their neutrality.
- Younger, higher educated people with children and a job are bigger advocates of citizen initiatives. Women have more confidence than men in the neutrality, while car users have less confidence.
- The majority of the respondents in the E17 zone knows Viadukaduk, but a considerable part of 40% does not know the group. In the other zones only 20% knows the group.
- Who knows Viadukaduk in the E17 zone is more often annoyed by air pollution and noise, higher educated and owner of a (semi-) detached house. Lower educated people who rent an apartment seem to be difficult to reach.

8.10 Conclusions

Since a summary of results was listed for all dimensions, this final section is limited to stressing the most remarkable or relevant results.

1. **The relation between perception of environmental impacts and modeled environmental impacts is weak**

- Weak positive correlation coefficients were found between subjective and objective exposure (0.121* for traffic noise and 0.159** for air pollution). This means that for the same modeled noise or air pollution levels the perception of people varies across the whole spectrum from low to high annoyance, with only a weak trend of higher annoyance corresponding to higher modeled exposure.

- For exposure to noise, the models predict annoyance much better in the B401 zone and the mixed zone, compared to the E17 zone. This confirms the idea that the noise maps underestimate the actual noise exposure in this zone, since low frequent impulse noise caused by the viaduct's construction joints is not included. In addition, it was discussed earlier that perception of noise is very dependent on contextual factors and personal sensitivity (Miedema & Oudshoorn, 2001; Schreckenberg et al., 2010). The low correlation coefficients in the survey analysis are in line with that. Also in the data analysis for Ghent (Chapter 5) only weak correlations were found. It can be concluded that modeled noise data are not a good proxy to assess annoyance and sleep disturbance.

– For air pollution, distortions in the modeled data can be part of the explanation, but also the distance to the viaduct has an impact. Annoyance by air pollution, and self-assessed relative exposure, are much more related to the viaducts than traffic noise, whereas the viaducts are not the only cause of air pollution in the area. Probably perception and awareness, strengthened by a view on the highway viaducts, play an important role. Since for air pollution the health effect is independent from annoyance, air pollution models are still useful.

2. The relation with socio-economic and housing variables differs for objective and subjective exposure

– The most remarkable contrast was found for housing characteristics. Apartment renters, who arrived more recently in the neighborhood, are significantly higher exposed according to the models of traffic noise and air pollution. However, detached house owners, who have been living longer in the neighborhood, report more annoyance and are more concerned about health effects. Probably the latter group places higher demands on their residential environment, and because of the longer length of residence, has experienced a firm increase in nuisance.

– The relation between rental houses and a higher modeled noise and air pollution exposure was also found in the data analysis for Ghent (Chapter 5) and is in line with the sparse literature on this topic (Grineski et al., 2007; Lam & Chung, 2012). However, the higher annoyance levels of detached house owners are in contrast with the findings of Pollack et al. (2004), who found that renters report more pollution. This again points to the importance of contextual explanations.

– A little weaker association was found for socio-economic and responsibility variables. According to modeled exposure, lower income and less-educated people are more exposed. However, these groups do not feel more annoyed. Instead, for air pollution especially higher educated and higher income people assess their exposure higher, probably because they are better informed and more aware. People without a car are also more exposed to air pollution and noise according to the models, but only report a higher annoyance of traffic noise (and more concern about health effects).

– The associations for air pollution exposure and socio-economic variables are in line with the data analysis in Chapter 5 and with earlier studies (Brainard et al., 2002; O'Neill et al., 2003; Chaix et al., 2006; Braubach & Fairburn, 2010; Goodman et al., 2011). The associations for traffic noise exposure were not found in the data analysis for Ghent, which fits the more varying research outcomes for this pollutant (Brainard et al., 2004; Fyhri & Klæboe, 2006; Kohlhuber et al., 2006; Havard et al., 2011; Bocquier et al., 2013). The relation of car ownership with a higher exposure to air pollution was also found in the data analysis for Ghent and is in line with earlier research (Mitchell & Dorling, 2003; Davoudi & Brooks, 2014). The relation of car ownership with traffic noise exposure was not found in the data analysis for Ghent nor in the literature.

– These findings can help argue that aspects of vulnerability, responsibility and housing should be integrated in environmental health policy. However, this is not a straightforward recommendation. Both the equal treatment of every citizen and the idea of paying more attention to vulnerable and less responsible populations can be defended with ethical arguments. Also the issue of owners versus renters is not easy to solve. As a politician, it is a logical choice to prioritize the rights of citizens who are permanent resident. When public health would be the point of departure, renters have to receive as much attention.

3. The opinion on environmental justice is mainly determined by perceived annoyance

– While in general most people believe in a minimum environmental quality for everyone, the opinions on the justice of the situation around the viaducts and the need to intervene are divided. The part of the population that feels more annoyed, thinks his/her exposure is relatively high, is concerned about health effects or already experiences health effects much more often thinks the situation is unfair and should be tackled. The personal subjective exposure is much more decisive than any of the socio-economic variables for assessing the justice of the situation. The fact that many of the residents in the area use the viaduct probably strengthens the opposing opinions. The lack of empathy for the situation of who feels annoyed or exposed, if one does not feel annoyed or exposed him or herself, makes it hard to intervene and take decisions. There will always be a significant part of the population that will disagree with an intervention.

4. Only a minority of the population finds its way to complaint procedures

– The few people that have already filed a complaint about traffic noise or air pollution are usually older, retired and/or unemployed, are highly annoyed by traffic noise and air pollution, have been living longer in their house, more often live in the E17 zone, and own their house. Younger people more often do not complain because they do not know the procedure, older people more often do not complain because they do not believe in it and do not feel recognized in their concerns.

– The fact that so few people ever complained about the nuisance of traffic noise and air pollution makes that many problems might remain underexposed. The problems that do come to the attention of the government are those of a specific group of people with the time to write a complaint and with higher demands of their environment.

5. The role of the government is not questioned, but additional approaches are needed

– Most people think the government is the best level to balance local interests against wider public interests in case of environmental pollution, but its neutrality is disputed. Complementary collaborative and/or co-evolutionary strategies would be good additions in solving an environmental conflict such as

the E17 and B401 viaducts, since a clear majority of the population believes in participation and the opportunities of involving "professionalized" residents' groups in policymaking for such cases. However, most people are also aware of the flaws, i.e. possible delay of the decision-making process, a government that does nothing with the results of a participation process and the questionable neutrality of citizen initiatives.

– Some groups have more confidence in one approach over the others. In general, people who feel highly annoyed by air pollution and noise, have less confidence in the government and advocate for collaborative and co-evolutionary strategies. In socio-economic terms, low-educated renters of an apartment, without children, are the most prominent believers in the role of the government. While the support for participation is widespread, women and people with a job have slightly more confidence in it than others. Younger, higher educated people with children and a job are the biggest advocates of citizen initiatives.

6. There is a lot of personal commitment, but socio-economic variables play a role

– More than half of the population wants to be involved in a participatory process towards a solution for the viaducts, and the majority of house owners would take additional protective measures if the government would subsidize. However, it is a specific group of socio-economically "strong" people that wants to be more involved in participation, rather thinks to have sufficient knowledge and skills, and would rather take additional protective measures in their house. This group is generally younger, often has children but especially has a higher income, a higher education, a job and owns a house.

– It is also the group of higher educated people, owning a (semi-)detached house (and feeling highly annoyed by air pollution and noise) that more often knows Viadukaduk and in this way can express its concerns.

7. The three zones have a different character

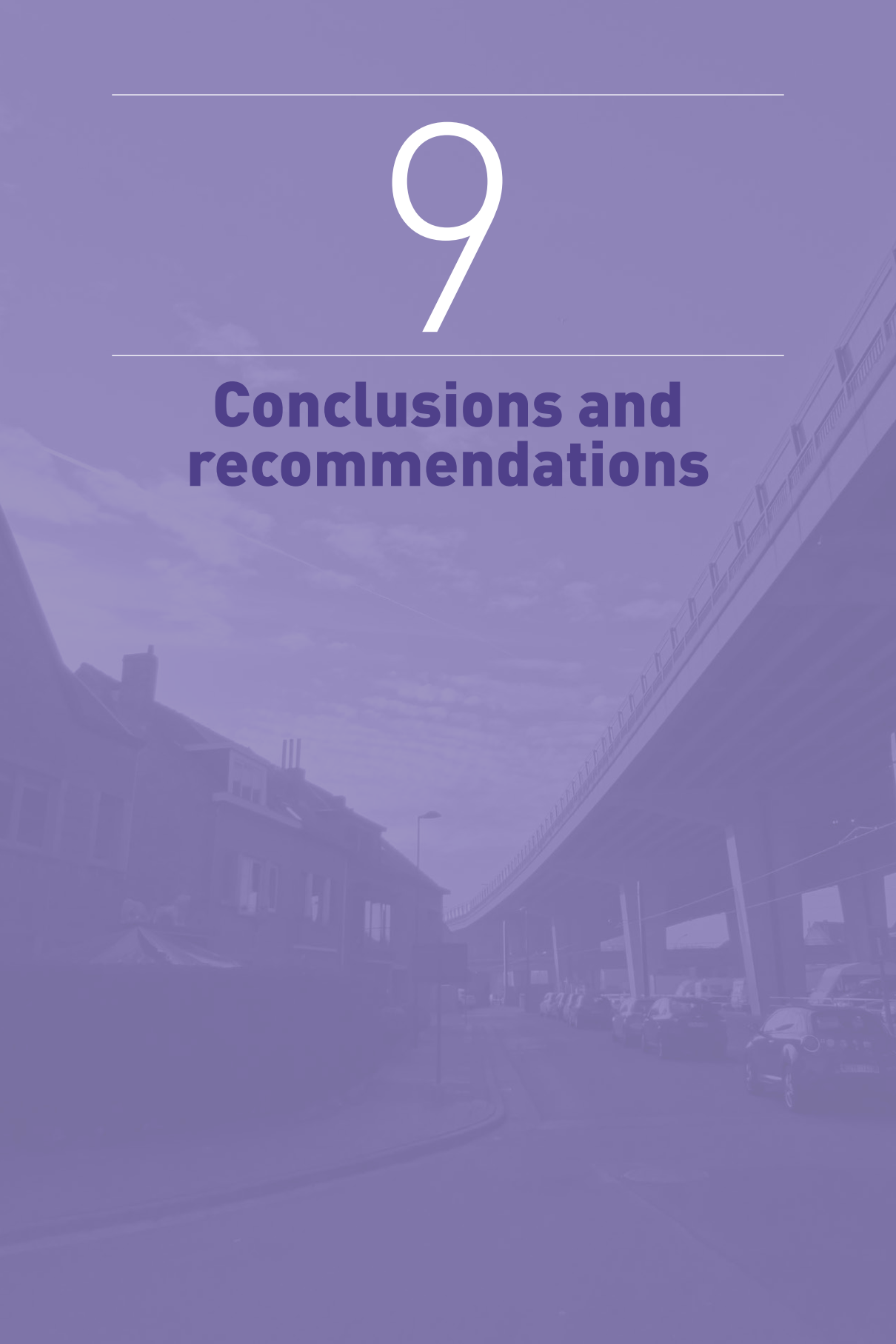
– The three zones are significantly different in housing and socio-economic characteristics, which might help explain the opinion of the respective residents on (the importance of) environmental quality and get insight in the processes behind the inequalities.

Table 36 Different character of the three zones

	E17 zone	B401 zone	mixed zone
modeled exposure	lowest for both impacts	highest for noise	highest for air pollution
subjective traffic noise exposure	highest annoyance, high relative exposure, more reported health effects	lowest annoyance, low relative exposure, less reported health effects	annoyance in between, higher relative exposure, more reported health effects
subjective air pollution exposure	*no significant differences between zones*	*no significant differences between zones*	*no significant differences between zones*
relation with viaduct	strongest association	weakest association	in between
ownership	80% owners, 20% renters	57% owners, 43% renters	75% owners, 25% renters
housing typology	32% (semi-) detached, 54% row house, 14% apartments	4% (semi-) detached, 37% row house, 59% apartments	8% (semi-) detached, 74% row house, 18% apartments
average settlement year	1997	2005	2004
average birth year	1966	1970	1971
families with children	23% with children 77% without children	14% with children 86% without children	31% with children 69% without children
educational level	secondary education overrepresented	university education overrepresented	low education overrepresented
relocation intentions	30% thinks about moving	48% thinks about moving	45% thinks about moving
specific (overrepresented) reasons to settle in neighborhood	availability of green space, parks and trees and the pleasantness of the neighborhood		low house prices
preferred (overrepresented) solutions	quiet pavement low-noise construction joints	avoiding sensitive facilities	

9

Conclusions and recommendations



9.1 Summary of results

This research started from the observation that the relation between the built environment and potential health effects receives increasing attention and awareness from researchers and the public. Yet, governments take a defensive position and continue to rely on a command-and-control policy with generic regulations, established limit values and fixed procedures, which are all static and only occasionally revised. This institutionalization of environmental health no longer works in our inherently dynamic, fragmented and volatile society. Therefore, this research tried to find new ways to integrate environmental health concerns in urban planning and policymaking, reconnecting both disciplines. A research framework with seven research subquestions was set up, corresponding to the chapters of this dissertation (see 1.2). Hereafter, the results of each research step are summarized by giving an answer to these subquestions. In the next section, a general answer is given to the main research question.

a. How did the current disconnect came into being?

For a long time the disciplines of urban planning and public or environmental health initially evolved in close collaboration with each other. Only in the course of the 20th century they became more segregated, as the public health paradigm came to focus on the individual instead of the environment, and separate government departments were established. Environmental health is now largely institutionalized, assuring a minimum environmental quality for everyone by use of generic standards and norms. At the same time, urban planners lost track of the health impact of their decisions.

b. What are the characteristics of the current disconnect?

First, there is a growing evidence base on the health effects of environmental impacts. Today it points to air pollution having the largest health impact, but noise causing the most annoyance. However, the more knowledge about both impacts, the more difficult it is to define general standards. For air pollution, no acceptable pollutant level or safe distance to a high-traffic road can be defined. For noise, contextual factors and personal sensitivity or perception play a fundamental role, and technical interventions to reduce sound levels may thus not have a proportionate effect on noise annoyance. In summary, environmental impacts lead to risks that might be linear and unambiguous at population level but cannot be easily translated to local situations.
Second, citizen awareness on environmental health effects has increased recently, illustrated by the growth of environmental pressure groups. The interviews with five of these groups revealed a large potential for including more bottom-up knowledge and citizen engagement in policy making, since these groups are professionally organized, take a critical but constructive position and focus on building collective expertise by combining expert and lay knowledge. The success of the pressure groups illustrates the citizens' distrust of the government, which still largely sticks to a command-and-control policy.
Third, the current command-and-control government policy on environmental

health was evaluated. In general, environmental regulations and assessments are rigid, generic and missing a holistic perspective. The four interviewed civil servants point to necessary improvements but are hesitant to give more room to bottom up initiatives. They question citizens' intentions, the representativeness of pressure groups and their merely local perspective hindering a social balancing at a larger scale.
Altogether, the institutionalization of environmental health is no longer sufficient in today's complex, fragmented and volatile society. Because a healthy living environment cannot be "manipulated" and rational comprehensive decisions based on a full understanding of all impact-effect relationships that account for context and perception are impossible, additional planning strategies need to be developed.

c. How to locate environmentally unhealthy situations and which planning strategies are needed to address them?

A literature review showed that no adequate framework can fully represent the complex web of dynamic processes through which the various determinants of health have their effects. Instead, both health and cities should be considered from a complexity perspective. This does not disprove the rationalist, orderly paradigm or its antithesis of post-modern disorder, but tries to bridge both opposing positions. According to complexity theory, the physical and social reality are composed of a wide range of interacting orderly, complex and disorderly phenomena, necessitating a combination of quantitative and qualitative methods to get insight and to intervene.
To locate environmentally unhealthy situations, an environmental justice claim-making framework was developed, based on ideas of Walker (4.6.1). He distinguishes between the descriptive concept of inequality and the normative concept of injustice, and stresses the aspect of claim-making in environmental justice debates.
To select appropriate planning strategies a matrix was developed with four planning strategies: path-dependent, collaborative, adaptive and co-evolutionary (4.6.2). Depending on the complexity of actor context and spatio-temporal context, another planning strategy may be needed. Apart from the co-evolutionary planning strategy, the matrix also expresses an overarching co-evolutionary idea. This is illustrated by the mutual existence of the different planning strategies, which could not only be applied in specific cases or settings, but also refer to each other in the improvement towards more healthy cities or regions. Citizen initiatives are evolving in relation to existing rules, regulations, environmental impact assessments and environmental health models; and the environmental regulatory framework of the path-dependent strategy could over time and space co-evolve with the more open and complex strategies to these issues.

d. What is the relation between objective exposure to environmental impacts and variables of nuisance, vulnerability, responsibility or housing?

An environmental justice data analysis was carried out for the municipal area of Ghent. It focused on the aspects of traffic noise and air pollution, because of the conclusive evidence of a direction relation of these impacts with health and

well-being, the significant health burden on the Flemish population, the obvious spatial inequality of exposure and data availability. This analysis resulted in four interesting observations.
First, it was found that modeled noise exposure is only weakly related to subjective noise exposure. This can partly be explained by inconsistencies in the noise modeling, but personal characteristics and sensitivity might play a bigger role, as suggested by other research. This raises questions about only using modeled noise maps for assessing the health impacts of noise exposure.
Second, it was found that more vulnerable populations, with lower incomes, more unemployment, and foreign origin, are more exposed to modeled air pollution (but not to modeled traffic noise). This is in line with other research.
Third, it was found that the more cars respondents own and the more they commute by car, the lower their exposure to air pollution in their residential environment. This inequality in distribution of responsibility and exposure to environmental pollution can provide an extra reason to call the situation not only unequal but also unjust. Correlations, however, are rather weak and who commutes by car experiences higher exposure levels to air pollution while driving on busy roads.
Fourth, it was found that neighborhoods with more rental houses, more house moves, a shorter length of residence and lower house prices, bear a higher average exposure to air pollution, and to a much lesser degree to noise. This finding can be interpreted in two ways. On the one hand some people deliberately choose to live in “more polluted” neighborhoods for some years, but others might get stuck in a rental situation, whether or not at the same location, with enduring negative environmental impacts.

e. What do spatial, historical and actor context add to environmental justice debates?

Together with the city of Ghent a smaller case area was selected in the south of the city, around the highway viaducts of E17 and B401. A historical analysis showed that both highways were top-down planned and constructed in the 1960s and 1970s, when the idea prevailed that highways could help reorganize urban areas. However, the different history they have gone through demonstrates the importance of contextual knowledge to understand a situation of environmental inequality.
As for the E17 viaduct, the local resistance against the plans was vigorous but with no end. During its lifetime, protest continued, primarily about the noise produced by the viaduct. This has led to several modifications: noise barriers, reduction of the speed limit and a section speed control system. Today, the pounding noise of the construction joints is the major source of annoyance and led to the emergence of a new pressure group, Viadukaduk. They could convince the city and local politicians to form a local front requesting change. The Flemish Agency for Roads and Traffic promised to alleviate noise exposure by maintenance works in 2020, but a long-term solution is still a long way off. Things are different for the B401 viaduct, or fly-over, which has no history of protest and pressure groups. It seems that environmental pollution plays less of a role here. However, today the future demolition of the viaduct is a symbol of the spatial and mobility policy of the current city council. The Flemish government, administering the road, has agreed with it on condition of a comprehensive city mobility plan.

For the case of the E17 viaduct, the major stakeholders and their claims were further analyzed through documentary analysis. The Ghent city council is merely a mediating actor, supporting their citizens in putting pressure on the Flemish Government. The positions of the Flemish government and the environmental pressure group Viadukaduk illustrate the disconnect described in chapter 3. The Flemish government adheres to a command-and-control policy, with many documents, plans and ideas from different government department, but with few concrete outcomes. The environmental pressure group Viadukaduk distrusts the Flemish government and claims to take a constructive position, by collecting information, consulting experts, networking with politicians and raising awareness among the citizens.
Applying the environmental justice claim-making framework to the case helps to understand the claims of different stakeholders and to gain new perspectives. It shows that there are different ways of how a situation could be judged and many "just" decisions. Applying the matrix of planning strategies shows that today the path-dependent approach is still dominant in the case area, together with attempts to collaborative strategies, individual examples of adaptive strategies and emerging opportunities of self-organizing, co-evolutionary strategies.

f. What do citizens think about environmental health, environmental justice and appropriate planning strategies?

To better understand the opinion of residents in the E17/B401 case area, a survey was developed and conducted. It led to six remarkable results.
First, the relation between perception of environmental impacts and modeled environmental impacts is weak, which means that for the same modeled noise or air pollution level the perception of people varies from low to high annoyance. For exposure to noise, it is known that personal sensitivity and contextual factors play a major role in defining subjective exposure, annoyance and several health effects. This puts the use of modeled noise maps to assess health impacts and take decisions into question. For air pollution, modeled data are still useful, since the health effect is independent from annoyance.
Second, the relation with socio-economic and housing variables differs for objective and subjective exposure. While more vulnerable, less responsible populations and temporary residents experience the highest modeled exposures to air pollution and noise, socio-economically stronger groups and permanent residents are generally more annoyed. This gives reasons to discuss incorporating vulnerability and responsibility aspects in environmental health policy.
Third, the survey results suggest that the opinion on environmental justice is mainly determined by perceived annoyance, and not by socio-economic variables. This lack of empathy for those who are annoyed makes it hard to intervene.
Fourth, only a specific group of people with sufficient time and knowledge, and with higher demands of their environment, seems to find its way to complaint procedures. This probably leaves certain problems underexposed.
Fifth, the majority of people does not question the role of the government, but advocates for additional collaborative and co-evolutionary approaches. However, most people also raise concerns about delay of the decision-making process, the neutrality of citizen initiatives and the attitude of the government towards participation.

Sixth, the population in the case area shows a high personal commitment to participate and adaptively protect their houses. However, socio-economic variables play an important role and especially people with a higher education, higher income, a job and a detached house take additional protective measures and think they can actively participate. It is the same group of people that rather knows the environmental pressure group Viadukaduk and can express its concerns in this way, questioning the unequivocal support of the city for such initiatives.

9.2 Conclusions

Taking the results of the different chapters into account the main research question is recaptured.

> **How can urban planning and environmental health be reconnected to meet the increasingly unique and changing expectations or needs of places and populations?**

At this point it should be stressed that it is impossible to give one specific final "answer". Instead of providing clear-cut solutions, adopting the paradigm of complexity rather enables one to interpret what goes on in the social, economic and political arenas in a new way that recognizes the limits of knowledge and prediction (Geyer & Rihani, 2010). It is also in this way the two developed frameworks should be interpreted: one for assessing the environmental justice of a situation, the other to find appropriate planning strategies. These frameworks do not give a unique solution for a problem but help to understand what is going on, to gain new perspectives and to form new ideas. The framework of environmental justice can be used for understanding and framing the claims of different stakeholders in an environmental justice case, but can also be the basis to discover new aspects and build new ways of reasoning. The matrix of planning strategies does not yield ready-made solutions, but opens up new planning strategies for environmental health in spatial policy.

9.2.1 Applicability of the theoretical framework

The empirical research of this dissertation was narrowed down to the environmental impacts of air pollution and noise, while other environmental impacts were discussed in 3.1. It is an interesting question whether the frameworks would also be applicable to these impacts, i.e. the absence of a restorative environment (green space) and the lack of physical activity because of a non-stimulating environment.

To answer this question, the fundamental difference between the two pairs of impacts should be stressed. Air pollution and environmental noise cause direct, validated, conclusive effects on human health. The pathways from impact to effect are more or less known and there is agreement on good indicators. For the indirect impact of the built environment on mental health and physical activity, the pathways through behavior and lifestyle are not clear and agreed upon. Many

possible confounders and residential self-selection bias complicate the research. In other words, the effect of indirect impacts would be very different for each place and person when compared to the effect of direct impacts. Also, assessing the justice of the distribution of these indirect impacts is harder since people are not "exposed" to an impact they cannot avoid. People can still choose to be physically active or find mental restoration elsewhere, even if their residential environment does not stimulate this.

Thus, applying the claim-making framework to these indirect impacts would have to be approached differently in the sense that discussions on evidence and justice of distribution would be more difficult. For air pollution and noise there is discussion about correct measurements and fair distributions, but for the indirect impacts there is no agreement whatsoever on what should be measured or distributed, because ideas on how to stimulate physical activity or find mental restoration are different for each person.
With regard to the matrix of planning strategies, indirect impacts are impossible to be decided on by path-dependent, top-down strategies. It would be essential to include local context and opinions of residents through adaptive and collaborative strategies if local health improvement is the goal. For example, physical activity might increase by providing indoor sports facilities in one neighborhood, while it might increase by providing bikeways in another. However, it should be noted that the possible measures related to the indirect impacts can also have other benefits. Adding bikeways or green space to a neighborhood is usually done because of other aims than improving local public health, aims that might still be reached by path-dependent strategies.

In summary, the frameworks would be applicable to these impacts as well, providing new insights and perspectives. However, this application would lead to different conclusions. It can be assumed that the frameworks would also be applicable to future environmental problems. They rather provide a specific perspective, a way of broadly evaluating a situation, instead of an approach with fixed steps towards a final judgment.

9.2.2 Reflections on the theoretical framework

The performed application in this dissertation can be brought back to the theoretical framework. The results of this application do not yet lead to fundamental doubts about the two frameworks and the applied concepts but foremost illustrate their usefulness. Both frameworks provide new ideas and perspectives to the planner or researcher, or can be used to communicate and convince planners, civil servants or politicians to adopt another mindset.

A particular strength of the environmental justice framework is the practical translation of concepts of justice. This helps to open up discussions and put things into perspective. While today discussions often stick to claims about evidence and justice of exposure distribution, the framework invites policymakers, citizens or researchers to also think about aspects of vulnerability, responsibility, procedures

and processes behind inequalities. While some parts of the framework are less useful for the case study in this dissertation, such as evidence claims about procedures, this might be different in other contexts. It is also difficult to assess the aspect of justice as recognition, especially in a specific micro case. However, it cannot be simply left out, since recognition plays a crucial role in the actions of all involved stakeholders. To make adaptations to the framework, first other applications should be carried out.

Another strength of the environmental justice framework is that it allows for both an objective and an interpretive approach. While in many practical cases the objective part is limited to measurements of exposure, in this dissertation it was extended. By carrying out a spatial data analysis connected to the environmental justice framework, objective information was gathered for several of the – sometimes considered subjective – dimensions of the framework. For example, inequalities in vulnerability and responsibility were examined in an objective way and a documentary analysis yielded more or less neutral information about the historical background of the case.
However, this further objectivation was combined with an interpretive approach of the opinions and claims of important stakeholders, including citizens. Perception of health impacts is at least as important as the objective health impact in discussions on environmental justice. To take the best decisions and conduct fruitful negotiations, this combination of top-down objective information and bottom-up perception provides the greatest chance of success.

9.2.3 Some ideas about process

By examining the dimension of process through a documentary analysis, a spatial data analysis and a survey, some ideas can be formulated about the underlying processes that led to the spatial inequalities in the case area. However, it is difficult to translate these ideas directly to other situations since spatial, temporal and actor context are always different. Moreover, it is impossible to come to firm conclusions on causal relations based on the data analysis and the survey since both are cross-sectional snapshots and not longitudinal analyses over the course of the years. By carrying out more case studies, and using historical data, claims about process could be better substantiated.

Two interesting findings ask for some explanation. First, it was found that both within Ghent and within the case area a specific group of people is generally exposed to higher modeled levels of air pollution. The people in this group are generally lower educated, have a lower income, are more often unemployed and more often rent their house. The unequal exposure rather seems a coincidence due to the existing building stock. It seems that apartment buildings and small row houses are more often located around the highways and major roads, in Ghent and in the E17/B401 case area. This type of housing attracts renters, lower incomes and lower educated people more than other types of housing. A good example is the “mixed zone” in the case area, where participants of the survey more often responded that financial constraints and low house prices played a role in settling

in the neighborhood. But also other housing typologies are present along the two highways, as the residential area around the E17 viaduct shows. There, many people live in a (semi-)detached house that was built long after the viaduct was built. This supports the idea that it is not a deliberate choice of a specific socio-economic group of citizens to live or not live in an area with high pollution levels. While it seems like a coincidence today, a more detailed look into historical data is needed to examine how the composition of these neighborhoods changed over the years or not.

A second interesting finding is related to the different subjective exposure and opinion on the viaducts in the different neighborhoods of the E17/B401 area. While objective (modeled) exposure is high everywhere around the viaducts, people react very differently. The main reason seems to be the expectations of the residential environment. A comparison of the two most different neighborhoods illustrates this. In the B401 zone respondents feel less exposed or annoyed and do not complain much about the viaduct. This can be explained by the profile of the residents. They are more often renters who live in an apartment without garden and who plan to live in the neighborhood only for a temporary period of time. Moreover, they live in an urban environment and do not necessarily point to the viaduct as the most important disturbing factor in their environment (according to the survey). It seems they accept an environment with some nuisance, maybe by balancing it against other factors such as accessibility or distance to the city center.
In the E17 zone things are different. Residents of this zone feel more exposed and annoyed, point to the viaduct as the most disturbing factor in their environment and even start to protest against it. This can again be explained by the profile of residents in this zone. They are more often owners of a comfortable house with a garden where they plan to live for many years. Moreover, many of them settled in the neighborhood because of the presence of green space, parks and trees (according to the survey). It seems they expected a rather quiet residential area, close to the city and with good accessibility. The survey result that for most residents annoyance has increased over the years may indicate that for some of them this is an unexpected source of nuisance. Since this does not fit their residential preferences of a suburban neighborhood where they would like to continue living, they complain more and start to protest. Finally, it cannot be ignored that the growing media attention and the actions of the citizen initiative Viadukaduk raised further awareness in this area, leading to more concern.

9.3 Policy recommendations

Although the results and experiences of the E17/B401 case have not been verified in a second case, some policy recommendations are formulated. These are probably also valid for other cases, at least in Flanders but maybe in a large part of the Western world. The recommendations are based on the empirical results of the research and try to translate these to concrete actions and policy strategies.

The basic idea behind the recommendations is the fact that, notwithstanding the conclusive evidence on the health effects of environmental impacts, there is no

objective and absolute truth on the environmental justice of a specific situation, and not one "right" policy decision. Injustice is a normative term that always involves a form of judgment or claim, thus claim-making is central to an environmental justice perspective (Walker, 2012). The basic combination in claim-making is to link evidence of a condition of inequality with a normative position on what is just or unjust. A claim on environmental justice thus usually depends on two main factors, the information the claim-maker possesses and his or her normative position.

- When citizens make claims, the factor information is heavily determined by perception of impacts. In general, citizens would likely pay more attention to environmental noise, while the health effects of air pollution are much larger. On the other hand, the normative position on what is just or unjust is related to expectations of the environment. In the residents survey was found that lower educated people, lower income people, renters and people who live in an apartment generally set lower expectations of their environment and make less complaints.

- The government is not biased by its own subjective experience of impacts, since it does not "live" in the neighborhood, and thus could have a more neutral perspective on the information. In theory, it has to make an important normative choice between (a combination of) different principles that are all just in a certain way: considering all people equally and aiming for a minimum environmental quality for everyone, giving priority to the more vulnerable ones or to those who contribute less to environmental pollution, giving priority to permanent residents instead of temporary renters, and so on. In practice, political concerns are often more important than ethical or public health considerations. A government would probably rather invest in noise abatement measures instead of measures to improve air quality, since citizens would value the first more. If the effect on public health was the starting point, much more resources would be attributed to air pollution than is happening today (both at city and Flemish level).

With this idea in mind, five policy recommendations were formulated that constitute a "roadmap" towards a better integration of planning and environmental health, with different "aims" along the road that together can support a longer process of system innovation.

1. **The current environmental regulatory framework should be revised and strengthened to better protect a minimum environmental quality for everyone.**

In the residents survey it was found that the majority of people does not question the role of the government. The current environmental regulatory framework with its generic norms, regulations, guidelines and environmental assessments should not be abandoned. By protecting legal security and equal treatment, this strategy can prevent the greatest environmental health excesses and care for a minimum environmental quality for everyone. In addition, setting general policy goals (such as the aim of Ghent city to decrease the traffic noise level at all houses below 70 dB(A) by 2030 or the European legal limit values for air pollution) ensures an active environmental health policy.

However, some adaptations to the current environmental regulatory framework are needed to make it more powerful. First of all, the instrument of environmental assessments should be adapted and reinforced. Environmental assessments should play a role in redressing the systematic environmental imbalances, explicitly recognizing that the public is not a homogenous group that has equal access to participatory processes (Walker, 2010). Therefore, there must be more room and appreciation for local contextual information in environmental assessments, as well as more participation possibilities and involvement of environmental health (medical) experts. Environmental assessments also should be able to propose obligatory mitigation measures or changes to plans or projects. Finally, the neutrality of assessments should be guaranteed by imposing an evaluation of the assessment report by a second group of experts.

The way of assessing the impacts of air pollution and noise should also be revised. For noise, it was found that modeled noise data are not a good proxy to assess annoyance, sleep disturbance and other stress-related health effects. Annoyance is much more dependent on personal sensitivity and perception, factors that cannot easily be included in modeling. Therefore, also subjective indicators of noise exposure should be taken into account in assessment processes and environmental health policy in general. For air pollution the health effect is independent from annoyance, so modeled data are still useful. Since the health effect of air pollution is much greater than the health effect of noise, governments should pay much more attention to air pollution than today. This can take concrete form by attributing a greater importance to air pollution in environmental assessments, or using air quality modeling in early stages of the planning process.

Finally, aspects of vulnerability and responsibility of populations should receive more attention in assessments and policymaking on environmental health issues. The general striving for a minimum environmental quality for everyone should be combined with additional actions that prioritize more vulnerable populations that are often also less responsible for environmental pollution. These populations have a lower socio-economic status, are more susceptible to the negative health impacts, while they often have less choice of residence and contribute less to environmental pollution (by means of private motorized transport). However, it is not a good idea to make a distinction between people who settled in the neighborhood before or after a polluting infrastructure was built, since the dynamics of the housing markets leave certain groups of people few choice and also the nuisance of existing infrastructures can change fundamentally over the years. To prevent future discussions on responsibility, guidelines should be developed for building at highly exposed locations. Also for the financing of mitigating measures to alleviate exposure the aspect of responsibility can be applied, e.g. by investing road pricing revenues in mitigating measures for traffic noise and air pollution.

2. Additional adaptive and collaborative planning strategies are needed to meet context-specific expectations and needs.

While the health effects of environmental impacts – such as air pollution and noise – on a population level are quite predictable and linear, in a local context

they are far more complex than a simple standard can account for. Universal interpretations and generic solutions can set general benchmarks but are not sufficient in meeting context- and actor-specific expectations that change over time (de Roo, 2000). Instead, creative adaptive solutions for specific situations are needed, in collaboration with the stakeholders at hand. These adaptive and collaborative strategies can be used in (infrastructure) planning processes, but can also be proactively applied if environmental health problems are detected by the government or indicated by citizens.

Adaptive solutions can be taken both at household level and neighborhood level. At household level, the installation of soundproofing or air filtration are good examples. These measures can be taken voluntarily or can be subsidized by the government. However, if measures necessitate personal initiative or financial contribution, one should be aware that especially socio-economically stronger population groups will take additional protective measures in their house. In this case the (city) government has to focus information and subsidization campaigns on more vulnerable groups with bigger health risks, which otherwise would not protect themselves. The subsidizing of soundproofing or air filtration to alleviate exposure can happen at project basis, and would then be considered an adaptive strategy. But once it becomes part of the environmental regulatory framework of a city or region it would become a generic rule and be considered a path-dependent strategy. As such this example illustrates the co-evolutionary idea behind the matrix of planning strategies.

At local level, with regard to the impacts of air pollution and traffic noise, adaptive measures can range from speed reduction to redirecting truck traffic and abandoning roads. Particularly for noise there is a broad scope for creative intervention, since perception is a determining factor for experiencing annoyance, sleep disturbance and several health effects. Thus, interventions should not only be targeted to reducing sound levels but can also try to change people's perception of exposure. Adding more green space, redesigning a neighborhood or just revising noise barrier aesthetics can all have a mediating effect and alleviate noise annoyance. Since perception plays such a big role and because of the valuable local and contextual information citizens can provide, a collaborative approach can help to find adaptive solutions.
However, consulting residents' groups and citizens is not without risk. It is often a specific group of younger, socio-economically stronger people that own a house that rather engage themselves. Moreover, the residents survey showed that most people mainly consider their own perceived annoyance to judge the justice of a situation, and in case they are not bothered lack empathy for the situation of who does feel annoyed or exposed. As environmental health will always be a personal and subjective issue, the government must keep some regulatory power and, as initiator of collaborative processes, ensure that a representative delegation of society takes part in these processes. Socio-economic groups that are difficult to reach through participatory policy and cannot raise their concerns through residents pressure groups, should be proactively involved or represented by intermediates. According to the residents survey, these groups are more often older, low-income and low-educated citizens and/or citizens who live only temporarily in the neighborhood in a rental apartment or house and have less expectations of environmental quality.

This recommendation applies to the case of B401, which has never known much protest or concern from citizens or pressure groups about environmental health. Also the residents survey did not point to major annoyance about traffic noise and air pollution in the neighborhood, probably because many residents deliberately choose for an urban environment and balance the lower environmental quality against location advantages of accessibility and facilities. Moreover, the neighborhood has a high share of rental houses where people only live temporarily, with lower requirements of the environment. The current plans to redevelop the area are rather a symbol of the spatial and mobility policy of the city council. In such a case, initiated by the government, the best way to deal with environmental health is proactively setting up a participatory process in which also the aspect of environmental health is discussed. Models and norms of environmental exposure can be an element in the discussion, but also residents' perception and specific local circumstances can be incorporated. While people living next to the B401 will probably experience a decrease in exposure, other people might experience an increase. The area that is invited to participate should be adapted accordingly. In this case the current approach of the city to set up a participative process might be a good choice. However, the city has to make every effort to include a representative part of the population. The residents survey showed that particularly renters, lower educated people, non-Belgians and older people are difficult to reach in this area.

3. Self-organizing strategies for environmental health can be fruitful, but government and research community remain necessary as a stabilizing factor.

Self-organizing initiatives, such as the Viadukaduk pressure group, spontaneously emerge to address environmental issues at hand. Their engagement can be very useful in revealing environmental health issues, collecting bottom-up contextual information, raising awareness among citizens and producing novel approaches to spatial conflicts (Glouberman et al., 2006). However, the self-evidence of a positive outcome of a fully co-evolutionary planning strategy for a fundamental issue such as public health is highly unsure. While co-evolution might lead to a fitter situation, it probably does not lead to a fairer situation. If a government too blindly adapts its way of addressing environmental health to changing awareness and perception of a certain part of the population, fair outcomes are not necessarily reached. It tends to be a specific group of people that actively engages with local citizen initiatives. According to the residents survey, these are usually younger, higher educated and higher income people, who own a house and have a job. This socio-economically strong and active group is not representative of the whole population, questioning the unequivocal support of the city for such initiatives. Moreover, people base their opinion mainly on their own perception and knowledge and not easily show empathy for others who have a different perception of the problem. If people do not dispose of the necessary information or do not feel annoyed, they will not take action. Therefore, environmental noise still more easily brings people into action compared to air pollution.

This does not mean all spontaneous bottom-up initiatives should be counteracted. Their expertise and commitment can be usefully incorporated in planning policy under certain conditions. At best, the government takes up an intermediate role,

counterbalancing the local initiative and caring for the equal representation of all citizens. This strategy applies to the case of E17, where the debate has emerged somewhat in a self-organizing way but quickly received the support of the city government, leading to a united front against the Flemish government. At best, the city government extends the debate, now focusing on the E17 viaduct, to nearby areas where environmental problems are at least as severe. Particular attention must go to the "mixed zone" in the case area, consisting of a part of Ledeberg where pollution levels are as high as in the E17 zone but where the lower environmental quality is taken for granted. The data analysis and survey showed that people in this zone are socio-economically weaker and often end up in the neighborhood because of financial constraints. Moreover, many residents do not feel recognized by the government, nor represented by Viadukaduk. Instead of only supporting Viadukaduk without further action, the city could grab the opportunity to build on the engagement and initiative of the residents group and extend the discussions to the Ledeberg area to reach a more just policy. Probably traditional participation approaches would not work in this area. But through local community centers and by actively engaging in local networks residents should be reached. In this way, the story becomes more than meeting the concerns of one pressure group, building a wider support base without losing the engagement and commitment of the initial initiative. In terms of the matrix of planning strategies it would mean that the city would seize the self-organizing initiative to set up a collaborative process to find adaptive solutions, safeguarding the fairness and equal representation of the population. Probably this is a too idealistic idea, since it would require proactive action of the city and a lot of time and money, with few added value in a political way. People who do not recognize the problem, will not complain about a government not solving it.

4. **A shared knowledge base is needed, with transparent and understandable dissemination of environmental health information, to raise awareness and have fair discussions on normative aspects.**

Because of the complexity of environment and health, it is impossible for planners, policymakers or citizens to have complete information on environmental health effects nor understand all available information. However, as said before, information is a crucial aspect in environmental justice claim-making, where evidence of a condition of inequality is linked with a normative position on what is just or unjust.

Today environmental justice discussions are for a large part on the evidence of exposure, on what constitutes reliable information. In the case of E17/B401 the citizen movement Viadukaduk does not agree with the methodology of the noise and air pollution maps, and contests the noise measurements of the Flemish government. The Flemish government in turn does not consider the local subjective concerns and measurements valid. This is in line with the idea of Walker (2010) that gathering evidence is a claim for knowledge, authority and power, because evidence is always problematic, not a matter of simple fact and truth, but produced through social processes.

To avoid discussions about evidence as much as possible and to focus the debate on normative aspects with correctly substantiated claims, a shared knowledge base should be built. It should constantly be updated with available information, both top-down expert knowledge and bottom-up local and subjective knowledge. Such a collective knowledge base could also change attitudes, raise awareness among planners, policymakers and citizens, and remove the distrust between different actors. At best, a shared knowledge base would banish misinformation and lead to fair and transparent discussions on ethical and normative aspects of policy choices. It would allow the government to take better decisions and citizens to be well-informed participants in planning processes.

To reach a shared knowledge base a transparent dissemination of information is necessary, both within the government and between the government and the public. At government level, this is only possible when the policy fields of environment, health, public works and planning evolve towards more interdisciplinary data integration. For the relation between the government and the public, the sharing of understandable information is even more crucial. Open digital platforms should be developed on which different sources of knowledge can be combined and interpreted. These platforms can encourage citizens to gain a broader picture of the situation based on objective top-down information, e.g. to make citizens aware of the health consequences of air pollution. In return, their local contextual information – such as perceived noise annoyance – should be transferred to the government. As such situational information is connected to empirical research evidence. However, collecting empirical evidence should not be the exclusive task of the government. The recent evolutions towards participatory, community-based measurement campaigns for air quality or noise are very valuable in counterbalancing the models and data of the government. Good examples are the citizen science projects of “CurieuzeNeuzen” or “AIRbezen” in the city of Antwerp, collecting local air pollution data but at the same time raising awareness. By these kinds of initiatives, the debate is increasingly opened up, allowing for fair environmental justice discussions.

5. Planners should be trained to take different roles and protect the public interest.

To realize the four recommendations outlined above, planners should be trained to take different roles, connected to the different planning strategies. In the path-dependent planning strategy, the planner is foremost an officer, who follows the rules and procedures of the environmental regulatory framework. In the adaptive strategy, the planner is an entrepreneur, who collects local contextual information and looks for customized solutions. In the collaborative strategy, the planner is a mediator or negotiator, who guides the negotiations by caring for an equal representation of all stakeholders and protecting the public interest. At last, in a co-evolutionary strategy, the planner would be a participant that should be very engaged and committed to bring the aspects of justice, vulnerability and responsibility into the discussion.

Particularly the entrepreneurial and mediating role of the planner are important in evolving towards a reconnection of environmental health and planning. Therefore, planners should be trained to at least understand the contribution of disciplines of environment and health, and to interpret and formulate legitimate claims about environmental justice. This requires adaptations to the educational programs of urban planning. As such, planners would not just leave the aspect of environmental health to regulated processes, but already be concerned with environmental health effects in the early stage of a spatial or infrastructural project. At best, they would be skilled to recognize possible adverse effects and devise suitable adaptive planning strategies, in collaboration with citizens but also specialists in environmental health. In these multi-actor and multi-disciplinary settings, the planner must keep an eye on legal security, equal treatment and fair representation, whereby vulnerability and responsibility can be important factors.

9.4 Recommendations for further research

Concerning the case E17/B401 the conducted research is still quite quantitative, relying heavily on spatial data analysis and a residents survey. While the survey is representative for the population in the case area, some groups are probably underrepresented. To make further progress in this case, the next step would be to organize focus groups with populations that are difficult to reach such as foreigners, lower educated people, students that are not officially registered in the area and other users of the area that live elsewhere. In addition, in bilateral interviews with the major stakeholders (Flemish government, city government and residents group) the results of the survey and the focus groups can be discussed. Finally, all stakeholders should meet with a representative sample of the population (or intermediates), to collaboratively find adaptive solutions for the short and the long term. The urban planner and/or the researcher could have an intermediate role in this discussion, keeping an eye on equal representation and legal security, and bringing aspects of environmental justice, vulnerability and responsibility into the debate. The spatial scope of this debate should not be set too narrowly and also environment and health researchers should take part in it. As such, the action-research approach of this dissertation might lead to effective change on the ground.

At a more general level it is essential to explore more cases, since ideas on environmental justice and planning strategies might depend on social, economic, cultural and political contexts. Similar case studies with data analysis, documentary analysis, a survey and maybe focus groups would allow for firmer conclusions. Such a situational approach seeks to explain how effects are being produced in different configurations, instead of just characterizing the effects by the type of context. It would lead to a further refinement of the practicability of the two developed frameworks and more informed policy recommendations.
New case studies can be located in Ghent but preferably also in other cities with different planning cultures, since this probably has a big impact on the preferred planning strategies. It would also be interesting to examine a neighborhood where no environmental threat is at stake, to check what these people think about environmental justice.

Looking back on the research, other important gaps in knowledge about this issue appear.
First, more research is needed on the communication and dissemination of environmental health information. It should be examined which environmental health data are useful in planning processes and how these data can be translated in an understandable way. It should also be explored how environmental health information can be best shared with the public in a transparent way and who should control such shared digital data platforms.
Another important missing element in this dissertation is the aspect of accessibility. It might play a big role in residential choices and be balanced against negative characteristics like environmental noise. Further data analyses are needed to explore this idea.
Finally, also the economic aspect was not assessed in this research. At population level, evolutions in environmental health – especially air pollution – are often translated in economic costs and benefits. Further research should examine whether cost-benefit analyses of environmental health are applicable and useful for comparing local projects as well. At first sight, it seems impossible to monetize all benefits of an environmental health intervention, because of the complexity of environment-health interrelations and the various non-health effects of interventions. But if reliable cost-benefit analyses for environmental health interventions would be possible, they could guide governments in investing their resources as efficiently as possible and provide a means of communication to the public.

10

Appendices

10.1 Appendix A1 – survey in Dutch

Enquête **34ZKFM**

Snelwegviaducten E17 en B401: heden en toekomst

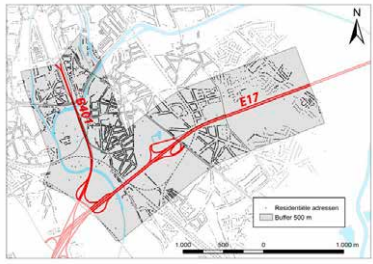
BELANGRIJKE TOELICHTING

Waarover gaat deze vragenlijst?

De vragenlijst gaat over de snelwegviaducten E17 en B401 (fly-over), die Gent-Zuid, Ledeberg en Gentbrugge doorkruisen. U woont op minder dan 500 meter van (minstens) één van deze viaducten. Afhankelijk van uw woonplaats heeft de enquête voor u dus betrekking op de E17, de B401 of beide.

De vragenlijst bestaat uit drie delen.

1. Huidige situatie: ervaart u vandaag omgevingshinder veroorzaakt door de viaducten en hoe gaat u daarmee om?
2. Beleidsstrategieën: moet deze ruimtelijke situatie aangepakt worden en hoe dan wel?
3. Algemene vragen over uzelf en uw gezin.



Wie moet de vragenlijst invullen?

De persoon naar wie de vragenlijst verzonden is. De naam van deze persoon vindt u bovenaan de begeleidende brief. De vragen moet u **persoonlijk** beantwoorden. Als u een vraag niet goed begrijpt of niet kan invullen, mag u natuurlijk uitleg vragen aan iemand, maar we willen wel **uw eigen mening** weten.

Hoe moet u ze invullen?

- Bij sommige vragen en antwoorden staat aangeduid dat u vragen mag overslaan. Volg hiervoor de in **rood** aangegeven instructies naast de vraag of het antwoord.
- Vul bij elke vraag **iets** in. U hebt altijd de optie om "geen mening", "ik weet het niet" of "andere" in te vullen. Een vraag waar niets bij aangeduid is, is ongeldig.
- Tenzij anders aangegeven, dient u één antwoord te geven op elke vraag.
- U kan de vragenlijst ook invullen via de link http://www.ugent.be/viaduct en de inlogcode die u bovenaan deze pagina vindt.
- Het invullen van de vragenlijst neemt ongeveer 15 minuten in beslag.

Hoe terugsturen?

Gelieve de ingevulde vragenlijst terug te sturen in **bijgevoegde enveloppe**. U hoeft geen postzegel te kleven en geen adres te noteren. De vragenlijst dient uiterlijk tegen **29 februari 2016** online ingevuld of per post teruggestuurd te worden.

Bescherming van de privacy

Het identificatienummer op de vragenlijst is nodig om te achterhalen wie een ingevulde vragenlijst heeft teruggestuurd. Uw antwoorden worden volledig anoniem verwerkt. Individuele antwoorden worden niet gepubliceerd, enkel de samengevoegde antwoorden van een grote groep mensen.

Vragen?

Voor vragen in verband met deze enquête kunt u contact opnemen met Thomas Verbeek via Thomas.Verbeek@UGent.be of 09 331 32 51.

Wij danken u van harte voor uw medewerking!

1 Huidige situatie – hinder

1.1 **Als u denkt aan de voorbije 12 maanden, hoe vaak had u in uw buurt last van verkeerslawaai?**
Met verkeerslawaai bedoelen we zowel wegverkeer (inclusief tram) als spoorverkeer. Indien u in de voorbije 12 maanden bent verhuisd, heeft de vraag enkel betrekking op uw huidige buurt.
○ nooit (➔ 1.4) ○ zelden ○ af en toe ○ vaak ○ altijd ○ ik weet het niet

1.2 **Wanneer had u last van verkeerslawaai?**
○ voornamelijk overdag ○ enkel overdag ○ zowel overdag als 's nachts
○ voornamelijk 's nachts ○ enkel 's nachts ○ ik weet het niet

1.3 **Denkt u dat dit verkeerslawaai mee veroorzaakt wordt door de nabijgelegen autosnelwegviaducten van de B401 (fly-over) en/of de E17?**
○ ja, deze snelwegen zijn voor mij de belangrijkste bron van verkeerslawaai
○ ja, maar andere wegen of spoorwegen in mijn buurt dragen evenveel bij tot het verkeerslawaai
○ ja, maar andere wegen of spoorwegen in mijn buurt dragen veel meer bij tot het verkeerslawaai
○ nee, deze dragen niet bij tot het verkeerslawaai, ik heb er geen last van
○ ik weet het niet

1.4 **Wat denkt u over uw blootstelling aan verkeerslawaai als u die vergelijkt met de gemiddelde Gentenaar?**
○ ik heb een veel hogere blootstelling ○ ik heb een lagere blootstelling
○ ik heb een hogere blootstelling ○ ik heb een veel lagere blootstelling
○ ik heb een gelijkaardige blootstelling ○ ik weet het niet

1.5 **Maakt u zich zorgen over verkeerslawaai in uw buurt en de mogelijke effecten op uw gezondheid?**
○ heel erg ○ eerder wel ○ eerder niet ○ helemaal niet ○ ik weet het niet

1.6 **Denkt u dat u gezondheidsproblemen hebt die veroorzaakt of verergerd worden door verkeerslawaai?**
○ ja, zeker ○ ja, misschien ○ nee, zeker niet ○ ik weet het niet

1.7 **Als u denkt aan de voorbije 12 maanden, hoe vaak had u in uw buurt last van luchtverontreiniging?**
Indien u in de voorbije 12 maanden bent verhuisd, heeft de vraag enkel betrekking op uw huidige buurt.
○ nooit (➔ 1.9) ○ zelden ○ af en toe ○ vaak ○ altijd ○ ik weet het niet

1.8 **Denkt u dat deze luchtverontreiniging mee veroorzaakt wordt door de nabijgelegen autosnelwegviaducten van de B401 (fly-over) en/of de E17?**
○ ja, deze snelwegen zijn voor mij de belangrijkste bron van luchtverontreiniging
○ ja, maar andere wegen in mijn buurt dragen evenveel bij tot de luchtverontreiniging
○ ja, maar andere wegen in mijn buurt dragen veel meer bij tot de luchtverontreiniging
○ nee, deze dragen niet bij tot de luchtverontreiniging, ik heb er geen last van
○ ik weet het niet

1.9 **Wat denkt u over uw blootstelling aan luchtverontreiniging als u die vergelijkt met de gemiddelde Gentenaar?**
○ ik heb een veel hogere blootstelling ○ ik heb een lagere blootstelling
○ ik heb een hogere blootstelling ○ ik heb een veel lagere blootstelling
○ ik heb een gelijkaardige blootstelling ○ ik weet het niet

1.10 **Maakt u zich zorgen over luchtverontreiniging in uw buurt en de mogelijke effecten op uw gezondheid?**
○ heel erg ○ eerder wel ○ eerder niet ○ helemaal niet ○ ik weet het niet

1.11 **Denkt u dat u gezondheidsproblemen hebt die veroorzaakt of verergerd worden door luchtverontreiniging?**
○ ja, zeker ○ ja, misschien ○ nee, zeker niet ○ ik weet het niet

1.12 **Wat is voor u de belangrijkste bron van omgevingshinder in uw buurt?**
○ verkeerslawaai ○ luchtverontreiniging ○ iets anders: .....

1.13 **Hoe belangrijk is uw woonomgeving voor uw levenskwaliteit?**
○ heel erg ○ eerder wel ○ neutraal ○ eerder niet ○ helemaal niet ○ geen mening

2 Huidige situatie – rechtvaardigheid

2.1 **In de nabijheid van de autosnelwegviaducten E17 en B401 wonen inwoners die verhoogd worden blootgesteld aan verkeerslawaai en luchtverontreiniging. Wat is uw mening over de volgende stellingen?**
Duid per rij één antwoord aan.

	helemaal akkoord	eerder akkoord	neutraal	eerder niet akkoord	helemaal niet akkoord	geen mening
1. Iedereen is vrij om te wonen waar hij wil en moet de gevolgen dragen van hinder in zijn omgeving.	○	○	○	○	○	○
2. Iedereen heeft recht op een minimum aan omgevingskwaliteit, ongeacht waar hij woont.	○	○	○	○	○	○
3. Het is niet eerlijk dat mensen die vlakbij de viaducten van E17 of B401 (fly-over) wonen, aan hoge niveaus van geluidshinder en luchtverontreiniging worden blootgesteld.	○	○	○	○	○	○
4. Wanneer omgevingshinder effect heeft op de gezondheid, moet de overheid ingrijpen.	○	○	○	○	○	○
5. Niet enkel de overheid is verantwoordelijk voor de hinder van de viaducten E17 en B401 (fly-over), de mensen die er wonen zijn mee verantwoordelijk.	○	○	○	○	○	○
6. De omgevingshinder rondom de E17 en B401 is onaanvaardbaar en moet aangepakt worden.	○	○	○	○	○	○

3 Huidige situatie – woning en verhuisplannen

3.1 **Bent u eigenaar of huurder van uw woning?** ○ eigenaar ○ huurder

3.2 **In wat voor type woning woont u?**
○ vrijstaande eengezinswoning ○ rijwoning ○ studio
○ half-vrijstaande eengezinswoning ○ appartement ○ kamer

3.3 **Hebt u een buitenruimte aan de woning, zoals een tuin of terras?** ○ ja ○ nee

3.4 **Sinds wanneer woont u hier?** *Vul een jaartal in.*
... ...

3.5 **Waarom hebt u gekozen om hier te wonen?**
Meerdere antwoorden mogelijk.
❒ ik woon er al heel mijn leven (➔ 3.7)
❒ ik heb de woning toegewezen gekregen
❒ afstand woon-werk verkeer
❒ nabijheid kinderen/ouders
❒ nabijheid familie/vrienden
❒ aanwezigheid groen/parken/bomen
❒ aangename buurt
❒ voldoende voorzieningen
❒ goede bereikbaarheid per auto
❒ goede bereikbaarheid per openbaar vervoer
❒ lage woningprijzen
❒ andere: .....

3.6 **Was u zich bewust van mogelijke lawaaihinder en luchtverontreiniging toen u hier kwam wonen?**
Meerdere antwoorden mogelijk.
- ☐ ja, maar de voordelen van de locatie wogen op tegen de nadelen
- ☐ ja, maar ik had weinig andere keuze (bv. omwille van financiële beperkingen en woningaanbod)
- ☐ ja, maar het leek draaglijk
- ☐ nee

3.7 **Is de hinder van verkeerslawaai veranderd in de loop van de tijd dat u hier woont?**
- ○ de hinder is heel erg toegenomen
- ○ de hinder is een beetje toegenomen
- ○ de hinder is op hetzelfde niveau gebleven
- ○ de hinder is een beetje afgenomen
- ○ de hinder is heel erg afgenomen
- ○ ik weet het niet

3.8 **Is de hinder van luchtverontreiniging veranderd in de loop van de tijd dat u hier woont?**
- ○ de hinder is heel erg toegenomen
- ○ de hinder is een beetje toegenomen
- ○ de hinder is op hetzelfde niveau gebleven
- ○ de hinder is een beetje afgenomen
- ○ de hinder is heel erg afgenomen
- ○ ik weet het niet

3.9 **Denkt u binnen de komende twee jaar te zullen verhuizen?**
- ○ nee (➔ 3.11)
- ○ misschien
- ○ ik zou wel willen, maar ik vind geen geschikte woning
- ○ ik zou wel willen, maar ik heb niet de nodige middelen
- ○ zeker wel
- ○ ik heb reeds een nieuwe woning gevonden

3.10 **Waarom gaat u of zou u willen verhuizen?**
Duid de belangrijkste redenen aan (maximum drie).
- ☐ persoonlijke omstandigheden (huwelijk, echtscheiding, ziekte, ...)
- ☐ werkgerelateerde omstandigheden
- ☐ ontevredenheid met de huidige woning
- ☐ ontevredenheid met de huidige buurt
- ☐ lawaaihinder in de huidige buurt
- ☐ luchtverontreiniging in de huidige buurt
- ☐ ik wil weg uit de stad
- ☐ andere: .....

3.11 **Zou u bij de keuze van een nieuwe woning rekening houden met verkeerslawaai en/of luchtverontreiniging?**
○ ja, zeker ○ ja, misschien ○ nee ○ ik weet het niet

4 Huidige situatie – klachten

4.1 **Hebt u ooit een klacht ingediend over verkeerslawaai of luchtverontreiniging?**
○ ja, als individuele burger ○ ja, als lid van een groep ○ nee (➔ 4.3) ○ ik weet het niet (➔ 5.1)

4.2 **Kan u verduidelijken op welke manier u ooit een klacht heeft ingediend?**
.....
.....
.....
(➔ 5.1)

4.3 **Waarom hebt u nog nooit een klacht ingediend over verkeerslawaai of luchtverontreiniging?**
Meerdere antwoorden mogelijk.
- ☐ ik vind het verkeerslawaai en de luchtverontreiniging in mijn omgeving aanvaardbaar
- ☐ ik weet niet hoe en waar ik een klacht kan indienen
- ☐ er wordt niet naar mij geluisterd
- ☐ er wordt niets gedaan met mijn klacht
- ☐ andere: .....

5 Beleidsstrategieën – overheid

5.1 **Er kan voor gekozen worden om een ruimtelijke problematiek zoals die van de snelwegviaducten E17 of B401 (fly-over) volledig aan de overheid over te laten. Hieronder volgen een aantal stellingen over deze aanpak. Geef aan of u met de stelling akkoord gaat of niet.**
Duid per rij één antwoord aan.

	helemaal akkoord	eerder akkoord	neutraal	eerder niet akkoord	helemaal niet akkoord	geen mening
1. De overheid is het best in staat om lokale hinder af te wegen tegenover de belangen op grotere schaal (bv. economisch).	○	○	○	○	○	○
2. De overheid denkt in het belang van alle burgers.	○	○	○	○	○	○
3. De overheid beschikt over de beste, onpartijdige informatie wanneer het gaat over problemen van milieuhinder (bv. geluidsoverlast en luchtverontreiniging).	○	○	○	○	○	○
4. Bepaalde bevolkingsgroepen of buurten zijn voor de overheid minder belangrijk en krijgen minder aandacht in het beleid.	○	○	○	○	○	○

5.2 **Er zijn verschillende beleidsniveaus betrokken in de problematiek van de snelwegviaducten E17 en B401. Hoe goed kent u hun beleid?**
Duid per rij één antwoord aan.

	ja, zeer goed	ja, gedeeltelijk	nee
1. Ik ken het standpunt en beleid van de Stad Gent met betrekking tot de snelwegviaducten E17 en B401 (fly-over).	○	○	○
2. Ik ken het standpunt en beleid van het Vlaams Gewest met betrekking tot de snelwegviaducten E17 en B401 (fly-over).	○	○	○
3. Ik ken de Europese milieunormen voor luchtverontreiniging en geluidsoverlast.	○	○	○

5.3 **Hieronder volgen een aantal stellingen over uw vertrouwen in het beleid van de verschillende overheidsniveaus, met betrekking tot de snelwegviaducten en de daardoor veroorzaakte milieuhinder. Geef aan of u met de stelling akkoord gaat of niet.**
Duid per rij één antwoord aan.

	helemaal akkoord	eerder akkoord	neutraal	eerder niet akkoord	helemaal niet akkoord	geen mening
1. Ik heb vertrouwen in het beleid van de Stad Gent met betrekking tot de toekomst van de snelwegviaducten E17 en B401 (fly-over).	○	○	○	○	○	○
2. Ik heb vertrouwen in het beleid van het Vlaams Gewest met betrekking tot de toekomst van de snelwegviaducten E17 en B401 (fly-over).	○	○	○	○	○	○
3. Ik heb vertrouwen in de Europese milieunormen voor luchtverontreiniging en geluidsoverlast.	○	○	○	○	○	○

6 Beleidsstrategieën – participatie

6.1 **De overheid kan er ook voor kiezen om burgers te betrekken in haar beleid en haar plannen. Dit noemt men participatie. Geef aan of u met de stelling akkoord gaat of niet.**
Duid per rij één antwoord aan.

	helemaal akkoord	eerder akkoord	neutraal	eerder niet akkoord	helemaal niet akkoord	geen mening
1. Door burgers te betrekken bij het beleid kan men betere oplossingen bereiken.	○	○	○	○	○	○
2. Door burgers te betrekken bij het beleid worden beslissingen vertraagd.	○	○	○	○	○	○
3. De belangen van de burgers worden beter verdedigd wanneer zij zelf worden betrokken bij het beleid.	○	○	○	○	○	○
4. Wanneer de overheid inspraak van de burgers organiseert, doet ze vaak niets met het resultaat.	○	○	○	○	○	○
5. De Stad Gent doet vandaag inspanningen om burgers te betrekken bij het beleid.	○	○	○	○	○	○
6. Het Vlaams Gewest doet vandaag inspanningen om burgers te betrekken bij het beleid.	○	○	○	○	○	○

6.2 **Vindt u dat de overheid burgers moet betrekken in de zoektocht naar een oplossing voor de omgevingshinder veroorzaakt door de snelwegviaducten van de E17 en de B401?**
○ ja, zeker ○ ja, misschien ○ nee, zeker niet ○ ik weet het niet niet **(➔ 6.4)**

6.3 **Waarom vindt u dat?**
.....
.....
.....

6.4 **Denkt u dat u voldoende kennis en vaardigheden hebt om zelf deel te nemen aan de zoektocht naar een oplossing voor de omgevingshinder veroorzaakt door de snelwegviaducten van de E17 en de B401?**
○ ja, zeker ○ ja, misschien ○ nee, zeker niet ○ ik weet het niet niet

6.5 **Wil u zelf betrokken worden bij het zoeken naar een oplossing?**
○ ja, zeker ○ ja, misschien ○ nee, zeker niet ○ ik weet het niet niet

7 Beleidsstrategieën – milderende maatregelen

7.1 **Om de omgevingshinder te verminderen kan gezocht worden naar milderende maatregelen. Deze maatregelen kunnen door de overheid worden uitgevoerd, maar ook door andere partijen.**

Welke maatregelen zijn er in uw woning al genomen om de blootstelling aan verkeerslawaai en luchtverontreiniging te verminderen? Welke zijn er nog nodig?
Duid per rij tweemaal een antwoord aan. Ook maatregelen die al genomen zijn, kunnen nog meer nodig zijn. Er kan bijvoorbeeld al geluidsisolatie aan één gevel zijn, maar er is misschien nog méér nodig.

	maatregel **genomen**			maatregel nog (meer) **nodig**		
geluidsisolatie	○ ja	○ nee	○ ik weet het niet	○ ja	○ nee	○ ik weet het niet
dubbel glas	○ ja	○ nee	○ ik weet het niet	○ ja	○ nee	○ ik weet het niet
luchtfiltering	○ ja	○ nee	○ ik weet het niet	○ ja	○ nee	○ ik weet het niet
andere:	○ ja	○ nee	○ ik weet het niet	○ ja	○ nee	○ ik weet het niet

7.2 **Indien u huiseigenaar bent: bent u bereid om bijkomende werken aan uw woning uit te voeren om uw omgevingshinder te beperken (bijvoorbeeld plaatsing van luchtfilters, geluidsisolatie, dubbel glas)?**

- ○ ja, met eigen financiële bijdrage
- ○ ja, met eigen financiële bijdrage, maar enkel als de overheid subsidieert
- ○ ja, maar zonder eigen financiële bijdrage
- ○ nee
- ○ niet van toepassing, ik ben huurder
- ○ ik weet het niet

7.3 **Welke lokale maatregelen zijn er volgens u al genomen om de blootstelling aan verkeerslawaai en luchtverontreiniging, veroorzaakt door de snelwegviaducten, te verminderen? Welke zijn er nog nodig?**
Duid per rij tweemaal een antwoord aan. Ook maatregelen die al genomen zijn, kunnen nog meer nodig zijn. Er kunnen bijvoorbeeld al geluidsmuren staan, maar er zijn er misschien nog méér nodig.

	maatregel **genomen**			maatregel nog (meer) **nodig**		
geluidsmuren	○ ja	○ nee	○ ik weet het niet	○ ja	○ nee	○ ik weet het niet
snelheidsverlaging op viaduct	○ ja	○ nee	○ ik weet het niet	○ ja	○ nee	○ ik weet het niet
aanleg stil wegdek	○ ja	○ nee	○ ik weet het niet	○ ja	○ nee	○ ik weet het niet
aanleg geluidsarme voegen	○ ja	○ nee	○ ik weet het niet	○ ja	○ nee	○ ik weet het niet
omleiding vrachtverkeer	○ ja	○ nee	○ ik weet het niet	○ ja	○ nee	○ ik weet het niet
vrachtverbod tijdens de nacht	○ ja	○ nee	○ ik weet het niet	○ ja	○ nee	○ ik weet het niet
vermijden van gevoelige functies zoals scholen, crèches, ziekenhuizen, rusthuizen, ...	○ ja	○ nee	○ ik weet het niet	○ ja	○ nee	○ ik weet het niet
andere:	○ ja	○ nee	○ ik weet het niet	○ ja	○ nee	○ ik weet het niet

8 Beleidsstrategieën – maatschappelijke actoren

8.1 **Er zijn verschillende belangengroepen met een standpunt en ideeën over de problematiek van de snelwegviaducten E17 en B401. Een mogelijke beleidsaanpak kan zijn om deze groepen samen met de overheid te laten zoeken naar een zo goed mogelijke oplossing.**

Geef hieronder aan welke groepen u bij naam kent, van welke u lid bent, van welke u het concrete standpunt kent over de toekomst van de snelwegviaducten E17 en B401 en door welke groepen u zich vertegenwoordigd voelt in het debat.
Per rij zijn meerdere antwoorden mogelijk.

	ik ken de **naam** van deze groep **niet**	ik ken de **naam** van deze groep **wel**	ik ben **lid** van deze groep	ik ken (ongeveer) het **standpunt** van deze groep over de viaducten E17 en B401	ik voel mij **vertegenwoordigd** door deze groep in het debat over de viaducten E17 en B401
UNIZO (Unie van Zelfstandige Ondernemers)	❒	❒	❒	❒	❒
TLV (Transport en Logistiek Vlaanderen)	❒	❒	❒	❒	❒
VTB-VAB (Vlaamse Toeristenbond-Vlaamse Automobilistenbond)	❒	❒	❒	❒	❒
VOKA (Vlaams Netwerk van Ondernemingen)	❒	❒	❒	❒	❒
Touring	❒	❒	❒	❒	❒
Febetra (Koninklijke federatie van Belgische transporteurs en logistieke dienstverleners)	❒	❒	❒	❒	❒
BBL (Bond Beter Leefmilieu)	❒	❒	❒	❒	❒
GMF (Gents Milieufront)	❒	❒	❒	❒	❒
ViaduKaduk (actiegroep E17-viaduct)	❒	❒	❒	❒	❒

8.2 **Zijn er nog groepen die volgens u ontbreken in bovenstaande opsomming? Vul deze hier in.**

.....
.....
.....

8.3 **De laatste jaren proberen groepen van burgers steeds meer invloed uit te oefenen op ruimtelijke plannen door zelf aan onderzoek te doen, experten te raadplegen, alternatieven voor te stellen, ... Gelooft u dat ruimtelijke problemen zoals die van het E17-viaduct of het B401-viaduct beter kunnen worden opgelost door deze groepen meer in het beleid te betrekken?**

○ ja, zeker ○ ja, misschien ○ nee, zeker niet ○ ik weet het niet (➔ 8.5)

8.4 **Waarom vindt u dat?**

.....
.....
.....

8.5 **Denkt u dat burgerbewegingen in het belang van alle buurtbewoners denken?**

○ ja, zeker ○ ja, misschien ○ nee, zeker niet ○ ik weet het niet

9 Algemene vragen – uzelf en uw gezin

9.1 **U bent een…** ○ vrouw ○ man

9.2 **In welk jaar bent u geboren? ....**

9.3 **Hoeveel personen wonen er samen in uw gezin (uzelf inbegrepen)?**

Met gezin bedoelen we alle personen waarmee u een huishouden vormt en onder hetzelfde dak woont.

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 of meer

○ niet van toepassing, ik woon in een gemeenschap

9.4 **Hoeveel inwonende kinderen zijn er in uw gezin in de volgende leeftijdscategorieën?**

Vul een aantal in of duid aan dat uw gezin geen inwonende kinderen telt.

0-6 jaar ..... 7-12 jaar ..... 13-17 jaar ..... +18 jaar .....

○ geen inwonende kinderen

9.5 **Welke nationaliteit hebt u momenteel?**

○ Belg ○ andere: .....

9.6 **Welke nationaliteit had u bij de geboorte?**

○ Belg ○ andere: .....

9.7 **Welke taal spreekt u thuis hoofdzakelijk?**

○ Nederlands ○ Duits ○ Italiaans
○ Frans ○ Turks ○ Arabisch
○ Engels ○ Russisch ○ andere: .....

10 Algemene vragen – uw studies, job en inkomen

10.1 **Wat is uw hoogst behaalde diploma?**

○ geen
○ lagere school
○ lager middelbaar
○ hoger middelbaar
○ hoger onderwijs korte type / professionele bachelor
○ hoger onderwijs lange type / master
○ andere: .....

10.2 **Hebt u momenteel een betaalde job?**

○ ja, een vaste job, voltijds ○ ja, een tijdelijke job, voltijds ○ nee
○ ja, een vaste job, deeltijds ○ ja, een tijdelijke job, deeltijds

10.3 **Welke omschrijving is op u van toepassing?**

Meerdere antwoorden mogelijk.

❒ ongeschoolde arbeider/ster
❒ geschoolde arbeider/ster
❒ bediende
❒ hoger bediende/kader
❒ zelfstandige
❒ vrij beroep
❒ ambtenaar/leerkracht
❒ minder dan één jaar werkzoekend
❒ één jaar of langer werkzoekend
❒ arbeidsongeschikt en/of invalide
❒ (brug)gepensioneerd
❒ huisvrouw/huisman
❒ schoolgaand/studerend
❒ andere: .....

10.4 **Wat is het totale netto beschikbare inkomen per maand van uw gezin?**

Met uw gezin bedoelen we alle familieleden die onder hetzelfde dak wonen. Onder uw gezinsinkomen vallen beroepsinkomsten (werknemersbezoldiging, vervangingsinkomsten, pensioen, enz.), inkomsten uit onroerende goeden (kadastraal inkomen, huur) en diverse inkomsten (kinderbijslag, alimentatie, enz.).

○ minder dan € 1000
○ tussen € 1000 en € 1999
○ tussen € 2000 en € 2999
○ tussen € 3000 en € 3999
○ tussen € 4000 en € 4999
○ meer dan € 5000
○ ik weet het niet of wens dit niet mee te delen

11 Algemene vragen – uw mobiliteit en uw gezondheid

11.1 **Hoeveel wagens bezit uw gezin?** ○ geen ○ 1 ○ 2 ○ 3 of meer

11.2 **Wat is uw hoofdvervoermiddel naar school of werk?**

○ eigen wagen
○ iemand anders zijn/haar wagen (carpooling)
○ openbaar vervoer (trein, tram, bus)
○ fiets
○ te voet
○ ik werk of studeer thuis
○ andere: .....
○ ik heb geen werk en studeer niet

11.3 **Hoe is uw gezondheid over het algemeen?**

○ heel erg slecht ○ slecht ○ redelijk ○ goed ○ heel erg goed

Bedankt voor uw tijd en medewerking!

Indien u nog opmerkingen, bedenkingen of andere ideeën hebt in verband met deze enquête of de snelwegviaducten E17 en B401, kunt u deze hieronder kwijt.

.....

.....

.....

.....

.....

.....

Bent u bereid om een aanvullend gesprek te hebben over de problematiek van de snelwegviaducten E17 en B401 of deel te nemen aan een focusgroep die verder ingaat op de te volgen aanpak? Vul dan hier uw contactgegevens in!

naam: .....

adres: .....

e-mailadres: .....

telefoonnummer: .....

10.2 Appendix A2 – survey in English

Survey **98WTGK**

Highway viaducts E17 and B401: today and tomorrow

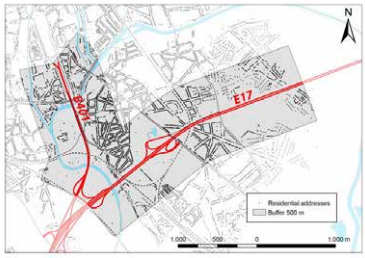
IMPORTANT INSTRUCTIONS

What is this questionnaire about?

The questionnaire is about the highway viaducts of E17 and B401 (fly-over), that cut through Ledeberg, Gentbrugge and the south of Ghent inner city. You live at less than 500 meter from (at least) one of these viaducts. Depending on where you live the questionnaire thus focuses on the viaduct of E17, B401 or both.

The questionnaire consists of three parts.

1. Current situation: do you experience nuisances caused by the viaducts and how do you deal with it?
2. Policy strategies: should this spatial situation be tackled and how?
3. General questions about you and your family.



Who should fill in the questionnaire?

The person who the questionnaire has been sent to. You will find the name of this person on the envelope and on top of the attached letter. You must answer the questions **personally**. If you do not understand a question well or you are unable to fill it in, you may of course ask someone for explanations, but we still want to know **your own opinion**.

How to fill in?

- Carefully read the questions and instructions. Sometimes you can skip questions, this is indicated by instructions in **red** next to a specific answer.
- Take care not to miss any questions. Please always answer something. There is always an option to indicate "no opinion", "I don't know" or "other". A question without answer is invalid.
- Unless mentioned otherwise, you have to give one answer per question.
- Completing the questionnaire takes more or less 15 minutes.

How to return?

Please return the completed questionnaire in the **enclosed envelope**. The postal costs are paid by the recipient and you do not need to mention an address. The questionnaire should be completed by **14 March 2016.**

Protection of privacy

The identification number on the questionnaire is necessary to find out who returned a completed questionnaire. Your answers will be processed **completely anonymously**. Individual answers will not be published, but only the aggregated answers of a large group of people.

Any questions?

In case you have any questions, or in case you need any help to fill in the questionnaire, please contact Thomas Verbeek via Thomas.Verbeek@UGent.be or 09 331 32 51.

We thank you for your cooperation!

1 Current situation – nuisance

1.1 **In the last 12 months, to what extent have you been annoyed by traffic noise in your neighbourhood?**
Traffic noise includes both road traffic (including tram) and rail traffic. If you have moved house in the last 12 months, this question only concerns your current neighbourhood.
○ never (➔ 1.4) ○ rarely ○ sometimes ○ often ○ always ○ I don't know

1.2 **When where you annoyed by traffic noise?**
○ mainly during the day ○ only during the day ○ both day and night
○ mainly at night ○ only at night ○ I don't know

1.3 **Do you think this traffic noise is also caused by the nearby highway viaducts of B401 (fly-over) and/or E17?**
○ yes, these highways are the most important source of traffic noise for me
○ yes, but other roads or railways in my neighbourhood have an equal contribution to the traffic noise
○ yes, but other roads or railways in my neighbourhood have a (much) higher contribution to the traffic noise
○ no, these highways do not contribute to the traffic noise, they do not bother me
○ I don't know

1.4 **What do you think about your exposure to traffic noise when you compare it with the average Ghent citizen?**
○ I have a much higher exposure ○ I have a lower exposure
○ I have a higher exposure ○ I have a much lower exposure
○ I have an equal exposure ○ I don't know

1.5 **Are you worried about traffic noise in your neighbourhood and the possible effects on your health?**
○ definitely yes ○ rather yes ○ rather not ○ not at all ○ I don't know

1.6 **Do you think you have health problems that are caused or aggravated by traffic noise?**
○ yes, certainly ○ yes, maybe ○ no, certainly not ○ I don't know

1.7 **In the last 12 months, to what extent have you been annoyed by air pollution in your neighbourhood?**
If you have moved house in the last 12 months, this question only concerns your current neighbourhood.
○ never (➔ 1.9) ○ rarely ○ sometimes ○ often ○ always ○ I don't know

1.8 **Do you think this air pollution is also caused by the nearby highway viaducts of B401 (fly-over) and/or E17?**
○ yes, these highways are the most important source of air pollution for me
○ yes, but other roads or railways in my neighbourhood have an equal contribution to the air pollution
○ yes, but other roads or railways in my neighbourhood have a (much) higher contribution to the air pollution
○ no, these highways do not contribute to the air pollution, they do not bother me
○ I don't know

1.9 **What do you think about your exposure to air pollution when you compare it with the average Ghent citizen?**
○ I have a much higher exposure ○ I have a lower exposure
○ I have a higher exposure ○ I have a much lower exposure
○ I have an equal exposure ○ I don't know

1.10 **Are you worried about air pollution in your neighbourhood and the possible effects on your health?**
○ definitely yes ○ rather yes ○ rather not ○ not at all ○ I don't know

1.11 **Do you think you have health problems that are caused or aggravated by air pollution?**
○ yes, certainly ○ yes, maybe ○ no, certainly not ○ I don't know

1.12 **Which source of environmental nuisance in your neighbourhood bothers you the most?**
○ traffic noise ○ air pollution ○ something else: .....

1.13 **Is your residential environment important for your quality of life?**
○ definitely yes ○ rather yes ○ neutral ○ rather not ○ not at all ○ no opinion

2 Current situation – justice

2.1 **In the vicinity of the highway viaducts of E17 and B401 live citizens that have a high exposure to traffic noise and air pollution. To what extent do you agree with these statements?**
Tick one answer for each row.

	totally agree	agree	neutral	disagree	totally disagree	no opinion
1. Everyone is free to live wherever they want and must bear the consequences of pollution in the environment.	○	○	○	○	○	○
2. Everyone is entitled to a minimum level of environmental quality, no matter where they live.	○	○	○	○	○	○
3. It is not fair that people who live close to the viaducts of E17 or B401 (fly-over) are exposed to high levels of noise and air pollution.	○	○	○	○	○	○
4. When environmental pollution has an effect on public health, the government should intervene.	○	○	○	○	○	○
5. Not only the government is responsible for the environmental nuisance caused by the viaducts of E17 and B401 (fly-over), also the people who live there are partly responsible.	○	○	○	○	○	○
6. The environmental pollution around the E17 and B401 is unacceptable and must be tackled.	○	○	○	○	○	○

3 Current situation – housing and moving house

3.1 **Do you own or rent your house?** ○ owner ○ renter

3.2 **Which type of housing do you live in?**
○ single-family detached house ○ single-family row house ○ studio flat
○ single-family semi-detached house ○ apartment ○ room

3.3 **Do you have an outdoor space, such as a garden or a terrace?** ○ yes ○ no

3.4 **Since when do you live in this house?** *Fill in a year.*
... ...

3.5 **What has played a part in the choice of moving to this house?**
Multiple answers possible.
☐ I have lived in this house for all my life (➔ 3.7)
☐ this house has been assigned to me
☐ distance commuter traffic
☐ want to live closer to my children/parents
☐ want to live closer to family/friends
☐ the existence of green space, parks, trees
☐ nice neighbourhood
☐ adequate facilities in the neighbourhood
☐ good accessibility by car
☐ good accessibility by public transport
☐ low house prices
☐ other: .....

3.6 **Were you aware of the possibility of noise and air pollution when you came to live here?**
Multiple answers possible.
☐ yes, but the advantages of the location outweighed the disadvantages
☐ yes, but I had little choice (e.g. because of financial constraints or availability of housing)
☐ yes, but it seemed bearable
☐ no

3.7 **Has the nuisance of traffic noise changed during the time you have been living here?**
○ the nuisance has increased a lot
○ the nuisance has increased a little
○ the nuisance is still on the same level
○ the nuisance has decreased a little
○ the nuisance has decreased a lot
○ I don't know

3.8 **Has the nuisance of air pollution changed during the time you have been living here?**
○ the nuisance has increased a lot
○ the nuisance has increased a little
○ the nuisance is still on the same level
○ the nuisance has decreased a little
○ the nuisance has decreased a lot
○ I don't know

3.9 **Do you consider moving in the coming two years?**
○ no (➔ 3.11)
○ possibly
○ I would like to, but I can't find a suitable house
○ I would like to, but I don't have the necessary resources
○ certainly
○ I have already found a new house

3.10 **What are the main reasons why you would move?**
Tick the most important reasons (maximum three answers).
☐ personal circumstances (marriage, divorce, disease, ...)
☐ work related circumstances
☐ not satisfied with your current house
☐ not satisfied with your current neighbourhood
☐ environmental noise in the current neighbourhood
☐ air pollution in the current neighbourhood
☐ I want to leave town
☐ other: .....

3.11 **Would you take traffic noise and air pollution into account when deciding on a new house?**
○ yes, certainly ○ yes, maybe ○ no ○ I don't know

4 Current situation – complaints

4.1 **Have you ever filed a formal complaint about traffic noise or air pollution?**
○ yes, as an individual citizen ○ ja, as member of a group of citizens ○ no (➔ 4.3) ○ I don't know (➔ 5.1)

4.2 **Can you explain how you filed a formal complaint?**
.....
.....
.....
(➔ 5.1)

4.3 **Why have you never filed a formal complaint about traffic noise or air pollution?**
Multiple answers possible.
☐ the traffic noise and air pollution in my neighbourhood are acceptable to me
☐ I don't know how and where I can file a formal complaint
☐ my voice is not heard
☐ nothing is being done with my complaint
☐ other: .....

5 Policy strategies – government

5.1 **It is an option to leave a spatial problem, such as the situation of the highway viaducts of E17 and B401 (fly-over), entirely to the government. Hereafter you find some statements about this approach. To what extent do you agree with these statements?**
Tick one answer for each row.

	totally agree	agree	neutral	disagree	totally disagree	no opinion
1. The government is best placed to balance local interests (e.g. environmental pollution) and wider public interests (e.g. economic).	○	○	○	○	○	○
2. The government acts in the best interests of all citizens.	○	○	○	○	○	○
3. The government has the best, unbiased information about situations of environmental pollution (e.g. noise and air pollution).	○	○	○	○	○	○
4. Certain population groups or neighbourhoods are less important for the government and get less attention in policymaking.	○	○	○	○	○	○

5.2 **There are different policy levels involved in the spatial problem of the highway viaducts of E17 and B401. How well do you know them?**
Tick one answer for each row.

	yes, very good	yes, partly	no
1. I know the position and policy of the City Government of Ghent concerning the highway viaducts of E17 and B401 (fly-over).	○	○	○
2. I know the position and policy of the Flemish Government concerning the highway viaducts of E17 and B401 (fly-over).	○	○	○
3. I know the European environmental standards for air pollution and environmental noise.	○	○	○

5.3 **Hereafter you find some statements about your confidence in the policy of different policy levels concerning the highway viaducts and the resulting environmental pollution. To what extent do you agree with these statements?**
Tick one answer for each row.

	totally agree	agree	neutral	disagree	totally disagree	no opinion
1. I have confidence in the policy of the City Government of Ghent concerning the future of the highway viaducts E17 and B401 (fly-over).	○	○	○	○	○	○
2. I have confidence in the policy of the Flemish Government concerning the future of the highway viaducts E17 and B401 (fly-over).	○	○	○	○	○	○
3. I have confidence in the European environmental standards for air pollution and environmental noise.	○	○	○	○	○	○

6 Policy strategies – participation

6.1 **The government can also choose to involve citizens in policymaking and planning processes. This is called participation. To what extent do you agree with these statements?**
Tick one answer for each row.

	totally agree	agree	neutral	disagree	totally disagree	no opinion
1. Citizen participation in policy can lead to better solutions.	○	○	○	○	○	○
2. Citizen participation in policy delays the decision-making process.	○	○	○	○	○	○
3. The citizens' interests are defended better when citizens participate in policy.	○	○	○	○	○	○
4. When the government consults the public, their ideas and opinions are often not taken into account.	○	○	○	○	○	○
5. The City Government of Ghent is making efforts to increase citizen participation in policy.	○	○	○	○	○	○
6. The Flemish Government is making efforts to increase citizen participation in policy.	○	○	○	○	○	○

6.2 **Do you think the government should involve citizens in finding solutions for the environmental pollution caused by the highway viaducts of E17 and B401?**
○ yes, certainly ○ yes, maybe ○ no, certainly not ○ I don't know (➔ 6.4)

6.3 **Why do you think that?**
.....
.....
.....

6.4 **Do you think you have sufficient knowledge and skills to contribute to finding solutions for the environmental pollution caused by the highway viaducts of E17 and B401?**
○ yes, certainly ○ yes, maybe ○ no, certainly not ○ I don't know

6.5 **Do you want to be involved in finding solutions?**
○ yes, certainly ○ yes, maybe ○ no, certainly not ○ I don't know

7 Policy strategies – mitigation measures

7.1 **A way to decrease environmental pollution is looking for mitigation measures. These measures can be implemented by the government but also by other actors.**

Which measures have already been taken in your house to decrease the exposure to traffic noise and air pollution? Which measures are still needed?
Tick two answers for each row. Also measures that have already been taken, can still be needed (more). E.g. a house can already have soundproofing on one facade, but more soundproofing may still be needed.

	measure **taken**			measure still (more) **needed**		
soundproofing	○ yes	○ no	○ I don't know	○ yes	○ no	○ I don't know
double glazed windows	○ yes	○ no	○ I don't know	○ yes	○ no	○ I don't know
air filtration or purification	○ yes	○ no	○ I don't know	○ yes	○ no	○ I don't know
other:	○ yes	○ no	○ I don't know	○ yes	○ no	○ I don't know

7.2 **In case you are the owner of your house: are you willing to implement additional measures to further limit your exposure to air pollution and noise (e.g. installation of air purification system, soundproofing, double glazed windows)?**

- ○ yes, entirely paid by myself
- ○ yes, with personal financial contribution, but only if the government subsidises
- ○ yes, but without personal financial contribution
- ○ no
- ○ not applicable, I rent my house
- ○ I don't know

7.3 **Which local measures have already been taken to decrease the exposure to traffic noise and air pollution, caused by the highway viaducts? Which measures are still needed?**
Tick two answers for each row. Also measures that have already been taken, can still be needed (more). E.g. there can already be noise barriers, but maybe more noise barriers are still needed.

	measure **taken**			measure still (more) **needed**		
noise barriers	○ yes	○ no	○ I don't know	○ yes	○ no	○ I don't know
speed reduction on viaduct	○ yes	○ no	○ I don't know	○ yes	○ no	○ I don't know
quiet pavement	○ yes	○ no	○ I don't know	○ yes	○ no	○ I don't know
low-noise construction joints	○ yes	○ no	○ I don't know	○ yes	○ no	○ I don't know
redirecting truck traffic	○ yes	○ no	○ I don't know	○ yes	○ no	○ I don't know
night ban on trucks	○ yes	○ no	○ I don't know	○ yes	○ no	○ I don't know
avoiding sensitive facilities such as schools, daycares, hospitals, centres, rest homes, ...	○ yes	○ no	○ I don't know	○ yes	○ no	○ I don't know
other:	○ yes	○ no	○ I don't know	○ yes	○ no	○ I don't know

8 Policy strategies – societal actors

8.1 **Several interest groups and civil society organisations take a position and have ideas concerning the problem of the highway viaducts of E17 and B401. A possible policy strategy is to bring these societal actors together with the government and let them share their ideas to find the best possible solution.**

Please indicate which groups you know by name, of which you are a member, of which you know the actual position concerning the future of the highway viaducts E17 and B401 and by which groups you feel represented in the debate.
Multiple answers per row are possible.

	I **don't know** the **name** of this group	I **know** the **name** of this group	I am a **member** of this group	I know (more or less) the **position** of this group concerning the viaducts E17 and B401	I feel **represented** by this group in the debate on the viaducts E17 and B401
UNIZO (Union of Self-Employed Entrepeneurs)	❒	❒	❒	❒	❒
TLV (Transport and Logistics Flanders)	❒	❒	❒	❒	❒
VTB-VAB (Flemish Tourists Association – Flemish Motorists Association)	❒	❒	❒	❒	❒
VOKA (Flemish Employers Association)	❒	❒	❒	❒	❒
Touring	❒	❒	❒	❒	❒
Febetra (Royal Federation of Belgian Carriers and Logistic Service Providers)	❒	❒	❒	❒	❒
BBL (Federation for a Better Environment)	❒	❒	❒	❒	❒
GMF (Ghent Environmental Front)	❒	❒	❒	❒	❒
ViaduKaduk (citizen initiative E17 viaduct)	❒	❒	❒	❒	❒

8.2 **Are there any groups missing in the above list, according to your opinion? Write their names here.**
.....
.....
.....

8.3 **In recent years groups of citizens increasingly try to influence spatial plans and spatial policy by carrying out research, consulting experts, proposing alternatives, ... Do you believe spatial problems, such as the situation of the highway viaducts of E17 and B401, can be solved in a better way by involving these groups in policymaking and planning processes?**
○ yes, certainly ○ yes, maybe ○ no, certainly not ○ I don't know (➔ 8.5)

8.4 **Why do you think that?**
.....
.....
.....

8.5 **Do you think citizen initiatives think in the interest of all residents?**
○ yes, certainly ○ yes, maybe ○ no, certainly not ○ I don't know

9 General questions – you and your family

9.1 **You are a…** ○ girl/woman ○ boy/man

9.2 **What is your year of birth? ....**

9.3 **How many persons live together in the family (yourself included)?**
By family we mean all persons of one household living together under one roof.
○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 or more
○ not applicable, I live in a community

9.4 **How many children living at home are there in the family in the following age categories?**
Fill in a number for each category, or indicate that there are no children living at home in the family.
0-6 years ..... 7-12 years ..... 13-17 years ..... +18 years .....
○ no children living at home

9.5 **Which nationality do you have at the moment?**
○ Belgian ○ other: .....

9.6 **Which nationality did you have at birth?**
○ Belgian ○ other: .....

9.7 **Which language do you mainly speak at home?**
○ Dutch ○ German ○ Italian
○ French ○ Turkish ○ Arabic
○ English ○ Russian ○ other: .....

10 General questions – your education, employment and income

10.1 **What is the highest degree you have obtained?**
○ none ○ higher secondary education ○ other:
○ primary education ○ non-university higher education .....
○ lower secondary education ○ university higher education

10.2 **Do you have a paid job at the moment?**

- ○ yes, a permanent job, full-time
- ○ yes, a permanent job, part-time
- ○ yes, a temporary job, full-time
- ○ yes, a temporary job, part-time
- ○ no

10.3 **Which description applies to your situation?**

Multiple answers possible.

- ☐ unskilled worker
- ☐ skilled worker
- ☐ employee
- ☐ executive position/management
- ☐ self-employed
- ☐ profession (doctor, lawyer, architect, ...)
- ☐ civil servant/teacher
- ☐ in search for employment for less than a year
- ☐ in search for employment for a year or more
- ☐ unable to work and/or disabled
- ☐ retired/early retired
- ☐ housewife/househusband
- ☐ school going/student
- ☐ other: .....

10.4 **What is your family's total available monthly income?**

Family being all family members living under the same roof. The total available monthly income of your household then consists of all real incomes from labour or wages/salaries, social allowances (such as child allowance, unemployment benefit, retirement pay, allowance for persons with a handicap, …) and additional allowances (such as interests, insurances, …).

- ○ less than € 1,000
- ○ between € 1,000 and € 1,999
- ○ between € 2,000 and € 2,999
- ○ between € 3,000 and € 3,999
- ○ between € 4,000 and € 4,999
- ○ more than € 5,000
- ○ I don't know or I don't want to answer this question

11 General questions – your mobility and your health

11.1 **How many cars does your family have?** ○ none ○ 1 ○ 2 ○ 3 or more

11.2 **In case you work or study, how do you usually travel to and from work or school?**

- ○ by my own car
- ○ by someone else's car (carpooling)
- ○ by public transport (train, tram, bus)
- ○ by bike
- ○ on foot
- ○ I work or study at home
- ○ other: .....
- ○ I don't work and don't study

11.3 **How is your health in general?**

○ very bad ○ bad ○ reasonably healthy ○ good ○ very good

We thank you for your time and for your cooperation!

If you have any more comments, thoughts or ideas concerning this questionnaire or the highway viaducts of E17 and B401, please write them down here.

.....

.....

.....

.....

.....

.....

Are you available for an additional interview concerning the highway viaducts E17 and B401 or willing to take part in a focus group that further explores possible policy strategies? Then please fill in your contact details.

name: .....

address: .....

e-mail: .....

phone: .....

10.3 Appendix A3 – survey in French

Enquête **39ADNS**

Viaducs autoroutiers E17 et B401: présent et avenir

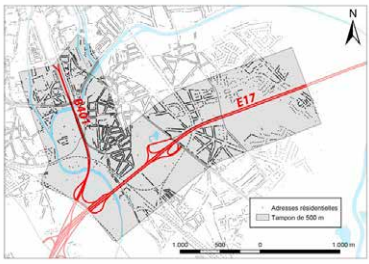
COMMENTAIRE IMPORTANT

Quel est l'objet de ce questionnaire?

Le questionnaire s'agit des viaducs autoroutiers E17 et B401 (fly-over), qui traversent Gentbrugge, Ledeberg, et le sud du centre-ville de Gand. Vous habitez à moins de 500 mètres d'au moins un des viaducs. En fonction de votre adresse, le questionnaire se concentre sur le viaduc E17, B401 ou les deux.

Le questionnaire est composé de trois parties.

1. Situation actuelle: êtes-vous affectés par la pollution causée par les viaducs et comment gérez-vous?
2. Stratégies politiques: comment traiter cette situation? Faut-il une action?
3. Questions générales sur vous-même et votre famille.



Qui doit remplir le questionnaire?

La personne à qui le questionnaire a été envoyé. Le nom de cette personne se trouve sur l'enveloppe et en haut de la lettre d'accompagnement. Si vous comprenez une question insuffisamment, vous êtes bien sûr libre de demander des explications à quelqu'un, mais nous souhaiterions quand-même avoir **votre opinion personnelle**.

Comment remplir le questionnaire?

- Lisez bien les questions et tous les commentaires annexes au préalable. A chaque fois, il sera indiqué de quelle façon vous êtes supposé de répondre. Parfois, vous pouvez sauter des questions, cela est indiqué par des instructions en **rouge** à côté d'une réponse spécifique.
- Essayez de répondre à toutes les questions. Vous avez toujours la possibilité de répondre "sans opinion", "je ne sais pas" ou "autre".
- Sauf indication contraire, vous devez donner une réponse par question.
- Remplir le questionnaire prend environ 15 minutes.

Comment renvoyer le questionnaire?

Veuillez renvoyer le questionnaire complété dans **l'enveloppe ci-jointe**. Il ne faut pas coller de timbre ni noter d'adresse. Le questionnaire doit être renvoyé au plus tard le **14 mars 2016**.

Protection de la vie privée

Le numéro d'identification repris sur le questionnaire est nécessaire afin de pouvoir identifier les personnes qui ont renvoyé un questionnaire complété. Vos réponses seront traitées de façon **tout à fait anonyme**. Les réponses ne sont pas publiées au niveau individuel mais bien au niveau d'un grand groupe de personnes.

Questions?

Si vous avez des questions ou avez besoin d'aide afin de compléter le questionnaire, vous pouvez contacter Thomas Verbeek par e-mail Thomas.Verbeek@UGent.be ou au numéro 09 331 32 51.

Nous vous remercions d'avance de votre coopération!

1 Situation actuelle – nuisances

1.1 **Quand vous pensez aux 12 derniers mois, dans quelle mesure se produisait le bruit de la circulation dans votre quartier?**
Le bruit de la circulation se compose à la fois des bruits routiers (y compris le tramway) et ferroviaires. Si vous avez déménagé au cours des 12 derniers mois, la question ne concerne que votre quartier actuel.
○ jamais (➔ 1.4) ○ rarement ○ parfois ○ souvent ○ toujours ○ je ne sais pas

1.2 **Quand exactement avez-vous souffert du bruit de la circulation?**
○ principalement dans la journée ○ seulement dans la journée ○ de jour comme de nuit
○ principalement dans la nuit ○ seulement dans la nuit ○ je ne sais pas

1.3 **Pensez-vous que les viaducs autoroutiers B401 (fly-over) et/ou E17 sont en partie responsables du bruit de la circulation auquel vous êtes exposé(e)?**
○ oui, pour moi ces autoroutes sont la source de bruit de la circulation la plus importante
○ oui, mais d'autres routes ou voies ferrées dans le quartier contribuent également au bruit de la circulation
○ oui, mais d'autres routes ou voies ferrées dans le quartier contribuent (beaucoup) plus au bruit de la circulation
○ non, ils ne contribuent pas au bruit de la circulation, ils ne me dérangent pas
○ je ne sais pas

1.4 **Que pensez-vous de votre exposition au bruit de la circulation, si vous la comparez avec le Gantois moyen?**
○ je suis beaucoup plus exposé(e) ○ je suis moins exposé(e)
○ je suis plus exposé(e) ○ je suis beaucoup moins exposé(e)
○ je suis également exposé(e) ○ je ne sais pas

1.5 **Êtes-vous inquiet(e) du bruit de la circulation dans votre quartier et les effets possibles sur votre santé?**
○ certainement oui ○ plutôt oui ○ plutôt non ○ pas du tout ○ je ne sais pas

1.6 **Pensez-vous que vous avez des problèmes de santé qui sont provoqués ou aggravés par le bruit de la circulation?**
○ oui, certainement ○ oui, peut-être ○ non, certainement pas ○ je ne sais pas

1.7 **Quand vous pensez aux 12 derniers mois, dans quelle mesure se produisait la pollution de l'air dans votre quartier?**
Si vous avez déménagé au cours des 12 derniers mois, la question ne concerne que votre quartier actuel.
○ jamais (➔ 1.9) ○ rarement ○ parfois ○ souvent ○ toujours ○ je ne sais pas

1.8 **Pensez-vous que les viaducs autoroutiers B401 (fly-over) et/ou E17 sont en partie responsables pour la pollution de l'air à laquelle vous êtes exposé(e)?**
○ oui, pour moi ces autoroutes sont la source de la pollution de l'air la plus importante
○ oui, mais d'autres routes dans le quartier contribuent également à la pollution de l'air
○ oui, mais d'autres routes dans le quartier contribuent (beaucoup) plus à la pollution d'air
○ non, ils ne contribuent pas à la pollution de l'air
○ je ne sais pas

1.9 **Que pensez-vous de votre exposition à la pollution de l'air, si vous la comparez avec le Gantois moyen?**
○ je suis beaucoup plus exposé(e) ○ je suis moins exposé(e)
○ je suis plus exposé(e) ○ je suis beaucoup moins exposé(e)
○ je suis également exposé(e) ○ je ne sais pas

1.10 **Êtes-vous inquiet(e) de la pollution de l'air dans votre quartier et les effets possibles sur votre santé?**
○ certainement oui ○ plutôt oui ○ plutôt non ○ pas du tout ○ je ne sais pas

1.11 **Pensez-vous que vous avez des problèmes de santé qui sont provoqués ou aggravés par la pollution de l'air?**
○ oui, certainement ○ oui, peut-être ○ non, certainement pas ○ je ne sais pas

1.12 **Quelle source de pollution de l'environnement dans votre quartier vous dérange le plus?**
○ bruit de la circulation ○ pollution de l'air ○ autres éléments gênants: .....

1.13 **Quelle est l'importance du lieu et des alentours de votre maison pour votre qualité de vie?**
○ extrêmement important ○ neutre ○ pas du tout important
○ plutôt important ○ plutôt pas important ○ pas d'opinion

2 Situation actuelle – justice

2.1 **Les personnes qui vivent à proximité des viaducs autoroutiers E17 et B401 sont exposées à des niveaux de bruit et de la pollution de l'air élevés. Dans quelle mesure êtes-vous d'accord avec ces propositions?**
Donnez une réponse pour chaque ligne.

	tout à fait d'accord	d'accord	neutre	pas d'accord	pas du tout d'accord	pas d'opinion
1. Chacun est libre de vivre où il veut et doit subir les conséquences de la pollution dans l'environnement.	○	○	○	○	○	○
2. Tout le monde a droit à un minimum de qualité de l'environnement, quel que soit le lieu de résidence.	○	○	○	○	○	○
3. Il est injuste que les gens qui vivent à proximité des viaducs E17 et B401 (fly-over), sont exposés à des niveaux de bruit et de la pollution de l'air élevés.	○	○	○	○	○	○
4. Si la pollution de l'environnement a un effet sur la santé publique, les pouvoirs publics doivent intervenir.	○	○	○	○	○	○
5. Non seulement les pouvoirs publics sont responsable des nuisances environnementales des autoroutes E17 et B401 (fly-over), les gens qui y vivent sont également responsables.	○	○	○	○	○	○
6. La pollution de l'environnement autour des viaducs E17 et B401 est inacceptable et doit être adressée.	○	○	○	○	○	○

3 Situation actuelle – votre maison et vos plans de déménagement

3.1 **Êtes-vous propriétaire ou locataire de votre maison?** ○ propriétaire ○ locataire

3.2 **Dans quel type d'habitation habitez-vous?**
○ maison individuelle – détachée ○ maison individuelle – adjacente ○ studio
○ maison individuelle – semi-détachée ○ appartement ○ chambre

3.3 **Avez-vous un espace extérieur sur la propriété, comme un jardin ou une terrasse?** ○ oui ○ non

3.4 **Depuis quand vivez-vous ici?** *Remplissez une année.*
... ...

3.5 **Quels facteurs ont contribué au choix de venir vivre dans votre habitation actuelle?**
Plusieurs réponses possibles.

- ☐ j'habite déjà toute ma vie dans cette maison (➔ 3.7)
- ☐ cette habitation m'a été attribuée
- ☐ distance maison-travail
- ☐ vivre proche de mes enfants/mes parents
- ☐ vivre proche de la famille, les amis
- ☐ présence d'espaces verts, parcs et arbres
- ☐ un quartier agréable
- ☐ facilités dans le quartier
- ☐ bonne accessibilité en voiture
- ☐ bonne accessibilité en transport en commun
- ☐ habitations moins chères
- ☐ autre raison: .....

3.6 **Étiez-vous au courant du potentiel du bruit et de la pollution de l'air quand vous êtes venu(e) ici?**
Plusieurs réponses possibles.

- ☐ oui, mais les avantages de l'endroit l'emportaient sur les inconvénients
- ☐ oui, mais j'avais peu de choix (ex. en raison de contraintes financières et la disponibilité de logements)
- ☐ oui, mais la situation semblait supportable
- ☐ non

3.7 **Est-ce que la nuisance du <u>bruit de la circulation</u> a changé pendant le temps que vous vivez ici?**

- ○ il y a beaucoup plus de nuisance
- ○ il y a un peu plus de nuisance
- ○ il y a autant de nuisance
- ○ il y a moins de nuisance
- ○ il y a beaucoup moins de nuisance
- ○ je ne sais pas

3.8 **Est-ce que la nuisance de la <u>pollution de l'air</u> a changé pendant le temps que vous vivez ici?**

- ○ il y a beaucoup plus de nuisance
- ○ il y a un peu plus de nuisance
- ○ il y a autant de nuisance
- ○ il y a moins de nuisance
- ○ il y a beaucoup moins de nuisance
- ○ je ne sais pas

3.9 **Pensez-vous à déménager dans les deux années à venir?**

- ○ non (➔ 3.11)
- ○ peut-être
- ○ j'aimerais bien, mais je ne trouve pas d'habitation qui répond aux besoins
- ○ j'aimerais bien, mais je ne dispose pas des moyens financiers nécessaires
- ○ certainement
- ○ j'ai déjà trouvé une nouvelle habitation

3.10 **Quelles seraient pour vous les raisons principales de déménager?**
Indiquez les trois raisons principales.

- ☐ des circonstances personnelles (mariage, divorce, maladie, ...)
- ☐ le travail
- ☐ insatisfait de l'état de l'habitation actuelle
- ☐ insatisfait de l'état du quartier actuel
- ☐ du bruit de la circulation dans le quartier actuel
- ☐ la pollution de l'air dans le quartier actuel
- ☐ je veux quitter la ville
- ☐ autre raison: .....

3.11 **Envisageriez-vous le bruit de la circulation et la pollution de l'air lors du choix d'un nouveau logement?**

○ oui, certainement ○ oui, peut-être ○ non ○ je ne sais pas

4 Situation actuelle – des plaintes

4.1 **Avez-vous déjà déposé une plainte officielle au sujet du bruit de la circulation ou de la pollution de l'air?**

○ oui, individuel/le ○ oui, comme membre d'un groupe ○ non (➔ 4.3) ○ je ne sais pas (➔ 5.1)

4.2 **Pourriez-vous préciser comment vous avez déposé une plainte officielle?**

.....
.....
..... (➔ 5.1)

4.3 **Pourquoi n'avez-vous jamais déposé une plainte officielle au sujet du bruit de la circulation ou de la pollution de l'air?**
Plusieurs réponses possibles.

- ❒ je trouve la nuisance du bruit de la circulation et de la pollution de l'air autour de moi acceptable
- ❒ je ne sais pas comment et où déposer une plainte
- ❒ les pouvoirs publics ne m'écoutent pas
- ❒ on ne fait rien avec ma plainte
- ❒ autre raison: .....

5 Stratégies politiques – les pouvoirs publics

5.1 **On peut choisir de confier les problèmes d'environnement, telle que la situation des viaducs autoroutiers E17 et B401, entièrement aux pouvoirs publics. Dans quelle mesure êtes-vous d'accord avec les propositions ci-dessous?**
Donnez une réponse pour chaque ligne.

	tout à fait d'accord	d'accord	neutre	pas d'accord	pas du tout d'accord	pas d'opinion
1. Les pouvoirs publics sont les mieux placés pour équilibrer les intérêts locaux (ex. la pollution locale) contre les intérêts régionaux (ex. la vue économique).	○	○	○	○	○	○
2. Les pouvoirs publics tiennent compte des intérêts de tous les citoyens.	○	○	○	○	○	○
3. Les pouvoirs publics disposent de la meilleure information indépendante des situations de la pollution d'environnement (ex. bruit de la circulation et pollution de l'air).	○	○	○	○	○	○
4. Certaines populations et/ou certains quartiers sont moins importants pour les pouvoirs publics et sont moins pris en considération dans les politiques.	○	○	○	○	○	○

5.2 **Il y a plusieurs niveaux politiques impliqués dans le problème de viaducs autoroutiers E17 et B401. Dans quelle mesure connaissez-vous leurs politiques?**
Donnez une réponse pour chaque ligne.

	oui, très bien	oui, en partie	non
1. Je connais la position et la politique de la Ville de Gand en ce qui concerne les viaducs autoroutiers E17 et B401 (fly-over).	○	○	○
2. Je connais la position et la politique de la Région flamande en ce qui concerne les viaducs autoroutiers E17 et B401 (fly-over).	○	○	○
3. Je connais les normes environnementales européennes en matière de la pollution de l'air et le bruit de la circulation.	○	○	○

5.3 **Ci-dessous vous trouvez quelques propositions sur votre confiance en les politiques des différents niveaux, en ce qui concerne les viaducs autoroutiers et la pollution de l'environnement en résultant. Dans quelle mesure êtes-vous d'accord avec ces propositions?**
Donnez une réponse pour chaque ligne.

	tout à fait d'accord	d'accord	neutre	pas d'accord	pas du tout d'accord	pas d'opinion
1. J'ai confiance en la politique de la Ville de Gand en ce qui concerne l'avenir des viaducs autoroutiers E17 et B401 (fly-over).	○	○	○	○	○	○
2. J'ai confiance en la politique de la Région flamande en ce qui concerne l'avenir des viaducs autoroutiers E17 et B401 (fly-over).	○	○	○	○	○	○
3. J'ai confiance en les normes environnementales européennes en matière de la pollution de l'air et le bruit de la circulation.	○	○	○	○	○	○

6 Stratégies politiques – participation

6.1 **Les pouvoirs publics peuvent choisir de faire participer les citoyens dans la politique et les décisions. On appelle cela la participation politique. Dans quelle mesure êtes-vous d'accord avec ces propositions?**
Donnez une réponse pour chaque ligne.

	tout à fait d'accord	d'accord	neutre	pas d'accord	pas du tout d'accord	pas d'opinion
1. En impliquant les citoyens dans la politique, on peut obtenir de meilleures solutions.	○	○	○	○	○	○
2. En impliquant les citoyens dans la politique, la décision est retardée.	○	○	○	○	○	○
3. Les intérêts des citoyens sont mieux défendus quand ils sont eux-mêmes impliqués dans la politique.	○	○	○	○	○	○
4. Quand les pouvoirs publics consultent les citoyens, souvent ils ne font rien avec le résultat.	○	○	○	○	○	○
5. La Ville de Gand fait des efforts pour impliquer les citoyens dans la politique.	○	○	○	○	○	○
6. La Région flamande fait des efforts pour impliquer les citoyens dans la politique.	○	○	○	○	○	○

6.2 **Pensez-vous que les pouvoirs publics devraient engager les citoyens dans la recherche d'une solution pour la pollution de l'environnement causée par les viaducs autoroutiers E17 et B401?**
○ oui, certainement ○ oui, peut-être ○ non, certainement pas ○ je ne sais pas (➔ 6.4)

6.3 **Pourquoi trouvez-vous cela?**
.....
.....
.....

6.4 **Pensez-vous que vous avez suffisamment de connaissance et de compétences pour vous engager dans la recherche d'une solution pour la pollution de l'environnement causée par les viaducs autoroutiers?**
○ oui, certainement ○ oui, peut-être ○ non, certainement pas ○ je ne sais pas

6.5 **Voulez-vous être impliqué(e) dans la recherche d'une solution?**
○ oui, certainement ○ oui, peut-être ○ non, certainement pas ○ je ne sais pas

7 Stratégies politiques – mesures d'atténuation

7.1 **Afin de réduire les nuisances environnementales, on peut rechercher des mesures d'atténuation. Ces mesures peuvent être prises par les pouvoirs publics, mais aussi par d'autres acteurs.**

Quelles mesures ont déjà été prises dans votre maison afin de réduire l'exposition au bruit de la circulation et à la pollution de l'air? Quelles sont encore nécessaires ?
Donnez deux réponses pour chaque ligne. Aussi des mesures qui ont déjà été prises, peuvent être encore nécessaire. Par exemple, l'isolation phonique d'une façade est mise en œuvre, mais plus d'isolation est nécessaire.

	mesure **prise**			mesure encore **nécessaire**		
isolation phonique	○ oui	○ non	○ je ne sais pas	○ oui	○ non	○ je ne sais pas
double vitrage	○ oui	○ non	○ je ne sais pas	○ oui	○ non	○ je ne sais pas
purificateur d'air	○ oui	○ non	○ je ne sais pas	○ oui	○ non	○ je ne sais pas
autre:	○ oui	○ non	○ je ne sais pas	○ oui	○ non	○ je ne sais pas

7.2 **Si vous êtes propriétaire d'une maison: êtes-vous prêt à effectuer des travaux supplémentaires pour réduire les nuisances environnementales (ex. installation d'un purificateur d'air, isolation phonique, double vitrage)?**
○ oui, avec contribution financière personnelle
○ oui, avec contribution financière personnelle, mais seulement si le gouvernement subventionne
○ oui, mais sans contribution financière personnelle
○ non
○ pas d'application, je suis locataire
○ je ne sais pas

7.3 **Selon vous, quelles mesures locales ont déjà été prises afin de réduire l'exposition au bruit de la circulation et la pollution de l'air, causés par les viaducs autoroutiers? Quelles sont encore nécessaires?**
Donnez deux réponses pour chaque ligne. Aussi des mesures qui ont déjà été prises, peuvent être encore nécessaire. Par exemple, il y a déjà des murs anti-bruits, mais plus de murs anti-bruits sont nécessaires.

	mesure **prise**			mesure (encore) **nécessaire**		
murs anti-bruits	○ oui	○ non	○ je ne sais pas	○ oui	○ non	○ je ne sais pas
réduction de la vitesse sur le viaduc	○ oui	○ non	○ je ne sais pas	○ oui	○ non	○ je ne sais pas
mesures de l'acoustique du revêtement	○ oui	○ non	○ je ne sais pas	○ oui	○ non	○ je ne sais pas
mesures de l'acoustique des joints de construction	○ oui	○ non	○ je ne sais pas	○ oui	○ non	○ je ne sais pas
déviation des poids lourds	○ oui	○ non	○ je ne sais pas	○ oui	○ non	○ je ne sais pas
interdiction pour camions de circuler la nuit	○ oui	○ non	○ je ne sais pas	○ oui	○ non	○ je ne sais pas
éviter des fonctions sensitives tels que les écoles, les hôpitaux, les crèches, les maisons de retraite, …	○ oui	○ non	○ je ne sais pas	○ oui	○ non	○ je ne sais pas
autre:	○ oui	○ non	○ je ne sais pas	○ oui	○ non	○ je ne sais pas

8 Stratégies politiques – acteurs de la société civile

8.1 **Il y a plusieurs groupes d'intérêt avec une position et des idées sur le problème des viaducs autoroutiers E17 et B401. Une approche politique peut être de réunir ces groupes avec les pouvoirs publics afin de trouver la meilleure solution possible pour tous les partis.**

Indiquez ci-dessous de quelles groupes vous connaissez le nom, desquelles vous êtes membre, desquelles vous connaissez la position sur l'avenir des viaducs autoroutiers E17 et B401 et par quelles groupes vous vous sentez représenté(e) dans le débat.
Plusieurs réponses possibles pour chaque ligne.

	je ne **connais pas** le **nom** de ce groupe	je **connais** le **nom** de ce groupe	je suis membre de ce groupe	je connais (à peu près) la **position** de ce groupe sur les viaducs autoroutiers E17 et B401	je me sens **représenté(e)** par ce groupe dans le débat sur les viaducs E17 et B401
UNIZO (Union des Entrepreneurs Indépendants)	☐	☐	☐	☐	☐
TLV (Transport et Logistique Flandres)	☐	☐	☐	☐	☐
VTB-VAB (Association des Touristes et Automobilistes Flamands)	☐	☐	☐	☐	☐
VOKA (Réseau Flamand des Entreprises)	☐	☐	☐	☐	☐
Touring	☐	☐	☐	☐	☐
Febetra (Fédération Royale Belge des transporteurs et des prestataires de services logistiques)	☐	☐	☐	☐	☐
BBL (Fédération pour un Meilleur Environnement)	☐	☐	☐	☐	☐
GMF (Front de l'Environnement Gantois)	☐	☐	☐	☐	☐
ViaduKaduk (initiative citoyenne du viaduc E17)	☐	☐	☐	☐	☐

8.2 **Y a-t-il des groupes qui manquent dans la liste ci-dessus à votre avis? Écrivez leurs noms ici.**

.....
.....
.....

8.3 **Ces dernières années des groupes de citoyens essaient d'exercer de plus en plus d'influence sur les plans d'aménagement et le développement territorial, par faire de la recherche, consulter des experts, proposer des alternatives, ... Croyez-vous que des problèmes comme ceux des viaducs autoroutiers E17 et B401 peuvent être mieux résolu en collaborant avec ces groupes?**

○ oui, certainement ○ oui, peut-être ○ non, certainement pas ○ je ne sais pas (➔ 8.5)

8.4 **Pourquoi trouvez-vous cela?**

.....
.....
.....

8.5 **Pensez-vous que les initiatives citoyennes pensent et/ou agissent dans l'intérêt de tous les résidents?**

○ oui, certainement ○ oui, peut-être ○ non, certainement pas ○ je ne sais pas

9 Questions générales – vous et votre famille

9.1 **Êtes-vous…** ○ femme ○ homme

9.2 **Quelle est votre année de naissance? ....**

9.3 **Combien de personnes vivent ensemble dans le ménage (vous-même y compris)?**
Par ménage nous considérons toutes les personnes vivant ensemble sous le même toit et qui partagent le même budget.
○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ou plus
○ pas d'application, je vis dans une communauté

9.4 **Combien d'enfants habitant chez leurs parents y a-t-il dans le ménage dans les catégories d'âge suivantes?**
Remplissez un nombre ou indiquez qu'aucun enfant n'habite chez vous.
0-6 ans ..... 7-12 ans ..... 13-17 ans ..... +18 ans .....
○ aucun enfant n'habite chez nous

9.5 **Quelle nationalité avez-vous actuellement?**
○ Belge ○ autre: .....

9.6 **Quelle nationalité aviez-vous lors de votre naissance?**
○ Belge ○ autre: .....

9.7 **Quelle langue parlez-vous principalement chez vous (à la maison)?**
○ néerlandais ○ allemand ○ italien
○ français ○ turc ○ arabe
○ anglais ○ russe ○ autre: .....

10 Questions générales – vos études, emploi et revenus

10.1 **Quel est votre diplôme le plus élevé?**
○ aucun diplôme ○ secondaire supérieur ○ enseignement universitaire
○ école primaire ○ enseignement supérieur non universitaire ○ autre: .....
○ secondaire inférieur

10.2 **Avez-vous un emploi rémunéré en ce moment?**
○ oui, un emploi fixe, à temps plein ○ oui, un emploi temporaire, à temps plein ○ non
○ oui, un emploi fixe, à temps partiel ○ oui, un emploi temporaire, à temps partiel

10.3 **Quelle description est applicable à votre situation?**
Plusieurs réponses possibles.
❒ ouvrier/ouvrière non qualifié(e) ❒ demandeur d'emploi depuis moins d'un an
❒ ouvrier/ouvrière qualifié(e) ❒ demandeur d'emploi depuis un an ou plus
❒ employé(e) ❒ en incapacité de travail et/ou invalidité
❒ employé(e) supérieur(e)/cadre ❒ à la (pré-)retraite
❒ indépendant(e) ❒ femme/homme au foyer
❒ profession libérale ❒ en âge scolaire/étudiant(e)
❒ fonctionnaire/professeur ❒ autre: .....

10.4 **Quelle est la totalité des revenus disponibles de votre ménage par mois?**
Le ménage étant tous les membres de la famille vivant sous le même toit. La totalité des revenus disponibles comprend donc tous les revenus nets issus de l'exercice d'une profession ou revenus professionnels, allocation sociales (telles que les allocations familiales, allocation de chômage, pension de retraite, allocation personnes handicapées, ...) et allocations supplémentaires (tels que des intérêts, assurances).
○ moins de € 1000 ○ entre € 3000 et € 3999 ○ je ne le sais pas ou je ne veux pas répondre à cette question
○ entre € 1000 et € 1999 ○ entre € 4000 et € 4999
○ entre € 2000 et € 2999 ○ € 5000 ou plus

11 Questions générales – votre mobilité et votre santé

11.1 **De combien de voitures dispose le ménage auquel vous appartenez?** ○ aucune ○ 1 ○ 2 ○ 3 ou plus

11.2 **Si vous travaillez ou allez encore à l'école, comment vous déplacez-vous en général pour aller à et revenir de votre travail/l'école?**

- ○ en propre voiture
- ○ en voiture de quelqu'un d'autre (carpooling)
- ○ en transport en commun (train, tram, bus)
- ○ à vélo
- ○ à pied
- ○ je travaille ou j'étudie à la maison
- ○ autre: .....
- ○ je ne travaille pas et n'étudie pas

11.3 **Comment est votre santé en général?**

○ très mauvaise ○ mauvaise ○ raisonnable ○ bonne ○ très bonne

Nous vous remercions pour votre temps et votre coopération!

Si vous avez des commentaires ou des idées concernant cette enquête ou la situation des viaducs autoroutiers E17 et B401, vous pouvez les écrire ci-dessous.

.....

.....

.....

.....

.....

.....

Vous déclarez-vous prêt(e) à avoir une conversation supplémentaire sur le problème des viaducs autoroutiers E17 et B401 ou à participer à un groupe de discussion pour explorer des approches possibles? Ainsi inscrivez vos coordonnées ci-dessous.

nom: .....

adresse: .....

e-mail: .....

numéro de téléphone: .....

10.4 Appendix B1 – accompanying letter in Dutch

UNIVERSITEIT GENT

FACULTEIT **INGENIEURSWETENSCHAPPEN EN ARCHITECTUUR**

Vakgroep **Civiele Techniek**
Afdeling **Mobiliteit en Ruimtelijke Planning**

Name *Street Number* 9000 GENT	**uw kenmerk** 34ZKFM	**datum** 04-02-2016
contactpersoon Thomas Verbeek	**e-mail** Thomas.Verbeek@UGent.be	**tel.** +32 9 331 32 51

Geachte heer *Name*,

Met deze brief nodig ik u graag uit om deel te nemen aan bijgevoegde enquête over de snelwegviaducten van de E17 (Gentbrugge) en B401 (fly-over; Ledeberg en Gent-Zuid). Uit de 20.000 Gentenaars die op minder dan 500 meter van deze viaducten wonen, werd u willekeurig geselecteerd. De enquête kadert in een doctoraatsonderzoek naar ruimtelijke planning, milieuhinder en gezondheid. In de vragenlijst wordt gepeild naar uw mening over geluidsoverlast en luchtverontreiniging veroorzaakt door de snelwegviaducten, of de huidige situatie volgens u moet aangepakt worden en op welke manier dit zou moeten gebeuren. Op de achterzijde van deze brief vindt u belangrijke bijkomende informatie over dit onderzoek.

Het invullen van deze enquête zal ongeveer 15 minuten van uw tijd kosten. De resultaten kunnen een schat aan informatie opleveren over hoe we met de situatie van de snelwegviaducten moeten omgaan. Het onderzoek verloopt dan ook in nauwe samenwerking met de Stad Gent.

Beantwoord de vragenlijst liefst meteen (zodat u het niet vergeet) en stuur hem uiterlijk tegen 29 februari 2016 in bijgevoegde enveloppe terug. U hoeft geen postzegel te kleven. U kan de vragenlijst ook via het internet invullen. Hiervoor gebruikt u het volgend internetadres om deel te nemen: http://www.ugent.be/viaduct. De logincode die u hiervoor nodig hebt, vindt u bovenaan de bijgevoegde vragenlijst en bovenaan deze brief.

Als blijk van onze waardering, ontvangen 10 willekeurig gelote personen een Fnac-bon ter waarde van 20 euro.

We danken u alvast voor uw medewerking en tekenen met de meeste hoogachting.

Thomas Verbeek
Doctoraatsstudent

Luuk Boelens
Professor Ruimtelijke Planning

Faculteit Ingenieurswetenschappen en Architectuur – Vakgroep Civiele Techniek – AMRP
Vrijdagmarkt 10/301, B-9000 Gent
www.UGent.be

NL : Indien u de Nederlandse taal niet voldoende beheerst, kan u de vragenlijst opvragen in het Engels, Frans of Turks. Vul hiervoor de aanvraagkaart in en stuur deze naar ons op (port betaald door bestemmeling).

EN : If you don't understand Dutch (well enough), you can receive the letter and questionnaire in English. Please fill in the application for receipt of the letter and questionnaire in English and send this card back. The postal costs are paid by the recipient.

FR : Si vous ne comprenez pas (ou insuffisamment) le néerlandais, vous pouvez recevoir la lettre et le questionnaire en version française. Remplissez la demande de réception de la lettre et le questionnaire en français et renvoyez cette carte de réponse, frais d'expédition payé par le destinataire.

TR : Hollandaca dilini yeterince anlayamıyorsanız, mektup ve anketin Türkçe versiyonunu talep edebilirsiniz. Mektubun ve anketin Türkçe versiyonu için lütfen kartı doldurup, geri gönderiniz. Posta masrafları alıcı tarafından karşılanacaktır.

- Bovenaan de brief vindt u de naam van de persoon van het gezin die gekozen is om de vragenlijst in te vullen. Het is belangrijk dat deze persoon zelf de vragenlijst invult, en niet iemand anders. Meer uitleg over het invullen van de vragenlijst vindt u op de vragenlijst zelf.

- Uw medewerking aan dit onderzoek is vrijwillig en u zal uiteraard geen nadelige gevolgen ervaren wanneer u toch niet zou kunnen meewerken. Ook bij het invullen van de vragenlijst staat het u volledig vrij vragen al dan niet te beantwoorden. Wees wel spaarzaam met vragen openlaten; enkel vragenlijsten die voor 95% zijn ingevuld, zijn bruikbaar voor het onderzoek.

- De antwoorden die u ons geeft, blijven strikt vertrouwelijk en worden anoniem verwerkt, met respect voor de privacywetgeving. In geen geval worden uw persoonlijke gegevens vrijgegeven. Enkel de globale resultaten van het onderzoek zullen publiek worden gemaakt.

- De code die op de vragenlijst vermeld wordt, is de inlogcode voor de online vragenlijst.

- Indien u vragen hebt of hulp nodig hebt bij het invullen van de vragenlijst, dan kan u steeds contact opnemen met Thomas Verbeek, doctoraatsstudent aan de Universiteit Gent en verantwoordelijke voor deze bevraging. U kan hem telefonisch bereiken via 09 331 32 51, of door te mailen naar Thomas.Verbeek@UGent.be.

Faculteit Ingenieurswetenschappen en Architectuur – Vakgroep Civiele Techniek – AMRP
Vrijdagmarkt 10/301, B-9000 Gent www.UGent.be

10.5 Appendix B2 – accompanying letter in English

FACULTY OF **ENGINEERING AND ARCHITECTURE**

Department of **Civil Engineering**
Centre for **Mobility and Spatial Planning**

Name *Street Number* 9000 GENT	**your ref** 98WTGK	**date** 26 February 2016
contact Thomas Verbeek	**e-mail** Thomas.Verbeek@UGent.be	**tel.** +32 9 331 32 51

Dear Mr *Name*,

With this letter I kindly invite you to participate in the attached survey about the highway viaducts of E17 (Gentbrugge) and B401 (fly-over; Ledeberg and the south of Ghent inner city). Out of 20,000 citizens who live at less than 500 meter from these viaducts, you were randomly selected. This survey is part of a doctoral research on spatial planning, environmental pollution and public health. In the questionnaire we ask for your opinion on noise and air pollution caused by the highway viaducts, whether the current situation should be tackled and how this should be done. On the backside of this letter and on the first page of the questionnaire you find additional information about this survey.

Completing the survey will take about 15 minutes of your time. The results may yield a wealth of information on how to deal with the situation of the highway viaducts. Therefore, the survey is conducted in close collaboration with the City Government of Ghent.

Please return the questionnaire in the enclosed envelope (postage paid by the addressee), before 14 March 2016. We want to apologize for the inability to complete an English version of the survey online and hope you don't mind to fill out a questionnaire on paper.

As a sign of our appreciation, 10 randomly selected respondents will receive a Fnac voucher of 20 €.

We thank you for your cooperation and look forward to your response.

Sincerely,

Thomas Verbeek
PhD student

Luuk Boelens
Professor of Spatial Planning

Faculty of Engineering and Architecture – Department of Civil Engineering – AMRP
Vrijdagmarkt 10/301, B-9000 Gent
www.UGent.be

- On top of the letter you find the name of the person that is randomly selected to participate in the survey. It is important that this person completes the questionnaire, and not someone else. On the first page of the questionnaire you find more instructions on filling in the questionnaire.

- Your participation in this research is voluntary and you will not experience adverse consequences if you are not able to participate. You can also choose to give no answer to specific questions. However, please be careful in leaving questions blank; only questionnaires that are completed for 95% are useful for the research.

- Your answers will be processed confidentially and completely anonymously, with respect to the privacy legislation. Only the answers of a large group of people will be published. Individual answers or personal details will never be released to the public.

Faculty of Engineering and Architecture – Department of Civil Engineering – AMRP
Vrijdagmarkt 10/301, B-9000 Gent
www.UGent.be

10.6 Appendix B3 – accompanying letter in French

UNIVERSITEIT GENT

FACULTEIT **INGENIEURSWETENSCHAPPEN EN ARCHITECTUUR**

Vakgroep **Civiele Techniek**
Afdeling **Mobiliteit en Ruimtelijke Planning**

Name
Street Number
9000 GENT

votre référence
3AJ8IK

date
le 29 février 2016

contact
Thomas Verbeek

email
Thomas.Verbeek@UGent.be

tél.
+32 9 331 32 51

Madame *Name*,

J'aimerais bien vous inviter à participer au sondage ci-joint sur les viaducs autoroutiers E17 (Gentbrugge) et B401 (fly-over, Ledeberg et le sud du centre-ville de Gand). De 20.000 habitants de Gand qui vivent à moins de 500 mètres des viaducs, vous avez été choisi au hasard. Le sondage fait partie d'une recherche doctorale sur l'aménagement du territoire, les nuisances de l'environnement et la santé publique. Le questionnaire permet de collecter des informations détaillées sur la pollution sonore et atmosphérique causées par les viaducs autoroutiers et les stratégies pour remédier à la situation. Au verso de cette lettre, vous trouverez des informations supplémentaires sur cette recherche.

Remplir ce questionnaire vous prendra environ 15 minutes. Le sondage permet de fournir une multitude d'informations sur la situation des viaducs autoroutiers E17 et B401. Pour cette raison l'enquête est menée en étroite collaboration avec les autorités de Gand.

Veuillez répondre au questionnaire aussi tôt que possible (de sorte que vous ne l'oubliez pas) et renvoyer le questionnaire dans l'enveloppe réponse ci-jointe, au plus tard le 14 mars 2016. Frais d'expédition payé par le destinataire.

En guise de remerciement pour votre participation, 10 personnes choisies au hasard recevront un chèque-cadeau Fnac d'une valeur de 20 euros.

Merci d'avance pour votre aide, et veuillez agréer l'expression de nos sentiments distingués.

Thomas Verbeek
Doctorant

Luuk Boelens
Professeur de planification urbaine

- Dans l'entête de la lettre, vous trouverez le nom de la personne qui a été choisie au hasard pour participer au sondage. Il est important que cette personne remplit le questionnaire, et pas quelqu'un d'autre. Sur la première page du questionnaire, vous trouverez des instructions détaillées pour le remplir.

- Votre participation au sondage est volontaire et si vous ne pouvez pas participer cela ne pose aucun problème. En remplissant le questionnaire, vous pouvez aussi choisir d'ignorer certaines questions. Toutefois, veuillez être prudent en laissant des questions sans réponse. Uniquement les questionnaires presque complets (95% du questionnaire rempli) sont utiles à l'enquête.

- Vos réponses seront traitées de façon confidentielle et anonyme en respectant les lois sur la vie privée. Uniquement les résultats globaux seront publiés. Les réponses individuelles ou les détails personnels ne seront jamais rendus publics.

Faculteit Ingenieurswetenschappen en Architectuur – Vakgroep Civiele Techniek – AMRP
Vrijdagmarkt 10/301, B-9000 Gent www.UGent.be

10.7 Appendix C – application for translation of survey

☐ I would like to receive an English version of the letter and the questionnaire.

Please put this card in the enclosed envelope and send it back. The postal costs are paid by the recipient.

☐ J'aimerais bien recevoir une version française de la lettre et du questionnaire.

Veuillez nous renvoyer cette carte dans l'enveloppe réponse ci-jointe. Port payé par le destinataire.

☐ Mektup ve anketin Türkçe versiyonunu almak istiyorum.

Lütfen bu kartı size diğer dokümanlarla birlikte gönderilen zarfa koyup, üzerindeki adrese gönderiniz. Posta masrafları alıcı tarafından karşılanacaktır.

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first name/prénom/isim ……

last name/nom de famille/soyisim ……

address/adresse/adres ……..

……..

10.8 Appendix D1 – first reminder letter

UNIVERSITEIT GENT

FACULTEIT **INGENIEURSWETENSCHAPPEN EN ARCHITECTUUR**

Vakgroep **Civiele Techniek**
Afdeling **Mobiliteit en Ruimtelijke Planning**

Name *Street Number* 9000 GENT	**uw kenmerk** J2TKDF	**datum** 26-02-2016
contactpersoon Thomas Verbeek	**e-mail** Thomas.Verbeek@UGent.be	**tel.** +32 9 331 32 51

FOR ENGLISH VERSION, SEE REVERSE SIDE.

Geachte mevrouw *Name*,

Een drietal weken geleden ontving u van ons een vragenlijst over de snelwegviaducten E17 en B401. Uit ongeveer 20.000 Gentenaars die binnen de 500 meter van één van beide viaducten woont, werd u willekeurig geselecteerd. De vragenlijst peilt naar de hinder die u al dan niet ervaart, of de situatie moet aangepakt worden en hoe dit zou moeten gebeuren.

Indien u deze vragenlijst reeds ingevuld heeft, dan willen wij u hartelijk danken voor uw medewerking. Mocht u dit vergeten zijn, dan hopen we dat u ze na deze herinnering alsnog invult.
We hebben al ongeveer 250 antwoorden ontvangen, maar om betrouwbare en bruikbare resultaten te bekomen hebben we minstens 380 antwoorden nodig. Hopelijk wil u er mee voor zorgen dat dit aantal gehaald wordt. Ook indien u géén hinder ervaart van de viaducten of tevreden bent met de huidige situatie, willen we u vragen om de enquête in te vullen. Enkel zo kunnen we een zo correct mogelijk beeld verkrijgen.

Mogen wij vragen de vragenlijst in te vullen en vóór 14 maart terug te sturen? Dit kan nog steeds door middel van de gratis retourenveloppe die u ontvangen hebt.
Mocht u geen vragenlijst ontvangen hebben of indien u deze niet meer vindt, kan u eenvoudig een nieuw exemplaar aanvragen door contact op te nemen via e-mail (Thomas.Verbeek@UGent.be) of telefonisch op het nummer 09 331 32 51. U kan nog steeds een anderstalige enquête aanvragen (Engels, Frans of Turks) door middel van de antwoordkaart of via bovenstaande contactgegevens.
U kan de vragenlijst ook online invullen op http://www.ugent.be/viaduct. De logincode die u hiervoor nodig hebt, vindt u bovenaan deze brief onder “uw kenmerk”.

We herinneren u er graag aan dat 10 willekeurig gelote deelnemers een Fnac-bon ter waarde van 20 euro ontvangen, als blijk van onze waardering.

Wij hopen op uw medewerking en tekenen met de meeste hoogachting.

Thomas Verbeek
Doctoraatsstudent

Luuk Boelens
Professor Ruimtelijke Planning

UNIVERSITEIT GENT

FACULTY OF **ENGINEERING AND ARCHITECTURE**

Department of **Civil Engineering**
Centre for **Mobility and Spatial Planning**

Name *Street Number* 9000 GENT	**your ref** J2TKDF	**date** 26-02-2016
contact Thomas Verbeek	**e-mail** Thomas.Verbeek@UGent.be	**tel.** +32 9 331 32 51

VOOR NEDERLANDSE VERSIE, ZIE OMMEZIJDE.

Dear Ms *Name*,

Three weeks ago we sent you a questionnaire about the highway viaducts of E17 and B401. Out of 20.000 citizens who live at less than 500 meters from these viaducts, you were randomly selected. We ask for your opinion on noise and air pollution, whether the situation of the viaducts should be tackled and how this should be done.

If you have already completed this questionnaire, we want to thank you for your cooperation. If you have forgotten this, we hope you still want to fill it in after this reminder.
We have already received about 250 responses, but to obtain reliable and useful results we need at least 380 responses. We hope you want to help achieve this aim. Even if you are not bothered by the highway viaducts or if you are satisfied with the current situation, we kindly ask you to complete the questionnaire. This will provide a true and fair view of the situation.

Please may we ask for your cooperation to complete the questionnaire and return it before 14 March 2016. For this purpose you can still use the postage-free return envelope.
If you have not received a questionnaire or if you cannot find it anymore, you can easily request a new copy by sending an e-mail (Thomas.Verbeek@UGent.be) or giving us a call on 09 331 32 51. You can still ask for a **translated version of the questionnaire in English, French or Turkish** by filling in the card we sent you before, or by contacting us by e-mail or telephone.
We want to apologize for the inability to complete a translated version of the survey online and hope you don't mind to fill out a questionnaire on paper.

We like to remind you that, as a sign of our appreciation, 10 randomly selected participants will receive a Fnac voucher of 20 €.

We hope for your cooperation and look forward to your response.
Sincerely,

Thomas Verbeek
PhD student

Luuk Boelens
Professor of Spatial Planning

Faculty of Engineering and Architecture – Department of Civil Engineering – AMRP
Vrijdagmarkt 10/301, B-9000 Gent

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10.9 Appendix D2 – second reminder letter (18-35 year olds)

FACULTEIT **INGENIEURSWETENSCHAPPEN EN ARCHITECTUUR**

Vakgroep **Civiele Techniek**
Afdeling **Mobiliteit en Ruimtelijke Planning**

Name *Street Number* 9000 GENT	**uw kenmerk** 42TMZV	**datum** 04-04-2016
contactpersoon Thomas Verbeek	**e-mail** Thomas.Verbeek@UGent.be	**tel.** +32 9 331 32 55

FOR ENGLISH VERSION, SEE REVERSE SIDE.

Geachte mevrouw *Name*,

Een tweetal maanden geleden ontving u van ons een vragenlijst over de snelwegviaducten E17 en B401. Uit ongeveer 20.000 Gentenaars die binnen de 500 meter van één van beide viaducten woont, werd u willekeurig geselecteerd. De vragenlijst peilt naar de hinder die u al dan niet ervaart, of de situatie moet aangepakt worden en hoe dit zou moeten gebeuren.

Momenteel hebben we 360 antwoorden ontvangen, maar om betrouwbare en wetenschappelijk bruikbare resultaten te bekomen hebben we minstens 380 antwoorden nodig. **Vooral uit de leeftijdscategorie van 18 tot 35 komt er onvoldoende reactie. Daarom willen we u nog een laatste keer vriendelijk vragen om deel te nemen aan de enquête.** Ook indien u géén hinder ervaart van de viaducten of tevreden bent met de huidige situatie is uw mening belangrijk. Enkel zo kunnen we een zo correct mogelijk beeld verkrijgen.

U kan de vragenlijst nog steeds online invullen op http://www.ugent.be/viaduct. De logincode die u hiervoor nodig hebt vindt u bovenaan deze brief onder “uw kenmerk”.
Mocht u de vragenlijst liever op papier invullen, kan u eenvoudig een nieuw exemplaar aanvragen door uw contactgegevens te bezorgen via e-mail (Thomas.Verbeek@UGent.be). U kan op die manier ook nog steeds een anderstalige enquête op papier aanvragen (Engels of Frans).

We herinneren u er graag aan dat 10 willekeurig gelote deelnemers een Fnac-bon ter waarde van 20 euro ontvangen, als blijk van onze waardering.

Wij hopen op uw medewerking en tekenen met de meeste hoogachting.

Thomas Verbeek
Doctoraatsstudent

Luuk Boelens
Professor Ruimtelijke Planning

Faculteit Ingenieurswetenschappen en Architectuur – Vakgroep Civiele Techniek – AMRP
Vrijdagmarkt 10/301, B-9000 Gent
www.UGent.be

UNIVERSITEIT GENT

FACULTY OF **ENGINEERING AND ARCHITECTURE**

Department of **Civil Engineering**
Centre for **Mobility and Spatial Planning**

Name *Street Number* 9000 GENT	**your ref** 42TMZV	**date** 04-04-2016
contact Thomas Verbeek	**e-mail** Thomas.Verbeek@UGent.be	**tel.** +32 9 331 32 55

VOOR NEDERLANDSE VERSIE, ZIE OMMEZIJDE.

Dear Ms *Name*,

Two months ago we sent you a questionnaire about the highway viaducts of E17 and B401. Out of 20.000 citizens who live at less than 500 meters from these viaducts, you were randomly selected. We ask for your opinion on noise and air pollution, whether the situation of the viaducts should be tackled and how this should be done.

We have already received about 360 responses, but to obtain reliable and scientifically useful results we need at least 380 responses. **Especially in the age group of 18 to 35 the response rate is still too low. Therefore we send you this final reminder to participate in the survey.** Even if you are not bothered by the highway viaducts or if you are satisfied with the current situation, we kindly ask you to complete the questionnaire. This will provide a true and fair view of the situation.

You can request a paper version of the questionnaire in English or French by sending an e-mail with your name, address and preferred language to Thomas.Verbeek@UGent.be.
We want to apologize for the inability to complete a translated version of the survey online and hope you don't mind to fill out a questionnaire on paper.

We like to remind you that, as a sign of our appreciation, 10 randomly selected participants will receive a Fnac voucher of 20 €.

We hope for your cooperation and look forward to your response.
Sincerely,

Thomas Verbeek
PhD student

Luuk Boelens
Professor of Spatial Planning

Faculty of Engineering and Architecture – Department of Civil Engineering – AMRP
Vrijdagmarkt 10/301, B-9000 Gent

www.UGent.be

10.10 Appendix E – univariate survey results

Univariate results for all survey questions for the case area as a whole are reported. Weighting adjustment is applied to represent the target population as good as possible. Since statistical requirements are met for the case area as a whole, results are representative.
Univariate results by zone (E17, B401, mixed) are only reported when differences between zones are significant according to a Chi Square test. The cases are not weighted and results are only indicative. The values that cause the significant difference are marked in grey in the cross tabulations, these have a standardized adjusted residual higher than 2.0 or lower than -2.0.
For a few questions, frequencies are compared with the frequencies of similar questions in the Livability Monitor for Ghent 2014, which is representative for the Ghent population. Chi Square tests are used to assess the significance of differences in frequencies.

10.10.1 Current situation – nuisance

10.10.1.1 Annoyance by traffic noise and air pollution

Q1.1 In the last 12 months, to what extent have you been annoyed by *traffic noise* in your neighbourhood?
Traffic noise includes both road traffic (including tram) and rail traffic. If you have moved house in the last 12 months, this question only concerns your current neighbourhood.

Q1.7 In the last 12 months, to what extent have you been annoyed by *air pollution* in your neighbourhood?
If you have moved house in the last 12 months, this question only concerns your current neighbourhood.

Table 37 Annoyance by traffic noise and air pollution in case area (cases weighted)

	Q1.1 Traffic noise		Q1.7 Air pollution	
	Frequency	Percent	Frequency	Percent
never	59	*14.8*	44	*11.1*
rarely	68	*17.0*	53	*13.5*
sometimes	110	*27.6*	98	*24.6*
often	97	*24.4*	78	*19.6*
always	64	*16.2*	60	*15.3*
I don't know	0	*0.0*	63	*15.9*
TOTAL VALID	397	*100.0*	396	*100.0*
No answer	2		3	
TOTAL	399		399	

Table 38 Annoyance by traffic noise in different zones (cases not weighted)

Q1.1	E17 zone	B401 zone	mixed zone	TOTAL
X^2=26.172 (8, N=397), p=.001	Percent	Percent	Percent	Percent
never	8.0	19.8	9.6	13.9
rarely	9.5	21.4	16.4	16.4
sometimes	33.6	25.7	26.0	28.5
often	28.5	22.5	24.7	24.9
always	20.4	10.7	23.3	16.4
TOTAL	100.0	100.0	100.0	100.0
Number of respondents	*137*	*187*	*73*	*397*

Table 39 Annoyance by traffic noise in case area compared to Livability Monitor for Ghent (cases not weighted)

Q1.1	E17/B401 survey	Livability Monitor Ghent
X^2=40.159, p=.000	Percent	Percent
never	13.9	12.2
rarely	16.4	29.7
sometimes	28.5	29.2
often	24.9	18.3
always	16.4	10.6
TOTAL	100.0	100.0
Number of respondents	*397*	*2348*

10.10.1.2 Temporal variation of traffic noise annoyance

Q1.2 When where you annoyed by *traffic noise*?
(question was not asked for air pollution)
(question only asked if not answered "never" on Q1.1)

Table 40 Temporal variation of traffic noise annoyance in case area (cases weighted)

Q1.2	Frequency	Percent
mainly during the day	103	*30.7*
mainly at night	63	*18.6*
only during the day	52	*15.4*
only at night	9	*2.5*
both day and night	97	*28.9*
I don't know	13	*3.9*
TOTAL VALID	336	*100.0*
No answer	2	
TOTAL	338	

10.10.1.3 Relation of annoyance with viaduct of E17/B401

Q1.3 Do you think this *traffic noise* is also caused by the nearby highway viaducts of B401 (fly-over) and/or E17?
(question only asked if not answered "never" on Q1.1)

Q1.8 Do you think this *air pollution* is also caused by the nearby highway viaducts of B401 (fly-over) and/or E17?
(question only asked if not answered "never" on Q1.7)

Table 41 Relation of annoyance with viaduct of E17/B401 in case area (cases weighted)

	Q1.3 For traffic noise		Q1.8 For air pollution	
	Frequency	Percent	Frequency	Percent
yes, these highways are the most important source of traffic noise/air pollution for me	109	*32.4*	129	*36.6*
yes, but other roads or railways in my neighborhood have an equal contribution to the traffic noise/air pollution	85	*25.4*	139	*39.6*
yes, but other roads or railways in my neighborhood have a (much) higher contribution to the traffic noise/air pollution	53	*15.7*	29	*8.2*
no, these highways do not contribute to the traffic noise/air pollution, they do not bother me	78	*23.4*	17	*4.8*
I don't know	10	*3.1*	38	*10.8*
TOTAL VALID	335	*100.0*	351	*100.0*
No answer	3		1	
TOTAL	338		352	

Table 42 Relation of traffic noise annoyance with viaduct of E17/B401 for different zones (cases not weighted)

Q1.3	E17 zone	B401 zone	mixed zone	TOTAL
X^2=60.033 (8, N=344), p=.000	Percent	Percent	Percent	Percent
yes, these highways are the most important source of traffic noise for me	58.3	19.7	29.2	35.8
yes, but other roads or railways in my neighborhood have an equal contribution to the traffic noise	24.4	28.3	26.2	26.5
yes, but other roads or railways in my neighborhood have a (much) higher contribution to the traffic noise	7.9	15.8	23.1	14.2
no, these highways do not contribute to the traffic noise, they do not bother me	8.7	32.9	21.5	21.8
I don't know	0.8	3.3	0.0	1.7
TOTAL	100.0	100.0	100.0	100.0
Number of respondents	*127*	*152*	*65*	*344*

Table 43 Relation of air pollution annoyance with viaduct of E17/B401 for different zones (cases not weighted)

Q1.8	E17 zone	B401 zone	mixed zone	TOTAL
X^2=23.663 (8, N=361), p=.003	Percent	Percent	Percent	Percent
yes, these highways are the most important source of air pollution for me	50.8	32.4	30.4	38.2
yes, but other roads or railways in my neighborhood have an equal contribution to the air pollution	35.2	42.4	36.2	38.8
yes, but other roads or railways in my neighborhood have a (much) higher contribution to the air pollution	0.8	9.4	13.0	7.2
no, these highways do not contribute to the air pollution, they do not bother me	2.5	6.5	5.8	5.0
I don't know	10.7	9.4	14.5	10.8
TOTAL	100.0	100.0	100.0	100.0
Number of respondents	122	170	69	361

10.10.1.4 Assessment of relative exposure to traffic noise and air pollution

Q1.4 What do you think about your exposure to *traffic noise* when you compare it with the average Ghent citizen?
Q1.9 What do you think about your exposure to *air pollution* when you compare it with the average Ghent citizen?

Table 44 Assessment of relative exposure to traffic noise and air pollution in case area (cases weighted)

	Q1.4 For traffic noise		Q1.9 For air pollution	
	Frequency	Percent	Frequency	Percent
I have a much higher exposure	44	*11.2*	52	*13.1*
I have a higher exposure	128	*32.3*	137	*34.8*
I have an equal exposure	120	*30.4*	135	*34.3*
I have a lower exposure	49	*12.4*	18	*4.7*
I have a much lower exposure	23	*5.7*	10	*2.6*
I don't know	31	*7.9*	41	*10.5*
TOTAL VALID	396	*100.0*	394	*100.0*
No answer	3		5	
TOTAL	399		399	

Table 45 Assessment of relative exposure to traffic noise for different zones (cases not weighted)

Q1.4	E17 zone	B401 zone	mixed zone	TOTAL
X^2=20.327 (10, N=396), p=.026	Percent	Percent	Percent	Percent
I have a much higher exposure	16.1	8.1	14.9	12.1
I have a higher exposure	35.8	28.1	36.5	32.3
I have an equal exposure	24.1	34.1	29.7	29.8
I have a lower exposure	8.0	15.1	10.8	11.9
I have a much lower exposure	4.4	8.1	1.4	5.6
I don't know	11.7	6.5	6.8	8.3
TOTAL	100.0	100.0	100.0	100.0
Number of respondents	*137*	*185*	*74*	*396*

10.10.1.5 Concerns about environmental impacts and health effects

Q1.5 Are you worried about *traffic noise* in your neighbourhood and the possible effects on your health?
Q1.10 Are you worried about *air pollution* in your neighbourhood and the possible effects on your health?

Table 46 Concerns about environmental impacts of traffic noise/air pollution and health effects in case area (cases weighted)

	Q1.5 For traffic noise		Q1.10 For air pollution	
	Frequency	Percent	Frequency	Percent
definitely yes	25	*6.4*	66	*16.8*
rather yes	144	*36.1*	197	*50.0*
rather not	138	*34.6*	86	*21.8*
not at all	82	*20.5*	36	*9.1*
I don't know	10	*2.4*	9	*2.3*
TOTAL VALID	398	*100.0*	394	*100.0*
No answer	1		4	
TOTAL	399		399	

10.10.1.6 Occurrence of health problems related to environmental impacts

Q1.6 Do you think you have health problems that are caused or aggravated by *traffic noise*?

Q1.11 Do you think you have health problems that are caused or aggravated by *air pollution*?

Table 47 Occurrence of health problems caused or aggravated by traffic noise/air pollution in case area (cases weighted)

	Q1.6 For traffic noise		Q1.11 For air pollution	
	Frequency	Percent	Frequency	Percent
yes, certainly	21	*5.4*	40	*10.1*
yes, maybe	77	*19.4*	113	*28.7*
no, certainly not	208	*52.5*	134	*33.9*
I don't know	90	*22.7*	108	*27.3*
TOTAL VALID	397	*100.0*	395	*100.0*
No answer	2		4	
TOTAL	399		399	

Table 48 Occurrence of health problems caused or aggravated by traffic noise for different zones (cases not weighted)

Q1.6	E17 zone	B401 zone	mixed zone	TOTAL
X^2=13.161 (6, N=397), p=.041	Percent	Percent	Percent	Percent
yes, certainly	6.6	3.8	9.5	5.8
yes, maybe	25.5	16.7	20.3	20.4
no, certainly not	42.3	60.2	45.9	51.4
I don't know	25.5	19.4	24.3	22.4
TOTAL	100.0	100.0	100.0	100.0
Number of respondents	*137*	*186*	*74*	*397*

10.10.1.7 Most important source of environmental nuisance

Q1.12 Which source of environmental nuisance in your neighbourhood bothers you the most?

Table 49 Most important source of environmental nuisance in case area (cases weighted)

Q1.12	Frequency	Percent
traffic noise	145	*37.4*
air pollution	123	*31.6*
something else	120	*31.0*
TOTAL VALID	388	*100.0*
No answer	11	
TOTAL	399	

Table 50 Most important source of environmental nuisance in case area, explanation category "something else" (cases weighted)

Q1.12 "something else"	Frequency	Percent
combination of nuisances	21	*17.8*
traffic noise and air pollution	17	*14.4*
construction works	16	*13.0*
street noise/neighbor's noise	13	*10.9*
traffic (congestion, excessive speed, parking problems)	13	*10.6*
not specified	12	*9.9*
train or tram	6	*4.9*
litter	4	*3.4*
other	18	*15.0*
TOTAL VALID	120	*100.0*

10.10.1.8 Importance of residential environment for living quality

Q1.13 Is your residential environment important for your quality of life?

Table 51 Importance of residential environment for living quality in case area (cases weighted)

Q1.13	Frequency	Percent
definitely yes	173	*46.4*
rather yes	152	*40.8*
neutral	37	*10.0*
rather not	2	*.6*
not at all	1	*.3*
no opinion	7	*1.9*
TOTAL VALID	372	*100.0*
No answer	26	
TOTAL	399	

10.10.2 Current situation – justice

10.10.2.1 Statements on environmental justice

Q2.1 In the vicinity of the highway viaducts of E17 and B401 live citizens that have a high exposure to traffic noise and air pollution. To what extent do you agree with these statements?
Tick one answer for each row.

Table 52 Opinion on statements on environmental justice in case area (cases weighted)
(TA: totally agree, A: agree, N: neutral, DA: disagree, TDA: totally disagree, NO: no opinion)

Q2.1	N	Mis-sing	Percentages					
			TA	A	N	DA	TDA	NO
1. Everyone is free to live wherever they want and must bear the consequences of pollution in the environment.	397	2	14.4	26.6	17.7	24.7	16.3	0.2
2. Everyone is entitled to a minimum level of environmental quality, no matter where they live.	397	2	54.8	33.6	9.4	0.8	0.5	0.8
3. It is not fair that people who live close to the viaducts of E17 or B401 (fly-over) are exposed to high levels of noise and air pollution.	397	2	25.0	32.7	27.9	10.2	2.9	1.3
4. When environmental pollution has an effect on public health, the government should intervene.	398	1	58.8	33.2	4.5	1.3	1.2	1.0
5. Not only the government is responsible for the environmental nuisance caused by the viaducts of E17 and B401 (fly-over), also the people who live there are partly responsible.	397	2	6.4	14.3	18.0	29.0	29.4	2.8
6. The environmental pollution around the E17 and B401 is unacceptable and must be tackled.	398	1	23.9	29.7	31.0	8.4	5.2	1.7

10.10.3 Current situation – housing and moving house

10.10.3.1 Home ownership

Q3.1 Do you own or rent your house?

Table 53 Home ownership in case area (cases weighted)

Q3.1	Frequency	Percent
owner	258	*65.0*
renter	139	*35.0*
TOTAL VALID	398	*100.0*
No answer	1	
TOTAL	399	

Table 54 Home ownership for different zones (cases not weighted)

Q3.1	E17 zone	B401 zone	mixed zone	TOTAL
X^2=22.727 (2, N=398), p=.000	Percent	Percent	Percent	Percent
owner	80.4	56.7	75.3	68.3
renter	19.6	43.3	24.7	31.7
TOTAL	100.0	100.0	100.0	100.0
Number of respondents	*138*	*187*	*73*	*398*

10.10.3.2 Housing typology

Q3.2 Which type of housing do you live in?

Table 55 Housing typology in case area (cases weighted)

Q3.2	Frequency	Percent
single-family detached house	15	*3.6*
single-family semi-detached house	32	*8.1*
single-family row house	196	*49.2*
apartment	153	*38.3*
studio flat	3	*.7*
TOTAL (all cases valid)	399	*100.0*

Table 56 Housing typology for different zones (cases not weighted) (some categories grouped because of too low counts in cross tabulation with original categories)

Q3.2	E17 zone	B401 zone	mixed zone	TOTAL
X^2=115.011 (4, N=399), p=.000	Percent	Percent	Percent	Percent
single-family (semi-)detached house	31.9	3.7	8.1	14.3
single-family row house	53.6	36.9	74.3	49.6
apartment or studio flat	14.5	59.4	17.6	36.1
TOTAL	100.0	100.0	100.0	100.0
Number of respondents	*138*	*187*	*74*	*399*

Q3.3 Do you have an outdoor space, such as a garden or a terrace?

Table 57 Disposal of outdoor space in case area (cases weighted)

Q3.3	Frequency	Percent
yes	353	*89.5*
no	42	*10.5*
TOTAL VALID	395	*100.0*
No answer	4	
TOTAL	399	

Table 58 Disposal of outdoor space for different zones (cases not weighted)

Q3.3	E17 zone	B401 zone	mixed zone	TOTAL
X^2=7.244 (2, N=395), p=.027	Percent	Percent	Percent	Percent
yes	96.4	88.1	88.9	91.1
no	3.6	11.9	11.1	8.9
TOTAL	100.0	100.0	100.0	100.0
Number of respondents	*138*	*185*	*72*	*395*

10.10.3.3 Housing trajectory

Q3.4 Since when do you live in this house?
Fill in a year.

Figure 104 Length of residence in case area (cases weighted)

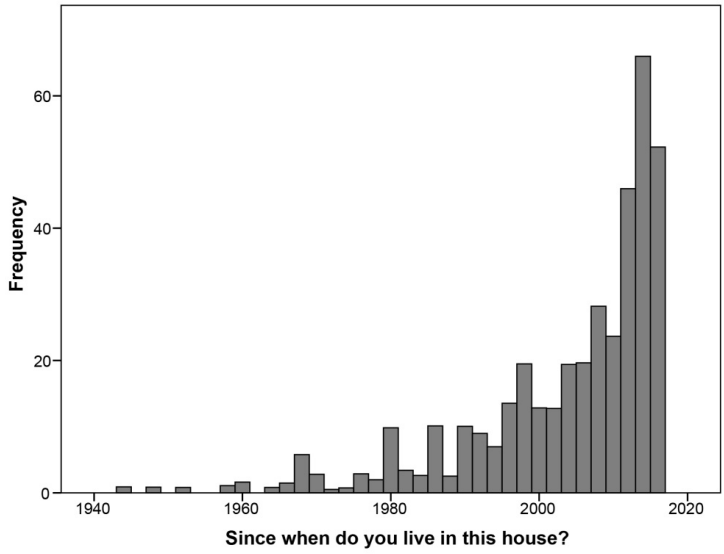

Table 59 Descriptive statistics for Q3.4 on length of residence in case area (cases weighted)

Q3.4	
Mean	2003.23
Median	2008.00
Standard Deviation	13.225
Minimum	1944
Maximum	2016
TOTAL VALID	390
No answer	9
TOTAL	399

Table 60 Results of one-way ANOVA for length of residence in different zones (Tukey post-hoc test to reveal significant differences)

Q3.4	E17 zone	B401 zone	mixed zone
ANOVA (F(2,388)=14.661, p=.000)	Mean=1997.43	Mean=2005.23	Mean=2003.93
E17 zone (Mean=1997.43)	-	p=.000	p=.002
B401 zone (Mean=2005.23)	-	-	p=.755
mixed zone (Mean=2003.93)	-	-	-
Number of respondents	*138*	*187*	*74*

Q3.5 What has played a part in the choice of moving to this house?

Multiple answers possible.

Table 61 Reasons for choice of residence in case area (cases weighted)

Q3.5	Frequency	Percent (of all cases)
I have lived in this house for all my life	18	*4.4*
this house has been assigned to me	17	*4.3*
distance commuter traffic	164	*41.2*
want to live closer to my children/parents	55	*13.9*
want to live closer to family/friends	64	*16.0*
the existence of green space, parks, trees	74	*18.7*
nice neighbourhood	131	*32.9*
adequate facilities in the neighbourhood	148	*37.2*
good accessibility by car	139	*34.8*
good accessibility by public transport	208	*52.2*
low house prices	90	*22.7*
other	72	*18.0*
TOTAL	399	*100.0*

Table 62 Reasons for choice of residence in case area, explanation category "other" (cases weighted)

Q3.5 "other"	Frequency	Percent (of all cases)
in or near the city (and its facilities)	13	*3.3*
specific characteristics of the house or rental conditions	12	*3.0*
living with parents, partner or family	11	*2.8*
got his house from parents, family or friends	6	*1.5*
I have always lived in this neighborhood	4	*1.0*
good accessibility by bike	4	*1.0*
business premises adjacent to the house	3	*0.8*
other reasons	3	*0.8*
not specified	16	*4.0*
TOTAL "other"	72	*18.0*
TOTAL	399	*100.0*

Table 63 Reasons for choice of residence for different zones (cases not weighted) (only reasons with significant differences between zones are reported)

Q3.5	E17 zone	B401 zone	mixed zone	TOTAL
	Percent	Percent	Percent	Percent
I have lived in this house for all my life *(X^2=10.083, p=.006)*	10.1	2.7	2.7	5.3
the existence of green space, parks, trees *(X^2=32.305, p=.000)*	37.0	16.0	6.8	21.6
nice neighborhood *(X^2=15.125, p=.001)*	44.2	34.2	17.6	34.6
good accessibility by car *(X^2=6.641, p=.036)*	40.6	35.8	23.0	35.1
low house prices *(X^2=26.627, p=.000)*	10.1	21.9	40.5	21.3
Number of respondents	*138*	*187*	*74*	*399*

10.10.3.4 Environmental pollution and housing

Q3.6 Were you aware of the possibility of noise and air pollution when you came to live here?

Multiple answers possible.

(question only asked if not answered "I have lived in this house for all my life" on Q3.5)

Table 64 Awareness on environmental pollution when making choice of residence in case area (cases weighted)

Q3.6	Frequency	Percent (of valid cases N=379)
yes, but the advantages of the location outweighed the disadvantages	129	*34.1*
yes, but I had little choice (e.g. because of financial constraints or availability of housing)	60	*16.0*
yes, but it seemed bearable	144	*37.9*
no	90	*23.8*
TOTAL VALID	379	
No answer	2	
TOTAL	381	

Table 65 Awareness on environmental pollution when making choice of residence for different zones (cases not weighted) (only answers with significant differences between zones are reported)

Q3.5	E17 zone	B401 zone	mixed zone	TOTAL
	Percent	Percent	Percent	Percent
yes, but I had little choice (e.g. because of financial constraints or availability of housing) *(X^2=6.298, p=.043)*	10.5	14.3	23.6	14.8
Number of respondents	*124*	*182*	*72*	*399*

Q3.7 Has the nuisance of *traffic noise* changed during the time you have been living here?

Q3.8 Has the nuisance of *air pollution* changed during the time you have been living here?

Table 66 Historical evolution of traffic noise and air pollution nuisance in case area (cases weighted)

	Q3.7 For traffic noise		Q3.8 For air pollution	
	Frequency	Percent	Frequency	Percent
the nuisance has increased a lot	91	*22.8*	71	*17.8*
the nuisance has increased a little	94	*23.7*	77	*19.4*
the nuisance is still on the same level	161	*40.7*	128	*32.3*
the nuisance has decreased a little	14	*3.5*	5	*1.3*
the nuisance has decreased a lot	5	*1.3*	2	*.4*
I don't know	31	*7.9*	114	*28.8*
TOTAL VALID	396	*100.0*	396	*100.0*
No answer	3		3	
TOTAL	399		399	

10.10.3.5 Moving house

Q3.9 Do you consider moving in the coming two years?

Table 67 Intentions of moving in case area (cases weighted)

Q3.9	Frequency	Percent
no	223	*56.1*
possibly	79	*19.9*
I would like to, but I can't find a suitable house	15	*3.7*
I would like to, but I don't have the necessary resources	42	*10.7*
certainly	29	*7.2*
I have already found a new house	10	*2.4*
TOTAL VALID	397	*100.0*
No answer	2	
TOTAL	399	

Table 68 Intentions of moving in case area compared to Livability Monitor for Ghent (cases not weighted)

Q3.9	E17/B401 survey	Livability Monitor Ghent
X^2=8.578, p=.127	Percent	Percent
no	*58.7*	*65.0*
possibly	*19.1*	*16.0*
I would like to, but I can't find a suitable house	*3.5*	*2.6*
I would like to, but I don't have the necessary resources	*9.8*	*7.2*
certainly	*6.0*	*6.7*
I have already found a new house	*2.8*	*2.4*
TOTAL	100.0	*100.0*
Number of respondents	*397*	*2369*

Table 69 Intentions of moving for different zones (cases not weighted) (some categories grouped because of too low counts in cross tabulation with original categories)

Q3.9	E17 zone	B401 zone	mixed zone	TOTAL
X^2=14.032, p=.029	Percent	Percent	Percent	Percent
no	69.6	51.9	55.4	58.7
possibly	14.5	22.2	20.3	19.1
I would like to, but I can't find a suitable house/don't have the financial resources	9.4	14.1	18.9	13.4
certainly/already found a new house	6.5	11.9	5.4	8.8
TOTAL	100.0	100.0	100.0	100.0
Number of respondents	*138*	*185*	*74*	*397*

Q3.10 What are the main reasons why you would move?

Tick the most important reasons (maximum three answers).
(question only asked if not answered "no" on Q3.9)

Table 70 Reasons for moving in case area (cases weighted)

Q3.10	Frequency	Percent (of valid cases N=174)
personal circumstances (marriage, divorce, disease ...)	56	*32.2*
work related circumstances	21	*12.0*
not satisfied with your current house	36	*20.6*
not satisfied with your current neighborhood	29	*16.8*
environmental noise in the current neighborhood	55	*31.8*
air pollution in the current neighborhood	52	*29.6*
I want to leave town	25	*14.1*
other	45	*25.7*
TOTAL	174	*100.0*

Table 71 Reasons for moving in case area, explanation category "other" (cases weighted)

Q3.10 "other"	Frequency	Percent (of valid cases N=174)
I wish to buy a house	8	*4.6*
traffic congestion, parking problems	3	*1.7*
personal health or childrens' health	2	*1.1*
other reason	9	*5.2*
not specified	23	*13.2*
TOTAL "other"	45	*25.7*
TOTAL	174	*100.0*

Table 72 Reasons for moving for different zones (cases not weighted) (only answers with significant differences between zones are reported)

Q3.10	E17 zone	B401 zone	mixed zone	TOTAL
	Percent	Percent	Percent	Percent
not satisfied with your current neighborhood *(X^2=6.290, p=.043)*	9.5	14.6	30.3	14.8
Number of respondents	*42*	*89*	*33*	*164*

Q3.11 Would you take traffic noise and air pollution into account when deciding on a new house?

Table 73 Influence of environmental pollution on new choice of residence in case area (cases weighted)

Q3.11	Frequency	Percent
yes, certainly	222	*56.9*
yes, maybe	112	*28.8*
no	26	*6.8*
I don't know	29	*7.5*
TOTAL VALID	389	*100.0*
No answer	9	
TOTAL	399	

10.10.4 Current situation – complaints

Q4.1 Have you ever filed a formal complaint about traffic noise or air pollution?

Table 74 Complaints about environmental pollution in case area (cases weighted)

Q4.1	Frequency	Percent
yes, as an individual citizen	9	*2.3*
yes, as member of a group of citizens	19	*4.7*
no	364	*91.7*
I don't know	5	*1.2*
TOTAL VALID	397	*100.0*
No answer	2	
TOTAL	399	

Table 75 Complaints about environmental pollution for different zones (cases not weighted) (some categories grouped because of too low counts in cross tabulation with original categories)

Q4.1	E17 zone	B401 zone	mixed zone	TOTAL
$X^2=11.047$, $p=.004$	Percent	Percent	Percent	Percent
yes	14.8	5.4	4.1	58.7
no	85.2	94.6	95.9	19.1
TOTAL	100.0	100.0	100.0	100.0
Number of respondents	*135*	*184*	*73*	*392*

Q4.2 Can you explain how you filed a formal complaint?
(question only asked if not answered "no" or "I don't know" on Q4.1)

yes, as an individual citizen
- with the city (3)
- with the public transport company (2)
- with the police (1)
- invalid or unclear answer (4)

yes, as member of a group of citizens
- I signed a petition (6)
- I am member or supporter of Viadukaduk (4)
- I was member of the pressure group "E17-lawaai" (3)
- I am member of an unspecified pressure group (2)
- with the city of Ghent and Flemish government, as managing agent of the apartment building (1)
- with the minister of transport (1)
- invalid or unclear answer (2)

Q4.3 Why have you never filed a formal complaint about traffic noise or air pollution?
Multiple answers possible
(question only asked if answered "no" on Q4.1)

Table 76 Reasons why never filed a formal complaint in case area (cases weighted)

Q4.3	Frequency	Percent (of valid cases N=364)
the traffic noise and air pollution in my neighborhood are acceptable to me	176	*48.3*
I don't know how and where I can file a formal complaint	90	*24.7*
my voice is not heard	26	*7.1*
nothing is being done with my complaint	55	*15.0*
other	69	*19.0*
TOTAL	364	*100.0*

Table 77 Reasons why never filed a formal complaint in case area, explanation category "other" (cases weighted)

Q4.3 "other"	Frequency	Percent (of valid cases N=364)
there is no concrete solution, big structural change is needed	13	3.6
I came to live here after the highway was constructed, so I don't have the right to complain	12	3.4
I am not annoyed by traffic noise or air pollution	11	3.0
I have never thought about it	7	2.1
it is to no use to think about it	6	1.8
the problem is already known	4	1.1
I adapt to the situation	4	1.0
I don't have the time	2	0.5
other reason	6	1.5
not specified	5	1.3
TOTAL "other"	69	*19.0*
TOTAL	364	*100.0*

Table 78 Reasons why never filed a formal complaint for different zones (cases not weighted) (only answers with significant differences between zones are reported)

Q4.3	E17 zone	B401 zone	mixed zone	TOTAL
	Percent	Percent	Percent	Percent
the traffic noise and air pollution in my neighborhood are acceptable to me *(X^2=6.620, p=.037)*	41.7	54.6	40.0	47.6
Number of respondents	*115*	*174*	*70*	*359*

10.10.5 Policy strategies – government

Q5.1 It is an option to leave a spatial problem, such as the situation of the highway viaducts of E17 and B401 (fly-over), entirely to the government. Hereafter you find some statements about this approach. To what extent do you agree with these statements?
Tick one answer for each row.

Table 79 Opinion on statements on the role of the government in case area (cases weighted) (TA: totally agree, A: agree, N: neutral, DA: disagree, TDA: totally disagree, NO: no opinion)

Q5.1	N	Mis-sing	Percentages					
			TA	A	N	DA	TDA	NO
1. The government is best placed to balance local interests (e.g. environmental pollution) and wider public interests (e.g. economic).	395	4	16.0	34.3	23.3	15.2	5.0	6.2
2. The government acts in the best interests of all citizens.	395	4	2.2	13.4	29.1	36.0	15.1	4.2
3. The government has the best, unbiased information about situations of environmental pollution (e.g. noise and air pollution).	395	3	7.3	25.9	27.3	27.2	6.4	6.0
4. Certain population groups or neighborhoods are less important for the government and get less attention in policymaking.	398	1	13.4	39.6	25.5	10.5	3.2	7.8

Table 80 Opinion on statements on the role of the government for different zones (cases not weighted) (some categories grouped for better interpretation)

Q5.1_2 The government acts in the best interests of all citizens.	**E17 zone**	**B401 zone**	**mixed zone**	**TOTAL**
X^2=11.183, p=.025	Percent	Percent	Percent	Percent
agree	18.0	19.7	4.2	16.2
neutral	29.7	30.9	28.2	30.0
disagree	52.3	49.4	67.6	53.8
TOTAL	100.0	100.0	100.0	100.0
Number of respondents	*128*	*178*	*71*	*377*
Q5.1_4 Certain population groups or neighborhoods are less important for the government and get less attention in policymaking.	**E17 zone**	**B401 zone**	**mixed zone**	**TOTAL**
X^2=9.501, p=.050	Percent	Percent	Percent	Percent
agree	59.7	50.9	71.0	57.8
neutral	23.3	32.0	20.3	26.7
disagree	17.1	17.2	8.7	15.5
TOTAL	100.0	100.0	100.0	100.0
Number of respondents	*129*	*169*	*69*	*367*

Q5.2 There are different policy levels involved in the spatial problem of the highway viaducts of E17 and B401. How well do you know them?
Tick one answer for each row.

Table 81 Opinion on statements on knowledge about the government in case area (cases weighted) (TA: totally agree, A: agree, N: neutral, DA: disagree, TDA: totally disagree, NO: no opinion)

Q5.2	N	Mis-sing	Percentages		
			yes, very good	yes, partly	no
1. I know the position and policy of the *City Government of Ghent* concerning the highway viaducts of E17 and B401 (fly-over).	399	0	8.6	31.4	60.0
2. I know the position and policy of the *Flemish Government* concerning the highway viaducts of E17 and B401 (fly-over).	398	1	4.8	16.6	78.6
3. I know the *European environmental standards* for air pollution and environmental noise.	398	1	3.3	14.6	82.1

Table 82 Opinion on statements on knowledge about the government for different zones (cases not weighted) (some categories grouped for better interpretation)

Q5.2_2 I know the position and policy of the *Flemish Government* concerning the highway viaducts of E17 and B401 (fly-over).	**E17 zone**	**B401 zone**	**mixed zone**	**TOTAL**
X^2=10.614, p=.031	Percent	Percent	Percent	Percent
yes, very good	8.0	3.8	4.1	5.3
yes, partly	23.9	13.4	14.9	17.3
no	68.1	82.8	81.1	77.4
TOTAL	100.0	100.0	100.0	100.0
Number of respondents	*138*	*186*	*74*	*398*

Q5.3 Hereafter you find some statements about your confidence in the policy of different policy levels concerning the highway viaducts and the resulting environmental pollution. To what extent do you agree with these statements?
Tick one answer for each row.

Table 83 Opinion on statements on confidence in the government in case area (cases weighted) (TA: totally agree, A: agree, N: neutral, DA: disagree, TDA: totally disagree, NO: no opinion)

Q5.3	N	Mis-sing	Percentages					
			TA	A	N	DA	TDA	NO
1. I have confidence in the policy of the *City Government of Ghent* concerning the future of the highway viaducts E17 and B401 (fly-over).	398	1	6.8	36.6	25.3	14.3	8.1	8.9
2. I have confidence in the policy of the *Flemish Government* concerning the future of the highway viaducts E17 and B401 (fly-over).	399	0	2.9	14.8	33.9	22.6	11.4	14.3
3. I have confidence in the *European environmental standards* for air pollution and environmental noise.	399	0	5.4	25.8	30.0	13.9	6.8	18.2

10.10.6 Policy strategies – participation

Q6.1 The government can also choose to involve citizens in policymaking and planning processes. This is called participation. To what extent do you agree with these statements?
Tick one answer for each row.

Table 84 Opinion on participation in case area (cases weighted) (TA: totally agree, A: agree, N: neutral, DA: disagree, TDA: totally disagree, NO: no opinion)

Q6.1	N	Mis-sing	Percentages					
			TA	A	N	DA	TDA	NO
1. Citizen participation in policy can lead to better solutions.	396	3	*29.8*	*51.5*	*12.1*	*3.1*	*1.4*	*2.1*
2. Citizen participation in policy delays the decision-making process.	395	3	*6.8*	*35.7*	*24.7*	*23.0*	*6.3*	*3.5*
3. The citizens' interests are defended better when citizens participate in policy.	397	2	*29.8*	*49.7*	*13.2*	*4.6*	*0.6*	*2.2*
4. When the government consults the public, their ideas and opinions are often not taken into account.	397	1	*12.0*	*27.9*	*34.2*	*10.6*	*0.9*	*14.4*
5. The *City Government of Ghent* is making efforts to increase citizen participation in policy.	397	1	*7.3*	*37.5*	*25.5*	*8.1*	*6.1*	*15.4*
6. The *Flemish Government* is making efforts to increase citizen participation in policy.	397	2	*1.7*	*6.6*	*34.2*	*17.1*	*14.2*	*26.2*

Q6.2 Do you think the government should involve citizens in finding solutions for the environmental pollution caused by the highway viaducts of E17 and B401?

Table 85 Opinion on participation for E17/B401 in case area (cases weighted)

Q6.2	Frequency	Percent
yes, certainly	178	*45.5*
yes, maybe	137	*34.9*
no, certainly not	15	*3.8*
I don't know	62	*15.8*
TOTAL VALID	392	*100.0*
No answer	7	
TOTAL	399	

Q6.3 Why do you think that?

(question only asked if not answered "I don't know" on Q6.2)

yes, certainly/maybe

- Citizens are most familiar with the local situation and bear the consequences (152)
- citizens might have creative, smart and feasible ideas (46)
- multiple perspectives and interaction between actors leads to better solutions (28)
- argument or consideration out of scope (23)
- participation leads to public support and a sense of responsibility (15)
- maybe, because (9)
  - only citizens with sufficient knowledge and skills should be involved
  - also car drivers (users of the viaduct) should be involved
  - there is a risk that citizens tend to focus on their own situation
  - only those who suffer from the negative effects should be involved

no, certainly not

- too many different opinions (4)
- citizens do not have sufficient knowledge (2)

Q6.4 Do you think you have sufficient knowledge and skills to contribute to finding solutions for the environmental pollution caused by the highway viaducts of E17 and B401?

Table 86 Opinion on knowledge and skills to engage in participation for E17/B401 in case area (cases weighted)

Q6.4	Frequency	Percent
yes, certainly	34	*8.7*
yes, maybe	125	*32.1*
no, certainly not	148	*38.0*
I don't know	83	*21.2*
TOTAL VALID	390	*100.0*
No answer	9	
TOTAL	399	

Q6.5 Do you want to be involved in finding solutions?

Table 87 Opinion on getting involved in participation for E17/B401 in case area (cases weighted)

Q6.4	Frequency	Percent
yes, certainly	44	*11.3*
yes, maybe	166	*42.3*
no, certainly not	117	*29.6*
I don't know	66	*16.8*
TOTAL VALID	393	*100.0*
No answer	5	
TOTAL	399	

10.10.7 Policy strategies – mitigating measures

Q7.1 A way to decrease environmental pollution is looking for mitigation measures. These measures can be implemented by the government but also by other actors.
Which measures have already been taken in your house to decrease the exposure to traffic noise and air pollution? Which measures are still needed?
Tick two answers for each row. Also measures that have already been taken, can still be needed (more). E.g. a house can already have soundproofing on one facade, but more soundproofing may still be needed.

Table 88 Adaptive measures in house in case area (cases weighted)

Q7.1 measures already taken in house	N	Mis-sing	Percentages			
			yes	no	I don't know	no answer
soundproofing	399	0	39.6	40.8	14.0	5.6
double glazed windows	399	0	87.9	8.7	2.2	1.2
air filtration or purification	399	0	11.0	68.4	14.4	6.3
other	399	0	2.9	12.5	21.9	62.7
Q7.1 measures still needed in house	**N**	**Mis-sing**	**Percentages**			
			yes	no	I don't know	no answer
soundproofing	399	0	35.9	28.8	13.8	21.6
double glazed windows	399	0	19.7	44.7	7.6	28.0
air filtration or purification	399	0	33.9	16.5	30.7	18.9
other	399	0	3.4	7.8	25.5	63.2

Other measures taken: plantings, sleep measures, ...
Other measures still needed: plantings, facade protection against soot pollution, ...

Table 89 Adaptive measures in house for different zones (cases not weighted) (only measures with significant differences between zones are reported; categories "I don't know" and "no answer" excluded)

Q7.1 measures already taken in house	E17 zone	B401 zone	mixed zone	TOTAL
	Percent "yes"	Percent "yes"	Percent "yes"	Percent "yes"
double glazed windows *(X^2=7.677, p=.022)*	95.6 (n=135)	87.4 (n=182)	94.4 (n=72)	91.5 (n=389)
air filtration or purification *(X^2=8.461, p=.015)*	7.3 (n=127)	14.6 (n=175)	22.7 (n=71)	13.8 (n=373)

Q7.2 In case you are the owner of your house: are you willing to implement additional measures to further limit your exposure to air pollution and noise (e.g. installation of air purification system, soundproofing, double glazed windows)?
(respondents who answered "renter" on Q3.1 were excluded)

Table 90 Opinion on implementing additional adaptive measures in house in case area (cases weighted)

Q7.2	Frequency	Percent
yes, entirely paid by myself	39	*15.5*
yes, with personal financial contribution, but only if the government subsidises	107	*42.3*
yes, but without personal financial contribution	40	*15.6*
no	41	*16.0*
I don't know	27	*10.6*
TOTAL VALID	253	*100.0*
No answer	5	
TOTAL	258	

Q7.3 Which local measures have already been taken to decrease the exposure to traffic noise and air pollution, caused by the highway viaducts? Which measures are still needed?

Tick two answers for each row. Also measures that have already been taken, can still be needed (more). E.g. there can already be noise barriers, but maybe more noise barriers are still needed.

Table 91 Local adaptive measures in case area (cases weighted)

Q7.3 local measures already taken	N	Mis-sing	Percentages			
			yes	no	I don't know	no answer
noise barriers	399	0	48.3	30.0	16.5	5.1
speed reduction on viaduct	399	0	66.3	9.1	19.7	4.8
quiet pavement	399	0	19.3	23.0	51.6	6.2
low-noise construction joints	399	0	16.6	26.4	50.5	6.5
redirecting truck traffic	399	0	11.9	45.6	36.2	6.3
night ban on trucks	399	0	7.6	44.8	40.4	7.2
avoiding sensitive facilities such as schools, daycares, hospitals, rest homes ...	399	0	5.9	33.8	52.7	7.6
other	399	0	0.3	5.4	33.2	61.0
Q7.3 local measures still needed	N	Mis-sing	Percentages			
			yes	no	I don't know	no answer
noise barriers	399	0	48.1	15.3	24.4	12.2
speed reduction on viaduct	399	0	32.4	29.7	22.0	15.9
quiet pavement	399	0	52.7	9.3	26.4	11.6
low-noise construction joints	399	0	54.2	7.8	26.8	11.3
redirecting truck traffic	399	0	43.2	14.7	29.8	12.4
night ban on trucks	399	0	35.4	19.5	31.2	13.9
avoiding sensitive facilities such as schools, daycares, hospitals, rest homes ...	399	0	27.9	14.1	43.1	14.9
other	399	0	7.1	2.5	30.8	59.7

Other measures still needed:
- demolishing, cover or tunnel (15)
- general mobility measures (ban on polluting cars, freight transport by ship, ...) (5)
- concrete mobility measures (park and ride, speed enforcement, fewer lanes, ...) (4)
- other (green areas, esthetic measures, safety measures, ...) (4)

Table 92 Local adaptive measures for different zones (cases not weighted) (only measures with significant differences between zones are reported; categories "I don't know" and "no answer" excluded)

Q7.3 local measures already taken	E17 zone	B401 zone	mixed zone	TOTAL
	Percent "yes"	Percent "yes"	Percent "yes"	Percent "yes"
noise barriers *(X^2=68.807, p=.000)*	86.1 (n=122)	39.6 (n=139)	80.4 (n=56)	64.7 (n=317)
speed reduction on viaduct *(X^2=10.069, p=.007)*	95.7 (n=117)	83.2 (n=137)	86.0 (n=57)	87.8 (n=311)
quiet pavement *(X^2=12.658, p=.002)*	35.1 (n=74)	61.1 (n=72)	32.4 (n=34)	45.0 (n=180)
low-noise construction joints *(X^2=11.036, p=.004)*	25.0 (n=80)	50.7 (n=75)	34.5 (n=29)	37.0 (n=184)
redirecting truck traffic *(X^2=15.567, p=.000)*	9.1 (n=99)	30.4 (n=102)	14.3 (n=42)	18.9 (n=243)
Q7.3 local measures still needed	**E17 zone**	**B401 zone**	**mixed zone**	**TOTAL**
	Percent "yes"	Percent "yes"	Percent "yes"	Percent "yes"
quiet pavement *(X^2=8.785, p=.012)*	91.8 (n=98)	78.0 (n=109)	89.6 (n=48)	85.5 (n=255)
low-noise construction joints *(X^2=12.783, p=.002)*	93.9 (n=99)	79.0 (n=105)	94.0 (n=50)	87.8 (n=254)
avoiding sensitive facilities such as schools, daycares, hospitals, rest homes ... *(X^2=8.529, p=.014)*	50.8 (n=61)	73.4 (n=79)	71.9 (n=32)	65.1 (n=172)

10.10.8 Policy strategies – societal actors

Q8.1 Several interest groups and civil society organisations take a position and have ideas concerning the problem of the highway viaducts of E17 and B401. A possible policy strategy is to bring these societal actors together with the government and let them share their ideas to find the best possible solution.
Please indicate which groups you know by name, of which you are a member, of which you know the actual position concerning the future of the highway viaducts E17 and B401 and by which groups you feel represented in the debate.
Multiple answers per row are possible.

Table 93 Opinion on societal actors with regard to E17/B401 in case area (cases weighted)

Q8.1 local measures already taken	N	Percentages			
		I know the **name** of this group	I am a **member** of this group	I know the **position** of this group concerning the viaducts E17/B401	I feel **represented** by this group in the debate on the viaducts E17/B401
UNIZO (Union of Self-Employed Entrepeneurs)	399	85.4	1.3	7.0	0.8
TLV (Transport and Logistics Flanders)	399	11.9	0.0	0.8	0.5
VTB-VAB (Flemish Tourists Association – Flemish Motorists Association)	399	82.1	5.8	2.8	1.8
VOKA (Flemish Employers Association)	399	71.1	0.8	3.3	1.3
Touring	399	87.2	6.5	2.8	0.5
Febetra (Royal Federation of Belgian Carriers and Logistic Service Providers)	399	31.6	0.0	1.0	0.3
BBL (Federation for a Better Environment)	399	72.6	0.0	10.5	10.3
GMF (Ghent Environmental Front)	399	37.3	1.8	9.0	8.0
ViaduKaduk (citizen initiative E17 viaduct)	399	30.3	1.0	12.5	8.3

Table 94 Being familiar with societal actors with regard to E17/B401 for different zones (cases not weighted) (only actors with significant differences between zones are reported)

Q8.1 I know the name of this group	**E17 zone**	**B401 zone**	**mixed zone**	**TOTAL**
	Percent "yes"	Percent "yes"	Percent "yes"	Percent "yes"
Viadukaduk *(X^2=61.770, p=.000)*	59.4 (n=138)	19.8 (n=187)	21.6 (n=74)	33.8 (n=399)

Q8.2 Are there any groups missing in the above list, according to your opinion? Write their names here.

Top answers:

- local residents or resident groups (10)
- Natuurpunt (a nature conservation association) (5)
- representatives from the health sector (3)
- Ghent University (2)
- public transport companies (2)
- political parties (2)
- Fietsersbond (a bicycle association) (2)

Q8.3 In recent years groups of citizens increasingly try to influence spatial plans and spatial policy by carrying out research, consulting experts, proposing alternatives, ... Do you believe spatial problems, such as the situation of the highway viaducts of E17 and B401, can be solved in a better way by involving these groups in policymaking and planning processes?

Table 95 Opinion on involving residents' groups in planning and policy of E17/B401 in case area (cases weighted)

Q8.3	Frequency	Percent
yes, certainly	119	*30.0*
yes, maybe	180	*45.5*
no, certainly not	15	*3.9*
I don't know	81	*20.6*
TOTAL VALID	395	*100.0*
No answer	4	
TOTAL	399	

Q8.4 Why do you think that?

yes, certainly/maybe

- more information and different perspectives can lead to better, out-of-the-box solutions (66)
- residents are directly involved, they live in the neighbourhood and know the problem better than anyone else (56)
- the members of such a group are engaged, well informed, motivated and have a local network (37)
- these groups do not put economic concerns first, are neutral and independent (34)
- democracy, representation, public control on political decisions (16)
- involving citizens leads to a better acceptation of a solution (9)
- yes, but
  - citizens should take a constructive position and not be too stubborn
  - are these groups neutral?
  - do citizens have sufficient knowledge?
  - maybe we better involve independent experts

no, certainly not

- these groups are biased and not representative for the neighbourhood (6)
- in the end the government decides, citizen engagement is to no avail and only leads to a longer decision process (4)
- these groups have insufficient skills and knowledge (3)

Q8.5 Do you think citizen initiatives think in the interest of all residents?

Table 96 Opinion on neutrality of resident groups in case area (cases weighted)

Q8.5	Frequency	Percent
yes, certainly	66	*16.7*
yes, maybe	187	*47.5*
no, certainly not	78	*19.7*
I don't know	63	*16.1*
TOTAL VALID	394	*100.0*
No answer	5	
TOTAL	399	

10.10.9 General questions

The full answer frequencies for the general questions are not included. These questions are particularly used in the bivariate analyses. Hereafter is only reported on the questions that have significantly different answer frequencies for the three zones in the case area, since this can give more insight in the makeup of these zones. For the question on subjective health the frequencies are compared with the similar question in the Livability Monitor for Ghent survey.

Q9.4 How many children living at home are there in the family in the following age categories?

Table 97 Children living at home for different zones (cases not weighted) (categories combined into a binary variable)

Q9.4_children living at home	E17 zone	B401 zone	mixed zone	TOTAL
X^2=10.526, p=.005	Percent	Percent	Percent	Percent
yes	22.5	13.9	31.1	20.1
no	77.5	86.1	68.9	79.9
TOTAL	100.0	100.0	100.0	100.0
Number of respondents	*138*	*187*	*74*	*399*

Q10.1 What is the highest degree you have obtained?

Table 98 Highest educational level for different zones (cases not weighted) (categories regrouped to allow for statistical test)

Q10.1	E17 zone	B401 zone	mixed zone	TOTAL
X^2=18.822, p=.016	Percent	Percent	Percent	Percent
none or primary education	1.5	2.7	8.1	3.3
lower secondary education	13.2	8.6	6.8	9.9
higher secondary education	28.7	17.3	18.9	21.5
non-university higher education	27.2	30.3	35.1	30.1
university higher education	29.4	41.1	31.1	35.2
TOTAL	100.0	100.0	100.0	100.0
Number of respondents	*136*	*185*	*74*	*395*

Q11.3 How is your health in general?

Table 99 Subjective health in case area compared to Livability Monitor for Ghent (cases not weighted)

Q11.3	E17/B401 survey	Livability Monitor Ghent
X^2=7.490, p=.112 (not significant)	Percent	Percent
very bad	0.0	0.3
bad	3.5	2.4
reasonably healthy	22.1	18.2
good	55.0	56.5
very good	19.3	22.5
TOTAL	100.0	100.0
Number of respondents	*398*	*2374*

10.11 Appendix F – bivariate survey results

Three types of statistical tests were carried out, depending on the type of variable:

- Ordinal/continuous variable with another ordinal/continuous variable: Spearman's rank correlation coefficient
  - Since most of the combinations are ordinal/ordinal or ordinal/continuous it was chosen to consequently calculate the Spearman rank correlation.
  - It is a nonparametric measure of rank correlation that assesses how well the relationship between two variables can be described using a monotonic function.
  - The score gives the strength of the correlation with 0.1 a weak correlation, 0.3 a medium correlation and 0.5 a strong correlation in social research.
  - Also significance scores are given with *<=0.05 and **<=0.01.
- Ordinal/continuous variable with binary variable: Mann Whitney U test
  - This test compares the distribution of the ordinal/continuous variable among both categories of the binary variable.
  - If the p-value is below 0.05 the distributions are significantly different, in this case in the table the category with the higher scores is indicated with a "+" and the lower with a "-".
- Binary variable with another binary variable: Chi Square test
  - This test compares the distribution of one variable among the two categories of the other and assesses whether the difference could be random or not.
  - If the p-value is below 0.05 the distributions are significantly different, in this case in the table the category with the higher scores is indicated with a "+" and the lower with a "-".

For all variables the "no opinion" or "no answer" category is excluded, to obtain an ordinal variable.
Significant results are marked in grey in the tables.

10.11.1 Distribution of subjective exposure

Table 100 Relation between modeled exposure and perceived exposure for case area and different zones

	all		E17 zone		B401 zone		mixed zone	
Spearman rank correlation continuous/ordinal variables	**L_{den} road**	**NO_2 conc.**	**L_{den} road**	**NO_2 conc.**	**L_{den} road**	**NO_2 conc.**	**L_{den} road**	**NO_2 conc.**
(1.1) traffic noise annoyance	.121*	-	-.004	-	.214**	-	.299*	-
(1.4) relative exposure to traffic noise	.165**	-	.193*	-	.277**	-	.142	-
(1.5) health concerns traffic noise	.079	-	.060	-	.111	-	.151	-
(1.6) health problems traffic noise	.029	-	.001	-	.096	-	.035	-
(1.7) air pollution annoyance	-	.159**	-	.176	-	.144	-	.076
(1.9) relative exposure to air pollution	-	.150**	-	.237**	-	.147	-	.091
(1.10) health concerns air pollution	-	.006	-	.027	-	-.058	-	.121
(1.11) health problems air pollution	-	.016	-	-.039	-	.107	-	.137

Table 101 Relation of shortest distance to highway with subjective exposure for case area and different zones

Spearman rank correlation continuous/ordinal variables	**all**	**E17 zone**	**B401 zone**	**mixed zone**
(1.1) traffic noise annoyance	-.065	-.085	-.105	-.108
(1.4) relative exposure to traffic noise	-.151**	-.163	-.219**	-.179
(1.5) health concerns traffic noise	-.049	-.028	-.055	-.210
(1.6) health problems traffic noise	-.037	.005	-.121	-.040
(1.7) air pollution annoyance	-.189**	-.234*	-.181*	-.098
(1.9) relative exposure to air pollution	-.110*	-.162	-.114	-.062
(1.10) health concerns air pollution	-.015	-.004	-.005	-.099
(1.11) health problems air pollution	-.037	.064	-.083	-.109

10.11.2 Exposure versus vulnerability, responsibility and housing

Table 102 Objective exposure and subjective exposure: relation with other variables

	objective exposure (modeled)		subjective exposure (annoyance)		subjective exposure (relative exposure)	
Spearman rank correlation continuous/ordinal variables	**L_{den} traffic noise**	**NO_2 air pollution**	**Q1.1 traffic noise**	**Q1.7 air pollution**	**Q1.4 traffic noise**	**Q1.9 air pollution**
(3.2) housing typology (studio flat → detached house)	-.413**	-.436**	.135**	-.026	.057	-.013
(3.4) year of settlement	.037	.143**	-.196**	-.125*	-.026	.108*
(3.9) intention to move house	.102*	.215**	.103*	.176**	.094	.127*
(9.2) birth year	-.108*	.041	-.158**	-.082	-.083	.045
(10.1) educational level	-.185**	-.121*	-.068	.001	.024	.157**
(10.4) income	-.242**	-.191**	-.078	.084	.047	.128*
(11.1) number of cars	-.193**	-.187**	-.123*	-.043	-.076	-.027
(11.3) subjective health	-.084	-.092	-.249**	-.265**	-.146**	-.133*
Mann-Whitney U test binary variables	**L_{den} traffic noise**	**NO_2 air pollution**	**Q1.1 traffic noise**	**Q1.7 air pollution**	**Q1.4 traffic noise**	**Q1.9 air pollution**
(3.1) ownership: owner/renter	.000 -/+	.000 -/+	.030 +/-	.003 +/-	.062	.221
(9.1) sex: female/male	.999	.477	.934	.200	.475	.467
(9.3) living alone: yes/no	.006 +/-	.068	.818	.661	.543	.917
(9.4) living with children: yes/no	.034 -/+	.122	.344	.072	.062	.013 +/-
(9.6) origin: Belgian/other	.347	.146	.064	.051	.009 +/-	.033 +/-
(10.2) employed: yes/no	.005 -/+	.304	.017 -/+	.405	.803	.002 +/-
(10.3) retired: yes/no	.014 +/-	.929	.007 +/-	.910	.570	.154
(11.2) commuting by car: yes/no	.105	.072	.562	.983	.376	.856

Table 103 Health concerns about environmental impacts and environment-related health problems: relation with other variables

	health concerns		health problems	
Spearman rank correlation continuous/ordinal variables	**Q1.5 traffic noise**	**Q1.10 air pollution**	**Q1.6 traffic noise**	**Q1.11 air pollution**
(1.1) traffic noise annoyance	.575**	.445**	.507**	.368**
(1.7) air pollution annoyance	.444**	.634**	.387**	.587**
(3.2) housing typology (studio flat → detached house)	.101*	.053	.113*	.041
(3.4) year of settlement	-.143**	-.028	-.221**	-.181**
(3.9) intention to move house	.112*	.164**	.081	.179**
(9.2) birth year	-.129*	.025	-.197**	-.089
(10.1) educational level	-.131*	.016	-.177**	-.046
(10.4) income	.018	.091	-.093	.053
(11.1) number of cars	-.123*	-.016	-.079	-.087
(11.3) subjective health	-.235**	-.190**	-.327**	-.244**
Mann-Whitney U test binary variables	**Q1.5 traffic noise**	**Q1.10 air pollution**	**Q1.6 traffic noise**	**Q1.11 air pollution**
(3.1) ownership: owner/renter	.260	.168	.121	.259
(9.1) sex: female/male	.779	.011 +/-	.959	.351
(9.3) living alone: yes/no	.124	.116	.571	.864
(9.4) living with children: yes/no	.258	.034 +/-	.750	.557
(9.6) origin: Belgian/other	.587	.631	.847	.829
(10.2) employed: yes/no	.313	.129	.000 -/+	.901
(10.3) retired: yes/no	.140	.302	.001 +/-	.341
(11.2) commuting by car: yes/no	.884	.709	.955	.869

10.11.3 Opinion on environmental justice

- Q2.1.1 Everyone is free to live wherever they want and must bear the consequences of pollution in the environment.
- Q2.1.2 Everyone is entitled to a minimum level of environmental quality, no matter where they live.
- Q2.1.3 It is not fair that people who live close to the viaducts of E17 or B401 (fly-over) are exposed to high levels of noise and air pollution.

– Q2.1.4 When environmental pollution has an effect on public health, the government should intervene.
– Q2.1.5 Not only the government is responsible for the environmental nuisance caused by the viaducts of E17 and B401 (fly-over), also the people who live there are partly responsible.
– Q2.1.6 The environmental pollution around the E17 and B401 is unacceptable and must be tackled.

Table 104 Opinion on environmental justice: relation with other variables

	ordinal *from fully disagree to fully agree*					
Spearman rank correlation continuous/ordinal variables	**Q2.1.1**	**Q2.1.2**	**Q2.1.3**	**Q2.1.4**	**Q2.1.5**	**Q2.1.6**
(1.1) traffic noise annoyance	-.297**	.124*	.357**	.153**	-.199**	.467**
(1.3) relation traffic noise with viaduct	-.199**	.218**	.269**	.211**	-.167**	.431**
(1.4) relative exposure to traffic noise	-.294**	.123*	.322**	.174**	-.175**	.490**
(1.5) health concerns traffic noise	-.328**	.232**	.514**	.278**	-.102*	.509**
(1.6) health problems traffic noise	-.347**	.238**	.474**	.185**	.007	.475**
(1.7) air pollution annoyance	-.356**	.174**	.383**	.170**	-.161**	.458**
(1.8) relation air pollution with viaduct	-.227**	.104	.288**	.223**	-.131*	.374**
(1.9) relative exposure to air pollution	-.395**	.146**	.289**	.189**	-.218**	.469**
(1.10) health concerns air pollution	-.399**	.243**	.444**	.319**	-.127*	.505**
(1.11) health problems air pollution	-.353**	.283**	.431**	.333**	-.068	.495**
(3.2) housing typology (studio flat → detached house)	-.119*	.081	.075	.025	-.109*	.096
(3.4) year of settlement	-.045	-.039	-.152**	-.078	.080	-.142**
(3.7) evolution traffic noise annoyance	-.234**	.157**	.299**	.175**	-.082	.433**
(3.8) evolution air pollution annoyance	-.273**	.190**	.348**	.282**	-.116	.518**
(3.9) intention to move house	-.117*	.076	.060	.050	-.048	.077
(9.2) birth year	-.040	-.031	-.219**	-.053	.036	-.135**
(10.1) educational level	-.134**	.000	-.063	.012	-.097	-.027
(10.4) income	-.012	.025	-.068	-.069	-.013	.010
(11.1) number of cars	.094	-.046	-.103*	-.076	-.037	-.127*
(11.3) subjective health	.229**	-.074	-.190**	-.065	-.016	-.175**
modeled traffic noise L_{den} road	.064	-.061	.044	.032	.043	.049
modeled air pollution NO_2	.082	-.037	-.051	-.029	.089	-.047

Table 104 Continuation

Mann-Whitney U test binary variables	Q2.1.1	Q2.1.2	Q2.1.3	Q2.1.4	Q2.1.5	Q2.1.6
(3.1) ownership: owner/renter	.078	.147	.007 +/-	.033 +/-	.013 -/+	.068
(9.1) sex: female/male	.089	.043 +/-	.135	.520	.696	.509
(9.3) living alone: yes/no	.907	.985	.993	.483	.243	.724
(9.4) living with children: yes/no	.061	.690	.816	.081	.476	.071
(9.6) origin: Belgian/other	.280	.071	.852	.879	.057	.080
(10.2) employed: yes/no	.122	.288	.023 -/+	.938	.030 -/+	.357
(10.3) retired: yes/no	.293	.180	.028 +/-	.707	.315	.169
(11.2) commuting by car: yes/no	.032 +/-	.915	.329	.057	.917	.017 -/+

10.11.4 Access to procedures

- Q4.1 Have you ever filed a formal complaint?
- Q4.3 Why have you never filed a formal complaint?

Table 105 Access to complaint procedures: relation with other variables

	binary *no/yes*			
Spearman rank correlation continuous/ordinal variables	**Q4.1 filed a complaint**	**Q4.3a don't know the procedure**	**Q4.3b don't believe in the procedure**	**Q4.3c situation is acceptable**
(1.1) traffic noise annoyance	.254**	.249**	.316**	-.555**
(1.7) air pollution annoyance	.204**	.261**	.241**	-.480**
(3.2) housing typology (studio flat → detached house)	.128*	.014	-.016	-.111*
(3.4) year of settlement	-.275**	.083	-.121*	.185**
(3.9) intention to move house	.052	.205**	.056	-.148**
(9.2) birth year	-.211**	.135**	-.164**	.096
(10.1) educational level	-.052	.005	-.065	.142**
(10.4) income	.002	.005	-.004	.041
(11.1) number of cars	.011	.007	-.018	.036
(11.3) subjective health	-.054	-.132**	-.088	.201**
modeled traffic noise L_{den} road	.067	.059	.091	-.084
modeled air pollution NO_2	.020	.061	.029	-.057

Table 105 Continuation

Chi-Square test binary variables	filed a complaint	don't know the procedure	don't believe in the procedure	situation is acceptable
(3.1) ownership: owner/renter	.038 +/-	.692	.532	.255
(9.1) sex: female/male	.216	.502	.415	.494
(9.3) living alone: yes/no	.389	.714	.598	.554
(9.4) living with children: yes/no	.843	.917	.940	.237
(9.6) origin: Belgian/other	.681	.975	.009 +/-	.238
(10.2) employed: yes/no	.023 -/+	.398	.006 -/+	.065
(10.3) retired: yes/no	.003 +/-	.287	.000 +/-	.110
(11.2) commuting by car: yes/no	.888	.277	.961	.491

10.11.5 Opinion on government policy

- Q5.1.1 The government is best placed to balance local interests (e.g. environmental pollution) and wider public interests (e.g. economic).
- Q5.1.2 The government acts in the best interests of all citizens.
- Q5.1.3 The government has the best, unbiased information about situations of environmental pollution (e.g. noise and air pollution).
- Q5.1.4 Certain population groups or neighbourhoods are less important for the government and get less attention in policymaking.
- Q5.3.1 I have confidence in the policy of the *City Government of Ghent* concerning the future of the highway viaducts E17 and B401 (fly-over).
- Q5.3.2 I have confidence in the policy of the *Flemish Government* concerning the future of the highway viaducts E17 and B401 (fly-over).
- Q5.3.3 I have confidence in the *European environmental standards* for air pollution and environmental noise.

Table 106 Statements on role of the government: relation with other variables

	ordinal *from fully disagree to fully agree*			
Spearman rank correlation continuous/ordinal variables	**Q5.1.1**	**Q5.1.2**	**Q5.1.3**	**Q5.1.4**
(1.1) traffic noise annoyance	-.075	-.181**	-.056	.160**
(1.7) air pollution annoyance	-.084	-.152**	-.048	.185**
(3.2) housing typology (studio flat → detached house)	-.104*	-.061	-.082	.015
(3.4) year of settlement	.021	.095	.046	-.165**
(3.9) intention to move house	.021	-.041	-.037	.079
(9.2) birth year	-.100	-.011	-.108*	-.070
(10.1) educational level	-.147**	-.044	-.072	-.008
(10.4) income	-.050	.104	.077	-.062
(11.1) number of cars	.003	-.004	-.077	-.071
(11.3) subjective health	.078	.154**	.062	-.191**
modeled traffic noise L_{den} road	.041	-.067	-.001	.103*
modeled air pollution NO_2	.006	-.026	-.046	.075
Mann-Whitney U test binary variables	**Q5.1.1**	**Q5.1.2**	**Q5.1.3**	**Q5.1.4**
(3.1) ownership: owner/renter	.042 -/+	.641	.271	.494
(9.1) sex: female/male	.906	.614	.304	.877
(9.3) living alone: yes/no	.068	.581	.225	.893
(9.4) living with children: yes/no	.002 -/+	.345	.368	.518
(9.6) origin: Belgian/other	.064	.009 -/+	.094	.860
(10.2) employed: yes/no	.114	.986	.323	.602
(10.3) retired: yes/no	.091	.701	.987	.794
(11.2) commuting by car: yes/no	.617	.484	.515	.514

Table 107 Confidence in different government levels: relation with other variables

	ordinal *from fully disagree to fully agree*		
Spearman rank correlation continuous/ordinal variables	**Q5.3.1**	**Q5.3.2**	**Q5.3.3**
(1.1) traffic noise annoyance	-.188**	-.278**	-.106
(1.7) air pollution annoyance	-.079	-.276**	-.131*
(3.2) housing typology (studio flat → detached house)	-.050	-.099	-.052
(3.4) year of settlement	.124*	.058	.125*
(3.9) intention to move house	-.062	-.072	-.089
(9.2) birth year	.108*	-.026	.088
(10.1) educational level	.010	-.225**	.020
(10.4) income	.072	-.074	.113
(11.1) number of cars	-.117*	.040	-.025
(11.3) subjective health	.089	.131*	.062
modeled traffic noise L_{den} road	-.037	-.056	-.071
modeled air pollution NO_2	-.077	-.044	-.117*
Mann-Whitney U test binary variables	**Q5.3.1**	**Q5.3.2**	**Q5.3.3**
(3.1) ownership: owner/renter	.221	.013 -/+	.925
(9.1) sex: female/male	.565	.971	.774
(9.3) living alone: yes/no	.123	.892	.187
(9.4) living with children: yes/no	.417	.034 -/+	.200
(9.6) origin: Belgian/other	.170	.008 -/+	.014 -/+
(10.2) employed: yes/no	.253	.087	.105
(10.3) retired: yes/no	.116	.659	.044 -/+
(11.2) commuting by car: yes/no	.251	.829	.599

10.11.6 Opinion on participation

- Q6.1.1 Citizen participation in policy can lead to better solutions.
- Q6.1.2 Citizen participation in policy delays the decision-making process.
- Q6.1.3 The citizens' interests are defended better when citizens participate in policy.
- Q6.1.4 When the government consults the public, their ideas and opinions are often not taken into account.
- Q6.2 Do you think the government should involve citizens in finding solutions for the environmental pollution caused by the highway viaducts of E17 and B401?

Table 108 Statements on participation: relation with other variables

	ordinal *from fully disagree to fully agree*				
Spearman rank correlation continuous/ordinal variables	**Q6.1.1**	**Q6.1.2**	**Q6.1.3**	**Q6.1.4**	**Q6.2**
(1.1) traffic noise annoyance	.084	-.141**	-.018	.045	.100
(1.7) air pollution annoyance	.146**	-.168**	.136*	.092	.186**
(3.2) housing typology (studio flat → detached house)	-.043	-.059	.021	-.106	.082
(3.4) year of settlement	.011	.022	.007	-.142**	-.055
(3.9) intention to move house	.138**	-.088	.130*	.046	.061
(9.2) birth year	.002	.041	.075	-.186**	.034
(10.1) educational level	-.013	.070	.059	-.124*	.035
(10.4) income	-.018	.005	.047	-.097	.039
(11.1) number of cars	-.104*	.096	-.031	-.034	-.037
(11.3) subjective health	-.103*	.099	-.069	-.086	-.084
modeled traffic noise L_{den} road	.064	-.073	.026	.118*	-.023
modeled air pollution NO_2	.058	-.062	-.021	.106*	-.072
Mann-Whitney U test binary variables	**Q6.1.1**	**Q6.1.2**	**Q6.1.3**	**Q6.1.4**	**Q6.2**
(3.1) ownership: owner/renter	.068	.711	.818	.198	.071
(9.1) sex: female/male	.135	.034 -/+	.025 +/-	.318	.852
(9.3) living alone: yes/no	.960	.802	.800	.443	.458
(9.4) living with children: yes/no	.243	.190	.694	.484	.647
(9.6) origin: Belgian/other	.719	.289	.162	.168	.049 +/-
(10.2) employed: yes/no	.161	.641	.001 +/-	.104	.001 +/-
(10.3) retired: yes/no	.406	.543	.009 -/+	.010 +/-	.001 -/+
(11.2) commuting by car: yes/no	.277	.653	.952	.116	.984

10.11.7 Personal engagement in participation

- Q6.4 Do you think you have sufficient knowledge and skills to contribute to finding solutions for the environmental pollution caused by the highway viaducts of E17 and B401?
- Q6.5 Do you want to be involved in finding solutions?

Table 109 Statements on participation: relation with other variables

	ordinal *from certainly not to certainly yes*	
Spearman rank correlation continuous/ordinal variables	**Q6.4**	**Q6.5**
(1.1) traffic noise annoyance	.160**	.245**
(1.7) air pollution annoyance	.136*	.233**
(3.2) housing typology (studio flat → detached house)	.012	.085
(3.4) year of settlement	.037	.072
(3.9) intention to move house	.095	.131*
(9.2) birth year	.097	.143**
(10.1) educational level	.199**	.212**
(10.4) income	.129*	.167**
(11.1) number of cars	-.044	-.023
(11.3) subjective health	-.067	-.099
modeled traffic noise L_{den} road	-.023	-.044
modeled air pollution NO_2	.013	.026
Mann-Whitney U test binary variables	**Q6.4**	**Q6.5**
(3.1) ownership: owner/renter	.191	.023 +/-
(9.1) sex: female/male	.000 -/+	.023 -/+
(9.3) living alone: yes/no	.275	.657
(9.4) living with children: yes/no	.004 +/-	.000 +/-
(9.6) origin: Belgian/other	.002 +/-	.062
(10.2) employed: yes/no	.005 +/-	.000 +/-
(10.3) retired: yes/no	.002 -/+	.000 -/+
(11.2) commuting by car: yes/no	.495	.384

10.11.8 Opinion on taking adaptive measures in house

- Q7.1 Which measures have already *been taken in your house* to decrease the exposure to traffic noise and air pollution?
  - soundproofing
  - double-glazed windows
  - air filtration or purification
- Q7.2 In case you are the owner of your house: are you willing to implement additional measures to further limit your exposure to air pollution and noise (e.g. installation of air purification system, soundproofing, double glazed windows)?

Table 110 Adaptive measures already taken in the house: relation with other variables

Q7.1	**binary *no/yes***		
Spearman rank correlation continuous/ordinal variables	**soundproofing**	**double-glazed windows**	**air filtration or purification**
(1.1) traffic noise annoyance	-.025	.052	-.146**
(1.7) air pollution annoyance	.028	.100	-.073
(3.2) housing typology (studio flat → detached house)	-.055	.141**	-.231**
(3.4) year of settlement	.014	.022	.262**
(3.9) intention to move house	-.018	-.047	-.051
(9.2) birth year	-.074	.014	.044
(10.1) educational level	-.074	.046	-.074
(10.4) income	-.010	.072	-.047
(11.1) number of cars	.056	.083	.045
(11.3) subjective health	-.024	-.089	.124*
modeled traffic noise L_{den} road	.043	-.047	.170**
modeled air pollution NO_2	.045	-.037	.142*
Chi-Square test binary variables	**soundproofing**	**double-glazed windows**	**air filtration or purification**
(3.1) ownership: owner/renter	.063	.000 +/-	.113
(9.1) sex: female/male	.231	.144	.738
(9.3) living alone: yes/no	.862	.501	.240
(9.4) living with children: yes/no	.255	.031 +/-	.111
(9.6) origin: Belgian/other	.635	.008 +/-	.205
(10.2) employed: yes/no	.125	.117	.122
(10.3) retired: yes/no	.034 +/-	.787	.890
(11.2) commuting by car: yes/no	.723	.516	.179

Table 111 Implementing additional protective measures in house: relation with other variables

	ordinal ***from certainly not to certainly yes***
Spearman rank correlation continuous/ordinal variables	**Q7.2**
(1.1) traffic noise annoyance	-.104
(1.7) air pollution annoyance	-.043
(3.2) housing typology (studio flat → detached house)	-.045
(3.4) year of settlement	.213**
(3.9) intention to move house	-.028
(9.2) birth year	.196**
(10.1) educational level	.270**
(10.4) income	.180*
(11.1) number of cars	.073
(11.3) subjective health	.113
modeled traffic noise L_{den} road	-.155*
modeled air pollution NO_2	-.078
Mann-Whitney U test binary variables	**Q7.2**
(3.1) ownership: owner/renter	.404
(9.1) sex: female/male	.129
(9.3) living alone: yes/no	.110
(9.4) living with children: yes/no	.003 +/-
(9.6) origin: Belgian/other	.423
(10.2) employed: yes/no	.020 +/-
(10.3) retired: yes/no	.011 -/+
(11.2) commuting by car: yes/no	.699

10.11.9 Opinion on citizen initiatives

- Q8.3 In recent years groups of citizens increasingly try to influence spatial plans and spatial policy by carrying out research, consulting experts, proposing alternatives, ... Do you believe spatial problems, such as the situation of the highway viaducts of E17 and B401, can be solved in a better way by involving these groups in policymaking and planning processes?
- Q8.5 Do you think citizen initiatives think in the interest of all residents?

Table 112 Opinion on citizen initiatives: relation with other variables

	ordinal *from certainly not to certainly yes*	
Spearman rank correlation continuous/ordinal variables	**Q8.3**	**Q8.5**
(1.1) traffic noise annoyance	.055	.138*
(1.7) air pollution annoyance	.244**	.148*
(3.2) housing typology (studio flat → detached house)	.073	.058
(3.4) year of settlement	.013	-.089
(3.9) intention to move house	.125*	.065
(9.2) birth year	.112*	-.012
(10.1) educational level	.130*	-.041
(10.4) income	.088	-.044
(11.1) number of cars	-.029	-.023
(11.3) subjective health	-.085	-.077
modeled traffic noise L_{den} road	.036	.065
modeled air pollution NO_2	-.086	-.116*
Mann-Whitney U test binary variables	**Q8.3**	**Q8.5**
(3.1) ownership: owner/renter	.297	.537
(9.1) sex: female/male	.589	.047 +/-
(9.3) living alone: yes/no	.228	.897
(9.4) living with children: yes/no	.000 +/-	.126
(9.6) origin: Belgian/other	.396	.551
(10.2) employed: yes/no	.003 +/-	.764
(10.3) retired: yes/no	.001 -/+	.751
(11.2) commuting by car: yes/no	.401	.008 -/+

10.11.10 Familiarity with Viadukaduk

Question 8.1 was analyzed for the subgroup of respondents of the E17 zone.

– Q8.1 Several interest groups and civil society organizations take a position and have ideas concerning the problem of the highway viaducts of E17 and B401. A possible policy strategy is to bring these societal actors together with the government and let them share their ideas to find the best possible solution. Please indicate whether you know Viadukaduk.

Table 113 Familiarity with Viadukaduk in E17 zone: relation with other variables

ONLY E17 ZONE	**binary** ***from no to yes***
Spearman rank correlation continuous/ordinal variables	**Q8.1_Viadukaduk**
(1.1) traffic noise annoyance	.249**
(1.7) air pollution annoyance	.226*
(3.2) housing typology (studio flat → detached house)	.189*
(3.4) year of settlement	-.088
(3.9) intention to move house	-.140
(9.2) birth year	-.123
(10.1) educational level	.212*
(10.4) income	.129
(11.1) number of cars	-.023
(11.3) subjective health	.016
modeled traffic noise L_{den} road	-.200*
modeled air pollution NO_2	-.159
Chi-Square test binary variables	**Q8.1_Viadukaduk**
(3.1) ownership: owner/renter	.002 +/-
(9.1) sex: female/male	.803
(9.3) living alone: yes/no	.866
(9.4) living with children: yes/no	.284
(9.6) origin: Belgian/other	.631
(10.2) employed: yes/no	.653
(10.3) retired: yes/no	.303
(11.2) commuting by car: yes/no	.242

10.11.11 Relation between explanatory variables

Table 114 Relation between explanatory variables

Spearman rank correlation continuous/ordinal variables	**Q3.2**	**Q3.4**	**Q3.9**	**Q9.2**	**Q10.1**	**Q10.4**	**Q11.1**	**Q11.3**
(3.2) housing typology (studio flat → detached house)	-	-.333**	-.192**	.005	-.001	.232**	.191**	-.033
(3.4) year of settlement	-	-	.178**	.575**	.322**	.153**	-.072	.207**
(3.9) intention to move house	-	-	-	.301**	.085	-.056	-.017	-.065
(9.2) birth year	-	-	-	-	.342**	.292**	.145**	.229**
(10.1) educational level	-	-	-	-	-	.357**	.073	.211**
(10.4) income	-	-	-	-	-	-	.365**	.277**
(11.1) number of cars	-	-	-	-	-	-	-	.166**
(11.3) subjective health	-	-	-	-	-	-	-	-
Mann-Whitney U test binary variables	**Q3.2**	**Q3.4**	**Q3.9**	**Q9.2**	**Q10.1**	**Q10.4**	**Q11.1**	**Q11.3**
(3.1) ownership: owner/ renter	.000 +/-	.000 -/+	.000 -/+	.000 -/+	.179	.008 +/-	.000 +/-	.064
(9.1) sex: female/male	.055	.304	.464	.925	.993	.556	.059	.972
(9.3) living alone: yes/no	.000 -/+	.992	.778	.000 -/+	.606	.000 -/+	.000 -/+	.061
(9.4) living with children: yes/no	.000 +/-	.137	.231	.000 +/-	.007 +/-	.000 +/-	.000 +/-	.861
(9.6) origin: Belgian/ other	.063	.033 -/+	.076	.028 -/+	.555	.399	.006 +/-	.761
(10.2) employed: yes/no	.158	.000 +/-	.014 +/-	.000 +/-	.000 +/-	.000 +/-	.001 +/-	.001 +/-
(10.3) retired: yes/no	.206	.000 -/+	.000 -/+	.000 -/+	.000 -/+	.000 -/+	.017 -/+	.014 -/+
(11.2) commuting by car: yes/no	.495	.314	.311	.646	.504	.234	.000 +/-	.778

Table 114 Continuation

Chi-Square test binary variables	Q3.1	Q9.1	Q9.3	Q9.4	Q9.6	Q10.2	Q10.3	Q11.2
(3.1) ownership: owner/ renter	-	.439	.355	.000 +-/-+	.000 +-/-+	.831	.280	.365
(9.1) sex: female/male	-	-	.014 -+/+-	.246	.570	.960	.656	.699
(9.3) living alone: yes/no	-	-	-	.000 -+/+-	.087	.000 -+/+-	.000 +-/-+	.905
(9.4) living with children: yes/no	-	-	-	-	.935	.000 +-/-+	.000 -+/+-	.663
(9.6) origin: Belgian/ other	-	-	-	-	-	.197	.048 +-/-+	.062
(10.2) employed: yes/no	-	-	-	-	-	-	.000 -+/+-	.002 +-/-+
(10.3) retired: yes/no	-	-	-	-	-	-	-	.062
(11.2) commuting by car: yes/no	-	-	-	-	-	-	-	-

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ISBN
978-94-91937-32-3

Internal and cover design
André Diepgrond

Cover picture
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Living Cities: Reconnecting Environmental Health and Urban Planning

While public health and urban planning were closely linked in the past, the relation has turned into a lock-in of two procedurally interrelated, but in fact disconnected domains of knowledge and action. In most cases, health intersects with spatial planning processes only through obligatory evaluations or restrictive environmental legislation. This institutionalization of health criteria in most western countries has difficulty in dealing with the rapidly changing spatial conditions of our complex society, the growing awareness of environmental impacts and the increasing empowerment and engagement of citizens.

This dissertation aims to move beyond this lock-in and explores new approaches to deal with environmental health concerns in planning practice. Building on complexity theory, an environmental justice framework is proposed to localize environmentally unhealthy situations, and a matrix of planning strategies is presented to address these situations. To verify whether these theoretical insights could help to solve urban environmental health conflicts, an empirical research methodology was developed consisting of interviews, spatial data analysis, documentary analysis and a residents' survey. This research framework was applied to the city of Ghent (Belgium) in close collaboration with the city administrations and a local citizen initiative. By combining quantitative with qualitative results, case-specific and general policy recommendations were formulated that can lead to a more central place for health in urban planning.

Thomas Verbeek (1985) holds a Master of Geography (Ghent University, 2007) and a Master of Urbanism and Spatial Planning (Ghent University, 2009). From 2010 to 2016, he worked as a research and teaching assistant at the Centre for Mobility and Spatial Planning at Ghent University, which provided him with the opportunity to carry out a PhD research project. His research interests include environmental health, urban governance and spatial justice.

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