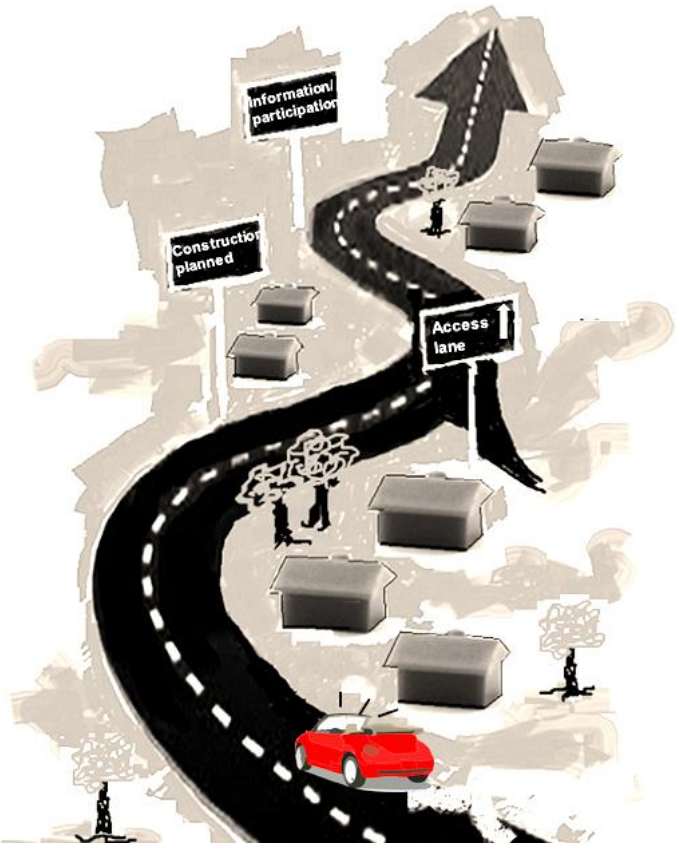
Chapter 1

Introduction



1.1 Background: Accessibility and environmental impacts of highway infrastructure

In many developed countries, considerable investments in highway infrastructure have been made in the last decades (World Economic Forum, 2016; Arts et al., 2016). For example, in the Netherlands, the primary focus of this study, the number of highway kilometres has grown considerably, from the first “Rijksweg 12” between Voorburg and Zoetermeer in 1937 to a network of 2,449 kilometres of national highways in 2015 (CBS, 2015). These investments have contributed significantly to assuring accessibility. Accessibility in relation to highways mainly refers to regional accessibility, i.e. good transportation links to regionally oriented concentrations of activity (Handy, 1993), the latter being vital to regions in terms of both economic potential and the social benefits of connecting people (e.g., Geurs & Van Wee, 2004; Van Wee et al., 2013). At the same time, travel patterns changed and car ownership increased vastly (Banister, 2002; Mom & Filarski, 2008), resulting in a higher relevance of good highway connections. Due to the large investments in the past decades, highway networks in most developed countries are currently heading towards saturation. Nevertheless, investments to assure the quality of the network still continue, although future projects will increasingly focus on optimizing and adjusting the existing network rather than on extending it (Arts, 2007; MIRT, 2016; Ten-t, 2014; FHWA, 2013).

With the growth of highway infrastructure and car use, the attention for the negative environmental nuisances caused by highways has also increased worldwide. Over the years, a substantial amount of research has confirmed that externalities caused by car travel such as noises and air pollution could have an adverse effect on people’s physical and psychological health (e.g., Stansfeld et al., 2000; Jongeneel et al., 2008; Weber, 2013). In the Netherlands, the first concerns with regard to this growth of traffic from an environmental perspective were raised in the 1960’s in the House of Representatives (Bosch and Van Der Ham, 1998). However, the real turn in perspective came in the 1970’s, when the plans for highway extension through the “Amelisweerd” woods near the city of Utrecht resulted in the first civil protest against the on-going investments in highways at the costs of nature (Arts et al., 2016; Van der Riet & Toussaint, 2014). Till then, environmental nuisances had been largely ignored and the focus of highway projects had been mainly on technical feasibility and economic accountability (Arts, 2004).

Worldwide, these environmental concerns led to more attention for environmental consequences of (highway) infrastructure. Among other things, this resulted in an increase in environmental regulations and the introduction of environmental impact assessment (EIA) legislation, i.e. the process of taking account of the potential

environmental consequences of a proposed action during the planning, design, decision making and implementation phases of that action for highway infrastructure (e.g., Arts, 2004; Morrison-Saunders & Arts, 2004). For example, the European Commission nowadays requires impact assessments of major initiatives such as transport infrastructure projects (Geurs et al., 2009). Political discussion on the monetization of economic and social costs and benefits of projects consequently led to the introduction of cost-benefit analyses. In the Netherlands, the use of such an analysis has been mandatory since 2000 (Eijgenraam et al., 2000; Heyma & Oosterhaven, 2005) in the evaluation of proposed larger projects led by the government, and aims to monetize the effects of infrastructural projects on welfare. More recently, there has been increasing attention for broader social impacts, i.e. impacts on the preferences, well-being, behaviour or perception of individuals, groups, social categories and society in general, although those impacts are still underexposed in policies partly due to their difficulty of assessment (Geurs et al., 2009; Vanclay et al., 2015).

The increasing attention for environmental nuisances in highway planning also led to an increase in the attention for environmental stakeholders within the planning process. The possibilities for stakeholders to give voice have been growing since the 1970's and have increasingly shifted towards more emphasis on social decision-making processes (Woltjer, 2000). This period is distinguished by an increase in what would later be called "communicative planning" or "collaborative planning" (Healey, 1997; Innes, 2004; Susskind & Field, 1996), which is focused on open plan processes, cooperation and consensus-seeking between different parties. Nowadays, economic interest of growth and accessibility need to be more balanced with social and environmental interests. Decision-making, planning and management of highway infrastructure, often taking place on the macro level, need to give careful account and can no longer take place without an extensive assessment of potential impacts on stakeholders.

Of all stakeholders, it is the people who are living in proximity to existing or planned highway infrastructure who are particularly influenced by this broader societal debate, and who may be affected by both accessibility and environmental nuisance of highways. How do they balance positive and negative effects of highways? How do they perceive existing and planned highway infrastructure in their daily lives? And to what extent and how do they want to be involved? What lessons can be drawn from this micro-perspective for decision-making about management and planning of highway infrastructure on the macro level? This study investigates the impact of highways from the perspective of residents, and centralizes the question how (planned) highway infrastructure influences the residential context, taking account of both positive and negative effects of highways.

1.2 The trade-off between accessibility and environment: a residents' perspective

As introduced above, highway infrastructure may have positive and negative impacts on residents. On the one hand, people living in proximity to highways may gain from higher accessibility generated by highway infrastructure (when an access lane is provided), as the highway makes it easier to reach places in a regional context. Especially in the 1960's, the importance of accessibility to people was stressed by models for locating different types of land use in which accessibility was traded off with other factors (Alonso, 1964; Muth, 1969; Wingo, 1961). More recent empirical studies of location decisions have shown that the role of accessibility has become less straightforward, and other aspects - such as housing quality, environment and social ties - also seem to be important to location choice (e.g., Molin & Timmermans, 2003; Weisbord et al., 1980). According to Giuliano (1989), the added value of good accessibility has decreased due to the growth of the transport network. Nevertheless, a residential location near a highway can still bring advantage for (specific groups of) people who appreciate good (regional) accessibility (Tillema et al., 2010). Although not specifically studied in the context of highway proximity, several studies indicate that, for example, accessibility is one of the aspects on which people seem to self-select into residential areas (e.g., Van Wee, 2009; Cao et al., 2009).

However, on the negative side, living close to highways is associated with environmental nuisances such as noise, air pollution, visual and barrier effects, the latter through fragmenting areas (e.g., Arts, 2004; Van Wee et al., 2013). Whereas visual and barrier effects are mainly caused by the presence of highway infrastructure, noise and air pollution are a consequence of the use of highway infrastructure. Whereas the benefits of highways, i.e. increased accessibility, spread over further distances, its environmental nuisances are mainly present within close proximity of a polluting source (e.g., Nelson, 1982; Eliasson, 2005). According to the European Environmental Agency (EEA), road traffic is, by far, the major source of traffic noise in Europe, both inside and outside of agglomerations (EEA, 2014). Car traffic is generally seen as the most annoying source of traffic noise after noise from aircrafts (e.g., Miedema & Vos, 1998). With regard to air pollution, although the levels of fine dust in the Netherlands generally stay below European standards, some days the norms are exceeded locally, close to polluting sources such as busy roads (RIVM, 2013). Summarizing, residents in proximity to highway infrastructure are likely to be more influenced by environmental effects of highways than people living further away.

Figure 1.1 summarizes a hypothetical situation of the simultaneous presence of highway related accessibility and nuisances to residents. People living in House 1 in close proximity to the highway and relatively far away from the highway access lane hypothetically experience the most negative situation, with relatively high environmental effects and low accessibility gains. The residents of House 2 also have high environmental exposure due to highway proximity, but are hypothetically better off with regard to accessibility gains because of easy access to an access lane. Those in House 3 have lower environmental effects due to further distance from the highway, however, their house is also positioned relatively further away from the access lane. The people living in House 4 experience the best position hypothetically, with relatively low environmental effects but accessibility gains as a consequence of access lane proximity. Following Figure 1.1, residents may thus, depending on their location, trade-off both positive and negative effects of highways within their residential context. It may thus be important to account for both effects in order to understand the implications of highway infrastructure to residents.

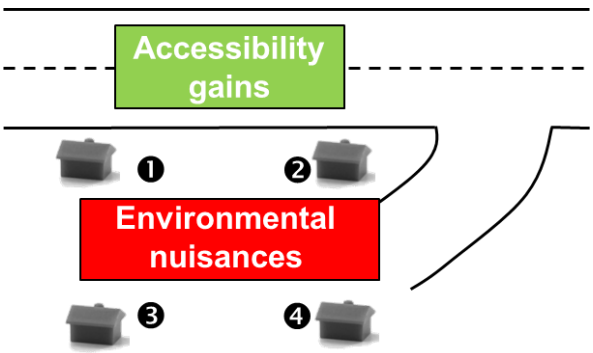


Figure 1.1 Hypothetical relationship between highway accessibility, nuisances and the residential context.

1.3 Current research on the impacts of highway infrastructure on residents

Over the years, various studies have to some extent provided insights into the impact of highway infrastructure proximity to residents. This section provides a brief exploration of those insights. Chapter 2 gives a more comprehensive overview of existing research.

Until now, studies into the impact of highway or road related environmental effects and accessibility on residents have mainly focused on their relationship to house prices, often by performing hedonic pricing analyses. A limited number of those

studies have included both, measures of accessibility (such as distance to an access lane or access to jobs) and environmental nuisances (such as distance to the highway, and to a lesser extent noise and air pollution levels). Generally, these studies argue that house prices decrease with closer proximity to a highway (or high level of noise or air pollution), whereas they increase due to proximity to an access lane (e.g., Levkovich et al., 2016; Theebe, 2004; Boarnet et al., 2003; Iacano, 2011), much like the hypothetical situation visualised in Figure 1.1. Nevertheless, although studies on house prices are able to provide a good overview of the general impact of highways, they do not specifically account for the fact that environmental effects and accessibility may be valued differently by residents (e.g., Rehdanz & Maddison, 2008; Van Praag & Baarsma, 2006; Wardman & Bristow, 2004). Several, mostly quantitative, studies have, for example, found that there is no one-to-one relationship between actual exposure to infrastructure and perceptions of people; in addition to actual exposure, different (other) environmental and personal factors are found to be associated with the perception of nuisances such as sight on the source, the amount of greenery, coping ability and noise sensitivity (e.g., Miedema & Vos, 1999; Gidlöf-Gunnarsson & Öhrström, 2007; Guski, 1999; Saksena, 2007). Thus, it seems worthwhile to also take account of *perceived* factors when trying to understand the impact of highway infrastructure.

Remarkably, however, only a limited number of studies have investigated the relationship between measures of (perceived) traffic related accessibility and/or environmental nuisances and people's *perceived residential satisfaction* or life satisfaction. Results of those studies are mixed, but most studies do not seem to find strong relationships between the actual distance or exposure to infrastructure and residents' satisfaction (Morris, 2013; Van Praag & Baarsma, 2006). One relevant issue in understanding this weak relationship might be potential residential self-selection, i.e. people who seemingly select themselves into neighbourhoods that fit their preferences (e.g., Van Dyck et al., 2011; Cao et al., 2009; Bohte, 2010; Morris, 2013). In other words: people who are less interested in good car accessibility may live further away from an access lane without being affected by this, whereas areas close to highway infrastructure may be inhabited by people who are less sensitive to its nuisances. However, the results of the limited number of studies providing indications for this phenomenon with regard to highway proximity are not consistent (e.g., Nijland et al., 2007; Arsenio, 2006). In contrast, the limited number of studies including perceptions of accessibility and/or (noise) nuisances (often alongside other location characteristics) most of the time found associations with residential satisfaction or life satisfaction (e.g., Van Praag & Baarsma, 2006; Hur & Morrow-Jones, 2008; Buys & Miller, 2012; Lovejoy, Handy,

& Mokhtarian, 2010; Rehdanz & Maddison, 2008; Kroesen et al., 2010; Nijland et al., 2007). However, it is difficult to draw conclusions based on these studies for the situation of highway infrastructure, due to their often decomposed nature (focusing on either accessibility or one type of nuisances), different measures used, or lack of focus on highways.

Another point which may be important in understanding the implications of highways on the residential context is the stage of highway development. Planned highway infrastructure is likely to change the residential context. Apart from some house pricing studies investigating the impact of (anticipation on) (highway) infrastructure development (e.g., Levkovich, 2016; Boarnet, 2003; Kang & Cervero, 2009; Reibel, 2008; Ten Siethof, 2002) there are no studies empirically analysing the impact of highway infrastructure (re)development on the residential context. Nevertheless, studies in the field of NIMBY (i.e. Not In My Back Yard protest, e.g. Dear, 1992; Devine-Wright, 2012), a phenomenon that is certainly relevant to highway infrastructure (planning) (see e.g., Arts, 2007), seem to suggest that unwanted developments in neighbourhoods are likely to have a negative effect on the residential context and could induce coping strategies such as opposition or (re)location. Dear (1992) argues that uncertainty with regard to potential effects on house prices, neighbourhood changes and personal safety may cause concerns and resistance against 'unwanted' facilities. Studies also argue that there may be variations in the likelihood of NIMBY reactions among residents, depending on characteristics of projects or communities (Dear, 1992; Johnson & Scicchitano, 2012). Nevertheless, it is not exactly clear to what extent and under what conditions residents oppose or encourage highway infrastructure (re)development that could incorporate both potential positive and negative effects to the residential context.

Whether or not highway infrastructure development is accepted in the residential context could also depend on the extent to which residents are involved in the planning process of projects through information and participation. So far, few specific studies have explicitly investigated this relationship in relation to planned highway infrastructure. However, several studies have looked into conditions for good public involvement processes in the broader context of (transport) planning, and most of them stress that higher levels of involvement in planning processes are more appreciated by the public and might result in more acceptance of highway projects (e.g., Arnstein, 1969; Innes, 2004; Healey, 1997; Woltjer, 2000). Studies generally agree on which factors are important in those processes, such as inclusiveness, transparency, communication and possibilities for co-design (e.g., Dietz & Stern, 2008; Bickerstaff et al., 2002; Rowe & Fewer, 2005). In the meantime, a limited number of studies indicate that individual preferences and

other contextual factors might also play a role in understanding the effectiveness of involvement methods (e.g., Rowe & Fewer, 2000; 2005). There is, however, only limited empirical insight into how exactly efforts to enhance involvement may influence the impact of highway infrastructure (projects) on the residential context from the perspective of (different groups of) residents.

To conclude, several studies have provided indications for the influence of existing and planned highway infrastructure on the residents' context. Nevertheless, current studies have their limitations when it comes to providing a more comprehensive picture of the impact of highway infrastructure from the perspective of residents, accounting for the trade-off between positive and negative effects, the implications of highway infrastructure development, and the potential role of involvement. Improving such insights could provide a more comprehensive understanding of the impact of highway infrastructure on (different groups of) residents, which might be relevant for highway infrastructure planning.

1.4 Policy and practices with regard to residents in highway infrastructure planning

In current highway infrastructure planning policy and practice in most developed countries, the interests of residents are considered in several ways, but especially via environmental (noise and air pollution) regulations, impact assessments (environmental impact assessment, social impact assessment, cost-benefit analysis) and public involvement strategies. This Section provides a brief overview of current practices in highway infrastructure planning to account for the case of residents, the focal point of the present study. We focus on planning practice in the Netherlands, a country where living near highways is an important issue in planning and policy making. As a result of its very dense population and highly-developed highway network - resulting in many people living nearby highways - highway development projects in the Netherlands are often heavily discussed (see Arts, 2007; Struiksma & Tillema, 2008; Heeres et al., 2012; see also Section 1.8).

1.4.1 Environmental regulation with regard to highway related nuisances

Due to the adverse effects of noise and air pollution on health, governments in many Western countries have developed policies that aim to reduce the negative environmental effects caused by (among other things) traffic on roads such as highway infrastructure in residential areas. Actions taken by highway authorities are mainly based on calculations of the (expected) amount of noise and air

pollution on a residential address. The standard indicator for noise in the European Union is L_{den} ("Level Day Evening Night"), which is an estimate for the average level of noise decibels at a certain address on a yearly basis. With regard to air quality, measurements are based on models estimating the yearly average concentration of different types of pollution for which the most important ones are particular matter (PM_{10} and $PM_{2.5}$) and nitrogen dioxide (NO_2). Both noise and air pollution models use traffic predictions from traffic modelling as their input.

In the Netherlands, noise regulation is currently mainly based on the Noise Abatement Act ("Wet geluidshinder") and the Environmental Mangement Act ("Wet Milieubeheer"). Policy mainly focuses on three pillars: 1) the reduction of noise emissions at their source – for example, through implementing quiet asphalt and traffic management; 2) reduction of noise transmission through, for example, zoning or barriers; and, 3) reducing noise exposure of the people through measures such as insulation of buildings (Weber, 2013). As the policy goal to eliminate all annoyance from noise has turned out to be unrealistic, the current policy aim is to avoid dwellings in areas with exposure levels above 65 dB along highways and above 70 dB along railways in 2020 (for a discussion, see Van Geel, 2006). Noise levels for new residential housing in proximity of highway infrastructure may not exceed the limit of 53 dB, whereas noise levels for existing houses may not exceed 63 dB, although maximum levels of 48 dB are preferred (Noise Abatement Act, 2016). Despite efforts to reduce the amount of noise, surveys indicate that the percentages of people experiencing annoyance caused by noise have hardly been reduced (Van den Berg, 2012).

With regard to air pollution, the Dutch policy is based on European norms and regulations (EU Directive 2008/50/EC). The maximum limits prescribed by the European Union for NO_2 and PM_{10} and $PM_{2.5}$ are 40µg/m^3, 40µg/m^3 and 25µg/m^3 respectively, on yearly basis. Policies are directed to reduce the concentrations. Infrastructure projects are tested on whether they will not exceed the maximum limits of air pollution. These and other measures are part of the National Cooperation Program Air quality (In Dutch: "Nationaal Samenwerkingsprogramma Luchtverontreiniging: NSL"), a program in which the national government cooperates with local governments in areas where concentrations are nearly exceeding the norms (for a discussion, see Busscher, 2014). As a consequence of the program, air quality has improved significantly in the last years (National Institute for Public Health and the Environment "RIVM", 2014). Nevertheless, increasing insights in the negative long-term health effects of particularly fine particular matter $PM_{2.5}$ and $PM_{0.1}$ (WHO, 2006) have led to an on-going discussion on whether to sharpen policy restrictions any further towards the future (Keuken et al., 2015; Janssen et al., 2016).

Additionally, with regard to barrier-effects and visual aspects of highways, Dutch policy provides several guidelines in order to assure the quality and uniformity of the highway and its integration in the directly surrounding landscape (see e.g., Rijkswaterstaat, 2012; Rijkswaterstaat, 2015), which are mainly based on a qualitative assessment.

1.4.2 Residents' interests in assessment tools

The implications of highway development on the residential context are considered in impact assessments, which are performed prior to the execution of larger highway investment projects. In the Netherlands, this is mostly operationalized in Environmental Impact Assessments (EIAs or in Dutch: "milieueffectrapportage", "m.e.r") and cost-benefits analyses by an approximation made by experts of potential effects of highway construction and use on the environment (e.g., noise, air pollution, barrier effects and traffic safety) and on accessibility gains (measured mainly by travel time gains). Such assessments are required for the major infrastructure planning projects in the Netherlands (Arts, 2004). Usually, such assessments are performed without direct inclusion of the values perceived by the local residential population; impact studies about the human living environment mostly focus on the potential health impacts that result from e.g., exposure to emissions and noises in a rather technical way (Stolp, 2006; Burdge & Vanclay, 1998; Geurs et al., 2009). Studies argue that the extent to which social impacts on groups such as residents are incorporated into (highway) infrastructure planning decision-making in the Netherlands (but also beyond) is still underdeveloped, as a lot of possible impacts – that are perceived by people but difficult to measure – are still not included (e.g., Stolp, 2006; Geurs et al., 2009).

1.4.3 Residents' involvement in infrastructure projects

In addition to environmental regulations and assessment tools, interests of residents are included in highway infrastructure planning via public involvement strategies. Compared to environmental regulations and impact assessments, public involvement is a way to directly assess the opinions and values of the residential population. Within current Dutch highway infrastructure planning (and beyond), there is increasing attention for more public involvement. This attention has grown especially since the Elverding committee (2008) concluded that involving citizens early in the process could improve the planning process, as well as reduce the amount of protest in later stages of a project. Stakeholder management (In Dutch:

"Omgevingsmanagement") has become more professionalized in the past years, during which time information and public participation activities towards residents have taken their place among the main tasks (e.g., Olander & Landin, 2005; Aaltonen, 2011; Rijkswaterstaat, 2013).

Residents are involved in highway infrastructure planning in both formal and informal ways. Following the "Aarhus Convention on Access to Information, Public Participation in Decision Making and Access to Justice in Environmental Matters" (1998) Dutch law formally requires that residents should at least be informed at several milestone moments in the project and have the possibility to give a formal written reaction to the plans designed by the government. Additionally, project teams responsible for developing highway projects usually provide several more informal ways for residents to be involved by various information efforts and possibilities to participate, the latter mainly via public meetings, workgroups or discussion groups initiated by the governmental project team (Rijkswaterstaat 2010; 2011; 2013). With regard to the level of participation (see also Arnstein, 1969; Edelenbos, 2000), possibilities for residents to participate in the highway infrastructure planning system are nowadays mostly centred on consultation of residents, i.e. gaining opinions of residents with the purpose of taking them into account in the planning process (Rijkswaterstaat, 2009). This level of participation (slowly) is slowly increasing, resulting in more power for the participants. Nevertheless, the highest levels of participation such as co-creation and empowerment of residents in highway infrastructure planning are still rather scarce (Rijkswaterstaat, 2009, Figure 1.2), due to – among other reasons - a tight project scope and different national and local interests which need to be balanced (Leendertse et al., 2015).

In sum, current highway infrastructure planning in the Netherlands – but also in other Western, developed countries – takes account of residents' interests in various ways. Nevertheless, those interests are mostly estimated by experts via environmental regulations and impact assessments (Stolp et al., 2002). In addition, the insights gained by public involvement – which is more a way of directly including opinions of the public into planning – are currently mainly based on the views of people actively attending public consultation meetings. However, it may be questioned to what extent those views of individuals are representing the broader residential community, as it is known from other research contexts that people who actively give voice are likely to be a selective group (e.g., Diduck & Sinclair, 2002; Mansfield et al., 2001; Woltjer, 2000). More general insights into the perceived impact of positive and negative effects of highway infrastructure, highway projects and involvement activities taken by the government on residents could assist highway infrastructure planners to include residents' interests more effectively.

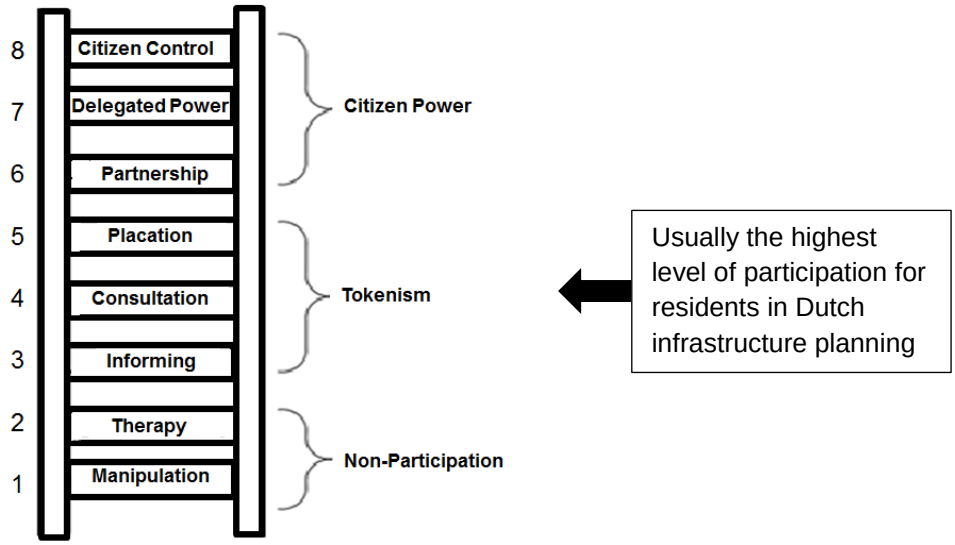


Figure 1.2 Participation ladder of Arnstein (own modification).

1.5 Knowledge gaps: Highway infrastructure and the residential context

The previous Sections indicate the importance of having a more comprehensive perspective on the impact of (planned) highway infrastructure from the perspective of residents, but also reveal several shortcomings in scientific literature and current planning practice. Below, three main gaps in existing knowledge are summarized, which need to be addressed in striving towards such a perspective and on which the present study will focus: A) unravelling the trade-off between positive and negative impacts of highway infrastructure, B) better understanding the implications of highway (re)development projects, and C) further defining the role of public involvement in addressing the impact of highway infrastructure.

A) Unravelling the trade-off between positive and negative effects of highways
Despite the insights revealed in existing research on the potential relevance of accessibility and nuisances to residents, current studies are often decomposed (focusing on either the one or the other), do not focus on the situation of highway infrastructure, or do not explicitly study the perspective of residents. In other words: there is a lack of insight into how (different) residents trade-off positive accessibility gains and negative effects– such as noise, air pollution and barrier-effects – of existing highway infrastructure in their residential context. A broader insight in the

influence of positive and negative effects of highway infrastructure from a residents' perspective could assist planners in better understanding the consequences of highways on (various) residents.

B) Better understanding the impact of highway projects

Complementary to a lack of knowledge on the impact of positive and negative effects in a situation of existing highway infrastructure, there is only limited insight into how (re)development of highway infrastructure influences the residential context. Following NIMBY literature, the (re)development of highway infrastructure in a residential area might be seen as an unwelcome change, and may be potentially disliked by residents. However, current knowledge is insufficient for understanding how (different) residents react to highway infrastructure projects in their residential context. This impact might be dependent on the characteristics of projects – is it an extension of an existing highway, for example, or a new highway connection –, on the phase a project is in – prior to or after realization –, but also on characteristics of residents in the area surrounding the highway. Nevertheless, the extent to which these factors play a role is not clear. Having insight in the impact of highway infrastructure projects on residents may help to better understand to what extent and under what conditions a changing highway environment through highway (re)development projects is more and less accepted by residents.

C) Further defining the role of public involvement

Finally, following the implications of highway projects on the residential context, the role of public involvement activities – i.e., information and participation of residents in addressing the impact of highway infrastructure projects – is not exactly clear. Despite many studies that have investigated how to design public involvement processes and conditions under which public participation works best, empirical knowledge about the impact of such involvement efforts from a residents' perspective is limited, specifically in the context of highway planning. More insight into the perception of efforts for involvement of the broader residential community may help to understand the extent to which and under what conditions it could indeed contribute to addressing the negative impact of highway infrastructure in residential areas.

1.6 Research aim and scope

In order to evaluate the impact of highway infrastructure from a residents' perspective and analyse the scientific and societal knowledge gaps as specified in Section 1.5, this research centralizes *residential satisfaction* as an important concept. Residential satisfaction or the match between actual and preferred housing conditions (e.g., Lu, 1998) is often seen as a proxy for a resident's quality of life and subjective wellbeing (e.g., Lu, 1998; Speare, 1974). Residential satisfaction is related to stress and could thus be seen as an important (first) indicator for coping strategies and (future) (re)location behaviour (e.g., Speare, 1974). Compared to measures such as house prices and moving behaviour, residential satisfaction as a self-reported measure may be better able to grasp a person's real emotion, which is of primary interest in the present study. In Chapter 2 this topic will be discussed in more detail.

1.6.1 Aim of the study

Intending to fill the research gaps, the aim of this study is:

> *"To gain greater insight in how positive and negative effects of highway infrastructure, planned highway projects and involvement activities influence residential satisfaction and consequent (re)location behaviour as to facilitate highway planning."*

In doing so, this study could contribute to a more integrated way of looking at highway infrastructure planning (e.g., Heeres et al., 2012; Arts, 2007) by accounting for the interaction between highway infrastructure and its implications for the broader (in this case residential) environment. In such an approach, residents and other relevant actors are involved in problem definitions and policy formulation (Weber, 2013). More general insights into the residents' perspective are of added value, as they could provide recommendations on how residential satisfaction close to highways could be further increased and consequent protest could be reduced.

1.6.2 Research scope: A conceptual framework

Figure 1.3 shows a conceptual framework which forms the basis for the present study.

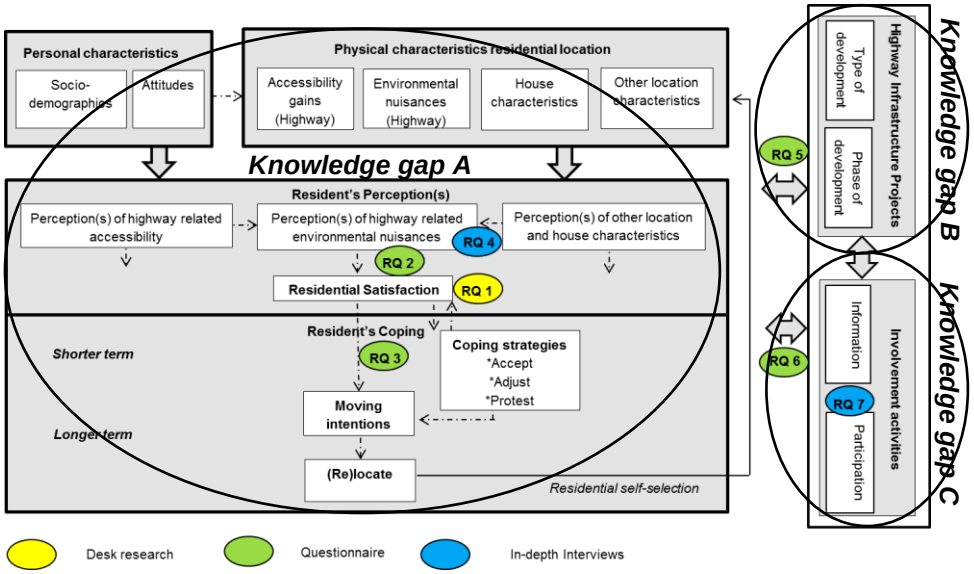


Figure 1.3 Conceptual model research.

Following knowledge gap A, in the framework accessibility gains and environmental nuisances of highway infrastructure are visualised as part of the broader *physical characteristics of the residential location* in which people with different *personal characteristics* choose to live, or not to live. This process may (partly) be a consequence of residential self-selection (e.g., Van Wee, 2009; Cao et al., 2009). The interaction between individuals and their physical environment is likely to influence the *resident's perception* of the location (e.g., Kirk, 1964; Gifford, 2007; Miedema & Vos, 1999; Kroesen et al., 2008). During the residential experience, residents develop perceptions of the highway in their residential context. Residents perceive a certain level of *accessibility* and a certain level of *environmental nuisances* caused by highways such as noise, air pollution and visual/barrier-effects. It is assumed that residents' perceptions of accessibility and nuisances of highways alongside other *location and house characteristics* are likely to be traded off in *residential satisfaction* (e.g., Hur & Morrow-Jones, 2008; Buys & Miller, 2012). A low residential satisfaction may be a proxy for *coping strategies*, and, in the longer term, residential *moving intentions* and actual *(re)location behaviour* (e.g., Speare, 1974; Lu, 1999).

Following knowledge gap B, *highway infrastructure projects* (Figure 1.3, right) could influence residential satisfaction, depending on their *type* (i.e. new development or adjustment) or *phase of development*. In a *phase* prior to

development; proposed plans for highway (re)development projects could influence residential satisfaction via expectations that residents have with regard to future changes of their environment as a consequence of such a highway project. During and after highway (re)development, actual changes in the highway environment have been created, which may have influenced a change in perceived accessibility, nuisances and/or other location characteristics such as traffic safety and greenery. Those could have changed residential satisfaction and influenced (re)location.

Following knowledge gap C, the extent to which a highway project influences residential satisfaction may also depend on how residents are involved in the planning process for such a highway project. *Involvement activities* such as *information* and *participation* (Figure 1.3, right) are likely to influence people's perceptions about the future plans (e.g., Healey, 1997; Innes, 2004). Whether activities for public involvement will be satisfactory to residents is assumed to depend on the quality of involvement activities, as well as on individual contextual characteristics (e.g., Rowe & Fewer, 2000; 2005).

1.7 Research questions

In order to address the research aim, seven research questions have been formulated. The research questions link to aspects in the conceptual model as presented in Figure 1.3 and relate to the knowledge gaps as presented earlier.

The first research question aims to explore existing knowledge on the impact of highways infrastructure on the residential context more extensively, and analyses the added value of linking the study of highway infrastructure to residential satisfaction.

> *RQ1) To what extent is the concept of residential satisfaction relevant for the study of the influence of highway infrastructure on residents, and how can this be used for understanding the impact of highway infrastructure on residents?*

Through an extensive literature review, the concept of residential satisfaction is further explained and compared to measures such as house prices and (re)location behaviour. In addition, existing knowledge regarding the potential role of highway accessibility and nuisances is further discussed, distinguishing between noise, air pollution, visual impacts and barrier-effects (i.e. fragmentation of areas). The literature review is linked to the conceptual model as presented in Figure 1.3, which provides the basis for the present study.

After having theoretically explored how to extend the scope of highway planning by using a residents' perspective, the conceptual model as presented in Figure 1.3 is investigated through several research questions. Starting with Knowledge Gap A, the trade-off between highway-related accessibility and environmental nuisances is empirically analysed in different steps. The second research research question two links both aspects to residential satisfaction.

RQ2) To what extent do highway-related accessibility and nuisances influence residential satisfaction?

As discussed earlier in Section 1.5, current literature lacks empirical evidence on how highway related accessibility and nuisances influence residential satisfaction. Following the conceptual framework presented in Figure 1.3, it is assumed that highway-related accessibility may positively influence residential satisfaction, whereas the presence of highway nuisances i.e. noises, air pollution and barrier-effects, may have a negative effect. It is expected that mainly perceived impacts of highways are likely to influence residential satisfaction. Therefore, in addition to (calculated) actual exposure and distance to the highway and access lane, perceptions of accessibility and nuisances are also studied. The proposed relationships are investigated by use of the data from a questionnaire that was conducted as part of this study (see Section 1.8 and Appendix A). These insights may help to understand the relative importance of highway nuisances and accessibility alongside other characteristics for residents living close to highway infrastructure.

After having tested the relationship between highway infrastructure and residential satisfaction, the third research question further investigates the link with coping and (re)location.

RQ3) To what extent do highway-related accessibility and nuisances influence residential moving intentions, by accounting for a mediating role of residential satisfaction?

Although the important role of residential satisfaction in understanding the relationship between residential characteristics and a resident's future relocation behaviour is confirmed in other contexts (e.g., Speare, 1974), it has not yet been empirically tested in relation to highway infrastructure proximity (see Figure 1.3). Based on questionnaire data collected among residents, the potential mediating role of residential satisfaction in understanding the relationship between highways and residents future moving intentions is investigated. In addition, the relationship between highway nuisances and accessibility is further explored; highway accessibility could either compensate for or directly influence (the perception of)

highway nuisances in residential moving intentions. The insights provide a more thorough understanding of the relationship between the highway, residential satisfaction and potential moving behaviour.

After the conducted investigation of the magnitude and direction of relationships between highway related accessibility, nuisances and residential satisfaction, the fourth research question further deepens the findings regarding the preceding research questions by exploring motivations behind the development of highway nuisance perception in the residential context.

RQ4) What are motivations of residents behind the development of highway nuisance perception during their residential experience?

Whereas earlier studies have investigated the perception of nuisances in a mostly quantitative way (see Section 1.3), this research question investigates how the perception of highway nuisances develops during the residential experience using a more qualitative approach. Based on in-depth interviews in a selected case area, this research question aims to provide a more in-depth insight into motivations behind the role of the highway in a residents' context. More specifically, the aim is to better understand under which conditions perceived highway nuisance does (not) develop in residents from the moment residents start living in the area. In addition, the study further uncovers the trade-off between highway nuisances and accessibility during the residential experience.

Subsequently, after more general insight into the influence of highway related accessibility and nuisances was gained, research question five specifically investigates the influence of highway infrastructure (re)development, i.e. a highway projects (Knowledge gap B).

RQ5) To what extent does a highway (re)development project change residential satisfaction and induce a change in the characteristics of the population along the highway?

Highway (re)development could change residential satisfaction via a change in e.g., (perceived) accessibility or a change in liveability – e.g., nuisances and other environmental changes (see knowledge gap B, Section 1.5 and Figure 1.3). In addition, it may also stimulate changes in the characteristics of the residential population through a (selective) outflow of unsatisfied people and an inflow of people with a more highway-oriented profile than the original population. The study addresses both aspects, based on questionnaire data collected in two residential areas along the same highway development project (*after* project execution). It investigates differences between residents and differences between (both)

residential areas. In addition, for two other residential areas, the study touches upon the effects of two proposed highway projects that have not yet been realized (*prior to* project execution), by studying the extent to which (different) residents expect a change in residential satisfaction as a consequence of the future project. Results could increase the understanding of the implications of highway projects in (different) residential areas.

The last two research questions focus on the potential role of governmental involvement activities in creating more acceptance of highway infrastructure planning (knowledge gap C). The sixth research question focuses on relationships between provided involvement activities and expected implications of projects on residential satisfaction *prior to* their execution. As most people's participation usually does not extend beyond receiving information, the research question focuses on better understanding the role of governmental information to residents.

RQ6) What is the relationship between residents' information reception and expected changes in residential satisfaction as a consequence of planned highway projects?

Although it is generally assumed that providing sufficient information as part of public involvement increases the acceptance of projects, only limited empirical insight in this relationship in the context of the planning of highway infrastructure is available. Based on questionnaire data, this research addresses the role of governmental information provision in and its contribution to explaining expectations towards changes in residential satisfaction among residents living in proximity of two announced highway projects. First, differences in residents' likelihood to receive (governmental) project team information actively (e.g., by going to meetings) or passively (by information provision brought to residents via e.g., mail) in the planning process are studied. Thereafter, relationships between receiving information and satisfaction with information are investigated. Finally, information receiving is related to residents' expectations towards highway projects. The research provides insights into residents' differences in information receiving behaviour. In addition, it gives indications about the extent to which information provided by governments contributes to information satisfaction and more positive expectations about the project.

Finally, the seventh research question investigates residents' satisfaction with involvement in highway projects.

RQ7) What are motivations of residents behind the development of satisfaction with involvement activities provided by governments in a highway infrastructure planning process?

Literature indicates the importance of residents' involvement in projects for the improvement of the planning process and for making better plans. However, in practice, it proves challenging to get people actively participating in and satisfied about their involvement in highway project planning processes. This research question addresses those issues, and aims to better understand how residents' satisfaction with governmentally provided involvement activities develops in the planning process of a highway project. Based on in-depth interviews among residents confronted with a planned highway project, motivations behind the development of satisfaction are grasped. In addition, motivations behind a resident's preferred level of involvement are addressed. From that, more in-depth knowledge could be gained on how to improve the broader involvement of residents in highway planning processes.

1.8 Research approach

This research investigates the influence of existing and planned highway infrastructure on residential satisfaction while focusing on the Netherlands. Just as other developed countries, the Netherlands has a well-developed highway infrastructure network and has experienced a development towards more awareness for environmental consequences of highway development in the past decades. Due to its small size and high population density, there are many claims on its scarce space (e.g., Arts et al., 2016; Elverding, 2008; Arts, 2007). As a consequence, infrastructure is often constructed close to residential areas and highway (re)development projects are highly discussed. This creates a challenging environment for studying the impacts of highways from a residents' perspective. Below the methodological approach of the study is further addressed.

In an attempt to create a better understanding of the impact of highway infrastructure on residential satisfaction, this research applies a mixed methods approach based on quantitative and qualitative research methods. Mixed methods is described by Tashakkori & Creswell (2007, pp. 4) as ''research in which the investigator collects and analyses data, integrates the findings and draws inferences using both qualitative and quantitative approaches''. Combining both quantitative and qualitative research methods for the present study could not only create insight into the magnitude of relationships between planned highway infrastructure and residential satisfaction, but could also provide a deeper understanding of how and why relationships do (not) occur. The use of a combination of quantitative and qualitative approaches may provide a better understanding of research problems than either approach alone (Creswell & Plano

Clark, 2007). In addition, it could provide stronger inferences, as using mixed methods can offset the disadvantages that certain of the methods have when used individually (Molina-Azorin, 2012). Through triangulation, more information can be gained about a phenomenon and about the robustness of findings when the findings from data generated by two or more methods are brought together (Moran-Ellis et al, 2006).

For the present study, a sequential mixed method design is used (Tashakkori & Teddlie, 1998). In other words, first, a quantitative method was applied by making use of questionnaire data collected in the context of this study[1] among residents in the proximity of highway infrastructure. Based on the questionnaire, relationships between the consequences of existing and planned highway infrastructure and residential satisfaction are investigated. The concepts in the questionnaire were defined based on a literature review and some expert interviews. Subsequently, a qualitative study approach has been used by means of in-depth interviews to further explain and understand insights gained from the quantitative study. Each research question in the study is answered based on either quantitative or qualitative research methods (see Figure 1.4). Finally, the results of the quantitative and qualitative study among residents are integrated in the conclusions of the study.

The study additionally benefitted from a cooperation program between the University of Groningen and Rijkswaterstaat, the executive agency of the Dutch Ministry of Infrastructure and the Environment, which is responsible for, among other things, the Dutch national highway network. This cooperation faciltated access to e.g., information about Rijkswaterstaat projects, planning practices and policies, and planning practitioners. Despite the close cooperation and funding by Rijkswaterstaat, the research was carried out as an independent study, as recorded in the formal cooperation agreement between the University and Rijkswaterstaat. During the study process, discussions with infrastructure planning practitioners at Rijkswaterstaat, complemented with other experts from the field helped to better understand the issues with regard to involving residents from a planning point of view and to make the implications of the study more concrete (see also Appendix C).

[1] The questionnaire data have been collected by the University of Groningen just before the PhD project started. The data has been used as a basis for the present study – see Appendix A.

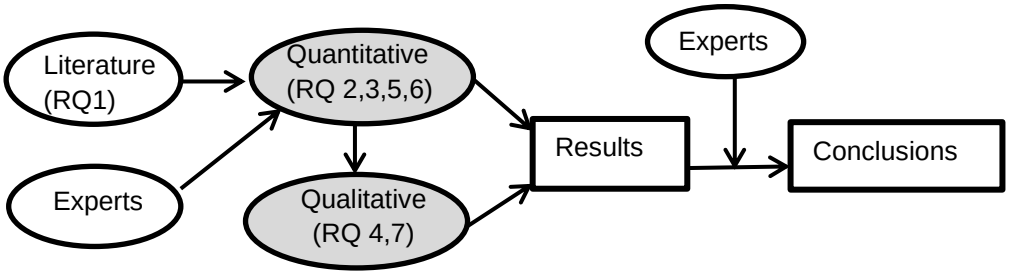


Figure 1.4 Data collection process.

The main data sources used for the empirical part of the study are further explained below: questionnaires and in-depth interviews.

1.8.1 Quantitative study: Questionnaire at seven highway locations

In order to answer the second, third, fifth and sixth research question, questionnaire data was used (see Figure 1.4), with the aim to explore the relationships between highway infrastructure and residential satisfaction. The questionnaire covers a broad range of questions concerning people's residential satisfaction, residential moving intentions, perceptions of (highway) accessibility and environmental nuisances alongside other (residential) location characteristics, complemented with questions about socio-demographics, attitudes and the resident's actual location. For selected case areas in which highway (re)development projects are planned or have recently been executed, the questionnaire also covers questions on residents' perceptions about the project and about public involvement activities set out by the governmental project team responsible for the project. The questionnaire can be found in Appendix A.

The questionnaire was set out on seven residential locations close to highways in the Netherlands (see Figure 1.5). Different types of cases were selected: two cases in the planning phase of a highway extension project (Groningen and Utrecht), two cases where new highway development had taken place six years earlier (Uden and Son), two cases in which a residential area had recently been constructed close to a highway (Veghel, Ypenburg) and one case in which no changes or adjustments had taken place or are planned for the coming years (Assen). In this way, potential relationships between the phase of highway infrastructure planning and residential satisfaction could be accounted for.

Data was collected in May 2011 among residents living within one kilometre from the highway (see Appendix A). This radius was partly based on studies indicating

that noise effects seem to fade away at a distance of 300–600 meters from a highway (Eliasson, 2005; Nelson, 1982). To get sufficient variation in highway exposure levels, the distance was extended to 1,000 metres. Relatively more questionnaires were spread within closer distance of the highway: within 0-300, 300-600 and 600-1,000 metre respectively 2,200, 1,800 and 1,500 questionnaires were spread (making a total of 5,500 questionnaires). To assure a systematic data collection process, the questionnaire was distributed to the first house(s) of each selected six-digit postal code every time, or at least wherever possible. A total of 1,396 useful questionnaires were received back (a response rate of 25.4%). The respondents are quite representative for the population in the residential areas, although younger people and one-person households are somewhat underrepresented (see also Appendix A). Data on highway proximity were linked to the questionnaire based on the resident's postal code. The nearest distance to the highway and to the highway access lane was calculated using GIS. In addition, mathematical calculations of NO_2 and PM_{10} were obtained from the Dutch Ministry of Infrastructure and the Environment for each postal code.

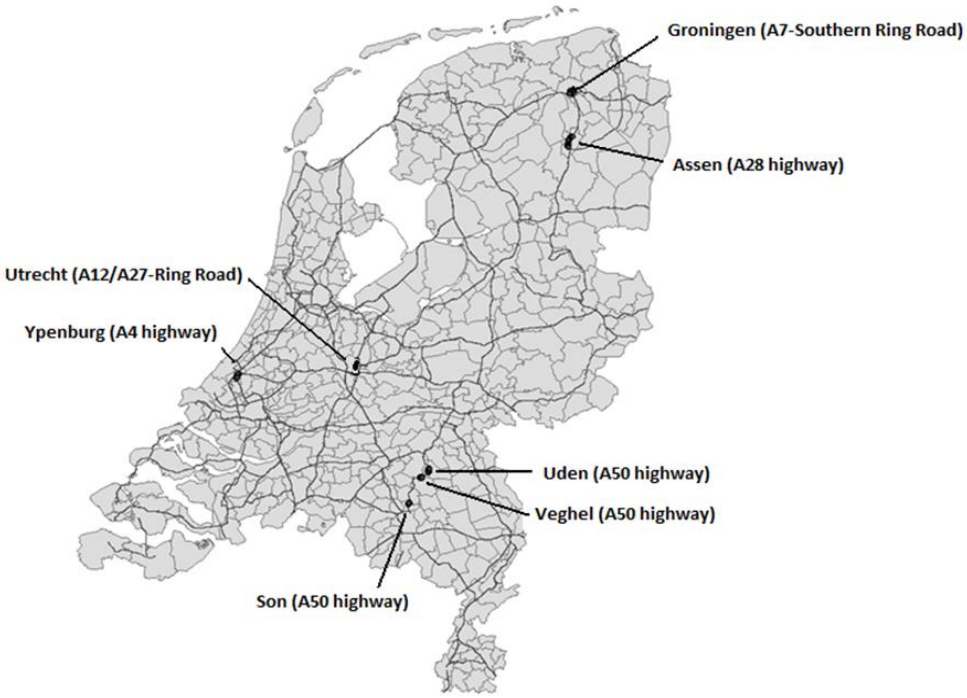


Figure 1.5 Geographical location of the selected cases.

1.8.2 In-depth interviews

In order to answer research question four and seven, in-depth interviews were conducted to improve our understanding of motivations of residents behind their experiences with (planned) highway infrastructure in their residential context. A case study approach was chosen, as this is useful for studying phenomena in relationship to their context (Yin, 2003; Flyberg, 2006).

The Southern Ring Road in Groningen was chosen as the case study area for investigating both research questions. The Southern Ring Road case is an urban highway crossing through the city of Groningen and serving as a part of the highway connecting the Netherlands and Germany. The case was chosen as 1) this urban highway was also studied in the questionnaire, and 2) the case can provide insight in residents' perceptions about an existing highway as well as a highway (re)development project, as an extension and adjustment of the highway and its surroundings was being discussed at the moment of study. In addition, the case is interesting as the highway passes close to several residential neighbourhoods in the city.

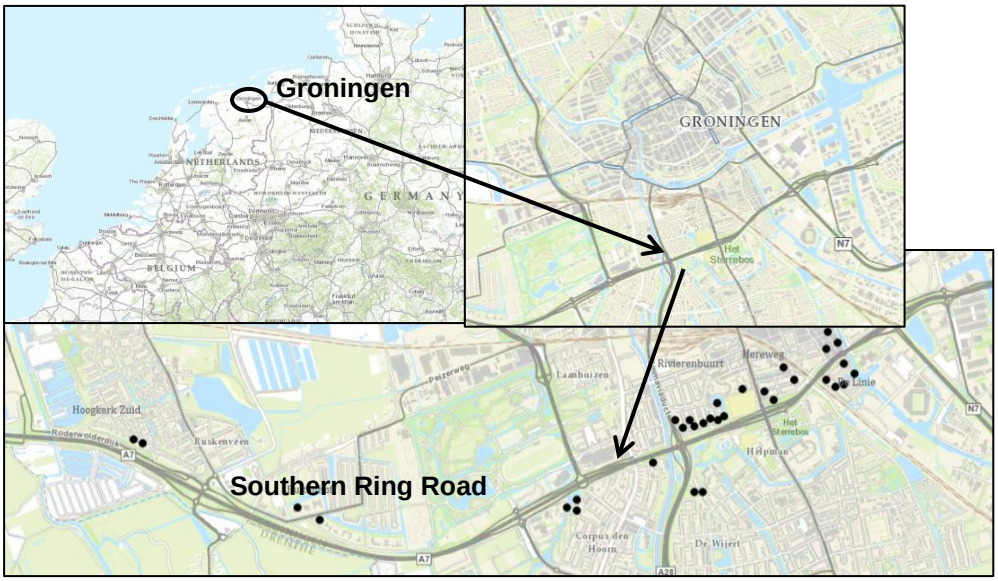


Figure 1.6 Geographical location interviewees along the Southern Ring Road Groningen (the respondents' homes are marked with dots).

Interviews were held with 38 respondents in the surrounding area of the ring road (Figure 1.6). To complement residents' stories, additional interviews were held with representatives of neighbourhood interest groups and the governmental project team conducting the planning process for the highway adjustment project (see also Appendix C). Residents were approached in three ways. A first group was approached using the contact information they provided in the questionnaire. A second group was specifically approached because their houses are situated in close proximity to the Southern Ring Road. A final group of residents was approached via snowballing, i.e. they were recommended by other participants. Residents were approached via invitation letters distributed to their houses (see Appendix B). An active recruitment approach was used by ringing people's doorbells a few days after the invitation letter had been delivered, after it proved difficult to find respondents via a more passive approach, i.e. by asking people to contact us themselves. New respondents were approached and interviewed until saturation in the variety of motivations had been reached with regard to A) the development of perceived highway nuisance perception (following the fourth research question) and B) satisfaction with involvement in the planning processes (following the seventh research question) (see also Hennink et al., 2011; Ritchie & Lewis, 2003). Additionally, the approach ensured respondents from several neighbourhoods and with a variety in socio-demographic variables. Appendix B provides background information of all interviewees.

1.9 Study Outline

The chapters in this book largely follow the study's research questions. Figure 1.7 provides an overview of the research process and outline, and links the chapters to the main research questions they address. Chapter 2 discusses the first research question and further elaborates on how to extend the scope of highway planning by use of residential satisfaction. Thereafter, following the second research question, the empirical relationship between highway nuisances, accessibility and residential satisfaction is first explored in Chapter 3. As an aside, the chapter also provides a first short exploration on the influence of proposed highway projects on residential satisfaction. Chapter 4 mainly focuses on the third research question and further investigates the importance of residential satisfaction as an intermediate between (perceived) highway proximity and moving intentions. Additionally, the chapter also further elaborates on the potential role of highway accessibility alongside other characteristics in compensating and/or mitigating highway nuisances. Chapter 5 takes a more qualitative approach and studies the development of highway nuisance perception, as specified in the fourth research question. Subsequently in

Chapter 6, the implications of highway (re)development are addressed as phrased in the fifth research question. Chapter 7 also partly addresses the fifth research question, by analysing residents' expectations towards a change in residential satisfaction as a consequence of a proposed highway project. However, this chapter particularly focuses on the role of information reception in the planning process of highway projects, the sixth research question. Subsequently, Chapter 8 discusses the seventh research question by analysing motivations behind residents' satisfaction with involvement in a highway planning process. Finally, in the study's conclusion (Chapter 9), a reflection is provided on the influence of existing and planned highway infrastructure from a residents' perspective based on the research findings. Additionally, recommendations are provided for both planning policy and practice and for further research directions.

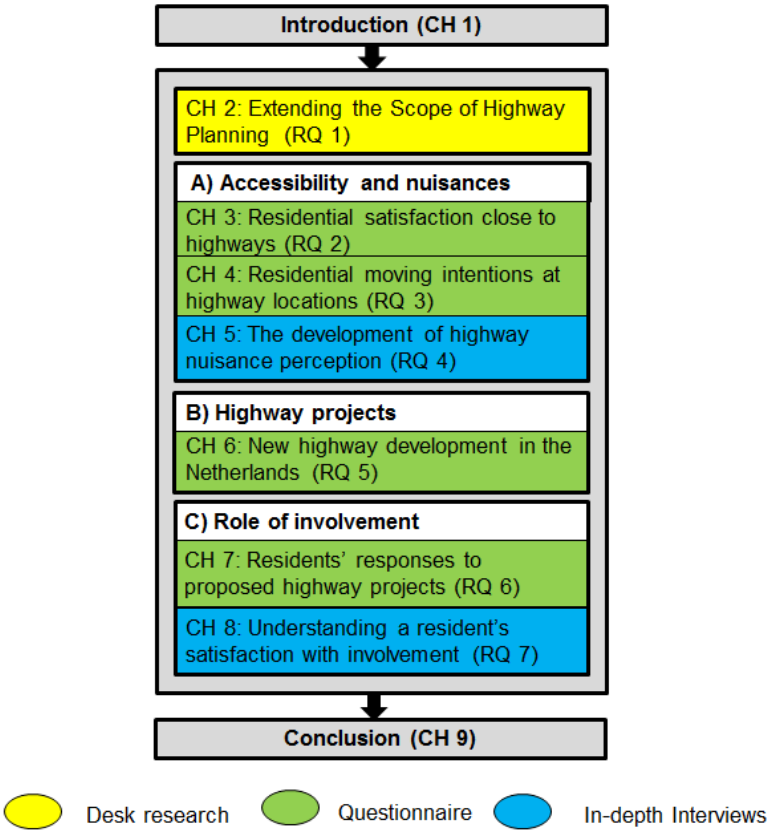


Figure 1.7 Study outline.

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