Health Council of the Netherlands

Social Aspects of the Living Environment in Relation to Environmental Health

Background study

Foreword

Scientific studies into the effects of physical environmental factors such as noise and a diverse range of harmful substances on health generally fail to take into account other factors that also affect health. Primary among these are social and psychological factors. This shortcoming in the basis of environmental health policy may compromise the optimum efficiency and cost-effectiveness of that policy. The Board of the Health Council has therefore asked dr. I. van Kamp to survey what is known about the role of social aspects in the relationship between living environment and health and about the possibilities to take account of these aspects in environmental health policy. This report contains the outcome of this review.

The neighbourhood has been taken as the starting point for and level of analysis in this review. Research into the effect of social factors with regard to environmental and health issues at neighbourhood level can be grouped according to three perspectives: that of environmental epidemiology, that of social epidemiology and that of environmental psychology. The main conclusion is that the three perspectives are as yet not brought together to a sufficient degree. It also becomes clear that, even without aiming for full integration, possibilities exist for improving this situation by looking for a common, consistent interpretation of the findings. This has the added value of possibly providing new reference points for environmental health policy. Theme-based detailing and a multi-disciplinary

approach, in which all three perspectives are represented, are essential in this regard. Appropriate themes include mobility, living and the environment and health of children and the elderly, for example.

I warmly support the approach toward environment-related and health-related issues that is advocated. The insights may prove useful in helping determine the knowledge agendas of the Ministry of Health, Welfare and Sport, the Ministry of Infrastructure and the Environment and the Ministry of the Interior and Kingdom Relations in particular.

The Hague, July 11, 2012

(signed)
Professor H. Obertop,
Acting President

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Authorship

This background study was compiled by dr. I. van Kamp, employed at the National Institute for Public Health and the Environment (RIVM), on behalf of the Health Council of the Netherlands. Editorial contributions were provided by Professor W.F. Passchier, Emeritus Professor of Risk Analysis, Maastricht University.

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The Health Council receives most requests for advice from the Ministers of Health, Welfare & Sport, Infrastructure & the Environment, Social Affairs & Employment, Economic Affairs, and Education, Culture & Science. The Council can publish advisory reports on its own initiative. It usually does this in order to ask attention for developments or trends that are thought to be relevant to government policy.

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INAHTA

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Contents

Executive Summary

Background and terms of reference

Numerous relationships play a role in environment-related health problems. Exposure to a stressor such as, for example, noise, radiation or a harmful substance related to a specific source or location can have a broad range of effects on health. Conversely, a specific health problem is often the result of several stressors that originate from different sources and to which an individual is exposed in different ways. The broader context in terms of an individual's home, living environment, working environment, mobility, socioeconomic status and social networks is important with respect to all forms of exposure and health problems.

This background study provides an overview of what is known about the role of social aspects in the relationship between living environment and health. The study deals with what we know and how we can incorporate what we know into environmental health policy. This objective was worked out into the following questions:

- How are social aspects defined and measured?
- What has research into the environment and health at neighbourhood level revealed about the role of social factors?
- What methods and instruments have been developed for the integrated study of social and environmental characteristics in relation to health?

Perspectives

The study into the influence of social factors in environmental health issues was carried out on the basis of three perspectives, namely an environmental epidemiology perspective, a social health perspective and a perception and behaviour perspective.

Environmental epidemiology studies the effects of physical environmental factors on health. To the extent that social factors are included in research, they are usually included as confounding variables for which 'corrections' must be made. The molecular approach is gaining ground within this perspective. Using what are referred to as biomarkers, exposure is determined at the level of the individual, as are early signs of diseases or other adverse effects on health. Another development within environmental epidemiology is the increasing use of geographic information systems to establish links between local exposure and local effects (referred to as small area statistics).

The relationship between social factors and health is central in social epidemiology. The influence of the physical environment is addressed only to a very limited extent. The focus is more on including behaviour and the social environment in the interpretation of research findings. Inequalities in terms of prosperity and opportunity are also being given increasing attention, both at the level of the individual and the level of social groups.

Environmental psychology studies the interaction between the physical environment and perception and behaviour. More than is the case with the other two approaches, this perspective also explores the positive effects of the environment on health and quality of life. Living environment, mobility and sustainability are central areas of research. In addition, the relationship between the way in which a given environment is perceived and behaviour that causes or reduces health risks is a key area of focus.

At present, the findings of the three research perspectives are not really linked together. Without aiming for a full integration of the perspectives, looking for a common, consistent interpretation of findings provides reference points for policy.

Evidence

In Western nations, increased health risks are usually related to an accumulation of unfavourable circumstances in certain neighbourhoods. Physical characteristics, such as a higher level of air pollution and noise and more industrial sites, social characteristics, such as less homeownership, a higher proportion of elderly residents and lower levels of education and income, and spatial characteristics, such as lower-quality housing, higher population density and less green areas, distinguish such neighbourhoods in an unfavourable sense from other neighbourhoods. Cause and consequence is difficult to unravel, and therefore also the precise relationship between the characteristics of the physical environment and health.

Social epidemiology research has shown that there is a link between socioeconomic status and health. A higher status in terms of education, profession and income is associated with better health. Although such links are also found in the Netherlands, they are by no means always straightforward. In addition to the socioeconomic status of residents, other social characteristics like the extent to which the neighbourhood is part of a metropolitan area and the marital status, age composition and ethnicity of the residents appear to play a role. Whether neighbourhood characteristics or the concentration of social groups in certain neighbourhoods dominate is unclear. Research into exceptions from the rule in terms of neighbourhoods that are doing relatively well in spite of an accumulation of unfavourable factors is worth mentioning in this regard. This research is important in that it provides insight into the resilience of such neighbourhoods and the individuals who live in them.

Research based on an environmental psychology perspective reveals that environmental stressors do not always have the same effects on health. Attitudes, expectations, sensitivity to the environment and other facets and coping strategies play a role. The same applies to the ability and conviction required to act adequately and efficiently in a given situation and the conviction on the part of individuals that they control their own living environments. The overview focuses on both perceived health and disorders like cardiovascular diseases that appear to be caused in part by chronic exposure to environmental stressors that an individual is virtually unable to control, such as noise. As limited as it may be, this study reveals that some living environments can also provide a

counterweight in the sense that a restorative effect is attributed to nature and peace and quiet.

All knowledge taken together, it must be noted that people and their neighbourhoods or residential locations mutually affect each other and are closely intertwined. Causes of socioeconomic health differences are therefore rooted in both the environment and human behaviour.

Instruments

Instruments recently developed to provide insight into the relationship between environment and health are all geared towards integration; geared towards, for example, combining the consequences of exposure to a multiplicity of environmental factors in terms of a heavier burden of disease or developing a few neighbourhood or district typologies that can be compared with composite indicators that say something about the physical quality of the environment.

The problem in the development of many instruments, particularly of indicators, is that the models that describe the relationship between people and their environments are incomplete and, as a result, interpreting the outcomes obtained through the use of the instruments is far from straightforward. This situation is also the result of the fact that many instruments are often based more on the availability of data rather than on a sound theoretical foundation.

Three developments stand out:

- Sets of instruments that, depending on the terms of reference, can be used flexibly to describe environmental health issues and monitor the effect of interventions
- Living environment indices or composite indicators designed to characterise the quality of an environment or health of a population on the basis of a single quantity or a few quantities and identify changes in the course of time
- The application of geographic information systems up to a high level of detail in spatial terms with the aim of establishing links without making the error of drawing conclusions about individuals using data pertaining to a group on the basis of the assumption that all members of a group have the same characteristics (referred to as ecological fallacy).

Although a limited degree of experience has been acquired in specific situations, the application of many of these instruments is still in its infancy.

Conclusion

It can be concluded that a spatial and social division exists in terms of ill health, burden on the environment and other unfavourable factors. Although social, physical and spatial problems appear to be mounting, insight into the causal links and the reference points for policy and interventions is still limited. Views regarding the way in which these inequalities should be dealt with differ. Some believe that physical intervention will lead to improvements at the social level, while others argue that only interventions that improve the economic situation will have a favourable effect.

The background study presents a picture that is at once optimistic and pessimistic; optimistic in the sense that the research data required is available and it is now widely acknowledged that social factors at individual level (like socioeconomic status) and group level (like social cohesion) must be taken into account in research into the relationship between the physical living environment and health. In parallel with the situation described in the foregoing, it is acknowledged within the social health perspective that the physical environment and the way in which that environment is perceived are important factors. Nevertheless, the bodies of knowledge developed within the frameworks of the three perspectives outlined above are as yet not brought together to a sufficient degree. This fragmentation accounts for the background study's pessimistic conclusion. The themebased detailing of the instruments developed should make it possible to bring the bodies of knowledge together. Appropriate themes are:

- Mobility
- Housing
- Preschool and school environments and long-term effects
- The environment and health of the elderly
- The distribution of physical and social characteristics across the population and the accompanying effects on health
- The varying effect of a neighbourhood organised to be conductive to health on different socioeconomic groups.

Chapter 1

Introduction

This background study provides an overview of the social aspects that play a role in the relationship between living environment and health. It is the outcome of a background study carried out for the Health Council of the Netherlands. The background study does not contain an exhaustive *review* of research findings in this area, but rather provides a sketch of what is known about the role played by social characteristics in relation to health deterioration or health improvement due to exposure to physical environmental factors. The background study brings together knowledge from several different disciplines. From the perspective of environmental epidemiology, social epidemiology and environmental psychology, the background study discusses the main approaches, summarises the key research findings and examines instruments that can offer reference points for research into the social dimension of environment and health as well as policy that takes this dimension into account. Examples of instruments are the health impact assessment (HIA*)[1,2] and the 'Liveability Meter' (*Leefbaarometer*).[3] Relevant policy frameworks are provided by the policy in the Netherlands with regard to deprived areas (vibrant urban districts) and more general policy with regard to a healthy design and layout of the living environment.

* HIA: health impact assessment.

1.1 Background

Where people live is one of the factors determining the cause and persistence of health differences between individuals. The urban living environment is made up of a wide range of material and immaterial factors. Environment-related health problems do not arise in isolation, but are the result of a complex interplay between spatial, social and physical factors.

Increasingly it is being recognised that these factors must be taken into account in relation to environmental health research. During the congress of *l'Observatoire Wallon de la Santé**, for example, the case was put forward in October 2010 under the title *Santé environnementale et vulnérabilités sociales*** for greater account to be taken of socially vulnerable and susceptible population groups when developing a second European environmental health plan. While environment-related health effects and social inequality are in themselves well-documented, the link between them has only recently become the subject of research.

If this broader context of environmental health problems is missing, the evaluation of the consequences can give an incomplete or inaccurate view of reality[4]. Research into the link between a combination of exposure to environmental factors and social-economic status can provide handholds for measures designed to influence the relationship between environment and health. The recent development of geographic information systems brings this type of research within the bounds of what is technically feasible.[5] However, the data currently available prevent adequate account being taken of the most vulnerable groups in environmental health policy.

It is generally recognised, however, that decisions in several different policy areas, such as living, working, environment, traffic and education, have an impact on public health. The Dutch government seeks to pay heed to this by conducting intersectoral policy. Harmonisation between research, policy and practice needs to be further strengthened, however.[6] This applies at the local level as well as, indeed particularly, at the national level. As any interventions in the physical environment generally require a significant preparation time and have very long-term consequences, it is furthermore necessary to have an understanding of the future development of the physical environment in conjunction with social and economic developments.[7]

* Walloon Health Observatory.
** Environmental health and social vulnerabilities.

1.2 Social and scientific trends

Increasing scale and urbanisation constitute the setting for this theme. More than half the population of Europe live in highly urbanised areas and the process of large-scale urbanisation continues in Europe as well as in the rest of the world. This is accompanied on the one hand by densification: an accumulation of functions (work, living, traffic and recreation) within a limited space. At the same time, however, mobility to and from the urban centres increases, particularly in terms of road traffic due to affluence and increased opportunities and possibilities. In addition to positive effects — such as an improved transport system, less segregation and improved accessibility of amenities and facilities, including health facilities — increasing urban densification has also led to relatively new problems specific to large cities. The increasing scale of urban development is putting strain on regional and local social cohesion.

The importance of gaining insight into the synergy and tension between economic, spatial and social developments is high on the European and national agenda (see, for example, the 7th Framework Programme of the European Union*). Traditionally, attention within environmental health research was mostly focused on local, specific and single threats with direct and acute consequences for health, such as the effects on health of environmental noise or particulate matter. In recent decades it has become increasingly clear that public health risks are also due to diffuse, indirect long-term problems that manifest themselves at different scale levels.[8] While the effects at an individual level are generally limited[5], the fact that far more people are exposed to transport-related contamination and pollution due to increased mobility and rapid technological developments means that the effects on public health will potentially increase in size.[8] These effects are also influenced by social and economic factors and are unevenly distributed across social groups, countries and regions: a higher social-economic status is consistently connected with better health.[9,10]

Concrete spatial and physical interventions that are often not primarily aimed at promoting health have been insufficiently evaluated in terms of their effects on health; while successes have been recorded it is often not clear which processes this was dependent on and to whom the benefits and the disadvantages of this policy eventually accrued (see, for example,[11]).

* http://cordis.europa.eu/fp7/home_en.html.

1.3 Environment and health in the Netherlands

It is estimated that between 2% and 5% of the total burden of disease in the Netherlands is attributable to a number of specific environmental factors.[12] If a broader definition of 'environment' is employed, that share can rise to 14% in Western Europe and 24% globally[13]. Important environmental factors are traffic accidents, airborne particulate matter, noise and radon in indoor air. In addition, some of the burden of disease is caused by adverse lifestyle habits, for example, such as an unhealthy diet and too little exercise. Diseases that are attributable to the environment in the Netherlands are[14]:

- conditions such as asthma, chronic bronchitis, cardiovascular diseases due to air pollution and noise, for example, or a worsening of these conditions;
- severe annoyance due to noise, sleep disorders, decreased ability to concentrate and disturbance of daily activities due to noise;
- feelings of insecurity and alienation, feeling unhealthy and being concerned about food contamination, for example.

The adverse effects of environmental factors on health occur in degrees. This relates not just to death or disease, but also to aspects of perception, such as annoyance, sleep disorders, health as experienced and satisfaction with the living environment.

Environment-related and health-related topics that are gaining importance are (see, inter alia,[15]):

- transport and health (air pollution, noise, accidents);
- climate change and associated health risks, such as increased incidence of skin cancer and infectious diseases such as malaria, cholera and AIDS;
- changing use of subsoil due to thermal energy storage, for example, and underground construction with consequences for exposure to low-frequency noise and safety, among other things;
- new energy technology and energy-saving measures and the impact of these on the living environment and health (for example wind energy, balanced ventilation);
- concern about exposure to chemical substances – among other things in relation to the risks to foetuses and cancer – and the related call for biomonitoring;
- environmental factors whose health effects are uncertain, such as base stations, mobile phones, nanotechnology, hormone-affecting substances (oestrogens) and genetically modified organisms.

1.4 Health-related and environment-related policy

The '*Nationale Aanpak Milieu en Gezondheid*' (National Environment and Health Programme) places particular emphasis on the following policy objectives in relation to the physical living environment[16]:

- improving the quality of the indoor environment in homes, schools and childcare centres;
- healthier design and provision of the physical living environment;
- improving the provision of information to citizens about the local living environment, thereby enabling citizens to become actively involved in their living environment;
- identifying and tracking environmental and health problems and the impact of policy in this connection.

The social dimension is only implicitly addressed in this regard, in the sense that it is clearly indicated for which groups an improvement (or deterioration) can occur, which strategy is pursued in order to reach vulnerable groups, the role of perception and behaviour, and the impact of any measures taken on social cohesion and social capital.

1.5 Key concepts in further detail

It is a characteristic feature that numerous relationships play a role in environment-related health problems. At the physical and social level, it is possible to distinguish several different domains that play a role in the relationship between the individual and his/her environment.[17] At the level of the environment these include the natural environment, natural resources, the built environment, facilities and amenities such as health services and green space, the social environment, the economic environment, culture, accessibility and the political climate. At the level of the individual, genes, personality, behaviour and lifestyle, motives, socioeconomic position and preferences play a role. Aspects of the social environment (social networks, socioeconomic status) are considered important at both levels.

Living conditions at the individual as well as the collective level influence the impact of an environmental health risk, not just due to variation in exposure and vulnerability, but also because social groups (often, although not exclusively, based on socioeconomic status) differ in terms of their ability to avoid or protect themselves against risks. In the Western world, measures in the field of

environmental hygiene and health services have significantly reduced the harmful impact of physical environmental factors. At the same time, the growth of the world population and technological developments have introduced new risks, whose eventual consequences are uncertain. Additionally, our understanding of the impact of combined exposure to several different environmental stressors is still limited. In many cases this relates to the combination of those factors with socioeconomic features and a lifestyle that leads to a worsening of existing diseases and conditions and to a reduced quality of life. Genetic and acquired traits determine the degree to which this affects individuals. These findings mean that it remains difficult to identify which specific reference points are available for effectively controlling the health risks originating in the living environment.[5]

Impact on health and well-being can also be linked to the way in which people perceive their environment and assess and interpret risks, to the extent to which they are able to influence their own environment as well as the coping strategies that an individual can rely on. Laypeople and experts sometimes differ in their assessment of the health risks of environmental factors. This is due, among other things, to the fact that their attention tends to be focused on different aspects of risks.[18-22] Additionally, concern about and fear of adverse health effects in turn affect health and, through stress mechanisms, can worsen health problems (see, for example,[23]). Characteristics such as susceptibility to stress and autonomy[24,25] and the perception of the living environment in terms of satisfaction, annoyance, concern, attitudes and risk perceptions can be considered as important factors at an individual level. Risk perception is also influenced by the social dimension: people with a lower socioeconomic status generally rely on a limited number of local sources of information providing clear and easy-to-understand messages.[26]

Social determinants of health are the economic and social conditions under which people live and which influence their health. The socio-cultural characteristics of a neighbourhood include the political, economic, ethnic and religious history of a community: standards and values (mores), the degree of interaction, public safety and social support networks. The social environment influences behaviour and, via behaviour, health by shaping standards, reinforcing social control and providing, or not providing, physical possibilities for displaying healthy behaviour (green space[27]).

A distinction must be made between social aspects at the individual level (social network) and at the collective, or group, level (cohesion and social capital). A social network is the collection of all social relationships and their characteristics. Networks influence behaviour by providing social support,

influence, commitment and a bond as well as access to resources and material goods that are important for health. It is debatable whether the individual level is suitable for establishing a link between social environment and health.[28] As Durkheim commented[29]: "The group thinks, feels and acts entirely differently from the way its members would if they were isolated. If therefore we begin by studying these members separately, we will understand nothing about what is taking place in the group".

Social cohesion refers to the degree of connectedness and solidarity between groups and individuals. Social capital can be generally described as the resources that are present in a community and shape the family and social organisation. Examples are trust, standards, reciprocity. So, social capital is part of the broader concept of social cohesion. Social capital is a public asset that is available to everyone, but the degree of access to it is unevenly distributed among income groups, sexes and ethnic groups due to segregation, work segmentation and other forms of discrimination.

1.6 Formulation of the question

Against this background, this essay aims to place the connection between living environment and health and well-being in a social context. It provides an overview of what is known about the role of social aspects at different scale levels in the relationship between living environment and health. What do we know and how can we incorporate what we know into environmental health policy? This objective has been elaborated into the following questions:

- How are social aspects defined and measured?
- What has research into the environment and health at neighbourhood level revealed about the role of social factors?
- What methods and instruments have been developed for the integrated study of social and environmental characteristics in relation to health?

While the living environment can be defined at different scale levels, the neighbourhood is taken as the primary starting point for and level of analysis here. The so-called deprived areas will be touched upon in this study, but they do not form the primary starting point.

1.7 Structure of the study

This background study is comprised of three main elements: approaches, evidence (scientific proof) and instruments. Chapter 2 summarises how social

aspects are defined and includes examples of analytical frameworks. Chapter 3 contains a summary of existing evidence and examines the applicability of this body of knowledge. Chapter 4 provides a brief overview of research methods and instruments. Chapter 5 makes proposals for future research and the further development of instruments.

Chapter 2

Social determinants in perspective

2.1 Environmental epidemiology perspective

In environmental epidemiology, the physical environment is generally operationalised in terms of physical/scientific, chemical and biological characteristics[8 30]. While the interaction with the social environment and spatial quality is often recognised, this has rarely been incorporated as a subject of study. Furthermore, the relative risk of a particular environmental factor is usually small in itself, and the effect of a combination of exposure to several different factors is difficult to study.[8]

Two trends are observable in response to these restrictions: on the one hand, the emergence of molecular epidemiology, which places emphasis on biomarkers as indication of individual exposure and susceptibility and, on the other, greater attention for the situations and context in which exposure takes place and integration with the public health approach (social epidemiology). Where the molecular approach runs the risk of losing the population perspective, the contextual approach is inclined to disregard processes at the individual level. Based on population data, conclusions are then drawn regarding the exposure and risks of individuals, a phenomenon often referred to under the term 'ecological fallacy'.[31] It is then wrongly assumed that all the members of a group have the same characteristics.

Ideally, the data from the different levels are combined – from the individual level to the level of ecosystems – and aggregation is performed over space and

time, taking into account the psychosocial and socioeconomic context. The case for a more integrated approach toward environmental health issues has been argued for some time; various initiatives to this end are currently being developed at national as well as international level.[32-35] Whether this approach has a practical application will become evident in the coming years.

Analytical frameworks within environmental epidemiology

Numerous conceptual frameworks have been developed in an attempt to come to grips with the complex relationship between the social and physical environment and health.[32,36-38] A recent example is a model that was developed in the INTARESE project*.[32] This is shown in Figure 1.

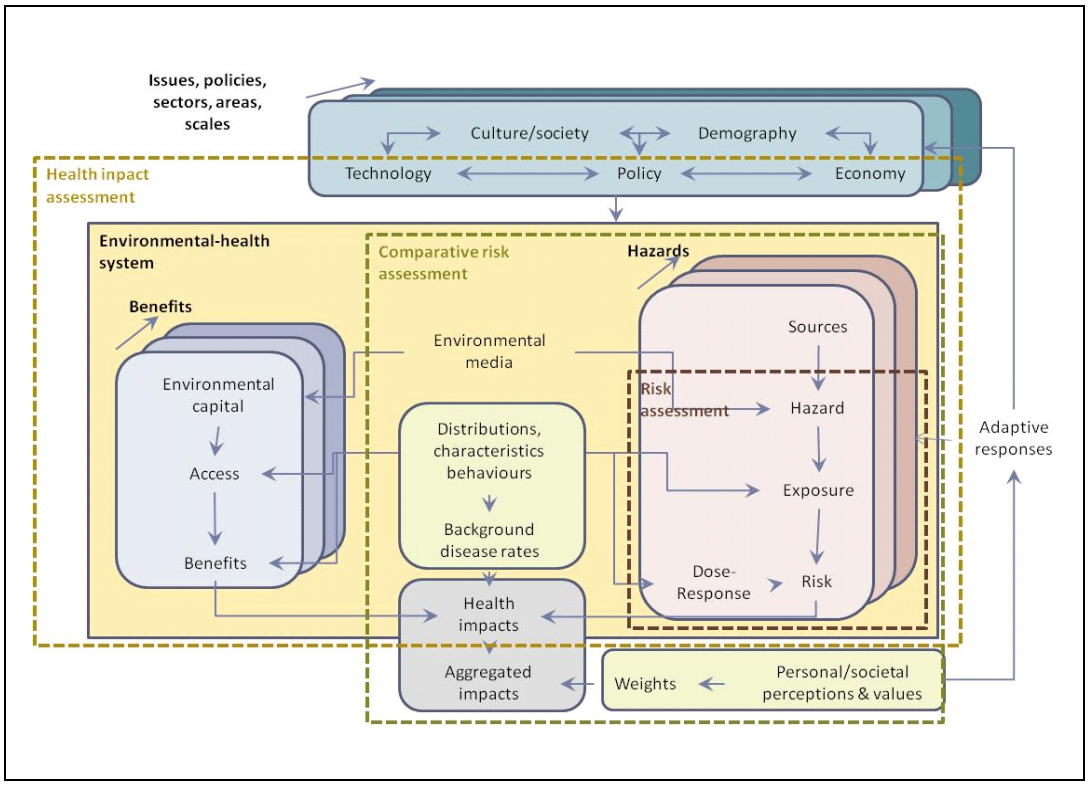


Figure 1 Model for an integrated analysis of environmental health impact.[32]

* INTARESE (Integrated Assessment of Health Risks of Environmental Stressors in Europe) is a project under the EU 6th Framework Programme that ended in 2011. Visit www.intarese.org.

Environment and health are described at a high aggregation level in the approach shown in Figure 1. The model uses a broad definition of the environment and refers not just to risk factors of the physical environment but also to other aspects of the living environment that can have a negative or positive impact on health. Health is defined not just in terms of disease and death, but also in terms of well-being. Health effects are the result of exposure to environmental factors, access to environmental capital and services. This process is mediated by behaviour and perception and is a function of the place where people live and spend their time, personal characteristics and social characteristics of the population (and associated attitudes). This environmental health system is in turn influenced by exogenous factors such as policy, interventions and technological, social and economic developments. Changes in this (changes in exposure, population composition, behaviour, care, etc.) also bring about a change in the impact of a specific exposure. Any study of the impact of environment on health should therefore take place in the context of these external factors, and vice versa: changes in the social demographic and economic conditions influence the environmental health relationships.

The model must be viewed as an 'umbrella' and is applicable if it is elaborated on the basis of theme-based research. Figure 2 gives an example for environmental pollution caused by road traffic.

2.2 Social health perspective

Social epidemiology studies the link between social factors and disease[40], in other words it examines the social distribution and social determinants of health. This implies identifying the environmental aspects that may be connected with a wide range of somatic and mental health outcomes, at the individual as well as the collective, or group, level. Social epidemiology focuses on the socioeconomic status of the region and the individual, in international literature often characterised by deprivation, social cohesion, social support, a neighbourhood's reputation, a neighbourhood's characteristics in terms of availability and accessibility of amenities and facilities.[41]

The socio-cultural characteristics of a neighbourhood or region encompass political, economic, ethnic and religious aspects that influence behaviour and, via behaviour, health. They are created by establishing standards and patterns of social control (what is good or bad for health), by offering, or not offering, environments and infrastructure that promote good health, by reducing or actually producing stress and by promoting or obstructing effective coping strategies (see, inter alia,[42]). Analyses that are restricted to determinants of

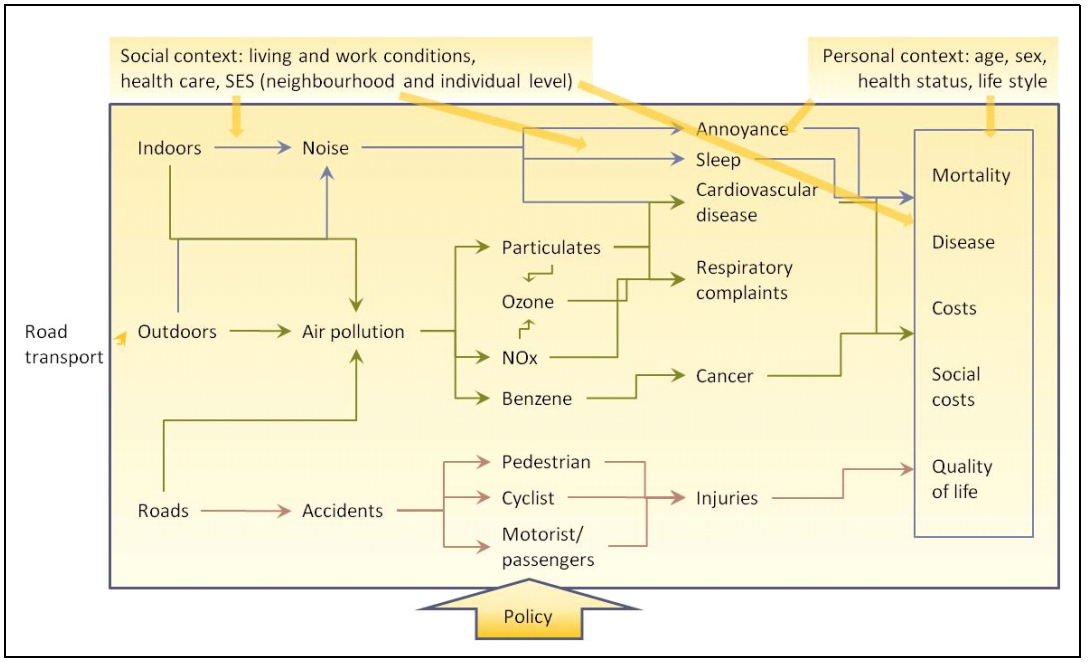


Figure 2 Analysis of the impact of road traffic on health (according to[39]).

health at the individual level are seen as too limited.[28] Ideally, aspects at the individual as well as the neighbourhood level are included in the analysis, with the interaction between the individual and his/her environment constituting a focal point.[43,44]

Social epidemiology also encompasses a distinct psycho-social element that is concerned with behaviour as well as endogenous biological reactions. The central focus here is constituted by the health-threatening potential of psychological stress caused by despairing circumstances, in other words tasks that are beyond a person's capacities or a lack of social support[45]. The approach is strictly individual and the central hypothesis is that chronic and acute social stress can increase the vulnerability of a person or can become directly pathogenic by affecting the neuro-endocrine system and can also give rise to health-threatening behaviour via the dietary pattern, sexual behaviour and the use of stimulants or narcotics (drugs).[45-47] A low socioeconomic status leads to low self-esteem and low resilience, and this in turn has an impact on behaviour, infections and performance. On the other hand, social capital and social cohesionp are proposed – and challenged – as the health-promoting

characteristics at population level, with the comment that a high degree of social cohesion can, via discrimination, result in giving social support to one group at the expense of other groups.

Incidentally, the introduction of the term 'social epidemiology' in 2000 set off a fierce discussion, as can be seen *inter alia* from a special issue of the *International Journal of Epidemiology* in 2001. Supporters emphasise the importance of a synthesis of medical-biological and sociological and psychological knowledge[48,49], while opponents[50] argue that epidemiology should restrict itself to the biological determinants of disease. Integration of specialised areas purportedly leads to trivial statements that society has no need of or interest in.

Social health research has for a long time focused exclusively on the impact of lifestyle factors.[51] Health research in particular research at neighbourhood level, mainly studied the socioeconomic health differences and the supposed connection of those differences with lifestyle. Until recently, the physical environment was largely overlooked in the analyses.[52] As part of research into socioeconomic health differences at neighbourhood level, a great deal of attention was focused on the question of whether we were dealing with differences between individuals or contextual differences, or a combination of both.

A further significant development is the growing interest in the life course approach in terms of conceptualising the cause and development of disease. This perspective has long formed the basis for thought and work within other disciplines, such as demography, sociology, biology and anthropology. Life course epidemiology can be seen as a reply to the chronic disease model that focused primarily on lifestyle factors of adults to explain the cause and development of disease. Within social epidemiology, the life course approach is used to study the effects of socioeconomic status between different stages of life and across generations; see Figure 3. Important themes are: health differences, social networks and support. But the social and physical determinants of health can also be studied using the life course approach. The distribution of determinants across age only partially parallels that of diseases. For most risk factors, it takes quite a long time before exposure actually results in disease.[53]

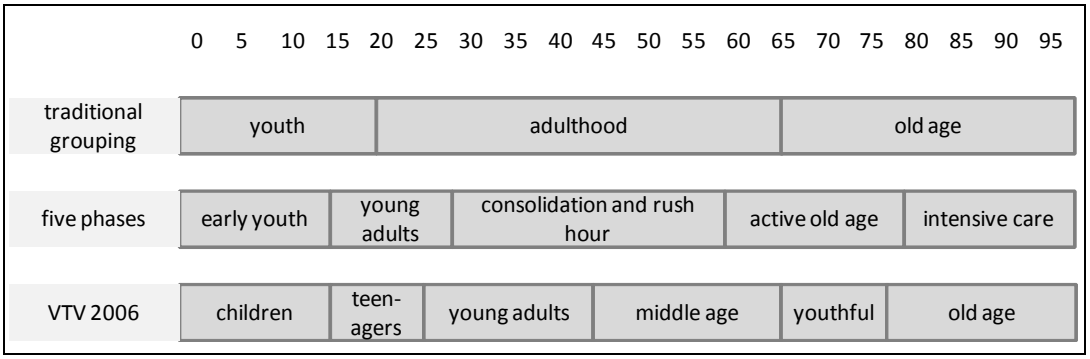


Figure 3 Three divisions into stages of life: 'traditional division', 'new division into five stages' and division according to the 2006 Public Health Status and Forecasts Report (*Volksgezondheid Toekomst Verkenning 2006*; *VTV 2006*).[54]

Analytical frameworks within social epidemiology

Within social epidemiology also a broad range of conceptual and measurement models has been developed (for an overview, see[55]), which in terms of complexity easily match the models developed within environmental epidemiology. A recent publication by the WHO[56] presents an analytical framework for studying social inequality in health, based on earlier work.[57-59] The analytical framework distinguishes between five levels:

1 *Socioeconomic context and position* strongly influence the nature, scale and distribution of health in society. Social class, gender, ethnicity, education, profession and income play a role in this regard. The relative impact of these factors depends on the national context: administrative structure, social and economic policy, culture and values.
2 *Exposure at material, psychosocial and behavioural level* is inversely related to social position. A lower social position is often linked to less favourable physical, psychic and social conditions. Many health programmes fail to take account of this differential effect on people and groups with a different social position. An analysis that does take this into account could provide insight into the risk factors that are relevant to particular groups. People with a low socioeconomic status are found to be exposed to various adverse conditions in connection with living, work, social cohesion, behaviour and physical living conditions.
3 *Difference in susceptibility*: The same degree of exposure to a particular risk factor can have a different impact in different social groups depending on the social, cultural and economic conditions and the previous life history. An

accumulation of risk factors (over time) might well have more impact than the individual exposure. Pre-existing illness and disease can also increase susceptibility to a specific exposure. Indications for these types of reinforcing effect are limited, however.

4 *Difference in impact on health and health care services:* The differential effects mentioned above can be strengthened by differences in the availability and possibilities of health care services for different social groups.

5 *Difference in consequences of health:* Poor health has various social and economic consequences (work, income, social inclusion).

The levels can overlap, due to a combination of exposure and susceptibility, for example (more air pollution in a neighbourhood with a low socioeconomic status). Additionally, not all levels are *per se* successively progressed through: for example, policy may have a direct impact on health services without impacting on the other levels. Each level can therefore form the starting point for analysis or intervention. The model in Figure 4 has been elaborated for a number of conditions. In Figure 5 this has been done for the development of an uneven distribution of cardiovascular diseases.

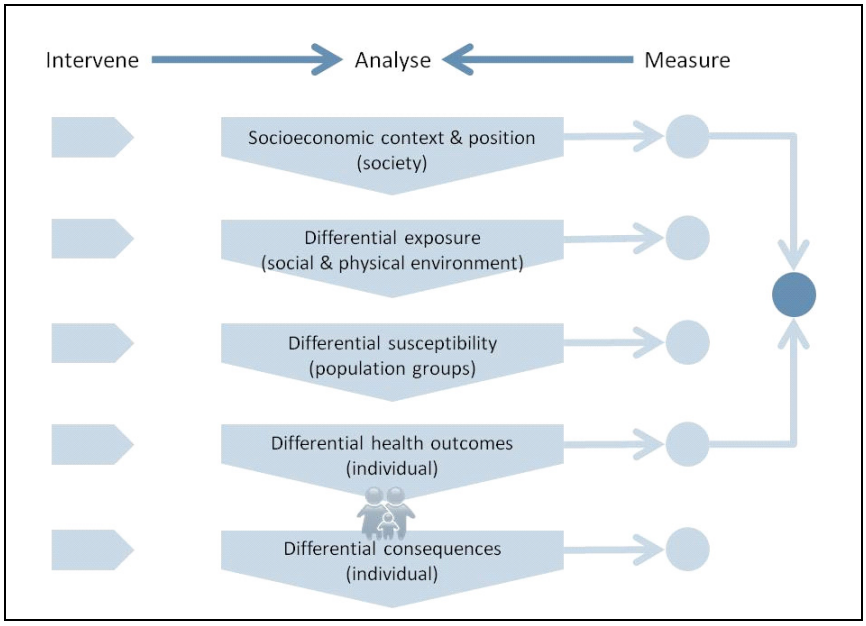


Figure 4 Analytical framework for determining priorities in public health policy.[56]

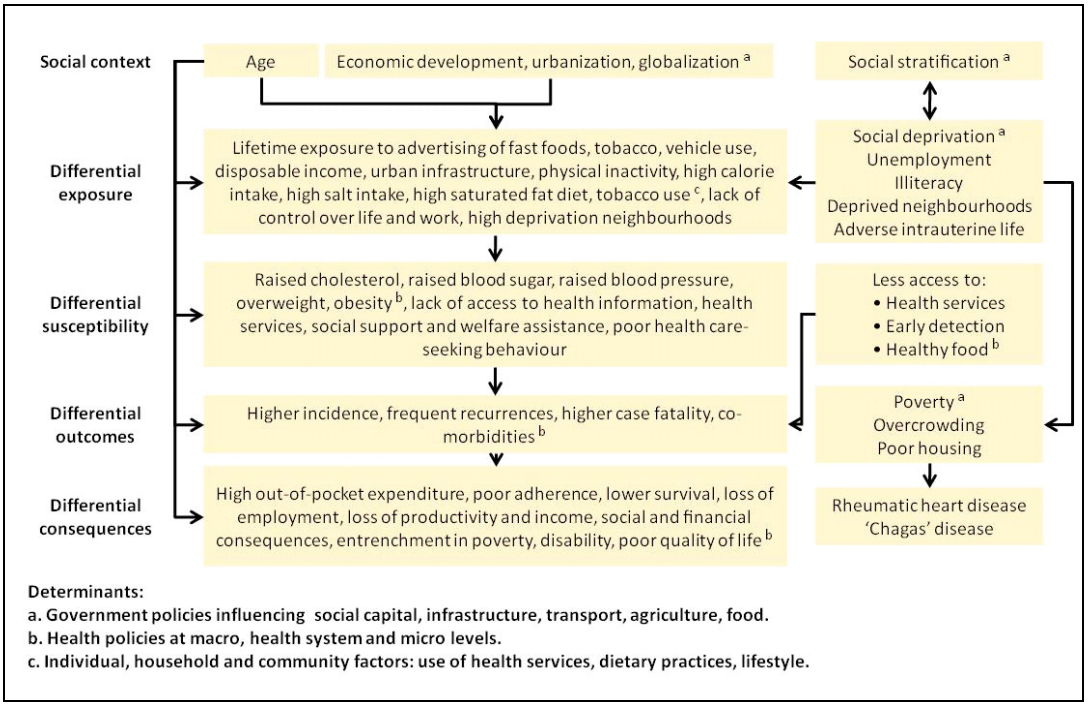


Figure 5 Model for gaining insight into the mechanisms behind an uneven distribution of cardiovascular diseases.[56]

2.3 Perception and behaviour perspective

Environmental psychology studies the interaction between people and environment. Perceptions, attitudes, valuations, image creation and the associated behaviour play an important role in this regard.[60] The starting point is the idea that perceptions and behaviour are heavily location dependent. Related disciplines such as environmental-behavioural science, social ecology, personal environmental science and behavioural geography have the same focus of research.

Research into the impact of the environment on well-being is often carried out on the shop floor and in living situations that are characterised by a heavy environmental burden, such as around busy traffic routes, in a highly industrialised area or near a large airport. It is found that in work situations physical characteristics such as air pollution, noise and light, and to a slightly lesser

degree ergonomic aspects, have an impact on the feeling of psychological well-being.[61]

Much research based on an environmental psychology perspective can be categorised under the heading 'annoyance research'. Here, the relationship between environment and health is placed in a stress theoretical framework. Annoyance is described as a feeling of aversion, anger, discomfort, dissatisfaction or indignation that occurs when noise or odour influences someone's thoughts, feelings or activities.[62,63] The degree of annoyance is generally measured using a standardised set of questions with different response categories.[64] Via stress processes, annoyance might lead to physiological effects that over time can give rise to chronic conditions, although other mechanisms are not excluded.[65]

Psychological research has examined how the perceived control one exercises over one's own living situation and the strategies that people choose for reducing the negative effects influence the degree of annoyance. Examples of such coping strategies include actively tackling a problem, avoiding the problem through lifestyle habits (smoking, drinking, use of medicines) and trivialising the problem. Problem-oriented behaviour is considered as the most effective coping strategy and avoidance the least effective.[66-68] In contrast to personal problems, it is not always the case with regard to environmental stressors, however, that a problem-oriented approach is best: while it may lead to reduced feelings of stress, over time it may give rise to increased blood pressure, for example.[66,69,70] This is largely due to the fact that in many cases environmental factors cannot be controlled by the individual, and hence can lead to disease via stress processes.

Analytical frameworks within environmental psychology

An example of a mechanistic (stress) model that describes how an environmental stressor can influence health is the model described by the Health Council of the Netherlands for the relationship between noise and health[65,71] (see Figure 6). The model structures the direct impact of noise on the organism as well as the stress process by which environmental noise can lead to indirect effects via perception (loudness, peaks, significance) and behaviour. Specifically, this pertains to annoyance, disturbance and physiological effects and, in the long term, illnesses and diseases such as cardiovascular diseases. This process is placed in the broader context of the physical, social, economic environment and technological development. From a psychological perspective the model is generic and also applicable to other environmental stressors. It is nonetheless important to take into account the fact that health effects vary significantly according to the degree

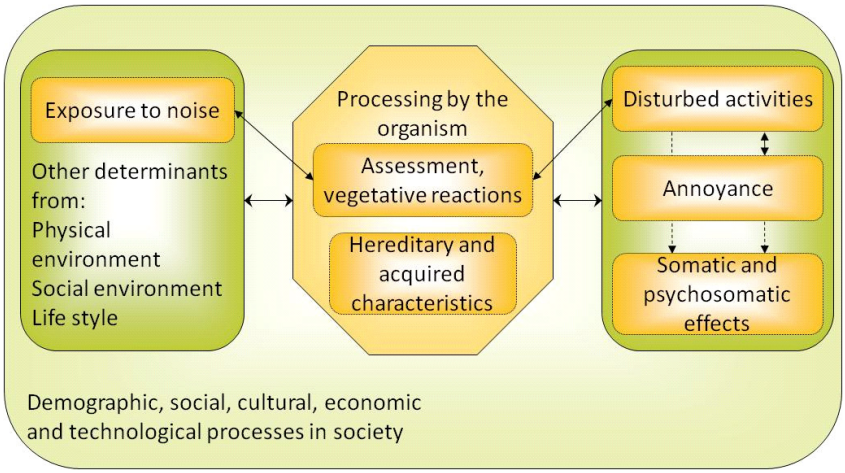


Figure 6 Conceptual model for the relationship between exposure to noise, health and quality of life.[65,71]

to which perception, annoyance and fear, control and coping play a role. Accordingly, while it may be possible to place the concern surrounding base stations for wireless communications in such a framework, it would seem obvious in the case of air pollution also to look at other processes. It is possible, for example, that in this case the process runs not so much via annoyance but rather via concern about respiratory problems in the person in question or his/her child. While mechanistic models take the individual as their starting point, they are compatible with generic approaches and can serve as an elaboration per issue, source or area/subarea.

This approach, which is very well established[72,73], has been applied to several environmental stressors[65,66,74-78] and has served as a basis for an elaboration of the social context of noise[79]; see Figure 7.

The elaboration of Figure 7 is based on the social and personal needs and motives that cause noise. Exposure to noise leads in turn to physiological changes and evokes inner responses that can be positive as well as negative: emotion, pleasure, feeling of strength versus feelings of stress, fear, annoyance. The physiological and emotional responses are dependent on the levels and the significance of the noise, the context in which people are exposed, personal characteristics such as susceptibility to noise and the extent to which a person is capable of restoration and recovery. This leads to social (behavioural) effects in

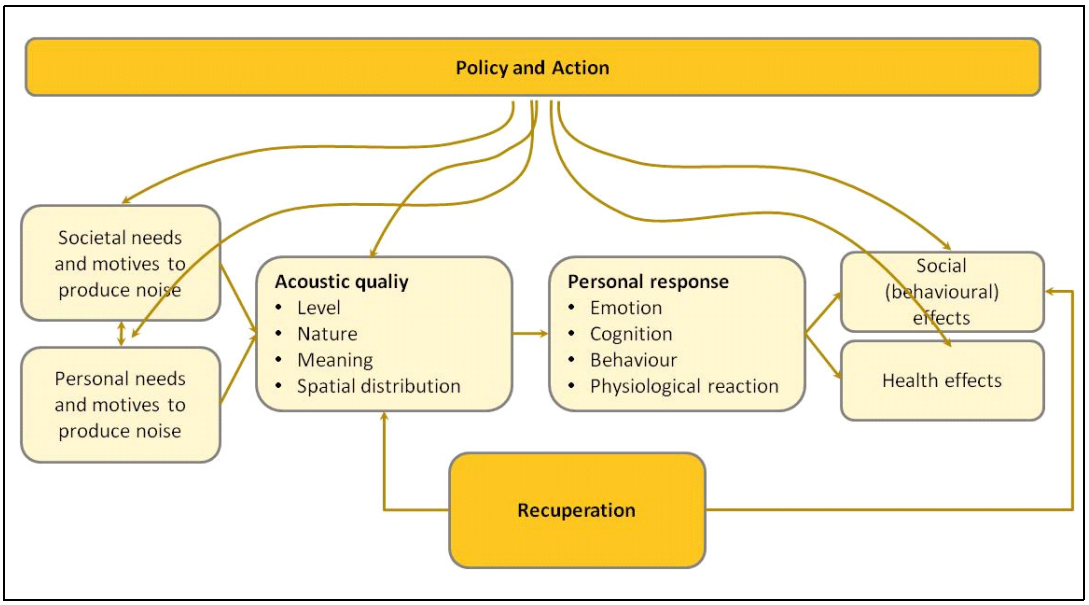


Figure 7 Description of the impact of noise, space and policy on social behaviour.[79]

addition to health effects. The arrows tentatively indicate the relationship within the model and suggest what the reference points might be for policy.

Sustainable development, resilience and empowerment

In the light of the growing realisation of the need for sustainable development, environmental psychology is increasingly focusing on congruity.[80] Congruity refers to the connective relationship between the individual and his/her living environment in terms of individual satisfaction in relation to objective environment characteristics. Bonnes et al. advocate a location-specific and sociopsychological approach toward sustainability.[81] Tackling obstacles in the relationship between people and their environment leads to them identifying positively with their immediate surroundings. People who feel involved with or committed to their living environment also feel greater responsibility for it. This approach has similarities with the resilience model. Resilience refers to the capacity of individuals and groups to perform well and to grow even under or after difficult circumstances and to find a balance between risk factors and protective factors.[82] Empowerment refers to the greater say given to individuals

and communities with regard to social, political, spiritual and economic issues.[83] This usually means that people become aware of their own possibilities for controlling their living situation.

2.4 Similarities and differences between the three perspectives

The different disciplines discussed above each employ their own terms and concepts and operate from different traditions. Interaction and collaboration between researchers from the various domains is still limited. But it is often the inability within a discipline to find adequate descriptions and an explanation for the social developments being studied that leads to the need for collaboration and new insights.

The three perspectives are distinguished by the manner in which social aspects are included in research: research is carried out within social groups and individuals with specific characteristics, or social characteristics are viewed as distortions or confounders, requiring a 'correction' to be made for them.

In Table 1, the three perspectives are summarised using a taxonomy developed by Pacione.[84] In spite of the differences, the reference points for integration are numerous. The three exogenous determinants of health – 'physical', 'lifestyle' and 'social' – are the most distinctive.[54] In the urban areas, the physical context consists mostly of characteristics of the built environment – density and variation –, noise, air pollution, indoor climate, accessibility of public transport and accessibility and quality of green space. Lifestyle includes factors such as nutrition, alcohol and drug abuse, exercise, sunbathing, mobile phone use and sexual behaviour. The social determinants encompass socioeconomic status, the pattern of social networks and cohesion, social capital and cultural factors.*

Causal networks are frequently not yet described in the approaches that are outlined. Knowledge is generally geared toward the individual, is mechanistic in nature and is not immediately suitable for studying geographic health differences at different scale levels.[38] While a synthesis of the different scale levels is possible in principle, this generally does not contribute to clarity, simplicity and, above all, usability.[30] Furthermore, the applicable scale level is heavily dependent on the question.[8] The different approaches are largely compatible and,

* Another definition of social determinants is: social determinants of health refer to specific characteristics of as well as routes along which social conditions influence health and that may be changed by means of evidence-based policy. Examples are income, education, profession, composition of the family, availability of health care, hygiene, exposure to danger, social support, discrimination and access to health facilities.[85,86]

depending on the research topic or policy question, can be used or combined as a starting point. This is done in particular for the purpose of classifying the (environmental) health indicators and determinants at different scale levels or for the purpose of studying the underlying mechanisms. The fact that the available data are often not suitable for assessing the complex models is a limiting factor.

In a ground-breaking publication, Kaplan[55] points out that in principle all epidemiology is 'social'. Interest in and literature on the impact of social factors on health and disease have been growing since the 1960s, and have increased exponentially since the 1980s. The various models each have in common that they describe different scale levels as well as several explanation routes and feedback mechanisms. According to Kaplan, they must be seen as metaphors that present complex connective relationships in a simplified manner. They can also be seen as cartoons that describe the essence of a theory. But if different scale levels are joined, they do too little and too much at the same time: their successful assessment and application is greatly dependent on the availability of data and of statistical analytical methods.

Table 1 Summary of the three perspectives according to domain, development/trend, scale level, period, indicator type and social groups (according to [84]). Indicator type: o-objective, s-subjective.

Perspective	Domain	Trends/Developments	Scale	Period	Indicator types	Social groups
Environmental epidemiology	Physical factors and disease in populations	1) Molecular epidemiology 2) Contextual focus 3) Small area statistics	Micro level Individual Collective Population	Short-term and long-term, retrospective, prospective	o Exposure o Mortality and morbidity	Restricted Geographical distribution of environmental burden (small areas)
Social epidemiology	Social factors and disease in populations	1) Psychosocial trend 2) Social capital and social cohesion 3) Social inequality due to differentiation at different scale levels (society, group, individual)	Individual (1) Collective (2,3) Population (2,3)	Often short-term: characteristics now are related to effects now	o Mortality and morbidity o Deprivation o Lifestyle s Health as experienced	Geographical distribution of burden of disease SES groups[a]
Environmental psychology	Interaction between physical environment (i.e. environmental stressors, space, green) and behaviour	Perception and coping as determinants of health differences between groups/ situations: • Working conditions • Impact of built environment • Recreation • Perception of nature • Sustainable behaviour	Individual Group level Specific context: *school, work, living*	Often short-term: characteristics now are related to effects now	o Exposure s Annoyance, relaxation/ leisure s Well-being, recovery Coping, controllability	Differences in work situation, living situation, context with high versus low exposure

[a]SES: socioeconomic status

The restrictions are as follows[55]:

- In most cases sufficient data are not available at all scale levels; where there are sufficient data, these data are often based on cross-sectional research, which makes it difficult to establish cause and effect.
- Advanced statistical methods are used to link social determinants of health to the incidence or prevalence of disease, for example linking low income to the relative risk of cardiovascular diseases. However, this fails to take into account the change in exposure over time and any change in behaviour.
- Analyses at neighbourhood level carry limited authority, since it is not clear whether the neighbourhood, often operationalised with the aid of health data that happen to be available, is the correct level. This leads to misclassification of exposures. The underlying mechanisms are often not known: how does a low income lead to cardiovascular diseases?
- In addition, social factors are often measured at the individual level and the incidence of disease at the population level.

In short, the models that are described in this chapter each offer important reference points, from a different perspective, for the integrated study of social, physical and spatial aspects and their common – and therefore complex – impact on health. However, integration between them is far from being a reality as yet.

Chapter 3

Evidence

3.1 Interaction between people and environment

In this chapter, the evidence is arranged and set out on the basis of the distinction previously made according to discipline: environmental epidemiology, social epidemiology and environmental psychology. The central focus is constituted by environment-related health problems, placed in their social context and in relationship with personal characteristics and the perception of the living environment. This chapter provides an illustration of the results of research into social context and of reference points that they offer for further research and policy.

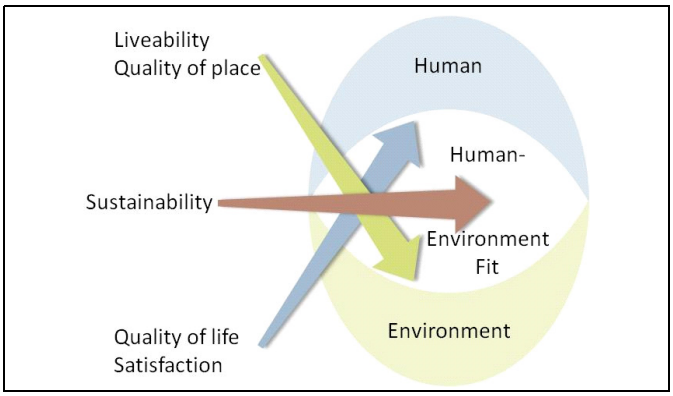


Figure 8 Perspective on the relationship between people and environment.[17]

Figure 8 illustrates the interaction between people and environment, with, on the one hand, 'liveability' as a characteristic of the environment and, on the other, 'quality of life' and 'satisfaction' as a response to this. Sustainability adds the aspect of time to this process. Liveability and quality of life can be considered as complementary. Liveability refers to the degree to which the environment matches people's wishes and what jointly determines the quality of life.

A constant theme running through the discussion about social aspects of environment and health is the question of whether health differences can be explained by the people or the living environment (neighbourhoods), or the combination of the two.

3.2 Environmental epidemiological evidence

Research into the socioeconomic distribution of physical characteristics of the environment is scarce. Some examples of research can be found in:[44,87-89]. Song[44] concluded that traffic stress was linked to lower perceived health and depression. Socioeconomic status and social support were found to play an important role in this regard. Research carried out in Rome confirmed earlier indications of a stronger unfavourable health effect from air pollution on people with a low social position.[87] The effect was due to an uneven distribution of traffic emissions and social deprivation and possible susceptibility to effects in the low-income groups. Research carried out by Kruize showed that also in the Netherlands groups with lower incomes tend on average to live in slightly worse environ-mental conditions than groups with higher incomes.[88] Incidentally, no linear relationship was found for road traffic: the lowest as well as the highest income groups are exposed to relatively high noise levels, while the middle groups are exposed to relatively low levels.

Environmental epidemiological studies at neighbourhood or regional level are generally descriptive in nature and often make use of specific environmental and health registrations and geographic information systems (GIS), with data being linked at the lowest possible scale level. In these cases, the spatial variation of exposure to environmental factors is related to health effects. The authority of this type of research is heavily dependent on the availability and quality of data on mediating and moderating variables at the neighbourhood or individual level.[90] The research is typified by its focus on specific exposure to specific sources at specific locations, such as living in the vicinity of a large airport[23,91,92], along busy motorways[93], near to a new rail track or route[94], in a green environment, or otherwise[95], around high-voltage power lines and transmitter masts[96], near to waste incineration plants[97] and in areas with a heavy environmental

burden, such as Rijnmond.[98] Other examples are studies into the possible exposure to toxic substances following an accident or disaster, such as after the air crash in the Bijlmer district of Amsterdam[99] and after the catastrophic fireworks explosion in Enschede.[100-102] In some cases data from disease registrations are supplemented with data from questionnaires. While social aspects such as the individual socioeconomic status, education and ethnicity are often included in the analysis as distorting, or confounding, factors, the distribution of the exposure across socioeconomic classes and features such as social support, social cohesion and access to health services are nonetheless not systematically included in the research as significant determinants of health. Epidemiological research of this type is usually policy guided and its purpose is to identify or monitor developments. It focuses more on the question: how bad is it?, than on the question: for whom?, or why? Rarely is it intended to examine how the living conditions in a particular neighbourhood or region can be optimised by a more even distribution of burdens and benefits.[88]

In a review article, Evans and Kantrowitz[103] describe what is known about the distribution of environmental factors across socioeconomically different groups and the relationship between environment and health; their review relates mainly to research carried out in the UK and the US. The physical environment is characterised by reference to exposure to toxic substances, noise and housing occupancy at work, school, home and neighbourhood level. While they found a systematic link between lower incomes and unfavourable environmental conditions, the data do not justify the conclusion that social health differences can be explained by differences in exposure to environmental factors. In many studies, socioeconomic status and deprivation are only studied in rough categories of ‘high’ and ‘low’ and research into social health differences in the specific context of living, work or school is very limited. Some authors refer to a clustering of poor physical as well as psychosocial conditions related to the work situation.[104,105] Lower occupational groups are systematically confronted with (more) monotonous work, a lack of autonomy and poorer physical conditions. Their sickness absence rate is higher and they are more likely to suffer from cardiovascular diseases. In this regard it is evidently difficult to unravel the impact of income and ethnicity. Moreover, most research focuses on individual exposure to specific sources in specific situations, while it is likely that the link between socioeconomic status and health is largely attributable to a combination or accumulation of problems. The authors cited consider it necessary that a database be constructed in which exposure to various environmental factors is differentiated according to socioeconomic status. A lack of longitudinal data is additionally identified.

In a recent review article, Brulle and Pellow[106] similarly call for more research that establishes a relationship between the uneven distribution in environmental burden across socioeconomic groups and health effects. In spite of the impressive amount of literature dealing with social health differences, the authors nonetheless believe that too little attention is paid to the role of physical conditions and combinations of exposures. They advocate an integration of the various research areas (see also[107]) and would also like to see sociology and ethnography incorporated.

Health effects are apparently the result of a complex connective relationship, which is difficult to unravel, between these factors at the individual and the neighbourhood level. All things considered, we can state that scientific understanding of the mechanisms by which social and physical neighbourhood characteristics can have an impact on the state of health is still very limited.

3.3 Social-epidemiological evidence

Our understanding of the relationship between socioeconomic status and health has grown significantly over the past few decades: people with a low socioeconomic status have a lower life expectancy than their well-to-do fellow citizens. These social and often geographic patterns of poor health and mortality risk are found in most countries.[108] Health effects at neighbourhood level in relation to which differences are found are premature mortality, general health, disease and disability, mental health and utilisation of healthcare services. There is a growing awareness that when it comes to health differences related to socioeconomic status, account must be taken not just of individual characteristics but also of environmental factors, physical as well as social. Of central importance in the social context is the socioeconomic status of the region and the individual, often referred to as the degree of deprivation, in addition to social cohesion, social support, a neighbourhood's reputation and a neighbourhood's characteristics in terms of availability and accessibility of amenities and facilities. Much research into neighbourhood-related health differences is based on an article by MacIntyre et al. published in 1993, in which assumptions about the neighbourhood's composition in combination with its physical and social characteristics were described for the first time.[109]

Geographic patterns of the state of health and mortality are found in most countries.[110] In the Netherlands also, there is a significant variation in healthy life expectancy between regions and neighbourhoods.[54,111] The 2006 Public Health Status and Forecasts Report (*Volksgezondheid Toekomst Verkenning 2006*) concluded that in almost all respects the health of people with a low

socioeconomic status in the Netherlands is worse than that of people with a high status. Aside from this, non-western immigrants constitute a vulnerable group in terms of health, as is shown among other things by a higher mortality risk among immigrant children. These socioeconomic and ethnic health disadvantages have remained more or less stable in the past ten years. Pickett[108] also concluded that the evidence for so-called neighbourhood effects on health is consistent in spite of the methodological restrictions of this type of research[112] and the use of regional characteristics as an approximation for neighbourhood characteristics. The results of the studies included in the meta analysis conducted by Pickett[108] largely support the composition hypothesis, which states that the demographic composition of neighbourhoods goes a long way to explaining the neighbourhood-related health differences. In this regard, the development of socioeconomic status over time at the individual level is found to be more significant than ad hoc measures of socioeconomic status, such as income or level of education at the time of study. Methodological problems with this type of research include the definition of neighbourhood, the use of composite measures of deprivation or disadvantage, and the differential impact of various determinants on different health outcomes. For example, it has been found that a low weight at birth is chiefly related to the level of income, while crime-related neighbourhood effects are more closely connected with the average level of education. More recent studies also confirmed the association between socioeconomic status at neighbourhood level and mortality as well as subjective health measures (for an overview, see[113]).

While these associations are found systematically, some people nonetheless question their causality and the suitability of methods for establishing them. As social factors generally hide an uneven distribution of other characteristics, such as differences in unhealthier lifestyle, heavy and riskier work, it is evident that research will have to focus far more on these underlying aspects.[40]

Recent research carried out in the Netherlands also showed that neighbourhood-related health differences are not solely attributable to differences in income (as an indicator for socioeconomic status).[114] Analysis of mortality and hospital admissions at neighbourhood level in combination with neighbourhood characteristics showed that urbanisation, marital status, age and ethnicity are significant contributory factors in terms of geographic health differences. The research focused on neighbourhoods where the relationship between income and mortality deviates from the general findings (the lower the income the higher the mortality) and therefore fits in the so-called resilience literature.[115] Resilience refers to the capacity to perform well and to grow even under or after difficult circumstances and to find a balance between risk factors and protective factors.

The concept is used at the individual as well as the regional level.[82] Areas with a higher mortality than would be expected on the basis of income are found mainly in urban areas with a high percentage of the elderly and a high percentage of single persons. Areas with a lower mortality than would be expected on the basis of the distribution of income are characterised by a low percentage of non-western immigrants. This is more likely to be explained by the social cohesion of a neighbourhood and the social support that is connected with this. The influence of urbanisation could also be attributable to unfavourable physical characteristics, such as traffic-related air pollution and noise[103] and the limited availability of green space, which might be indirectly related to the higher mortality rate and the number of hospital admissions.[52,95,116] This has not been examined further, however.

If the composition of the neighbourhood is more relevant than the characteristics of the neighbourhood, should we then endorse Wynia's conclusion: "it is down to the people: immigrants without any prospects and who, in the absence of education and knowledge of the country and its language, have to settle for a limited income"[117]? As we have seen, lower occupational groups are indeed systematically confronted with monotonous work, a lack of autonomy and poorer physical conditions, and a low income is related to a high sickness absence rate and a higher incidence of cardiovascular diseases, but this 'right' is not confined to immigrants alone. While non-western immigrants are more likely to live in a deprived area, in the Netherlands no significant differences are found in mortality between adult non-western immigrants and the native Dutch (see[114]), but they are certainly ill more often and their medical consumption is higher.[54] What makes people vulnerable and to what extent psychosocial aspects play a role in this regard remains unclear.

3.4 Environmental psychological evidence

Environmental psychology deals with the reciprocal relationship between the environment and people's behaviour, so with the impact of the environment on people as well as with the impact of people on the environment. Mediating personal characteristics such as attitudes, expectations, (environmental) susceptibility, coping strategies, the ability and conviction required to act adequately and efficiently in a given situation (self efficacy) and the conviction on the part of individuals that they control their own environment and their own life (perceived control) play a central role here. There is an impressive array of literature available that has demonstrated the relationship of these psychosocial mechanisms with health problems (see, inter alia,[28,118-120]).

Environmental stressors are generally chronic in nature, are usually not controllable by the individual, are generally not urgent, are viewed negatively, and while they may be observable to a certain degree, they are not always noticed and even then not by everyone.[121] As such, they are distinct from other chronic stressors, also referred to as daily hassles, which are usually considered to be observable and controllable. Both types have in common that they are chronic and constant and over time have a greater impact on health than one-off stressful events. A further characteristic of environmental stressors is that they tend to cluster, such as traffic-related air pollution and noise or a lack of green space, and that they generally affect large groups of people.

The perception of the environment can have positive as well as negative aspects. A park in the living environment, for example, can have a favourable effect on health because it stimulates people to take more exercise. But if it is seen as an unsafe place strewn with rubbish, the effect can be quite the reverse. More recently, attention is being focused not just on the negative aspects but also on the positive aspects of the physical environment, such as green amenities, space, peace and quiet and aesthetic aspects, which can contribute to promoting health through recovery from psychophysiological and emotional stress.[122,123] The available knowledge is still strongly anecdotal and based on research with study subjects in a laboratory environment and a incidental example of field research[124] and is largely limited to the availability of recreational green space and amenities and infrastructural factors that encourage people to cycle more or to go running or to use public transport.[95,125,126] An important question is whether a green urban environment contributes to psychophysiological and mental recovery after stress in combination and interaction with other physical characteristics of the environment. A further question is to what extent social aspects play a role in this regard. Research in the Netherlands has shown that a green environment is associated with a perception of good health regardless of socioeconomic status[95], although a study conducted in the UK showed that the relationship between green and health also heavily depends on living environment and levels of income.[125] The effects of a natural environment on health in the long term and the factors determining these possible effects are not known.

Another field of research in this connection is residential satisfaction research. Residents' perception of the living environment is determined by a large number of factors relating to physical, social and spatial aspects.[127-135] Physical characteristics of the home – size and quality – and physical and social characteristics of the living environment – air, noise, green space, other amenities and facilities, or crime, annoyance, population composition of the

neighbourhood, quality of amenities – play a role in this regard. The most important predictors of residential satisfaction are by far neighbourhood social cohesion, social and physical safety and the level of facilities and amenities. Personal characteristics such as age, gender or socioeconomic status appear to have only marginal impact on the level of perception. Not only the actual characteristics but also the perceived characteristics in particular play a role. Both aspects are only rarely addressed simultaneously in research, however.[84,136-139] Research conducted in eight European cities showed that the quality of the home and the physical quality of the immediate living environment (established by trained observers) significantly determine the degree of satisfaction with home and neighbourhood.[140] Features of the interior and exterior environment, such as light, green space, noise and air quality, were important predictors of satisfaction and well-being. The demographic context, physical characteristics of the environment, year of construction and urbanisation apparently also influence health and well-being.

Analysis of data from the Housing Need Survey (*Woonbehoefte Onderzoek*; WBO) and the later Netherlands Housing Survey (*WoonOnderzoek Nederland*; WoON) revealed that annoyance in the broad sense – refuse and rubbish on the street, traffic and noise – have a significant impact on residential satisfaction in the Netherlands.[141] Studies conducted around Schiphol showed that satisfaction with the living environment is largely determined by the degree of satisfaction with the home, satisfaction with the noise situation in the living environment, expectation concerning the development of the neighbourhood and the degree to which people feel safe in their own surroundings. Characteristics of the physical and spatial situation, including exposure to noise, external safety risks and the proximity to Schiphol, have only a very limited impact on the satisfaction with the living environment in the area surveyed.[23]

3.5 Autonomous and controllable factors

The dualism between environment characteristics and the composition of the neighbourhood is artificial: people and their neighbourhood or residential location mutually influence each other.[142,143] That was also apparent above: neighbourhood and people are so interwoven, including in the results of research, that it is almost impossible to consistently examine or otherwise highlight the role of one or the other. Based on the available data, it is possible to state that socioeconomic health differences are the unavoidable consequence of a market economy, which leads to an uneven distribution of ‘goods’ and ‘bads’.[144] It is not really possible to develop an opinion on the justice or injustice of this

phenomenon on scientific grounds.[10] This is a political choice that is dependent on the view of what is just and on the basis and existence of the health differences.[57,145]

Socioeconomic health differences are alternately attributed to individual responsibility – a view that prevails in the Anglo-Saxon model[146] – versus a more social deterministic view – on mainland Europe. The latter 'ideology' assumes that no one chooses to live in an area with low environmental quality. In a ground-breaking publication, Kawachi et al.[42] found that there is much discussion on which concepts, strategies, interpretation and explanatory models should be used with regard to socioeconomic health differences. Determinants of health are not clear, and factual information is very limited. The essence of the discussion is summarised in the following questions:

- What type of health differences should be studied?
- What is the difference between health inequality and health inequity?
    - is there a difference in health between social groups and is that then due to material deprivation (poverty), an uneven distribution of socioeconomic status, or do psychosocial mechanisms play a role?
    - does the nature of the distribution of income have an effect, in addition to the influence of the amount of income?
- Are we dealing with social effects or effects of the physical environment, or an interaction between the two?
- What impact do people's life paths have on health differences?

These questions involve different levels of analysis. In the context of this background study, our interest is focused mainly on aspects of socioeconomic health differences that are controllable, or can be influenced.

Chapter 4

Methods and instruments

Since the 1990s, the quality of the living environment has been a focus of attention. Different attempts have been made to integrate economic, social and ecological aspects, opinions on the living environment and health aspects into a single index for the quality of an area, region or neighbourhood. Originally, the focus was primarily on sustainable development and nature conservation, as is apparent from several approaches emphasising the ecological footprint. In recent years there has been an increasing need at the local level for instruments that enable the relationship between health and environment to be incorporated in spatial and urban planning endeavours. A recent overview describes a broad range of instruments that can be used at the local level.[147]

Additionally, different methods have been used for the benefit of research at the neighbourhood and district level and environment-related, nature-related and health-related policy with the aim of clustering the physical and social data from neighbourhoods or postcode areas into a typology, whether or not in relation to health indicators. Geographic information systems are increasingly being utilised for this purpose and the statistical approaches in the field of so-called small area statistics are becoming increasingly refined.

This chapter includes examples of instruments and methods that are currently available. They are accompanied by the question in particular of how and to what degree social characteristics are incorporated in the different approaches. Here, again the overview follows the three previously described perspectives as far as possible, although this is not always possible due to overlap.

4.1 Environmental epidemiological instruments

4.1.1 Intarese Toolkit for integrated health impact assessment

Modern approaches toward risk governance require a well-substantiated and broad evaluation. Nevertheless, relatively little is invested in developing good methodologies for this purpose.[148] Within the framework of the EU project INTARESE, collaboration has begun on developing a set of methods to enable integrated environmental health assessment. By applying this toolkit, policy-makers gain an insight into the impact of environmental factors and policy measures on health. This instrument is based on the model described in section 2.1 (Figure 1). The toolkit contains a guide for an integrated assessment, a description of and access to the data and tools necessary in that regard as well as several detailed examples and case studies.*

According to the accompanying text, social characteristics of populations are never uniform. How the environment impacts on the people concerned is likely to vary, depending on their personal characteristics and situations. If these variations are ignored, this can lead to errors and an incorrect assessment of the positive and negative consequences of exposure and interventions. Reference is made to these contextual factors through the terms vulnerability and susceptibility.[149]

In literature, the terms vulnerability and susceptibility are described with considerable variety (see, inter alia, [150]). This motivated a different committee of the Health Council to exclusively use the term: groups with an increased risk.[151] This essay follows the description used in the INTARESE toolkit.[149] Susceptibility refers to the degree to which individuals and groups may respond to a given exposure. These can be innate and acquired responses. Acquired susceptibility may be due to disease, age or socioeconomic status. It should be noted that socioeconomic status is not a precise identification of a causal factor. Vulnerability is determined by susceptibility, but also by the degree of exposure. In the latter case, vulnerability is therefore also a function of where people live, how and where they spend their time, and their lifestyle. For example, living near busy roads or spending long hours on the road increases vulnerability to air pollution. The vulnerable groups also include people who live at locations with several social risk factors and who have less access to protective measures.

* For a detailed description, please visit www.integrated-assessment.eu.

Vulnerability and susceptibility must be taken into account when determining environment-related health effects. This requires that:

- the study population is segregated into relevant subgroups (for example on the basis of age, gender or socioeconomic status);
- relevant information on factors affecting vulnerability (behaviour, activity patterns) is incorporated;
- relevant information on the factors affecting susceptibility is used for specific subgroups;
- outcomes are reported for the different subpopulation groups, as well as for the study populations as a whole, so that the differences and inequalities can be identified.

Incidentally, this need not lead to a restriction of interventions on the most exposed places or among the most vulnerable groups. A decrease in the exposure of the population as a whole can also lead to health benefits.

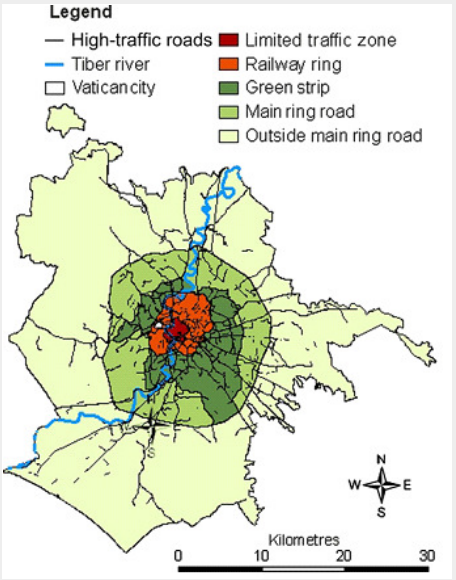
In the various case studies that formed a basis for the development of the INTARESE toolkit, the outcomes were differentiated according to socioeconomic groups. In the 'waste' case study, a direct relationship was found between social class and living near to waste processing locations for Italy and the UK, but not for Slovenia. In the UK, 55% of the people living within a 3km radius of such a plant belonged to the lowest social class, as against 3% who belonged to the highest social class. Exposure to particulate matter (PM_{10}) and nitrogen oxide (NO_2) showed the same pattern in both the UK and the Italian case studies.

In the 'transport' case study, among other things the measures taken to ban old vehicles from the centre of Rome (see Box 1), The Hague (see Box 4) and London were evaluated. The measures led to a 30% decrease in traffic intensity (and hence exposure to particulate matter) at street level and a 10% decrease across the city. This was accompanied by a longer life expectancy and a reduction in the number of hospital admissions. A slightly better improvement in air quality for people in the lowest socioeconomic classes was found in Rome than in London.

These examples show that the INTARESE instrument is suitable for identifying socioeconomic health differences in relation to the environment.

***Box* 1 Traffic in Rome.**[152]

The objective of the 'Rome' substudy in the framework of the INTARESE project was to evaluate the effect of traffic-regulating measures on air quality and health. The intervention comprised the creation of two 'low-emission' zones in Rome in the period 2001-2005. The socioeconomic position (SEP) of the population was taken into account when assessing the impact of the intervention. On the basis of the INTARESE model, various characteristics and outcomes were identified: number and age of cars, PM_{10} and NO_2 concentrations, exposure at population level and the number of life years gained.



Between 2001 and 2005, the total number of cars decreased by almost 4%. NO_2 and PM_{10} concentrations decreased from 22.9 to 17.4 $\mu g \bullet m^{-3}$ and from 7.8 to 6.2 $\mu g \bullet m^{-3}$, res-pectively. In the two 'low-emission' zones there was an additional reduction in air pollution (NO_2: -4.13 and -2.99 $\mu g \bullet m^{-3}$; PM_{10}: -0.70 and -0.47 $\mu g \bullet m^{-3}$). The life expectancy gain due to the NO_2 reduction was estimated at 3.4 days per person for the 264,522 residents living near busy roads (921 years per 100,000). The life expectancy gain per person was greater for the highest SEP group (1,387 years per 100,000) than for the residents from the lowest SEP group (340 years per 100,000). It was concluded that the measure implemented in Rome led to a reduction in air pollution, with the health benefits accruing largely to the more affluent residents.

4.1.2 *Living environment indices*

The various measures that are currently used in the Netherlands originate from the 1990s. At that time, attention was focused on nature conservation and sustainable development at the national level, rather than on social health differences and the quality of neighbourhoods. The growing technological possibilities for linking large databases, the emergence of geographic information systems and the 'post-modern' optimism of this period[153] are clearly evident in these endeavours. Examples are provided by the 'Home' policy document (nota '*Thuis*') issued by the former Ministry of Housing, Spatial Planning and the Environment (see Box 2)[154], the living environment balance statement (*Leefomgevingsbalans*) issued by the National Institute for Public Health and the Environment (RIVM)[155] and the ecological footprint approach.[156,157]

Box 2 **The 'Home' policy document (*nota 'Thuis'*).**[154]

The primary aim of the 'Home' policy document was the integration of human action into the natural environment with a view to long-term developments. The importance of mutual cooperation between environmental policy, housing and social policy, for example, is emphasised in the policy document, and a model was developed in which the quality of the living environment was measured against dimensions of the natural and created environment along different axes. The starting point in this regard was that sustainable development requires a coordinated policy: when discussing economic issues, spatial, environmental and social aspects must be studied as far as possible in conjunction with one another. Sustainability must always be viewed in connection with social context.

The living environment balance statement (*Leefomgevingsbalans*) can be seen as a continuation of the 'Home' policy document. The concept was developed by the National Institute for Public Health and the Environment (RIVM) on behalf of the Ministry of Housing, Spatial Planning and the Environment with the aim of identifying changes in the living environment and evaluating interventions. The living environment balance statement focuses solely on the physical environment: social aspects such as average level of education, socioeconomic

status and suchlike were deliberately disregarded. Instead, attention was focused on how people rated their environment, and this was measured against and combined with the economic and ecological values. The ecological footprint approach, which is related to the aforementioned approach in terms of the ecological component, refers to the amount of land that is needed in order to maintain a particular lifestyle for a particular group of people.* [157,158]

4.1.3 *Composite health indicators*

In recent years, several composite health indicators have been developed that are aimed at identifying environment-related effects on health. These indicators may possibly offer reference points for identifying a difference in impact between social groups.

City & Environment Health Impact Assessment (HIA)

The City & Environment Health Impact Assessment (*GES Stad & Milieu*) is a standardised approach for assessing spatial plans at an early stage in terms of their environmental and health impact.[159] Application of this instrument leads to so-called HIA ratings (*GES-scores*) for a specific area. The precise rating is dependent on the degree of exposure in a particular area. Experts from government agencies have established exposure classes for each environmental factor and assigned them a HIA rating from 1 to 9. The rating indicates the degree by which the applicable standard is exceeded or its limit is not met for the environmental factor in question.[159,160] On the basis of these tables it is possible to quickly determine the environmental health quality in terms of the HIA rating in a particular area, in so far as exposure data are available.

The City & Environment Health Impact Assessment is frequently applied by Municipal Health Services (GGDs) as well as local and regional public authorities. One advantage of this method is that a HIA rating is relatively easy to interpret due to its normative nature. A drawback is that scales of HIA ratings have only been established for a limited number of physical factors and that the ratings cannot be combined (or at least no rules have been specified for this). Furthermore, the exposure classes are relatively broad, so that the impact of interventions is often insufficiently evident.[161,162]

* The approach proposed in the living environment balance statement was not incorporated in the policy, because it included too many uncertainties.

Disability-adjusted life years (DALYs)

The World Bank and the World Health Organization (WHO) have developed a measure for the 'burden of disease' as a means of assessing the state of health of a country or region: the DALY (disability-adjusted life year).[163] This measure has also been developed in order to determine the portion of the burden of disease that can be attributed to one or more environmental factors.[164,165] The burden of disease associated with a particular environmental factor gives an overall picture of the impact of the factor on the origin of diseases and mortality. This impact is expressed in disability-adjusted life years (DALYs), with the impact being weighted with the severity of the disease on a scale from 0 to 1 (with 1 corresponding to death). With the aid of exposure-response relationships from environmental epidemiology and data about the exposure, it is possible to estimate the burden of disease that is the result of a particular level of exposure (most of the calculations of the burden of disease that are carried out relate to environmental factors that damage health). By taking into account the application of the weighting factors and the number of incident cases of disease and mortality, it is possible to bring together various effects and to compare, or combine, the contributions of several different environmental factors. These combination opportunities are an advantage of the burden of disease approach, but at the same time they imply value judgements on the seriousness of the effects and on compensation possibilities (many people who experience a slight deterioration in health over an extended period of time have the same weighting as a small group that dies at an early age, for example).

The burden of disease approach has meanwhile been applied in the Netherlands as well as on a European scale in order to gain insight into the impact of physical environmental factors on health.[166-169] DALY estimates can be used to answer questions such as: which environmental factor or environmental policy measure leads to the greatest or smallest increase in the burden of disease? One problem is that rather a lot of data and considerable expertise are required to perform the burden of disease calculations, and it is precisely these data and this expertise that are in short supply. An additional problem confronting application on a local scale is that the necessary data are often not available at that scale level, making DALY estimates impossible, or at least highly uncertain. Calculating the burden of disease at the local scale is a tricky issue, therefore, and an issue about which consensus has yet to be reached in scientific circles. There are fewer restrictions at the national, regional or metropolitan level.

One advantage of the approach is presented by the possibility to study the effect of combined exposures. Additionally, adjustments to new scientific knowledge, in particular knowledge about exposure-response relationships, are relatively simple. However, interpreting the outcomes of a calculation of the burden of disease is not a simple matter. In absolute terms, the figures are not very informative. Their usefulness lies in comparisons in particular, for example comparisons of different options for interventions or comparisons of the burden of disease in different areas expressed per head of population. In practice, it is found that a burden of disease expressed in DALYs is frequently considered to be abstract and rather uninspiring information.

4.2 Social epidemiological instruments: neighbourhood survey

4.2.1 Aggregation of neighbourhood characteristics

A failure of many neighbourhood surveys is the frequent lack of an explicit definition of which neighbourhood characteristics are really relevant to health and healthy behaviour. Often, individual characteristics are aggregated or neighbourhood characteristics are derived from data from population censuses and other surveys.[170] No physical and social characteristics of the local environment that may influence specific health problems have been specified based on theoretical considerations. In an attempt to change this, Cummins et al. combined Maslow's hierarchy of needs with approaches in the field of urban planning.[112] The available data were then clustered at different scale levels. What is striking is that many physical characteristics that are relevant to health – such as air pollution, noise, road safety and external safety – were not included in the list of relevant charac-teristics. By contrast, willingness to vote and car ownership, among other things, were included. The authors label the lack of data the main obstacle to compiling a valid contextual index. These authors too are eventually compelled to embrace a random and data-driven choice of indicators. This is exemplary for the many attempts to develop a typology at the international[143] and national level.[12,171-174]

4.2.2 District typologies

In the Netherlands, district typologies have been developed by the National Institute for Public Health and the Environment (RIVM)[12,54], the Netherlands Institute for Social Research (SCP)[173] and RIGO Research en Advies, among others.[171,172]

In the context of the Fifth National Environmental Survey (*Vijfde Nationale Milieuverkenning*)[12] the RIVM collected data about spatial, physical and social characteristics, health and the assessment of the living environment and health for several sampled cities. These data were linked to living environments. The aim was to assess whether there was evidence of an accumulation of problems in domains such as the physical and social environment for each living environment. In the four sampled cities, a clustering of problems in the social, physical and environmental domains is found to occur mainly in the older urban districts. These are specifically inner-city areas, the pre-war and early post-war residential areas with multi-family housing and districts with a high building density. In these cities, 45-65% of the population lives in such a district. The green urban districts and those with a village-like character received a more favourable rating in all domains, with the exception of social safety, which received a low rating in the green urban districts and in the villages also. The quality of the environment (noise and nitrogen oxide) is clearly poorest in the inner-city areas. The health of the residents and how they rate the liveability are also poorer in inner-city areas, although these are not so clearly related to the degree of urbanisation as the other factors. See Figure 9.

The measure for the quality of the living environment developed by the SCP in 2003[175] was related to objective as well as subjective characteristics of a neighbourhood in 2005.[173] The aspects of the physical environment pertained to degradation, lack of space, annoyance and a low level of facilities and amenities. With the aid of data from existing sources, it was possible to express the quality in a single measurement unit. This measure was linked to several social aspects: age, type of household and ethnic origin; the ratio of rented and owner-occupied housing and the buying/selling price of the owner-occupied houses; the length of residence; social status of the neighbourhood and social cohesion.

According to the author, the measure has proved its usability because it produced plausible outcomes. For example, the districts with a high percentage of single persons were more likely to have a low quality of living environment than districts with a predominance of families. Secondly, the people living in poor-quality districts had a more negative opinion about the district than people living in good-quality districts. People living in good-quality districts are more satisfied with the living environment: there are fewer removals from these districts, fewer people are considering moving and people tend to live there longer. Thirdly, the measure was useful for describing the history of districts during the period 1994-2002. If the connections and correlations between the quality of the living environment and other characteristics of the district do not

change over the course of time then it is also possible to make general statements concerning the future.
Problems were noted in relation to the definition of 'crowding'; in the Netherlands, the number of rooms per person is evidently a less accurate indicator than in the UK or the US. It also proved difficult to identify perceptions with an 'emotional overtone' (for example with regard to degradation). The correlation of subjective characteristics to the actual characteristics of the environment was found to be limited. This is partly due to the scale level at which the measurement was conducted.

A further restrictive element is the fact that the measure developed by the SCP only includes physical aspects. The measure is mainly suitable for detecting physical shortcomings in the living environment at a low scale level. The assumption in this regard is that improvements in the physical environment will also have a favourable impact on the social character of the district, while analysis showed that people mainly respond to the social significance of physical (physically unattractive) aspects. Evaluation of the impact of physical interventions on the way in which people experience this might increase our insight into this mechanism.

In order to gain insight into the accumulation of unfavourable factors in neighbourhoods, a cluster analysis was carried out at the level of neighbourhoods within the framework of the Public Health Status and Forecasts Report (*Volksgezondheid Toekomst Verkenning*)[54] and as a continuation of the aforementioned exercise in the context of the Fifth National Environmental Survey (*Vijfde Nationale Milieuverkenning*)[12]. Data from different sources relating to social and physical living environment, lifestyle, socioeconomic characteristics and health were examined in terms of their interrelation. An initial analysis revealed two clusters: a group in which problems accumulate and a group in which few problems are joined. The areas in which problems accumulate were then analysed once again in the same manner, after which three clusters could be distinguished. The clusters in the problem areas received a lower than average rating on almost all the indicators. The fourth cluster received a relatively favourable rating on all subareas. The neighbourhoods in the first cluster were characterised by an accumulation of health disadvantages, poor social and physical quality of the environment combined with socioeconomic disadvantages. The second cluster was characterised by a high degree or urbanisation and moderate problem issues on the remaining indicators. The third cluster also had moderate problem issues on the different domains and had a slightly higher rate of occupational disability. The final cluster contained areas with a high degree of affluence, a good health status and a favourable social and

physical environment. The distinction was largely determined by the degree of urbanisation and socioeconomic characteristics and far less by spatial aspects, such as the amount of green space and amenities in a neighbourhood. The average number of hours that people spent doing some form of sport and the number of hours spent watching television, or not watching TV, was found to be heavily related to social characteristics such as level of education, while the percentage of people declared incapacitated for work correlated to relative affluence.

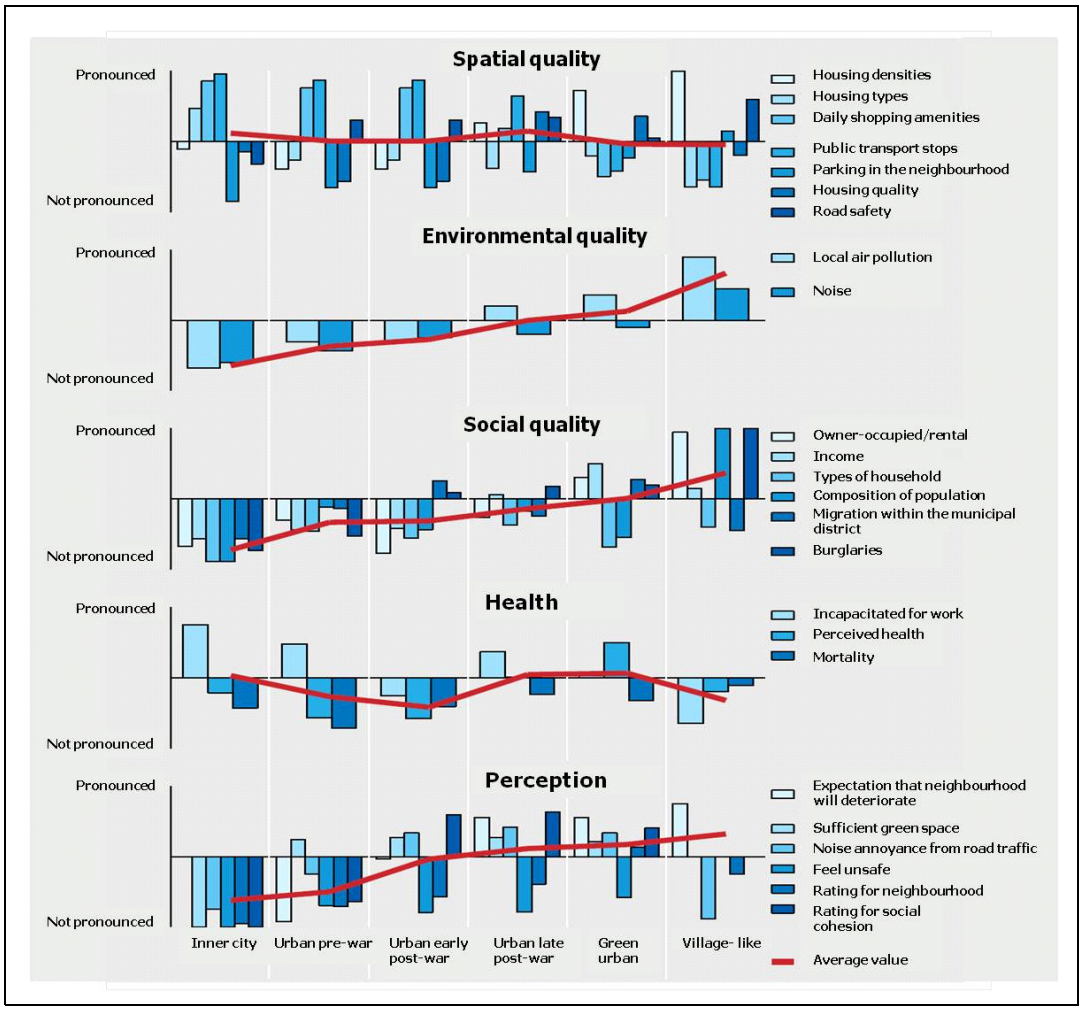


Figure 9 The quality of life and health per type of living environment.[12]

In an attempt to integrate the different aspects of liveability for the Netherlands as a whole at a low-scale spatial level, the national 'Liveability' District Monitor (*Wijkmonitor 'Leefbaarheid'*) was developed at the request of the Ministry of Housing, Spatial Planning and the Environment; this was later developed into the 'Liveability Meter' (*Leefbaarometer*).[3,171] The instrument is essentially intended to track developments in liveability and to detect problems at an early stage, thereby enabling timely intervention. At the same time, it is possible to assess whether solving problems in one district might not give rise to problems elsewhere. As such, the instrument combines a research and policy objective. The data were linked at postcode level in four figures plus two letters. This linking at a low scale level took into account the fact that people focus largely on their immediate living environment when forming their perceptions of the district. The Liveability Meter includes 50 indicators and comprises the following domains:

- housing stock
- public space
- level of amenities and facilities
- composition of the population
- social cohesion
- safety.

These objective characteristics were then related to perceptions and behaviour. The high degree of interrelation between the different factors meant it was difficult to distinguish between the different dimensions (social, physical, perception, behaviour and safety). As in the survey carried out by the Netherlands Institute for Social Research (SCP) and the National Institute for Public Health and the Environment (RIVM), there was a strong correlation between accumulation of the physical and social characteristics and perception, and also between perception and behaviour. It is interesting to note that perception was largely determined by the social dimension, while behaviour (moving etc.) was largely determined by annoyance and safety. Weighting performed on the basis of aspects of perception resulted in a 'Liveability Meter' in the form of a single composite index at the level of the postcode in four figures plus two letters. This index is intended to reflect the extent of problems in districts in the Netherlands and distinguishes districts that are rated positively from districts that receive a negative rating. A significant advantage is that use can be made of data that are regularly updated, which makes the instrument ideally suited for monitoring. See Figure 10.

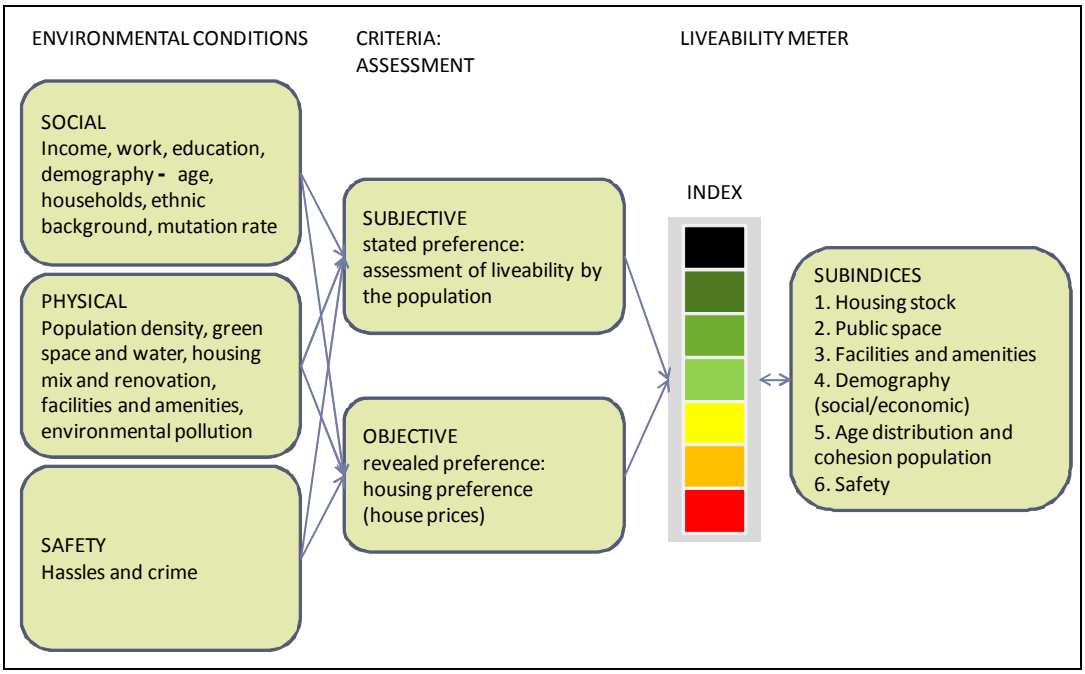


Figure 10 Diagrammatic overview of the Liveability Meter.[172]

The Liveability Meter takes satisfaction and not health as its orientation point. Accordingly, changes in the measurements recorded by the Liveability Meter will mainly concern immediately observable changes – for example more or less graffiti or public green space and amenities. Changes in physical environmental factors, such as air pollution, generally express their impact, particularly on health, in the relatively long term and will therefore not be expressed, or will only be expressed to a limited degree, in the Liveability Meter.

An example of a district typological approach is elaborated in Box 3. In the study described, different types of district with contrasting socioeconomic status and varying incidence of favourable and unfavourable environmental factors were compared in terms of well-being and health.

***Box* 3 Quality of the living environment and health in different types of neighbourhood.**[176]

The National Institute for Public Health and the Environment (RIVM) has assessed how residents from different types of residential environment rated their living environment, to what extent they experienced annoyance and disturbance, and their perception of their health. The aim of this study, which was carried out amongst more than 3,600 residents on behalf of the Ministry of Infrastructure and the Environment, was to develop a methodology for identifying the quality of the local living environment (environment/ surroundings, living amenities, spatial planning) in combination with well-being and health.

The researchers linked data about perception to objective environmental characteristics at a detailed spatial scale level. As the effects on health and well-being are frequently not just a direct consequence of exposure to physical environmental factors, but can also constitute a 'stressor' via perception, it is important to measure both aspects since, in addition to the objective aspects of the living environment, personal characteristics and the (social) context also determine the degree of residential satisfaction and how the quality of the environment is rated. The perception of the residents can also include signals pointing to problems in the neighbourhood that cannot be derived from measurements of the physical quality of the environment.

The data were collected at the lowest possible scale level. As such, the outcomes were able to offer policymakers greater insight into what people consider important in their immediate residential environment. A further feature of the study was that districts were selected according to the type of residential environment (inner-city, urban non-inner city and green urban) and on the basis of contrasting characteristics with regard to socioeconomic status and accumulation of environmental problems (little green space and amenities, elevated levels of air pollution and noise).

It was concluded that the selected approach was promising and offered significant reference points for policy. Annoyance and sleep disturbance due to road traffic were important and were found to be heavily influenced not just by the actual noise levels, but also by the expectation that the noise situation would deteriorate in the future. The accumulation of environmental problems was found to have only limited significance, after taking into account the individual environmental factors. Socioeconomic status was of significance largely at the individual level and in relation to more personal aspects and perceptions.

In terms of the health endpoints, the findings evidently confirmed the selection hypothesis: inner-city districts in combination with a low socio-economic status achieved a lower rating across the board. Differences in perceived health were not attributable to an accumulation of environmental factors, although this was the case for differences in specific physical complaints. After correction for socioeconomic status and degree of urbanisation, these did show a connection with the accumulation of environmental factors.

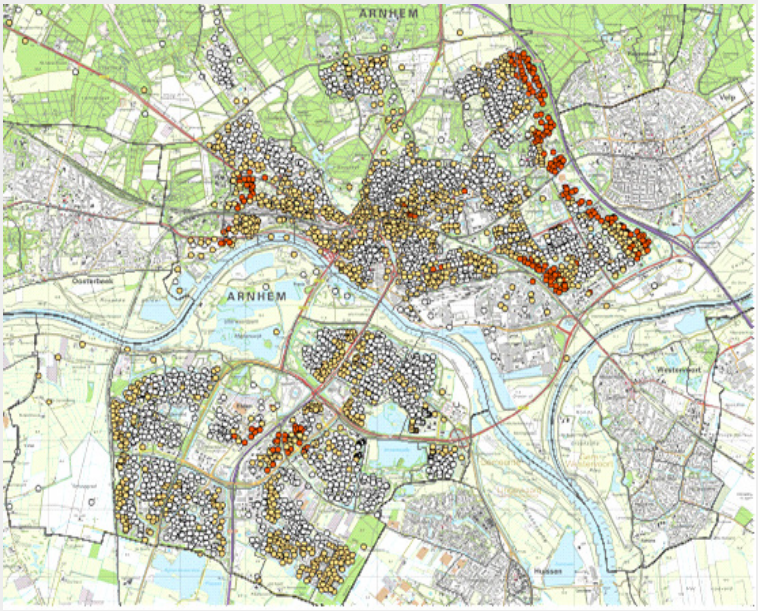


Figure: Areas per postcode comprising four figures and two letters in Arnhem divided into 0 (white), 1 (yellow), 2 (red) or 3 (dark brown) ratings according to the following three criteria: yearly average accumulated noise levels due to rail, aircraft or road traffic noise greater than 58 dB(A); yearly average NO_2 concentration greater than 30 µg • m^{-3}; no publicly accessible green amenities within a radius of 500 metres from the home.

4.2.3 *Statistical aggregation*

Since the end of the 1980s, geographic information systems (GIS) have found increasing application in environmental epidemiology as well as for estimating health risks in the United Kingdom in particular, but also in the Netherlands.

Accurate and detailed exposure and health data are essential for this. The generally poor quality of the exposure estimates, uncertainty regarding the time that elapses between exposure and health effect (latency) and regional and temporal differences in data collection are significant problems with this approach.[177] The fact that the degree of exposure may only be established on a spatial basis is also problematic: even in the case of air pollution, where there is direct contact between the polluting substance and the body, exposure varies considerably according to the behavioural pattern and pattern of activity. The distance to the road is frequently taken as an indicator[93], but the use of regression (distribution) models based on GIS is gaining in popularity and importance. The geographic representation of disease has also become customary, although at a low scale level it is difficult to interpret the patterns, due in part to latency and migration.

The combination of exposure estimates and demographic characteristics makes it possible to make a prediction of the number of disease cases, provided that an exposure-response relationship is available, which is only the case for a limited number of agents.

Identifying the incidence of disease at neighbourhood level and tracking patterns of disease over time may be an instrument for assessing whether there are any changes in environmental conditions. Application at neighbourhood is referred to as small area health statistics (SAHS). The main aim of SAHS is to assess in an efficient manner the health risk of exposure to environmental factors at the level of the population. Emphasis is placed on the use of health statistics and linking them with environmental data (at the lowest possible scale level). Depending on the availability of data on exposure, disease, premature mortality and the composition of the population at postcode or spatial coordinate level, it is possible to demonstrate or refute confounder-adjusted geographic correlations.

Some people doubt the usability of this method for monitoring purposes or as an instrument for dispelling concern about local environmental factors.[19,90] Arguments include the poor exposure characterisation, the inability to take full account of the impact of socioeconomic status and of other factors relevant to a specific disease, such as past exposure at various residential and work locations.[178] The method is nonetheless considered to be usable for the swift assessment of questions relating to disease clusters in relation to local environmental factors. Based on initial identification of this type, a decision may then be made on whether further research is needed.*

* The biggest obstacle to applying SAHS in the Netherlands is the accessibility of the registration data and the possibility for linking such data. Several years ago, the Health Council of the Netherlands organised an invitational conference on the application of SAHS in relation to environmental health issues.[90]

4.2.4 *Combination of small area health statistics and other instruments*

There are many instances in which neighbourhood surveys in relation to the environment and health could make use of the SAHS method described above. A distinctive feature in this regard is the use of ecological or aggregated data on exposure and health (based on registration data). The likelihood of incorrect or inaccurate interpretation is considerable in this respect (ecological pitfall, see 2.1): conclusions about individuals are made on the basis of data aggregated for the group, under the assumption that all the members of a group have the same characteristics. However, data at the individual level are generally not available, or they are not authoritative enough to allow conclusions to be drawn at a low scale level. This problem could be resolved by supplementing research at an aggregated level with data at the individual level within research areas (i.e. neighbourhoods), with a direct link being established between exposure and health effects.[31] The following nonetheless applies[31]:

- drawing conclusions from aggregated data can be correct if the contrast in exposure between areas or neighbourhoods is significant and can therefore reduce the likelihood of bias or distortion due to the measurement errors in individual data;
- the combined use of aggregated and individual data can be particularly relevant where the contrast between neighbourhoods is too small;
- combining ecological data with data at the individual level can moreover enhance the authority and relevance of the individual data.

4.3 Usability

A characteristic feature is the generic nature of the methods and instruments described above. While they take into account social and economic factors, detailed knowledge about which factors are truly relevant is lacking. The different typologies have yielded a wealth of information and make possible a comparison of neighbourhoods as well as the performance of monitoring over time. Evaluations of interventions might increase our understanding of the impact of subfactors.

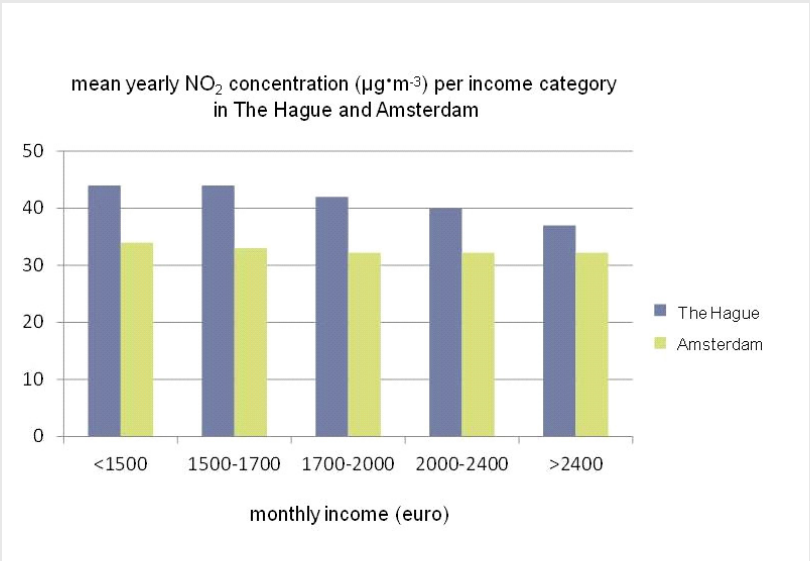
The clustering of the different factors at the social and physical level presents a challenge. It compelled the researchers at RIGO, for example, to adjust for ethnicity because the distribution of physical and social characteristics correlated to ethnicity to such a degree that this threatened to become the dominant factor. This points to a strong selection mechanism.

The indices that have been developed are certainly usable as instruments for detecting problem situations. A classification into types of neighbourhood, as demonstrated in the 2006 Public Health Status and Forecasts Report (*Volksgezondheid Toekomst Verkenning 2006*)[54], would appear to be very usable for research purposes. The historical data of the Netherlands Institute for Social Research (SCP) could constitute an important supplement in this regard. The SAHS method is also promising, particular when used in combination with other methods allowing data to be collected at the individual level. Box 4 gives an example.

Box 4 Traffic circulation plan in The Hague

Traffic causes many problems in The Hague: traffic jams, air pollution and excessive noise levels. A new traffic circulation plan (*Verkeerscirculatieplan*; VCP) that was adopted by the city council in 2009 and implemented in 2010 was intended to reduce the volume of motor traffic at several hot spots. Hot spots are streets where the EU standards for air quality (PM_{10} and NO_2) are exceeded. Health improvement was not explicitly mentioned as an argument for VCP. Measures included the introduction of one-way traffic and closing off some streets altogether. By diverting goods and private traffic, the city centre was made largely inaccessible to cars and commercial vehicles, with the exception of local goods traffic. It was believed that this would lead to a reduction in the number of hot spots due to improved air quality and reduced noise levels. In addition, it was expected that the proportion of journeys made by bicycle in the city centre would increase.

The study – carried out as part of the INTARESE project – focused on the health impact of the interventions.[179] Special attention was paid to the distribution of the environmental burden across groups with varying socioeconomic status. In The Hague, low-income groups and immigrants have greater exposure to traffic-related pollution than groups with a higher socioeconomic status.



The figure shows that in The Hague uneven exposure to NO_2 is more pronounced than in Amsterdam. The researchers found that the – albeit limited – reduction of NO_2 concentrations due to the introduction of the VCP was greater for the groups with a higher socioeconomic status than for the groups with the lowest socioeconomic status. Furthermore, the estimated health benefits due to increased physical activity exceeded those that were attributable to the reduction in air pollution, noise and the number of traffic accidents, although it was not possible to establish this with certainty. These results were, incidentally, not categorised by social group.

Chapter 5

Conclusion and recommendations

5.1 Reflection

The broad formulation of the issue forming the basis of this document has inherently meant that the search for social aspects in the relationship between environment and health has led us through a maze of approaches, concepts and data. It can be concluded that a spatial and social division exists in terms of health problems, burden on the environment and other unfavourable factors. While evidence has been found for an accumulation of social, physical and spatial problems, insight into the causal links and the reference points for policy and interventions is still limited. Views regarding the way in which these inequalities should be dealt with differ. Some believe that physical interventions will lead to improvements at the social level, while others argue that only interventions that are accompanied by an improvement in the economic situation will have a favourable effect. That direct improvement in income need not be the key aspect is evident from the fact that since the fall of the Berlin Wall, life expectancy amongst inhabitants of the former GDR has increased.[180] The expectation of an improvement might in itself have a favourable effect, while conversely the expectation of a deterioration has an unfavourable impact, as was shown in a study carried out around Schiphol.[92]

Expectations and outlook appear to play an important role. The finding of the Netherlands Institute for Social Research (SCP) that even where there is no evidence of degradation some people nonetheless perceive this to be the case is

illustrative in this regard.[173] This then is not so much related to the actual situation, but rather to the unfavourable assessment, or rating, of a number of characteristics (for example, it is not safe here because the benches are covered in graffiti). In the same line, RIGO found that perceptions are determined by social environmental aspects, while actual behaviour is far more closely associated with aspects such as actual annoyance and insecurity[17]. It is this type of information, which remains anecdotal for the time being, that requires more systematic analysis. This can only be done on the basis of theme-based research in relation to the environment and health, with the role of social, economic and psychological processes being simultaneously analysed on the basis of case studies. Environment-related health problems do not arise in isolation, but are the result of a complex interplay between spatial, social and physical factors and occur in a socioeconomic context.

5.2 Conclusion

The conclusion is therefore that all the research confirms that it is not possible to designate one or a few factors as determining how the living environment influences health. There is always a combination and mutual interaction of factors at play, and usually also an accumulation of favourable or unfavourable factors. Furthermore, individuals and populations do not respond passively to exposure to that combined set of factors in respect of the living environment. Personal and social characteristics determine the extent to which that exposure jointly defines health.

Three perspectives have been discussed in the background study: that of environmental epidemiology, of social epidemiology and of environmental psychology. They emphasise physical environmental variables, social characteristics and perception and behaviour variables, respectively. In recent years, considerable progress has been made in research that has been carried out from each perspective. Environmental epidemiology has been marked by the emergence of biomarkers and geographic information systems. In the field of social epidemiology there has been a greater focus on opportunities for personal development and well-being, between individuals as well as between social groups. And research based on an environmental psychology perspective has yielded insights into the manner in which the environment and the perception of the environment have a positive but also a negative impact on health.

But given the conclusion that the interrelationship between living environment and health cannot be understood within the scope of a single perspective, let alone that sufficient reference points for intervention can be

found within that single perspective, the limited interrelationship between work carried out within the three perspectives is regrettable. The new findings and possibilities can only be fully developed and contribute to a sustainable public health endeavour if environmental epidemiologists, social epidemiologists and environmental psychologists join forces. Then we will go beyond the level of merely paying attention to examples of threshold values being exceeded for single physical factors derived from simple, generic exposure-response relationships. Then we will acquire a greater understanding of why certain social groups are disproportionately affected by an accumulation of environmental factors and why other groups, who would appear to be similar from a social perspective, demonstrate far greater resilience. And then we will be able to explain the response to and the perception of the living environment and the ensuing stressors not just on the basis of individual characteristics but also on the basis of social cohesion and social capital.

Accordingly, the contextual approach towards environment-related health problems advocated here requires a far-reaching form of multi-disciplinary collaboration. This is best achieved in the context of a theme-based study of the interrelationship between living environment and health and of the effect of policy and interventions on that relationship. That would inevitably require a theme-based integration and elaboration of insights and models Examples of relevant themes, including from a policy perspective, are:

- mobility
- housing/living
- (pre-)school environment and long-term effects
- environment and health of the elderly
- distribution of physical and social characteristics across the population and the accompanying effects on health
- the varying effect of a neighbourhood organised to be conducive to health on different socioeconomic groups.

The background study has yielded points of interest for such an elaboration. Principal among them are:

- attention to the phase of life: the relationship between living environment and health differs from one stage of life to the next, but influences – physical, social and psychological – in one stage of life also have an as yet relatively unknown effect on health in the next;
- attention to protective factors and influences and the balance between protective and endangering factors: an even balance can strengthen the

resilience of communities and neighbourhoods. What makes or can make that balance sustainable is unknown, however;
- attention to linking up indicators: in addition to a theoretical anchoring of indicators, a set of indicators that does justice to the various perspectives can provide more timely and better insight into health benefits and disadvantages in dependency with the living environment and the social characteristics of the residents;
- attention to an evaluation of policy and interventions: since the relationship between living environment and health is too complex for a single intervention to dispel all environment-related ill-health issues, a policy with gradual, staged interventions and providing for close tracking is necessary. The aforementioned set of indicators can constitute an essential instrument in this respect.

Finally: the background study has focused on the level of the neighbourhood. That might come as a surprise in an increasingly globalised society in which there is a fear of health-threatening changes in the living environment of the world as a whole, or in any event of large regions. But it is at the local environment level that the impact on the health of individuals and communities is evident. That is why the findings and conclusions of the background study are certainly as relevant to the response and adaptation to global environmental changes and the resulting social change as to the impact of the living environment that is more local in origin. Neighbourhood and world are closely interconnected from each of the perspectives described in this background study.

Postscript

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