The Public's Perceptions of Air Pollution. What's in a Name?

Authors: Noël, Charlotte, Van Landschoot, Lisa, Vanroelen, Christophe, and Gadeyne, Sylvie

Source: Environmental Health Insights, 16(1)

Published By: SAGE Publishing

URL: https://doi.org/10.1177/11786302221123563

The Public's Perceptions of Air Pollution. What's in a Name?

Charlotte Noël, Lisa Van Landschoot, Christophe Vanroelen and Sylvie Gadeyne

Interface Demography, Vrije Universiteit Brussel, Brussels, Belgium.

Environmental Health Insights
Volume 16: 1–16

DOI: 10.1177/11786302221123563

ABSTRACT: Air pollution is a major global health threat. There is growing evidence for a negative effect of air pollution on health and well-being. Relationships between air pollution and health are mediated by health risk perceptions and play a crucial role in public response to it. Air pollution in the public's mind is often different from air pollution defined by the scientific community. Therefore, in order to develop successful prevention and alleviation strategies, an understanding of public risk perceptions is key. The central question of this paper is: 'How does "the public" (in Brussels) perceive air pollution?' This research is an attempt to enrich the limited body of qualitative research in the field, approaching the topic of perception from 4 different, complementary angles: definition, association, categorisation and problematisation. About 51 interviews were conducted in the Brussels-Capital Region. Consistent with earlier research, this research illustrates that perceptions of air pollution are diverse, subjective, context-dependent and often deviate from conceptualisations and definitions in the scientific community. Respondents underestimate the potential harm and problematisation depends on comparative strategies and perceived avoidability. The novel aspect of this paper is the identification of 5 mental schemes by which specific elements are categorised as being air pollution: (1) the source of the element, (2) its health impact, (3) its climate impact, (4) its functionality and (5) sensory perceptions. The insights gained from this research contribute to the field of environmental epidemiology through a better understanding of how 'the public' perceives air pollution and in what way this may deviate from how it is perceived by experts. We hope to raise the awareness among experts and policy makers that air pollution perceptions are far from universal and consensual but on the contrary individual and contested.

KEYWORDS: Health risk perceptions, laymen, air pollution, Brussels-Capital Region, qualitative research, face-to-face interviews

RECEIVED: April 19, 2022. **ACCEPTED:** August 8, 2022.

TYPE: Original Research

FUNDING: The authors disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: from Innoviris, the regional institute for research and innovation of the Brussels-Capital Region for the research reported in this article.

DECLARATION OF CONFLICTING INTERESTS: The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

CORRESPONDING AUTHOR: Charlotte Noël, Interface Demography, Vrije Universiteit Brussel, Pleinlaan 2, Brussels 1050, Belgium.
Email: charlotte.noel@vub.be

Introduction

Air pollution is alongside climate change one of the biggest environmental threats to human health.[1] According to the WHO, 91% of the world's population lives in places where ambient air pollution levels exceed WHO guideline limits.[2] Despite improvements in air quality over the past 3 decades, exposure to air pollution is estimated to cause 7 million premature deaths, and results in the loss of millions more healthy years of life.[1]

There is indeed growing evidence for a negative effect of air pollution on health and well-being. Many studies provide solid evidence of an association between high concentrations of air pollution and mortality[3] or other health outcomes, such as increased ischaemic heart disease, strokes, infections of the lower respiratory tract, asthma or chronic obstructive pulmonary disease[4] and mental health indicators, such as psychological stress, symptoms of depression or suicide.[5-9] Brain damage caused by air pollution seems to be associated with dementia and with weakened cognitive functioning throughout the life course.[10,11] Exposure to air pollutants has potentially harmful effects from the earliest stages of life with negative effects on pregnancies as well as long-term effects that affect susceptibility to disease later in life.[12]

Given this growing evidence of a negative impact on health and quality of life, there is generally an increasing interest in fighting air pollution at the global, regional and local level. It is therefore important to figure out what air pollution is exactly about.

Air pollution obviously has an ontologically objective existence, but the way in which people come to know and make sense of it, is highly contextual, subjective and therefore far from universal.[13] Air pollution in the public's mind is often different from air pollution as defined by the scientific community. Truth claims of scientists are evidence-based and therefore more convincing for policy makers. However, from a policy perspective, definitions and perceptions of the public need to be considered as well as they define the margins for possible policy action to a large extent. Perceptions being influenced by the social, economic and political context, by knowledge and evolving insights, they will differ between people and contexts. The ambition of this paper is to make a taxonomy of definitions, perceptions and associations that go along with air pollution among Brussels' citizens.

Background

Why does one's perception about air pollution matter? Relationships between environmental exposure (eg, air pollution) and physical and mental health (eg, respiratory effects) are mediated by perceptions of the 'exposure' (eg, air quality).[14] Risk perceptions – or more exactly the there out resulting attitudes – play thus a crucial role in the public's response to

environmental exposure[15] and in its response to the sources of the exposure. These attitudes impact health both in a direct and an indirect way. In a direct way, high risk perceptions might constitute a cognitive antecedent of a stress reaction negatively impacting upon mental health[16,17] or on the other hand, when risks are underestimated, people might not take appropriate measures to protect themselves which impacts on their physical health. Attitudes resulting from risk perceptions also mediate the potentially harmful human health effects of air pollution in a more indirect way since they might result in behavioural changes and support measures aiming to decrease air pollution thereby mitigating air pollution and its negative health impact. Public awareness and realistic perceptions of the health risks associated with air pollution are therefore key in improving public health and in creating public support for policy measures aimed at reducing air pollution.

In order to develop successful prevention and alleviation strategies, understanding risk perceptions is key. Risk perceptions can be defined as involving '*people's beliefs, attitudes, judgements and feelings, as well as the wider cultural and social dispositions they adopt towards hazards and their benefits*'.[18] Key in shaping a health risk perception, is the definition and identification of air pollution. Indeed, if air pollution is not recognised as such, one will not act upon it.[14] These reactions might consist of (individual) behavioural changes, impacting heath directly through protective measures or indirectly through behaviours that reduce levels of air pollution at a personal level (eg, changes in car use). Risk awareness is also crucial for citizens to engage in collective action (eg, through different forms or degrees of activism and to support/call for policy initiatives initiated by local, regional or national governments).[7,13] Therefore, understanding how individuals perceive air pollution, is crucial for combating it and to improve public health.

From a review of qualitative research on air pollution perceptions we learn that qualitative research about the topic remains fairly scarce and most often neglects how air pollution is defined by the public and which mental schemes are employed to categorise an element as being air pollution or not.[13]

What we learn from the existing body of research on the topic, is that the public and scientists define air pollution differently. The scientific community focuses on specific pollutants derived from multiple sources; the public rarely refers to specific pollutants and rather emphasises the sources of air pollution. In their study on pupils' knowledge of air pollution in Greece, Dimitriou and Christidou[19] observed that the majority of respondents referred to specific air pollutants as 'smoke', 'exhaust-gases' or 'harmful substances', without making any distinction between the different substances found in the air.

Knowledge about air pollution sources differs between experts and the public. The public often associates air pollution sources with odour. In the Nairobi slums, for instance, smelly drainage channels and toilets were frequently cited as a source of air pollution.[20] Similarly, respondents in Beijing[21] mentioned garbage as a source of air pollution thereby considering odour as the clue connecting garbage with air pollution.

What people categorise as being air pollution is very much culturally defined. In a community in California, smoke caused by wildland fire was perceived as air pollution.[22] On the contrary, in a study on open burning of municipal solid waste (MSW-burning) in India, respondents expressed the belief that smoke from ceremonial fire is a purifier when good fuel is used.[23] When asked explicitly if smoke from MSW-burning also purifies, there was consensus that it was not purifying, but polluting. The 'pure' character of ceremonial fire smoke relative to MSW-burning smoke was explained through the fuel used for the burning. In a community in Australia, the presentation of wood smoke as natural and the idea that wood heating is a traditional source of warmth counteracts the strong association of pollution with modernity and 'artificial' sources of energy (Reeve, Scott, Hine and Bhullar, 2013).[24] Obviously, the classification of elements as contributing to air pollution is context-dependent. People refer to sources of pollution that are part of their daily lives and the society they live in. Respondents from a London study for instance indicated cars, buses, heavy goods vehicles and pollen as the most significant causes of air pollution,[25] while respondents in a poor neighbourhood in Nairobi mostly pointed to road dust, industrial areas and burning trash.[26] In sum, definitions of air pollution and elements identified as air pollution are not universal: they differ between experts and the public and between different populations in different contexts.

Study aim and research questions

In this qualitative study, we aim at identifying the beliefs, attitudes, judgements and feelings that the public in the Brussels-Capital Region has about ambient air pollution. Our main research question is: *How does the public (in Brussels) perceive air pollution?*

This question (see Figure 1) crystallises into 4 sub-questions that approach the topic of perception each from a different but complementary angle:

1. How does the public define air pollution? (cognition)
2. Which associations does air pollution evoke in the public? (intuition)
3. Which elements are perceived by the public as being air pollution and why? (mental schemes)
4. Is perceived air pollution also seen as problematic by the public? (ethic)

We consider it relevant to investigate whether air pollution is problematized by the respondents as people can only be mobilised or stimulated to fight air pollution if they recognise it to be problematic. This research aims to enrich the limited body of qualitative research on health risk perception of air pollution.

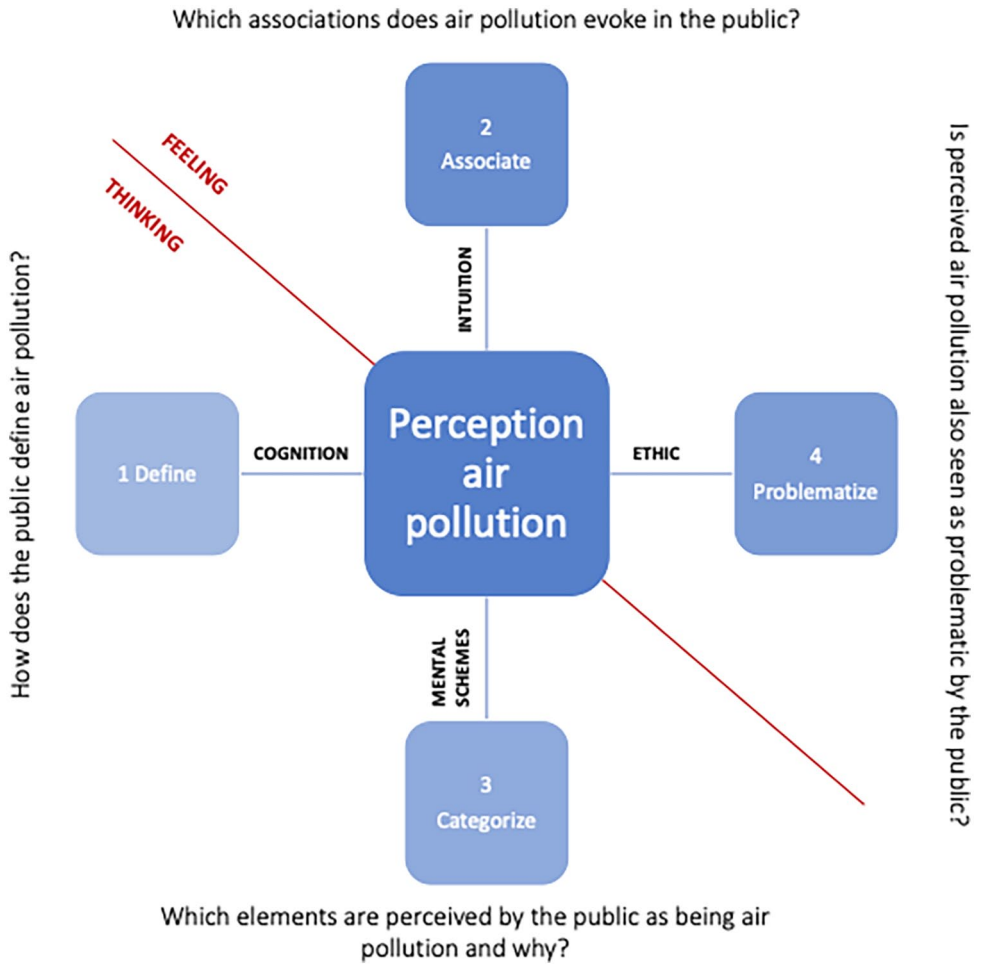

Figure 1. Schematic overview of the research questions and how they relate to the main research question.

It is to our knowledge the first research investigating how air pollution is defined and identified by the public. The richness of the research lies in the different angles from which the study of 'perception' is approached and the detailed and complementary information that results thereout.

First, we present the results related to the definitions of air pollution given by our respondents. The definition question was designed to come to the essence of air pollution through a cognitive way of thinking stimulating the respondent to be concise, to the point and synthetic. To explore the sentimental dimension of respondent's perceptions in a more intuitive way, an association exercise was done to invite the respondent to think in an open-minded way. The categorisations exercise intended to explore the symbolic dimension of air pollution through mental schemes handed by the respondent. Mental schemas are cognitive structures or mental representations that allows people to categorise knowledge about the world. These schemas help to simplify interactions with the world. In this paper, we focus more specifically on object schemas.[27,28] Expressing claims about the problematisation of air pollution encompasses a more ethical dimension through the values expressed towards the problematic character of air pollution. Both 'feeling' and 'thinking' are touched upon through these 4 questions by means of conscious and more unconscious processes. The insights gained from this research should contribute to the field of environmental epidemiology through a better understanding of how 'the public' perceives air pollution.

Methods

Methodology

This study adheres to a symbolic interactionist perspective, viewing social interaction in terms of the meaning that social actors attach to action and things.[29] In line with this perspective, we use a qualitative research methodology. We use individual face-to-face in-depth interviews with 51 respondents. The duration of the semi-structured interviews was 90 minutes on average.

Two themes were explored during the interview, perceptions about public green spaces within the Brussels-Capital Region (BCR) and perceptions about air pollution. During the recruitment, respondents were not informed that the subject of air pollution was going to be discussed to avoid that they would inform themselves about the topic as a preparation to the interview, thereby creating potential bias.

Recruitment and fieldwork

Respondents were recruited through the distribution of flyers, a call in a Brussels Facebook group, civil society organisations and schools and snowball-recruitment. The interviews were conducted between October 2019 and March 2020. Interviews were in Dutch or French. An incentive of 15 euros was granted to the respondents after participation to the interview.

Respondents were interviewed by the first and second author, at different places: the Vrije Universiteit Brussel, the respondent's home, a place of preference of the respondent and in the civil society organisations or schools that helped with the recruitment.

Analyses

The interviews were audio-recorded, transcribed, analysed and manually coded according to the pre-determined research questions.

The data used for this paper were generated through 3 questions in the interview guide.

The first one (to answer research question 2) consisted of a free association question at the start of the interview asking: *'What does the word "air pollution" spontaneously make you think of? Which words, images, ideas, impressions, associations or feelings come to mind?'* In the second question (to answer research question 1) respondents were asked how they define air pollution: *'Suppose I don't know anything about air pollution and I ask you, what is air pollution, how would you define it?'* The third question (to answer research question 3) was a fairly comprehensive one that examined which specific elements[1] were categorised as air pollution and why: *'I am going to list a few elements. For each item, I will ask whether you consider this to be air pollution or not. Then I am going to ask you why you think it is or is not air pollution. This question is not intended as a test. It does not matter whether your answer is right or wrong. All I want to understand is the reasoning behind your answer'*. With this question, it was our intention to get an idea of the mental schemes employed by the respondent to perceive a specific element as being air pollution or not.

We also investigated the extent to which identified air pollution is polemised. This issue did not belong to our initial research aim, but appeared to be important during discussions with our respondents resulting from the 3 aforementioned questions.

The analysis is supplemented with quotations of respondents characterised through an anonymous identification code that refers to some main characteristics such as age, gender, migration background and socioeconomic situation (see Appendix 1).

Results

We recruited a diverse group of people in terms of age, gender, sociocultural background and socio-economic position (see details in Table 1). In what follows we report on the perceptions about air pollution through (1) definition, (2) association, (3) categorisation and (4) problematisation.

Table 1. Overview of the respondents.

OVERVIEW (N = 51)	
Age	
16-25	20
26-65	23
Over 65	8
Gender	
Female (F)	39
Male (M)	12
Sociocultural background	
Belgium	27
Northern Europe	1
Southern Europe	1
Turkey	4
Northern Afrika	10
Sub-Sahara-Afrika	6
Middle East	1
Asia	1
Socio-economic situation	
Low socio-economic classes (L)	19
Middle and high socio-economic classes (MH)	32

How does the public define air pollution? (Cognition)

To understand how air pollution is perceived, it is first important to know how it is defined. Analysis of the definitions of air pollution indicated that respondents most often referred to the sources of air pollution (n = 38) and also to its consequences (n = 26) while defining air pollution. In doing so, they exclusively denoted anthropogenic sources (no one mentioned natural sources).

> *'Air pollution is actually what man makes, it's what we produce more than the earth can handle. What the earth can convert into good air for us'. (R34)*

Many respondents (n = 13) referred exclusively to cars as a source of air pollution in their definition.

> *'They are the exhaust fumes from the cars and there is something in them that gets into the lungs and makes you cough and is not very healthy. So the less we drive, the better. Although public transport could be better too'. (R33)*

Other sources mentioned by the respondents were boats, trucks, infrastructure works, fire, machinery, factories and aircraft. Less conventional sources such as cigarettes and barbecues were brought up as well.

Respondents rarely (n = 5) referred to specific pollutants (PM, NO_2, soot. . .) but rather to vague terms such as particles, things, elements, small particles of carbon dioxide and small dust.

> *'Air pollution is dirty particles in the air. I don't know exactly what that is'. (R45)*

In addition, they often (n = 4) referred to sources perceptible through the senses, such as the water vapour from nuclear power plants, which was perceived as polluting smoke, or to sensory manifestations of air pollution such as particulate matter on windows or white doors.

> *'Air pollutants are particles that are in the air and go everywhere. On the plants, in the respiratory system. I also see it on the windows. The windows are dirty very fast. There are small dust particles on them'. (R46)*

Next to sources, respondents also cited the negative health impact of air pollution (n = 24). No specific diseases or disorders were mentioned, instead reference was made to health problems in general, especially for vulnerable groups such as the elderly, people with respiratory problems and children. Some respondents also referred to the impact that air pollution has on the climate (n = 8).

> *'They are tiny particles in the air that are created by man himself and caused by the way he lives. This results in the air becoming polluted causing atmospheric warming'. (R39)*

In sum, our respondents saw air pollution solely as the consequence of human activity, perceived cars as the main source of air pollution without referring to specific pollutants. They mainly referred to sensory sources and manifestations of air pollution. The impact of air pollution on health and to a lesser extent on climate change seemed central in their definitions. Air pollution was perceived as 'negative for health' in general terms especially for 'weaker' persons in society.

What associations does air pollution evoke in the public? (Intuition)

To gain insight into the emotive and associative dimension of air pollution perception, we asked respondents which associations 'air pollution' evoked in them.

Air pollution seemed to be a vague concept for our respondents. They mainly associated it with sources such as cars and other motorised traffic (n = 28), to a lesser extent with general sources such as exhaust gases, chemical products, petrol or smog (=11) and to a limited extent (n = 4) with the specific pollutants PM and CO_2. Besides the car and other motorised transport, other conventional sources of air pollution such as industry, agriculture and wood combustion were mentioned sporadically (n = 3). Air pollution was also associated with less conventional sources such as rubbish, barbecues, the smell of snacks, dustbins, smoking people, the smell of food, the smell of cigarettes, dog fouling and smelly places such as underground and train stations. The link with air pollution was made by the smell that these elements emit and, in the case of the barbeque, also the dust that thereout results.

Air pollution was also often associated with the word 'disease' (n = 16), mainly referring to health problems in general and to breathing, lung problems or asthma in particular. Respondents rarely referred to their own situation or concrete personal experience (n = 2). Connections with other health problems such as cancer, cardiovascular diseases, inflammation of the airways, worse mental health, brain damage, low birth weight or mortality were not made by our respondents, in contrast to expert knowledge. Air pollution was emotionally exclusively associated with negative feelings (n = 3) such as sadness, anger, concern and disappointment.

Respondents made less obvious or, from a scientific point of view, even incorrect associations. Certain visually perceptible elements were incorrectly labelled as air pollution, such as clouds for example.

Again, it appeared that respondents often associated air pollution with sources that can be sensed through smell, sight and sound. Consequently, air pollution is geographically associated with places with many perceived sources of air pollution, especially cars. The city as a place with high levels of air pollution was contrasted with places outside the city that were associated with cleaner air. Air pollution was thus mainly perceived as an urban phenomenon.

> *'. . .There is more air pollution in the city than in the countryside because there are many cars and many people. Houses are close together, people go around the city more by car than by public transport'. (R21)*

> *'On the countryside you don't see smog. I feel much healthier when I am in the countryside'. (R24)*

In addition, air pollution was associated with elements that are part of the local context in which it occurs and that contribute to it in a direct or indirect way, such as 'Flemish people who come to Brussels by car' and 'a lack of bicycle lanes'. Thus, there is a tension between residents of the Brussels Region – about half of the inhabitants of Brussels do not own a car[30] – and the Flemish who commute to Brussels by car. This creates the image that it is the Flemish who come to pollute the Brussels' air. The results also mirror the existing field of tension between those who travel mainly by bicycle and those who travel mainly by car within the BCR. Those who cycle complain that there is not enough (safe) space for cyclists and that it is 'King Car' that dominates the public space.

In sum, respondents associated air pollution with vague non-specific pollutants and were rather partial in their identification of air pollution sources. They associated air pollution with 'negative health' in general or with lung diseases that have a negative impact on breathing specifically. Furthermore, it appeared again that respondents associate air pollution with sensory perceptions, that they blur the distinction between climate and environmental problems, and make 'erroneous' associations from a scientific point of view. Air pollution is mainly perceived as an urban phenomenon for which the 'other' is blamed. Respondents made associations linked to the local context that reveal fields of tension between different actors.

What elements are perceived by the public as being air pollution and why? (Mental schemes)

We asked respondents if they would categorise specific elements as air pollution or not and why. The elements discussed in the interview were: particulate matter caused by forest fires, cigarette smoke (secondary smoke), pollen, particulate matter caused by wood burning (stove), ammonia from manure, methane caused by the intestinal system of livestock, water vapour, particulate matter caused by traffic and particulate matter caused by volcanic eruptions (see Appendix 2 for more information about this question).

Firstly, data showed that there was no unanimity in the categorisation of elements as air pollution or not (see Appendix 3). The only exception concerned 'particulates caused by traffic', which was unanimously categorised as air pollution.

Secondly, the categorisation of an element as air pollution was only to a limited extent based on the element itself. For example, relatively few respondents categorised 'particulate matter' independently of its context. There was unanimity on the categorisation of 'particulate matter caused by traffic' as air pollution, but no unanimity regarding 'particulate matter caused by forest fires', 'particulate matter caused by wood burning' and 'particulate matter caused by volcanic eruptions', notwithstanding the fact that these all refer to the same element: of 'particulate matter'.

In this case, when respondents have no explicit knowledge of a certain element being air pollution or not through education or media, people fall back on different mental schemes while categorising elements as air pollution. Based on the data, we were able to identify 5 different mental schemes: the origin of the element, the health impact of the element, the climate impact of the element, sensory perceptions of the element and functionality of the element. An overview of the mental schemes used per element can be found in Appendix 4.

Mental scheme 1: The origin of the element. The most common mental scheme related to the origin of the element. It mainly evaluates whether the element has an anthropogenic or a natural origin. Elements of anthropogenic origin were usually perceived as air pollution, whereas elements of natural origin were generally not perceived as air pollution. The origin of an element was however not unambiguously determined by different respondents and involved different dimensions: the element itself, the source from which the element raised and the origin of the source.

An element itself could be associated by its name or by its origin with positive, natural things or, on the contrary, with negative, artificial things. For example, according to this mental scheme, 'pollen' was not perceived as air pollution because it is a 'natural' element.

> *'Pollen? No. That's natural, isn't it?' (R4)*

Ammonia and methane, on the other hand, were perceived by many respondents as chemical non-natural elements and therefore as air pollution.

> *'Ammonia from manure is, I think, definitely air pollution because chemicals are then released into the air and that causes bad air quality. . . Methane, again, is chemical so bad'. (R5)*

The same logic was applied to the element 'particulate matter caused by traffic'.

> *'Yes, it is air pollution, because it is not natural'. (R27)*

The second dimension is *the source from which the element originates*. For example, some respondents did not categorise particulate matter from untreated, natural wood as air pollution, whereas particulate matter resulting from the combustion of treated wood or from petrol was categorised as air pollution because the source was perceived as non-natural or no longer natural.

> *'I don't think "particulate matter caused by wood burning" is air pollution because to me, anything natural has no negative impact on health. Unless the wood was processed of course'. (R9)*

Similarly, the element 'water vapour' was generally not seen as air pollution since the raw material from which water vapour is formed – water – is perceived as natural. If, on the other hand, the water is not or no longer natural, it was categorised as air pollution.

> *'It depends on what kind of water one evaporates. If you evaporate water from a clean river, it is not air pollution at all, but if you evaporate water from the toilets, that is pollution. Water from factories is polluted'. (R27)*

The origin of the source from which the element originates is the third dimension of the origin and can be natural or in contrast human initiated. Several respondents did not perceive particulate matter from a volcano as air pollution, whereas particulate matter from wood combustion was perceived as air pollution. Although both cases involve the same element (particulate matter), the 'ignition mechanism' behind them is different.

After all, a volcanic eruption is a natural phenomenon where burning wood is initiated by human activity.

> *'I don't think particulate matter from a volcano is air pollution because it is something natural'. (R9)*

Another example relates to the element 'ammonia from manure'. Those who perceived the source of the element ammonia – livestock, animal husbandry or manure – as natural, did not categorise it as air pollution. Accordingly, one respondent perceived 'farts' as the source of 'methane caused by the intestinal system of livestock'. Since farts were perceived as natural, the resulting methane was also perceived as such and therefore not categorised as air pollution.

> *'No, methane caused by the intestinal system of cattle is not air pollution because everyone farts, that's human, that's natural'. (R3)*

For other respondents, the categorisation of this element as air pollution depended on the scale at which animals are farmed. Methane caused by the intestinal system of cattle' farmed on a large scale was perceived as unnatural and was therefore categorised as air pollution.

> *'It is natural, but in nature you never find such concentrations of cows together, producing so much. So actually it is not natural but human'. (R33)*

Mental scheme 2: The health impact of the element. The second most common mental schema concerned the perceived health impact of the element, evaluating the extent to which the element has a negative health impact. Elements that were perceived as harmful, were categorised as air pollution.

> *'Actually, from the moment there is a harmfulness, I think there is pollution. So, I think we have to define air pollution from the point of view of harmfulness. Because otherwise you shouldn't call it pollution, then it's just an aspect of the air like pollen'. (R32)*

The health impact of an element was not unambiguously determined by different respondents and includes different dimensions: a time dimension, a spatial dimension and the experience dimension.

The time dimension refers to both the duration of exposure and the duration of the health impact. For example, 'pollen' was often not considered to be air pollution because there is no continuous exposure. Pollen exposure and any resulting health problems were considered as of temporary, seasonal nature.

> *'I think that pollen is a natural phenomenon that is not harmful to health but that can trigger allergic reactions but that it is not harmful to health in the long term in the way that air pollution is. I think pollen can just cause an annual allergic reaction that also stops and that also has no long-term effects on health or on nature. I would not call it pollution. Pollution is really something that is harmful. Pollen is more of an element that is in the air and that can be inhaled and that can cause temporary irritation that is not harmful to overall health, but only irritation. Just like the sound of small children causes irritation, just like other natural things can cause irritation but are not harmful'. (R32)*

Similarly, particulate matter caused by burning wood is limited in duration, as it is only in the cold evenings that stoves are lit. The exposure to and impact of 'particulate matter caused by traffic', on the other hand, was not perceived as being seasonal but continuous.

> *'Yes cars have a very big impact on air pollution. We can say that cars circulate in the streets 24/7'. (R41)*

Similarly, 'particulate matter caused by volcanic eruptions' was not categorised as air pollution because of its perceived short duration.

> *'A volcanic eruption does not last very long. The particulate matter goes out of the air. Because it is short, it is not air pollution'. (R6)*

The spatial dimension also determines how respondents assess the health impact of elements. This spatial dimension consists of several aspects: the scale of the health impact, the concentration of the source and the distance to the source.

The *scale* at which people experience a health impact determined if an element is categorised as air pollution or not. For example, the proportion of the population that suffers from the effects of 'pollen' is perceived to be limited compared to the proportion of the population that suffers from the effects of exposure to 'particulate matter caused by traffic'.

> *'There are people who are allergic to pollen but I don't think that is air pollution. It is the reproduction of the plants. It can also cause health problems for some people but those are more exceptions. It is not dangerous for everyone. Smoking is dangerous for everyone'. (R46)*

Some respondents stated that 'pollen' is air pollution for people who are sensitive to it, but not for people who are not affected by it. They 'individualise' the phenomenon of air pollution.

> *'Yes, pollen is air pollution for people who suffer from it'. (R2)*

Similarly, the *concentration* of the source influences the extent to which resulting elements were perceived as negative for health. The health impact of particulate matter caused by wood combustion for instance was perceived as relatively limited due to its perceived low concentration. Particulate matter caused by forest fires, on the other hand, was perceived as having a negative impact on health since the resulting concentration of particulate matter is perceived as being much higher.

> *'Forest fires are pollution because it is so very massive but wood burning, yes, if everyone is doing that now, then yes. Then I think it can be very polluting. But it remains fairly minimal compared to your air. But it will have an impact on air quality for a while. You're going to smell that strongly for a while'. (R5)*

The *distance* to the source also influences the perception of the health impact. For example, the distance to traffic and the resulting particulate matter was perceived as relatively small. Particulate matter from wood combustion was perceived as

remaining far away because it is emitted at a height via the chimney, as a result of which its impact on health was estimated to be more limited.

> *'That's not good for your health. I do think that's something because it's above the roofs, that that dissipates faster so that's less harmful to you as an individual anyway if you're downstairs'. (R13)*

In addition, personal *experiences* played a role in evaluating the negative health impact of a certain element. A respondent who experienced a direct, severe and perceived as with air pollution related physical reaction to 'particulate matter from wood burning' said:

> *'Yes, that is air pollution. Although I only became aware of it later in life, namely when there was an awareness campaign by the Flemish government and I worked for the Flemish government. And I couldn't believe it at first, but I've experienced it first-hand because I was at my father's house the other day. He has a wood-burning stove and the heating was broken. I lit the stove. I know it's not good for the environment but I felt like burning wood for once and the next day I had a severe asthma attack. I'm not used to doing that so maybe I didn't do it right, maybe I didn't let it soak in and I really felt it'. (R32)*

Although many respondents fell back on either the single mental schema of origin or the mental schema of health impact, there were also respondents who combined both and perceived elements of natural origin as harmless in terms of health.

> *'I think everything that is natural, that is not man-made, is good, that it does not have a negative impact on us'. (R4)*

Mental scheme 3: The impact of the element on the climate. The third frequently used mental scheme related to the perceived impact of the element on the climate. A perceived negative impact on the climate usually resulted in the element being categorised as air pollution. For example, methane was associated with global warming and was therefore categorised as air pollution by some respondents.

> *'Methane is a gas that is certainly one of the causes of global warming, so yes. It is also in the air. So that pollutes the climate, but on the other hand, it doesn't affect us as much, but it's still bad for the climate. So, yes'. (R14)*

The element 'cigarette smoke' was also categorised as air pollution due to its perceived negative impact on the climate.

> *'A cigarette is something that is on fire and also puts CO_2 into the air I think'. (R11)*

With regard to 'particulate matter caused by traffic', one respondent commented:

> *'Yes, that is simply the biggest contributor to greenhouse gases in the atmosphere'. (R15)*

Mental scheme 4: Sensory perceptions. The fourth less frequently used mental scheme related to the sensory. When elements were associated with negative sensory perceptions, they were categorised as air pollution on that basis. For example, particulate matter caused by traffic was associated with a perceptible odour.

> *'I think you notice that when you come outside. Then you smell it and feel it and it doesn't feel good'. (R30)*

Besides odour, sight proved to be also important in the perception of air pollution. For example, one respondent remarked in relation to particulate matter caused by traffic:

> *'Yes, you notice it when it rains. Then the sky is grey and if you look at the raindrops, you can see that they are not entirely clear. That there are particles in them'. (R37)*

Mental scheme 5: Functionality of the element. A final least frequently used mental scheme, related to the perceived functionality of the element. Certain elements were not categorised as air pollution because of their function within a particular ecosystem. For example, water vapour was not perceived as air pollution as it is part of a natural cycle.

> *'Water vapour, no, that's just rain. That falls down and that is part of the cycle'. (R21)*

Methane caused by the intestinal system of cattle' was not perceived as air pollution by some respondents as it was associated with manure and manure was perceived as good for the soil.

> *'No, methane is not an air pollutant. It is an energy that we can use. It is a raw material'. (R46)*

The element 'pollen' was not categorised as air pollution because of its link with green elements in the neighbourhood.

> *'For me it is, because I have hay fever. But is that air pollution? Not ultimately, except for people. That's not actually air pollution but I would still prefer, no I don't want less pollen because that means even less green, so yes. I don't see that as air pollution because I think that if there is pollen in the neighbourhood, there is also greenery in the neighbourhood. And because I don't think that's really bad for your health because ultimately that's just the, the fact that there are flowers growing or grass living. That seems to me to be rather a positive thing'. (R23)*

We conclude that different mental schemes with different dimensions were used to categorise or not elements as air pollution. We did not observe unanimity in the use of these mental schemes: different mental schemes were used by different respondents, but also within one and the same respondent. Frequently, different mental pictures were weighed against each other about an element, whereby respondents nuanced or questioned the categorisations they had made.

'Yes, in the strictest sense of the word, I think that is air pollution. It causes the air quality in the immediate vicinity of the volcano to drop drastically and become very unhealthy. On the other hand, I am now contradicting myself because I just said that it is man-made and a volcanic eruption is not man-made but I would still classify it as air pollution'. (R29)

'Ok, health is important to me, but to me climate is still ahead of health in the sense that if our climate is all fucked up, which we are doing well, then we have nothing to worry about in terms of our health because we are not going to be here anyway. So for me, climate is ahead of health'. (R14)

Is perceived air pollution perceived as problematic by the public? (Ethic)

If people are to be mobilised to reduce air pollution, it is important that elements categorised as air pollution are problematized. Our data showed that categorised elements were not always problematized to the same extent by our respondents. We therefore examined why specific forms of air pollution are problematized, while others are not. We identified 2 mechanisms that influence the extent to which air pollution is relativized or problematized: comparative problematisation and perceived avoidability of emissions.

Comparative problematisation. Comparative problematisation resulted in the problematisation or conversely in the relativisation of perceived air pollution. Comparative problematisation contained several dimensions: a spatial dimension, a time dimension and a source dimension.

In a spatial perspective, respondents relativized air pollution by claiming that air quality was worse elsewhere than in their own environment. Other respondents, on the other hand, polemised the existing air quality by comparing it with places where they felt air quality was better.

Some respondents put air pollution into perspective by comparing pollution levels with a past in which there was much more air pollution or by stating that it has always existed.

'Yes, particulate matter is pollution. I don't think we should attach the importance to it that we do now. That is something completely different. Because we can't say that the world has just become civilised from five years ago. Before five years ago there was no talk about that. There are many things that are now suddenly very important, but that is the way the media works. The way that influence works from all sides. Particulate matter has always existed. There is relatively less particulate matter than there used to be, despite the honking, because there used to be a lot of people who burned coal, or burned wood. A few hundred years ago there was a lot of particulate pollution. But now all of a sudden that's a hot topic. . . .And pollution from burning wood has always been there. It has been going on for six million years, when they were roasting mammoth legs on a wood fire'. (R2)

'And then there are the combustion residues of all kinds. Like CO emissions, particulates and so on. These have always been present. The stove in the Middle Ages, the open fire in the castles that was'. (R8)

Other respondents, on the other hand, problematized the current air quality by comparing it with a past in which, according to them, air pollution was much more limited.

Several respondents balanced different forms or sources of air pollution against each other. Certain forms or sources were seen as worse and therefore more problematic. For example, particulate matter caused by forest fires was generally perceived to be less problematic than air pollution from cars. Factories and cars were perceived as not natural while forest fires were generally considered as natural.

'I would say yes and no. Yes, that (particulate matter caused dose fires) makes the air dirty but that is not as bad as factories or cars because it comes from nature. The others are manufactured substances and they are worse than fire from nature'. (R50)

Perceived avoidability. Another mechanism influencing the problematisation of air pollution was its perceived avoidability. Air pollution was often problematized when it was perceived as avoidable. When it was perceived as inevitable, it was often relativised.

'So what can be mitigated as a negative effect from human action, I do think is pollutant and so I also think that due attention should be paid to mitigating it'. (R8)

For example, 'particulate matter caused by traffic' was perceived as problematic air pollution when it was considered avoidable, whereas 'particulate matter caused by forest fires' was not considered as problematic when forest fires were seen as a natural phenomenon making them unavoidable. As a result, particulate matter from an ignited forest fire was problematized where particulate matter from an ignited forest fire was relativised.

'It is the smoke from the fire that remains in the air but it is not done intentionally. It's just a natural disaster and no one can really do anything about it'. (R20)

Similarly, categorised air pollution consisting of 'particulate matter caused by volcanic eruptions' was never perceived as problematic as respondents considered it as unavoidable.

'From a purely material point of view, yes. If that is a natural phenomenon. Radioactive radiation is also there as a natural phenomenon. Is that positive or negative, no, it is there. That is a fact. . . .The forest fires in Brazil are an example of a forest fire that is not a natural phenomenon. It is malicious. But if pollution arises from a natural phenomenon, there is no way around it. Then you have to accept that natural phenomenon and its consequences'. (R8)

'That's like those forest fires. That's not intentional but it's bad. It's still bad but just the fact that it's not intentional, it's ok'. (R20)

Another example relates to 'particulate matter caused by burning wood'. When wood was burnt for fun and therefore perceived as avoidable, it was problematized; when wood was burnt for survival to heat or cook on, the resulting air pollution was put into perspective as it was considered unavoidable.

'I keep playing with the tension you can find between the causing or the natural process. A wood-burning stove is effectively polluting. Can it be replaced? If that wood-burning stove is to serve only to see a bit of atmospheric pleasant flames, then I would say, maybe not so much. If it is necessary to heat you, then yes'. (R8)

The same reasoning was applied to the categorisation of 'cigarette smoke' as air pollution. For the following respondent, the 'avoidability' of cigarette smoke determined the extent to which it was problematized.

'Smoking is disturbing to the environment, it is polluting. It is air pollution because it is a negative consequence of an action that can be avoided'. (R8)

Discussion, Limitations, Further Research and Conclusion

Discussion

The aim of this research was to understand the perception of air pollution by the public in the BCR. We investigated this perception through 4 sub-questions that approached the topic of perception each from a different but complementary angle: definition, association, categorisation and problematisation.

The first dimension investigated how the public defines air pollution. Data showed that respondents depict air pollution solely as a consequence of human activity, thereby portraying the car as the main source of air pollution without referring to specific pollutants such as NO_2, O_3 or PM. This observation aligns with the findings of Dimitriou and Christidou.[19]

A recurrent theme in definitions is the negative health impact of air pollution. Respondents refer to health in general terms and tend to link this negative impact to 'vulnerable' groups in society rather than to their own health. Furthermore, in line with earlier research, respondents refer in their definitions to sensory sources and manifestations of air pollution. The most frequent mentioned pollutant was PM, the most tangible of all. Intangible pollutants such as NO_2, or SO_2 were not noticed at all.

The second dimension that we studied concerned the associations that air pollution evokes in the public. The gathered data partially overlapped with the data gathered on definitions but were complementary and gave more detail. Respondents seemed partial in identifying sources of air pollution and in identifying negative health outcomes derived from these sources. They also made associations that deviate from scientific knowledge and that demonstrated ambiguities and misunderstandings about air pollution. Finally, respondents seemed to perceive air pollution as an exclusively urban phenomenon caused by 'the other'.

Related to the perception of the public about the health impact of air pollution, 3 insights are relevant. First, nevertheless the negative impact of air pollution was central in the definitions of, the associations with and the categorisation of air pollution, it was not mentioned by all respondents. In line with former research, a relatively big share of people does not consequently link air pollution to health problems.[19,26]

Second, when reference is made to health impacts of air pollution this is done in a general and often partial way. Former research stated that people's perceptions tend to be influenced less by scientifically derived information and more by local and personal experiences.[31] These experiences are more acute and relate more easily to respiratory complaints than other long-term impacts that are less obvious from the perspective of the public (eg, cognition and depressive symptoms). Third, respondents tend to link the negative health impact of air pollution to vulnerable groups rather than to their own health.

These insights contrast with the established scientific body of knowledge showing a diverse set of serious, often long lasting negative impacts of air pollution on health for all. These scientific insights obviously do not reach the public, which results in an under-estimation of the health impact associated with air pollution. Respondents clearly underestimate the probability and the severity of the harm resulting from air pollution. This has implications for their health risk perception. A study on the relationship between perceived likelihood of a threat, perceived severity of a threat and the motivation to act, established an interaction between likelihood and severity. The motivation to take precautions essentially vanished when either probability or severity was perceived as zero.[32] Also Bickerstaff and Walker[33] found that their respondents related air pollution to poor health at a general level and that only few identified health problems directly affecting themselves. People might not deny the health risk of air pollution but its personal effect as a psychological reaction to avoid psychic anxiety.

Our results also emphasise that perceptions of air pollution are context dependent. Respondents refer to pollution sources that are part of their daily lives and the society they are living in. The emphasis that Brussels respondents lay on the car as the most important source of air pollution and the agreement among them that PM resulting from traffic is air pollution is an illustration of this. Indeed, at the time of the interviews, there was a lot of debate about the polluting impact of cars and civil society (Filter Café Filtré) was protesting against car traffic near schools in different neighbourhoods across the city. It is illustrated that local actions, media and social networks can impact public perception about air pollution.[34] This partial focus on cars as the main source of air pollution might however result in an underestimation of the actual exposure to air pollution from other sources. For NO_2, 44% of the concentrations in the BCR originate from traffic[35] but for PM_{10}, 59% of the emissions is caused by the heating of buildings and (only) 38% by the transport sector.[36]

The third dimension related to the categorisation of elements as being air pollution and the reasons behind this categorisation. Our research led to the identification of 5 mental schemes present during the categorisation and identification processes related to air pollutants. These schemes allow for a

better understanding of the hidden, partly unconscious rationales behind such processes. However, there was no unanimity about the categorisation of elements as being air pollutants or not, except for PM caused by traffic.

This categorisation of elements as being air pollution did not happen in a vacuum but in a specific context that influenced this process through 5 mental schemes: the origin of the element, its health impact, its impact on the climate, sensory perceptions and functionality of the element.

Our respondents – especially the younger ones – seemed very concerned about the climate. At the time of the interviews, weekly manifestations were organised and frequented by many students to stress the importance of climate action. However, respondents blur the distinction between climate problems and environmental problems. This distinction made by the scientific community seems absent among the public. And indeed, nevertheless different problems, air pollution and climate change are intertwined.[37] Air quality is closely linked to the earth's climate and ecosystems globally. Many of the drivers of air pollution (ie, combustion of fossil fuels) are also sources of greenhouse gas emissions. Policies to reduce air pollution, therefore, can for many pollutants offer a 'win-win' strategy for both climate and health, lowering the burden of diseases attributable to air pollution and contributing to the near- and long-term mitigation of climate change.[38-40] Linking the topic of air pollution to climate change in sensitising communications might thus increase the motivation of the public to support specific measures aimed at limiting air pollution.

Saksena[14] already stated that if air pollution is not recognised as such, one will not act upon it. We agree with this statement but argue that an extra step is required for action to be undertaken once air pollution has been 'identified' or recognised: problematisation. Therefore, a fourth dimension of the perception about air pollution that we studied was its problematisation.

Respondents tended to problematize or on the contrary to relativize the identified air pollution through comparative problematizing or through the perceived avoidability of the identified air pollution. We identified 3 dimensions of comparative problematisation, a spatial dimension, a time dimension and a source dimension. Related to the avoidability of the identified air pollution, it is often problematized when it is perceived as avoidable. Whereas when it is perceived as inevitable, it is often relativised.

The observed relativisation of the problematic character of (identified) air pollution through comparative problematizing aligns with a disassociation strategy that has been labelled by others as 'othering'.[41]

The observation that the avoidability of the identified air pollution is linked to its problematisation, aligns partly with earlier research. Xu et al.[21] found in this respect that when people feel powerless about an issue which they have to bear with, that they tend to allocate little concern to it.

Our research contributed to a better understanding of how the public in Brussels perceive air pollution.

This research illustrates that the notion of air pollution is difficult for the public to conceptualise. The public's perceptions are diverse, subjective and often deviate from the way in which air pollution is conceptualised by the scientific community.

It should increase the awareness among experts and policy makers that perceptions about air pollution are far from universal and consensual but on the contrary individual and contested. These insights are highly relevant: to fight air pollution, it is key that all actors communicate at the same conceptual level. Important is that health promoters are/become aware that there might be a communication bias because of different perceptions about air pollution. There is indeed room and need for communication/information/sensitisation about the negative impacts of air pollution on health taking the severity and the probability of its impact into account, the different sources of air pollution, and the different ways to combat it.

To develop successful health campaigns and sensitisation strategies and to find carrying capacity for the implementation of policy measures to fight air pollution, an understanding of the perceptions of the 'target group' is key.

There is no room to elaborate on how these health campaigns and sensitisation strategies should look like concretely, but we think that it is worthwhile to give some relevant suggestions that were touched upon by our respondents during the interview. It is important to take into account the trustworthiness of the information sources,[31,41] the scale of the information,[33,42,43] the comprehensiveness of information[31,33,44] and the degree of affect in information.[45,46]

Limitations and further research

This study has several limitations.

Firstly, a bias might have occurred resulting from the recruitment of the respondents. Those willing to do an interview – knowing that it was about public green spaces (they didn't know in advance that another important part of the interview was on air pollution) – might have been more 'nature-minded' resulting in the recruitment of profiles that were more against the perceived main contributor of air pollution 'the car'. However, since we were aware of this potential bias during the recruitment phase, we decided to provide an incentive of 15 euros in cash in order to also attract a diverse mix of people, some ecology-minded, some not. Some of the respondents motivated by this incentive to participate in the interview might have not been intrinsically motivated to participate but this was seen as an advantage to increase the diversity of profiles and perceptions in the research.

Secondly, concerning the problematisation of identified air pollution, our results were only partial since this topic was initially not the focus of our research and questions did not

explicitly focus on this topic. However, since it appeared relevant, we dedicated attention to and reported about it. Other research explicitly focussing on the topic, identifies more factors that influence the concern related to air pollution such as personal health experiences, uncontrollability or powerlessness, crowding-out effects, perceived benefits, perceived fairness, delays of health effects and habituation.[21]

The identification of the different mental schemes to categorise elements as being air pollution or not, is novel. Further research could further finetune and compare these results. First, it would be interesting to investigate through quantitative research methods, whether different social groups – in terms of age, sex, socioeconomic situation or socio-cultural background – tend to rely on specific mental schemes to further finetune understandings about how perceptions develop and their implications for targeted health campaigns and sensitisation strategies. Another interesting research project could investigate whether different social groups have different associations with air pollution. Secondly, if perceptions are context-dependent, it would be interesting to repeat this research in a totally different social, cultural or political context. In this respect Douglas[47] developed a 'cultural theory' of risk in which she considers dirt – and pollution – as a 'matter out of place' in terms of the range of powers and dangers symbolically constructed in a cultural universe. She states that dirt is not a unique and isolated phenomenon. Where there is dirt, there is a symbolic system. Dirt is the by-product of an organisation and of a classification of matters that causes the rejection of non-appropriate elements. These elements are not on the right place according to a dominating or ruling symbolic system. Repeating this research in other places, in another cultural universes with other symbolic systems might be interesting to pinpoint differences and analogies between them.

Conclusion

This qualitative research investigated how the public in Brussels perceives air pollution and is an attempt to enrich the limited body of qualitative research in the field. We studied this perception from 4 different, complementary angles: definition, association, categorisation and problematisation.

This research illustrates that the notion of air pollution is difficult for the public to conceptualise and that their perceptions are diverse, subjective, context dependent and often deviate from conceptualisations and definitions by the scientific community.

Respondents underestimate the probability and severity of the harm involved and its problematisation depends on comparative strategies and its perceived avoidability. We identified 5 mental schemes by means of which elements are categorised, or not categorised by respondents as being air pollution: (1) the source of the element, (2) the health impact of the element, (3) the impact of the element on the climate, (4) sensory perceptions and (5) the functionality of the element.

We hope to have contributed to a better understanding of how the public in Brussels perceives air pollution and to an increased awareness among experts and policy makers that perceptions about air pollution are far from universal and consensual but on the contrary individual and contested. After all, these understandings and awareness are key in order to fight air pollution in a successful way through the development of effective and targeted health campaigns, sensitisation strategies in order to create common ground for the implementation of measures to fight air pollution successfully.

NOTE

1. Elements here refer to particulate matter from different sources, smoke, pollen, ammonia, methane and water vapour. These elements form the basis for our analysis. Elements should thus not be understood as defined from a chemistry or physics point of view as substances that cannot be broken down into simpler components by any non-nuclear chemical reactions.

REFERENCES

1. WHO. *New WHO Global Air Quality Guidelines Aim to Save Millions of Lives From Air Pollution*. Published 2021. Accessed February 21, 2022.
2. WHO. Ambient air pollution data. Published 2022. Accessed February 21, 2022. https://www.who.int/data/gho/data/themes/air-pollution/ambient-air-pollution
3. Rajagopalan S, Al-Kindi SG, Brook RD. Air pollution and cardiovascular disease. *J Am Coll Cardiol*. 2018;72:2054-2070.
4. Health Effects Institute. *State of Global Air: A Special Report on Global Exposure to Air Pollution and Its Disease Burden*. Health Effects Institute; 2018. https://www.stateofglobalair.org/resources?resource_category=All&page=1
5. Sass V, Kravitz-Wirtz N, Karceski SM, Hajat A, Crowder K, Takeuchi D. The effects of air pollution on individual psychological distress. *Health Place*. 2017;48:72-79.
6. Casas L, Cox B, Bauwelinck M, Nemery B, Deboosere P, Nawrot TS. Does air pollution trigger suicide? A case-crossover analysis of suicide deaths over the life span. *Eur J Epidemiol*. 2017;32:973-981.
7. Malagón-Rojas JN, Parra-Barrera EL, Toloza-Pérez YG, et al. Assessment of factors influencing personal exposure to air pollution on main roads in Bogota: a mixed-method study. *Preprints*. 2022;58:1125.
8. Buoli M, Grassi S, Caldiroli A, et al. Is there a link between air pollution and mental disorders? *Environ Int*. 2018;118:154-168.
9. Chen S, Oliva P, Zhang P. Air pollution and mental health: evidence from China. *NBER Work Pap Ser*. 2018:1-53.
10. Clifford A, Lang L, Chen R, Anstey KJ, Seaton A. Exposure to air pollution and cognitive functioning across the life course—a systematic literature review. *Environ Res*. 2016;147:383-398.
11. Chen H, Kwong JC, Copes R, et al. Exposure to ambient air pollution and the incidence of dementia: a population-based cohort study. *Environ Int*. 2017;108:271-277.
12. Saenen ND, Martens DS, Neven KY, et al. Air pollution-induced placental alterations: an interplay of oxidative stress, epigenetics, and the aging phenotype? *Clin Epigenetics*. 2019;11:124-214.
13. Noël C, Vanroelen C, Gadeyne S. Qualitative research about public health risk perceptions on ambient air pollution. A review study. *SSM Popul Heal*. 2021;15:100879. doi:10.1016/j.ssmph.2021.100879
14. Saksena S. Public perceptions of urban air pollution risks. *Risk Hazards Crisis Public Policy*. 2011;2:19-37.
15. Slovic P. *The Perception of Risk*. Earthscan Publications; 2000.
16. Baldwin C, Cave B, Rawstorne P. Measuring the impact of public understandings of risk from urban and industrial development on community psychosocial well-being: a mixed methods strategy. *Int J Community Well-Being*. 2020;3:57-82.
17. Lima ML. On the influence of risk perception on mental health: living near an incinerator. *J Environ Psychol*. 2004;24:71-84.
18. Pidgeon NF, Hood C, Jones D, Turner BA; Royal Society Study Group. Risk perception. In: *Risk Analysis, Perception and Management*. Royal Society; 1992:89-134.

19. Dimitriou A, Christidou V. Pupils' understanding of air pollution. *J Biol Educ*. 2007;42:24-29.
20. Muindi K, Egondi T, Kimani-Murage E, Rocklov J, Ng N. "We are used to this": a qualitative assessment of the perceptions of and attitudes towards air pollution amongst slum residents in Nairobi. *BMC Public Health*. 2014;14:226-229.
21. Xu J, Chi CSF, Zhu K. Concern or apathy: the attitude of the public toward urban air pollution. *J Risk Res*. 2017;20:482-498.
22. Cisneros R, Alcala E, Schweizer D, Burke N. Smoke complaints caused by wildland fire in the southern Sierra Nevada region, California. *Int J Wildland Fire*. 2018;27:677-683.
23. Ramaswami A, Baidwan NK, Nagpure AS. Exploring social and infrastructural factors affecting open burning of municipal solid waste (MSW) in Indian cities: a comparative case study of three neighborhoods of Delhi. *Waste Manag Res*. 2016;34:1164-1172.
24. Reeve, I., Scott, J., Hine, D. W., & Bhullar, N. (2013). "This is not a burning issue for me": How citizens justify their use of wood heaters in a city with a severe air pollution problem. *Energy Policy*, 57, 204-211. https://doi.org/10.1016/j.enpol.2013.01.042
25. Day R. Place and the experience of air quality. *Health Place*. 2007;13:249-260.
26. Ngo NS, Kokoyo S, Klopp J. Why participation matters for air quality studies: risk perceptions, understandings of air pollution and mobilization in a poor neighborhood in Nairobi, Kenya. *Public Health*. 2017;142:177-185.
27. N. Wat is een schema in de psychologie? Definitie en voorbeelden. Published 2019. Accessed December 21, 2021. https://www.greelane.com/nl/science-tech-math/sociale-wetenschappen/schema-definition-4691768/
28. Baldwin MW. Relational schemas and the processing of social information. *Psychol Bull*. 1992;112:461-484.
29. Bryman A. *Social Research Methods*. 2nd ed. Oxford University Press; 2004.
30. BISA. FOCUS NR.32 Brusselse Huishoudens En de Auto. 2017. https://bisa.brussels/nieuws/brusselse-huishoudens-en-de-auto
31. Bickerstaff K, Walker G. Clearing the smog? Public responses to air-quality information. *Local Environ*. 1999;4:279-294.
32. Weinstein ND. Perceived probability, perceived severity, and health-protective behavior. *Health Psychol*. 2000;19:65-74.
33. Bickerstaff K, Walker G. The place(s) of matter: matter out of place – public understandings of air pollution. *Prog Hum Geogr*. 2003;27:45-67.
34. Hong W, Wei Y, Wang S. Left behind in perception of air pollution? A hidden form of spatial injustice in China. *Environ Plann C Polit Space*. 2022;40:666-684.
35. Leefmilieu Brussel.Luchtkwaliteit: concentratie van stikstofdioxide (NO_2). Published 2021. Accessed February 20, 2022. https://leefmilieu.brussels/het-leefmilieu-een-stand-van-zaken/volledige-versie/lucht/luchtkwaliteit-concentratie-van-stikstofdioxide-no2
36. Leefmilieu Brussel. Emissie van fijne deeltjes (PM10).
37. European Environment Agency. *Air Quality in Europe—2018 Report*. Copenhagen; 2018. doi:10.2800/777411
38. European Environment Agency. *Air Quality in Europe—2015 Report*. 2015. papers2://publication/uuid/1D25F41B-C673-4FDA-AB71-CC5A2AD97FDD
39. Kuylenstierna JCI, Hicks WK, Cinderby S, Vallack HW, Engardt M. Benefits of integrating air pollution and climate change policy. *Water Air Soil Pollut*. 2001;130:1175-1180.
40. European Commission. Air pollution and climate change. 2010. https://ec.europa.eu/environment/integration/research/newsalert/pdf/24si_en.pdf
41. Bush J, Moffatt S, Dunn C. Even the birds round here cough. *Health Place*. 2001;7:47-56.
42. Bickerstaff K, Walker G. Public understandings of air pollution: the "localisation" of environmental risk. *Glob Environ Change*. 2001;11:133-145.
43. Moffatt S, Bush J, Dunn C, Howel D, Prince H. *Public Awareness of Air Quality and Respiratory Health and the Impact of Health Advice*. University of Newcastle; 1999.
44. Bush J, Moffatt S, Dunn CE. Keeping the public informed? Public negotiation of air quality information. *Public Underst Sci*. 2001;10:213-229.
45. Guo Y, Li Y. Online amplification of air pollution risk perception: the moderating role of affect in information. *Inf Commun Soc*. 2018;21:80-93.
46. Slovic P. The more who die, the less we care. In: Slovic P, ed. *The Feeling of Risk: New Perspectives on Risk Perception*. Routledge, 2013. doi:10.4324/9781849776677
47. Douglas M. *De La Souillure*. La Découverte; 1992.

Appendices

Appendix 1. Characteristics respondents.

R NO	AGE	GENDER	MIGRATION BACKGROUND	SOCIO-ECONOMIC SITUATION
R1	37	Female	Belgium	Middle/high
R2	51	Female	Belgium	Middle/high
R3	16	Female	Sub-Sahara Africa	Middle/high
R4	18	Male	Turkey	Low
R5	16	Female	Southern Europe	Middle/high
R6	17	Male	Sub-Sahara Africa	Low
R7	67	Female	Belgium	Middle/high
R8	67	Male	Belgium	Middle/high
R9	59	Female	Northern Africa	Middle/high
R10	18	Male	Sub-Sahara Africa	Low
R11	24	Male	Belgium	Middle/high
R12	25	Male	Belgium	Middle/high
R13	29	Female	Belgium	Middle/high
R14	17	Female	Belgium	Middle/high
R15	17	Male	Middle East	Low

(Continued)

Appendix 1. (Continued)

R NO	AGE	GENDER	MIGRATION BACKGROUND	SOCIO-ECONOMIC SITUATION
R16	18	Male	Northern Africa	Low
R17	53	Female	Belgium	Low
R18	74	Female	Belgium	Low
R19	17	Female	Belgium	Middle/high
R20	18	Female	Turkey	Middle/high
R21	18	Female	Sub-Sahara Africa	Low
R22	18	Female	Northern Africa	Middle/high
R23	29	Female	Belgium	Middle/high
R24	56	Female	Belgium	Middle/high
R25	42	Female	Northern Africa	Low
R26	49	Female	Northern Africa	Low
R27	70	Female	Belgium	Low
R28	75	Female	Belgium	Middle/high
R29	28	Male	Belgium	Middle/high
R30	27	Female	Belgium	Middle/high
R31	42	Male	Sub-Sahara Africa	Low
R32	40	Female	Belgium	Middle/high
R33	40	Female	Northern Africa	Middle/high
R34	26	Female	Northern Africa	Middle/high
R35	80	Female	Belgium	Middle/high
R36	25	Male	Asia	Middle/high
R37	37	Female	Turkey	Low
R38	65	Female	Northern Africa	Low
R39	29	Female	Northern Africa	Low
R40	23	Female	Belgium	Low
R41	22	Female	Turkey	Low
R42	68	Male	Belgium	Middle/high
R43	63	Female	Belgium	Low
R44	30	Female	Northern Europe	Middle/high
R45	25	Female	Belgium	Middle/high
R46	40	Female	Belgium	Middle/high
R47	31	Female	Belgium	Middle/high
R48	26	Female	Belgium	Middle/high
R49	18	Female	Sub-Sahara Africa	Middle/high
R50	18	Female	Northern Africa	Low
R51	72	Female	Belgium	Middle/high

Appendix 2

Additional information on which elements were perceived as air pollution and why?. In order to answer research questions 3 and 4, the answers to the following question were analysed: 'I am going to list some elements. I am going to ask you each time, is this element according to you air pollution yes or no? Then I am going to ask you why you think this element is or is not air pollution. This question is not intended as a test. It does not matter whether your answer is right or wrong. All I want to understand is the reasoning behind your answer'.

This question was not meant to gauge the respondent's knowledge, but to get a picture on the basis of which mental schemes the respondent does or does not perceive a specific element as being air pollution. The following elements were discussed (always in the same order):

- Particulate matter caused by forest fires
- Cigarette smoke (secondary smoke)
- Pollen
- Particulate matter caused by wood burning (stove)
- Ammonia from manure
- Methane caused by the intestinal system of livestock
- Water vapour
- Particulate matter caused by traffic
- Particulate matter caused by volcanic eruptions

The different elements were chosen in such a way that there was variation in different pollutants. We also created a variation of sources within the same element 'particulate matter' and a variation of sources within the particulate matter pollutant (forest fires, wood burning, traffic, volcanic eruptions). We also provided variation in elements from natural sources and from anthropogenic sources. We also included elements that are by definition not air pollution (pollen, water vapour) but are potentially perceived as such.

In order to avoid guessing and meaningless reflections, the respondent was clearly told that if he or she really had no idea to what extent the element was or was not air pollution, or even did not know the element, this was no problem and would not be further asked. For example, there were several respondents who could not say anything about ammonia from manure and methane caused by the intestinal system of cattle. Also, not everyone was familiar with the element particulate matter.

Furthermore, it should be specified that respondents did not find this an easy exercise and their answers were often formulated in the form of 'I think' rather than 'I am sure'.

Within the framework of this exercise, respondents were also confronted with inconsistencies of their own answers in order to obtain a deeper reflection and more refined answers.

Appendix 3. Frequency table for categorising elements as air pollution or not.

	I DON'T KNOW	YES, IT IS AIR POLLUTION	NO, IT IS NO AIR POLLUTION	NO UNAMBIGUOUS ANSWER	MISSING
Particulate matter caused by forest fires	2	43	2	2	2
Cigarette smoke (secondary smoke)	0	41	5	2	3
Pollen	2	4	38	5	2
Particulate matter caused by wood burning (stove)	1	40	2	3	5
Ammonia from manure	13	22	8	4	4
Methane caused by the intestinal system of livestock	12	27	7	1	4
Water vapour	4	4	36	3	4
Particulate matter caused by traffic	0	46	0	0	5
Particulate matter caused by volcanic eruptions	7	27	8	5	4

Appendix 4. An overview of the mental schemes used per element (an 'X' indicates that for the elements in the left column, the classification of an element as air pollution happened or through 'knowledge' that an element is air pollution [first column] or through the application of different mental schemes).

	KNOWLEDGE	MENTAL SCHEME 1: ORIGIN	MENTAL SCHEME 2: IMPACT ON HEALTH	MENTAL SCHEME 3: IMPACT ON THE CLIMATE	MENTAL SCHEME 4: SENSORY PERCEPTIONS	MENTAL SCHEME 5: FUNCTIONALITY
Particulate matter caused by forest fires	X	X	X	X		
Particulate matter caused by wood burning (stove)	X	X	X	X	X	
Particulate matter caused by traffic		X	X	X	X	
Particulate matter caused by volcanic eruptions		X	X	X	X	
Cigarette smoke (secondary smoke)	X	X	X	X	X	
Ammonia from manure	X	X	X			X
Methane caused by the intestinal system of livestock	X	X		X		X
Pollen		X	X			X
Water vapour		X	X			X