sustainability

MDPI

Article

Health Impact Assessment to Promote Urban Health: A Trans-Disciplinary Case Study in Strasbourg, France

Guilhem Dardier [1,*], Derek P. T. H. Christie [2,3,*], Jean Simos [2], Anne Roué Le Gall [1], Nicola L. Cantoreggi [2], Lorris Tabbone [4], Yoann Mallet [4] and Françoise Jabot [1]

1. Univ Rennes, EHESP, CNRS, ARENES–UMR 6051, 35000 Rennes, France
2. Institut de Santé Globale, Université de Genève, Campus Biotech, 9, Chemin des Mines, 1202 Genève, Switzerland
3. School of Health Sciences Fribourg, HES-SO University of Applied Sciences and Arts Western Switzerland, 1700 Fribourg, Switzerland
4. Ecole des Hautes Études en Santé Publique (EHESP), 15 Avenue du Professeur Léon-Bernard, 35043 Rennes, France

* Correspondence: guilhem.dardier@ehesp.fr (G.D.); derek.christie@unige.ch (D.P.T.H.C.); Tel.: +33-299-022-600 (G.D.)

Abstract: Health Impact Assessment (HIA), an inherently trans-disciplinary approach, is used to help evaluate and improve projects or programmes in sectors such as transportation, where new infrastructure is likely to have effects on health. This article describes the screening, scoping, appraisal, and recommendation steps of an HIA on a new 24 km highway around the conurbation of Strasbourg, France. Methods included a literature review and quantitative estimates of the health effects of air pollution and noise. Although planned, interviews and focus groups proved impossible due to political and administrative difficulties. In replacement, answers to a related public inquiry were submitted to a secondary, thematic analysis. The new infrastructure is likely to create or help maintain some jobs in the short term and might accelerate certain journeys, but it does not seem able to improve local mobility and air quality issues. It crystallises the dissatisfaction of a part of the local population and raises the question of the transparency of the design and validation processes of major infrastructure projects. Despite an unfavourable political context, the HIA approach described in this article was able to overcome methodological difficulties and obstacles thanks to creative research methods and trans-disciplinarity to finally yield relevant information and suggestions for urban health promotion.

Keywords: health impact assessment; environmental health; transportation; secondary data; political context; trans-disciplinarity

check for updates

Citation: Dardier, G.; Christie, D.P.T.H.; Simos, J.; Roué Le Gall, A.; Cantoreggi, N.L.; Tabbone, L.; Mallet, Y.; Jabot, F. Health Impact Assessment to Promote Urban Health: A Trans-Disciplinary Case Study in Strasbourg, France. *Sustainability* **2023**, *15*, 8013. https://doi.org/10.3390/su15108013

Academic Editor: Roderick J. Lawrence

Received: 29 March 2023
Revised: 1 May 2023
Accepted: 4 May 2023
Published: 15 May 2023

1. Introduction

The crucial connection between transportation and health has been emphasised for many years by international agencies including the United Nations Economic Commission for Europe (UNECE) and the World Health Organization (WHO), through initiatives such as the Transport, Health and Environment Pan-European Programme (THE PEP). However, at a local level, there is little consensus about how tools such as Health Impact Assessment (HIA) might be used to investigate and/or improve road projects likely to have an impact on health. This article suggests a detailed analysis of a case study in France as a way forward. As HIA is only rarely used to investigate the building of new roads, this approach may prove useful for other projects or settings.

In eastern France, the A35 highway has cut through densely populated areas in the Strasbourg metropolitan area since opening to traffic in 1965, exposing many residents to environmental air pollution and noise (see Figure 1) (There is abundant documentation on these potential negative environmental and health impacts on the website of the French

Environmental Authority (https://www.igedd.developpement-durable.gouv.fr/ accessed on 30 June 2022), in particular, its report of 21 February 2018; the history of resistance to the COS project and other press kits can be found at: https://gcononmerci.org/ accessed on 30 June 2022). This is one of the reasons why, since the 1970s, the construction of a partial ring road to the west, Contournement Ouest de Strasbourg (COS), in French, has been considered to relieve the A35 of some of its traffic.

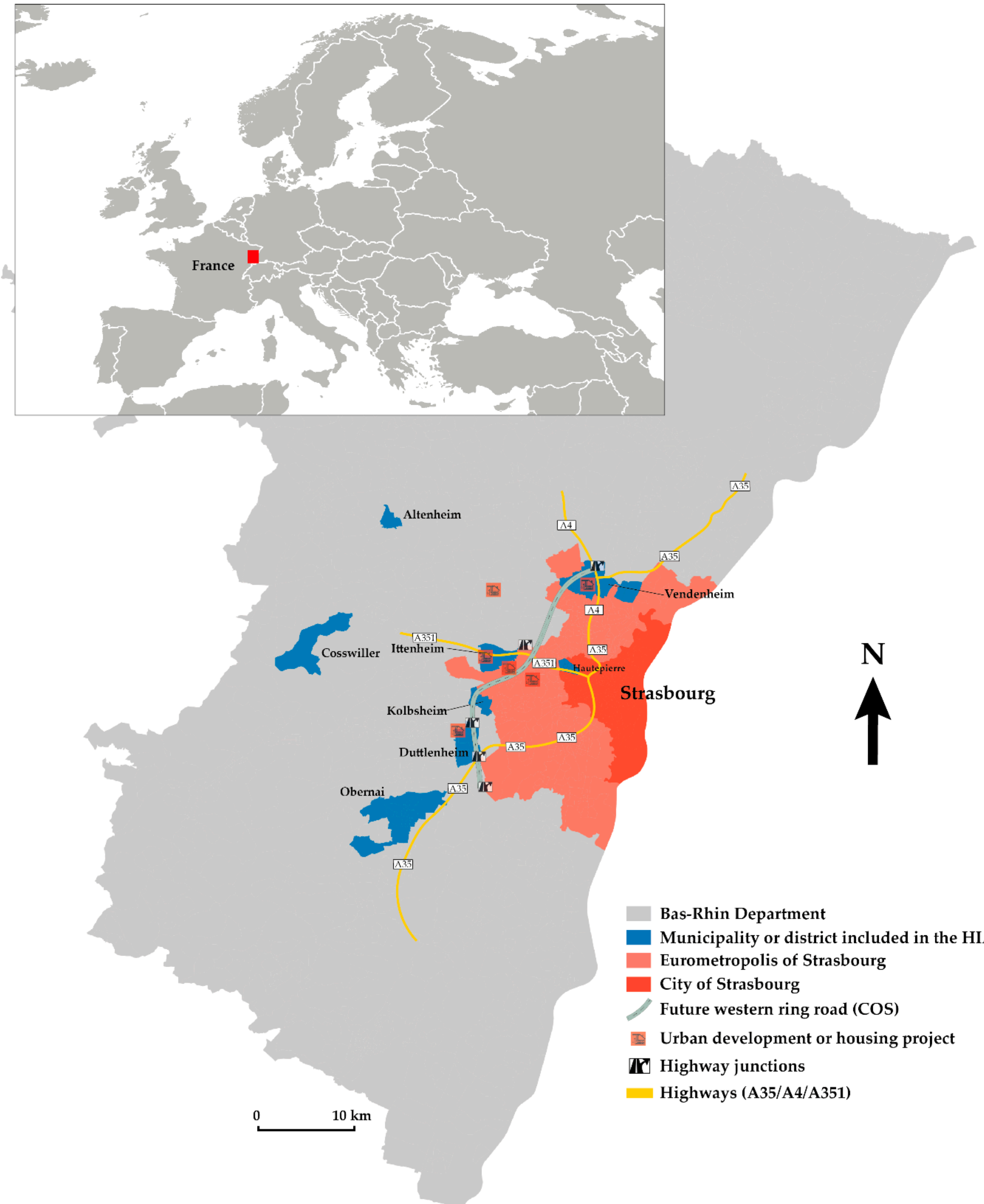

Figure 1. The new ring road (in grey) lies to the west of the more central pre-existing highway (the A35, in orange) [1].

The ring road project has been controversial ever since its genesis [2]. Up to 2017, criticism was mainly levelled at the expected increase in total traffic, as well as the environmental consequences in terms of air quality, biodiversity, and the transformation of natural environments. Despite being mentioned in the public debate, the potential impacts of this project on population health, in its various dimensions (physical, mental, social), were poorly documented. In late 2017, a group of elected representatives of the Euro-metropolis and the City of Strasbourg asked for this knowledge gap to be filled. For some of these officials, who were opposed to the construction of the new highway, the goal was also to obtain arguments to use in the public debate. To achieve these public health and political goals, they chose to commission a health impact assessment (HIA).

The HIA described in this article was launched in March 2018 and sought to analyse the potential impacts of the new road on population health.

Under the Gothenburg consensus, Health Impact Assessment (HIA) is a "combination of procedures, methods, and tools by which a policy, programme or project may be judged as to its potential effects on the health of a population and the distribution of effects within the population" [3]. HIA is sometimes considered together with environmental impact assessment (EIA); however, it has more in common with the policy appraisal process than with EIA [4]. The main differences between EIA and HIA, given that both are framed by a Pressure State Impact Response Framework, are discussed in Section 2.

Since the inception of HIA, its definitions and approaches have been subject to discussion. For example, a fundamental tension has been highlighted between a methodology seeking to quantify health impacts and a broader approach based on the social determinants of health [5].

Despite these difficulties, HIA remains a useful instrument to promote and safeguard public health, globally. It may even acquire more traction in the future thanks to the promising development of new system-level approaches such as planetary health [6,7]; and especially in relation to SDG 3 and SDG 11 [8,9].

HIA can be applied across many sectors. In practice, transportation is one of the areas where HIA has been used the most. However, a detailed analysis of the 96 projects in a recent review of transportation HIAs found none focusing on the construction of new roads [10].

Road traffic is a recognised source of noise, air pollution, stress, and accidents and is, therefore, an important source of health risks throughout the world. A global estimate using 2004 figures and based on traffic accidents alone placed the number of deaths at over 1.2 million and disability-adjusted life-years (DALYs) lost at over 40 million years, for an economic loss in excess of 167 billion USD [11]. Around ten years later, the estimates were in the range of 1.25 million deaths (based on 2013 figures), 70 million DALYs, and 74 billion USD (both based on 2015 figures). It is important to note that nearly 90% of the road accident-related DALYS in 2015 were lost in low-income and middle-income countries, whereas over half of the economic loss was in high-income countries [12].

Estimating the impact of traffic-related air pollution is challenging, because of the diverse nature of the various particulate and gaseous pollutants in outdoor air and because road traffic is only one of the sources of outdoor air pollution [13–16]. Nevertheless, several studies and reviews have shown that deaths and DALYs lost due to traffic-related air pollution are very high globally. For example, ambient $PM_{2.5}$ alone was the fifth-ranking mortality risk factor globally in 2015 and exposure to it caused around 4.2 million deaths and 103 million DALYs in 2015, representing 7.6% of total global deaths and 4.2% of global DALYs. Road traffic is not the only source of $PM_{2.5}$ and $PM_{2.5}$ is not the only pollutant produced by road traffic. However, it is striking that the deaths attributable to ambient $PM_{2.5}$ increased from 3.5 million in 1990 to 4.2 million in 2015. Exposure to ozone caused an additional 254,000 (95% UI 97,000–422,000) deaths and a loss of 4.1 million (1.6 million to 6.8 million) DALYs from chronic obstructive pulmonary disease alone in 2015 [17].

The purpose of this paper is to show that HIA is a procedure that, by mobilising the knowledge of numerous disciplines in a trans-disciplinary approach, can facilitate health promotion for individuals, communities, and larger urban populations. The COS case will illustrate this, and prove that even in a disadvantageous context, HIA can overcome political and administrative obstacles. Section 2 presents the general context of how new road infrastructure impacts health and the relative evidence base. Section 3 explains how HIA works, and the methods used during the assessment. Section 4 presents the main results, and, before the conclusion, Section 5 discusses trans-disciplinarity aspects and the context's complexities (geographical, methodological, and political).

2. Context and Literature Review

Due to their importance for health [18] and their concision in space and time, HIA has been viewed for a long time as a useful tool for investigating the intended and unintended health effects of road projects [19,20].

Six steps or phases are the hallmarks of the HIA process: screening; scoping; impact appraisal; recommendations; implementation; and monitoring and evaluation. The full HIA process has been described in detail elsewhere [4,21].

Community participation often forms an important part of HIA [22] but is not a sine qua non condition for it. Indeed, some authors have argued that the goals of collecting quantifiable data, and consulting stakeholders with the ultimate aim of empowering them and influencing policy, may enter into conflict with each other [23].

In May 2018, a stepwise online search was carried out by a single researcher (DPTHC) on 5 websites (Google, Google-Scholar, PubMed, ScienceDirect, and Web of Science/Web of Knowledge) using the following terms in combination: HIA, "health impact assessment", road, highway, freeway, motorway. Any articles referring to HIAs on road projects were selected. With a view to identifying road-related HIAs published outside the peer-reviewed literature, known websites related to HIA were also analysed using similar criteria/keywords. The same two-pronged review of the peer-reviewed and grey literature was carried out again in May 2020 and for a third time in September 2022.

In parallel, e-mails were sent to key researchers in the field (identified through their publications) to find out whether any HIAs had been missed. Then, the titles and the abstracts (when available) were read in order to ascertain whether the article (a) described an HIA; and (b) referred to a road construction project.

Articles were selected if they included at least the first four phases of the HIA process: screening; scoping; risk assessment; and recommendations. Studies that merely presented modelling exercises, even if they were labelled as HIAs, were excluded from the analysis. Initially, all articles describing projects including road construction were included. A short report was produced for each selected case study, with a description of the road project and the HIA methodology, with special attention to the health determinants that were used. These reports were submitted to the other authors for comments. A comparative analysis was then carried out by the entire team, between the selected projects, based on the type of road project, the type of HIA, and the array of health determinants that were described.

The online searches yielded a total of 83 potential HIAs on road construction projects. Analysis of a recent review article investigating HIAs in the USA between 2000 and 2017 [10] enriched with direct contacts with the researchers involved (B. Cole & K. MacLeod, personal communication) yielded a further 96 potential road construction HIAs. Careful analysis of all the project titles and abstracts identified in this way enabled these figures to be considerably reduced. First, nine of the roads related HIAs identified through the online search were in the list supplied by Cole & MacLeod. Second, among the remaining 87 HIAs, none corresponded to the building of new roads. They addressed projects that were expected to improve health and/or road safety: reducing speed limits, promoting active transportation and/or public transportation (transit), road pricing, the creation of roundabouts, transit subsidies (increase or decrease), etc. Among all the candidate HIAs, we identified only five which might potentially have to do with road construction. These we checked in detail and ascertained that they all dealt with pre-existing roads, which were to be transformed into "complete streets" or other schemes likely to lead to health benefits rather than an increase in health risks.

In all, only 15 articles were identified, none of which were published in peer-reviewed journals. These HIAs were then analysed as regards the health determinants that they studied. A closer look at the identified articles showed that only 4 related to the construction of new roads and a further 2 to highway expansion (see Table 1). Reverting to the results of our literature search, we realised that only one HIA on a new road project had been identified in the peer-reviewed literature, but after closer inspection, it turned out to follow a modelling methodology rather than an HIA methodology [24].

Table 1. The six identified HIAs related to road construction projects.

Project	Location	Type	Year
A483/A489 Newtown	UK, Wales	Several options including a new road	2009
Wrexham Industrial Estate	UK, Wales	Two new access roads	2009
Ortiz Avenue Road Widening	USA, Florida	Expansion (extra lanes)	2011
South Devon link road	UK, Devon	New road (bypass)	2012
M4 corridor enhancement measures	UK, Wales	Several options including a new road	2012

Our review shows that most of the health determinants investigated in HIAs related to road projects are social (lifestyles and behaviour, social and community cohesion/severance, economic conditions, etc.), rather than environmental (soil and water, noise and vibrations, air quality, and the natural environment, including green space and biodiversity). Another interesting aspect of these HIAs was their high degree of interdisciplinarity. Indeed, this fact must be compared to another observation already noted in the scientific literature and which would explain the discrepancy between the large number of EIAs already carried out on road projects and the very small number of HIAs carried out on similar proposals: the sectorisation linked to the proliferation of impact assessment tools, such as EIAs, which prevents a trans-disciplinary approach [25,26]. We further discuss trans-disciplinarity in Section 5, but this discrepancy calls into question the necessary integration of EIA with HIA. Thus, it is important to summarise the main differences and similarities between these two tools (see Table 2).

Table 2. A comparison between EIA and HIA approaches (adapted from [27]).

	EIA	HIA
Definition	Scientific, systematic, and preferably participatory analysis process: -the negative effects of a project on the environment in order to identify them, assess them, and adopt the necessary measures to avoid and mitigate them or, failing that, compensate for them, -positive impacts to improve them.	Combination of procedures, methods, and tools by which a policy, programme, or project may be judged as to its potential effects on the health of a population and the distribution of effects within the population. HIA identifies appropriate measures to manage these effects.
Objectives	Inform the decision-maker by providing an assessment of the environmental and social issues of the proposal, as well as the measures to be taken to improve it from both an environmental and social point of view, before the decision is made.	Inform the decision-maker by providing an assessment of the health issue (in the broad sense) of the proposal, as well as the measures to be taken to improve it in terms of public health and the distribution of costs and benefits, before the decision is made.
Position in the decision-making process	At the pre-project stage in the initiator's planning.	At the stage of the proposal (project or strategy or program or policy) formulation.

Table 2. *Cont.*

	EIA	HIA
Procedure	1. Screening 2. Scoping 3. Appraisal 4. Review and recommendations (decision) 5. Monitoring and follow-up	1. Screening 2. Scoping 3. Appraisal 4. Report and recommendations (decision) 5. Monitoring 6. Evaluation
Strengths	-Promotes interdisciplinarity and intersectorality. -Scientific approach, globally applied, and generally mandatory with a legal basis. -Involves a broad and diverse public in the decision-making process.	-Promotes trans-disciplinarity and intersectorality. -Scientific approach recognised and promoted by the WHO, with legal bases in certain jurisdictions, applied mainly voluntarily. -Participation of a targeted or broad public, depending on the nature of the issues and the level of socio-political concerns.
Limitations, weaknesses, or challenges	-Rigid legal, regulatory, and administrative frameworks that provide little flexibility. -Implementation is not always effective due to the weak commitment of the State and lack of funds, time, and expertise. -Instrumentalisation of the procedure that distorts its purpose. -Little learning from project to project due to lack of dissemination of monitoring and follow-up reports and lack of resources for effective monitoring.	-Difficulty in quantifying some health impacts. -Implementation is not always effective and efficient due to the low commitment of the State and lack of availability of funds, time, and expertise. -Lack of awareness and interest in health from other sectors. -Difficulty in demonstrating the value and short-term return on investment of voluntary HIA.

Nevertheless, our results show that HIAs on road projects tend to concentrate on a limited set of health determinants. This finding is supported by an HIA typology on "urban transport and planning in cities", which found that HIAs in this wide field were mainly considered under the angle of road safety [18]. Furthermore, our results also show that, although HIA has become relatively common, especially in the USA, its application to road projects is piecemeal. HIAs on new road projects are very rare both in the peer-reviewed and grey literature, compared to HIAs in other fields, including the refurbishment or modification of existing roads. Another recent, wide-ranging scoping review on HIAs related to transportation which identified 158 such studies confirm our findings [28].

Thus, HIA is very rarely being carried out in one of the areas where it is the most needed: on the many new roads that are currently being built, worldwide. We note that in many countries, such projects are submitted to compulsory environmental impact assessments, but not to compulsory HIA.

3. Materials and Methods

As mentioned in Section 1, the HIA process is structured in 6 steps. The initial step of screening (S1) defines whether a policy, programme, or project is amenable to HIA, and includes a brief examination of its potential links and health. Scoping (S2) determines the scope and terms of reference of the HIA: the type of assessment to be carried out, why, how, by whom, etc. It establishes boundaries for the HIA and thus its study area. In the appraisal step (S3), the potential of the project to affect health is assessed: it consists in evaluating the various positive and/or negative impacts on the health of the affected population, as well as the distribution of these impacts within the population. Reporting (S4) sets out the results of the assessment, presents the evidence, and contains recommendations that seek to minimise the negative impacts and maximise the positive impacts of the decision on health. Monitoring (S5) consists of setting up a mechanism to follow up on the implementation of the recommendations. Evaluation (S6) can be undertaken by analysing the conditions under which the HIA was carried out (process evaluation) and/or compliance with HIA standards (quality assessment). It should also assess the effectiveness and impact of the HIA on decision-making, representations, and practices, as well as its added value. HIA is a flexible and creative process that depends on available data and other types of information [4]. It uses tools from the medical (epidemiology), social, economic, and environmental sciences, in a multisectoral and trans-disciplinary perspective, where methods and theories from the different disciplines do not only coexist side-by-side (multidisciplinary) or are synthesised into "a coordinated and coherent whole" (interdisciplinary) [29], but merge to create new hybrid frameworks and new knowledge [30].

To identify and characterise the road project's impacts on health, the HIA described in this case study followed international practice standards from the screening step (S1) to the fourth step of recommendations and the drafting of the assessment report (S4).

During the screening step (S1), two tasks were carried out simultaneously. The first consisted in collecting and studying the available project documentation (including all the studies and reports related to the new ring road and the existing A35 highway) as well as meeting with the HIA and COS project promoters, coupled with a field visit. This work aimed to conduct a preliminary analysis of the project, its context, and the issues at stake, and to highlight the potential interest of an HIA. The second task was the literature review presented in Section 2, aiming to identify HIAs carried out on similar highway projects around the world and gather evidence on the relationships between transport on roads and health.

During the scoping step (S2), these data were used to determine the scope of the HIA, i.e., to select the determinants of health on which to focus for impact assessment. Thus, data were first used to identify the hypothetical impacts on health that the new project might have and develop the causal mechanisms and pathways that link them to the project. These hypotheses, represented in a causal model, were then confronted with the local health and social issues related to the project.

The selection of health determinants to be investigated was based on the following criteria:

(a) Territorial issues: does the determinant affected by the project contribute to the health status of local populations?
(b) Impacts nature and magnitude: is the determinant likely to be significantly affected by the project? Or is the determinant likely to significantly affect the health of the populations? Or are the effects of the project likely to be unevenly distributed among different population groups?
(c) HIA added value: can the approach provide new data and/or solutions in addition to the information already available?
(d) Data availability: will it be possible to mobilise and/or produce the necessary data to estimate the potential effects of the project on the determinant concerned?

Each health determinant was listed and prioritized in a scoping matrix (see Table 3). For the first three criteria (a-b-c), each health determinant was rated according to a scale of 3 (L-limited, M-medium, H-high) based on previous work. Those which received the highest rating on at least two criteria and no "limited" rating on the third criterion were ranked as priority 1 and retained. The others, rated as priority 2 or 3, were discarded. The fourth criterion (d) was applied in a second step. Determinants for which there was a clear lack of data were discarded. The determinants classified as priority 1 and satisfying the criterion of data availability (A = mainly available, B = partially available, C = not available) were therefore finally retained.

Based on this work, the evaluation team suggested narrowing down the scope of the HIA to ten determinants of health gathered in six categories: outdoor air quality, noise, mobility and access to healthcare services, traffic security, local development, and living environment. This choice was discussed and validated by the HIA commissioners during the first HIA steering committee meeting.

Table 3. HIA COS project scoping matrix.

	Inclusion Criteria			Priority	Exclusion Criteria	Selection
Determinant	**Territorial Issues**	**Impacts Nature & Magnitude**	**HIA Added Value**		**Data Availability**	
Outdoor air quality	H	H	M	1	A	Yes
Indoor air quality	H	M	M	2	C	No
Soils	M	M	L	3	A	No
Water	H	M	L	2	A	No
Natural hazards	M	H	M	2	A	No
Waste	L	M	L	3	A	No
Biodiversity	H	H	L	2	A	No
Temperature	H	H	L	2	A	No
Noise	H	H	M	1	B	Yes
Landscape ambiance	M	H	M	2	B	No
Light ambiance	L	M	H	2	C	No
Road safety	M	H	H	1	B	Yes
Mobility	H	H	M	1	B	Yes
Housing	H	M	M	2	C	No
Social cohesion	M	H	H	1	B	Yes
Discrimination	M	L	H	2	C	No
Employment	M	M	M	2	B	No
Economic development	H	H	M	1	B	Yes
Agriculture	H	H	M	1	B	Yes
Urban development	H	H	M	1	B	Yes
Physical activity	H	M	H	1	C	No
Food	H	M	H	1	C	No
Risk behaviours	M	L	H	2	B	No
Pace of life	M	H	H	1	C	No
Perceived environment	M	H	H	1	B	Yes
Economic resources	M	M	H	2	B	No
Access to services	H	H	M	1	B	Yes
Healthcare offer	H	L	M	2	A	No

During the impact appraisal step (S3), each of the six selected determinants of health was broken down into a set of questions associated with analytical variables and indicators. Then, the quantitative and qualitative data to answer these questions were identified and extracted from different studies, including the ring road environmental impact assessment (current and future traffic on both the existing A35 and the COS according to different project scenarios, current and estimated roadway noise levels and concentrations of $N0_2$ and $PM_{2.5}$ within our study area according to different project scenarios, total population and population density per km^2 within our study area, baseline all-cause mortality within our study area, citizens' and local stakeholders' opinions and views regarding the ring road, etc.). Finally, these data were analysed using the most appropriate methods and models: statistical data processing for outdoor air quality (using the WHO-promoted AirQ+

software), noise (Miedema and Oudshoorn model), and road accidents (Nilsson-Elvik or Power model); map-based approach for local development as well as mobility and access to health services; literature review for all determinants of health; NVivo qualitative analysis of the comments collected during the public inquiry on the COS project for all determinants of health, in particular local development and the living environment. The NVivo-assisted analysis of the public inquiry was conducted in two phases: an initial thematic analysis of extracts dealing directly or indirectly with the determinants of health included in the scope of the study (724 such extracts were identified), in order to try to understand how the project was likely to impact peoples' living environment and wellbeing and compare this information with the scientific literature; a second computer-assisted analysis of all the 1349 extracts in the public inquiry, to identify the links made by the contributors between the project, health determinants, and health outcomes. The goal was to establish a second causal model corresponding to these representations and compare it with the causal model based on the literature.

Once the analysis was completed for each health determinant, the results were compiled in a matrix where each identified positive or negative impact was characterised in terms of intensity, probability of occurrence, duration, geographical extent, affected groups, and effect on social and spatial health inequalities. This impact matrix made it possible to produce an overall estimate of the project's impacts on health, considering possible synergies and antagonisms between its various effects.

4. Results

4.1. Impacts on Outdoor Air Quality

Four scenarios, all for 2021, were considered: a "business as usual" scenario (Scenario 1), used as a baseline; a second scenario with the COS, the A35 upgrade, and the roll-out of the measures in the urban mobility plan (Scenario 2); a third scenario, with the three above-mentioned measures and a bus-only lane on the A35 (Scenario 3); and a fourth scenario opening the bus-only lane to high occupancy vehicles–HOV (Scenario 4). Their effects on air pollution and resulting mortality were compared using the AirQ+ software [31,32].

Without the ring road, we estimated that, in 2021, 4.9% of the annual deaths in Strasbourg will be attributable to NO_2 emissions and 3.7% to $PM_{2.5}$ emissions. In the other project scenarios, which imply both the creation of the bypass and the A35 upgrading, these proportions would be respectively 4.8% and 3.7%–an infinitesimal decrease.

At the metropolitan level, the share of annual deaths attributable to NO_2 in 2021 would be 4.3% in all project scenarios. This amounts to around 170 deaths per year. For $PM_{2.5}$, the share of annual deaths attributable would be 3.5% in 2021. This represents 138 deaths per year. Again, there is almost no difference between the scenarios.

Therefore, it seems that the new road and A35 upgrade would only have a very limited impact on local mortality attributable to outdoor air pollution. Yet, each year, an estimated 300 deaths attributable to $PM_{2.5}$ and NO_2 occur in the Strasbourg metropolitan area, with almost two-thirds of these deaths occurring in the city of Strasbourg itself (64% for NO_2 and 61% for $PM_{2.5}$).

4.2. Impacts on Noise

Three study scenarios were selected: (i) before the commissioning of the COS, i.e., the initial state (2017—reference situation); (ii) after commissioning of the COS and without acoustic protection (2040 COS); and (iii) after the commissioning of the COS and the implementation of acoustic protection measures (2040 COS AP).

In order to calculate the health effects of road noise according to these three scenarios, we used the model developed by Miedema and Oudshoorm [33–36]. We cross-referenced population data with (i) the results of the 2017 acoustic measurement campaigns; and (ii–iii) the distribution maps of the noise generated by the COS in 2040, without and with acoustic protection. Two estimates of the populations exposed to each sound level studied were made. If there was any doubt about the assignment of a sound level to a geographical band, the first estimate systematically assigned it the highest sound level (high hypothesis) while the second systematically assigned it the lowest sound level (low hypothesis).

The ring road is expected to slightly increase the number of people exposed to noise levels ranging from 43 to 68 dB(A), in a 1000-m corridor on either side of the road. This will result in negative effects on the health and quality of life of the affected populations, including an increase in the number of people likely to experience significant annoyance (an additional 1 to 4 percentage points of the study area population) and develop sleep disturbances: an additional 0.5 to 1.5 percentage points of the study area population (see Table 4). Although not calculated in our study, the excess risk of cardiovascular disease associated with the extra noise generated by the ring road should not be assumed to be zero. Ultimately, through the noise it generates in an initially quiet area, the ring road is likely to cause a loss of healthy life years in its neighbouring population. We would have liked to include the A35 upgrade in the analysis but, in the absence of data related to the project, it was not possible to consider its impact on roadway noise.

Table 4. The number of people likely to develop sleep disorders by noise level and scenario in the Strasbourg conurbation.

Light Level dB(A)	Number of People with Sleep Disorders–High Hypothesis			Number of People with Sleep Disorders–Low Hypothesis		
	2017	**2040 COS**	**2040 COS AP**	**2017**	**2040 COS**	**2040 COS AP**
>55	40	200	190	40	100	95
55–50	55	109	101	55	68	65
50–45	64	109	106	64	73	68
45–40	77	77	86	77	77	75
40–35	85	-	-	85	68	75
Total	321 (3.1%)	495 (4.7%)	483 (4.6%)	321 (3.1%)	386 (3.7%)	378 (3.6%)

4.3. Impacts on Mobility and Access to Health Care Services

Concerning travel conditions, the new ring road is likely to generate savings in terms of distance and time, but these appear to be limited in comparison with many other local mobility issues. Furthermore, they will be unevenly distributed, based on the type of travel and its origins and destinations. There would be improved suburb-to-suburb and north–south transit flows, some improved internal connections within Strasbourg, but unimproved or even slightly deteriorated commuting to and from Strasbourg. Moreover, these time and distance savings remain dependent on individuals' future mobility choices, which are difficult to anticipate. Finally, the new bypass, which will be a toll road, represents an extra financial cost for its users compared with the existing A35, which is toll-free. These results call for caution regarding the effectiveness and socio-spatial distribution of the positive effects of the project on local mobility.

Concerning access to health care services, the ring road should also have positive but limited effects, with a risk of uneven socio-spatial distribution. On the one hand, access to primary care services appears to be relatively unaffected since the access routes are outside the ring road's area of influence, either closer to the city centre or in more remote areas [37]. On the other hand, there should be a slight improvement in access to secondary and tertiary care services, particularly for the inhabitants of municipalities and for the medical facilities located on both ends of the road. However, a slight decline in quality of service is possible for the municipalities located towards the central portion of the new road.

4.4. Impacts on Road Safety

In recent years, injuries from road accidents represent the seventh leading cause of death in the world [38]. In France, it is the first cause of death among 15–24-year-olds [39]. Beyond road users' behavior (consumption of alcohol or narcotics, use of the telephone and other distractors), the main factors which influence the frequency and severity (number of fatalities and injuries) of traffic accidents are road design [40–42], speed [43,44], traffic volume and car congestion [45–47], as well as the percent of trucks in total traffic [48].

Since the new ring road is not set to change the overall highway traffic, we observed limited differences in the number of annual road traffic deaths and injuries compared to the scenario where the ring road would not be built ("business as usual" scenario 1), with very slight variations according to the details of the A35 upgrade (see Table 5).

Table 5. Number of deaths and injuries per year on A35 and COS for different project scenarios.

Scenario	Fatalities	Injuries	Evolution of Fatalities	Evolution of Injuries
Scenario 1	1.55	37.46	-	-
Scenario 2	1.52	36.87	−2%	−2%
Scenario 3	1.57	38.07	+2%	+2%
Scenario 4	0.79	26.29	−49%	−30%

Rather than dedicating a traffic lane to public transport (scenario 2) and carpooling (scenario 3), it is speed reduction, by 20 km/h (scenario 4), that proves to be most effective thanks to a reduction in the frequency of road accidents (due to improvements in travel conditions and reduced traffic congestion) and in the severity of the remaining accidents (due to the reduction of impact velocity). This reduction in the number of fatalities and injuries will be even more significant if the effective speed reduction on A35 is accompanied by a decrease in the number of heavy goods vehicles on this road.

4.5. Impacts on Local Development

In terms of local development, the new ring road would have three main effects. First, the destruction of valuable agricultural land would represent a great loss for many inhabitants of the Strasbourg area, who are culturally or emotionally attached to agriculture. This loss is more associated with the landscape and heritage value of the land than with its productive function. Indeed, several studies show that the generally positive perception of agriculture by non-farmers stems more from an interest in health and the environment than from an awareness of economic or nutrition issues [49,50]. According to Keogh & Connolly [51], agriculture is positively associated with national or regional identity and the quality of territories.

Second, land and house prices are likely to vary along the new ring road, with an expected increase in prices around the five highway junctions and exit roads but a decrease in the immediate vicinity of the highway [52–55].

Third, in addition to direct job creation, it is possible that the new road will encourage the development of business parks and shopping centres in its surroundings [56]. However, at least in the short term, it represents as much of a constraint as a facilitator of urban sprawl and it is difficult to conclude that it will be an incentive for new housing projects.

By confronting these effects of the project on local development with the location of highway junctions and changes in travel times within the study area, four "high stakes areas", in terms of economic activities, housing development, and property price increases, were identified.

4.6. Impacts on the Living Environment

Regarding the living environment, the new road is expected to have four main effects. First, as observed in other highway projects [57], the new infrastructure will significantly affect people's sensitive experience, through the reduced status of the spaces surrounding it. Therefore, it could contribute to limiting the use of many green and natural spaces, which are sources of well-being, physical activity, and social interaction, and increase community severance [58–61].

Second, the development of shopping malls, business clusters, or economic development areas near highway junctions could lead to the creation of new businesses or services, thus threatening existing shops and places anchored in everyday life, which constitute the third level of sociability, after family and the workplace [57].

Third, the new highway could, in the long term, incentivise urban sprawl and dispersed settlements, thus weakening social bonds. As found in other studies [62], the resulting negative consequences would primarily weigh on socioeconomically disadvantaged people.

Finally, the new road could affect the relationship that locals have with their territory and the way they value it [63]. The people who contributed to the public inquiry widely reported a feeling of injustice regarding a situation that ignores their life choices and their opinion, emphasising a lack of consultation for the project design and validation process.

4.7. Global Assessment

While the new road is likely to create or keep jobs, improve certain journeys, and relieve the A35 highway of a small portion of its traffic, it does not appear to be able to solve mobility and outdoor air quality local issues on its own. The creation of new disturbances for residents and uncertainty in terms of economic and urban development in western Strasbourg are major issues, especially since the project crystallises the discontent of part of the local population, who see it as more than just a disturbance, but also a project that calls into question their lifestyle choices and the efficiency of community participation. There is a risk that the negative impacts will be concentrated on the inhabitants of the municipalities crossed by the COS as well as on vulnerable people (children, elderly, non-motorised, and/or socio-economically disadvantaged households), but there is a lack of available data to estimate plausible different health impacts for specific population groups. Finally, the spatial distribution of the positive and negative impacts and the risk of their concentration on certain groups (socioeconomically privileged households with a car vs. carless households with few financial resources, as well as residents and vulnerable groups) raise legitimate concerns in terms of equity, a core principle of HIA.

These impacts on the determinants of health are likely to translate into corresponding effects on the health status of populations: neutral or negligible effects on respiratory diseases; a slight increase in the prevalence of chronic (including cardiovascular) diseases, via an increase in noise and a reduction of physical activity; an increase or decrease in road trauma and associated mortality, depending on the A35 highway development scenario and its flanking measures; differential effects on access to health services according to the level of service and residential area; a decrease in quality of life and well-being for people living in close vicinity to the infrastructure, but an increase in well-being for its future users who do not live too close to it; and a tendency to slightly increase rather than reduce existing social and spatial health inequalities.

5. Discussion

Health impact assessment is a health promotion approach that supports values such as sustainable development, equity, and the ethical use of data. It is also a structured method that considers health in a broad definition. It brings together several academic disciplines and allows the comparison of several types and sources of data [4]. In France, HIA is not mandatory for any kind of project, programme, or policy and is therefore based on the goodwill of the stakeholders involved in the process as well as their ability to work together and be open to inputs from the community.

The initial proposal by the study team met the HIA international standards of practice [64]. The hypothesis of the supposed added value of this HIA based on the analysis of the studies and reports related to the COS project (in total, 26 documents were analysed) and used in the scoping matrix (see Table 3), has been clearly confirmed by the results obtained, which shed new light on the elements to be used by decision-makers. In addition to an analysis of the scientific and grey literature, this assessment included the collection of new data using various techniques (individual and group interviews, field observation, etc.). Such data, both quantitative and qualitative, are useful to contextualise the study and get a better understanding of the current opinions and behaviours of local populations. The team was made up of experts from different backgrounds and urban health research seeks to solve complex and multidimensional problems. The trans-disciplinary approach was therefore the one recommended for the case study that we had to deal with (see Section 5.1).

Because of the controversial nature of the COS project [2], which can be found in other infrastructural projects in France [65], the HIA was implemented in difficult conditions that did not allow the work to be carried out according to the initial plan. Such conditions created difficulties and complexity throughout the HIA process and required adjustments, mainly in three areas (see Sections 5.2 and 5.3).

5.1. Trans-Disciplinarity

Given the effects of multiple factors on health in the urban context, an understanding of the complexity of health problems in the urban environment is beyond the boundaries of any single discipline, thus the involvement of multiple disciplines and sectors and various research methods is required [66]. Domains such as health, environmental science, and political science need to be merged to develop coordination in policies and projects that promote sustainable development in urban and peri-urban regions. Whereas multidisciplinarity implies that each discipline works in a self-contained manner, interdisciplinary goes one step further by approaching an issue from several perspectives which are integrated to provide an outcome.

In trans-disciplinary research, however, the focus is on organising knowledge around a complex and heterogeneous subject rather than thinking about the disciplines whereby knowledge is commonly subdivided. Trans-disciplinarity involves a fusion of disciplinary knowledge with the know-how of lay people thus creating a new hybrid that is different from any specific constituent part [67]. It distinguishes itself from other cross-disciplinary approaches such as interdisciplinarity and multidisciplinarity in that a "fusion" of different disciplines and perspectives into a common conceptual framework is involved and researchers are expected to leave the comfort zones of their disciplines [68]. This fusion of disciplines and experts can include non-academic or non-scientific stakeholders such as community organisations or the population of study [69]. Importantly, all types of expertise are valued equally; no academic discipline or expertise is privileged throughout the research process.

HIA is inherently trans-disciplinary, and knowledge is produced not only by the coming together of experts from different disciplines but also through interactions with local stakeholders and citizens. It follows that HIA teams tend to come from different scientific backgrounds, with diverse knowledge and skills. In our case study, to handle the multiple health determinants related to such a project, a team of seven researchers was set up, with groundings in public health, political science, urban planning, geography, engineering, urban studies, natural sciences, transportation, and HIA practice. After working together over several meetings, the team decided on a single trans-disciplinary methodological approach combining inputs from each field. It has developed "critical awareness": the understanding that all disciplines and fields have substantive and methodological strengths and limitations. With regard to ensuring successful conflict resolution, the concept of "psychological safety" was promoted from the beginning: the team operated in an environment where members feel comfortable expressing independent thoughts and opinions as well as divergent assumptions about the nature of varied research approaches, without fear of embarrassment, rejection, or punishment. It allowed the team to promote active listening and debate and discussions that are characterised by open sharing of ideas and mutual respect [70].

This led to a successful trans-disciplinarity implementation characterised as "a series of negotiations and recursive interactions between disciplinary practices", meeting all the identified conditions for success [71]: (i) mutual trust amongst participants in interdisciplinary work; (ii) robust disciplinary science, combined with (iii) individuals' confidence in their own disciplines, and with (iv) mutual respect for others' disciplines; (v) space and time for sharing of knowledge, and exploration of different constructions of problems and methods; (vi) planned opportunities to negotiate at the borders; (vii) agreement that 'the problem' can be framed in different ways.

5.2. Methodological Creativity

The first difficulty, encountered during the scoping stage (S2), concerns the definition of the geographical perimeter for the HIA. The scale of the road project–24 kilometres long, and its integration into a highway network make the question of the most appropriate scale for assessing its various effects highly fraught, especially when access to all the project documentation cannot be ensured. Moreover, while the setting of geographical boundaries is identified as an important task of the HIA scoping step [64], international standards of practice do not provide clear guidance nor a precise method for doing it [72]. For this HIA, it was decided to define a broad and flexible geographical scope to avoid neglecting any impact, area, or population group likely to be affected. In other words, when the potential impacts are attached to a specific geographical area and their expression depends only on the highway project itself (e.g., roadway noise and road accidents), the study perimeter is restricted to this area. When the impacts are diffuse and do not depend solely on the project itself (e.g., mobility, local development, and living environment), the perimeter is extended to all the communities crossed by the new road, with a focus on selected municipalities or neighbourhoods. This focus makes it possible to study the reactions of different types of territories to the opening of the new road and to capture its effects on social and spatial health inequalities.

Unfortunately, the lack of local health data and the absence of contacts with potential partners prevented the inclusion of a neighbouring German municipality within the HIA. However, when appropriate and feasible, contextual elements linked to Germany were taken into account in the analysis (e.g., the existence of a LKW-Maut heavy goods vehicle tax, configuration of the German highway network, main trans-European road freight flows, etc.).

Another difficulty, encountered during the impact appraisal step (S3), relates to data collection. In this regard, we faced two main issues: first, we were not allowed (see Section 5.3) to access the study site and to contact the services and partners who had previously been identified, especially local elected officials, association representatives, and inhabitants; second, it was impossible to collect all the project documentation concerning both the A35 upgrading and the local mobility policy, even though their inclusion in the scope of the study had been requested by the sponsors.

As seen in several HIAs on road projects [10], these barriers to data collection may lead to unequal treatment of the various determinants of health, with social determinants being addressed only through the scientific literature, or even to a restriction of the HIA to the environmental determinants of health. In order to reconcile the holistic and systemic nature of HIA with the constraints of the field, it was decided to turn to the public inquiry which had been organised from 4 April to 17 May 2018 by an independent commission appointed by the Strasbourg administrative court regarding the COS project (see Section 3). Although this survey does not escape the limitations of secondary data analysis (data collected for a different purpose and under uncontrolled or even unknown conditions, loss of data) [73], it makes it possible to integrate the voices of local stakeholders, which is a requirement of HIA that is often difficult to meet [74]. Moreover, such work represents a new and innovative experience because, although the effects of public inquiries and their role in decision-making processes have been studied, they are rarely used in HIAs and not in such depth [75]. Given the recurrent nature of barriers to data collection in HIA, as well as the existence of public inquiries in many countries, this is an interesting avenue to explore to deal with difficulties regarding access to local data.

5.3. Adaptability to Power Relationships and Connectivity with the Public Inquiry

Throughout this HIA, controversy and power games between stakeholders formed a significant obstacle to its successful completion. Those conditions did not allow the HIA implementation to be carried out according to the mode of governance initially planned. Indeed, the coordination and monitoring had to be ensured through the steering committee for the validation of the orientations and a technical committee, under the responsibility of the Eurometropolis of Strasbourg. A meeting of the steering committee was held on 5 July 2018, with a reduced workforce. The three other meetings planned at the key stages of the process to validate the methodological options were not convened by the Eurometropolis. Indeed, in September 2018 the prime HIA commissioners decided to leave the Eurometropolis coalition government in disagreement with its president about the COS project management. Because of this upheaval, the HIA process was impeded by local authorities, though not stopped. A technical committee responsible for supporting implementation alongside the HIA team and facilitating the mobilisation of other partners was never created. Although agreed upon during the scoping phase (S2), the HIA team was not allowed to consult local stakeholders, including interviews with local elected officials, institutions, association representatives, and residents.

This main obstacle was avoided by using data from the public inquiry whose collection was related to the environmental impact assessment process, and whose results were freely available. Over 1400 responses by various members of the public were submitted to an ad hoc secondary analysis. Based on this information, a model showing how the project was perceived by the public was created and confronted with the model which had previously been designed by the HIA team based on a literature review. Using data generated for another purpose (environmental impact), the HIA nevertheless succeeded in identifying the needs of the population. The results provided evidence that consensus around this project was unattainable and that decision-makers had to imagine other solutions to fulfil the expectations of the population, especially around the value (far higher than anyone had expected) that citizens attributed to nature and agricultural land. This secondary analysis proved to be a real trove of information and was completely unplanned.

Decision-makers who are convinced of the value of their project may find it difficult to consider other perspectives, and this makes consensus impossible and restricts the development of innovative solutions through informed dialogue and compromise [76]. Power relationships may come into play and various constituencies try to use HIA to further their vision and their own agenda. It is essential for HIA practitioners and researchers to be able to: (i) recognise power relationships when they are at play in real-life situations, and (ii) imagine creative research methods to be used to neutralise power relations [77].

5.4. Limitations of the Study

The conclusions presented in this paper draw on a single case study, which raises a legitimate concern about the ability to generalise our conclusions, each case having its specific characteristics and context. However, actions can be implemented to mitigate the potential pitfalls of the case study methodology [78], most of which are in line with the HIA approach in general and the work presented here (clear definition of the scope of the case, analysis of the context of the case and its influences, focus on data collection in line with the research questions, triangulation of data sources and confrontation with the theoretical and empirical literature, transparency of the research process, integration with the theoretical framework). Therefore, more than just an illustrative example of HIA added value in the promotion of urban health, this case study confronts methodological issues and offers practical solutions that can be useful for HIA promoters and practitioners facing similar challenges, in areas such as trans-disciplinarity and adaptability during the entire HIA process, connectivity with the EIA and the public inquiry for data collection, and methodological creativity for scoping and data analysis.

6. Conclusions

While the investigated road project is likely to create or help maintain some jobs in the short term and might accelerate certain journeys and relieve the pre-existing A35 of a small part of its traffic, it does not seem able to improve local mobility and air quality issues. The creation of new nuisances for residents and the uncertainties in terms of economic and urban development in western Strasbourg are major issues, especially since the project crystallises the dissatisfaction of a part of the local population, who perceive, beyond its future nuisances, COS as a questioning of his life choices and as a lack of democracy. Moreover, the effects of induced demand (new road infrastructure leads to increases in car use and car ownership) are counterproductive in an age where cities need climate-friendly infrastructure that supports low-carbon lifestyles. Finally, the socio-spatial distribution of the COS project effects, the risk of concentration of the positive and negative impacts on certain population groups (motorised households, socio-economically advantaged and mobile on the residential level versus non-motorised households, captives and with few resources as well as residents and vulnerable population) raise legitimate fears in terms of fairness, one of the cardinal concerns of HIA.

This case study raises the question of the transparency of the planning and validation processes of major infrastructure projects, and their ability to consider their potential impact on urban health and effectively integrate citizens' voices. Despite an unfavourable political context, the HIA approach described in this article was able to overcome methodological difficulties and obstacles, thanks to creative research methods and trans-disciplinarity, to finally yield relevant information and suggestions for urban health promotion.

If urban areas are still failing to be "inclusive, safe, resilient and sustainable" as set out in SDG11, even in one of the richer parts of the world, then we would suggest prioritising urban quality in the future. One way of doing this could be to apply HIA more often to transportation projects, especially the building of new roads.

Author Contributions: Conceptualisation, J.S., A.R.L.G., N.L.C. and F.J.; data curation, G.D. and Y.M.; formal analysis, G.D., D.P.T.H.C., J.S., A.R.L.G., N.L.C., L.T., Y.M. and F.J.; investigation, G.D., D.P.T.H.C., L.T., Y.M. and F.J.; methodology, J.S., A.R.L.G., N.L.C. and F.J.; project administration, G.D., J.S. and F.J.; software, D.P.T.H.C., L.T. and Y.M.; supervision, J.S., A.R.L.G., N.L.C. and F.J.; visualisation, G.D. and L.T.; writing—original draft, G.D., D.P.T.H.C., J.S., A.R.L.G., N.L.C. and F.J.; writing—review and editing, J.S. and D.P.T.H.C. All authors have read and agreed to the published version of the manuscript.

Funding: The health impact assessment was funded by the City and the Eurometropolis of Strasbourg. No further funding was received for this work.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the analysis or interpretation of data, in the writing of the manuscript, or in the decision to publish the results.

References

1. Jabot, F.; Roué Le Gall, A.; Simos, J.; Dardier, G.; Tabbone, L.; Christie, D.; Mallet, Y.; Cantoreggi, N. *Evaluation D'impact Sur La Santé Du Projet de Contournement Ouest De Strasbourg*; Ecole des Hautes Études en Santé Publique: Rennes, France; Université de Genève: Genève, Switzerland, 2019; 200p.
2. Vergne, O. La contestation des projets d'infrastructures de transports: L'exemple du Grand Contournement Ouest (GCO) de Strasbourg. *Rev. Géogr. Est* **2017**, *57*, 3–4. [CrossRef]
3. WHO European Centre for Health Policy. *Gothenburg Consensus Paper*; WHO Regional Bureau: Copenhagen, Denmark, 1999.
4. Kemm, J.E. *Past Achievement, Current Understanding and Future Progress in Health Impact Assessment*; Oxford University Press: Oxford, UK, 2013.
5. Morgan, R.K. Health impact assessment: The wider context. *Bull. World Health Organ.* **2003**, *81*, 390.

6. Thondoo, M.; Rojas-Rueda, D.; Gupta, J.; de Vries, D.H.; Nieuwenhuijsen, M.J. Systematic Literature Review of Health Impact Assessments in Low and Middle-Income Countries. *Int. J. Environ. Res. Public Health* **2019**, *16*, 2018. [CrossRef]
7. Osofsky, S.A.; Pongsiri, M.J. Operationalising planetary health as a game-changing paradigm: Health impact assessments are key. *Lancet Planet Health* **2018**, *2*, e54–e55. [CrossRef] [PubMed]
8. Ebi, K.L.; Harris, F.; Sioen, G.B.; Wannous, C.; Anyamba, A.; Bi, P.; Capon, A. Transdisciplinary research priorities for human and planetary health in the context of the 2030 agenda for sustainable development. *Int. J. Environ. Res. Public Health* **2020**, *17*, 8890. [CrossRef] [PubMed]
9. Talukder, B.; Ganguli, N.; Matthew, R.; VanLoon, G.W.; Hipel, K.W.; Orbinski, J. Climate change-triggered land degradation and planetary health: A review. *Land Degrad. Dev.* **2021**, *32*, 4509–4522. [CrossRef]
10. Cole, B.L.; MacLeod, K.E.; Spriggs, R. Health Impact Assessment of Transportation Projects and Policies: Living-Up to Aims of Advancing Population Health and Health Equity? *Annu. Rev. Public Health* **2019**, *40*, 305–318. [CrossRef]
11. Dalal, K.; Lin, Z.; Gifford, M.; Svanstrom, L. Economics of global burden of road traffic injuries and their relationship with health system variables. *Int. J. Prev. Med.* **2013**, *4*, 1442–1450. [PubMed]
12. Chen, S.; Kuhn, M.; Prettner, K.; Bloom, D.E. The global macroeconomic burden of road injuries: Estimates and projections for 166 countries. *Lancet Planet Health* **2019**, *3*, e390–e398. [CrossRef]
13. Colvile, R.N.; Hutchinson, E.J.; Mindell, J.S.; Warren, R.F. The transport sector as a source of air pollution. *Atmos. Environ.* **2001**, *35*, 1537–1565. [CrossRef]
14. da Souza, C.D.R.; Silva, S.D.; da Silva, M.A.V.; D'Agosto, M.d.A.; Barboza, A.P. Inventory of conventional air pollutants emissions from road transportation for the state of Rio de Janeiro. *Energy Policy* **2013**, *53*, 125–135. [CrossRef]
15. Diapouli, E.; Manousakas, M.; Vratolis, S.; Vasilatou, V.; Maggos, T.; Saraga, D.; Grigoratos, T.; Argyropoulos, G.; Voutsa, D.; Samara, C.; et al. Evolution of air pollution source contributions over one decade, derived by PM10 and PM2.5 source apportionment in two metropolitan urban areas in Greece. *Atmos. Environ.* **2017**, *164*, 416–430. [CrossRef]
16. Deshmukh, P.; Kimbrough, S.; Krabbe, S.; Logan, R.; Isakov, V.; Baldauf, R. Identifying air pollution source impacts in urban communities using mobile monitoring. *Sci. Total Environ.* **2020**, *715*, 136979. [CrossRef] [PubMed]
17. Diapouli, E.; Manousakas, M.; Vratolis, S.; Vasilatou, V.; Maggos, T.; Saraga, D.; Grigoratos, T.; Argyropoulos, G.; Voutsa, D.; Samara, C.; et al. Estimates and 25-year trends of the global burden of disease attributable to ambient air pollution: An analysis of data from the Global Burden of Diseases Study 2015. *Lancet* **2017**, *389*, 1907–1918. [CrossRef]
18. Mueller, N.; Rojas-Rueda, D.; Cole-Hunter, T.; de Nazelle, A.; Dons, E.; Gerike, R.; Nieuwenhuijsen, M. Health impact assessment of active transportation: A systematic review. *Prev. Med.* **2015**, *76*, 103–114. [CrossRef] [PubMed]
19. Dannenberg, A.L. Effectiveness of Health Impact Assessments: A Synthesis of Data From Five Impact Evaluation Reports. *Prev. Chronic Dis.* **2016**, *13*, E84. [CrossRef]
20. Thomson, H.; Jepson, R.; Hurley, F.; Douglas, M. Assessing the unintended health impacts of road transport policies and interventions: Translating research evidence for use in policy and practice. *BMC Public Health* **2008**, *8*, 339. [CrossRef] [PubMed]
21. Scott-Samuel, A. Health impact assessment. *BMJ* **1996**, *313*, 183–184. [CrossRef] [PubMed]
22. den Broeder, L.; Uiters, E.; ten Have, W.; Wagemakers, A.; Schuit, A.J. Community participation in Health Impact Assessment. A scoping review of the literature. *Environ. Impact Assess. Rev.* **2017**, *66*, 33–42. [CrossRef]
23. Wright, J.; Parry, J.; Mathers, J. Participation in health impact assessment: Objectives, methods and core values. *Bull. World Health Organ.* **2005**, *83*, 58–63. [PubMed]
24. Van Brusselen, D.; Arrazola de Onate, W.; Maiheu, B.; Vranckx, S.; Lefebvre, W.; Janssen, S.; Avonts, D. Health Impact Assessment of a Predicted Air Quality Change by Moving Traffic from an Urban Ring Road into a Tunnel. The Case of Antwerp, Belgium. *PLoS ONE* **2016**, *11*, e0154052. [CrossRef] [PubMed]
25. Morrison-Saunders, A.; Pope, J.; Gunn, J.A.; Bond, A.; Retief, F. Strengthening impact assessment: A call for integration and focus. *Impact Assess. Proj. Apprais.* **2014**, *32*, 2–8. [CrossRef]
26. Morgan, R.K. Environmental impact assessment: The state of the art. *Impact Assess. Proj. Apprais.* **2012**, *30*, 5–14. [CrossRef]
27. Diallo, T.; André, P.; Cantoreggi, N.; Simos, J.; Christinet, N. Evaluations environnementales et évaluation d'impact sur la santé. In *Environnement et Santé Publique—Fondements et Pratiques*; Goupil-Sormany, I., Ed.; Presses de l'EHESP: Rennes, France, 2023.
28. Waheed, F.; Ferguson, G.M.; Ollson, C.A.; MacLellan, J.I.; McCallum, L.C.; Cole, D.C. Health Impact Assessment of transportation projects, plans and policies: A scoping review. *Environ. Impact Assess. Rev.* **2018**, *71*, 17–25. [CrossRef]
29. Choi, B.C.; Pak, A.W. Multidisciplinarity, interdisciplinarity and transdisciplinarity in health research, services, education and policy: 1. Definitions, objectives, and evidence of effectiveness. *Clin. Investig. Med.* **2006**, *29*, 351–364.
30. Simos, J.; Christie, D.; Jabot, F.; Le Gall, A.R.; Cantoreggi, N. The Ongoing Contribution of Health Impact Assessment to Health Promotion Research. In *Global Handbook of Health Promotion Research*; Jourdan, D., Potvin, L., Eds.; Springer: Cham, Switzerland, 2023; Volume 3. [CrossRef]
31. Mudu, P.; Gapp, C.; Dunbar, M. *AirQ+ − Example of Calculations*; World Health Organization, Regional Office for Europe: Copenhagen, Denmark, 2018; HO/EURO:2018-2965-42723-59596.
32. Sacks, J.D.; Fann, N.; Gumy, S.; Kim, I.; Ruggeri, G.; Mudu, P. Quantifying the Public Health Benefits of Reducing Air Pollution: Critically Assessing the Features and Capabilities of WHO's AirQ+ and U.S. EPA's Environmental Benefits Mapping and Analysis Program-Community Edition (BenMAP-CE). *Atmosphere* **2020**, *11*, 516. [CrossRef]

33. Miedema, H.M.; Oudshoorn, C.G. Annoyance from transportation noise: Relationships with exposure metrics DNL and DENL and their confidence intervals. *Environ. Health Perspect.* **2001**, *109*, 409–416. [CrossRef]
34. Miedema, H.M.; Henk, M.E. Annoyance Caused by Environmental Noise: Elements for Evidence-Based Noise Policies. *J. Soc. Issues* **2007**, *63*, 41–57. [CrossRef]
35. WHO. *Burden of Disease from Environmental Noise: Quantification of Healthy Life Years Lost in Europe*; World Health Organization, Regional Office for Europe: Copenhagen, Denmark, 2011. Available online: https://apps.who.int/iris/handle/10665/326424 (accessed on 5 December 2022).
36. Cantoreggi, N.; Lieb, C.; Perez, L.; Schäffer, B.; Rochat, J.N.; Vienneau, D. *Plan Sectoriel De L'infrastructure Aéronautique (PSIA) De L'aéroport De GENÈVE-Cointrin (GA): Évaluation D'impacts Sur La Santé*; University of Geneva: Geneva, Switzerland, 2016.
37. ATIH. *Analyse De L'activité Hospitalière*; Agence Technique De L'information Sur L'hospitalisation: Lyon, France, 2018; p. 30.
38. GBD 2013 Mortality and Causes of Death Collaborators. Global, Regional, and National Age–Sex Specific All-Cause and Cause-Specific Mortality for 240 Causes of Death, 1990–2013: A Systematic Analysis for the Global Burden of Disease Study 2013. *Lancet* **2015**, *385*, 117–171. [CrossRef]
39. Rey, G.; Piffaretti, C.; Rondet, C.; Lamarche-Vadel, A.; Moreno-Betancur, M. Analyse de la mortalité par cause: Pondération des causes multiples. *Bul. Epidémiol. Hebd.* **2017**, *1*, 13–19.
40. Park, B.-J.; Kay, F.; Lord, D. Evaluating the Effects of Freeway Design Elements on Safety. *Transp. Res. Rec.* **2010**, *2195*, 58–69. [CrossRef]
41. Morency, P.; Gauvin, L.; Plante, C.; Fournier, M.; Morency, C. Neighborhood Social Inequalities in Road Traffic Injuries: The Influence of Traffic Volume and Road Design. *Am. J. Public Health* **2012**, *102*, 1112–1119. [CrossRef]
42. Wang, C.; Quddus, M.A.; Ison, S.G. The effect of traffic and road characteristics on road safety: A review and future research direction. *Saf. Sci.* **2013**, *57*, 264–275. [CrossRef]
43. Elvik, R. *The Power Model of the Relationship between Speed and Road Safety: Update and New Analyses*; Transportøkonomisk Institutt: Oslo, Norway, 2009.
44. Imprialou, M.-I.; Quddus, M.A.; Pitfield, D.E.; Lord, D. Re-visiting crash–speed relationships: A new perspective in crash modelling. *Accid. Anal. Prev.* **2016**, *86*, 173–185. [CrossRef] [PubMed]
45. Zhou, M.; Sisiopiku, V.P. Relationship Between Volume-to-Capacity Ratios and Accident Rates. *Transp. Res. Rec.* **1997**, *1581*, 47–52. [CrossRef]
46. Lord, D.; Manar, A.; Vizioli, A. Modeling crash-flow-density and crash-flow-V/C ratio relationships for rural and urban freeway segments. *Accid. Anal. Prev.* **2005**, *37*, 185–199. [CrossRef]
47. Kononov, J.; Durso, C.; Reeves, D.; Allery, B.K. Relationship between traffic density, speed, and safety and its implications for setting variable speed limits on freeways. *Transp. Res. Rec.* **2012**, *2280*, 1–9. [CrossRef]
48. Chang, L.-Y.; Mannering, F. Analysis of injury severity and vehicle occupancy in truck- and non-truck-involved accidents. *Accid. Anal. Prev.* **1999**, *31*, 579–592. [CrossRef]
49. Wachenheim, C.J.; Rathge, R.W. Societal perceptions of agriculture Agribusiness and Applied Economics. In *Report No. 449. Department of Agribusiness and Applied Economics Agricultural Experiment Station*; North Dakota State University: Fargo, ND, USA, 2000; p. 58.
50. Morgan, C.; Widmar, N.; Wilcox, M.; Croney, C. Perceptions of Agriculture and Food Corporate Social Responsibility. *J. Food Prod. Mark.* **2018**, *24*, 146–162. [CrossRef]
51. Keogh, C.; Connolly, A.J. Using Event Sponsorship to Cross the Chasm between Consumer Perceptions of Agriculture and On-farm Realities. *Int. Food Agribus. Manag. Rev.* **2014**, *17*, 225–237.
52. Waddell, P.; Berry, B.; Hoch, I. Residential Property Values in a Multimodal Urban Area: New Evidence on the Implicit Price of Location. *J. Real Estate Financ. Econ.* **1993**, *7*, 117–141. [CrossRef]
53. Kilpatrick, J.A.; Throupe, R.C.; Carruthers, J.I.; Krause, A. The Impact of Transit Corridors on Residential Property Values. *J. Real Estate Res.* **2007**, *29*, 303–320. [CrossRef]
54. Human Impact Partners. *I-710 Corridor Project Health Impact Assessment*; Human Impact Partners: Oakland, CA, USA, 2011.
55. Levkovich, O.D.; Rouwendal, J.; van Marwijk, R. The effects of highway development on housing prices. *Transportation* **2016**, *43*, 379–405. [CrossRef]
56. ARCOS. *Contournement Ouest de Strasbourg. Synthèse Actualisée De L'étude D'impact*; Consortium ARCOS: Paris, France, 2006; p. 180.
57. Nimegeer, A.; Thomson, H.; Foley, L.; Hilton, S.; Crawford, F.; Ogilvie, D. Experiences of connectivity and severance in the wake of a new motorway: Implications for health and well-being. *Soc. Sci. Med.* **2018**, *197*, 78–86. [CrossRef] [PubMed]
58. Mindell, J.S.; Karlsen, S. Community Severance and Health: What Do We Actually Know? *J. Urban Health Bull. N. Y. Acad. Med.* **2012**, *89*, 232–246. [CrossRef] [PubMed]
59. Miciukiewicz, K.; Vigar, G. Mobility and Social Cohesion in the Splintered City: Challenging Technocentric Transport Research and Policy-Making Practices. *Urban Stud.* **2012**, *49*, 1941–1957. [CrossRef]
60. Anciaes, P.R.; Boniface, S.; Dhanani, A.; Mindell, J.S.; Groce, N. Urban Transport and Community Severance: Linking Research and Policy to Link People and Places. *J. Transp. Health* **2016**, *3*, 268–277. [CrossRef]
61. Foley, L.; Prins, R.; Crawford, F.; Sahlqvist, S.; Ogilvie, D. Effects of Living near a New Urban Motorway on the Travel Behaviour of Local Residents in Deprived Areas: Evidence from a Natural Experimental Study. *Health Place* **2017**, *43*, 57–65. [CrossRef]

62. Nguyen, D. Evidence of the Impacts of Urban Sprawl on Social Capital. *Environ. Plan. B Plan. Des.* **2010**, *37*, 610–627. [CrossRef]
63. Guermond, Y. L'identité territoriale: L'ambiguïté d'un concept géographique. *L'Espace Géogr.* **2006**, *35*, 291–297. [CrossRef]
64. Bhatia, R.; Farhang, L.; Heller, J.; Lee, M.; Orenstein, M.; Richardson, M.; Wernham, A. *Minimum Elements and Practice Standards for Health Impact Assessment, Version 3*. September, 2014. Available online: https://humanimpact.org/hipprojects/hia-minimum-elements-and-practice-standards/ (accessed on 5 December 2022).
65. Rocher, L. Infrastructure urbaine, planification et controverse: Le projet différé d'un contournement routier au sud d'Angers. *Norois* **2013**, *227*, 83–96. [CrossRef]
66. O'Campo, P.; Kirst, M.; Schaefer-McDaniel, N.; Hwang, S. Introducing a Transdisciplinary Approach to Applied Urban Health Research. In *Converging Disciplines*; Kirst, M., Schaefer-McDaniel, N., Hwang, S., O'Campo, P., Eds.; Springer: New York, NY, USA, 2011. [CrossRef]
67. Lawrence, R.J. Housing and health: Beyond disciplinary confinement. *J. Urban Health* **2006**, *83*, 540–549. [CrossRef] [PubMed]
68. Lawrence, R.J.; Després, C. Futures of trans-disciplinarity. *Futures* **2004**, *36*, 397–405. [CrossRef]
69. Ramadier, T. Transdisciplinarity and its challenges: The case of urban studies. *Futures* **2004**, *36*, 423–439. [CrossRef]
70. Black, D.; Scally, G.; Orme, J.; Hunt, A.; Pilkington, P.; Lawrence, R.; Eb, K. Moving Health Upstream in Urban Development: Reflections on the Operationalization of a Transdisciplinary Case Study. *Glob. Chall.* **2018**, *3*, 1700103. [CrossRef]
71. Petts, J.; Owens, S.; Bulkeley, H. Crossing boundaries: Interdisciplinarity in the context of urban environments. *Geoforum* **2008**, *39*, 593–601. [CrossRef]
72. Hebert, K.A.; Wendel, A.M.; Kennedy, S.K.; Dannenberg, A.L. Health impact assessment: A comparison of 45 local, national, and international guidelines. *Environ. Impact Assess. Rev.* **2012**, *34*, 74–82. [CrossRef]
73. Pienta, A.; O'Rourke, J.; Franks, M. Getting started: Working with secondary data. Secondary Data Analysis. In *Secondary Data Analysis: An Introduction for Psychologists*; American Psychological Association: Washington, DC, USA, 2011; pp. 13–25.
74. Mahoney, M.E.; Potter, J.-L.; Marsh, R.S. Community participation in HIA: Discords in teleology and terminology. *Crit. Public Health* **2007**, *17*, 229–241. [CrossRef]
75. Fourniau, J.-M. L'expérience démocratique des « citoyens en tant que riverains » dans les conflits d'aménagement. *Rev. Eur. Des Sci. Soc.* **2007**, *XLV*, 149–179. [CrossRef]
76. Potvin, L.; Gendron, S.; Bilodeau, A.; Chabot, P. Integrating social theory into public health practice. *Am. J. Public Health* **2005**, *95*, 591–595. [CrossRef]
77. Woodall, J.; Warwick-Booth, L.; South, J.; Cross, R. What makes health promotion research distinct? *Scand. J. Public Health* **2018**, *46* (Suppl. S20), 118–122. [CrossRef] [PubMed]
78. Crowe, S.; Cresswell, K.; Robertson, A.; Huby, G.; Avery, A.; Sheikh, A. The case study approach. *BMC Med. Res. Methodol.* **2011**, *11*, 100. [CrossRef] [PubMed]