Report

March 2022

Evaluation

Socio-Economic Evaluation of the Health Effects of Public Investment Projects

Report by the working group chaired by Benoît Dervaux and Lise Rochaix

EXECUTIVE SUMMARY

MINISTÈRE DE LA TRANSITION ÉCOLOGIQUE
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EXECUTIVE SUMMARY

1 Background and motivations

For the **proper allocation of public resources**, the purpose of the Socio-Economic Evaluation is to assess, based on transparent criteria, the usefulness and **collective value** of public investment projects or public policies, including with regard to the top priority of protecting personal health. However, the consideration of health effects in assessments is often limited to isolated and exploratory attempts. The lack of tools or monetary values serving to assess and measure effects on personal health – referred to in this report as "**health effects**" to cover illnesses as well as quality of life, a term used in the field of health economics[1] – would appear to be one of the reasons they are absent from ex ante socio-economic evaluations, which ultimately means they are not included in the decision-making process.

Accordingly, and to encourage the **transfer of methodological developments from the healthcare sector** (such as the use of a synthetic health metric) **to other sectors** and to highlight the **cost of inaction**, the Expert Committee on Socio-Economic Evaluation Methods, created by France Stratégie and the General Secretariat for Investment, launched a working group on the socio-economic evaluation of the health effects of public investment projects. The Committee appointed two co-chairs to the working group: Benoît Dervaux, health economist and senior lecturer on public health at Université de Lille and Centre hospitalier universitaire de Lille (UMR 1167 RID-AGE), and Lise Rochaix, full professor of economics at Université Paris 1 Panthéon-Sorbonne, affiliated with the Paris School of Economics -PSE-, and scientific head of the Hospinnomics chair (PSE and AP-HP).

The working group sought to establish a methodology for estimating the **tangible and intangible costs of health effects** that could be applied to a number of different sectors, including four in particular: **psychological damage of floods, health benefits of housing energy renovations**, **noise pollution generated by construction, and health benefits**

[1] By extension, in this report the term "health cost" refers to physical and non-physical health costs alike.

of physical activity in public spaces[1].

The report, summarised by this document, presents the group's methodological choices and results. It is aimed at those likely to commission, carry out or use the results of socio-economic evaluations of public investment projects or public policies with health effects, including beyond the four applications studied more specifically by the group.

2 Methodology choices for the monetary valuation of health effects

Several methods, underpinned by more or less robust theoretical foundations, exist to place a monetary value on mortality or morbidity effects: willingness to pay (WTP), burden of illness or "proxy"' methods based on the valuation of a synthetic health metric.

2.1 Valuation of mortality effects

In France, the valuation of **mortality** effects is subject to a **very precise framework** with the existence of a benchmark value of a statistical life (VSL) and based on the amount that each individual is willing to pay for a mortality risk reduction. **The working group chose to use this framework and to assess mortality costs by estimating the number of deaths to which the VSL is applied, set by the Quinet Commission (2013) at €3.43 million$_{2018}$.**

That said, a number of questions remain unanswered in the literature, including whether or not the value of a death depends on the age at which it occurs.

2.2 Valuation of morbidity effects

The valuation of illnesses (known as "**morbidity**") has been covered by **heterogeneous**, long-standing **literature focused on the ex-post estimation of WTP**, i.e. for the treatment of a health effect. However, the evaluation of public policies requires the mobilisation of ex ante WTP, i.e. for the reduction of a health risk. Some concepts have been empirically estimated (e.g. the *value of a statistical case of cancer*, to estimate the amount payable for a reduction in the risk of developing cancer, or the *value of a statistical illness profile*, which attributes a WTP for a reduction in the risk of deteriorating health). However, the use of estimated values in different studies with different approaches, where applicable, could very well challenge the robustness of the approach.

[1] These applications were addressed in four publications in the "Théma - Essentiel" collection of the French General Commission for Sustainable Development in March 2022. They can also be consulted online on the France Stratégie website.

Accordingly, in a pragmatic approach, and while WTP is based directly on a trade-off between income and health status, **the working group chose, for the purpose of estimating intangible morbidity costs, an alternative approach to WTP by distinguishing the stage in which health status preferences are revealed (with death and perfect health at opposite extremes), from the income/mortality risk trade-off stage**.

In the first stage, health status preferences can be translated using a quality of life coefficient, ranging from 0 to 1, for the *Quality Adjusted Life Years* (QALY) metric or a disability coefficient for the *Disability Adjusted Life Years* (DALY) metric, depending on the reference point chosen (0 corresponds to death for QALY and to perfect health for DALY). While QALY is the preferred metric in health economics, there is little harmonised data for major illnesses of interest. **DALY was therefore used to express illness in terms of "years of life lost"**, using epidemiological data on the ***Global Burden of Disease*** (GBD). These data have the advantage of being centralised and made available by a single data producer (Institute Health Metrics Evaluation), on an enforceable and easily accessible basis. Of these data, the group used the number of prevalent cases (illnesses at a given point in time *t*) and the annual number of incident cases (number of new cases between *t* and *t+1*) to estimate durations of illness. These in turn are multiplied by the disability coefficients to obtain the number of years of life lost per patient.

In the second stage, the group chose to value each year of life lost due to illness[1] using the monetary value of one year of life as set by the Quinet Commission (2013) at €131,000$_{2018}$, in the absence of a reference value in the literature specific to one year of good health. To account for the uncertainty surrounding the value used for this purpose, the intangible costs are halved in a sensitivity analysis (see values in brackets in the sections below), based on recent studies (Herrera-Auraujo *et al.*, 2020).

The working group chose to add intangible costs to medical expenses for each illness (as well as some of the indirect morbidity costs, including daily allowances)[2]. To that end, it relied on the **French Health Insurance map of pathologies and healthcare expenses**, which quantifies the annual expense per case for all items combined (primary care consultations, medications, etc.) associated with a set of pathologies.

[1] Regardless of age.

[2] There is no consensus on whether or not to add medical expenses to intangible costs. The risk of double-counting associated with this practice varies according to the method used to estimate intangible costs. The method used by the group justifies its choice to add medical expenses to intangible costs.

3 Development of turnkey tools

In order to **illustrate the feasibility of applying socio-economic calculus to environmental health and its contribution**, four fields of application were more specifically examined. The group thus provides assessment tools based on the monetary values of the health effects estimated using i) the methods described above and ii) the probabilities of occurrence of these health effects according to different criteria. These tools are more or less operational depending on the application, based on knowledge available at the time the tools were developed.

3.1 Floods

In France, in order to be eligible for a grant from the major natural risk prevention fund, **flood prevention action programmes** ("PAPI"), whose structural measures cost more than €2 million (before tax), must be subject to an ex-ante socio-economic evaluation, based on a method defined by the Ministry in charge of risk prevention. In excess of €5 million (before tax), the method consists of a Flood Multi-Criteria Analysis or "Flood MCA". At present, the health of flooding victims is not incorporated in this method.

In response to the expectation of project's holders that the **traumatising effect of floods** should be taken into account *at a minimum*, the working group focused on adverse psychological impact (expressed here as post-traumatic stress disorder, PTSD) and developed a method for integrating this adverse psychological impact into the Flood MCA. Given that other health risks also exist, this is a low-end estimate of the average health costs associated with flooding.

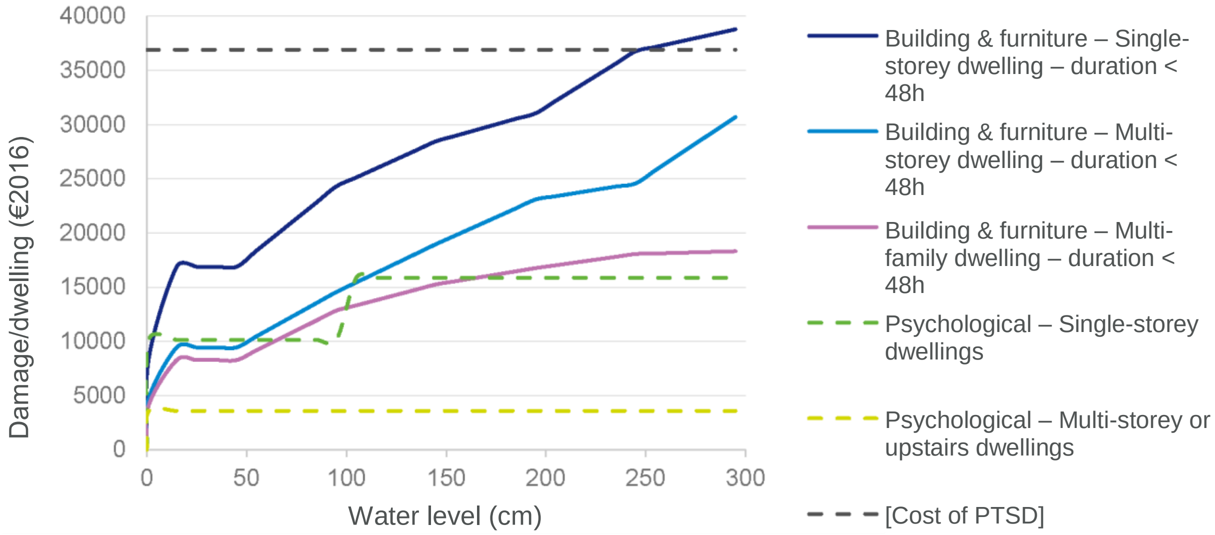
The average cost to society of a person with PTSD is estimated at €36,900 (medical expenses and, for the vast majority of the cost, loss of well-being) (sensitivity analysis: €18,880)[1]. Taking into account the **probability of post-flood PTSD, which ranges from 4% to 20%** according to the Chen and Liu meta-analysis (2015) and differs according to the type of housing (single-storey or multi-storey) and the height of water inside the dwelling, **the average per-capita adverse psychological impact (expressed as PTSD) in flood-prone areas ranges from €1,600 to €7,400 (sensitivity analysis: from €830 to €3,800)**. Considering an average of 2.2 people per dwelling, the average adverse psychological impact per dwelling represents roughly half of the average damage to the building and furniture of a single-storey dwelling, and between 1/3 and 1/6 of the average damage to the building and furniture of a multi-storey or multi-family dwelling.

[1] The magnitude of the deviation from the central value reflects the high proportion of intangible morbidity costs in the total cost of PTSD.

This integration of adverse psychological impacts into the Flood MCA is facilitated by the provision of an **"indicator sheet" describing the steps to be taken by the project's holder**.This sheet is appended to the Flood MCA methodology guide.

This approach should be continued for the purpose of being adapted to other hazards (e.g. torrential flooding), including other health effects (e.g. health effects associated with mould, injuries, deaths, etc.) and addressing other affected populations (e.g. people working in flooded areas).

Figure A - Comparison of average adverse psychological impact (PTSD) and damage to buildings and furniture per dwelling



Note: housing damage amounts are obtained by applying national housing damage functions per property valid for lowland floods, and a flood duration of less than 48 hours. The "building" and "furniture" components are summed for each water level. Adverse psychological impact per dwelling is obtained by taking the average number of inhabitants per dwelling (2.2, the average size of a household in France in 2017 according to INSEE), and applying the per capita values in euros estimated by the working group (see Chapter 2, section 2.2.3).

Source: Flooding group

3.2 Energy inefficiency in housing

In France, the Energy-Climate Act sets the goal of renovating "energy sieves" within ten years. There is evidence stating that occupants of the most energy-intensive dwellings, and in particular low-income households, are subject to **increased risk to their health, largely due to low indoor temperatures** (below 16 and 18 °C depending on the study and the health effects). Low indoor temperatures are responsible in particular for cardiovascular and respiratory illnesses, which in some cases can lead to death. The working group developed a method for integrating health benefits into the evaluation of energy renovation actions.

About **1.3 million dwellings are thought to be at risk from low indoor temperatures in France**. According to a criterion defined by the UK's *Housing Health and Safety Rating System* (HHSRS), these are dwellings that consume a total of more than 378 kWh/m²/year[1] for their heating, domestic hot water and air conditioning combined. These dwellings account for around one-fourth of energy sieves, defined in France as dwellings rated F and G according to the former Energy Performance Diagnostic Analysis ("DPE") (before July 2021).

For each of these dwellings, it is possible to estimate an average annual health cost from two variables. First, the average cost of a health effect attributable to low indoor temperatures reflects the health costs of the health effects considered: heart attacks (some of which are followed by death), severe respiratory infections and pneumonia treated in primary care. This average cost, estimated at €134,600 (sensitivity analysis: €122,400[2]), is then multiplied by the one-year probability of illness in the dwelling, estimated at 1/18 under the HHSRS method (2000), but varying according to income, which is a determining factor in terms of defining fuel poverty, according to Ezratty *et al.* (2018). In this study, the probability rises to 1/4 for households with income below the poverty line[3], which thus have the highest exposure to the risk of a health event, but is only around 1/320 for middle-income and affluent households (deciles 4 to 10).

The average annual health cost is thus estimated at €7,500 (€5,700 in social costs related to mortality, €1,400 in social costs related to morbidity due to occupants' loss of well-being, and €400 in healthcare costs) (sensitivity analysis: €6,800, broken down into €5,700, €680 and €400, respectively) **without taking income differences** into account. This cost is estimated at €400 for affluent households (sensitivity analysis: €380) and more than €33,000 for households below the poverty line (sensitivity analysis: €30,600).

Renovation to a sufficient level of performance (< 225 kWh/m²/year for combined heating/hot water/air conditioning) would eliminate these health costs[4]. For example, a programme to renovate the 1.3 million dwellings would prevent the deaths of 2,200 people each year and generate a total gross annual gain of almost €10 billion (sensitivity analysis: €9 billion).

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[1] Expressed as final energy.

[2] The small deviation from the central value reflects the importance of the mortality cost relative to the morbidity cost of health effects attributable to low indoor temperatures.

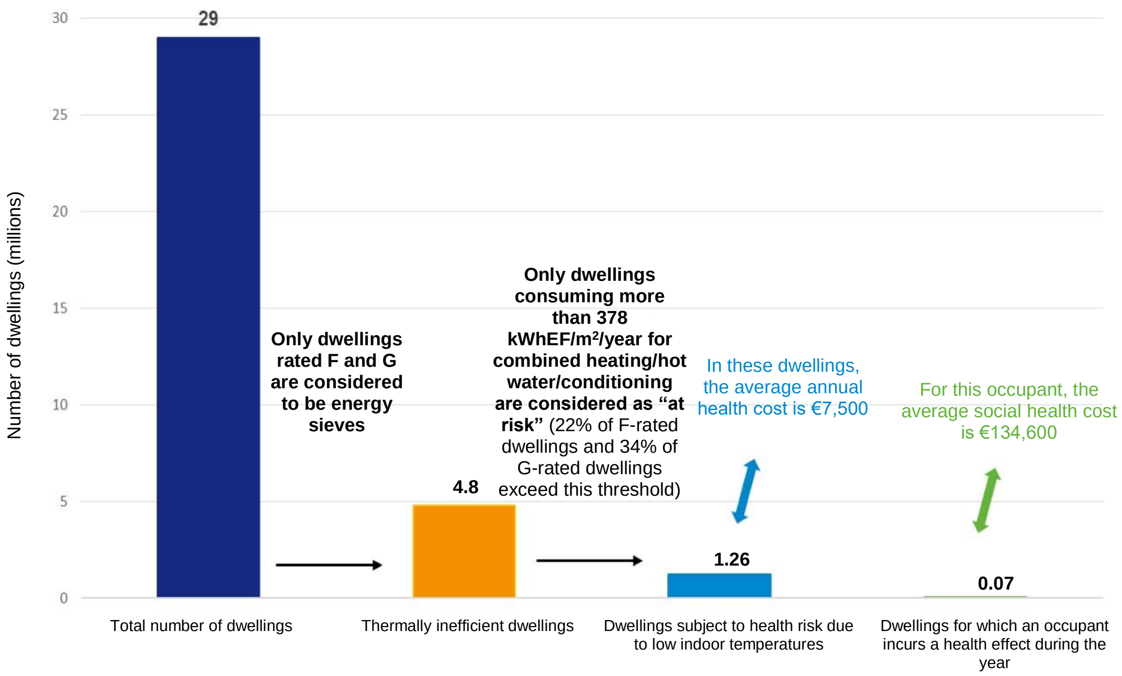
[3] As defined by INSEE, set by convention at 60% of median income.

[4] The improved thermal performance of the dwelling allows occupants to increase heating temperature while saving on the energy bill compared to pre-renovation situation, even if this gain is partially allocated to expenses other than heating.

A **turnkey calculation tool** is made available to facilitate socio-economic evaluations, and can be used by the project's holder to optimise available information (access to the energy consumption of the dwelling or only to the "DPE" rating, access to household income or not).

The method proposed by the working group (identification of at-risk dwellings and quantification of health effects) was adopted in the interest of **not overestimating health benefits** (effects on mental health or indirect costs such as learning losses were not considered, and effects caused by mould were not added), while integrating both market and non-market costs. **This method was largely based on the studies conducted by the EDF Medical Research Department** (Ezratty *et al*., 2018)**, which itself adapted the studies performed in the UK in the late 1990s to France** (**HHSRS, 2000**). While these UK studies would appear to be the most robust at this point in time, **the working group estimates should nevertheless be confirmed by a comparable study carried out in France**, combining data on dwelling features (incl. heating energy) and occupant characteristics (income) with health data.

Figure B - Selection of dwellings where the average health cost per dwelling applies



Note: Figure taken from Chapter 2, Section 3.2.2, of the report.

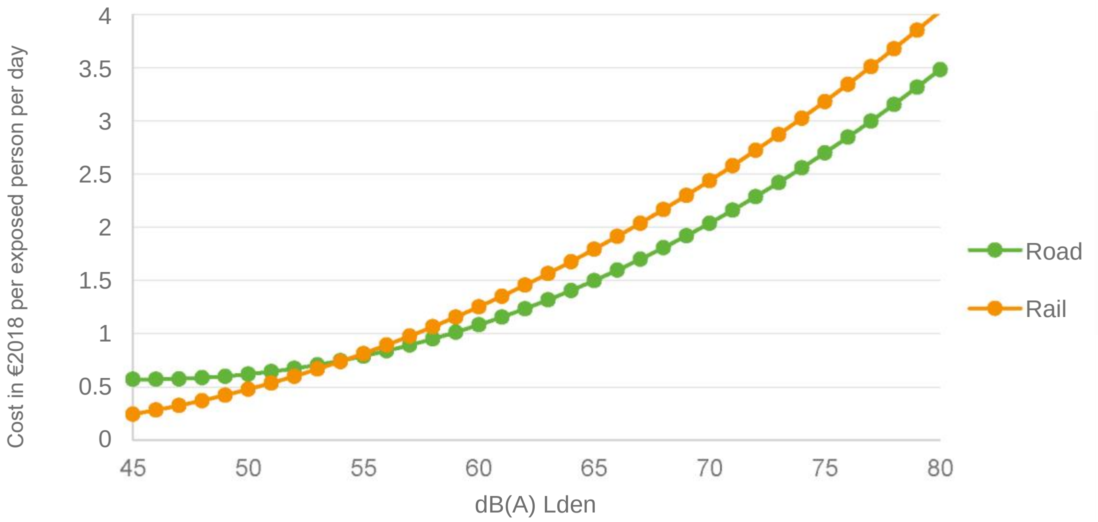
Source: Energy Inefficiency group

3.3 Construction noise

Although it is now accepted that construction noise is one of the sources of noise pollution in the home, and that there are auditory effects caused by high noise levels as well as non-auditory effects caused by low noise levels, **the effects of the construction phase of a public investment project are rarely included in the ex-ante socio-economic evaluations** of such projects.

The cost of annoyance per exposed person was estimated to be between €0.24 and €4 per day (sensitivity analysis: €0.12 to €2) depending on noise level, estimated from traffic noise studies (o/w WHO, 2018), and assuming a linear cost with the duration of exposure.

Figure C - Daily cost of annoyance per exposed person by noise level



Note: Figure adapted from Chapter 2, section 4.2.2, of the report. Annual costs were divided by 365 to obtain daily costs.

Source: Construction Noise group, based on WHO dose-response curves (2018) for traffic noise, Miedema and Vos (2004) for industrial noise, Liu et al. (2017) for construction noise, and DW (annoyance) = 0.02 (WHO, 2011) and VAV = 131,000 €2018 (considering here that the DALY value is equal to the 2013 Quinet VSL)

The number of exposed persons must be estimated on a case-by-case basis, as it depends on the nature of the construction site (type of construction, machinery used, etc.) and its environment (population and building densities), which vary greatly from one situation to another. A **case study** was thus performed on the site of the future Grand Paris Express metro station in Champigny-sur-Marne. For this site, 4,400 local residents would be exposed to the noise generated by a typical day of earthworks and foundation works (highly noisy open-air construction phase) according to the data used and the assumptions made by the working group. This gives an average cost of annoyance per typical day of €4,200 (sensitivity analysis: €2,100).

While the approach would benefit from taking other health effects into account (sleep disorders and cardiovascular diseases), **the exercise is primarily intended to be replicated** in order to establish representative costs for various types of worksites and construction environments. These costs could be used to conduct ex-ante socio-economic evaluations of public investment projects, including the interest of noise reduction measures at a construction site (noise barrier, phasing of sources, replacement of noisy equipment, etc.). This would raise awareness and draw attention to the health consequences of construction sites while also initiating a more systematic approach to prevention in the field.

3.4 Physical activity in the public space

Physical activity is interpreted as including much more than athletic activities alone: it can be conducted on the job (bricklayers, bakers, etc.), during active commutes (walking and cycling), in everyday domestic tasks (tidying up, cleaning, etc.) or during leisure time (sport, but also gardening, DIY, etc.).

In France, although the beneficial effects of physical activity on health (mortality and morbidity) have been widely demonstrated, **only 61% of adults meet WHO recommendations for physical activity** (150 to 300 minutes of moderate physical activity per week for adults) (Esteban survey, 2017). These people are referred to as “active” by the working group, to distinguish them from “inactive” people whose physical activity falls below WHO recommendations.

To help quantify the cost of inaction, raise awareness of the benefits of physical activity and encourage more and faster initiatives, the working group developed a **tool to assess the health benefits of reduced physical inactivity in the population**. This tool is based on an estimate of the **proportion of premature deaths and persons suffering from eleven types of illnesses** (cancers, cardiovascular diseases, neurodegenerative and respiratory diseases, diabetes, etc.) attributable to insufficient physical activity, and on **average costs for each illness** (between €20,000 and €200,000, depending on the illness).

In addition, two population sub-categories (20-39s and 40-74s) were defined to account for age differences in rates of incidence, mortality and prevalence of physical inactivity.

The tool confirms that the average social cost of physical inactivity in France is around €140 billion per year (sensitivity analysis: €137 billion), corresponding to more than 38,000 deaths and 62,000 illnesses caused each year. The annual avoided cost for a person who becomes active and remains active until death is estimated to be between €840 for a person aged 20-39 (sensitivity analysis: €817) and €23,275 for a person aged 40-74 (sensitivity analysis: €22,760 euros). More than 90% of these amounts are related to the social cost of mortality, about 5% to the cost of well-being losses due to illness and the rest to healthcare expenses.

Of the multiple levers for promoting physical activity, the possibilities offered by the provision of public spaces continue to be under-utilised, despite their obvious benefits. A grid has thus been developed to help design public spaces conducive to physical activity. Using seven attributes relating to development characteristics and environment (physical and temporal accessibility, equipment dedicated to physical activity or comfort, presence of other nearby physical activity venues, level of physical activity of the potential beneficiary population, etc.), the grid serves to identify situations likely to maximise the usage potential of the space to be developed and/or for the physical activity that it can generate.

Figure D - Estimated health impacts of physical inactivity

Physically inactive persons have a risk of...

mortality	1.5 to 2.5
diabetes	1.4 to 2.9
obesity	1.3
hearth disease	1.25 to 2
stroke	1.25 to 2.5
Parkinson's/Alzheimer's	1.2/1.8
cancer *(breast, uterine, stomach, bladder, oesophageal)*	1.25
COPD	1.25

times higher than physically active persons

Note: Figure taken from Chapter 2, Section 5.2.2, of the report. Here, the term "inactive" refers to a lack of physical activity and not to non-compliance with WHO recommendations.

Sources: Anses (2016), Friedenreich et al. *(2020), Inserm (2008), PAGA Committee (2018)*

These two public decision-making tools remain independent at this stage: additional studies, some of which are identified in the report, must be carried out to make them compatible and make it possible to assess the health benefits of increased physical activity generated by a public-space development subject to ex-ante socio-economic evaluation.

4 Extensions

These four application examples offer **possibilities for transferring monetary values or tools to other sectors**. For example, PTSD value can be used to assess other policies such as natural or industrial risk prevention, road or workplace safety policies, or crisis intervention and management programmes. The method for assessing the health benefits of energy renovation can be applied to university dormitories, prisons, etc. The tool for assessing the health benefits of physical activity can be used to evaluate programmes to promote physical activity among identified target populations (e.g. in prisons) beyond the scope of development projects.

These applications also demonstrate the **feasibility of integrating health effects into socio-economic assessments**, and **encourage new approaches to building turnkey tools in order to be able to integrate other risk situations**, some of which are identified by the group (high temperatures in dwellings, pollution and vibrations caused by construction sites, sedentary lifestyles[1], etc.). With this in mind, the working group

[1] A sedentary lifestyle is different from physical inactivity. Being sufficiently active does not protect against the health effects of a sedentary lifestyle (see Chapter 2, section 5, of the report).

recommends not only relying on varied and complementary expertise, and on the pre-existing socio-economic evaluation framework (benchmark values, discount rates, etc.), but also:

- **systematically conducting ex-post surveys** to better assess the impact of public investment projects and public policies on key health factors (however varied they may be: environmental and housing conditions, behaviours such as diet or physical activity, etc.);
- **developing epidemiological surveys** to gain a better understanding of the links between key health factors and health (by improving consideration of the various determining factors, multi-exposure or co-exposure situations, and the existence of multi-factor pathologies);
- **expanding databases** and their potential uses in order to estimate the tangible and intangible costs of health effects under an incidence approach, but also to enable these databases to be used to determine unit costs and epidemiological data;
- **re-examining methods for estimating intangible morbidity costs** (WTP vs. valuation of a synthetic health metric, choice of health metric, etc.) and intangible mortality costs (VSL vs. value of a statistical life year or VSLY);
- **incorporating personal characteristics** in all these studies, in order to be able to differentiate the effects of a project or policy according to multiple categories of persons already more or less exposed or more or less vulnerable, with the aim of assessing the project or policy's impact on inequalities and thus going beyond the simple criterion of efficiency in socio-economic assessment by integrating **equity issues**.

At the public policy level, these applications also demonstrate that there is still room for improvement in socio-economic impact assessments.

5 Appendices

5.1 Summary of costs estimated by the working group

Values calculated for the "Flood" application		
Average per-capita adverse psychological impact for a multi-storey or upstairs dwelling in a flood zone	€1,628 2016 (1,590 + 38)	Loss of well-being + medical expenses
Average per-capita adverse psychological impact for a single-storey dwelling exposed to a water level of less than 1 m	€4,731 2016 (4,622 + 109)	Loss of well-being + medical expenses
Average per-capita adverse psychological impact for a single-storey dwelling exposed to a water level of more than 1 m	€7,404 2016 (7,233 + 171)	Loss of well-being + medical expenses
Values calculated for the "Energy inefficiency of dwellings" application		
Average annual health costs related to low indoor temperatures per dwelling occupied by a household below the poverty line	€33,656 2018 (25,710 + 6,127 + 1,819)	Social cost of mortality + loss of well-being due to illness + medical expenses
Average annual health costs related to low indoor temperatures per dwelling occupied by a household in the top three income deciles but above the poverty line	€6,731 2018 (5,142 + 1,225 + 364)	Social cost of mortality + loss of well-being due to illness + medical expenses
Average annual health costs related to low indoor temperatures per dwelling occupied by a household in the top three income deciles	€19,231 2018 (14,691 + 3,501 + 1,039)	Social cost of mortality + loss of well-being due to illness + medical expenses
Average annual health costs related to low indoor temperatures per dwelling occupied by a household in income deciles 4 to 10	€421 2018 (321 + 77 + 23)	Social cost of mortality + loss of well-being due to illness + medical expenses
Average annual health costs related to low indoor temperatures per dwelling, average value (to be used if no information on household occupant income is available)	€7,479 2018 (5,713 + 1,362 + 404)	Social cost of mortality + loss of well-being due to illness + medical expenses
Annual health benefits of renovating the 1.3 million dwellings in France subject to health risk due to low indoor temperatures	€10 bn 2018 (7.4 bn + 1.7 bn + 0.5 bn)	Social cost of mortality + loss of well-being due to illness + medical expenses
Values calculated for the "Noise" application		
Daily cost of annoyance per person exposed to roadway noise	Between €0.57 and €3.48 2018 depending on noise level	Loss of well-being
Daily cost of annoyance per person exposed to railway noise	Between €0.24 and €4.03 2018 depending on	Loss of well-being

	noise level	
Annoyance cost generated by one day of earthworks and foundation works on the future Champigny-sur-Marne metro station	€4,200$_{2018}$	Loss of well-being
Values calculated for the "Physical activity" application		
Average annual health costs per inactive person aged 20-39	€843$_{2018}$ (775 + 52 + 16)	Social cost of mortality + loss of well-being due to illness + medical expenses
Average annual health costs per inactive person aged 40-74	€23,277$_{2018}$ (21,946 + 1,030 + 301)	Social cost of mortality + loss of well-being due to illness + medical expenses
Annual health benefits of eliminating (until death) physical inactivity in all persons aged 20-74 without chronic illness in France	€140 bn$_{2018}$ (131.7 bn + 6.3 bn + 1.8 bn)	Social cost of mortality + loss of well-being due to illness + medical expenses
"Gross" values of health effects used to calculate costs of different applications		
One-year annoyance cost	€2,620$_{2018}$	Loss of well-being
PTSD cost over its entire duration [b]	€36,907$_{2016}$ (36,056 + 851)	Loss of well-being + medical expenses
Cost of acute heart failure resulting in death	€3,441,541$_{2018}$ (3.43 m + 3,561 + 9,980)	Social cost of mortality [c] + loss of well-being due to illness + medical expenses
Cost of acute heart failure not resulting in death (including after-effects)	€50,487$_{2018}$ (29,550 + 20,938)	Loss of well-being due to illness + medical expenses
Cost of severe respiratory infection over its entire duration	€75,676$_{2018}$ (64,320 + 11,356)	Loss of well-being due to illness + medical expenses
Cost of pneumonia treated in private practice over its entire duration	€181$_{2018}$ (162 + 19)	Loss of well-being due to illness + medical expenses
Cost of heart disease over its entire duration	€45,994$_{2018}$ (25,056 + 20,938)	Loss of well-being due to illness + medical expenses
Cost of an ischaemic stroke (including after-effects)	€203,528$_{2018}$ (164,583 + 38,946)	Loss of well-being due to illness + medical expenses
Cost of breast cancer over its entire duration	€137,507$_{2018}$ (90,539 + 46,968)	Loss of well-being due to illness + medical expenses
Cost of colon cancer over its entire duration	€84,805$_{2018}$ (58,089 + 26,716)	Loss of well-being due to illness + medical expenses
Cost of stomach cancer over its entire duration	€42,848$_{2018}$ (31,138 + 11,710)	Loss of well-being due to illness + medical expenses
Cost of bladder cancer over its entire duration	€94,785$_{2018}$ (61,947 + 32,838)	Loss of well-being due to illness + medical expenses
Cost of oesophageal cancer over its entire duration	€46,231$_{2018}$ (35,050 + 11,181)	Loss of well-being due to illness + medical expenses

Cost of a case of diabetes over its entire duration	€184,156₂₀₁₈ (147,642 + 36,514)	Loss of well-being due to illness + medical expenses
Cost of COPD over its entire duration	€74,434₂₀₁₈ (64,028 + 10,405)	Loss of well-being due to illness + medical expenses
Cost of Alzheimer's over its entire duration	€135,524₂₀₁₈ (112,506 + 22,748)	Loss of well-being due to illness + medical expenses
Cost of Parkinson's over its entire duration	€190,315₂₀₁₈ (158,163 + 32,152)	Loss of well-being due to illness + medical expenses

[a] "Inactive" within the meaning of not meeting WHO physical activity recommendations.

[b] the duration of post-traumatic stress disorder used here is specific to a natural disaster.

[c] here the cost of mortality is included according to the definition of the health effect (acute heart failure resulting in death). For the other health effects in the table, in case of death, the mortality cost corresponding to the VSL of €3.43m$_{2018}$ should be added.

Note: the values for the applications were calculated using the "raw" health cost values from the last part of the table, and taking into account their probability of occurrence for each application. For example, the "Average per-capita adverse psychological impact for a multi-storey or upstairs dwelling in a flood zone" is €1,628 (o/w €1,590 in loss of well-being and €38 in medical expenses). It was calculated based on the "PTSD cost over its entire duration" of €36,907 multiplied by the 4.41% probability of experiencing PTSD for occupants of a multi-storey or upstairs dwelling in a flood zone.

Note: the working group recommends conducting a sensitivity test in which the "loss of well-being due to illness" is divided in half.

Source: working group

5.2 Summary of working group feedback, recommendations and advice

	FEEDBACK to build sector-specific turnkey tools
F1	Rely on a variety of expertise in order to benefit from the complementarity of: - knowledge of the project and its impacts on key health factors; - knowledge of links between key health factors and health effects; - monetary values of health effects.
F2	Make all stages in the construction of tools and intermediate results transparent in order to minimise the cost of updating them and thus ensure a continuous improvement process. *The tools must be adaptable in order to remain in sync with real social and economic conditions, advances in knowledge and available data.*
F3	Design and configure turnkey tools based on data available ex-ante for project's holders.
F4	To ensure the quality (representativeness, robustness, etc.) of results: **a.** prioritise the use of meta-analyses and recognised, commonly used data sources; **b.** pay particular attention to the transfer conditions of results and data.
F5	Observe the recommendations of the applicable socio-economic calculation and in particular: - apply benchmark values (and their rules of evolution over time) set by the government;

	- discount costs over the entire duration of health effects (at the rate recommended by France Stratégie).
F6	Reflect uncertainties (surrounding input data or data introduced by assumptions necessary for the construction of turnkey tools and values) using sensitivity analyses and providing results in the form of ranges.
	RECOMMENDATIONS for the use of existing turnkey tools
R1	**a.** Use, and where necessary adapt, existing tools, even where this requires the formulation of assumptions, in order to propose an initial approximation of health effects that can be given weight in the decision-making process. **b.** Accompany this initial estimate with the most transparent possible analysis of over/under-estimation risks.
R2	Complement the quantitative analysis made possible by turnkey tools with a qualitative approach serving at least to: - incorporate health effects for which no tools yet exist; - discuss, as far as possible, health effects differentiated by population group.
R3	Share feedback on the operationality of the tools and the results obtained in order to ensure a continuous improvement process.
	ADVICE for improving existing tools in the future *Notes: Only general actions have been included here. The reader is referred to the "Areas for Improvement" section of each application for actions specific to one of the four sectors studied in the report. The conditions of the actions recommended below will need to be discussed and clarified by their promoters.*

A1	***Creation of conditions for establishing causal links between public investment and exposure to a key health factor***
	Create conditions:
	- for effective feedback to funding providers and competent public authorities on i) public investment projects and ii) key health factors;
	- for systematic ex-post socio-economic assessments of public investment projects:
	    o on different investments (taking into account their diversity, thus calling for collection of descriptive data on projects);
	    o covering more or less exposed populations (to reflect differences in impacts between individuals, thus calling for collection of data on key health factors);
	as new projects are developed.

A2	***Expanded knowledge of causal links between exposure to a key health factor and a health metric*** Estimate new relative risks by developing aetiological studies: - in France or in similar contexts; - covering more or less vulnerable populations (to reflect differences in impacts between individuals); by adapting the incorporation of confounding factors (in particular to address cases of co/multi-exposure or co-morbidity).

A3	***Update to government recommendations for the monetary valuation of mortality*** **a.** Re-examine estimation methods and amounts of benchmark VSLs and VSLYs in the light of recent studies. **b.** Decide on how these two values will be used (over time, and according to age, risk, etc.).
A4	***Creation of conditions for a successful incidence approach to monetary valuation of morbidity*** **a.** In order for an impact approach to be adopted, longitudinal studies should be launched to assess the duration of illnesses other than according to the prevalence/incidence ratio. The design of the studies should distinguish between the duration of illness and the duration of treatment where relevant. **b.** In order for these durations to be included in long-term analyses, establish rules of evolution that reflect, among other things, the consequences of technical progress (earlier diagnosis and/or reduced mortality).
A5	***Selection of a method for the monetary valuation of loss of well-being due to illness*** **a.** Expand the theoretical foundations of the monetary valuation of quality-adjusted life years (QALYs) or disability-adjusted life years (DALYs): - decide on the health metric to be used (QALY, DALY), taking into account, among other criteria (to be determined), the possibility of improving i) the estimation of quality of life or disability coefficients (estimation of coefficients for more detailed categories of illnesses or for different levels of severity; for example, in a French population, or a similar population), and ii) the accessibility of these coefficients; - define the monetary value to be applied to each adjusted life year, based on existing studies on the value of a life year and on the estimation of willingness to pay per QALY or DALY. **b.** Compare and contrast these theoretical foundations with a critical review of the willingness-to-pay approach.
A6	***Improvement in accessibility of health insurance data for estimating medical expenses*** **a.** In order to establish robust annual medical costs, facilitate the use of health insurance data by: - making high-granularity data available (e.g. differentiating between different types of cancers); - allowing adjusted costs to be quantified in case of co-morbidity. **b.** In order to integrate these costs into long-term analyses, rules for the evolution of these values should be made available, taking technical progress into account.
A7	***Proposed methods for assessing opportunity costs associated with illness*** Advance knowledge used to assess the indirect morbidity costs: production losses, domestic activity losses and leisure activity losses.

Source: working group

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