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Health in SEA: International good practice and ongoing shortcomings

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1. Introduction

1.1. Aim of the report

This report provides the theoretical, conceptual, and practical background for developing the Irish 'Health in Strategic Environmental Assessment (SEA)' Guidance. Evidence for how health is, and how it can be, considered in SEA is presented. This is done considering the existing knowledge on the linkages between the broad topics of 'environment' and 'health.' How the interrelationships between human health and other environmental topics are currently made – in general and within SEA – is portrayed. This is based on a review of the international professional published literature (NB: reviews of specific national and international SEA cases will be provided in a separate deliverable as part of Work Package 2).

Overall, the importance of considering health in SEA is derived from the ability of underlying legislation, policies, plans and programmes to affect human health (direct impact) and to influence human behaviour (indirect impact), which can lead to improved health outcomes. Regarding direct impacts, issues such as noise and pollution are to be considered. With regards to indirect impacts, as an example, built and natural environments can either encourage or discourage certain activities, such as cycling or walking to work. Determinants of health can therefore be influenced through legislation, policies, plans and programmes and their associated SEAs (Carmichael et al., 2019).

The objectives of this report are:

- To identify key links between the broad topics of environment and health;
- To establish how the interrelationships between human health and other environmental topics are currently dealt with in practice in considering significant human health effects of legislation, policies, plans and programmes in SEA; and
- To identify good practice and any possible gaps and shortcomings, based on a review of peer-reviewed and grey literatures.

1.2. What should health in SEA include?

The overall framework for what needs to be included when considering health in SEA is provided by the European SEA Directive (European Parliament and Council of the European Union, 2001) and the Protocol on SEA to the Convention on EIA in a Transboundary Context (United Nations

Economic Commission for Europe, 2017), subsequently referred to as the 'SEA Protocol'. These underlie all SEA practices in Ireland, and establish all environmental and health aspects that should be considered in SEA. Annex 1 to the Directive (European Parliament and Council of the European Union, 2001) states that in SEA:

> "The information to be provided under Article 5(1), subject to Article 5(2) and (3), is the following:
>
> *"(f) the likely significant effects (1) on the environment, including on issues such as biodiversity, population, human health, fauna, flora, soil, water, air, climatic factors, material assets, cultural heritage including architectural and archaeological heritage, landscape and the interrelationship between the above factors."*

It then goes on to explain that:

> *"(1) These effects should include secondary, cumulative, synergistic, short, medium and long-term permanent and temporary, positive and negative effects."*

Furthermore, the SEA Protocol (United Nations Economic Commission for Europe, 2017) requires member states (including Ireland) to ensure that:

> *"environmental, including health, considerations are thoroughly taken into account in the development of plans and programmes and, to the extent appropriate, policies and legislation (Article 1)."*

By definition, 'Environmental, including health, effect' means:

> *"any effect on the environment, including human health, flora, fauna, biodiversity, soil, climate, air, water, landscape, natural sites, material assets, cultural heritage and the interaction among these factors." (Article 2).*

The SEA Protocol also acknowledges that:

> *"the benefits to the health and well-being of present and future generations that will follow if the need to protect and improve people's health is taken into account as an integral part of SEA, and recognising the work led by the World Health Organization in this respect."*

According to these two pieces of legislation, environmental aspects that need to be examined with regards to their relevance for human health, therefore, include the following:

- biodiversity (including fauna, flora);
- population;
- soil;

- water;
- air;
- climatic factors;
- material assets;
- cultural heritage including architectural and archaeological heritage;
- landscapes; and
- natural sites.

Noise is another aspect to be considered, according to the EU SEA Guidance (European Commission and Directorate-General for Environment, 2003). Similarly, the Irish SEA Guidelines from 2020 also require consideration of Seveso sites and radiation (radon and electromagnetic fields) (Department of Housing Local Government and Heritage, 2020). These additions are noted in the Irish 2022 SEA guidance (Department of Housing Local Government and Heritage, 2022).

When considering what health in SEA should include it is also important to consider the sustainable development goals (SDGs) of the United Nations 2030 Agenda (2015). This consists of 17 goals and 169 targets. Menne et al. (2020) noted how health is both an enabler, and a major outcome, of sustainable development. SDG3 is dedicated to health and well-being for all at all ages, and it has 13 targets. Achieving SDG3 depends upon action in each of the other SDGs and advancement across other sectors and settings.

Menne et al. (2020) suggested that implementing the SDGs requires a new collective approach, not confined to the health sector but with engagement of actors and sectors who do not traditionally share mutual objectives. They introduce an 'E4A' approach, which stands for engage, assess, align, accelerate and account. All of the E4A aspects are connected with SEA. The E4A approach aims to support countries in the World Health Organization (WHO) European Region to achieve the health-related SDG targets.

2. Study Scope

This report focuses on human health as an integral component of SEA and its interaction with other environmental aspects. In line with the purpose of the project brief underlying this report, the assumption is that all aspects are considered in an integrative manner, rather than in separate assessments. With regards to human health, such a separate assessment would be a Health Impact Assessment (HIA).

For the purpose of this report, all relevant published evidence is being considered. This comes from a wide range of sources, which occasionally includes other types of impact assessments, such as HIA.

The planned Health in SEA guidance will be in line with what is required by the European SEA Directive (European Parliament and Council of the European Union, 2001), the SEA Protocol (United Nations Economic Commission for Europe, 2017), EU SEA guidance (European Commission and Directorate-General for Environment, 2003) and national SEA guidelines (Department of Housing Local Government and Heritage, 2020, 2022). We also acknowledge the 2012 'Resource Manual to Support Application of the UNECE Protocol on Strategic Environmental Assessment'. This is introduced in further detail in section 4.1. This includes an Annex (A1.1) on health. Another important objective is to meet international ambitions, as expressed by the United Nations SDGs Agenda (United Nations, 2015).

The Irish Health in SEA Guidance will aim to empower responsible authorities, agencies, and consultants to consider human health in SEA appropriately and proportionately. It is in this context that current best international practice is to be considered, as established by e.g. the United Nations Economic Commission for Europe (2023). This is likely to divert somewhat from existing practices on how human health is considered in SEA in Ireland (Environmental Protection Agency, 2004; Scott and Marsden, 2003). Furthermore, recently released HIA good practice principles by the International Association for Impact Assessment (Winkler et al., 2021) and HIA guidance for Ireland by the Institute of Public Health in Ireland (Pyper et al., 2021) are acknowledged.

This report is (and subsequent project outputs will be) predicated on the research evidence as to how human health is impacted by plans and programmes (and, taking the UNECE SEA Protocol into account*, to the extent appropriate,* [this will be extended to] *policies and legislation),* and by

the likely associated effects on the environment. This includes, but is not restricted to, biophysical and chemical environmental impacts. These impacts can lead to physical and mental health outcomes. As the UNECE SEA Protocol adds well-being to human health, this will subsequently also be considered. A proportionate approach towards the consideration of health in SEA is of key importance (i.e. health is only one of many aspects to be assessed). This will therefore be further explained. Finally, governance issues in the context of health in SEA will be elaborated on.

Subsequently in this chapter, first human health is defined. Next, the key concepts of 'environmental health' and 'one health' as well as 'well-being' are elaborated on. Thereafter, what a proportionate approach to 'health in SEA' means is explored. Finally, important governance issues in the context of the consideration of health in SEA are explained.

2.1. Definition of human health

The most commonly used definition of the term "health" is from the 1946 constitution of the World Health Organization (WHO):

> *"Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity"* (World Health Organization, 1946)

This definition is the basis for the 'Healthy Ireland Framework' (Department of Health, 2019). It is also the starting point for many HIA guidelines worldwide (Public Health England, 2020; Pyper et al., 2021; Winkler et al., 2021; World Health Organization Regional Office for Europe, 2014).

The WHO definition has been used to establish the following determinants of health (World Health Organization, 2017b):

- the social and economic environment;
- the physical environment; and
- the person's individual characteristics and behaviours.

As understanding grows of the factors that affect human health, the concept of determinants of health is expanding to include, for example, legal (Gostin et al., 2019)[1] and commercial (Kickbusch et al., 2016)[2] determinants of health.

[1] Gostin et al. (2019) identify four legal determinants of health: law; governance of national and global health institutions; fair, evidence-based health interventions; and legal capacity (p.1860).

[2] Kickbusch et al. (2016) define the field of work which embraces commercial determinants of health as being 'a synergistic, multidisciplinary field that addresses the drivers and channels through which corporations propagate the non-communicable diseases pandemic' (p.e895).

There is currently a growing concern (particularly in light of the climate change crisis and following the COVID-19 pandemic) with regards to human health impacts from the physical environment, and the health consequences of human impacts on the natural environment. This is illustrated by the discourse surrounding 'environmental health' and 'one health' (which encompasses 'planetary health'). These are subsequently introduced further.

2.2. Environmental Health

'Environmental health' focuses on the impact of people on the environment and the impact of the environment on them (Moeller, 2005). In 1995, the European Environment Agency defined environmental health as including:

> *"… both, the direct pathological effects of chemicals, radiation and some biological agents, and the effects (often indirect) on health and well-being (see below) of the broad physical, psychological, social and aesthetic environment, which includes housing, urban development, land use and transport*" (European Environment Agency, 1995).

Major environmental health risk concerns include exposure to environmental pollutants (e.g. air and noise pollution, heavy metals) and climate-related events (European Environment Agency, 2023). Importantly, the environmental health discourse emphasizes the preservation of the natural, living, and occupational (physical and social) environment which is highly relevant for SEA.

Environmental health recognises that human health is dependent on and benefits from a healthy natural environment and ecosystem. In this context, the Millennium Ecosystem Assessment (2003) mentions, for example:

- An impairment of the water-cleansing capacity of wetlands may adversely affect those who drink the water.
- Building dams can increase mosquito breeding; and thus the transmission of malaria.
- Deforestation of hillsides can expose downstream communities to the hazards of flooding (and its associated health impacts).

2.3. One Health

'One health' is:

> *"an integrated, unifying approach to balance and optimize the health of people, animals and ecosystems"* (World Health Organization, 2023b).

It follows the discourse of environmental health and emphasizes the interconnections of human and animal health, acknowledging that human activities and stressed ecosystems provide opportunities for diseases to transmit to humans and spread (World Health Organization, 2023b). The 'one health' concept received attention internationally after the COVID-19 pandemic and it is said to be key for preventing the next pandemic (European Environment Agency, 2019; World Bank, 2022; World Health Organization, 2023b).

Zoonotic diseases that are transmitted from animals to humans are viewed as a major threat, and more than 60% of emerging infectious diseases (EIDs) that are reported globally come from animals (World Health Organization, 2023b). As such, human activities that interfere with wildlife are of fundamental concern. These activities include e.g. agriculture, forestry, and urban sprawl (World Bank, 2022).

The 'one health' concept focuses on the prevention, as well as minimization of the risk of animal-to-human transmissions ('spillovers'). Associated prevention measures include setting up buffer zones between human activities and wildlife. They also include social measures, such as risk communication and policies for triggering behavioural changes.

The 'one health' concept provides for an extension to the long-term preservation of ecosystem services, particularly concerning potential diseases and harm by human-caused perturbations to the ecosystem (Seltenrich, 2018). Here, the natural environment is said to provide four types of services to humans; provisioning, regulating, cultural and supporting services. These are explained in

Figure ***1***.

Figure** 1: **Ecosystem services to humans.

Provisioning Services (Products obtained from ecosystem) • Food • Fresh water • Fuelwood • Fiber • Biochemical • Genetic resources	**Regulating Services** (Benefits obtained from regulation of ecosystem process) • Climate regulation • Disease regulation • Water regulation • Water purification • Pollination	**Cultural Service** (Nonmaterial benefits obtained from ecosystems) • Spiritual and religious • Recreation and ecotourism • Aesthetic • Inspirational • Educational • Sense of place • Cultural heritage
Supporting Services (Services necessary for the production of all other ecosystem services) • Soil formation • Nutrient cycling • Primary production		

Source: Millennium Ecosystem Assessment (2003).

2.4. Well-being

As stated above, the UNECE SEA Protocol adds well-being to human health, which is therefore defined here further. Well-being is:

> *"a positive state experienced by individuals and societies. just like human health itself, it is determined by social, economic and environmental conditions"* (World Health Organization, 2021c).

The interpretation of well-being is diverse and overlaps with many subjects in physical and mental health. It covers elements from the personal positive vision of health to principles of human rights, sustainable development and one (or 'planetary') health (Marsh et al., 2020).

At a personal level, the concept of well-being is associated with the philosophy of how happy or good people feel in life. Social well-being refers to the sum of individual well-being in society. Social well-being depends on the quality of government, social services, social context, and interpersonal relationships in society (Faculty of Public Health, 2024). Furthermore, the environment is found to contribute to individual and social well-being. As shown in

Figure ***1***, ecosystems provide services like clean air, water, and food (European Environment Agency, 2023). Natural resources also support production and consumption, as well as create wealth and jobs (European Environment Agency, 2014). Any negative environmental impacts can therefore affect human well-being.

In the first 'Well-being Framework for Ireland' report, well-being has been conceptualized as consisting of a person, society, and place (Department of the Taoiseach, 2021). Also, personal, social, and environmental aspects, as well as the living environment, working conditions, and cultural factors are included.

Regarding the natural environment, three aspects are important:

1) the environment as experienced, with a focus on the aesthetic value;
2) environmental quality; and
3) human impacts, with a focus on the preservation of the natural environment for the future well-being and intergeneration equality (Government of Ireland, 2023).

2.5. 'Proportionate' consideration of health in SEA

The IAIA/European Public Health Association (EUPHA) reference paper for health in Environmental Impact Assessment (EIA) (Cave et al., 2020) has *proportionality* as one of its principles. The focus is on the scoping stage and then on identifying likely and significant impacts. This has been adapted for SEA, for this project, and it provides us with a working definition of *proportionate, as follows*:

> "*Human health is a broad topic so its assessment should be carefully scoped. Scoping should focus on whether the potential impacts are likely to be significant. This should take into consideration the scope and scale of the plan/programme, ensuring that significant health effects are addressed at the relevant planning level. Effort should then focus on identifying design changes to tackle adverse health effects and to enhance potential health benefits and to securing commitment to these changes. The assessment findings should be presented in a concise and precise manner, giving appropriate weight to health as a factor that influences the plan or programme."*

In order to assess health impacts proportionally, the context of SEA needs to be understood. Whilst the 'the scope of assessment [needs to be set] in consultation with health authorities' (World Health Organization, 2022 update, p.5), the specific decision tier and administrative level play a key role for deciding on an adequate scope. The sector of application is also of importance.

WHO (2022 update, pp.8-9), provide an example of the health issues that SEA may address at different tiers and sectors. Table 1 explores what this may look like for energy and transport.

Table 1: Issues to be addressed in strategic environmental assessments at different tiers

Tier	**Issues addressed in strategic environmental assessments**
Energy/Transport policies or legislation, (to be assessed to the extent appropriate, in accordance with art. 13)	What are the impacts of a transport/energy plan on human health in terms of air pollution and noise? To what extent circular/smart city consideration have been introduced in a plan to green it? Is electromobility foreseen, car free areas, bicycle areas and traffic restrictions in certain areas depending on their inhabitants? Has the state of the environment been assessed and are data available before developing a new plan? For energy plans in particular have the impacts been thoroughly studied in terms of emissions and solid and liquid waste? How does existing energy/transport infrastructure/use support health? What are the main challenges the current approach suffers from when trying to maintain/improve health levels? What health benefits (or risks) would accrue/arise from modifying energy/transport infrastructure or use? Which options are better for health and what would be a realistic mix/transition?
Energy/Transport plans	What energy/transport infrastructure/use maximizes positive health effects and minimizes negative ones? What health trade-offs are involved (for example, land-take)?
Energy/Transport programmes	What infrastructure developments should be prioritized, considering not only costs and benefits (for example alternative ways to spend money to improve health) but also both positive and negative health outcomes?
Projects (subject to environmental impact assessment)[3]	*What are the environmental, social and economic health effects of specific projects and how can they be avoided, mitigated or enhanced?*

Source: adapted from Fischer (2007)

[3] A key ingredient for effective strategic environmental assessment is an awareness of what issues should be assessed and what issues are addressed elsewhere. This is why the project level is mentioned here. However, project issues are not assessed by SEA

2.6. Governance of Strategic Environmental Assessment and human health

The main substantive goal of the health in SEA guidance is for human health to be effectively considered in plan and programme (and to the extent appropriate, policy and legislation) preparation, resulting in improved human health. In this context, governance surrounding SEA needs to be understood. Numerous aspects play a role for achieving good SEA governance. These are reflected in the key SEA features and building blocks that were introduced by Fischer and González (2021). With regards to the consideration of health in Irish SEA, the following aspects are particularly relevant (adapted from Fischer and González, 2021):

- SEA as a decision support tool generates (scientific) evidence for enhancing informed decision-making and supports processes for good governance; SEA functions as a 'science and an art' in that it provides scientific environmental and health evidence to decision makers (for improving decisions) whilst accepting the political nature of decision processes.
- Whilst SEA is currently legislated as a decision support procedure for specific plans and programmes (and occasionally policies and legislation), it also inherently functions as a framework which goes beyond such a procedure, embracing different decision tiers in which environmental and human health impacts, as well as particular environmental and human health issues and alternatives are systematically addressed at the different tiers of plans and programmes (and occasionally policies and legislation).
- The focus of SEA (and human health in it) is associated with the questions asked at different decision tiers; for example: 'why' and 'what' questions (course of direction) at the policy or legislation level; 'how' and 'where' questions (course of action) at the plan level; and 'where' and 'when' questions (action) at the programme level.
- Associated with tiering, timescales of actions and impacts considered by SEA usually shift from more long-term in more strategic situations (e.g. at the legislation and policy tiers) to short term in situations that deal with concrete implementation (which can be plans and particularly programmes).
- SEA is applied at different administrative levels, including trans-national/cross-border, national, regional, local and neighbourhood levels. These levels overlap with decision tiers; in order for SEA to work effectively, it is important to develop an understanding for what environmental (including human health) aspects are addressed where.

- SEA is applied to different sectors and its specific format will differ from sector to sector (see also Fischer, 2007).
- Different questions are often associated with different courses of action for those in charge of SEA; these may include acting as a moderator in the presence of potentially competing goals (e.g. in policy situations), and a facilitator in plan and/or technician in situations where programmes are prepared for implementation.
- SEA often focuses on bio-physical issues (flora and fauna, air, water, soil, human beings) and landscapes due to legal requirements revolving around those; however, with regards to health, consideration of relevant wider socio-economic determinants of human health are also important.
- Whenever possible, SEA should aim at using a range of quantitative and qualitative methods to identify and examine assessment issues (including human health) from different angles.
- SEA should always be tiered with project EIA and linked to other levels of decision-making; in this context, it can help to reconcile and streamline environmental and human health aims, objectives and actions of different tiers and administrative levels.

Other important aspects of SEA governance include the existence of institutional support and appropriate guidance. The fact that 'Health in SEA' Guidance is developed is in itself an expression of the institutional support that currently exists in Ireland for a proportionate approach to considering health in SEA. This is a key contextual issue, together with capacity building. The 'Health in SEA' Guidance is expected to play a key role in facilitating effective health-inclusive SEA.

3. How does the World Health Organization frame health and the environment with reference to Strategic Environmental Assessment?

3.1. Introduction

As the starting point to the Irish 'Health in SEA Guidance', that is to be developed as part of this research project, is the WHO definition of health. This chapter explores how the environment and health are addressed in the various publications of the WHO. It helps to identify good practice/professional boundaries/drivers that underpin and determine the scope of human health within SEA.

In order to identify relevant documents, and also to establish the types of links made between the environment and health in the current professional debate, a search was conducted that focussed on documents concerned with the environment and health published by the WHO headquarters in Geneva and by the WHO's Regional Office for Europe. In this context, internal institutional libraries of the research team were used along with WHO websites (World Health Organization, 2021d). The WHO database 'IRIS' groups reports by communities and collections (of which there are eight, including WHO headquarters, six regional offices and the WHO Framework Convention on Tobacco Control), by issue date (starting 1930s up to 2024), by authors (over 61,000), by titles (nearly 263,000) and by subjects (also known as Medical Subject Headings (MeSH), of which there are over 6,700).

The first search was conducted of reports in the communities and also the collection for the Regional Office for Europe which had the word 'environment' in its heading (see Table 2). The language was restricted to English and the time frame was 2018 to 2024. The time frame was set to capture work arising from, and conducted since, the 2017 Ministerial Conference on Environment and Health in Ostrava. This search returned 75 hits (see Table 3).

Table 2: Search string of WHO's "communities and collections".

Communities and collections		**Regional Office for Europe**
Subject MeSH	Contains	environment
Date issued	Contains	2018, 2019, 2020, 2021, 2022, 2023, 2024*
Language	Contains	English

* The search function does not have an OR function. seven separate searches were performed.
From WHO (World Health Organization, 2021a)

Table 3: Results of search of WHO's "communities and collections".

Year	No. of hits
2018	10
2019	4
2020	11
2021	15
2022	8
2023	27
2024	0
Total	**75**

The titles of these 75 hits are listed in Table 13. The discussion in section 3.2 is predominantly based on these works. The discussion also includes some consideration of documents found in a wider scan of the IRIS database.[4]

3.2. WHO Regional Office for Europe

The European Programme of Work, 2020–2025, sets out a vision of how the WHO Regional Office for Europe can support health authorities in Member States to ensure universal access to quality care without fear of financial hardship; offer effective protection against health emergencies; and enable people to thrive in healthy communities, where public health actions and appropriate public policies secure a better life in an economy of well-being (World Health Organization Regional Office for Europe, 2021a).

Importantly, the 'one health' concept introduced earlier has been embraced as being of key importance for the work of the WHO Regional Office for Europe. In this context, in 2022 the Food and Agriculture Organization of the United Nations (FAO), the UN Environment Programme (UNEP), the WHO and the World Organisation for Animal Health (WOAH), launched the Antimicrobial Resistance (AMR) Multi-Stakeholder Partnership Platform (Food and Agriculture Organization, 2024). These organisations, known collectively as the 'Quadripartite', set this platform up as a joint initiative to highlight and address the threat AMR presents to humans, animals, plants, ecosystems and livelihoods (World Health Organization, 2022). The aim is for the

[4] A wider scan was also conducted of the IRIS database. The results of that scan are presented in Table 14 in the Appendices section. A total of 3,614 sources were identified that explore interlinkages between health and the environment.

Platform to engage and empower stakeholders across the One Health spectrum and to build consensus among public and private stakeholders on the global AMR vision, gain knowledge to foster a collective understanding of AMR challenges and opportunities, and take multi-stakeholder actions to contain, combat and reverse AMR in line with the Global Action Plan (World Health Organization, 2016a) and National Action Plans.

Subsequently the WHO Regional Office for Europe interpretation of health and the environment is portrayed under four main headings:

(1) Environmental Health;

(2) Environmental Health Inequalities;

(3) Environmental topics relevant for health; and

(4) Food.

3.2.1 Environmental Health

In 2023, the WHO Regional Office for Europe published an overview of the environmental burden of disease and additional relevant environment and health data and facts across the region. The report states that 15% of all deaths could be prevented through healthier environments. It identified key risk areas as being air pollution, water, sanitation and hygiene, chemicals, radiation and climate change. European cities and their health-care systems were identified as being central to achieving environmental sustainability (World Health Organization Regional Office for Europe, 2023g).

The Ministerial Conferences on Environment and Health have brought together health and environment ministries from the 53 countries in the WHO European region since 1989. They take place approximately every five years (World Health Organization Regional Office for Europe, 2024b). The conferences seek political commitments and actions to address the risks which span the environment and health. Each conference concludes with a declaration, named after the location of the conference, which typically situates the work in the context of human rights and UN policies and establishes a framework for action (see Table 15 in the Appendices section for extracts from declarations from 1989 onwards).

A comparison of the agendas from the 2010 and 2023 meetings shows that while topics are presented slightly differently, the framework for health and the environment has remained consistent. In 2010, the WHO stated that a range of environmental risk factors threatens health (World Health Organization Regional Office for Europe, 2010c, p.1):

(1) inadequate water and sanitation;

(2) unsafe home and recreational environments;

(3) lack of spatial planning for physical activity;

(4) indoor and outdoor air pollution; and

(5) hazardous chemicals.

All of these can be of relevance in SEA in various ways. The 2004 Budapest declaration included a commitment to taking significant health effects into account in the assessment of strategic proposals under the UNECE Protocol on Strategic Environmental Assessment (World Health Organization Regional Office for Europe, 2004, para 13) and importantly, in 2010, the Parma conference included a side-event on "Protecting and improving human health through SEA" (United Nations Economic Commission for Europe, 2010).

The most recent 2023 Budapest Declaration focused on the ''triple crisis" brought by the intertwining of (World Health Organization Regional Office for Europe, 2023c):

(1) climate change;

(2) environmental pollution; and

(3) biodiversity loss.

A reference was included to the recently adopted human right to a clean, healthy and sustainable environment (United Nations General Assembly, 2022). The Declaration also presents a 'Roadmap for Healthier People, a Thriving Planet and a Sustainable Future 2023-2030' (World Health Organization Regional Office for Europe, 2023c, Annex 1). This:

> *'provides a set of actions for Member States' consideration to facilitate implementation … and accelerate progress to prevent and reduce the health consequences posed by climate change, environmental pollution, and biodiversity loss … [and] … to strengthen governance, human resources, financing and knowledge for health and the environment'* (page 5).

Actions are grouped under the following headings:

- climate change;
- environmental pollution;
- biodiversity loss and land degradation;

- water, sanitation and hygiene;
- waste and contaminated sites;
- transport and mobility; and
- planning of built environment.

Impact assessment is mentioned in the section *Planning of built environment*, which has the following actions:

- #67: Make use of HIAs; and
- #68: integrating further the assessment of environmental, including health, effects, in decision-making and planning procedures by leveraging the *Protocol on Strategic Environmental Assessments under the Espoo Convention on Environmental Impact Assessment in a Transboundary Context*.

3.2.2 Environmental Health Inequalities

In 2024, the WHO Regional Office for Europe states that the environment is a major determinant of health, estimated to contribute to almost 20% of all deaths in the WHO European Region (World Health Organization Regional Office for Europe, 2024a). In 2019, the World Health Organization Regional Office for Europe (2019) published its second assessment of environmental health inequalities across its region. The assessment considered various environmental settings and presented 19 environmental health inequality indicators, categorized into the five domains shown in Table 4. Social determinants of health, for example, housing, are included in the indicators.

Table 4: Five domains of environmental health inequality indicators.

Housing-related inequalities	**Basic service inequalities**	**Inequalities related to urban environments and transport**	**Work-related inequalities**	**Injury-related inequalities**
lack of a flush toilet	lack of access to basic drinking water services	exposure to air pollution	work-related injuries and mortality	fatal poisoning
lack of a bath or shower	lack of access to basic sanitation services	self-reported noise annoyance	risks in working environments	fatal falls
overcrowding	energy poverty	fatal road traffic/transport injuries		
dampness in the home		lack of access to recreational or green areas		
inability to keep the home adequately warm		chemical exposure		
inability to keep the home adequately cool in summer		contaminated sites		

Source: World Health Organization Regional Office for Europe (2019).

The report authors state that:

- environmental health inequalities occur in all countries, irrespective of the level of development and the environmental or economic status;
- the occurrence of environmental health inequalities has tended to persist or even increase over time, despite the improvement of environmental conditions observed in most countries in the WHO European Region;
- inequalities can often be significant, with some population subgroups exposed or affected five times more than others (for example, men aged 25-29 years are five times more likely than women to die from road traffic injuries);
- higher levels of environmental or injury risk are most often associated with, and are partly explained by, socioeconomic deprivation (notably poverty and low income) or other forms of disadvantage, such as those related to demographic or spatial determinants;

- in some cases, environmental exposure may also be higher among affluent or socially advantaged population subgroups (for example, self-reported noise annoyance experienced by affluent people living in city centres; mortality rates due to falls among elderly people are higher in countries with the highest income levels);
- the lack of data on inequalities in environmental conditions restricts a broad assessment in many countries and therefore represents a major concern.

Differential exposure to environmental risks translates into health inequalities, but the available environmental monitoring data do not currently allow an accurate quantification of these (World Health Organization Regional Office for Europe, 2019, p.xi).

In 2023 the WHO Regional Office for Europe published a collection of concepts and actions to deliver effective environment and health actions (World Health Organization Regional Office for Europe, 2023d). This summarises a range of models and approaches. It refers to HIA and also to the "drivers, pressures, state, exposure, effects, action" (DPSEEA) model which supports the identification of policy options and indicators to aid decision-making in environment and health:

- Drivers: A spectrum of societal, economic or behavioural issues.
- Pressures: Result of interaction of drivers, which modify environmental states.
- State: Modification of the state of the environment in response to pressures.
- Exposure: Result of interplay between individuals and aspects of the environment that may affect health and well-being.
- Effect: Once a person has been exposed to a hazard, health effects can vary in type, intensity and magnitude, depending on the type of hazard, the level of exposure and other factors.
- Action: An approach to health hazard control and prevention that focuses on hazards of human origin is useful as it addresses potentially remediable problems, giving due regard to uncertainty that exists about the extent of risks to human health associated with specific agents in the environment, or with the broader development process.

The UNECE information document on SEA and health also refers to this DPSEEA model (United Nations Economic Commission for Europe, 2023).

3.2.3 Environmental topics relevant for health

The following sections explore the environmental topics that the WHO has found to be relevant for health. These include:

(1) air quality;

(2) noise;

(3) water quality;

(4) climate change;

(5) chemical pollution;

(6) land use; and

(7) biodiversity.

Air quality and noise cause the largest burden of disease and the reviews of these topics look at indicators and compare these with standards required by the European Union (which differ from the standards identified by the WHO, see Table 16 in the Appendices section). The remaining topics are not covered in such depth.

3.2.3.1 Air quality

Air pollution, from both outdoor and indoor sources, represents the single largest environmental risk to health globally (World Health Organization Regional Office for Europe, 2017b) and in the WHO European Region (World Health Organization Regional Office for Europe, 2023b). Table 16, in the Appendices, shows the health outcomes associated with different pollutants.

The WHO Regional Office for Europe promotes regional, national and local actions to reduce ambient air pollution to the WHO recommended levels. The WHO highlights the following two key concerns:

(1) The need to reduce particulate matter (PM_{10} and $PM_{2.5}$) in major cities. Exposure to PM is associated with a range of adverse health outcomes and there is no evidence of a level of exposure at which change to human health does not occur (World Health Organization, 2019a).

(2) Protecting vulnerable groups, such as older adults, children, pregnant women and people with an underlying disease, as these groups are vulnerable and are at higher risk of severe health impacts when exposed to air pollution (World Health Organization, 2019a).

In 2023, the WHO Regional Office for Europe published a resource package for protecting health through ambient air quality management (World Health Organization Regional Office for Europe, 2023j). This is for policy-makers and stakeholders involved in air quality management at the national and local levels and is intended to assist with implementation of the WHO global air quality guidelines (World Health Organization, 2021f).

The analysis of air quality in SEA is required to align with the Air Quality Standards (AQStandards) as set by the European Commission (European Commission, no date-b). Table 16, in the Appendices section, compares these standards with the Air Quality Guidelines (AQG) as provided by the WHO. Each allows for progressive improvement of air quality. For example, the WHO AQGs provide interim targets and the AQS have limit- and target-values. The European Commission explains that a limit value is legally binding from the date it enters into force subject to any exceedances permitted by the legislation. A target value is less strict than a limit value as it creates an obligation to take all necessary measures that do not entail disproportionate costs to ensure that it is attained (European Commission, no date-b).

The levels set by WHO and the European Commission (see Table 16 in the Appendices section) are not always fully aligned. The WHO AQGs are more stringent than the AQStandards but they are not legally binding. They do not distinguish between indoor and outdoor pollution.

3.2.3.2 Noise

In the European context, community noise is a primary focus, including protection of vulnerable groups that are more sensitive to noise disturbance, including children, the elderly, people who are chronically ill and shift workers. Traffic is a prominent source of noise pollution and the WHO has emphasised the need to quantify evidence of the impacts of combined noise from various sources (World Health Organization, 1999; World Health Organization Regional Office for Europe, 2010a).

In 2018, the WHO published *Environmental Noise Guidelines for the European Region* which showed that noise was one of the top environmental hazards to both physical and mental health and well-being across the European Region (World Health Organization Regional Office for Europe, 2018). The guidelines are source-, and not environment-, specific and so they aim to cover all settings where people spend a significant portion of their time. The guidelines focus on the WHO European Region and provide policy guidance to Member States that is compatible with the noise indicators used in the European Union's Environmental Noise Directive (END) (European Parliament and Council of the European Union, 2002) see Table 17 in the Appendices section.

In preparing the *Environmental Noise Guidelines for the European Region*, it was recognized that non acoustic factors can be a confounder in both, environmental risk factors between noise levels and critical health effects and the effects of acoustic interventions on health outcomes (World Health Organization Regional Office for Europe, 2018, p.13). Non-acoustic factors include:

> "*gender; age; education; subjective noise sensitivity; extroversion/introversion; general stress score; co-morbidity; length of residence; duration of stay at dwelling in the day; window orientation of a bedroom or living room towards the street; personal evaluation of the source; attitudes towards the noise source; coping capacity with respect to noise; perception of malfeasance by the authorities responsible; body mass index; smoking habits*."

Table 18 and Table 19, both in the Appendices section, show how the guidelines differentiate between critical and important health outcomes.

The European Commission (no date-a) explains how the END (European Parliament and Council of the European Union, 2002) is the main EU and EEA law to identify noise pollution levels and act upon them. END focuses on four action areas:

- determining exposure to environmental noise and assessing its health effects at single dwelling level;
- ensuring that information on environmental noise and its effects is made available to the public;
- preventing and reducing environmental noise; and
- preserving environmental noise quality in areas where it is good.

The END Directive also requires EU and EEA countries to prepare and publish noise maps and noise management action plans every 5 years for agglomerations with more than 100,000 inhabitants; major roads (more than 3 million vehicles a year); major railways (more than 30,000 trains a year); and major airports (more than 50,000 take-offs or landings a year, including small aircrafts and helicopters). The European Commission (no date-a) explains how Annex II of the Environmental Noise Directive (European Parliament and Council of the European Union, 2002) describes the common EU methods for calculating exposure to different noise levels. Annex III of the Environmental Noise Directive describes the methods for calculating the burden of disease caused by exposure to specific noise levels. The methods include dose-effect relations for a set of health endpoints such as cardiovascular disease, annoyance and sleep disturbance. Annex III was revised in 2020, following the latest scientific review, performed by the WHO, of the health effects of noise (European Commission, no date-a).

3.2.3.3 Water quality

WHO initiatives on water quality emphasise the safe management of drinking water and the provision of sanitation and hygiene. Collectively these are known as WASH (water, sanitation and hygiene) services. There are two primary objectives in WHO's WASH initiatives: preventing infectious water-related diseases and ensuring universal sanitation and hygiene (World Health Organization Regional Office for Europe, 2020, 2023l). The WASH initiatives aim to reduce human disease risk caused by contamination of the water sources, from natural continents or human pollution, as well as communicable disease transmission between humans. There are three pathways:

- drinking water should be available free from faecal and chemical contamination;
- water should be supplied for sanitation so that excreta can be disposed of, and treated, off-site; and
- water should be supplied for hand washing with soap in the household.

3.2.3.4 Climate change

WHO reviewed the way health is addressed in nationally determined contributions and long-term strategies. These cover (World Health Organization, 2023a):

- leadership and governance;
- co-benefits to health of climate change mitigation;
- adaptation and resilience;
- loss and damage to health; and
- climate finance for health and health in long-term strategies.

An expert meeting convened by the World Health Organization Regional Office for Europe (2023i) discussed how actions that mitigate against, and adapt to, climate change can have co-benefits for noncommunicable diseases (NCDs). The expert meeting identified policies that would address the main risk factors of NCDs and contribute to achieving climate mitigation:

- Physical inactivity: policies to support walking and/or cycling can both improve health through increased physical activity and reduce air pollution and carbon emissions by decreasing dependence on travel in private motorized vehicles (see also Lavin et al., 2011a).

- Unhealthy diets (including overconsumption): promotion of sustainable healthy food systems can improve the availability of and access to healthy diets while reducing the environmental impact of food production.
- Alcohol consumption, tobacco use: production of alcohol and tobacco products has a detrimental impact on the environment and carbon emissions through transport, water use and packaging.

These have implications for the SEA mitigation of policies.

The WHO recognises that the health sector has a dual role to play in in addressing the changing climate (World Health Organization Regional Office for Europe and United Nations Development Programme, 2020):

- it must provide health services that are resilient and adapted to the changing climate; and
- it must ensure that its actions contribute to reducing carbon emissions in the way that it uses resources.

The World Health Organization Regional Office for Europe (2023m) has set up a *Working Group on Health in Climate Change*. This working group has identified priorities for policies addressing climate change. These are presented in Table 20. They have implications for the mitigation identified for human health in SEA in that they support addressing fossil fuels and identify the importance of transitioning to food systems that are more sustainable. They also emphasize the role that the health sector should take in raising and sustaining ambitions for mitigation and adaptation.

The WHO Regional Office for Europe has developed software for quantifying the consequences for human health and its related costs achieved by improving national air quality by reducing domestic carbon emissions. This software is CLIMAQ-H (Climate change mitigation, air quality and health) (World Health Organization Regional Office for Europe, 2023a).

3.2.3.5 Chemical Pollution

In 2016, WHO HQ sought to enhance global health sector engagement in the strategic approach to international chemicals management. It set out a 'road map' towards a 2020 goal (World Health Organization, 2017a). This identifies where the health sector has either a lead or important supporting role to play in the management of chemicals and it recognises the need for multisectoral cooperation. Reports on chemicals and radiation are found under the MeSH heading 'Environmental Exposure' (World Health Organization, 2021d) and the WHO keeps under review

the health impacts of chemicals that can be reduced or removed through environmental management (World Health Organization, 2016b, 2021e).

The chemicals 'road map' has an accompanying workbook which collects information on risk reduction; institutional capacity; knowledge and evidence and leadership and coordination (World Health Organization, 2018). A first step in risk reduction is to identify priorities so this could align with health in SEA.

Human biomonitoring (HBM) directly measures the concentration of chemical pollutants or their metabolites in human fluids and tissues (World Health Organization Regional Office for Europe, 2023h). It is a reliable tool for the assessment of human exposure to chemicals from different sources, by different pathways and during certain periods of life.

3.2.3.6 Land use change

Increased urbanisation can lead to an increase in private motorised transport, a decrease in physical activity, and an increase in Road Traffic Injuries (RTIs). This has been a major focus of the work of the WHO Regional Office for Europe which summarised key messages to enable local policy-makers and urban planners to protect environments and health by building urban resilience (World Health Organization Regional Office for Europe, 2022d, 2022e, 2022f). This identifies three action areas:

- administrative and organizational processes;
- tools, indicators and frameworks; and
- spatial planning, design and management interventions in the built environment.

Challenges and solutions are identified for each action area.

The WHO Health Economic Assessment Tool enables users to calculate the economic value of changes to modes of transport (World Health Organization Regional Office for Europe, 2021c). It looks across the following domains of physical activity; air pollution; crash risk; and carbon emissions and it can be used as a sensitivity test for options as the amounts of active transport are adjusted. Tools for urban design and health are presented in World Health Organization Regional Office for Europe (2022c).

Land use changes which bring people into contact with green environments can increase the risk of zoonotic diseases such as Lymes Disease. WHO's focus is on land use with regard to urbanisation and agricultural expansion, both of which fragment and disturb natural habitats.

Changes in patterns of human-wildlife-livestock contact will change the risk of zoonotic infectious diseases. An increase in population density caused by urbanisation can also influence the emergence and spread of infectious diseases (World Health Organization Regional Office for Europe, 2022a). The use, and indeed the misuse, of antimicrobial agents in agriculture and in veterinary medicine means that agricultural practices and expansion affects AMR.

3.2.3.7 Biodiversity

Biodiversity is integral to life on earth and can be beneficial to both, physical and mental health. The WHO Regional Office for Europe examined evidence for the connections between nature, biodiversity and health (2021d). The ways that green and blue space affect human health have also been examined (World Health Organization Regional Office for Europe, 2021b). Green space was defined as including urban green space; parks; gardens; forests and woodlands; grasslands and meadows; trees and other plants; as well as biodiversity overall. Blue space was defined as being coasts, inland waters and marine space. Both green and blue spaces were found to provide beneficial effects on human health and the report states that a policy focus on mental health and well-being through green and blue space provides an approach to address the interrelated issues of climate adaptation, social inclusiveness and socioeconomic crisis (World Health Organization Regional Office for Europe, 2021b).

Biodiversity decline is identified as a threat to human health as it increases the zoonotic infection risk due to the dilution effect of zoonotic parasites. One of the causes of biodiversity decline is the overconsumption of wildlife, wildlife trade, and invasive plant and animal species. For invasive species, it is noted that some are vectors or reservoirs for pathogens. The introduction of invasive species can also affect human health by exposing humans to new pathogens, bites and stings (World Health Organization Regional Office for Europe, 2022a).

3.2.4 Food

Food cuts across many of the topics identified above. The WHO convened an International Panel of Experts on Sustainable Food Systems which identified five pathways through which food systems negatively affect health (World Health Organization, 2021b):

- unhealthy diets and food insecurity;
- zoonotic pathogens and antimicrobial resistance;
- unsafe and adulterated foods;
- environmental contamination and degradation; and

- occupational hazards.

The panel also identified factors that influence the pathways, internally within food systems and externally through social, economic, environmental and commercial determinants of health and these include the food systems (citizen behaviour; food environments and food supply chains), the outputs of the food systems (e.g. diet; food insecurity; zoonotic disease, chemical hazards; labour conditions etc) and health outcomes.

The Diet Impact Assessment model provides a tool for analysing the health, environmental and affordability implications of dietary change (World Health Organization Regional Office for Europe, 2023f). It is intended to help devise pathways towards healthy and sustainable diets at a country level. The user is guided through the following steps: consumption analysis; health analysis; environmental analysis; planetary boundary analysis; cost-of-diet analysis; valuation of health impacts; and nutritional analysis.

3.3. Health and wellbeing

The One Health agenda means that social and economic determinants are integral to, and cannot be divorced from, the physical environment. The WHO Regional Office for Europe provides a framework to assess human, social, economic and planetary well-being for health (2023e). This indicates key policy areas and indicators for each dimension listed above.

The WHO provides indicators for monitoring Social Determinants of Health Equity (World Health Organization, 2024). These use international datasets and they are shown in Table 21. They cover the following determinants of health:

- economic security and equality;
- education;
- physical environment;
- social and community context;
- health behaviours; and
- health care.

Furthermore, actions are also provided for each of the policy goals (see Table 22). These bridge the physical, economic and social environment and can contribute to the human health and the population topics in SEA.

A recent Economic and Social Research Institute (ESRI) report (Humes et al., 2024) examines the effect of residential development on healthcare demand.

3.4. Compendium 'Health and Environment'

In 2022, the World Health Organization published an update to guidance issued by it, and other UN bodies such as UNDP, UN Environment and UNICEF (World Health Organization, 2022 update). This compendium is global in scope and covers the following topics:

- air pollution;
- WASH;
- solid waste;
- chemicals;
- radiation;
- climate change;
- nature and health;
- safe environments and mobility;
- safe and healthy food; and
- environmental noise.

For each topic, the compendium indicates the links between environmental diseases and health. These are presented in Figure 2 under the overarching headings of infectious and parasitic diseases, neonatal and nutritional disease and non-communicable diseases. All of these may need to be considered in SEA. The compendium also lists associated guidance documents that have been issued for each of the topics above. It identifies the sector that is involved in planning and implementation, the level of implementation; e.g. national, workplace, community; and the type of instrument (e.g. regulation). The compendium concludes with priorities for action in the following settings: cities and other urban settlements; housing; workplaces and health care facilities. It notes the importance of social determinants of health, but states that these are outside its scope.

Figure 2: Indicative linkages between environmental risk factor and disease or injury.

	Environmental risk factor													
Disease or injury	**WASH**	**Indoor fuel combustion**	**Second-hand tobacco smoke**	**Ambient air pollution**	**Noise**	**Chemicals [b]**	**Other housing risks**	**Recreational environment**	**Water resources management**	**Land and built environment**	**Other community risks**	**Radiation**	**Occupation**	**Climate change [c]**
Infectious & parasitic diseases														
Respiratory infections		●	●	●			●							
Diarrhoeal diseases	●							●						●
Intestinal nematode infections	●												●	○
Malaria									●		●		●	●
Trachoma	●													○
Schistosomiasis	●							●					●	○
Chagas disease							●							○
Lymphatic filariasis	●							●					●	○
Onchocerciasis								●					●	○
Leishmaniasis							●						●	○
Dengue							●						●	●
Japanese encephalitis									●				●	○
HIV/AIDS													●	
STDs													●	
Hepatitis B and C													●	
Tuberculosis													●	
Other infectious diseases	●						●		●				●	
Neonatal & nutritional diseases														
Neonatal conditions	●	●	●	●		●							●	○
Protein–energy malnutrition[d]	●										●			●
Noncommunicable diseases														
Cancers		●	●	●		●					●	●	●	
Neuropsychiatric disorders					●	●	●						●	●
Cataracts		●										●	●	
Hearing loss					●	●							●	
Cardiovascular diseases		●	●	●	●	●				●			●	●
COPD		●	●	●										
Diabetes		●	●	●										
Asthma		●	●	●		●	●						●	○

	Environmental risk factor													
Disease or injury	**WASH**	**Indoor fuel combustion**	**Second-hand tobacco smoke**	**Ambient air pollution**	**Noise**	**Chemicals [b]**	**Other housing risks**	**Recreational environment**	**Water resources management**	**Land and built environment**	**Other community risks**	**Radiation**	**Occupation**	**Climate change [c]**
Other respiratory diseases													●	○
Chronic kidney diseases							●						●	○
Skin diseases	●						●						●	
Musculoskeletal diseases	●												●	
Congenital anomalies			●	●		●						●	●	
Injuries														
Road traffic accidents										●			●	
Falls							●	●		●	●			
Drownings								●			●		●	●
Burns							●						●	○
Poisonings						●	●						●	
Other unintentional injuries							●	●		●	●	●	●	●
Violence						●	●			●			●	○
Self-harm						●	●			●			●	○

Key: Coloured dots represent attributable fractions; an attributable fraction is the proportional reduction in death or disease that would occur if exposure to a risk were removed or reduced to a minimum exposure distribution currently achieved in certain population groups. The ranges of the attributable fractions are:

○ influence likely but not yet quantifiable; ● < 5%; ● 5–25%; and ● > 25%

The environmental attributable fractions are indicative values, based on comparative risk assessment or expert opinion. They are discussed in further detail in Prüss-Üstün et al. (2016).

b Limited to industrial and agricultural chemicals and chemicals involved in acute poisonings.

c Global climate change will increasingly influence our lives. This table covers current risks to health. While hollow circles have been added to this table to highlight likely future impacts of climate change on health, most future health impacts are not currently quantifiable.

d Malnutrition and consequences.

Source: World Health Organization (2022 update).

3.5. Conclusion

This chapter has looked at ways in which the WHO frames health and the environment. This demonstrates the agenda for public health at an international level. Consideration has been given to the requirements of health in SEA. It is shown that the links between environment and health have long been recognised by the WHO and the agenda is set through scientific evidence and political guidance, across the WHO European Region, by a series of ministerial meetings.

This chapter shows how the WHO operationalises the definition of health which is in its constitution. This review has focussed on environmental aspects. Within this environmental paradigm there are findings that are relevant to SEA practice: for example, the recognition of the importance of taking societal context into account when developing policy solutions; of considering social inequalities and equity in all analysis; of recognising that the physical environment has effects, both beneficial and adverse, on physical and on mental health; and of the intricate links between the social and the physical environment.

The chapter has shown indicators and tools that may be of use in SEA for the policy areas for identifying effects on health and on health inequalities arising from legislation, policies, plans and programmes. It has also identified ways in which health analysis may contribute to mitigation advice in SEA, for example through conceptual frameworks such as DPSEEA or through the recognition of the co-benefits achievable when policies are aligned. For the WHO, the consideration of health and the environment is not restricted to the physical environment but encompasses the social and economic environments. The WHO also identifies an active role for the health sector, and encourages cross-sectoral working with the health sector.

4. Existing guidelines on health in Strategic Environmental Assessment

In 2011 The Institute of Public Health in Ireland (IPH) conducted research on the level of health in SEAs and published a report concluding that health is not routinely including in SEAs on the Island of Ireland. The IPH went on to state that there was a need to localise existing guidance to enhance the level and width of health in SEAs (Lavin et al., 2011b). In this chapter, an overview of guidance documents for SEA and health are provided. The timeframe for documents to be included is the past 20 years (i.e. 2004), the year the SEA Directive had to be transposed into national law by EU members states. Guidelines released by the UNECE in support of the implementation of the UNECE SEA Protocol; the European Commission in support of the implementation of the SEA Directive; and the International Atomic Energy Agency in support of the application of SEA of nuclear power programmes; as well as the Irish SEA guidelines are considered. Furthermore, at the end of the chapter, the recent Irish HIA guidelines are also briefly introduced. This is mainly for information purposes, as Irish practitioners need to acknowledge them, including those working on SEA.

4.1. Support of the application of the UNECE Strategic Environmental Assessment Protocol

In 2012, the UNECE and the Regional Environmental Center for Central and Eastern Europe published a Resource Manual to support the application of the Protocol on Strategic Environmental Assessment (United Nations Economic Commission for Europe and Regional Environmental Center for Central and Eastern Europe, 2012). Annex A1.1 of this Resource Manual provided guidance on health. Here, an overview is provided for how to address health in SEA. Firstly, why health matters is explained and practical implications of the consideration of health and a health definition are provided. A practice example is introduced next (Czech Operational Programme for 2007–2013 for “Enterprise and Innovation”). Consultation of environmental and health authorities is explored and how to assess impacts on health is explained. In this context, environmental risk factors are introduced. Questions are provided for helping to identify possible effects of plans and programmes. Differences between SEA and HIA are explored before finally recommendations are provided for how to include health in scoping and the SEA report.

In 2023, the UNECE in collaboration with the WHO published an information document ‘Assessing Health Impacts in Strategic Environmental Assessment’ (United Nations Economic Commission

for Europe, 2023). Importantly, this reiterates the importance of the definition of health described in the WHO constitution. It also suggests that the health focus in SEA practice should be on population health, which could be defined geographically or by shared characteristics. In the scoping process, the SEA should consider if the plan or programme (and to the extent appropriate, legislation or policy) would have impacts on health inequalities, healthy lifestyles, safe and cohesive communities, socioeconomic conditions, environmental conditions and health and social care services. While it does not identify the detailed environmental impacts that should be included, the guideline sets up a generic framework for assessing health impacts in SEA practice. It suggests that SEA should do so through a six-stage DPSEEA framework: Driving Force, Pressure, State, Exposure, Effect and Action (see also Section 3.2.2 for more details on this framework). This framework traces the relationship between health effects and other factors in society, thus helping the assessors show and map the health impacts of the determinants and identify actions to address the health impacts (United Nations Economic Commission for Europe, 2023).

4.2. Support of the implementation of the Strategic Environmental Assessment Directive

Two guidance documents were published for the implementation of the SEA Directive, one for the original SEA Directive (European Commission, 2004) and one for integrating climate change and biodiversity into SEA (European Commission, 2013). The guidance documents of the original SEA Directive (European Parliament and Council of the European Union, 2001) reaffirmed that the risks to human health should be considered in SEA, and a comprehensive and systematic approach is needed to determine the effects (European Commission, 2004). However, it does not explain further the definition or scope of human health risk. The later guidance document on the integration of climate change and biodiversity, though, has implied the scope of human health risks.

In the context of climate change and biodiversity, biodiversity is identified to provide ecosystem services that provide livelihood opportunities and health and recreational benefits. Climate change impacts are explained to include direct human health impacts due to extreme weather events and damage to infrastructure and food production (European Commission, 2013). Although the guidance does not explain the scope of human health directly, it is implied that human health includes physical health, mental health and the health of the ecosystem that provides services to the livelihood, food production and economic activities.

In addition to these two guidance documents, the 2022 EU report on the SEA Directive ruling of the Court of Justice of the European Union explained the subject of human health in the rights of individuals concerned (European Commission, 2022). It highlighted that the purpose of the directive is to protect the environment and quality of life, and that the effects should be assessed and take account of the concerns. By extension of this purpose, it is concluded that it must include the prevention of financial damage if that damage is the direct economic consequence of the environmental effects.

4.3. Strategic Environmental Assessment guidelines of the International Atomic Energy

In 2018, the International Atomic Energy Agency (IAEA) published 'SEA guidelines for Nuclear Power Programmes (IAEA, 2018). On page 25, the approach to health is outlined as follows:

> *'Public health, well-being and safety are key aspects for consideration in SEA for nuclear power programmes. With regard to physical determinants of health, radiological aspects are of particular importance.'*

With its 'Simplified Approach for Estimating Impacts of Electricity Generation' (SIMPACTS; see https://www.iaea.org/topics/energy-planning/energy-modelling-tools), the IAEA provides a tool to assess the geographical distribution of public health implications during standard operations of a nuclear power plant. With regard to non-standard operations and for avoiding incidents and accidents, safety considerations in the development of nuclear energy require careful attention. Other aspects that may have an impact on physical health determinants include noise and emissions associated with mining, construction of facilities and transport.

The IAEA guidelines continue to state that (p 25):

> *"When considering health in SEA, it is not only the physical determinants that require attention but also various social aspects. In this context, the 'health determinants' approach promoted by the World Health Organization can be applied […]. As regards the development of nuclear energy, other health aspects that may need to be taken into account include mental health, as perceptions of threats posed by nuclear energy may have a very real impact on the health of local or regional populations. Existing epidemiological studies may provide a baseline in this case."*

4.4. Strategic Environmental Assessment: Irish Guidelines for Regional Assemblies and Planning Authorities

In these 2022 guidelines, Box 3.1 lists the 'Characteristics of the effects and of the area likely to be affected, having regard, in […] particular, to' Amongst others, these include ' the risks to human health or the environment (for example, due to accidents)'

Furthermore, one box and two figures are included in the guidelines that provide examples of how health has been addressed in good practice SEAs. These include box 5.2, which provides an example from Clare County Development Plan 2017–2023, where existing environmental issues relating to population and human health are shown. Furthermore, Figure 8.1 provides an example of proposals for monitoring from Fingal County Development Plan 2017-2023, referring to air quality and noise. Finally, Figure 8.2 provides for another example of proposals for monitoring from the Dublin City Development Plan 2016-2022, which lists densities, number of residential properties and 'percentage increase in the number of schools, crèches, community parks, sports facilities and primary health centres' (See Department of Housing Local Government and Heritage, 2022).

4.5. Health Impact Assessment in Ireland

In 2021, The Institute of Public Health in Ireland (IPH) issued guidance on HIA (Pyper et al., 2021)}. This notes that health should be considered in environmental assessment at strategic and at project levels and it provides guidance and tools to enable this to happen. It emphasises the importance of a proportionate approach to human health and it makes the case that HIA principles and approach can, and should, be applied whether the assessment is a standalone HIA or part of an environmental assessment. It provides guidance on ways to identify *likely significant effects* as per the SEA and EIA Directives. In this context, it includes a focus on vulnerable groups and the general population. It also lays out the role health authorities should play when preparing environmental assessments (see Pyper et al., 2021).

5. Environment and health links: a review of the academic literature

5.1. Introduction and methodology

There is a long history of research on the relationship between the environment and human health, and it has caught much attention in recent years. In this context, a desktop search on the Scopus database (Jan 2024) using the keywords 'human' AND 'health' AND 'environment' returned a total of 78,741 documents, with 17,036 of them published since Jan 2021. The research projects underlying these documents are conducted across academic disciplines, including medical science, environmental science, social science, engineering, and others.

The health consideration in SEA focuses on several aspects. SEA practice concerns the environmental impact on the scale of plans and programmes (and where appropriate policies and legislation). As explained earlier, the consideration of human health is specified to the likely significant effects of the receptors that are associated with the issues listed in Articles 2 to 7 of the UNECE SEA Protocol and Annex I (f) of the SEA Directive. Furthermore, the guideline of the EU SEA Directive (European Commission, 2004) states that the list is not exhaustive and that other relevant issues may be included, such as noise (as is also mentioned in the EU SEA Guidance (European Commission and Directorate-General for Environment, 2003)). Finally, the Irish SEA Guidelines from 2020 (Department of Housing Local Government and Heritage, 2020) mention Seveso sites and Radon radiation.

As a reminder, the environmental issues to be considered in SEA, listed in the EU SEA Directive and in the UNECE SEA Protocol (Articles 2-7) are *biodiversity, human health, fauna, flora, soil, water, air, material assets, cultural heritage, including architectural and archaeological heritage, landscape and the interaction among these factors.* Whilst the SEA Directive includes *climatic factors*, the Protocl refers to *climate*. Furthermore, the SEA Directive includes *population* and the Protocol *natural sites*.

Importantly, SEA legislation and guidelines do not explicitly explain what potential human health impacts of the identified environmental subjects should be considered. A literature review is, therefore, necessary of which this chapter summarises the findings.

5.2. Methodology

As indicated above, the objective of the literature review was to identify the potential human health impacts associated with the environmental issues that are commonly included in SEA practice. If legal requirements are clear, practice can go above those. If they are unclear, it is important to obtain an understanding of how issues are interpreted in practice. Environmental and human health impact linkage could be described in a source-pathway-receptor manner (United Nations Economic Commission for Europe, 2023).

Following this principle, human health impacts contain three components:

(1) the quality and change of the environment (as expressed by each environmental issue) as the source;

(2) the direct and indirect exposure to the environment as the pathway; and

(3) the individual and the communities receiving the impacts as the receptors.

The literature review covers all three components to provide a comprehensive picture of the link between environmental impacts and human health (NB: the 78,741 hits from the search for 'human' AND 'health' AND 'environment' were examined with regards to dealing with these components). In addition, the potential human health impact *outcomes* of receptors are also summarised.

The literature review underlying this chapter is based on the peer-reviewed documents archived in the Scopus database. This is a comprehensive database of peer-reviewed journals in the field of (physical and social) environmental sciences, publications over the past several decades. The collection in the Scopus database can be considered sufficient for the literature review on the topic (see, for example, Fischer, 2023a). There are other databases. The 'Newer Dimensions database, for example, has a greater number of documents, but these are not freely accessible i.e. they are behind a paywall (Singh et al., 2021),

As there is a large volume of relevant documents on the environment and human health, restrictions have been set to focus the search of literature on the latest and most relevant publications. The search has been limited to the documents published within the last three years (i.e. since Jan 2021), in particular as a comprehensive literature review was already conducted in 2021 for the WHO and UNECE (World Health Organization, 2022 update). However, in cases where there is not insufficient information from the articles published in the last three years, the search was extended to five years.

SEA is analysed here from a view that concerns the environment as a determinant affecting human health. The literature search is limited to the subjects of environmental as well as earth and planetary sciences (i.e. it is not conducted from an epidemiological point of view). The literature search is restricted to review articles (which reduced the number of documents to 10,773). These restrictions helped to identify the most relevant articles.

The search string for identifying documents on Scopus is designed with reference to the environmental issues listed in Articles 2-7 of the UNECE SEA Protocol and Annex I (f) of the SEA Directive and the Irish SEA guidelines as described in Chapter 1. Repeated searches were conducted using the keywords of each environmental subject listed, with "human" ,"health" and "review". The following search string was used:

(KEY (*Environmental Subjects**) AND KEY (human) AND KEY (health) AND KEY (review)) AND (LIMIT-TO (SUBJAREA , "ENVI") OR LIMIT-TO (SUBJAREA , "EART"))

* Environmental subjects are substituted with the following terms for repeated searches: Air pollution OR Air Quality/ Water Pollution OR Water Quality/ Flora OR Fauna OR Biodiversity/ Climate/ Material Assets/ Culture OR Heritage/ Landscape/Natural site/ Noise.

The documents returned from the search were manually screened to select those that are relevant to SEA in terms of the subjects and scope of the study. Table 5 shows the included and excluded subjects and the underlying rationale.

Table 5: Included and excluded environmental health subjects

Subjects	**Example**	**Rationale**
Environment and health subjects included in the literature review		
Review of health risks associated with environmental pollution, including the direct and indirect impacts	Studies on disease risks caused by air pollution	It provides information of the associated health outcomes
Review of health opportunities associated with favourable environments	Studies of the mental health benefits of green space availability	It provides information of the associated health outcomes

Subjects	Example	Rationale
Review of factors affecting the environmental health outcomes	Studies of the factors causing noise annoyance	It provides information of the factors associated with the health outcomes
Review of pathways of human exposure to environmental pollutants	Studies of the human exposure pathways of micro and nano plastics.	It provides information of the environmental and health pathway.
Review of the difference in health risks and opportunities among population groups	Cohort studies of the response of air pollution among different age groups	It identifies the vulnerable groups
Environment and health subjects excluded in the literature review		
Research methodology reviews	Studies of the use of AI learning in environmental health studies.	It does not contain reviews on health outcome
Review of occupational health risks	Studies of chemical exposure of mining workers	Occupational health risk is associated with many local factors such as the specific works, equipment, and managements. These factors are job and location specific and cannot be summarised without detailed examination of the context
Review of indoor environmental health risks	Studies exposure of particulate matter generated indoor	Indoor environment is affected by mostly local factors. The subject is currently not usually covered in SEA studies; however, the emerging literature on indoor

Subjects	Example	Rationale
		air quality and environmental health implications indicates that this is increasingly a strategic issue.
Environmental control technologies reviews	Studies on the effectiveness of water treatment methods in removing contaminants	This subject is more associated with engineering studies and not covered in SEA studies
Mapping studies	Investigation studies of the spatial exposure of air pollution	These studies focus on the local factors instead of health outcomes
Project reviews	Review of the public health outcomes from certain projects	SEA studies usually do not cover project level assessments
Policy and environmental management studies	Review of the effectiveness of air pollution control policies.	These studies focus more on the policy implementation than health risks

Not all reviewed documents are in the reference list, as some of them do not present any clear evidence. Whilst these documents were initially reviewed, the findings are not included here.

5.3. Environmental issues affecting human health

Following on from what was outlined above, subsequently, the following environmental issues are covered:

- Air quality;
- Water quality;
- Flora, fauna and biodiversity;
- Natural sites;
- Landscapes;

- Noise;
- Climate; and
- Radon and electromagnetic field.

There were no results for environment and health linkages for cultural heritage, material assets and Seveso sites. These subjects are therefore subsequently not listed.

5.3.1 Air Quality

Air Pollution is recognised as one of the greatest environmental risks to human health, which increases the risk of disease and premature death (World Health Organization Regional Office for Europe, 2023k). In Europe, particulate matter ($PM_{2.5}$), nitrogen oxides (NO_x) non-methane volatile organic compounds (NMVOCs), ammonia (NH_3) and sulphur dioxide (SO_2) are key air pollutants of concern (European Environment Agency, 2022). The potential human health impact associated with air pollution have received much research attention in recent years. Using the search string described above returned 541 documents that were published since 2021. After screening and filtering documents that are off-topic, such as indoor air pollution, project review and local studies, 79 documents were collected and reviewed.

The literature suggests that there is evidence that elevated concentration of air pollutants ($PM_{2.5}$, PM_{10}, NO_2, and SO_2) increase the risk of cardiovascular diseases, respiratory diseases and unfavourable pregnancy/birth-related outcomes (Markozannes et al., 2022). Ammonia (NH_3) as a substantial contributor of PM has also been suggested to cause respiratory disease directly and indirectly (Wyer et al., 2022). Studies in recent years concluded that air pollution (especially $PM_{2.5}$) may have more health risks than previously anticipated. In this context, various studies found that $PM_{2.5}$ causes oxidative stress, inflammation, as well as DNA damage to the cardiovascular and respiratory system (Chen et al., 2024; Monti et al., 2023; Sun et al., 2023; Xue et al., 2022; Zhang et al., 2022b). It also potentially affects the gastrointestinal system (Pritchett et al., 2022), kidney functions (Rasking et al., 2022) and reproductive system (Wang et al., 2021). Both, $PM_{2.5}$ and PM_{10} are observed to adversely affect pregnant women's health and birth outcomes (Song et al., 2023; Zhu et al., 2023). $PM_{2.5}$, PM_{10} and NO_2 are observed to potentially increase the risk of being overweight and obese in children and adolescents (Zheng et al., 2024). Furthermore, $PM_{2.5}$ and NO_2 are observed to be associated with worsening human psychological functioning (Thompson et al., 2023). Exposure to ammonia have the potential to increase the risk of developing asthma in young children (Wyer et al., 2022).

In addition to increasing the risk of developing disease in the first place, air pollution can lead to complications for those suffering from other respiratory diseases. For example, NO_x is observed to potentially worsen pollen allergies (Verscheure et al., 2023). PM, O_3, NO_2, and CO were observed to be positively associated with COVID-19 incidences, in which $PM_{2.5-}$ and NO_2 were correlated with COVID-19 deaths (Hernandez Carballo et al., 2022).

Finally, air pollution has been observed to be associated with mental health problems (Chen et al., 2024). Long term exposure to PM, especially PM2.5 is observed to be correlated with depression and suicide (Liu et al., 2021b).

NB: It is important to note that while there are many environmental and epidemiology studies on the human health effect of air pollution, the causality of many observed impacts has not yet been fully established (Markozannes et al., 2022). For a summary, see Table 6 at the end of this chapter.

5.3.2 Water Quality

Water quality is known to be connected with human health in multiple ways. The UNECE Protocol of Water and Health primarily concerns drinking water, hygiene and water use for recreation (United Nations Economic Commission for Europe and World Health Organization Regional Office for Europe, 2021). Scopus found 376 documents concerning water quality and human health published since 2021. After screening and filtering, 34 documents were identified and reviewed.

Drinking water contaminated by chemicals and microbial pathogens is known to pose various health risks. Chemicals such as residue of fertilisers, herbicides and pesticides are identified to increase the risk of developing cancers (Derbalah and Sakugawa, 2023; El-Nahhal and El-Nahhal, 2021; Picetti et al., 2022; Syafrudin et al., 2021). Heavy metals in drinking water can damage different internal organs, increasing the risk of developing disease and cancer (Alagan et al., 2023; Zhang et al., 2023). Microbial pathogens such as bacteria and parasites can infect a human body's systems and organs, causing inflammation and chronic diseases (Kristanti et al., 2022). It is noted that there are also concerns that drinking water may play a role in the transmission and outbreak of waterborne diseases. However, this is said to require further study (Lee et al., 2023a).

For bathing water, chemical residues from agricultural activities such as herbicides has been known to commonly contaminate surface water through surface runoff and ground water leaching, which is a potential pathway posing public health risks (Derbalah and Sakugawa, 2023). However, the details of these risks are not documented.

There are two rising concerns of water quality related public health risks. First is the antibiotic pollution and transmission of antimicrobial resistance to humans. Antibiotic pollution has been detected in rivers and antimicrobial resistant waterborne organisms were found in coastal and freshwater bodies. Studies found that antimicrobial resistant organisms in water have the potential to transmit antimicrobial resistance to humans (Velazquez-Meza et al., 2022).

The second concern is micro and nano plastic pollution in fresh and coastal waters. Microplastics are found to potentially induce gastrointestinal tract inflammation and oxidative stress (Janani et al., 2024). Macro and nano plastics can pass to human through the food web (Ardestani, 2022). However, there is insufficient evidence on the human health impact that is directly caused by the increasing cumulation of micro and nano plastics in seafood, such as shrimps (Timilsina et al., 2023). For a summary, see Table 6 at the end of this chapter.

5.3.3 Flora, Fauna and Biodiversity

Flora, Fauna and Biodiversity cover subjects concerning the associations between biota, ecosystems and human health. There is overlap within the subjects discussed in the section on natural sites with regards to the association of natural elements and human health. Generally speaking, natural sites cover sites with biota associated with human health (United Nations Economic Commission for Europe, 2014). Therefore, this section focuses on the health, abundance and diversity of species and ecosystems, whereas the natural sites' section focuses on natural assets, such as green and blue spaces.

For this theme, Scopus identified 181 documents published since 2021. After screening and filtering them, 24 were reviewed. Results from the 2021 literature review are acknowledged and can be accessed here: World Health Organization 2022 update. These focused on the conditions of the biota or ecosystems without specifying any particular flora or fauna species.

Biota and ecosystems have been found to affect human health in multiple ways. Natural and urban ecosystems provide services to human societies, including food production (Giglio et al., 2023; Marselle et al., 2021a), as well as cultural, social and scientific values (Giglio et al., 2023; Marselle et al., 2021a). Urban ecosystems have been found to affect mental health, wellbeing, and improved social cohesion (Marselle et al., 2021b; Reyes-Riveros et al., 2021; Robinson et al., 2024). It is noted that besides the diversity of species, the abundance of specific distinctive species was be associated with improved mental health and well-being (Marselle et al., 2021b).

As biota are the foundation of food production, some recent studies focused on the possibility of pollutants entering the food web to potentially pass to human. Micro and nano plastics (Dube

and Okuthe, 2023; Liang et al., 2024; Timilsina et al., 2023) as well as chemicals like polycyclic aromatic hydrocarbon (PAH) have already been established to contaminate the food web (de Pinho et al., 2023). There are also concerns over the antimicrobial resistance in natural biota and the possibility of this affecting humans (Ding et al., 2023). While the contamination of the food web is found to pose a human health risk, there is little evidence to confirm associated human health outcomes.

Another potential association between biodiversity and human health is the "Biodiversity Hypothesis" which that the diversity of biota helps in human healthy development of the immune and digestive system. However, the underlying mechanisms and evidence remain unclear (Marselle et al., 2021a; Potter et al., 2023). For a summary, see Table 6 at the end of this chapter.

5.3.4 Natural Sites

The UNECE's implementation guide of the Aarhus Convention states that "Natural sites may refer to any objects of nature that are of specific value" (United Nations Economic Commission for Europe, 2014, p.51). It covers a wide range of different topics. Some of these are covered in section 5.4.3. This section focuses on the topics that are not covered elsewhere. The health benefits associated with the provision of accessible natural sites have caught much research attention in recent years. Scopus found 52 documents with the keywords "natural sites", "green infrastructure", "green space" and "blue space" published after 2021. After screening and filtering them, 39 were reviewed. Most of the studies focused on green spaces, with only few mentioning blue spaces.

Green and blue spaces provide human health benefits in multiple ways. Generally speaking, green and blue spaces benefit human health with regards to five groups of functions (Potter et al., 2023; Zhao et al., 2022):

- ecosystem services;
- absorption of pollutants;
- spaces for physical activities;
- alleviation of stress; and
- enhancement of sleep quality.

The health benefits of access to ecosystem services are described in section 5.3.3. Here, other functions are explained. Green spaces are found to improve human mental health in various ways. Green space enables an exposure of calming natural environments that can reduce anxiety (Labib et al., 2022; Robinson et al., 2024) and lower the risk of depression (Bolanis et al., 2024; Labib et al., 2022; Liu et al., 2021a). Provision of green spaces also enhance social cohesion (Huang and Lin, 2023; Robinson et al., 2024) by offering spaces to engage in daily life activities (Huang and Lin, 2023). Letting children spend time in green spaces is suggested to help children's intra- and interpersonal socio-emotional functions and development (Mygind et al., 2021).

Green spaces have been found to improve physical health outcomes. Physical activities improve cardiovascular functioning (Robinson et al., 2024). It is found that the provision of green spaces has positive associations with lower levels of obesity (Sillman et al., 2022; Ye et al., 2022; Zhang et al., 2022b), and with lower risks of developing respiratory diseases (Mueller et al., 2022; Zhang et al., 2022b), as well as type 2 diabetes (Zhang et al., 2022b).

Studies have found that green spaces can improve children's health. It is suggested that green spaces have protective effects regarding childhood obesity and children's mental health. Furthermore, they could be beneficial for children's lung and circulatory functions (Ye et al., 2022) as well as neuropsychological development (Luque-Garcia et al., 2022). Green space also have potential benefits with regards to children's behavioural outcomes (Zare Sakhvidi et al., 2022). However, no association has been established between green space exposure and children's academic performance (Ahmed et al., 2022). Here, so far the overall quantity and quality of evidence on children's health outcomes has remained insufficient and requires further investigation (Luque-Garcia et al., 2022; Ye et al., 2022).

While green spaces are found to have various health benefits, the characteristics of them are also important, affecting the extent of health outcomes. Important factors include environment type, size, connectivity, structure, naturalness and biodiversity (Nguyen et al., 2021; Reyes-Riveros et al., 2021). Green spaces that are of low quality and that are difficult to access can result in different outcomes, some potentially negative (e.g. attracting antisocial behaviour(Astell-Burt et al., 2022). For a summary, see Table 6 at the end of this chapter.

5.3.5 Landscape

Scopus found 15 documents concerning the association of landscape and human health published since 2021. After screening and filtering, five of them were found to be relevant. Due to the low

number of documents, the search was extended to include documents published within ten years (i.e. from 2013). With the extended search, 27 documents were found and seven were reviewed.

The overall findings are similar to those described in section 5.3.4. Six out of the seven reviewed documents focus on the natural landscape. These state that natural landscapes provide ecosystem services to humans (Coutts and Hahn, 2015; Nishi and Hashimoto, 2022). Similar to green spaces, exposure to natural landscapes is found to benefit human well-being and to improve mental health as well as providing spaces for physical activities (Hjort et al., 2023; Huang and Lin, 2023; Li et al., 2023b; Zhang et al., 2021). Studies have also found that outdoor natural environments can help the patients on psychiatric wards to recover (Hjort et al., 2023).

In an urban landscape, transportation and the built environment characteristics (e.g. connectivity, aesthetic, safety) affect adult's motivation of physical activities (Salvo et al., 2018). For a summary, see Table 6 at the end of this chapter.

5.3.6 Noise

Sixty-seven documents published since 2021 were identified that dealt with noise and human health impacts. After filtering them, nine articles were reviewed. Among these, traffic noise is the most common type of noise, covered in eight of the articles.

There is evidence for noise exposure being associated with physical health and well-being, in particular by causing annoyance (Ata Teneler and Hassoy, 2023; Seidler et al., 2023). Furthermore, elevated noise levels at night time (L_{night}) have been associated with sleep disturbance (Ata Teneler and Hassoy, 2023; Smith et al., 2022).

Exposure to noise was found to be associated with some forms of cognitive impairment. Furthermore, reading and language skills were found to be affected by elevated noise levels (Thompson et al., 2022), potentially adversely affecting children's learning (Dohmen et al., 2022; Thompson et al., 2022). There are potential associations between noise and other cognitive functions, such as executive functions, but evidence for this to date has remained thin (Thompson et al., 2022). Noise exposure (mainly from traffic) has been found to affect the central nervous system and brain, contributing to an increased risk of neuropsychiatric disorders (Hahad et al., 2022). Noise is also likely to be potentially associated with obesity, but this requires the generation of further evidence (Gui et al., 2022).

While annoyance has been identified as a key noise issue, the extent of annoyance is associated with personal perceptions (Ata Teneler and Hassoy, 2023). Whilst what has been outlined in this

section is connected with findings for the general public, occupational risks are different, however, these are not covered here. For a summary, see Table 6 at the end of this chapter.

5.3.7 Climate

On Scopus, 341 documents were identified concerning the association between climate and human health. After screening and filtering, 33 documents were reviewed that included a review of direct and indirect health impacts caused by climate change.

An immediate direct impact of climate change is change in temperatures. Heat is related to ill health, such as dehydration (Faurie et al., 2022). An increase in temperatures is found to elevate the risk of cardiovascular disease (Faurie et al., 2022; Jurgilevich et al., 2023), kidney diseases (Faurie et al., 2022; Jurgilevich et al., 2023; Liu et al., 2021a), respiratory diseases (Faurie et al., 2022), type 2 diabetes and mental disorders (Natour et al., 2022). Heat also increases the morbidity risks of diabetes patients (Moon, 2021). Heat has the potential to have adverse effects on pregnant women, increasing the risk of unfavourable birth outcomes (Dalugoda et al., 2022; Haghighi et al., 2021; Syed et al., 2022). Elevated temperatures are found to increase the toxicity of nano-plastics to microorganisms and aquatic animals but effects on humans remain uncertain (Zhang et al., 2022a).

In addition to heat, extreme weather events and modifications to the natural environment are associated with climate change. These also pose multiple health risks to humans. Heatwaves, also increase the risks of cardiovascular disease, kidney diseases (Jurgilevich et al., 2023) and mental disorders (Li et al., 2023a). Storms and flooding cause accidents and injuries, which can also affect mental health, exacerbating any existing physical and mental health conditions (Anderson et al., 2022; Jurgilevich et al., 2023). Wildfire emits particulate matter and the associated particulate matter is found to increase the negative effects of non-wildfire particulate matter (Jiao et al., 2024). Respiratory and cardiovascular diseases increase healthcare needs in the aftermath of extreme weather events that lead to, for example, floods, droughts and wildfires (Lee et al., 2023b).

The human health risks caused by the modification of the natural environment are highlighted in some recent research. Studies found that ocean acidification and warming increase the toxicity of harmful algae bloom and harmful effects on humans (Dermawan et al., 2022). Climate change is suggested to affect individual susceptibility to Tuberculosis, particularly among developing countries (Kharwadkar et al., 2022) Among tropical low and middle-income countries, it is also

suggested that the transmission rates of several vector-borne diseases may increase (Leal Filho et al., 2022).

Physical environments (such as green and blue infrastructure) , as well as associated policy and planning (such as health care services) affect health risks associated with climate change, in particular, extreme climate events (Jurgilevich et al., 2023). Climate change impact can cause health inequity, as some ethnic groups and economically disadvantaged people are found to be more susceptible to the impact of climate change due to existing health disparities (Smith et al., 2022). For a summary, see Table 6 at the end of this chapter.

5.3.8 Radon

16 documents on radon and human health were identified since 2021. The Scopus search was extended to include documents that were published since 2013. A total number of 36 documents were found of which seven were reviewed, based on relevance.

Radon is a radioactive gas. Humans can be exposed to Radon through inhalation or contaminated water (Ademola and Ojeniran, 2017; Nayak et al., 2022). Radon is a confirmed carcinogenic agent that can lead to lung cancer (Hanninen et al., 2014; Li et al., 2020; Nayak et al., 2022; Ngoc et al., 2022; Su et al., 2022). Studies have also suggested that radon may be correlated with other forms of cancer, such as childhood leukaemia (Ngoc et al., 2022), melanoma and kidney cancer (Nayak et al., 2022). Besides cancers, radon is associated with the development of chronic obstructive pulmonary disease (Nayak et al., 2022). There are studies suggesting that exposure to radon affects other systems, such as the heart and brain, but the evidence is currently thin (Nayak et al., 2022). For a summary, see Table 6 at the end of this chapter.

5.3.9 Summary

Table 6 summarises the results from this chapter. Environmental subjects are listed and associated health risks. Furthermore, vulnerable groups are depicted. Health aspects of indoor air pollution were outlined by the Institute of Public Health in Ireland (Lavin et al., 2006).

Table 6: Environmental Health risks and opportunities and vulnerable groups

Environmental Subject	**Health risks and opportunities**	**Vulnerable groups identified through this search [not exhaustive]**
Air Quality: (Particulate matter and chemical pollution)	Disease risks: - Cardiovascular (Markozannes et al., 2022) - Respiratory (Markozannes et al., 2022; Wyer et al., 2022) - other diseases and body functions (Pritchett et al., 2022; Rasking et al., 2022) Unfavourable birth outcomes (Markozannes et al., 2022; Song et al., 2023; Zhu et al., 2023) Mental Health (e.g. depression and anxiety) (Chen et al., 2024; Davoudi et al., 2021; Liu et al., 2021b) Psychological functions (Thompson et al., 2023) Development of obesity in children (Zheng et al., 2024) Deterioration of conditions for those with existing respiratory diseases (Hernandez Carballo et al., 2022; Verscheure et al., 2023)	Children (Wyer et al., 2022; Zhang et al., 2022b; Zheng et al., 2024) Pregnant women (Song et al., 2023; Zhu et al., 2023) Elderly (Liu et al., 2021a; Sun et al., 2023)
Water	Non-communicable disease risk (damage to internal organ and cancer risk) (Derbalah and Sakugawa, 2023; El-Nahhal and El-Nahhal,	No vulnerable groups specified

Environmental Subject	Health risks and opportunities	Vulnerable groups identified through this search [not exhaustive]
	2021; Picetti et al., 2022; Syafrudin et al., 2021) Microbial infections (Kristanti et al., 2022) Waterborne disease transmissions (Lee et al., 2023a) Antimicrobial resistance (Farrell et al., 2021; Grenni, 2022)	
Flora, Fauna and Biodiversity	Ecosystem services (Giglio et al., 2023; Marselle et al., 2021b) Contamination of food web and microbial resistance (Ding et al., 2023; Liang et al., 2024) Affecting immune and digestive system (Marselle et al., 2021b; Potter et al., 2023)	No vulnerable groups specified
Noise	Sleep disturbance (Ata Teneler and Hassoy, 2023; Smith et al., 2022) Cognitive functions (Thompson et al., 2022) Impact on central nervous system and brain (Hahad et al., 2022)	Children (Dohmen et al., 2022; Thompson et al., 2022)
Climate	Heat induced non-communicable disease risks (e.g. cardiovascular and kidney disease) (Faurie et al., 2022; Jurgilevich et al., 2023; Liu et al., 2021a)	Pregnant women (Dalugoda et al., 2022; Haghighi et al., 2021; Syed et al., 2022)

Environmental Subject	**Health risks and opportunities**	**Vulnerable groups identified through this search [not exhaustive]**
	Unfavourable birth outcomes (Dalugoda et al., 2022; Haghighi et al., 2021; Syed et al., 2022) Extreme climate events such as flooding, heatwave and wildfire lead to injuries, mental health risks and can exacerbate existing health conditions (Anderson et al., 2022; Jiao et al., 2024; Jurgilevich et al., 2023)	
Radon	Cancer risks, especially lung cancer (Hanninen et al., 2014; Li et al., 2020; Nayak et al., 2022; Ngoc et al., 2022; Su et al., 2022)	No vulnerable groups specified

6. Health in current Strategic Environmental Assessment practice

6.1. Introduction and methodology

In order to be able to set good practice standards for the future, it is important to understand the current level of assessment of health in SEA practice, as well as in other related environmental and health assessments. To do this, a scientific literature review was conducted on Scopus for the relevant literature using the search strings:

(ABS(health) AND ABS("strategic environmental assessment")) AND PUBYEAR > 2003 AND (LIMIT-TO (SUBJAREA,"SOCI")),

(ABS (health) AND ABS ("sustainability appraisal")) AND PUBYEAR > 2003 AND (LIMIT-TO (SUBJAREA , "SOCI")), and

(ABS (health) AND ABS ("Strategic Health Impact Assessment") OR ABS ("Strategic Health Assessment") AND PUBYEAR > 2003 AND (LIMIT-TO (SUBJAREA , "SOCI"))

We limited the keyword search to the article abstracts, excluded all but the subject area of 'Social Science'[5] and focused on the publication period from 2004 (the year the SEA Directive came into effect) to January 2024.

In addition to the database searches, we included articles from the literature review conducted in the 2022 report '*Learning from practice - Case studies of health in strategic environmental assessment and environmental impact assessment across the WHO European Region*' (World Health Organization Regional Office for Europe, 2022b).

Following the literature search and narrowing of the results based on inclusion and exclusion criteria, the remaining articles were categorized regarding the type of assessment (i.e. SEA, HIA, EIA, SA, and others) and type of documentation (policy, plan, programme, project). They were then analysed with regards to the inclusion of health, as follows: the wider determinants of health, indicators of health inequalities, the inclusion of health authorities or other health stakeholders in the assessment process, and significant findings of health. The chapter concludes

[5] when doing a Scopus search with 'environmental assessment' in the title, the abstract or keywords, Fischer (2023a) found that only about 10% of all hits apply to the decision support instrument which is considered here, whilst the rest falls into various other categories, in particular 'environmental science'. Limiting the search to 'social science' the results conform closely with those 10%.

by summarizing and discussing the similarities, differences and shortcomings of the current level of health in SEAs.

6.1.1 Inclusion and exclusion criteria

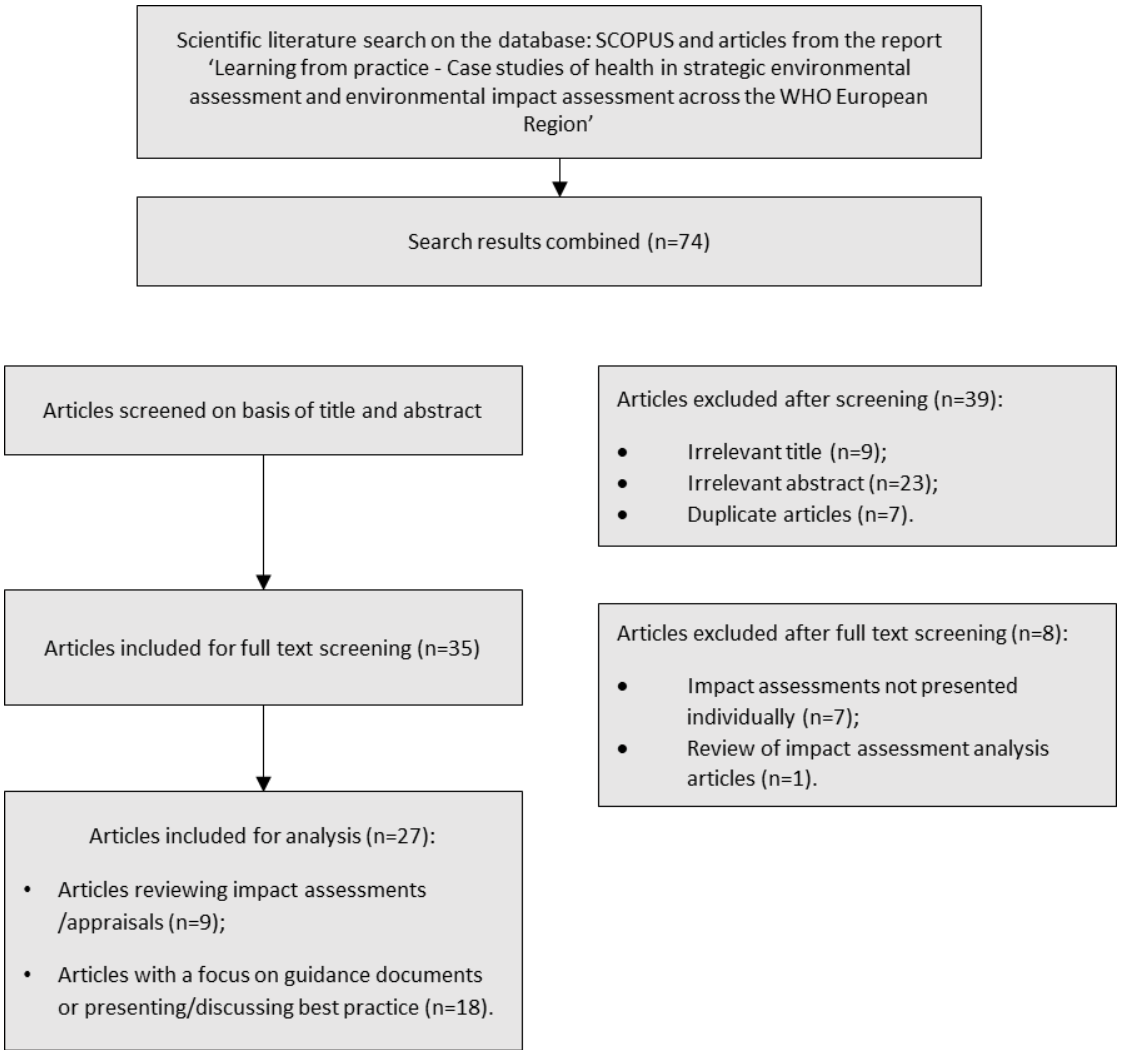
We conducted two rounds of screening of the search results to find relevant articles. The first round consisted of screening the titles and abstracts for relevance and excluding any duplicate articles. **¡Error! No se encuentra el origen de la referencia.** lists the criteria that were used to determine the relevance of articles.

Table 7: Inclusion and exclusion criteria.

Inclusion criteria	**Exclusion criteria**
Regarding SEA, HIA, Strategic HIA, Strategic Health Assessment, EIA, Sustainability Assessment, Sustainability Appraisal.	Only regarding social impact assessment, human right impact assessment, economic assessment or life cycle assessment.
About policy, plan, programme, project, proposal and the above-mentioned assessments/appraisals.	Only mentioning health as a side note, i.e. not assessing the level of health in impact assessments.
Discussing guidelines or exploring best practice for including and assessing health in impact assessments.	Discussing general impact assessment guidelines or best practices, i.e. not with a focus on health explicitly.

The second round of screening was a full-text review of the identified scientific articles. In this round, articles were reviewed in terms of whether they presented impact assessments individually or in aggregation. For our further analysis, individually presented impact assessments are necessary. Below is the screening process visualised with a flowchart based on the PRISMA method (**¡Error! No se encuentra el origen de la referencia.**).

Figure 3: PRISMA flowchart of search approach



6.1.2 Health review

To understand how health is considered in impact assessments, we conducted a search term analysis of articles reviewing impact assessments with a focus on health. We looked at a selection of health identifiers to cover the assessment's width and depth of health inclusion. In **¡Error! No se encuentra el origen de la referencia.**, an overview is provided of the identifiers and the methods of analysis. The rationale behind including health indicators is subsequently explained.

Table 8: Assessment indicators and search terms / methods of analysis.

Assessment indicators	**Search terms and method of analysis**
Mention and assessment of health outcome	Searches used: "outcome"
Mention and assessment of significant findings for health	Searches used: "significan" to cover significance and significant
Definition of 'significance'	Analysis of the results sections
Inclusion of health authorities/stakeholders in assessment process	Searches used: "stakeholder", "public health" and "authorit" to cover authority and authorities
Mention of the term 'wider/social determinants of health'	Searches used: "Determinants", "DoH" (Determinants of Health)
Assessment of determinants of health other than environmental, built environment or biophysical	Analysis of the results sections
Mentioning and assessment of health (in)equality / health equity	Searches used: "equalit" to cover inequality, inequalities, equality and equalities; and "equit" to cover inequity, inequities, equity and equities.

The concept of Wider Determinants of Health (DOH) is recognized by major organizations, including the WHO (World Health Organization, 2017b), as a fundamental basis for health assessments. Recognizing the concept of the DOH is the starting point, as it will be difficult to assess health impacts fully if there is no knowledge of health determinants as such. However, it is not sufficient to be aware of a concept; what the concept stands for needs to be integrated into the assessment. Impact assessments, including SEAs, tend to focus on biophysical and environmental health impacts (Fischer et al., 2018; Fischer et al., 2010). To look at the width of the assessments in terms of how health is covered, we examined whether the IAs had assessed other determinants of health.

In addition to having a broad lens of health, it is also important to acknowledge a possible difference in health impacts and outcomes across population groups, and the resulting mitigation measures needed. Depending on the baseline level of e.g. health and disparity, vulnerable population groups are likely to be more adversely affected than more affluent population groups. Stratification of this kind is currently not the standard practice when conducting impact assessments, as shown by Luyten et al. (2023). Reviewing a sample of health impact assessments, they found that stratification of population groups was lacking on climate change mitigation and adaptation.

Health outcomes, in addition to health effects, are important to consider when conducting impact assessments, to reach an appropriate depth of the assessment. It is not enough for an assessment to state what the immediate effect to health will be, such as change to housing or similar. It is similarly important to understand the long-term health outcomes. Health outcomes themselves are important in relation to monitoring over time.

It is a requirement in the EU SEA Directive to provide information on significant effects to health, including defining what significance means in the specific context of the assessment (European Parliament and Council of the European Union, 2001). Significance is of key importance in assessment since all changes to the existing human experience will impact health to some extent. However, and similarly to what is happening with e.g. environmental impacts in environmental assessments (where scoping out irrelevant issues is just as important as scoping in those that are relevant (Fischer, 2023b)), it would not be proportionate to assess everything in all impact assessments. Therefore, the effect to health must be significant in order to be included in the assessment.

Tamburrini et al. (2011) showed that the involvement of health stakeholders in the consultation process of selected HIAs improved the consideration of historically vulnerable populations. It also broadened the scope of health considered and improved the cooperation between health departments and local governments among other things. The involvement of health stakeholders might then allude to the level at which health is assessed and might enhance the consideration of health in impact assessment.

6.1.3 Assessment methods

All included articles use different methods and on indicators to determine the level of health in the IAs. When going through the articles, we established whether the impact assessment had

mentioned or assessed an health indicator (y=yes or n=no) or if the authors had not included this in their own analysis (n/a = no available data in article), to avoid an analytical misinterpretation.

6.2. Results of the literature review

The literature search resulted in two main types of articles:

1) Guidelines and best practice discussions on health in impact assessments and
2) Articles analysing impact assessment reports, including the level of health.

¡Error! No se encuentra el origen de la referencia. shows the number and types of assessments covered in the articles.

Table 9: Number and types of assessments covered in the articles

	Number of assessments	**Type: policy, plan, programme, or project**
SEA	7	4 plans, 3 projects
HIA	3	All projects
EIA	14	All projects
EIS	3	All projects
Sustainability Assessment / Sustainability Appraisal	2	All projects
Total	**29**	**4 plans** **25 projects**

In total, the nine relevant articles analysed 25 individual cases with one or more impact assessments, including: seven SEAs; three HIAs; 14 EIAs; three EIS'; and two sustainability assessments/ appraisals. Four of the impact assessments were EIAs based on the publicly available environmental impact statements (EISs) / EIA reports. Three of the EIAs were assessed in two of different articles, and their results have been combined. Of the 29 impact assessments, only four assessed plans, the remaining assessed projects. **¡Error! No se encuentra el origen de la referencia.** and **¡Error! No se encuentra el origen de la referencia.** present the results by type of IA.

Table 10: Wider determinants and health inequality/equity in the reviewed IA.

	Mentioning of the term 'wider/social determinants of health'			**Assessment** of determinants of health other than environmental, built environment or biophysical.			**Mentioning and assessment** of health (in)equality / health equity		
	yes	**no**	**n/a**	**yes**	**no**	**n/a**	**yes**	**no**	**n/a**
SEA	0 (0%)	0 (0%)	7 (100%)	4 (57%)	0 (0%)	3 (43%)	0 (0%)	3 (43%)	4 (57%)
HIA	0 (0%)	0 (0%)	3 (100%)	3 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (100%)
EIA	1 (7%)	2 (14%)	11 (79%)	3 (21%)	8 (57%)	3 (21%)	2 (14%)	8 (57%)	4 (29%)
EIS	1 (33%)	2 (67%)	0 (0%)	3 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (100%)
SA	0 (0%)	0 (0%)	2 (100%)	2 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	2 (100%)

Table 11: Health outcomes health authorities / stakeholders and significance in the reviewed IA.

	Mentioning and assessment of health outcome			**Inclusion** of health authorities/stakeholders in assessment process			**Mentioning and assessment** of significance for health		
	yes	**no**	**n/a**	**yes**	**no**	**n/a**	**yes**	**no**	**n/a**
SEA	0 (0%)	1 (14%)	6 (86%)	0 (0%)	0 (0%)	7	1 (14%)	6 (86%)	0 (0%)
HIA	0 (0%)	1 (33%)	2 (67%)	0 (0%)	0 (0%)	3 (100%)	1 (33%)	2 (67%)	0 (0%)
EIA	3 (21%)	6 (43%)	5 (36%)	0 (0%)	0 (0%)	14 (100%)	4 (29%)	0 (0%)	10 (71%)
EIS	0 (0%)	0 (0%)	3 (100%)	0 (0%)	0 (0%)	3 (100%)	0 (0%)	0 (0%)	3 (100%)
SA	0 (0%)	0 (0%)	2 (100%)	0 (0%)	0 (0%)	2 (100%)	0 (0%)	2 (100%)	0 (0%)

6.2.1 The scope of health

None of the articles mentioned whether the SEAs or the HIAs included the term 'Wider Determinants of Health'. Of the 14 EIAs, one mentioned the 'Wider Determinants of Health', two did not. One EISs mentioned the term 'Wider Determinants of Health', whilst two did not.

Four out of seven SEAs assessed determinants of health other than environmental, built environment or biophysical, such as housing, access to health services, other public services and fresh produce, employment and livelihood (Humboldt-Dachroeden et al., 2019). There was no information on determinants of health in the articles about the remaining three SEAs. The three HIAs included in the review, all covered a broader range of health determinants. Three of the EIAs assessed health determinants in addition to environmental, built environment or biophysical factors, such as health, wellbeing, equity and community health, housing affordability (Hresc et al., 2018). Eight of the EIAs did not assess a wide range of determinants, however, one of the papers presented an analysis of three mega transport projects, with the focal point of finding the underlying issue of the lack of health in EIAs. The researchers discovered that especially the

"compliance process" approach without project options narrowed the opportunity to do a proper analysis of health and transport links (Harris et al., 2018). All three EISs assessed a wider range of health determinants, including community health and infrastructure, health status, social well-being, indigenous health, infant and maternal health, communicable disease, mortality, as well as medical service and hospital utilization (Hackett et al., 2018). Both SAs assessed a broad range of determinants.

6.2.2 Examining/assessing health inequalities and health equity

Three of the SEAs had distinctly not considered the issues of health (in)equality or health equity. None of the articles discussed whether HIAs had considered health (in)equality or health equity. A majority of those focusing on EIAs looked at data on consideration of health (in)equality and health equity, however only two of the EIAs analysed health (in)equality and health equity, whereas eight did not. One of the EIAs looked at the relationship between stress in the community and inequity in social and economic opportunities, housing and cost of living for Aboriginal residents in Australia (Hresc et al., 2018). The other EIA included a shallow assessment of equity by looking at the social and psychological impacts on indigenous people resulting from a railway project in Vietnam (Pham et al., 2018). There was no information available on the EISs on the subject of health (in)equality or health equity.

6.2.3 Health outcomes

One SEA and one HIA had distinctly not considered health outcomes. There was no data for the remaining SEAs and HIAs regarding health outcomes. Three EIAs included health outcomes. In one EIA the association between economic determinants and health outcomes was assessed qualitatively (Gwimbi et al., 2020).The other two EIAs provided an, in the authors opinion, insufficient assessment of economic indicators and health outcomes in relation to housing affordability among other issues (Hresc et al., 2018). The remaining six EIAs did not consider health outcomes. There was no data for the EISs on the subject of health outcomes.

6.2.4 Engaging with health stakeholders

None of the articles examined inclusion of relevant health stakeholders in IA.

6.2.5 Defining significance

One SEA and one HIA considered significant findings for health, the remaining six SEAs and two HIAs did not. Four of the EIAs considered the significance of health to some extent. However, there was no data for the remaining ten EIAs. There was no data for the EISs on the subject of

significant findings for health and none of the SAs looked at significance in relation to health. Additionally, none of the articles that covered significance in relation to health stated whether the IAs had provided a definition of the term 'significance'.

6.2.6 Good practice

In addition to looking specifically for the health indicators we had predetermined, we also analysed the articles for what they considered to be "good practice" in terms of including health in IAs. In addition to the included articles, we also looked at the seven previously excluded articles within aggregated results, totalling 16 articles. The articles reviewed an extensive array of health indicators to determine the level of health included in the analysed IAs. These indicators are presented in **¡Error! No se encuentra el origen de la referencia.**, along with how many articles included them, and which percentage of the 16 articles included the indicator. The indicators overlapping with the previously defined health indicators are highlighted in bold.

Table 12: Health indicators analysed.

Health indicator	**Number (% of 16 articles)**
Determinants of health other than environmental, built environment or biophysical	14 (88%)
Significant findings for health	8 (50%)
Explicit consideration or interpretation of human health	7 (44%)
Vulnerable and minority groups / distributional effects across different population groups	7 (44%)
Health impacts (positive and negative)	5 (31%)
Health outcomes	5 (31%)
Health (in)equality / health equity	5 (31%)
Health data / evidence / literature review	5 (31%)
Health baseline / profile	4 (25%)
Health monitoring (formal and informal)	3 (19%)
Mitigation measures (negative and positive)	3 (19%)
Qualitative vs quantitative assessment of health	2 (13%)
Risks to human health	2 (13%)
Inclusion of health authorities / stakeholders in assessment process	2 (13%)
Risks to human health	1 (6%)
Cumulative effects	1 (6%)

While not necessarily representing a broad review of many determinants of health, 14 of the 16 articles (88%) looked at one or more determinants of health other than environmental, built environment or biophysical determinants. Such determinants included general health and quality

of life, open and green space, modal shift, fuel poverty, cohesion/exclusion/support, physical activity, mental well-being, healthy access to services, local public facilities, mixed-use developments and social networks (Diallo et al., 2017; Douglas et al., 2011; Fischer et al., 2018). Eight (50%) of the articles reported significant findings for health. One article found that four Danish SEAs looked at significance in terms of site-specific sensitivity and human health impacts (Kørnøv, 2009), however, another article found that while many IAs included or mentioned significance, more than half of the assessed SEAs in the study had failed to determine impact significance a to satisfactory level (Fischer, 2010). Explicit consideration or interpretation of human health and vulnerable and minority groups / distributional effects across different population groups in IAs were both considered in seven (44%) of the articles. Only five (31%) of the articles assessed the inclusion of health impacts and health outcomes with regards to health (in)equality / health equity or health data / evidence / literature review. Four (25%) of the articles looked at whether IAs presented a baseline to describe the community impacted. Health monitoring and mitigation measures were included in the review of three (19%) articles. The least reviewed health indicators include qualitative vs quantitative assessment of health; risks to human health; inclusion of health authorities / stakeholders in assessment process. All of these were only assessed in two (13%) of the articles. Risks to human health and cumulative impacts were assessed in one (6%) article each only.

6.3. Discussion of health in SEA practice

When setting out to do a literature review to examine the level of health in SEA practice and other impact assessments, we had a preconceived idea of what is important. This is exemplified by the indicators we included in our assessment. Due to the meta-level nature of our review, it is not possible to compare the IAs directly against each other to establish whether the inclusion of health can be considered 'good practice', since we do not know whether the indicators we had defined were mentioned or assessed. What we do know, however, is what the authors found relevant, as this is what they included in their reviews. For example, we did not find evidence for any of the SEAs or HIAs mentioning the term wider/social determinants of health, and it was in inexplicit ways that information was presented on which health determinants were included in any of the IAs. Surprisingly, only a couple of articles considered issues regarding health inequalities and health equity or health outcomes to be of relevance when assessing health in IAs. Even more surprising is that none of the articles looked at the level of inclusion of health stakeholders in the assessment processes, which is something that is otherwise widely

encouraged and found to elevate the overall level of health in plans/programmes and projects. Significance in relation to health was the most assessed indicator from our list, which makes sense, as significance is mentioned in both, European SEA and EIA legislation. Data on significance was, however, still lacking for 13 of the cases, and none of the articles provided a definition of health from any IA, indicating that while researchers find this important in terms of health, this has not translated into practice yet.

When looking at what indicators the different articles reviewed IAs against, we found that all our predefined indicators were included in various levels across the 16 articles. While not necessarily representing a broad review of determinants, or an explicit mentioning of determinants of health, nearly all articles included one or more determinants of health other than environmental, built environment or biophysical. These included e.g. physical activity, mental well-being and quality f life etc. Half of the articles found it relevant to review IAs for significance in terms of health findings. While we did not discover any articles looking at inclusion of health stakeholders in the first round of analysis, we found two articles doing so in the second round.

In addition to the predetermined health indicators, the analysis revealed 11 additional health indicators that researchers reviewed health in IAs for (as presented in **¡Error! No se encuentra el origen de la referencia.**). Some of the indicators suggest that researchers wanted to know whether the basic understanding of health in general and of the affected population was in place. These indicators include the explicit consideration or interpretation of human health, a health baseline or profile and the inclusion of health data, evidence, or a literature review in the assessment, as well as a consideration of vulnerable and minority groups and the distributional effects across different population groups. Researchers also sought to understand how and to what level IAs assessed health by looking at both qualitative and quantitative methods, cumulative effects, positive and negative health impacts, risks to human health, monitoring and mitigation efforts.

6.4. Summary of findings

All predefined health indicators were included in at least two articles each, and we found an additional 11 indicators. The indicators used differed widely between the articles, suggesting a diverse view on good practice for health in IAs and a lack of a universally agreed definition of what constitutes good practice for inclusion of health in IAs. Additionally, the level of health included in IAs will vary depending on the type of IA and which legislation is relevant. The literature review

reveals an opportunity for defining an encompassing approach to health in SEA, by seeking inspiration in the approach of other IAs.

7. Concluding remarks

In this report linkages between the environment and health in the context of SEA application and occasionally impact assessment in general were explored, based on published (i.e. secondary) sources. In this context, searches were conducted with three different foci, as follows:

1 Connections made between the environment and health (possibly in the context of impact assessment) in documents published by the WHO;

2 Connections made between environmental and health (possibly in the context of impact assessment) in the professional literature, as appearing on the abstract and citation database 'scopus'; and

3 Consideration of human health in SEAs, SAs, HIAs and EIAs, as reported on in the international literature since 2004.

The starting point for the searches were the environmental aspects that should be considered in SEA, according to the European SEA Directive, the UNECE SEA Protocol, as well as EU and Irish SEA guidelines. In addition to human health, these include:

- biodiversity (including fauna, flora),
- population,
- soil,
- water,
- air,
- climatic factors,
- material assets,
- cultural heritage including architectural and archaeological heritage,
- landscapes,
- natural sites,
- noise,
- Seveso sites; and
- radiation (radon and electromagnetic fields).

Importantly for this report, the key relevance of an adequate consideration of health in SEA is derived from an estimation of the WHO) that for the WHO European Region 15% of deaths are preventable through healthier environments (World Health Organization Regional Office for Europe, 2023g).

Subsequently, key interlinkages between environmental and health aspects emerging from the reviews are summarised. This is followed by a reflection on how health is currently dealt with in SEA. Finally, emerging good practice in health and SEA is discussed.

7.1. Key interlinkages between environmental and health aspects

There are numerous interlinkages between the environmental aspects listed above and health. Environmental impacts have a wide range of potential health effects, affecting physical and mental health as well as well-being. With regards to impacts to be assessed in SEA, these express itself as direct impacts, with, for example, air and water pollution or noise having potentially direct health impacts (most immediately through poisoning or immediate deafness), that include both, communicable and non-communicable diseases. These can range from infectious diseases, over respiratory and coronary diseases to insomnia and associated with this, anxiety, depression and neuro-psychiatric disorders. Possible longer-term effects can include cancers, asthma and hearing impairment or loss. Furthermore, plans and programmes (and to the extent applicable, legislation and policies) can have more indirect effects in terms of an ability to influence human behaviour (e.g. active travel such as walking and cycling) with health implications, as they can potentially address issues such as obesity, diabetes and other related illnesses / non-communicable diseases. With regards to both, direct and indirect health impacts, they differ between different groups in society, with certain groups, such as the elderly, pregnant women, children and people with pre-existing health issues often being more vulnerable than others.

The 'One Health' concept acknowledges that there are important linkages between environmental, animal and human health. These should be considered in relevant plans and programmes (and to the extent appropriate legislation and policies) in order to help avoid the spread of emerging infectious diseases and prevent disease outbreaks. In this context, it is important that more than 60% of emerging infectious diseases reported globally come from animals. There are issues with regards to agriculture, forestry and urban sprawl and harm to ecosystem services that may need to be acknowledged by SEA.

Determinants of health are acknowledged to include social and economic environments, the physical environment and a person's individual characteristics and behaviours. Whilst the environmental aspects listed above all form part of the physical environment, they are firmly connected with the social and economic context within which plans and programmes (and to the extent appropriate legislation and policies) are prepared. Furthermore, as mentioned earlier in

this chapter, actions assessed by SEA can influence individuals' behaviours. Therefore, all determinants of health need to be carefully considered for inclusion in SEA.

An important starting point for how to approach the consideration of health in SEA are the Unites Nations sustainable development goals (SDGs). Key in any SEA practice is the proportionate consideration of health, i.e. those aspects should be included that can potentially be significantly affected by a plan or programme (or to the extent appropriate legislation or policy).

7.2. Current evidence for how health is dealt with in SEA

Based on the reviews conducted of the existing literature it is clear that health features in all SEAs to some extent. However, connections are not always and necessarily explicitly explained. Rather, certain air and water quality standards and noise targets may be acknowledged without any further investigation what potentially not meeting them may actually mean for human health. Furthermore, the main focus of SEA with regards to an assessment of the causes of health impacts is clearly on those (bio-physical) environmental aspects mentioned in the SEA Directive and Protocol, as well as European and Irish SEA guidelines. Whilst wider (socio-economic) determinants of health are only occasionally included, they do play a role in SEA when found to be relevant.

With regards to the types of health impacts included, there is currently little evidence available. However, it is probably fair to say that connections with concrete diseases (communicable and non-communicable) are made only occasionally in SEA. This is in line with the findings of a literature review which was conducted in 2020 for the WHO (published in 2022), in which 35 articles were identified through a Scopus search and reviewed (on the consideration of both, SEA and EIA).

Further evidence for how health is currently dealt with in SEA will be provided in a later report in the context of this Irish EPA project on the development of 'health in SEA' guidance. Twenty SEAs (10 international and 10 from Ireland) will be reviewed with regards to what determinants of health are considered and what connections between environmental impacts and human health effects / outcomes are made.

7.3. Good practice in health and SEA

Specific good practice cases for the consideration of health in SEA will be identified in the forthcoming report on the review of 20 SEA cases (10 international and 10 from Ireland).

However, some preliminary recommendations can be provided here, as is done in the subsequent bullet point list:

- Health effects from environmental impacts should be explicitly stated with regards to e.g. possible communicable and non-communicable diseases that may occur due to environmental impacts.
- Carefully consider environmental risk factors for disease and injury as introduced by the WHO and shown in chapter 3 (Figure 2).
- Carefully consider environmental impacts and potential health outcomes described in chapter 5.
- Consider inequalities within populations with a particular focus on the vulnerable.
- With regards to how to assess health impacts in SEA, consider the DPSEEA model (Driving Force, Pressure, State, Exposure, Effect and Action).
- Consider tools that are available to measure health impacts, as introduced in chapter 3.
- Consider indicators used to track changes in health (see appendices).

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9. Acronyms and abbreviations

Acronym/ abbreviation	In full
AMR	Anti Microbial Resistance
AQG	Air Quality Guidelines
AQS	Air Quality Standards
CLIMAQ-H	Climate change mitigation, air quality and health
DHLGH	Department of Housing Local Government and Heritage
DoH	Department of Health
DPSEEA	Driving Force, Pressure, State, Exposure, Effect and Action
E4A	engage, assess, align, accelerate and account
EEA	European Environment Agency
EIA	Environmental Impact Assessment
END	Environmental Noise Directive
EPA	Environmental Protection Agency
EU	European Union
EUPHA	European Public Health Association
FAO	Food and Agriculture Organization
HIA	Health Impact Assessment
IA	Impact Assessment
IAEA	International Atomic Energy Agency
IAIA	International Association for Impact Assessment
MeSH	Medical Subject Headings
NCD	Noncommunicable Diseases
NH_3	ammonia
NMVOCs	non-methane volatile organic compounds
NO_x	nitrogen oxides
PM	Particulate Matter
SA	Sustainability Assessment / Appraisal
SDG	Sustainable Development Goals

Acronym/ abbreviation	**In full**
SEA	Strategic Environmental Assessment
SIMPACTS	Simplified Approach for Estimating Impacts of Electricity Generation
SO_2	sulfur dioxide
UNECE	United Nations Economic Commission for Europe
WASH	Water, Sanitation and Hygiene
WHO	World Health Organization
WOAH	World Organisation for Animal Health

10. Appendices

10.1. Searches of WHO IRIS database

Table 13: Titles returned in the search of WHO's "communities and collections".

Date	Title
2023	Report of the twelfth meeting of the European Environment and Health Task Force: Bonn, 23 24 November 2022
2023	Report of the thirteenth meeting of the European Environment and Health Task Force: Brussels, 20 21 April 2023
2023	Achieving health benefits from carbon reductions. Manual for use of the climate change mitigation, air quality and health tool
2023	Risk communication of ambient air pollution in the WHO European Region: review of air quality indexes and lessons learned
2023	Statement of the WHO European Healthy Cities Network and WHO Regions for Health Network presented at the Seventh Ministerial Conference on Environment and Health Budapest, Hungary, 5 7 July 2023
2023	Tenth meeting of the Working Group on Health in Climate Change (HIC) of the European Environment and Health Task Force: meeting report: virtual session, 11 12 October 2022
2023	Protecting health through ambient air quality management: a resource package for the WHO European Region
2023	Human biomonitoring programmes: importance for protecting human health from negative impacts of chemicals: technical summary
2023	Human biomonitoring: assessment of exposure to chemicals and their health risks: summary for decision makers
2023	A healthy environment in the WHO European Region: why it matters and what steps we can take to improve health
2023	Zero regrets: scaling up action on climate change mitigation and adaptation for health in the WHO European Region, second edition. Key messages from the Working Group on Health in Climate Change
2023	Health-related priorities in chemical safety focus on human biomonitoring and poison centres: 12 13 October 2022, Bonn, Germany: meeting report
2023	Hospitals of the future: a technical brief on re-thinking the architecture of hospitals
2023	At least one poison centre in each country: summary for policy makers
2023	Poison centres as essential unit for poisoning prevention and sound chemicals management: technical summary
2023	Driving transformative action: from Ostrava to Budapest and beyond with National Portfolios of Actions on Environment and Health: policy brief
2023	Delivering effective environment and health actions: a compendium of concepts, approaches and tools for the WHO European Region
2023	Health in the well-being economy: background paper: working together to achieve healthy, fairer, prosperous societies across the WHO European Region

Date	Title
2023	Noncommunicable diseases and climate change: report of an expert meeting, Bonn, Germany, 1 2 December 2022
2023	Budapest Youth Declaration 2023
2023	Seventy-third Regional Committee for Europe: Astana, 24 26 October 2023: decision: declaration of the Seventh Ministerial Conference on Environment and Health
2023	The Diet Impact Assessment model: a tool for analyzing the health, environmental and affordability implications of dietary change
2023	Transforming the health and social equity landscape: promoting socially just and inclusive growth to improve resilience, solidarity and peace: executive summary
2023	Declaration of the Seventh Ministerial Conference on Environment and Health: Budapest, Hungary 5 7 July 2023
2023	Progress in the WHO European Region towards the SDGs in the context of the Ostrava Declaration on Environment and Health: mid-way to 2030
2023	Report of the special session of the European Environment and Health Task Force, Budapest, 4 July 2023
2023	Uptake and impact of the WHO Environmental noise guidelines for the European Region: experiences from Member States
2022	Learning from practice: case studies of health in strategic environmental assessment and environmental impact assessment across the WHO European Region. Executive summary
2022	Bottom up to the rescue! How NGOs, social movements, and local action are essential tools for a new social contract towards a wellbeing economy
2022	How do the cultural contexts of waste practices affect health and well-being?
2022	Learning from practice: case studies of health in strategic environmental assessment and environmental impact assessment across the WHO European Region
2022	Vienna Declaration: building forward better by transforming to new, clean, safe, healthy and inclusive mobility and transport
2022	One health through the lens of the Sustainable Development Goals
2022	Urban design for health: inspiration for the use of urban design to promote physical activity and healthy diets in the WHO European Region
2022	Resilience of age-friendly environments during the COVID-19 pandemic: lessons learnt from 12 European cities
2021	Aide-memoire: personal protective equipment. In: Infection prevention and control: guidance to action tools
2021	Aide-memoire: environmental cleaning, waste and linen management. In: Infection prevention and control: guidance to action tools
2021	Aide-memoire: respiratory and hand hygiene. In: Infection prevention and control: guidance to action tools
2021	Eighth meeting of the working group on health in climate change (HIC) of the European environment and health task force: meeting report: virtual session, 8 9 December 2020
2021	Ninth meeting of the Working Group on Health in Climate Change (HIC) of the European Environment and Health Task Force: meeting report: virtual session, 19 May 2021
2021	Report of the tenth meeting of the European Environment and Health Task Force: virtual, 17 18 February 2021
2021	Green and blue spaces and mental health: new evidence and perspectives for action

Date	Title
2021	Seventy-first Regional Committee for Europe: virtual session, 13 15 September 2021: progress report on the implementation of the European Environment and Health Process
2021	Slide to order: a food systems approach to meals delivery apps: WHO European Office for the Prevention and Control of Noncommunicable diseases.
2021	A systems approach to meal delivery apps (MDAs): WHO European Office for the Prevention and Control of Noncommunicable Diseases
2021	European Environment and Health Task Force (EHTF): Rules of Procedure as adopted at the 10th meeting of the EHTF, 17 18 February 2021
2021	Infection prevention and control: guidance to action tools
2021	Protecting health through urban redevelopment of contaminated sites: planning brief
2021	Effective risk communication for environment and health: a strategic report on recent trends, theories and concepts
2021	Nature, biodiversity and health: an overview of interconnections
2020	Seventieth Regional Committee for Europe: virtual session, 14 15 September 2020: progress report on implementation of the European Environment and Health Process
2020	Health sector involvement in chemicals management: implementation of the WHO Chemicals Road Map at a national level: Minsk, Belarus, 11 12 February 2020: meeting report
2020	Alcohol consumption in the WHO European Region
2020	Seventieth Regional Committee for Europe: virtual session, 14 15 September 2020: European Programme of Work, 2020 2025 â€œUnited Action for Better Health in Europeâ€
2020	Seventieth Regional Committee for Europe: virtual session, 14 15 September 2020: draft resolution: European Programme of Work, 2020 2025 â€œUnited Action for Better Health in Europeâ€
2020	Seventh meeting of the Working Group on Health in Climate Change (HIC) of the European Environment and Health Task Force: Bonn, Germany, 11 12 September 2019: meeting report
2020	Seventieth Regional Committee for Europe: virtual session, 14 15 September 2020: resolution: European Programme of Work, 2020 2025 "United action for better health in Europe"
2020	Health behaviours among adolescents in Romania: Health Behaviour in School-aged Children (HBSC) study 2018: research report
2020	Seventieth Regional Committee for Europe: virtual session, 14 15 September 2020: financial and administrative implications for the Secretariat of the draft Regional Committee resolution on the European Programme of Work, 2020 2025 â€œUnited Action for Better Health in Europeâ€
2020	Report of the ninth meeting of the European Environment and Health Task Force. Bonn, 9 10 December 2019
2020	WHO European Healthy Cities Network Phase VII (2019 2024): support package for implementation: compendium of tools, resources and networks
2019	The global climate crisis: a public health emergency
2019	Setting research priorities in environment and health: report of a meeting in Bonn, Germany, 30 November 1 December 2017
2019	Updating the evidence related to heat health action planning: 21 22 November 2018, Bonn, Germany: meeting report

Date	Title
2019	Sanitation in the pan-European region: 12 13 February 2019, Bonn, Germany: meeting report
2018	Health and Sustainable Development Goals: team meeting: 18 19 January 2018, Copenhagen, Denmark
2018	Copenhagen Consensus of Mayors: healthier and happier cities for all: a transformative approach for safe, inclusive, sustainable and resilient societies
2018	Sixty-eighth Regional Committee for Europe: Rome, 17 20 September 2018: draft WHO global strategy on health, environment and climate change
2018	Sixty-eighth Regional Committee for Europe: Rome, 17 20 September 2018: progress report on the work of the geographically dispersed offices of the WHO Regional Office for Europe
2018	Sixty-eighth Regional Committee for Europe: Rome, 17 20 September 2018: technical briefing on healthy people through environmentally sustainable urban transport: towards the fifth High-level Meeting on Transport, Health and Environment
2018	Sixty-eighth Regional Committee for Europe: Rome, 17 20 September 2018: progress report on implementation of the European Environment and Health Process
2018	Making THE (Transport, Health and Environment) link: Transport, Health and Environment Pan-European Programme and the Sustainable Development Goals
2018	Sixth meeting of the Working Group on Health in Climate Change (HIC) of the European Environment and Health Task Force: 12 13 June 2018, Bonn, Germany: meeting report
2018	Air quality and health: fact sheet on Sustainable Development Goals (SDGs): health targets
2018	Healthy environments for healthier people

From WHO (World Health Organization, 2021a)

Table 14: Search results for environment related Medical Subjects Headings.

	Number of results		
MeSH Subjects	**All languages**	**English**	
Environment	372	162	
Environment and Public Health	643	237	
Environment Design	12	8	
Environment, Controlled	3	2	
Environmental Determinants	1	0	
Environmental Exposure	1,064	696	Training materials Reports on chemicals and radiation
Environmental Health	2,940	1457	
Environmental Health	6	3	
Environmental Illness	8	5	
Environmental Impact Assessment	1	1	Circular economy
Environmental Indicators	23	10	Fact sheets Learning from practice
Environmental Medicine	2	1	
Environmental Monitoring	998	566	
Environmental Policy	522	175	
Environmental Pollutants	171	98	
Environmental Pollution	339	149	
Environmental Restoration and Remediation	9	1	
Social Environment	136	42	
Strategic Environmental Assessment	1	1	
	7,251	3,614	

From World Health Organization Regional Office for Europe (2021d)

10.2. Selected text from declarations at the ministerial conferences on environment and health

Table 15: Ministerial conferences on environment and health.

Location, year	Selected text	Reference
Budapest 2023	*Alarmed* by the substantial and persistent burden of ill health due to environmental risk factors in the WHO European Region, accounting for at least 1.4 million premature deaths per year, 569,000 of which are attributable to ambient air pollution, and 154,000 to household air pollution, and *concerned* that environmental risks contribute to one-fourth of all non-communicable diseases globally, including cancer, and cardiovascular, respiratory and mental diseases, as well as to infectious diseases;	(World Health Organization Regional Office for Europe, 2023c)
	Concerned that the ''triple crisis'' brought by the intertwining of climate change, environmental pollution and biodiversity loss is causing unprecedented and rapidly unfolding impacts on our lives, threatening eco-systems, human and animal health and well-being across generations in our Region	
Ostrava 2017	*Recognize* that the 2030 Agenda for Sustainable Development highlights critical and inseparable links between development, environment, human health and well-being, and the economy as central to the attainment of a wide range of human rights, including: the rights to life; the enjoyment of the highest attainable standard of physical and mental health; an adequate standard of living; safe food, drinking-water and sanitation; safety; and clean soil, waters and air, which are key to promoting just, peaceful, inclusive and prosperous societies today and in the future	(World Health Organization Regional Office for Europe, 2017a)
Parma 2010	Focus on children's health – the conference included a side-event on "Protecting and improving human health through SEA" (United Nations Economic Commission for Europe, 2010). WHO was requested by the Member States in the European Region to produce noise guidelines that included not only transportation noise sources but also personal electronic devices, toys and wind turbines, which had not yet been considered in existing guidelines.	(World Health Organization Regional Office for Europe, 2010b, 2010c)

Location, year	Selected text	Reference
Budapest 2004	2. Noting the important contributions to recognition of the public health relevance of the links between children's health and the environment made by previous processes such as those leading to the Convention on the Rights of the Child, the Millennium Development Goals and the Plan of Implementation of the World Summit on Sustainable Development (WSSD), we are aware of the need to continue to implement these commitments in order to improve the conditions in which children in the European Region of WHO grow, live, learn, work and play.	(World Health Organization Regional Office for Europe, 2004)
	5a: transport and health Transport, Health and Environment Pan-European Programme (THE PEP)	
	Para 10. We recognize the need for high-quality and independent health and environment research as a precondition of evidence-based policy-making. We acknowledge the active role played by WHO, the European Commission and the European Science Foundation in reviewing the developments in health and environment research.	
	Para 13: We recall the UNECE Protocol on Strategic Environmental Assessment to the Convention on Environmental Impact Assessment in a Transboundary Context 4 adopted and signed at the Fifth Ministerial Conference "Environment for Europe" held in Kiev from 21 to 23 May 2003, that acknowledges the benefits to the health and well-being of present and future generations that will follow if the need to protect and improve people's health is taken into account as an integral part of strategic environmental assessment. We commit ourselves to taking significant health effects into account in the assessment of strategic proposals under the Protocol	
London 1999	EUROPEAN HEALTH21 TARGET 9: REDUCING INJURY FROM VIOLENCE AND ACCIDENTS. By the year 2020, there should be a significant and sustainable decrease in injuries, disability and death arising from accidents and violence in the Region	(World Health Organization Regional Office for Europe, 1999)
	EUROPEAN HEALTH21 TARGET 10: A HEALTHY AND SAFE PHYSICAL ENVIRONMENT. By the year 2015, people in the Region should live in a safer physical environment, with exposure to contaminants hazardous to health at levels not exceeding internationally agreed standards	

Location, year	Selected text	Reference
	EUROPEAN HEALTH21 TARGET 11: HEALTHIER LIVING. By the year 2015, people across society should have adopted healthier patterns of living	
Frankfurt am Main 1989	Principles for public policy including 1: Good health and wellbeing require a clean and harmonious environment in which physical, psychological, social and aesthetic factors are all given their due importance. The environment should be regarded as a resource for improving living conditions and increasing wellbeing. 2. The preferred approach should be to promote the principle of "prevention is better than cure". 3. The health of every individual, especially those in vulnerable and high-risk groups, must be protected. Special attention should be paid to disadvantaged groups. … 7. All aspects of socioeconomic development that relate to the impact of the environment on health and wellbeing must be considered. … 10. Environmental standards need to be continually reviewed to take account of new knowledge about the environment and health and of the effects of future economic development. Where applicable such standards should be harmonized.	(World Health Organization Regional Office for Europe, 1989)

10.3. Comparison of EU Air Quality Standards and WHO Air Quality Guidelines

Table 16: Comparison of EU and WHO Air Quality Standards.

		EC Air Quality Standards (AQS)*		WHO Air Quality Guidelines (AQG)		
	Averaging period	**Concentration**	**Permitted exceedances each year**	**Concentration**	**Source/Definition**	**Health Outcomes**
Arsenic (As)	1 year	6 ng/m^3	n/a	n/a	A safe level of arsenic in air cannot be established (World Health Organization, 2019b; World Health Organization Regional Office for Europe, 2000).	Lung cancer
Benzene	1 year	5 µg/m^3	n/a	n/a	Benzene is carcinogenic to humans and no safe level of exposure can be recommended (World Health Organization, 2019c).	Chronic exposure can result in bone marrow depression. Occupational exposure has shown an increased mortality from leukaemia.
Cadmium (Cd)	1 year	5 ng/m^3	n/a	5 ng/m^3	From World Health Organization (2019d) Cadmium compounds are classified as Group 1 human carcinogens	High inhalation exposure to cadmium oxide fumes results in acute pneumonitis with pulmonary oedema, which may be lethal.

		EC Air Quality Standards (AQS)*		WHO Air Quality Guidelines (AQG)		
	Averaging period	**Concentration**	**Permitted exceedances each year**	**Concentration**	**Source/Definition**	**Health Outcomes**
					(World Health Organization Regional Office for Europe, 2000)	Long-term, high-level occupational exposure is associated with lung changes, primarily characterized by chronic obstructive pulmonary disease. Exposure to cadmium and cadmium compounds (e.g. through cadmium fumes) causes lung cancer.
Carbon monoxide (CO)	Maximum daily 8 hour mean	10 mg/m^3	n/a	4 µg/m^3	99th percentile of the annual distribution of daily maximum 8-hour average concentrations (equivalent to 3-4 exceedances per year) (World Health Organization, 2021f)	Myocardial infarction; hospital and emergency room admissions; mortality
Lead (Pb)	1 year	0.5 µg/m^3	n/a	It is recommended that efforts be made to ensure that at least 98% of an exposed population, including preschool children, have blood lead	On this basis, the annual average lead level in air should not exceed 0.5 µg/m^3 (World Health Organization	Central nervous system effects; cognitive functioning

		EC Air Quality Standards (AQS)*		WHO Air Quality Guidelines (AQG)		
	Averaging period	**Concentration**	**Permitted exceedances each year**	**Concentration**	**Source/Definition**	**Health Outcomes**
				levels that do not exceed 100 µg/l. In this case, the median blood lead level would not exceed 54 µg/l.	Regional Office for Europe, 2000)	
Nickel (Ni)	1 year	20 ng/m^3	n/a	n/a	Nickel compounds are human carcinogens by inhalation exposure … no safe level for nickel compounds can be recommended (World Health Organization Regional Office for Europe, 2000).	Lung cancer; nasal cancer
Nitrogen dioxide (NO_2)	1 hour	200 µg/m^3	18	200 µg/m^3	From (World Health Organization Regional Office for Europe, 2023j, p.4)	Respiratory mortality; acute lower respiratory infection mortality
Nitrogen dioxide (NO_2)	24-hour			25 µg/m^3	99th percentile of the annual distribution of daily maximum 8-hour average concentrations	As above

		EC Air Quality Standards (AQS)*		WHO Air Quality Guidelines (AQG)		
	Averaging period	**Concentration**	**Permitted exceedances each year**	**Concentration**	**Source/Definition**	**Health Outcomes**
					(equivalent to 3-4 exceedances per year) (World Health Organization, 2021f)	
Nitrogen dioxide (NO_2)	1 year	40 µg/m^3	n/a	10 µg/m^3	From World Health Organization (2021f)	As above
Ozone	Maximum daily 8 hour mean	120 µg/m^3	25 days averaged over 3 years	60 µg/m^3	Peak season level: average of daily maximum 8-hour mean O_2 concentration in the six consecutive months with the highest six-month running-average O_2 concentration (World Health Organization, 2021f)	Respiratory mortality
Ozone				100 µg/m^3	99th percentile of the annual distribution of daily maximum 8-hour average concentrations (equivalent to 3-4 exceedances per year) (World Health Organization, 2021f)	As above

		EC Air Quality Standards (AQS)*		WHO Air Quality Guidelines (AQG)		
	Averaging period	**Concentration**	**Permitted exceedances each year**	**Concentration**	**Source/Definition**	**Health Outcomes**
$PM_{2.5}$: Fine particles	1 year	25 µg/m^3	n/a	5 µg/m^3	From World Health Organization (2021f)	Circulatory mortality; non-malignant respiratory mortality[6]; lung cancer mortality.
$PM_{2.5}$: Fine particles	1 year	20 µg/m^3	n/a	15 µg/m^3	From World Health Organization (2021f)	As above.
PM_{10}: Particulate matter	24 hours	50 µg/m^3	35	45 µg/m^3	From World Health Organization (2021f)	Respiratory mortality; lung cancer mortality; ischaemic heart disease mortality.
PM_{10}: Particulate matter	1 year	40 µg/m^3	n/a	15 µg/m^3	From World Health Organization (2021f)	As above.

[6] Non-malignant respiratory disease (NMRD) is an umbrella term. It includes conditions such as interstitial lung disease (ILD), bronchiectasis and chronic obstructive pulmonary disease (COPD).

		EC Air Quality Standards (AQS)*		WHO Air Quality Guidelines (AQG)		
	Averaging period	**Concentration**	**Permitted exceedances each year**	**Concentration**	**Source/Definition**	**Health Outcomes**
Polycyclic Aromatic Hydrocarbons	1 year	1 ng/m^3 (expressed as concentration of Benzo(a)pyrene)	n/a	n/a	No threshold can be determined and all indoor exposures are considered relevant to health (World Health Organization Regional Office for Europe, 2010d)	Human health effects from indirect exposure to low levels of PAHs are unknown. Large amounts of naphthalene in air can irritate eyes and breathing passages. Occupational skin exposure with liquid naphthalene and breathing its vapours may be harmful. Workers have become sick with blood and liver problems from large amounts of exposure. Several of the PAHs and some specific mixtures are considered to be cancer-causing chemicals (Centers for Disease Control and Prevention, 2022).
Sulphur dioxide (SO_2)	1 hour	350 µg/m^3	24		From World Health Organization (2021f)	Asthma hospital admissions and emergency room visits; non-accidental mortality; respiratory mortality

		EC Air Quality Standards (AQS)*		WHO Air Quality Guidelines (AQG)		
	Averaging period	**Concentration**	**Permitted exceedances each year**	**Concentration**	**Source/Definition**	**Health Outcomes**
Sulphur dioxide (SO_2)	24 hours	125 µg/m^3	3	40 µg/m^3	99th percentile of the annual distribution of daily maximum 8-hour average concentrations (equivalent to 3-4 exceedances per year) (World Health Organization, 2021f)	As above.

* from European Commission (no date-b)

** Under EU law, a limit value is legally binding from the date it enters into force subject to any exceedances permitted by the legislation. For a target value, the obligation is to take all necessary measures that do not entail disproportionate costs to ensure that it is attained, and so it is less strict than a limit value (European Commission, no date-b).

10.4. Indicators for noise and health

Table 17: Indicators in the European Noise Directive (END).

The END specifies a number of noise indicators to be applied by Member States in noise mapping and action planning. The most important are L_{den} and L_{night}. The L_{den} indicator is an average sound pressure level over all days, evenings and nights in a year (EEA, 2010). This compound indicator was adopted by the EU in the END (EC, 2002a). The L_{den} in decibels (dB) is defined by a specific formula, where: L_{day} is the A-weighted long-term average sound level as defined in ISO 1996-1: 2016, determined over all the day periods of a year; $L_{evening}$ is the A-weighted long-term average sound level as defined in ISO 1996-1: 2016, determined over all the evening periods of a year; and L_{night} is the A-weighted long-term average sound level as defined in ISO 1996-1: 2016, determined over all the night periods of a year (ISO, 2016). The L_{night}, according to the definition in the END, is an equivalent outdoor sound pressure level, measured at the most exposed façade, associated with a particular type of noise source during night time (at least eight hours), calculated over a period of a year (WHO Regional Office for Europe, 2009). Annex I of the END gives technical definitions for L_{den} and L_{night}, as well as supplementary noise indicators, which might be useful for monitoring special noise situations. For example, in the case of noisy but short-lived noise like shooting noise or noise emitted by trains, $L_{A,max}$ is often used. This is a measure of the maximum sound pressure reached during a defined measurement period. It is used to set noise limits and is sometimes considered in studies to determine certain health effects (such as awakening reactions).

Source: (World Health Organization Regional Office for Europe, 2018, p.3-4).

Table 18: Critical noise-related health outcomes, outcome measures identified and justifications for selection in the END.

Critical health outcome	**Critical health outcome measures (priority measures marked in bold)**	**Justification for selection**
Cardiovascular diseases (L_{den})	Self-reported or measured prevalence, incidence, hospital admission or mortality due to: ischaemic heart disease (IHD) (including angina pectoris and/or myocardial infarction) hypertension stroke	Except for self-reports, these are objective measures of the outcome, affect a large proportion of the population, have important health consequences and can lead to more severe diseases and/or mortality. Disability Weighting (DW):[7] for IHD: 0.405. DW for hypertension: 0.117.
Effects on sleep (L_{night})	percentage of the population highly sleep-disturbed (%HSD), self-reported, assessed with a standardized scale polysomnography measured outcomes (probability of additional awakenings) cardiac and blood pressure outcome measures during sleep motility measured sleep outcomes in adults sleep disturbance in children	This is the most meaningful, policy-relevant measure of this health outcome. Self-reported sleep disturbances are a very common problem in the general population: they affect quality of life directly and may also lead to subsequent health impediments. Effects on sleep may be in the causal pathway to cardiovascular disease. This measure is not a proxy for physiological sleep quality parameters but is an important outcome in its own right. DW for %HSD: 0.07.
Annoyance (L_{den})	percentage of the population highly annoyed (%HA), assessed with standardized scale percentage annoyed, preferably assessed with standardized scale	This is the most objective measure of this health outcome. Large proportions of the population are affected by noise annoyance, even at relatively low exposure levels. Annoyance may be in the causal pathway to cardiovascular disease. DW for %HA: 0.02.
Cognitive impairment (L_{den})	reading and oral comprehension assessed with tests impairment assessed with standardized tests short and long-term memory deficit attention deficit executive function deficit (working memory capacity)	This outcome measure is the most meaningful: it can affect vulnerable individuals (children) and have a significant impact later in life. DW for impaired reading and oral comprehension: 0.006.

[7] This rating varies between 0 and 1, in which 0 indicates no disability and 1 indicates the maximum amount of disability. The rates are derived from large population surveys in which people are asked to rank a specific disease for its impact on several abilities. The DWs have been proven useful in calculating the burden of disease.

Critical health outcome	Critical health outcome measures (priority measures marked in bold)	Justification for selection
Hearing impairment and tinnitus L_{Aeq} and $L_{AF,max}$[8]	permanent hearing impairment measured by audiometry permanent tinnitus	This outcome measure can affect vulnerable individuals (children) and have a significant impact later in life. It is the most objective measure for which there is an ISO standard (ISO, 2013), specifying how to estimate noise-induced hearing loss. DW for mild severity level (threshold at 25 dB) for childhood onset: 0.0150.

Source: (World Health Organization Regional Office for Europe, 2018, p.18-19)

Table 19: Important noise-related health outcomes and health outcome measures reviewed in the END.

Important health outcome	Health outcome measures reviewed
Adverse birth outcomes (L_{den})	pre-term delivery low birth weight congenital anomalies
Quality of life, well-being and mental health (L_{den})	self-reported health and quality of life medication intake for depression and anxiety self-reported depression, anxiety and psychological distress interviewer-assessed depressive and anxiety disorders emotional and conduct disorders in children children's hyperactivity other mental health outcomes
Metabolic outcomes (L_{den})	prevalence, incidence, hospital admission or mortality due to: type 2 diabetes obesity

Source: (World Health Organization Regional Office for Europe, 2018, p.19)

[8] LA_{eq} is an A-weighted, equivalent continuous sound pressure level during a stated time interval starting at t1 and ending at t2, expressed in dB, of a noise at a given point in space.
$L_{AF,max}$ is the maximum time-weighted and A-weighted sound pressure level with FAST time constant within a stated time interval starting at t1 and ending at t2, expressed in dB.

10.5. The WHO's Working Group on Health in Climate Change

Table 20: The "asks" set by the WHO's working group on health in climate change

No.	Headline	Health-oriented "asks"
1	Strive for "net zero" before 2050.	The sooner net zero is reached, the greater the health co-benefits such as improved air quality, a more physically active population and healthier diets.
2	Tackle emissions from fossil fuels.	Clean energy and transport will bring immediate health gains through better air quality, and are integral to achieving climate objectives.
3	Promote healthy dietary choices.	Transitioning to more sustainable food systems that are low in greenhouse gas emissions is beneficial for health, biodiversity and climate.
4	Introduce "climate change and health in all policies".	The causes and impacts of climate change are cross-sectoral; solutions must be integrated into decision-making across all sectors and levels of government. The health sector needs to engage in cross-sectoral climate action, and health needs must become a core consideration within climate action in all health-determining sectors.
5	Accelerate health adaptation at all levels of governance.	Synergies with other sectors' adaptation policies need to be optimized to prevent climate impacts on health, enhance climate resilience, promote health and health equity, and avoid maladaptation.
6	Lead by example.	Scaling up adaptation action to enhance the climate resilience of health systems and health-care facilities is essential, hand in hand with proactively promoting and striving for low-carbon and environmentally sustainable health service delivery.
7	Strengthen the role of health professionals.	A strong health voice can raise and sustain ambition for both mitigation and adaptation.
8	Promote meaningful dialogue by policy-makers with local communities and civil society.	Participatory engagement can inform effective and equitable policies, maximize health co-benefits and minimize unintended harms and inequalities.
9	Make the case for climate investments in the health sector.	Maximizing the economic opportunities presented by strong national climate policies, will enable ambitious climate change mitigation and adaptation in the health and health-determining sectors.
10	Strengthen the evidence.	To inform policy-making, it is important to monitor trends in health impacts of climate change and the health effects of adaptation and mitigation actions, and to evaluate rigorously the effectiveness of climate policies.

Source: World Health Organization Regional Office for Europe (2023m).

10.6. Indicators for Monitoring Determinants of Health Equity

Table 21: Indicators for monitoring social determinants of health equity.

Subdomain	Indicator	Disaggregation dimension	Data source
SDH			
Economic security and equality			
Employment	Unemployment rate (%)	Age, disability, sex	United Nations (UN) Department of Economic and Social Affairs Statistics Division SDG Indicators Database (UN SDG Indicators Database). Available at https:// unstats.un.org/sdgs /dataportal
	Employment to population ratio (female, male, total) (modeled ILO estimate)	Age, sex	International Labour Organization (ILO). "ILO Modelled Estimates and Projections database (ILOEST)" ILOSTAT. Available at: https://ilostat.ilo. org/data
	Vulnerable employment, total (% of total employment) (modeled ILO estimate)	Sex	World Bank, World Development Indicators database. Estimates are based on data obtained from International Labour Organization, ILOSTAT at https://ilostat.ilo.or g/data
	Children aged 5–17 years engaged in child labour (%)	Age, sex	UN SDG Indicators Database. Available at https://unstats. un.org/sdgs/datapo rtal
	Average hourly earnings of employees (local currency)	Occupation, sex	UN SDG Indicators Database. Available at https://unstats.

Subdomain	Indicator	Disaggregation dimension	Data source
			un.org/sdgs/datapo rtal
	Fatal occupational injuries among employees (per 100 000 employees)	Migrant status, sex	UN SDG Indicators Database. Available at https://unstats. un.org/sdgs/datapo rtal
	Non-fatal occupational injuries among employees (per 100 000 employees)	Migrant status, sex	UN SDG Indicators Database. Available at https://unstats. un.org/sdgs/datapo rtal
Food insecurity	Moderate or severe food insecurity in the population (%)	If applied at household level, disaggregation is possible based on household characteristics such as: location, household income, composition (including for example presence and number of small children, members with disabilities, elderly members, etc.), sex, age and education of the household head, etc. If applied at individual level, disaggregation by sex is possible	UN SDG Indicators Database. Available at https://unstats. un.org/sdgs/datapo rtal
Food insecurity	Severe food insecurity (%)	If applied at household level, disaggregation is possible based on household characteristics such as: location, household income, composition (including for example presence and number of small children, members with disabilities, elderly members, etc.), sex, age and education of	UN SDG Indicators Database. Available at https://unstats. un.org/sdgs/datapo rtal

Subdomain	Indicator	Disaggregation dimension	Data source
		the household head, etc. If applied at individual level, disaggregation by sex is possible	
Income inequality	Gini index	-	World Bank, Poverty and Inequality Platform. Data are based on primary household survey data obtained from government statistical agencies and World Bank country departments. Data for high- income economies are mostly from the Luxembourg Income Study database. Available at: http://pip.worldbank.org.
	Growth rates of household expenditure or income per capita among the bottom 40 per cent of the population and the total population	-	UN SDG Indicators Database. Available at https://unstats.un.org/sdgs/dataportal
Poverty	Population living below international poverty line (%)	Age, employment status, geographic location (rural/urban), sex	UN SDG Indicators Database. Available at https://unstats.un.org/sdgs/dataportal
	Population living below national poverty (%)	Age, sex	UN SDG Indicators Database. Available at https://unstats.

Subdomain	Indicator	Disaggregation dimension	Data source
			un.org/sdgs/datapo rtal
	Population living in multidimensional poverty (%)	Age, geographic location (rural/urban), sex	UN SDG Indicators Database. Available at https://unstats. un.org/sdgs/datapo rtal
	Households living in multidimensional poverty (%)	Age, geographic location (rural/urban), sex	UN SDG Indicators Database. Available at https://unstats. un.org/sdgs/datapo rtal
	Average share of weighted deprivations of total households (intensity) (%)	Age, geographic location (rural/urban), sex	UN SDG Indicators Database. Available at https://unstats. un.org/sdgs/datapo rtal
	Multidimensional deprivation for children (% of population under 18)	Age, geographic location (rural/urban), sex	UN SDG Indicators Database. Available at https://unstats. un.org/sdgs/datapo rtal
Education			
Education access	Participation rate in organized learning (one year before official primary entry age) (%)	Age, sex (administrative sources) Age, geographic location, income, sex (household surveys)	UN SDG Indicators Database. Available at https://unstats. un.org/sdgs/datapo rtal
	Net school enrolment rate (pre-primary, primary, secondary, tertiary) (%)	Level of education, sex	UNESCO Institute for Statistics. Available at: http://uis.unesco.or g
	Participation rate of youth and adults in formal and non-formal education and training in the previous 12 months (%)	Age and sex	UN SDG Indicators Database. Available at https://unstats. un.org/sdgs/datapo rtal
Education quality	Pupil-trained teacher ratio by education level (pre-primary, primary, lower and upper secondary education)	Education level and type of institution (public/private)	UNESCO Institute for Statistics. Available at: http://uis.unesco.or g

Subdomain	Indicator	Disaggregation dimension	Data source
Education quality	Teachers with the minimum required qualifications (%)	Education level, sex, and type of institution (public/private)	UN SDG Indicators Database. Available at https://unstats.un.org/sdgs/dataportal
Education outcomes	Children aged 36−59 months who are developmentally on track in at least three of the following domains: literacy-numeracy, physical development, social-emotional development, and learning (% of children aged 36–59 months) (%)	Sex	UN SDG Indicators Database. Available at https://unstats.un.org/sdgs/dataportal
	Children and young people (a) in grades 2/3; (b) at the end of primary; and (c) at the end of lower secondary achieving at least a minimum proficiency level in (i) reading and (ii) mathematics (%)	Education level and sex	UN SDG Indicators Database. Available at https://unstats.un.org/sdgs/dataportal
	Population in a given age group achieving at least a fixed level of proficiency in functional (a) literacy and (b) numeracy skills (%)	Age, geographic location (rural/ urban), income, type of skill	UN SDG Indicators Database. Available at https://unstats.un.org/sdgs/dataportal
	Completion rate (primary, lower secondary, upper secondary)	Education level, geographic location (rural/urban), sex, and wealth quintile	UN SDG Indicators Database. Available at https://unstats.un.org/sdgs/dataportal
	Educational attainment rate, at least completed (primary, lower secondary, upper secondary, Master's or equivalent, Doctoral or equivalent)	Age, economic status, and education level	UNESCO Institute for Statistics. Available at: http://uis.unesco.org

Subdomain	Indicator	Disaggregation dimension	Data source
Physical environment			
Air quality and climate	Average mean levels of air pollution of particulate matter (PM10 and PM2.5) in cities (population weighted)	National, regional and global data are disaggregated into cities, towns, urban and rural areas	UN SDG Indicators Database. Available at https://unstats.un.org/sdgs/dataportal
	Population experiencing droughts, floods, extreme temperatures (% of population, average 1990–2009)	-	EM-DAT: The OFDA/CRED International Disaster Database: www.emdat.be, Université Catholique de Louvain, Brussels (Belgium), World Bank.
Disasters	Number of deaths, missing persons and directly affected persons attributed to disasters* (per 100 000 population)	Number of deaths attributed to disasters, number of missing persons attributed to disasters, number of directly affected people attributed to disaster Desirable disaggregation: hazard, geography (administrative unit), sex, age, disability, income	UN SDG Indicators Database. Available at https://unstats.un.org/sdgs/dataportal
Energy, fuels and technologies	Population with access to electricity (%)	Geographic location (rural/urban)	IEA, IRENA, UNSD, World Bank, WHO. 2023. Tracking SDG 7: The Energy Progress Report. World Bank, Washington DC. © World Bank. License: Creative Commons Attribution—NonCommercial 3.0 IGO (CC BY-NC 3.0 IGO).

Subdomain	Indicator	Disaggregation dimension	Data source
Energy, fuels and technologies	Population with primary reliance on clean fuels and technologies for cooking (%)	Geographic location (rural/urban)	IEA, IRENA, UNSD, World Bank, WHO. 2023. Tracking SDG 7: The Energy Progress Report. World Bank, Washington DC. © World Bank. License: Creative Commons Attribution—NonCommercial 3.0 IGO (CC BY-NC 3.0 IGO).
Housing	Households that live in overcrowded dwellings (%)	Income quintile	Organisation for Economic Co-operation and Development (OECD) Affordable Housing Database. Available at: https://www.oecd.org/housing/data/affordable-housing-database
	Homeless as a percent of total population (%)	Age, sex (where data are available)	OECD Affordable Housing Database. Available at: https://www.oecd.org/housing/data/affordable-housing-database
	Households that own their homes (%)	Age, income quintile	OECD Affordable Housing Database. Available at: https://www.oecd.org/housing/data/affordable-housing-database
	Housing price-to-income ratio (housing affordability)	-	OECD “Housing prices” indicator. Available at: https://data.oecd.

Subdomain	Indicator	Disaggregation dimension	Data source
			org/price/housing-prices.htm
	Population spending more than 40% of disposable income on mortgage and rent (housing cost overburden) (%)	Income quintile, tenure (Rent (private), Rent (subsidized), Own with mortgage)	OECD Affordable Housing Database. Available at: https://www.oecd.org/housing/data/affordable-housing-database
Land tenure	Adult population with secure tenure rights to land, (a) with legally recognized documentation, and (b) who perceive their rights to land as secure, by sex and type of tenure (%)	Sex (note: only for both sexes and female, not male) and local communities	UN SDG Indicators Database. Available at https://unstats.un.org/sdgs/dataportal
Road safety	Death rate due to road traffic injuries (%)	Age, sex	UN SDG Indicators Database. Available at https://unstats.un.org/sdgs/dataportal
Water, Sanitation and Hygiene (WASH)	Population using basic sanitation services (%)	Geographic location (urban/rural, sub-national regions, etc.) and socioeconomic characteristics (wealth, education, ethnicity, etc.) is possible in a growing number of countries	UN SDG Indicators Database. Available at https://unstats.un.org/sdgs/dataportal
	Mortality rate attributed to unsafe water, unsafe sanitation and lack of hygiene from diarrhoea, intestinal nematode infections, malnutrition and acute respiratory infections (deaths per 100 000 population)	Age (under 5), sex	UN SDG Indicators Database. Available at https://unstats.un.org/sdgs/dataportal

Subdomain	Indicator	Disaggregation dimension	Data source
	Population practicing open defecation (%)	Service level (i.e. no services/ open defecation, unimproved, limited, basic, and safely managed services) Geographic location (urban/rural, sub-national regions, etc.) and socioeconomic characteristics (wealth, education, ethnicity, etc.) is possible in a growing number of countries Individual characteristics (age, sex, disability, etc.) may also be made where data permit	UN SDG Indicators Database. Available at https://unstats.un.org/sdgs/dataportal
Water, Sanitation and Hygiene (WASH)	Population with basic handwashing facilities on premises (%)	Service level (i.e. no facility, limited, and basic facility Geographic location (urban/rural, sub-national regions, etc.) and socioeconomic characteristics (wealth, education, ethnicity, etc.) is possible in a growing number of countries Individual characteristics (age, sex, disability, etc.) may also be made where data permit	UN SDG Indicators Database. Available at https://unstats.un.org/sdgs/dataportal
	Population using safely managed drinking water services (%)	Geographic location (rural/urban)	UN SDG Indicators Database. Available at https://unstats.un.org/sdgs/dataportal

Subdomain	Indicator	Disaggregation dimension	Data source
	Population using safely managed sanitation services (%)	Service level (i.e. no services/ open defecation, unimproved, limited, basic, and safely managed services) Geographic location (urban/rural, sub-national regions, etc.) and socioeconomic characteristics (wealth, education, ethnicity, etc.) is possible in a growing number of countries Individual characteristics (age, sex, disability, etc.) may also be made where data permit	UN SDG Indicators Database. Available at https://unstats.un.org/sdgs/dataportal
Urbanization	Urban population living in slums, informal settlements or inadequate housing (%)	Desirable disaggregation: hazard, geography (administrative unit), sex, age, disability, income	UN SDG Indicators Database. Available at https://unstats.un.org/sdgs/dataportal
	Ratio of land consumption rate to population growth rate in urban areas	Potential disaggregation: Geographic location (operational urban area vs administratively defined urban area, urban wide vs intra-urban growth trends); Type of growth (infill, expansion, leapfrogging); City type (large vs medium sized vs small); Type of land use consumed by the urbanization process	UN SDG Indicators Database. Available at https://unstats.un.org/sdgs/dataportal
	Average share of the built-up area of cities	Age, disability, sex	UN SDG Indicators Database. Available

Subdomain	Indicator	Disaggregation dimension	Data source
	that is open space for public use for all (%)		at https://unstats.un.org/sdgs/dataportal
	Municipal solid waste collected and managed in controlled facilities out of total municipal waste generated, by cities (%)	Data for this indicator can be disaggregated at various levels in accordance with the country's policy information needs. For instance: · Location (intra-urban · Source of waste generation (e.g., residential, industrial, office, or MSW material received by recovery facilities) · Type of final treatment and disposal · MSW generation rate of different income level (high, middle, low) · MSW generation rate in different cities	UN SDG Indicators Database. Available at https://unstats.un.org/sdgs/dataportal
	Population that has convenient access to public transport in urban areas (%)	Age, disability, sex	UN SDG Indicators Database. Available at https://unstats.un.org/sdgs/dataportal
Social and community context			
Conflict, crime and violence	Total conflict-related deaths per 100 000 population (per 100 000 population)	Recommended disaggregation: · Sex of person killed · Age of person killed · Cause of death (e.g., heavy weapons, explosive munitions, denial of access to/destruction of objects indispensable to survival, etc.) · Status of person killed	UN SDG Indicators Database. Available at https://unstats.un.org/sdgs/dataportal

Subdomain	Indicator	Disaggregation dimension	Data source
		(e.g., civilian, other protected person, member of armed forces, person directly participating in hostilities, unknown)	
	Number of victims of intentional homicide per 100 000 population (victims per 100 000 population)	Recommended disaggregation: · Sex and age of the victim and the perpetrator (suspected offender) · Relationship between victim and perpetrator (intimate partner, other family member, acquaintance, etc.) · Means of perpetration (firearm, sharp object, etc.) · Situational context/motivation (organized crime, inter- personal violence, etc.)	UN SDG Indicators Database. Available at https://unstats.un.org/sdgs/dataportal
	Population subjected to (a) physical violence, (b) psychological violence and (c) sexual violence in the previous 12 months (%)	Age, citizenship, education, ethnicity, income, sex	UN SDG Indicators Database. Available at https://unstats.un.org/sdgs/dataportal
	Number of victims of human trafficking (per 100 000 population)	Age, form of exploitation, sex	UN Office on Drugs and Crime (UNODC) data portal. Available at: https://dataunodc.un.org

Subdomain	Indicator	Disaggregation dimension	Data source
	Population that feel safe walking alone around the area they live after dark (%)	Recommended disaggregation: · Age · Citizenship · Disability status · Ethnicity · Migration background · Sex · Time of day (perception of safety "during the day" and "after dark")	UN SDG Indicators Database. Available at https://unstats.un.org/sdgs/dataportal
Discrimination	Population reporting having felt discriminated against (%)	Disability, grounds of discrimination, sex	UN SDG Indicators Database. Available at https://unstats.un.org/sdgs/dataportal
Forced displacement and migration	Internally displaced persons, total displaced by conflict and violence (number of people)	-	The Internal Displacement Monitoring Centre. Available at: http://www.internal- displacement.org
	Refugee population by country or territory of origin (%)	Recommended disaggregation: · Age (esp. % of children) · Geographical location (urban/ rural) · Place of residence (in camps/ out of camps) · Sex	UN SDG Indicators Database. Available at https://unstats.un.org/sdgs/dataportal
Forced displacement and migration	Net migration	Age, sex	UN Population Division. Trends in Total Migrant Stock: 2008 Revision.
	International migrant stock (% of population)	Age, sex	UN Population Division. Trends in Total Migrant Stock: 2008 Revision.
Gender equality and women's empowerment	Gender inequality index	-	UN Development Programme (UNDP). Human development data.

Subdomain	Indicator	Disaggregation dimension	Data source
			Available at http://hdr.undp.org/en/data
	Women who were first married or in a union before age 15 and before age 18 (% of women ages 20–24) (%)	-	UN SDG Indicators Database. Available at https://unstats.un.org/sdgs/dataportal
	Women making their own informed decisions regarding sexual relations, contraceptive use and reproductive health care (% of women age 15–49)	Age, education, geographic location, place of residence, wealth quintile	UN SDG Indicators Database. Available at https://unstats.un.org/sdgs/dataportal
Healthy ageing	Proportion of older people living in age-friendly cities and communities (%)	-	WHO Maternal, Newborn, Child and Adolescent Health and Ageing Data portal. Available at https://platform.who.int/data/maternal-newborn-child-adolescent-ageing/ indicator-explorer-new/mca/proportion-of-older-people- living-in-age-friendly-cities-and-communities
Incarceration	Persons held in prisons, penal institutions or correctional institutions (persons held per 100 000)	Age, category, sex	UN Office on Drugs and Crime (UNODC) data portal. Available at: https://dataunodc.un.org
Social support	Population who report having friends or relatives whom they can count on in times of trouble (%)	Age	OECD database. Available at https://stats.oecd.org

Subdomain	Indicator	Disaggregation dimension	Data source
Health behaviours			
Alcohol	"Alcohol per capita consumption (aged 15 years and older) within a calendar year in Litres of pure alcohol"	Age, sex	UN SDG Indicators Database. Available at https://unstats.un.org/sdgs/dataportal
Physical activity	Insufficiently physically active persons (adults aged 18 years and older, adolescents aged 11–17 years) (%)	Age, sex, other relevant sociodemographic stratifiers where available	World Health Organization (WHO) Global Health Observatory. Available at https://www.who.int/data/gho
Tobacco	Current tobacco use among persons aged 15 years and older (age-standardized rate) (%)	Sex	UN SDG Indicators Database. Available at https://unstats.un.org/sdgs/dataportal
Nutrition	Children under 5 years who are stunted (%)	Age, place of residence, sex, socioeconomic status	UN SDG Indicators Database. Available at https://unstats.un.org/sdgs/dataportal
	Children under 5 years who are wasted (%)	Age, place of residence, sex, socioeconomic status	UN SDG Indicators Database. Available at https://unstats.un.org/sdgs/dataportal
	Children under 5 years who are overweight (%)	Age, place of residence, sex, socioeconomic status	UN SDG Indicators Database. Available at https://unstats.un.org/sdgs/dataportal
Nutrition	Population experiencing undernourishment (%)	Place of residence (rural/urban)	UN SDG Indicators Database. Available at https://unstats.un.org/sdgs/dataportal
	Adults who are overweight (BMI>=25) and obese (BMI>=30) (% adult population)	Age, sex, other relevant sociodemographic stratifiers where available	WHO Global Health Observatory. Available at https://www.who.int/data/gho
Health care			

Subdomain	Indicator	Disaggregation dimension	Data source
Health care access and affordability	Population that skipped a medical consultation due to costs (%)	Age, sex	OECD database. Available at https://stats.oecd.org/
	Population that skipped medical tests, treatment or follow-up due to costs (%)	Age, sex	OECD database. Available at https://stats.oecd.org/
	Population that skipped prescribed medicines due to costs (%)	Age, sex	OECD database. Available at https://stats.oecd.org/
Health care access and affordability	Households with out-of-pocket payments greater than 40% of capacity to pay for health care (catastrophic health spending) (%)	Consumption quintile Disaggregation by place of residence (urban and rural), age or employment status of the head of the household, household composition and other factors is included in country-level and regional-level analysis where relevant	WHO Global Health Observatory. Available at https://www.who.int/data/gho
	Population spending more than 10% of household consumption or income on out-of-pocket health care expenditure (%)	Age, place of residence (rural/urban), sex	WHO Global Health Observatory. Available at https://www.who.int/data/gho
	Population spending more than 25% of household consumption or income on out-of-pocket health care expenditure (%)	Age, place of residence (rural/urban), sex	WHO Global Health Observatory. Available at https://www.who.int/data/gho
Health system	Physicians per capita (per 1 000 people)	Age, location (urban/rural), occupational specialization, main work activity, provider type (public/private), sex	WHO Global Health Workforce Statistics, OECD, supplemented by country data

Subdomain	Indicator	Disaggregation dimension	Data source
	Nurses and midwives per capita (per 1 000 people)	Age, location (urban/rural), occupational specialization, main work activity, provider type (public/private), sex	WHO Global Health Workforce Statistics, OECD, supplemented by country data
	Health workers per capita: physicians, nursing/midwifery personnel, dentistry personnel, pharmaceutical personnel (per 10 000 population)	Geographic area, occupation	UN SDG Indicators Database. Available at https://unstats.un.org/sdgs/dataportal
	Community health workers per capita (per 1 000 people)	Age, location (urban/rural), occupational specialization, main work activity, provider type (public/private), sex	WHO Global Health Workforce Statistics, OECD, supplemented by country data
	Health facilities per capita (per 10 000 population) (health facility density and distribution)	Density of specific services, facility ownership, location (district, province, national), type	WHO Global Health Observatory. Available at https://www.who.int/data/gho
	Hospital beds per capita (per 10 000 population)	Provider type (public/private)	WHO Global Health Workforce Statistics, OECD, supplemented by country data

BMI: body mass index: PM: particulate matter; SDG: Sustainable Development Goal; UHC: universal health coverage; UN: United Nations; UNDP: United Nations l, Scientific and Cultural Organization; WHO: World Health Organization.

Source: World Health Organization (2024).

Table 22: Actions and indicators for social determinants of health equity.

Subdomain	Indicator	Disaggregation dimension	Data source
Actions			
Policies to promote economic security and equality			
Employment: social policies	Level of national compliance with labour rights (freedom of association and collective bargaining) based on International Labour Organization textual sources and national legislation	Migrant status, sex	UN SDG Indicators Database. Available at https://unstats.un.org/sdgs/dataportal
	Coverage of unemployment benefits and active labour market policy (ALMP) (% of population)	Economic status	UN SDG Indicators Database. Available at https://unstats.un.org/sdgs/dataportal
Employment: governance	Existence of a developed and operationalized national strategy for youth employment, as a distinct strategy or as part of a national employment strategy	-	UN SDG Indicators Database. Available at https://unstats.un.org/sdgs/dataportal
Food insecurity: public policies	"Population supported by food and/or social assistance programmes (%)"	Category of vulnerable groups (e.g., children, families, young people, indigenous, elderly, disabled, unemployed, etc.) Type of food or social assistance programme and by numbers of people benefiting from the different types	Food and Agricultural Organization of the United Nations. Milan Urban Food Policy Pact Monitoring Framework.
Income inequality: macroeconomic policies	Redistributive impact of fiscal policy (note: defined as the Gini Index of pre-fiscal per capita (or equivalized) income less the Gini Index of post-fiscal per capita (or equivalized) income)	Age, disability status, ethnic grouping, gender, geographic location (rural/urban), income (note: can be disaggregated for as many subgroups as are represented in the surveys or micro-data from which the indicator is drawn)	UN SDG Indicators Database. Available at https://unstats.un.org/sdgs/dataportal
Poverty: public policies	Coverage of social safety net programmes (% of population)	Economic status	World Bank Open Data (original source:

Subdomain	Indicator	Disaggregation dimension	Data source
			UNESCO Institute for Statistics)
	Coverage of social insurance programmes (% of population)	Economic status	World Bank Open Data (original source: UNESCO Institute for Statistics)
	Population covered by at least one social protection benefit (%)	Sex	World Bank Open Data (original source: UNESCO Institute for Statistics)
	Children/households receiving child/family cash benefit (%)	Sex	World Bank Open Data (original source: UNESCO Institute for Statistics)
Policies to ensure access to quality of education			
Education: public policies	Government expenditure on education, total (% of GDP)	-	UNESCO Institute for Statistics (UIS). UIS.Stat Bulk Data Download Service. Available at https://apiportal.uis.unesco. org/bdds
	Government expenditure on education, total (% of government expenditure)	-	UNESCO Institute for Statistics (UIS). UIS.Stat Bulk Data Download Service. Available at https://apiportal.uis.unesco. org/bdds
	Government expenditure per student, primary, secondary, tertiary (% of GDP per capita)	-	UNESCO Institute for Statistics. Available at http://uis.unesco.org
Policies to protect the physical environment			
Air quality and climate: social policies	Environmental Policy Stringency Index	-	OECD database. Available at https://stats.oecd.org
	Nationally determined contributions, long-term strategies, national adaptation plans and adaptation communications, as reported to the secretariat of the United Nations Framework Convention on Climate Change	-	UN SDG Indicators Database. Available at https://unstats.un.org/sdgs/dataportal

Subdomain	Indicator	Disaggregation dimension	Data source
Disasters: governance	Number of countries that adopt and implement national disaster risk reduction strategies in line with the Sendai Framework for Disaster Risk Reduction 2015–2030	-	UN SDG Indicators Database. Available at https://unstats.un.org/sdgs/dataportal
	Proportion of local governments that adopt and implement local disaster risk reduction strategies in line with national disaster risk reduction strategies	-	UN SDG Indicators Database. Available at https://unstats.un.org/sdgs/dataportal
Energy, fuels, and technologies: social policies	Regulatory Indicators for Sustainable Energy (RISE) policy scorecard	-	World Bank. Regulatory Indicators for Sustainable Energy (RISE). Available at https://rise.esmap.org
Housing: social policies	Social rental dwellings as a share of total dwellings (%)	-	OECD database. Available at https://stats.oecd.org
	Public spending on housing allowance as % of GDP		OECD database. Available at https://stats.oecd.org
Housing: social policies	Measures to finance housing improvements and regeneration		OECD database. Available at https://stats.oecd.org
Land tenure: social policies	International property rights index	-	Property rights alliance. Avalable at https://www.landinternational propertyrightsindex.org/
Road safety: public policies	Existence of national seat belt laws	-	WHO Global Health Observatory. Available at https://www.who.int/data/gho
Urban planning: governance	National urban policies or regional development plans that (a) respond to population dynamics; (b) ensure balanced territorial development; and (c) increase local fiscal space	-	UN SDG Indicators Database. Available at https://unstats.un.org/sdgs/dataportal

Subdomain	Indicator	Disaggregation dimension	Data source
Water, sanitation and hygiene (WASH): governance	Amount of water- and sanitation- related official development assistance that is part of a government-coordinated spending plan	-	UN SDG Indicators Database. Available at https://unstats.un.org/sdgs/dataportal
	Local administrative units with established and operational policies and procedures for participation of local communities in water and sanitation management (%)	-	UN SDG Indicators Database. Available at https://unstats.un.org/sdgs/dataportal
Policies to strengthen social and community context			
Civic engagement and trust: governance	Positions in national and local institutions, including (a) the legislatures; (b) the public service; and (c) the judiciary, compared to national distributions, by sex, age, persons with disabilities and population groups (%)	Age, persons with disabilities, population subgroup (country specific), sex	UN SDG Indicators Database. Available at https://unstats.un.org/sdgs/dataportal
Conflict, crime and violence: governance	Existence of independent national human rights institutions in compliance with the Paris Principles	-	UN SDG Indicators Database. Available at https://unstats.un.org/sdgs/dataportal
Discrimination: governance	Legal frameworks in place to promote, enforce and monitor equality and non-discrimination on the basis of sex	-	UN SDG Indicators Database. Available at https://unstats.un.org/sdgs/dataportal
Forced displacement and migration: social policies	Migration policies that facilitate orderly, safe, regular and responsible migration and mobility of people (%)	Six policy domains: (i) migrant rights; (ii) whole-of-government/ evidence-based policies; (iii) cooperation and partnerships; · socioeconomic well-being; · mobility dimensions of crises; and (vi) safe, orderly and regular migration	UN SDG Indicators Database. Available at https://unstats.un.org/sdgs/dataportal
Gender equality and women's empowerment: governance	Seats held by women in · national parliaments and · local governments (%)	-	UN SDG Indicators Database. Available at https://unstats.

Subdomain	Indicator	Disaggregation dimension	Data source
			un.org/sdgs/dataport al
Healthy ageing: governance	National plans, policies or strategies on ageing and health	-	WHO Global Health Observatory. Available at https://www.who. int/data/gho
Incarceration: governance	Unsentenced detainees as a proportion of overall prison population (%)	Age, length of pre-trial (unsentenced) detention, sex	UN SDG Indicators Database. Available at https://unstats. un.org/sdgs/dataport al
Social support: governance	National strategy for social connection	-	National data sources (note: a global dataset does not yet exist)
Policies to shift health behaviours			
Alcohol: social policies	Written national policy or strategy on alcohol, year adopted	-	WHO Global Health Observatory. Available at https://www.who. int/data/gho
Physical activity: governance	Global action plan on physical activity	-	National data sources (note: a global dataset does not yet exist)
Tobacco: social policies	Average price of cigarettes ($)	-	WHO Global Health Observatory. Available at https://www.who. int/data/gho
Nutrition: social policies	Sugar sweetened tax	-	World Bank. Global SSB Tax Database. Available at https://ssbtax.worldb ank.org
Policies to achieve access to quality essential health care			
Health: public policies	Coverage of essential health services (Universal health coverage (UHC) service coverage index)	Geographic location (rural/urban)	UN SDG Indicators Database. Available at https://unstats. un.org/sdgs/dataport al
BMI: body mass index: PM: particulate matter; SDG: Sustainable Development Goal; UHC: universal health coverage; UN: United Nations; UNDP: United Nations l, Scientific and Cultural Organization; WHO: World Health Organization.			

Source: World Health Organization (2024).