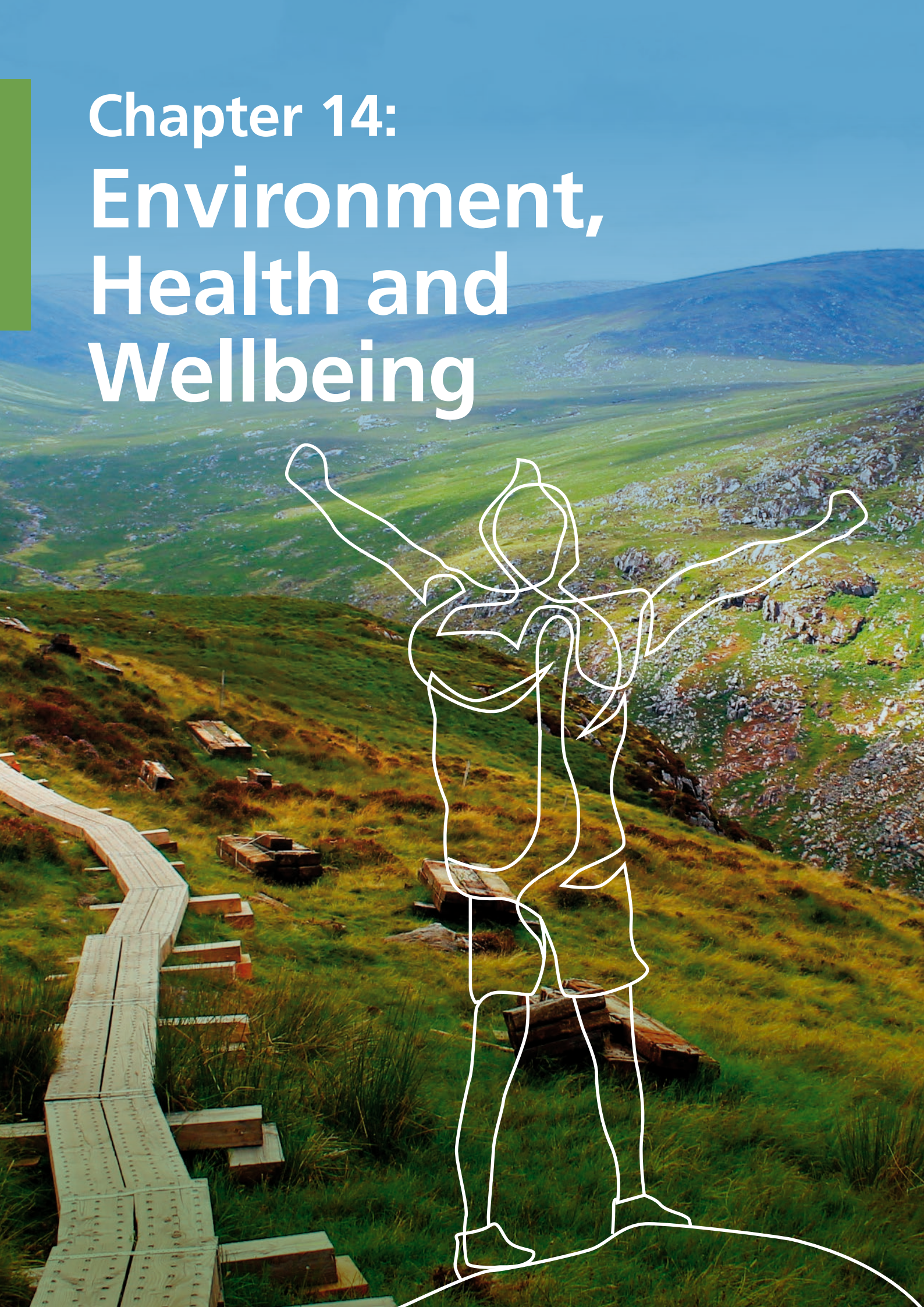
Chapter 14:
Environment, Health and Wellbeing



Environment, Health and Wellbeing

1. Introduction

Our health is affected by our surrounding environment in many and complex ways. Our most basic needs are clean air, clean water and food, and safe shelter. The quality of each one of these needs is directly influenced by the quality of our environment. It follows that preventing damage and pollution to the environment helps to protect our health and wellbeing, allowing us to live longer and healthier lives.

We have made some notable strides both in Ireland and elsewhere in addressing environmental and health issues, which are resulting in improved health and wellbeing among our population. The positive impact resulting from the introduction of the 'smoky coal ban' in Dublin in 1990 is a good example of the tangible impact that regulation of solid fuels and subsequent reductions in pollution levels can have on people's health. Research has shown that the introduction of the ban has resulted in approximately 350 fewer deaths per year, reducing cardiovascular, cerebrovascular and respiratory mortality in the general population (Clancy *et al*., 2002). Since its introduction in Dublin, the ban was subsequently extended to other cities and towns in Ireland, with a nationwide restriction on the sale of smoky fuels in Ireland introduced in 2022. An analysis of the effect of the phased extension of smoky coal bans to towns in Ireland found that there are now fewer diagnoses of respiratory disease among older people than there were before the bans were implemented (Lyons *et al*., 2023).

Every day we are subject to various environmental exposures – those that can help us and those that can harm us. Engagement with our green and blue spaces and exposure to our natural environment can generally have a protective effect on our health – improving mental health, reducing stress, improving physical activity and reducing premature mortality. Harmful environmental exposures include air pollution from burning solid fuels and from traffic, excessive noise from transport, exposure to the radioactive gas radon, consumption of poor-quality drinking water, and exposure to hazardous chemicals from various sources. The impact that these environmental risks, both individually and in combination, have on our health is substantial, with one in ten premature deaths in Europe linked to environmental pollution (EEA, 2023a). Data have shown that over 18% of premature cardiovascular deaths are caused by certain environmental risks (EEA, 2023b) with over 10% of premature cancer deaths attributable to certain environmental carcinogens (EEA, 2022).

Further compounding this, the risks and impacts associated with harmful environmental exposure are also unequally distributed across society, giving rise to unequal and unjust health outcomes for different population groups such as vulnerable members of society (children, older people) and those with more disadvantaged socioeconomic status (EEA, 2019a) (Topic Box 4.1).

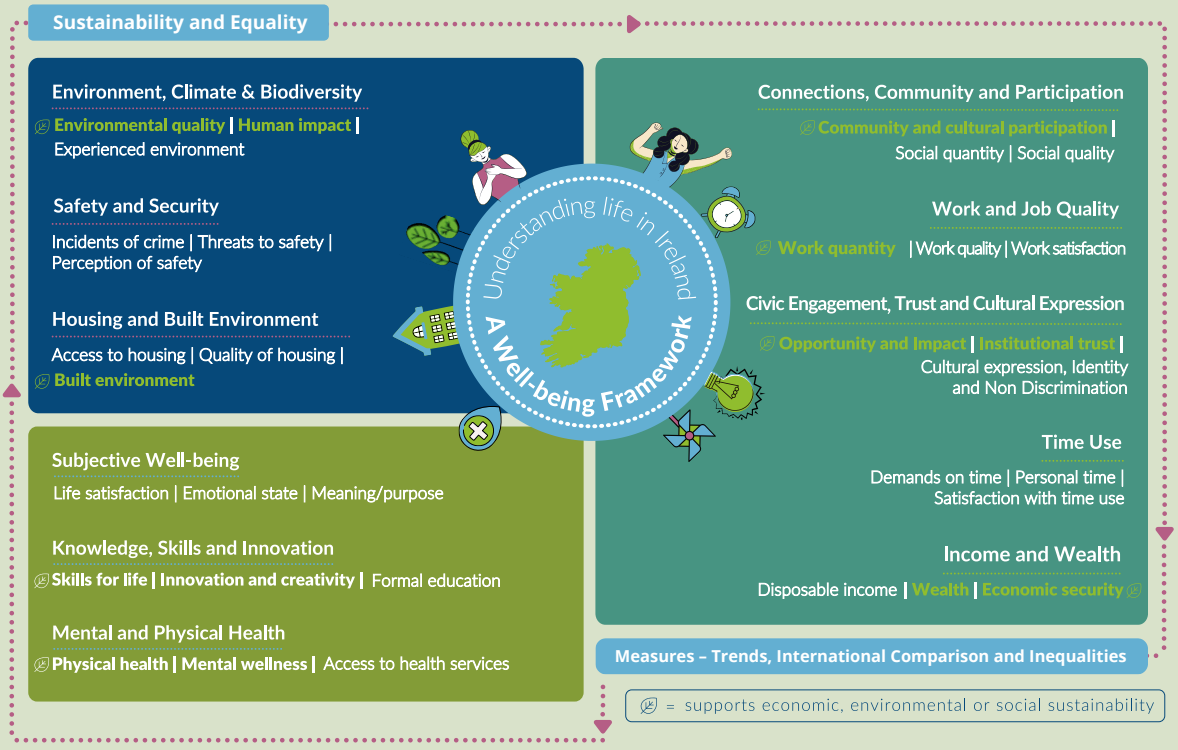
The positive news is that we can do something about it. The harmful environmental exposures causing health impacts and premature deaths are modifiable and within our power to change. By tackling issues such as air and water pollution, radon, chemical exposure and greenhouse gas (GHG) emissions, we can take tangible steps to improve and protect our health. Primary prevention is the greatest tool we have in protecting the health of our population and that of the environment. Proactive prevention measures, through regulation and policy as well as through individual action by all members of society making changes to how they live, can help to deliver a safer, healthier place to live now and in the future. Indeed, one of the six priority objectives of the Eighth Environment Action Programme to 2030 (Decision (EU) 2022/591) is to pursue zero pollution to protect the health and wellbeing of humans, animals and ecosystems from environment-related risks, exposures and negative impacts.

This chapter discusses current evidence and policy in relation to the various types of environmental exposure positively or negatively impacting our health and identifies measures that must be taken to protect our environment and improve the health and wellbeing of all people living in Ireland.

Topic Box 14.1 The Wellbeing Framework for Ireland

It is increasingly recognised that traditional macro-economic indicators, such as gross domestic product, fail to provide a comprehensive picture of the diverse experiences and wellbeing of people and households. A cross-government initiative called the Wellbeing Framework (WBF) for Ireland has been developed, which aims to capture a more complete and holistic view of how our society is faring and how Ireland is doing as a country. The WBF for Ireland focuses on quality of life, with a particular emphasis on sustainability and equality (Figure 14.1).

Figure 14.1 Well-being Framework for Ireland



Source: Department of the Taoiseach, 2023a

In the government's most recent annual analysis, the environment, climate and biodiversity dimension (one of 11 dimensions analysed) was the only one that showed negative overall performance, with poor performance in all four dimension indicators (pollution/grime, water body quality, GHG emissions, waste generated) (Department of the Taoiseach, 2023a). When compared with other European Union (EU) countries, Ireland had the highest emissions in tonnes per capita and was below the EU average in water body quality and waste generated per capita.

While the WBF for Ireland is still in the early stages of implementation, assessments carried out through the framework can help to bring new information more clearly into the policymaking space. Significant opportunity exists for the framework to capture data of greater breadth and depth on environmental issues, which can then be better linked with wellbeing objectives. There should also be greater focus around environmental justice issues to help in identifying inequalities and make them more visible, which has been called for by the National Economic and Social Council and others (O'Neill S. *et al.*, 2022; NESC, 2023). Environmental inequalities are not well addressed by current policy and are likely to endure, and potentially expand, into the future (EEA, 2019b). Identifying and increasing the visibility of inequalities under frameworks such as the WBF would make these issues more evident, allowing a greater focus and targeted and measurable action across policy areas.

2. Positive environmental exposures – enhancing our health and wellbeing

Engagement and contact with our natural environment is associated with measurable improvements in the health and wellbeing of the population – getting outdoors and using our green and blue spaces can have a multitude of benefits for our health, both physically and mentally. A growing body of evidence has pointed to the beneficial health effects of living near and engaging with natural environments, with links to improved mental health and wellbeing, physical activity levels and social interactions and reduced stress levels. Our natural environment is also capable of reducing many hazards such as noise and air pollution. A meta-analysis of cohort studies examining green spaces and mortality identified a protective effect from exposure to greenness (Rojas-Rueda *et al*., 2019), and a meta-analysis of blue spaces demonstrated positive health impacts at a population level (Smith *et al*., 2021).

The COVID-19 pandemic transformed how people use their surrounding natural environment and gave us a renewed and increased appreciation of the nature in and environment of our local areas. With this revitalised appreciation for our local environment and societal desire for healthier living, coupled with increasing challenges associated with rising population numbers and levels of urbanisation and the need for compact growth, the drive to make our urban areas more resilient, sustainable and rich in nature-based infrastructure has never been more urgent. Spatial planning is one of the most significant ways of achieving this, in the context of both health protection and health promotion. Health-centred planning, design and management can help protect us from many of the environmental hazards we are exposed to in urban settings, such as air pollution, noise from busy roads, flooding and increased temperatures due to the urban heat island effect. Well-designed, connected and accessible spaces can help citizens to make more sustainable choices and live healthier lives by promoting active travel and physical activity and by offering a sense of community.

Urban greening has become a well-established priority in international frameworks and European policy as a key contributor to sustainability. The EU Biodiversity Strategy for 2030 calls on all cities with more than 20,000 inhabitants to develop urban greening plans incorporating measures from parks and gardens to green roofs and urban farms to help towns and cities grow greener in the future and provide vital benefits for physical and mental health and wellbeing (EC, 2021).

The **3–30–300** rule (Figure 14.2) is an emerging concept developed by Prof Cecil Konijnendijk of the Nature Based Solutions Institute (Konijnendijk, 2023), which introduces objective benchmarks for urban areas to promote equitable nature access. It stipulates that:

3 – Everyone should be able to see at least three mature trees from their home, place of work or study.

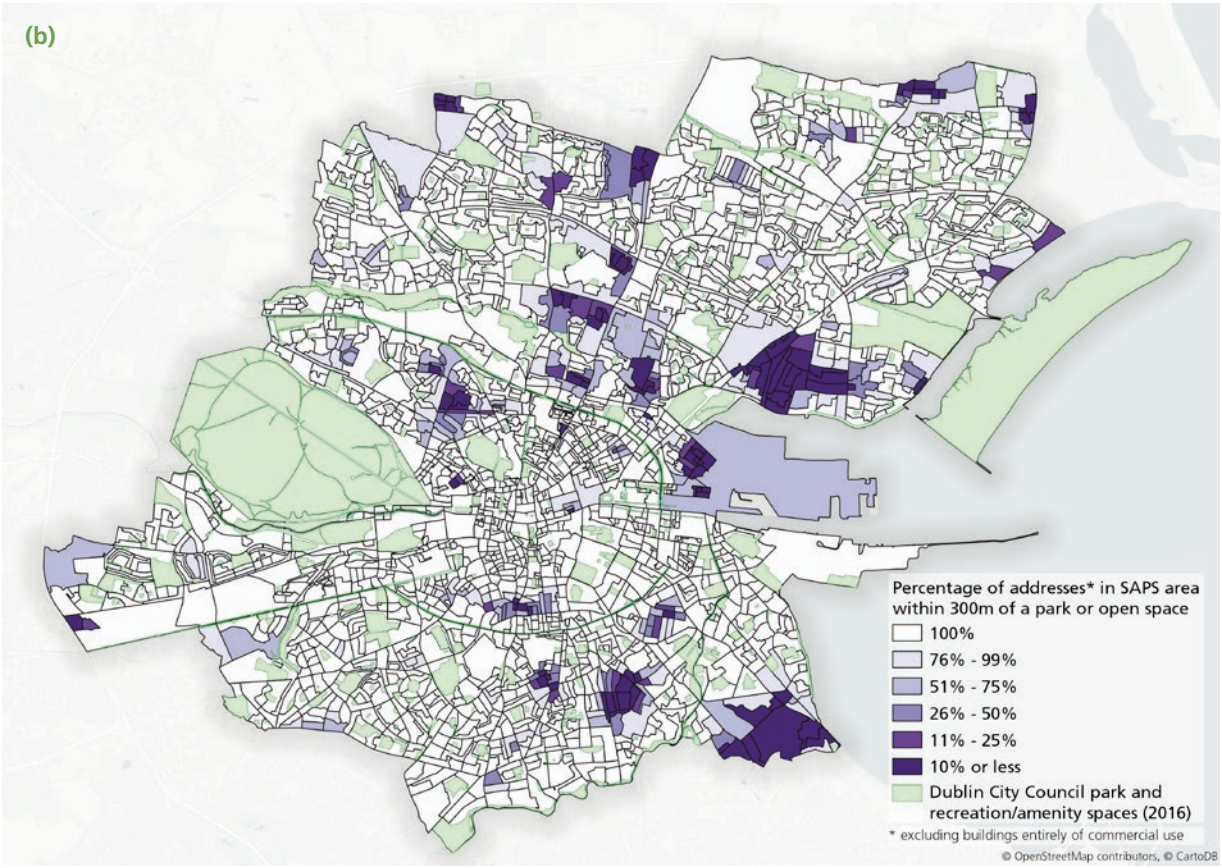
30 – Every neighbourhood should have at least 30% tree canopy cover.

300 – In line with recommendations from the World Health Organization (WHO) Regional Office for Europe, everyone should be a maximum distance of 300 m from their nearest high-quality public green space.

Figure 14.2 (a) Visualisation of the 3–30–300 rule (b) Percentage of addresses (from Geodirectory) in small area population statistic (SAPS) areas of which are within 300m of a Dublin City Council park or open spaces as outlined within the Dublin City Council Parks and open Spaces 2016 dataset[1]

(a)

(b)



Source: (A) UNECE, 2021.

1 data.gov.ie/dataset/parks-gardens-and-public-spaces-dcc#:~:text=This%20dataset (18 September 2024).

While availability of green space is important, spaces must be of high quality in various respects, including safety, accessibility, cleanliness and wider service provision, to be perceived as being adequate by the local community (Scott *et al*., 2020; Barlow *et al*., 2021). By enhancing the provision and design of new and existing green spaces by incorporating specific attributes valued by the local community, green spaces can be maximised as health-promoting environments.

Ireland's National Planning Framework 2040 (DHLGH, 2018) recognises the key national environmental challenges we face, in terms of climate change, air quality, health risks to drinking water, urban waste water and protecting our natural environment, and indicates that the planning system will be 'responsive' to these challenges. Our urban areas are at the front line in terms of vulnerability to the progressively worsening impacts of climate change – they are significant sources of GHG emissions while also housing a significant proportion of our population.

Nature-based solutions

Nature-based solutions (NbSs) are a key tool in helping to address climate change, biodiversity loss and environmental pollution while simultaneously benefiting human health, societal wellbeing and urban prosperity. NbSs have gained much momentum and focus in recent years (Faivre *et al*., 2017) as multifunctional solutions for addressing socio-environmental challenges and benefiting both human wellbeing and biodiversity. Solutions can encompass a broad range of approaches including green and blue infrastructure and natural water retention measures, as well as ecosystem-based adaptation and disaster risk reduction measures (EEA, 2021a). The International Union for Conservation of Nature estimates that one-third of climate mitigation measures needed to meet the goals of the Paris Agreement can be provided by NbSs.

We currently have much knowledge around NbSs, including evidence of their benefits and good examples of NbSs in practice. We also have national guidance to assist local authorities and planning professionals with NbSs for the management of rainwater and surface water run-off in urban areas (DHLGH, 2021), as well as regional guidance around NbSs and blue–green infrastructure (Southern Regional Assembly, n.d.). Mainstreaming and upscaling the implementation of appropriate localised NbSs should be prioritised as a means of addressing many environmental challenges while co-benefiting health and wellbeing.

The design and implementation of NbSs should be inclusive and collaborative from the outset, allowing communities to participate in the design of their own spaces, thereby mobilising local knowledge into local solutions. This is of particular importance, as national-level research has demonstrated the success of this approach as a means of providing guidance and insights into innovative approaches that could be explored (Scott *et al*., 2020; Clavin *et al*., 2021). Monitoring and evaluating the performance and impact of NbS interventions across various societal challenge areas (including climate resilience, water management, air quality and biodiversity, as well as health and wellbeing) is essential if we are to fully understand the success of NbSs, and also provides evidence to inform policy and further action for appropriate land use planning and management (Dumitru *et al*., 2021).

3. Key environmental and health issues

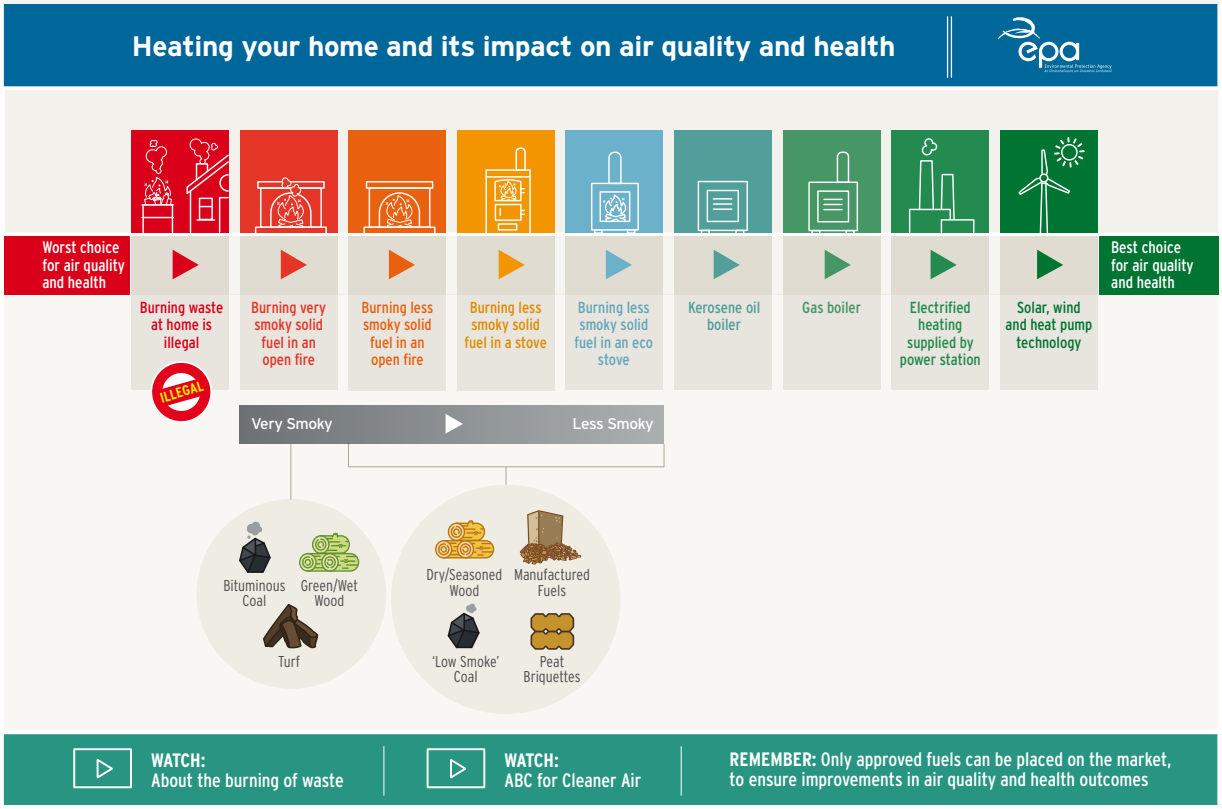
Air pollution

Air pollution is the single greatest environmental threat to our health, causing an estimated 1600 premature deaths annually from conditions such as cardiovascular disease and respiratory illnesses (EEA, 2023c). The air pollutants of concern for health in Ireland are fine particulate matter (with a diameter of less that 2.5 µm ($PM_{2.5}$)) and nitrogen dioxide (NO_2) (EPA, 2023a).

Higher levels of $PM_{2.5}$, the most impactful pollutant on health, are associated with burning solid fuels in our towns and villages, affecting localised air pollution levels. High levels of NO_2 in large cities and urban areas are associated with road traffic (EPA, 2023a).

In 2021, WHO published revised air quality guidelines that substantially lower the guidelines for both NO_2 and $PM_{2.5}$. At EU level a revision of the Cleaner Air for Europe Directive (2008/50/EC) has been progressed, while at national level Ireland's first Clean Air Strategy sets the country an ambition of progressively moving towards achieving the WHO guideline limits by 2040. Meeting the WHO guideline limits will be a major challenge for Ireland, but it is one that is essential if we are to safeguard the health of our citizens (see Chapter 2 for more details).

Figure 14.3 Better ways to heat your home



Source: EPA, 2024a

Solid fuel use. When we heat our homes by burning solid fuels such as coal, peat and wood in stoves or open fires, harmful air pollutants, including $PM_{2.5}$, are released. As well as having an impact on the outdoor air quality in our locality, burning of solid fuel has an impact on our indoor air quality by exposing occupants to considerable levels of air pollutants. The choices we make in how we heat our homes can have a large bearing on our health and the health of our family and the community in which we live (Topic Box 14.2).

New Solid Fuel Regulations came into effect in October 2022 restricting the sale of smoky fuels in Ireland (S.I No. 529/2022; see also Chapter 2 for more details). The primary objective of the regulations is to improve air quality and people's health by ensuring that the most polluting fuels are no longer available on the Irish market. A range of policy measures are needed to encourage the transition away from the use of peat and other solid fuels, towards more sustainable alternatives (Figure 14.3). An examination of the implementation of policy measures in other countries suggests that measures to tackle solid fuel use are most effective when implemented as a suite of supportive interventions (Eakins *et al*., 2022). Targeted education and awareness of the negative effects of using solid fuels, better burning practices, the costs and benefits of using cleaner heating systems such as heat pumps, and the benefits of retrofitting homes are needed, particularly in localities where significant air pollution will continue. Coupled with this, more targeted support schemes offering incentives for retrofitting homes are needed for highly polluting homes. The Climate Change Advisory Council's *Annual Review 2023* (CCAC, 2023) recommends that the number of retrofits needs to increase each year and that homes using peat or coal as their main heating fuel should be prioritised.

Transport-related air pollution. Road traffic and vehicle emissions are the main outdoor source of the harmful air pollutant NO_2. As our towns and cities tend to have greater volumes of traffic, higher concentrations of NO_2 are seen on busy roads, representing a risk to health in these often densely populated urban areas. Almost 70% of journeys are by private car (CSO, 2021), signalling that there is much more to do in enabling and encouraging the transition to more active modes of travel (see Chapter 11 for more details).

Noise pollution

Environmental noise can originate from a wide range of sources, but noise from transport sources (road, rail and aircraft) results in the largest population exposure to excessive noise levels. Over 1 million people are estimated to be exposed to transport noise levels above the mandatory noise level reporting thresholds given in the Environmental Noise Directive (2002/49/EC). Moreover, nearly 1.5 million people are exposed to road traffic noise above the stricter WHO Environmental Noise Guidelines for the European Region (WHO, 2018). The EU Zero Pollution Action Plan aims to reduce the number of people chronically disturbed by transport noise by 30% by 2030 compared with 2017.

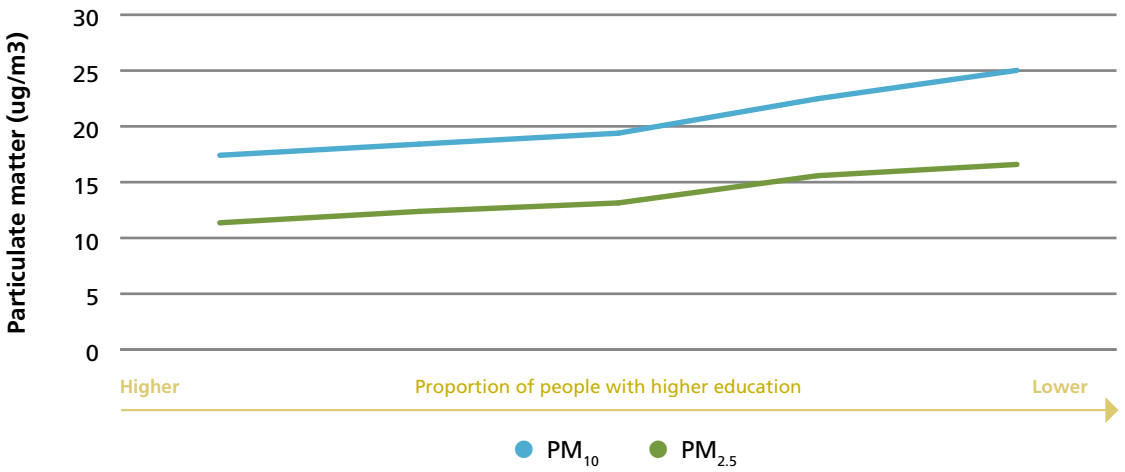
There is a clear link between transport policy and reducing environmental noise from transport. While some work has been ongoing to tackle noise in Ireland, such as the use of lower noise road surfaces, traffic calming measures to reduce speed and noise monitoring at residential locations, the actions so far are not sufficient to meet the targets in the EU Action Plan. New noise action plans are in development at local authority level, and national sustainable mobility policies should provide some benefits. There is also a need to focus on the identification and protection of quiet areas as outlined in the Environmental Noise Directive. Such areas may also provide a multitude of additional co-benefits that can improve health and wellbeing and reduce harmful environmental exposures.

Topic Box 14.2 Unequal exposure and impacts

There are marked differences in the vulnerability of certain cohorts of society to environmental hazards – individuals who are already in poor health, as well as young and elderly people, are vulnerable cohorts of society that tend to be more adversely impacted than the general population. Research using data from the Irish Longitudinal Study on Ageing has demonstrated that long-term low-level exposure to $PM_{2.5}$ is associated with poorer mental health in older people in Ireland (Lyons *et al.*, 2024).

Groups disadvantaged in terms of socio-economic status, such as those on lower incomes or who are unemployed, are also disproportionally more affected by environmental hazards because of factors such as poorer housing conditions or living in areas with high volumes of road traffic. An analysis of the differences in exposure to certain air pollutants (ETC/ACM, 2018; EEA, 2019a) found that regions characterised by lower socio-economic status (e.g. lower levels of education) tended to have higher levels of $PM_{2.5}$ and PM_{10} (particulate matter with a diameter of less than 10 micrometres) air pollution (Figure 14.4).

Figure 14.4 Difference in exposure to particulate matter ($PM_{2.5}$ and PM_{10} mean pollution) in European regions, classified according to the proportion of people without higher education in the population (2013–2014)



Source: Adapted from ETC/ACM, 2018

Children are particularly vulnerable to air pollution. Their higher breathing rate and lower physical height means that they can be more directly susceptible to air pollution from traffic exhausts. Moreover, their bodies, organs and immune systems are still developing (see Chapter 2 for more details). It is estimated that air pollution causes over 1200 deaths in those under the age of 18 every year in European Environment Agency (EEA) member and collaborating countries (EEA, 2023d). Recent research funded by the Environmental Protection Agency (EPA) demonstrated a strong positive association between $PM_{2.5}$ levels and prescribing rates of drugs used to treat asthma and chronic obstructive airway disease, particularly in young children (aged 0–4 years) (Ó Domhnaill *et al.*, 2023).

The implementation of policy measures may not benefit all members of society evenly. There is a need to assess and understand inequalities in exposure levels, as well as inequalities in impact, at a more granular scale so we can focus measures appropriately and, importantly, track changes over time.

Safe and clean water and sanitation

Drinking water. Drinking water can pose a risk to health if it is contaminated by pathogens or certain chemicals. The recast Drinking Water Directive[2] ((EU) 2020/2184) brings significant new requirements for water suppliers and regulators. These include implementing a risk-based approach (drinking water safety plans) across the whole drinking water supply chain and an updated list of more stringent existing (e.g. lead) and new standards (e.g. per- and polyfluoroalkyl substances (PFAS)). Nationally, water comes from a public water supply operated by Uisce Éireann (82% of population), a private household supply such as a well (12% of population) or a private group water scheme (6% of the population).

Compliance with the microbiological and chemical standards for public drinking water supplies remains high at greater than 99.7%, and this compares well with the EU-wide historical compliance rate of more than 99.5% for a range of chemical parameters.[3] Drinking water treatment in many supplies is still, however, not robust enough to ensure that all supplies will be resilient and safe into the future, with 57 public supplies identified by the EPA as requiring remedial action in its most recent update (EPA, 2024b).

The quality of water from private supplies (including group schemes) is consistently lower than that from public supplies, with little indication that this disparity is improving. About 1 in 20 private supplies tested fail to meet *Escherichia coli* standards, compared with only 1 in 200 public water supplies. Concerningly, each year on average over one-quarter of small private supplies are not subject to any monitoring. Private wells are not regulated so information on their quality is not available. Ireland has one of the highest notification rates in Europe for certain notifiable pathogens, including Shiga toxin-producing *E. coli* (STEC) (also referred to as verocytotoxin-producing *E. coli* (VTEC)) (Topic Box 14.3).

In addition to issues with microbial contamination, there are a number of issues related to chemical contamination. There has been an increase in the number of supplies listed on the EPA's action list because they contain trihalomethanes (THMs). In January 2024, the European Court of Justice ruled that Ireland had failed to fully implement the Drinking Water Directive in relation to breaches of the limit for THMs in 30 drinking water supplies, 21 of which were Uisce Éireann public supplies (see Chapter 16 for further information). There are also issues with lead, with limited action taken to replace lead pipework under the National Lead Strategy. This is particularly urgent and requires leadership at a national level given the cumulative risk to health posed by exposure to lead in drinking water supplies. The recast Drinking Water Directive includes requirements to halve the level of lead that is permitted in drinking water (from 10 µg/l to 5 µg/l) by January 2036. Compliance with this limit will most likely not be achieved without the replacement of all lead connections. The Lead Remediation Grant Scheme[4] provides 100% of costs up to €5,000 for householders to replace lead drinking water pipes within the boundaries of their property.

2 Implemented by the European Union Drinking Water Regulations 2023 (S.I. No. 99/2023).

3 www.eea.europa.eu/publications/zero-pollution/health/water-pollution (accessed 16 July 2024).

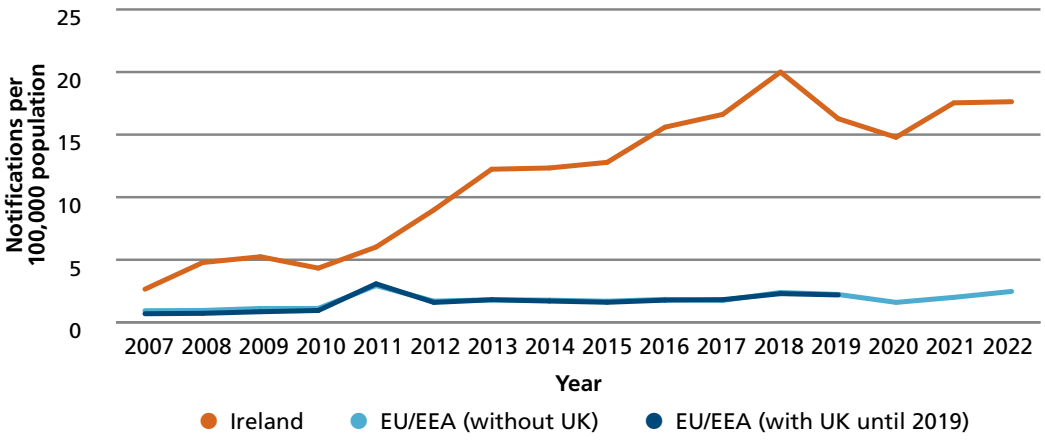
4 gov – Domestic Lead Remediation Grant Scheme – Customer Leaflet (www.gov.ie/en/publication/7fe5d-domestic-lead-remediation-grant-scheme-customer-leaflet/) (accessed 20 September 2024).

Topic Box 14.3 STEC/VTEC infections in Ireland: a persistent threat to public health and wellbeing

STEC/VTEC infections are a significant concern for public health in Ireland. Ireland consistently reports the highest rates of STEC/VTEC infections in the EU, with an increasing trend since 2010 (Figure 14.5). Ruminants, mainly cattle, are the primary reservoir of this zoonotic pathogen, which they shed in their faeces. A low infectious dose, with ingestion of just ten STEC/VTEC bacteria from contaminated food or water, is enough to cause symptomatic disease (FSAI, 2010). Children under the age of 5 and the older population are particularly vulnerable to severe illness caused by STEC/VTEC infection and a complication called haemolytic uraemic syndrome, which can be life threatening.

More recent data from the Health Protection Surveillance Centre (HPSC) and the European Centre for Disease Prevention and Control (ECDC) highlight that Irish STEC/VTEC notification rates were one of the highest in Europe in 2022. Many factors combine to favour human exposure to this zoonotic pathogen in Ireland:[5] high levels of rainfall, the high density of ruminant animals at pasture and the high proportion of rural dwellers who rely on private sources of untreated water all contribute to our increased risk. Exposure to private well water was the most commonly reported risk factor among STEC/VTEC cases in 2022 (HPSC, 2024). Meteorological events, including persistent and heavy rainfall, have also been shown to concur with STEC/VTEC outbreaks (O'Dwyer *et al*., 2016), suggesting that a changing climate is likely to influence the pattern and frequency of outbreaks of this disease in the future.

Figure 14.5 Trends in STEC/VTEC in the EU and Ireland, 2007–2022



Source: Adapted from ECDC, Surveillance Atlas of Infectious Diseases[6]

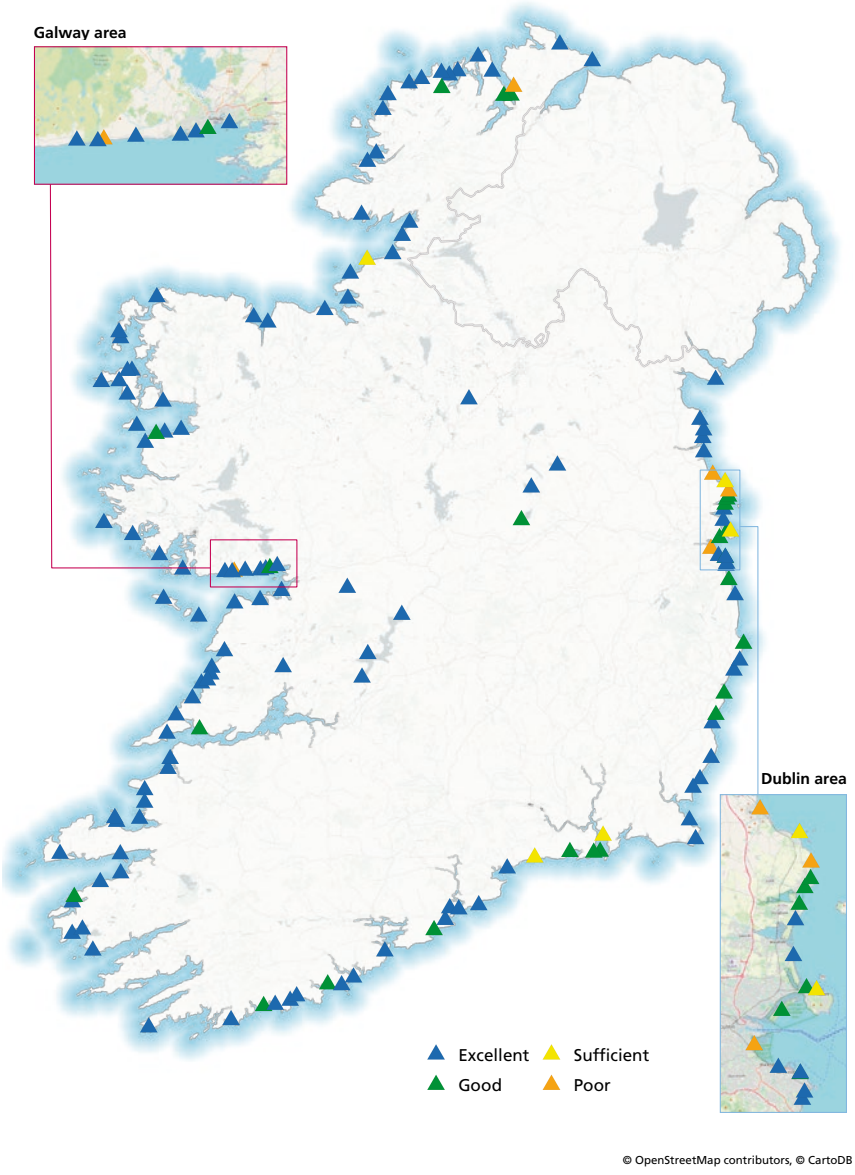
Quantifying the relative contribution of potential environmental sources, pathways and temporal dynamics of STEC/VTEC contamination is a priority area, particularly in light of climate change impacts. Improvements in private water supplies are essential if we are to protect human health. This includes ensuring that private wells are properly constructed such that the well head is adequately protected and contamination by surface run-off is prevented and that water is treated by ultraviolet radiation or ultrafiltration. While funding is available through the Department of Housing, Local Government and Heritage (DHLGH) for improvement works for private supplies and group water schemes, during the 2019–2021 funding cycle of the Multi-annual Rural Water Programme, over 60% (€36 million) of the funding available for infrastructural improvements went unused by water suppliers.

5 Zoonotic pathogens are infectious diseases that can be transmitted from animals to humans.

6 https://atlas.ecdc.europa.eu/public/index.aspx – examining notification rate of confirmed cases of STEC/VTEC infection.

Bathing water. The use of our local environment is changing, with swimming now increasingly becoming a year-round activity. The overall quality of Ireland's bathing water is high with 97% (143 of 148) of sites meeting or exceeding the minimum standard in 2023 (EPA, 2024c) (Figure 14.6). Localised issues remain from impacts from urban waste water discharge incidents, agricultural run-off and dog fouling. Ireland is below the European average in terms of the percentage of bathing water sites rated as excellent (79.1% vs 85.7%) (EEA, 2023e). Increasing the use of 'prior warning' notices (228 issued in 2023) to warn bathers of potential problems, along with a conservative approach to closing beaches in response to potential water quality impacts, is serving to protect bathers' health. However, given the increasing recreational use of our bathing waters, further health protection would be served by local authorities officially designating more bathing sites and providing better information for those who wish to swim all year round. The public can suggest new bathing water locations to their local authority in order to have additional bathing water sites designated. It is essential that there is timely provision of information to swimmers and other recreational water users to help them make informed choices to protect their health.

Figure 14.6 Map showing bathing water sites and the bathing water quality status of each



Source: EPA, 2024c

Domestic waste water treatment systems. There are nearly half a million domestic waste water treatment systems, mostly septic tanks, in Ireland. Faulty septic tanks systems can contaminate household drinking water wells with harmful bacteria and viruses and can pollute water bodies. Of all septic tanks inspected by local authorities in 2023, 45% failed inspection, with a significant number identified as a risk to human health and the environment (EPA, 2024d). When septic tanks are not functioning properly, it is critical that householders fix the problem to prevent unnecessary risk to their family's health. Local authorities require householders to fix systems that fail inspection. The most recent report on domestic waste water treatment system inspections found that the number of advisory notices open for more than 2 years (576) has continued to increase and remains a concern (EPA, 2024d). More consistent enforcement is needed by local authorities when advisory notices are not addressed. The septic tank grant scheme[7] operated by DHLGH was amended in 2024, increasing the available grant from €5,000 to €12,000. This presents a significant opportunity for householders to repair, upgrade or replace their septic tanks, thereby preventing needless risks to human health and the environment.

Urban waste water. Untreated and poorly treated waste water can contain harmful bacteria and viruses that pose a risk to people's health. The treatment of waste water is therefore essential to protect our environment and public health. Once treated, the effluent is discharged into rivers, estuaries, lakes and coastal waters. More than 1 billion litres of waste water are collected each day in Ireland's sewers and treated at over 1000 Uisce Éireann treatment plants. In Ireland, urban waste water treatment is still not as good as it needs to be, and this is putting our environment and public health at risk. Waste water treatment failed to meet EU standards in 15 large towns and cities in 2022 (EPA, 2023). These included the Greater Dublin Area, served by an overloaded plant at Ringsend that treats over 40% of Ireland's urban waste water. Infrastructure upgrades to increase the capacity of the Ringsend plant and bring it up to the required standard are well advanced. The works are due to be completed in 2025 but the upgraded infrastructure in place since the start of 2024 has the capability to meet EU standards, provided it is operated and managed effectively.

At the end of 2023, raw sewage from 19 towns and villages was being discharged into the environment every day, which poses an unacceptable risk to the environment and public health. The EPA has repeatedly highlighted that these areas must be connected to waste water treatment plants as a matter of urgency.

A legacy of underinvestment means that multi-billion euro spending is required to bring all infrastructure up to standard – it is likely to take at least two decades to bring all infrastructure up to standard. While progress has been made in several areas over the last few years, the EPA has highlighted that the pace at which Uisce Éireann must deliver improvements needs to accelerate (EPA, 2023). Uisce Éireann's next investment plan for 2025–2029 must prioritise resources to tackle priority areas highlighted by the EPA.

Topic Box 14.4 describes the establishment of the National Wastewater Surveillance Programme, a valuable tool that public health officials use to monitor infectious diseases through waste water across the country.

7 gov – Domestic waste water treatment systems (septic tanks) (www.gov.ie) (29 July 2024).

Topic Box 14.4 Our waste water as a powerful public health monitoring tool – establishment of Ireland's National Wastewater Surveillance Programme

The pandemic saw the implementation of waste water monitoring across Europe as a tool to track COVID-19 and its variants in the community. People infected with the SARS-CoV-2 virus can shed virus in their faeces and urine, which can then be detected in untreated waste water. Analysis of the waste water can be used to inform public health teams providing estimates of the frequency of infection and of variants of the virus that are circulating. The analysis acts as an additional, complementary tool providing community-level information to other public health surveillance systems monitoring the number of people testing positive or seen in healthcare facilities.

Ireland's National SARS-CoV-2 (COVID-19) Wastewater Surveillance Programme was established in 2020 by the Health Service Executive (HSE), Uisce Éireann, the National Virus Reference Laboratory and University College Dublin, and involved the sampling of 68 waste water catchment areas across Ireland on a weekly basis (Ringsend sampled twice per week). The catchment area analysed covered 80% of the population connected to the public waste water treatment facilities across a broad geographical area. The results of analysis of samples continue to be reported on a weekly basis by the HPSC.[8] Since January 2023, the number of catchment areas covered by the COVID-19 surveillance programme has been reduced to 30; however, the programme still covers approximately 70% of the population connected to the public waste water system. Beyond COVID-19, the establishment and operation of the surveillance programme now represents a national surveillance infrastructure that could be readily applied to micropollutants (biological and chemical contaminants in water in trace quantities). Waste water surveillance could be a powerful public health tool acting as an early warning system for environmental or human health threats, or allowing longitudinal surveillance for contaminants or pathogens of concern. For example, indirect environmental surveillance for antimicrobial resistance (AMR) consistently lags behind direct surveillance for AMR in human or animal populations; however, systematic waste water surveillance now offers a timely and powerful opportunity to gain insights and to provide a more integrated view of AMR dynamics in our populations and ecosystems.

There is also opportunity to combine the waste water monitoring systems in operation across various countries into an integrated global network for disease surveillance (Keshaviah *et al*., 2023). Ireland is currently collaborating with other countries across Europe to develop the use of waste water surveillance and to integrate this with other public health surveillance tools.

Antimicrobial resistance. Antibiotics revolutionised the treatment of bacterial infections and made many modern medical procedures possible. However, the overuse and misuse of antimicrobials such as antibiotics, for human or animal health, has resulted in a rapid increase in AMR, which jeopardises the effectiveness of these medicines and modern healthcare systems. AMR is considered responsible for more than 35,000 deaths each year in the EU and European Economic Area countries (ECDC, 2020). An analysis of the economic burden of AMR in Ireland in 2019 found that over 4700 resistant infections occurred across 50 public hospitals, resulting in 215 deaths and approximately 5000 years of healthy life lost. In addition, these patients' lengthier hospital stays were estimated to cost at least an additional €12 million in that year (HIQA, 2021). AMR has been identified as one of the top three health threats for priority action by the European Commission and EU Member States (HERA, 2022), and it is consistently listed as one of the strategic risks facing Ireland under the government's annual national risk assessment (Department of the Taoiseach, 2023b).

8 www.hpsc.ie/a-z/nationalwastewatersurveillanceprogramme/ (accessed 16 July 2024).

AMR is a quintessential One Health issue: One Health recognises that the health of humans, animals and the environment are closely linked and interdependent. Ireland's second One Health National Action Plan on AMR 2021-2025 (iNAP2) is the successor plan to Ireland's first National Action Plan on AMR 2017-2020 (iNAP1) and outlines over 150 actions, both One Health-focused as well as sector-specific, to tackle the issue of AMR in Ireland (DAFM & DOH, 2021). Compared with public health and the health of food-producing animals, the health of the environment has, to date, received little attention with regard to AMR. However, the environment is a complex reservoir of antimicrobial-resistant organisms and genes that can drive AMR, and is a critical, but often overlooked, dimension of this One Health issue (see section 5).

A recent research project revealed the presence of antimicrobial-resistant organisms and AMR genes of clinical concern in our aquatic environment, including those that are resistant to last-resort antimicrobials such as carbapenemase-producing Enterobacterales (Hooban *et al*., 2021, 2022; Cahill *et al*., 2023; Morris *et al*., 2024). Discharged waste water, particularly that emanating from healthcare facilities, was found to play a significant role in dissemination of AMR in the natural aquatic environment. This persistence of resistant microbes and AMR genetic elements in our environment is an important signal of a wider problem around the use of antimicrobials, which is continuing to drive AMR.

iNAP2

OBAIR LE CHÉILE CHUN ÁBHAIR FHRITHMHIOCRÓBACHA A CHOSAINT DON TODHCHAÍ

WORKING TOGETHER TO PROTECT ANTIMICROBIALS FOR THE FUTURE

Ireland, like many other countries, does not currently have a systematic surveillance system to monitor levels of AMR in our environment. Several antimicrobial compounds are included in the Water Framework Directive (2000/60/EC) watchlist for monitoring; however, the number of substances monitored and the frequency and density of monitoring are very limited. Proposed revisions to various pieces of EU legislation, including the Urban Waste Water Treatment Directive (91/271/EEC), the Water Framework Directive, the Groundwater Directive (2006/118/EC) and the Environmental Quality Standards Directive (2008/105/EC), intend to include monitoring for AMR genes. A recent European Council recommendation (2023/C 220/01) under the 2023 Commission revision of pharmaceuticals legislation highlights that environmental monitoring of antimicrobial-resistant organisms and AMR genes in our waters, waste water and agricultural soils is 'essential' to understand the level of environmental contamination and the risk posed to human health (European Council, 2023). Indeed, provisional political agreement was reached in March 2024 on proposals to review the EU Urban Waste Water Treatment Directive's higher standards of treatment and monitoring activities for micropollutants and AMR. Therefore, it seems likely that it will eventually become a legislative requirement to monitor AMR in our environment. Ireland has already made a substantial investment in research in recent years on the environmental dimension of AMR – this provides us with a wealth of evidence on which we should build. If we are to gain the requisite evidence to have a more holistic understanding of AMR and the risks it poses to human and animal health, we must step up our surveillance, not only of residues of antimicrobial compounds but also of resistant microorganisms and microbial genes coding for AMR.

Algal blooms. Harmful algal blooms occurred at a number of freshwater lakes across the island of Ireland in 2023, affecting recreational bathing sites and drinking water sources and posing serious risks to aquatic life, as well as ecological, animal and human health. Toxic blue–green algae blooms are caused by cyanobacteria, which are natural inhabitants of freshwater and marine waters. These bacteria and the toxins they produce during a bloom can potentially kill livestock, wild animals and pets if ingested and can also cause harm to people who come into contact with, or swallow, the affected water. Human activities can influence the extent to which cyanobacteria can proliferate, with excess nutrients arising from agriculture and waste water systems within catchments areas, combined with climate change and weather conditions, driving the occurrence of blooms. Local authorities have responsibility for monitoring, risk assessing and analysing waters for suspect blooms. The HSE Bathing Water Working Group has developed guidance for responding to incidents of microbiological pollution in bathing waters. Restricting bathing and other water-contact activities and posting on-site warning signs are some of the recommended actions for safe practice in managing contact with blooms. Health warnings and swimming restrictions were placed across many lakes on the island of Ireland in 2023 due to harmful algal blooms. It is likely that we will continue to see changing patterns and incidences of algal blooms as a result of continued anthropogenic pressures and climate change impacts. It is essential that local authorities remain vigilant in promptly identifying harmful algal blooms and notifying the public to help safeguard public health.

Shellfish waters. Waters used for the farming or harvesting of shellfish (e.g. oysters, mussels and clams) are protected. If waste water is discharged into the catchments of these waters without adequate treatment (e.g. disinfection of treated waste water using ultraviolet lamps) it has the potential to contaminate shellfish with bacteria and viruses. This can put public health at risk, as people may get sick by eating contaminated shellfish. The EPA has highlighted that Uisce Éireann is taking too long to complete assessments of shellfish waters and to carry out necessary improvements: 23 assessments were overdue in 2022 (EPA, 2023b). The EPA requires Uisce Éireann to implement improvements to protect shellfish waters without delay and expedite the remaining assessments. It is vital that adequate funding for these works is allocated by Uisce Éireann so that the assessments and infrastructure works can be completed.

Radiation

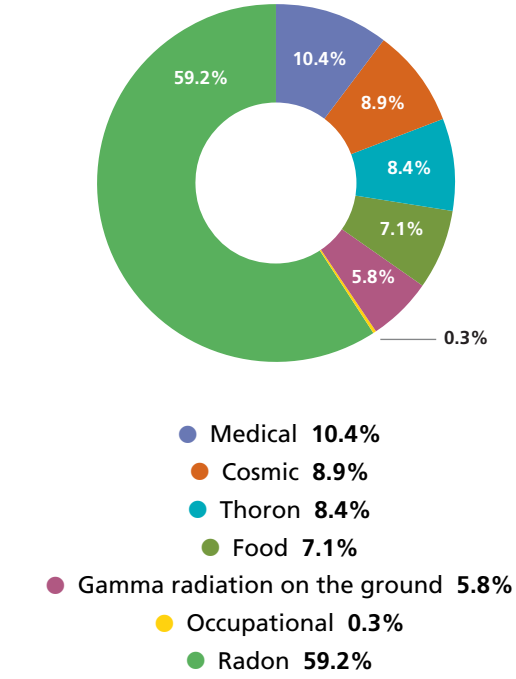
Radiation can be of benefit to our health, for example in medical imaging or in medical treatments, but radiation also has the potential to cause negative health impacts. The estimations of radiation doses received from various pathways were updated in 2024, and while no major changes were found in the overall doses, there was some additional exposure from increased air travel and a reduction in the average estimated dose from medical imaging.

The average annual radiation dose for a person in Ireland from all sources is 4.172 mSv (EPA, 2024e) (Figure 14.7). This exposure comes predominantly from natural sources, which, together with medical exposures, account for 99% of the total average exposure.

Our greatest radiation exposure comes from radon (59% of total), which is linked to approximately 350 new cases of lung cancer each year in Ireland (Figure 14.8) (Murphy *et al*., 2021). Radon is a natural radioactive gas that is emitted from the ground into our buildings, where the levels build up.

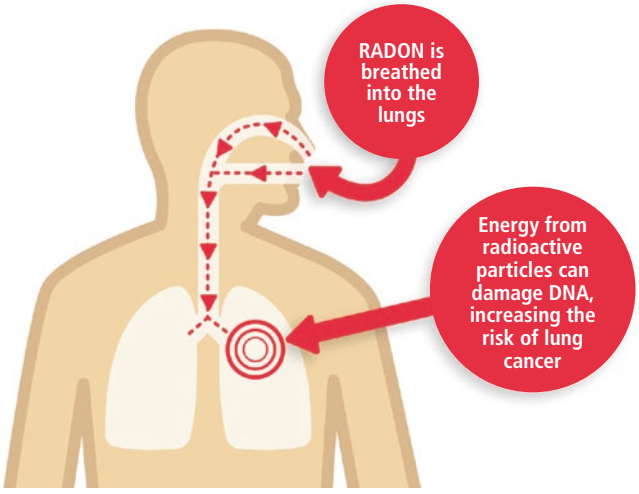
Ireland has a more significant radon problem than many European countries because of its geology. The EPA published new radon risk maps in 2022 (Figure 14.9) using approximately 30,000 radon measurements combined with detailed geological information. According to the new maps, one-third of the country is now designated as a high radon area (areas where one in five homes are likely to have a high radon level), and 170,000 homes nationally could have radon levels above the national reference level of 200 Bq/m^3. This is an increase of 45,000 homes from the previous estimate in 2002. Householders can search by their Eircode to see the radon risk in their area (www.epa.ie/radon).

Figure 14.7 Sources of average radiation dose in Ireland



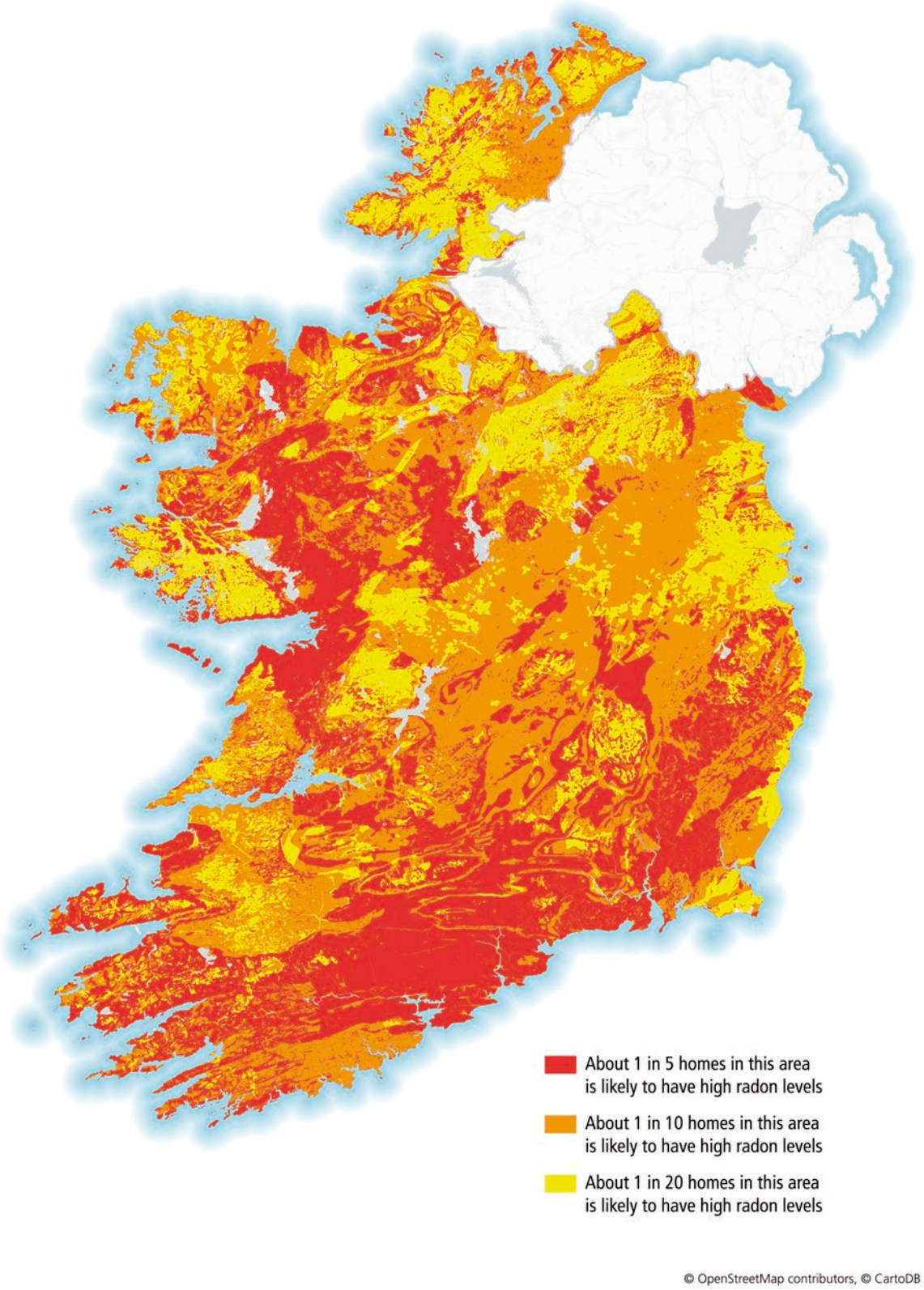
Source: EPA, 2024e

Figure 14.8 Radon damages the lungs, increasing the risk of lung cancer



Source: EPA, n.d.

Figure 14.9 Radon risk map of Ireland



Source: EPA, n.d.

Digital radon gas detector.

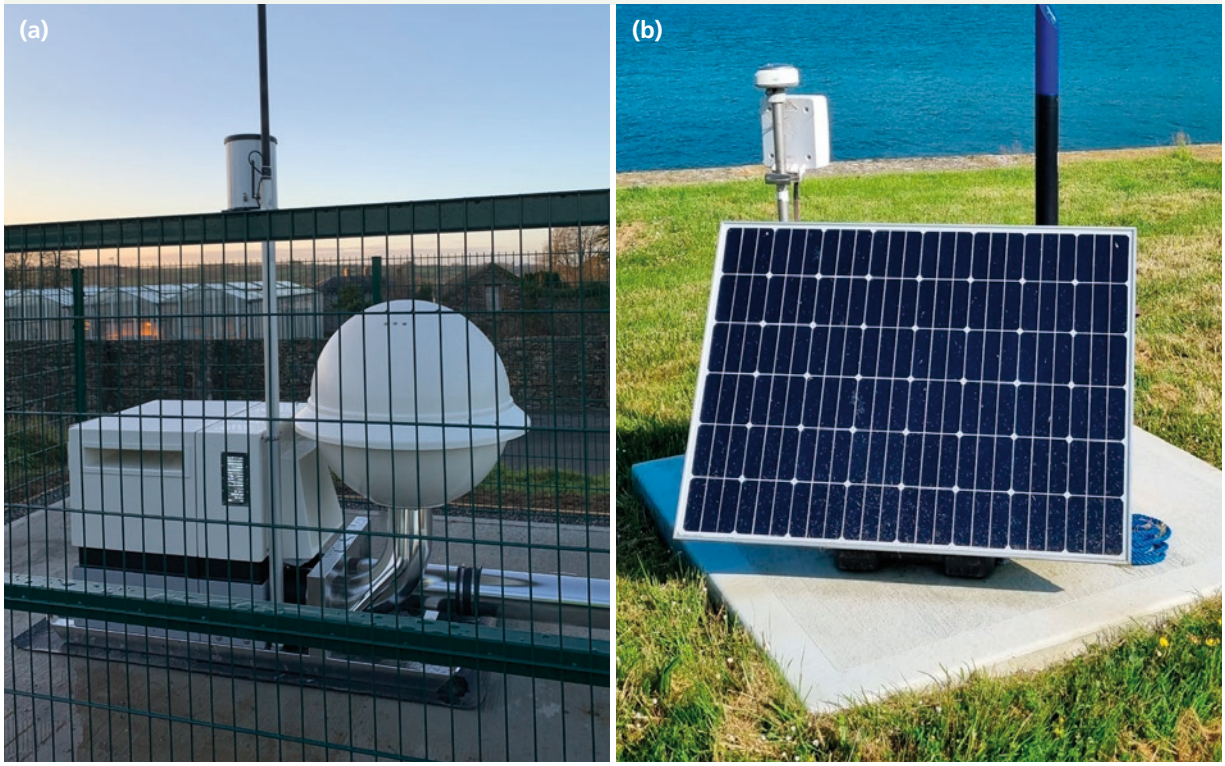
Strengthening of passive prevention measures for radon in new builds is a priority focus of the government's National Radon Control Strategy (2019–2024).[9] Updated building guidance from the DHLGH published in 2023 references the new radon risk map and restates the requirements for all new buildings to be fitted with a standby radon sump and for all new buildings in areas with high radon levels to have a radon membrane installed (Technical Guidance Document C). All employers with workplaces in areas with high radon levels are required to test them for radon and must remediate where necessary. Recognising that primary prevention in new builds is the most effective way of protecting the population against radon, strengthening radon prevention measures in new builds nationwide irrespective of radon risk must be a critical element of national action to protect citizens from this modifiable cancer risk.

Protection against radon in older buildings and homes is an area requiring specific focus. The Programme for Government set an ambitious target of retrofitting 500,000 homes by 2030. While the target of 500,000 retrofits moves Ireland in the right direction in its ambitions to become a sustainable, low-carbon and energy-efficient economy, research has highlighted the potential for radon levels to increase or decrease following a home retrofit, depending on the ventilation strategy employed during the retrofit, with increases linked to insufficient ventilation post retrofit (McGrath *et al*., 2021).

It is critical that ambitions under the national retrofit programme are used as an opportunity to reduce the levels of radon in our existing building stock and that sufficient measures, such as a post-retrofit radon measurement, are used to ensure that levels of radon are below the national reference level. The EPA strongly recommends that all existing households test their homes for radon and take action if the levels are high.

9 www.epa.ie/publications/monitoring--assessment/radon/The-National-Radon-Control-Strategy-Phase-2.pdf (access 26 September 2024).

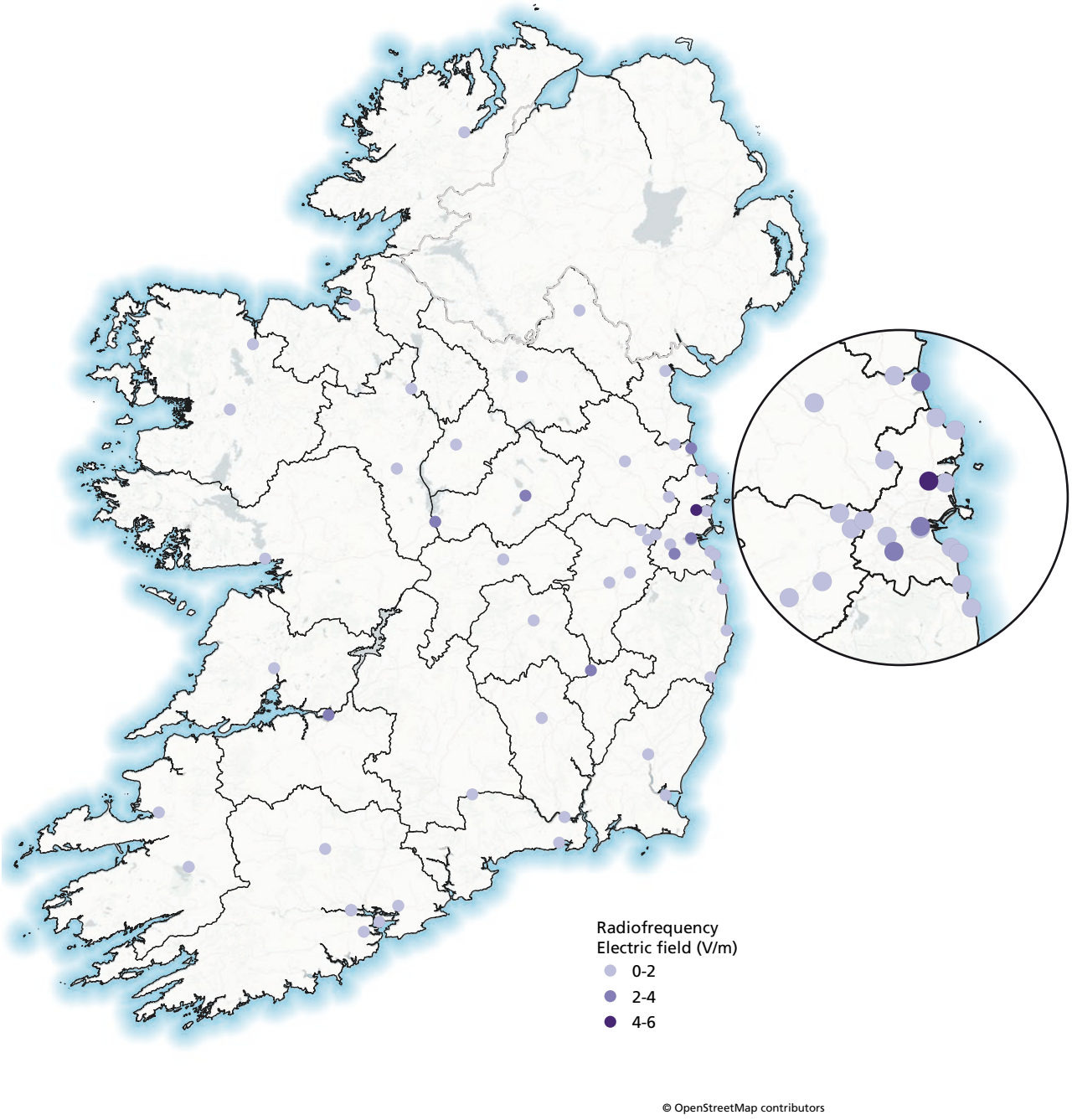
Figure 14.10 (a) A high-volume air sampler in the National Radiation Monitoring Network, and (b) a gamma spectroscopic measuring system in the upgraded National Radiation Monitoring Network



The EPA's National Radiation Monitoring Network constantly monitors radiation levels in air across Ireland. Between 2019 and 2023 the network was upgraded to bring the number of monitoring stations up to 26 (Figure 14.10). In the event of a nuclear emergency, data from the network will support decision-making on whether there is a need to implement public protective actions. Routine monitoring of levels of artificial radioactivity in air shows that the levels of artificial radionuclides are low and do not pose a significant risk to the health of the Irish population. The EPA also monitors samples of seawater, seaweed, sediment, fish and shellfish from fixed locations around the coast, in the Irish Sea and from fishing ports for radioactivity. While levels of artificial radioactivity in the Irish marine environment remain detectable, the environmental concentrations are lower than historical levels and do not have an impact on humans or the marine environment. The OSPAR Commission's Fifth Periodic Evaluation (OSPAR, 2023) concluded that Contracting Parties have made significant progress towards fulfilling the aim of ensuring that concentrations in the environment are near background values for naturally occurring radioactive substances and close to zero for artificial radioactive substances.

Electromagnetic fields. Electromagnetic fields (EMFs) are generated by many services that are expected in a modern society. EMFs are generated whenever electricity is produced, distributed or used and are used to transmit information via mobile phones, media broadcasts and Wi-Fi. The EPA monitored radio frequency EMFs from mobile phones, media broadcasts and Wi-Fi at street level in 55 urban sites during 2021 and 2022 (Figure 14.11) (EPA, 2023c). The typical level found was 1 V/m, which is substantially below the lowest reference level (28 V/m) recommended by the International Commission on Non-Ionizing Radiation Protection. According to WHO, no health effects have been identified for EMF exposure at levels below these guidelines set for members of the public. Further monitoring of EMF exposure from other technologies commenced in 2024.

Figure 14.11 Results from radio frequency electromagnetic field measurement in Ireland



Source: EPA, 2023c

Chemicals

Chemicals play a vital part in our daily lives. We are in contact with them all the time at home and at work. They are used to clean the water we drink, used in the production of the food we eat, form the clothing we wear and the electronics we use, and cure us from many illnesses, to name just a few vital uses. There has been a 50-fold increase in the production of chemicals since 1950, and the number is anticipated to triple again by 2050 (EEA, 2018). In 2021 over 90 million tonnes of chemicals posing risks to human health were produced and consumed in the EU.[10] Humanity is now deemed to have exceeded its safe operating space – or to be outside its planetary boundary – for novel chemical entities and pollution (Persson *et al*., 2022).

Some chemicals or products containing them may harm us when in use (e.g. through ingestion, inhalation or absorption through the skin), while others, if not managed properly, may be released into the environment and cause pollution. Some of these chemicals move freely in the environment (e.g. from air to water), travelling long distances from where they were first released, while others can accumulate in soils and potentially enter the food chain. Substances harmful to us or to our environment can be classified by the threats they pose; for example, some groups may cause cancer while others may be highly toxic to humans and other animals or plants. Chemical pollution can also have long-term and large-scale impacts on our environment, including degrading ecosystems, reducing biodiversity by causing declines in animal populations or diversity, and compromising the ecosystem services humans require for clean drinking water and food production. The transition towards safer and more sustainable chemicals and the control and phasing out of the most harmful chemicals is therefore critical for human and ecosystem health.

Persistent organic pollutants. Certain chemicals that are highly persistent in the environment, can bioaccumulate and are toxic to humans and wildlife have been classified as persistent organic pollutants (POPs). They can pose serious, prolonged risks to human health and the environment. Given the hazards they present, the Stockholm Convention on Persistent Organic Pollutants was adopted, which aims to protect human health and the environment by taking measures to eliminate or reduce the release of listed POPs into the environment. Under the Convention, there are bans on the production and use of certain POPs. The POPs controlled under the Convention fall into three broad groups:

1. pesticides, such as dichlorodiphenyltrichloroethane (DTT) and pentachlorobenzene
2. unintentionally produced POPs, such as dioxins and furans, which can be produced from backyard burning and accidental fires
3. industrial POPs, such as specific chemicals containing bromine, fluorine or chlorine, including three specific PFAS (perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA) and perfluorohexanesulfonic acid (PFHxS)).

Ireland's last national implementation plan under the Stockholm Convention, which outlines measures taken to eliminate or reduce the release of POPs into the environment from intentional production, was published in 2018 (EPA, 2018). A revised plan is due to be published in 2024.

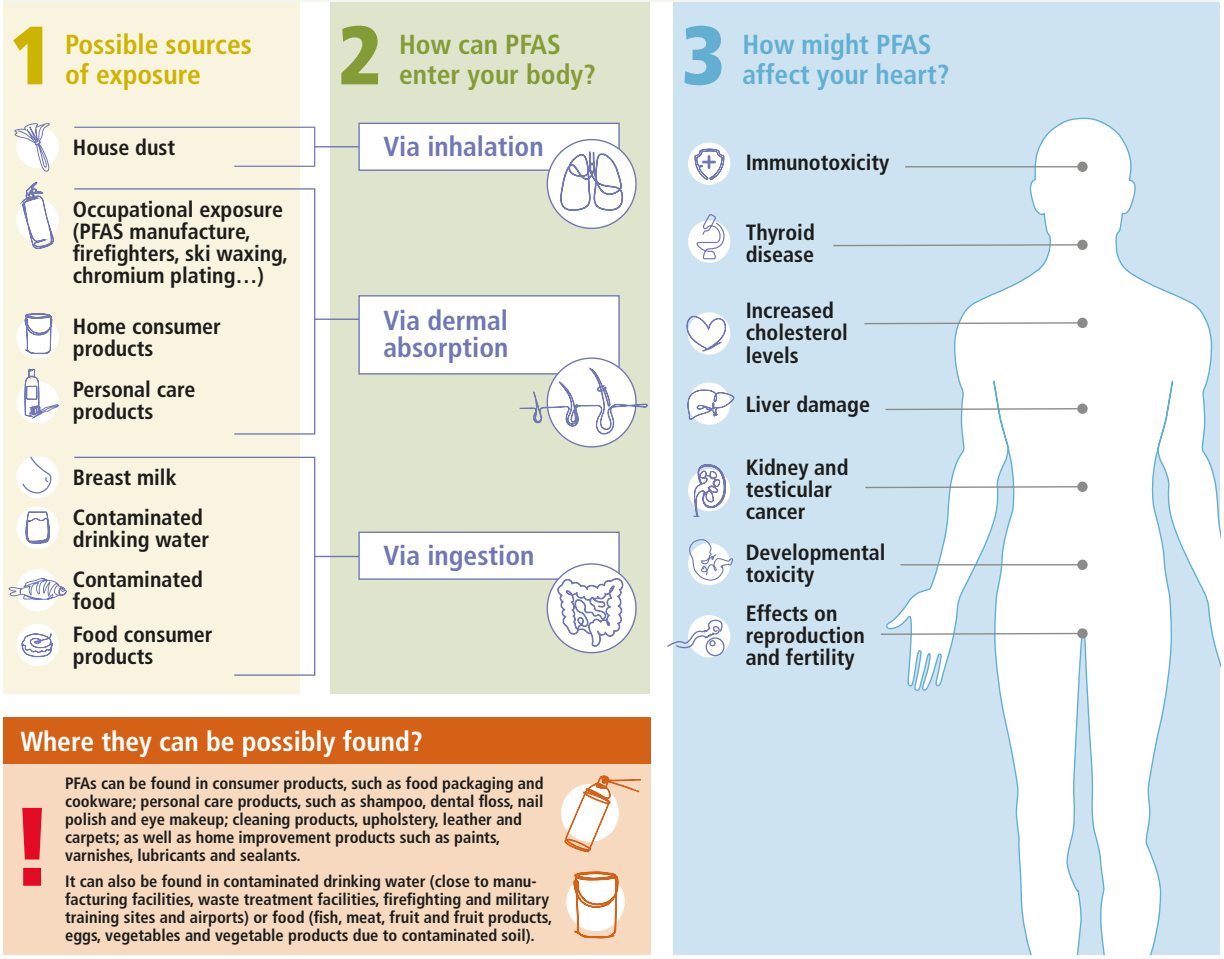
Per- and polyfluoroalkyl substances. PFAS (commonly known as 'forever chemicals') have attracted much attention on European and international stages in recent years. PFAS are part of a very large group of chemicals that are temperature and chemical resistant, are capable of imparting water and oil repellence and have surfactant properties. These chemical and physical properties have seen the widespread and ubiquitous use of PFAS in a range of consumer products and industrial processes over many years, such as in clothing, non-stick cookware, firefighting foams and food packaging.

10 ec.europa.eu/eurostat/statistics-explained/index.php?title=Chemicals_production_and_consumption_statistics (accessed 16 July 2024).

Many PFAS are toxic to humans and animals, with available epidemiological studies suggesting associations between PFAS and several health effects including cancer, immune system disruptions, increases in cholesterol, pregnancy complications and lower birth weights (ATSDR, 2021), with the risk of health effects dependent on many factors including exposure dose, frequency, route and duration, as well as individual and other factors. People may be exposed to PFAS through various routes (Figure 14.12). The European Food Safety Authority (EFSA) has recommended a maximum weekly intake of 4.4 ng/kg body weight[11] for a total of four selected PFAS, which is based on scientific opinion on the risks to human health arising from the presence of these substances in food. The EU Drinking Water Directive also sets limits for total amounts of PFAS allowed in water for human consumption.

PFAS were detected in the blood of all teenage study participants sampled under an EU human biomonitoring programme, with over 14% of samples exceeding the current EFSA guideline value.[12] While levels of two of the most prevalent and regulated PFAS, PFOA and PFOS, were found to be decreasing, levels of replacement PFAS were detected, highlighting the urgent need to avoid regrettable substitutions of hazardous chemicals such as PFAS.

Figure 14.12 Exposure sources, pathways and health effects associated with per- and polyfluoroalkyl substances



Source: HBM4EU, 2022

11 1 ng = 0.000000001 gram.

12 Study conducted under the European Human Biomonitoring for European Union project (HBM4EU).

The issue of PFAS is also one of national concern, with PFAS detected in the Irish environment, including in surface waters, groundwaters, transitional and coastal water bodies, sediments and certain biota. The EPA report *Water Quality in Ireland 2016–2021* indicated that 2.7% of surface waters failed to achieve good chemical status due to the presence of PFOS (EPA, 2022), a PFAS that has been restricted under the Stockholm Convention since 2009/2010. The EPA-funded FUEL project investigated the risks posed by PFAS in Irish landfills and highlighted a potential risk of PFAS contamination of groundwater sources from unlined or partially lined landfills, as well as waste water treatment facilities receiving landfill leachate (Harrad *et al*., 2020a).

Environmental monitoring performed at a number of sites at risk of PFAS contamination because of their close proximity to firefighting training facilities, large scale storage facilities and waste water treatment facilities, particularly those receiving landfill leachate, found elevated levels of PFAS in many instances (EPA, 2021a). A national human biomonitoring study examined the Irish population's exposure to PFAS through non-dietary sources, which was found to fall below the EFSA's tolerable weekly intake (Harrad *et al*., 2020b). Concentrations of PFAS found in Irish breastmilk did not indicate a health concern for nursing infants based on EFSA breastfeeding exposure scenarios. However, pharmacokinetic modelling of the level of adult exposure to PFAS that would result in the levels observed in breastmilk suggests that overall exposure of some individuals may approach or exceed EFSA's tolerable weekly intake, pointing to the need for an assessment of dietary exposure to PFAS in Ireland. This study highlights the power of human biomonitoring studies as valuable surveillance tools that can provide useful baseline data around population exposure to PFAS. Regular re-assessment should be performed nationally to facilitate ongoing monitoring and evaluation of the impact of measures taken to reduce human exposure to PFAS and other such chemicals. Many European countries have well-established human biomonitoring programmes in place as a tool for chemical risk assessment. While some human biomonitoring work has been undertaken in Ireland, consideration should be given to establishing a more formalised ongoing monitoring programme. An EPA-funded research project is currently conducting a feasibility study to determine the prospect of having an ongoing national human biomonitoring programme in Ireland.

While action is being taken at both EU and global levels to combat the harmful effects of PFAS, given the nature of the issue, progress is slow. The EU Chemicals Strategy for Sustainability (CSS) aims to phase out PFASs, allowing use only when they are essential for society. In 2024 the European Commission published guiding criteria and principles for the essential use concept in EU legislation dealing with chemicals to facilitate decision-making and increase regulatory efficiency to achieve the phasing out of harmful substances in non-essential uses (EC, 2024). While there are currently three groups of PFAS restricted under the Stockholm Convention, under the REACH Regulation[13] there are two proposed broad restrictions on the use of PFAS that point to a new way of tackling groups of chemicals rather than one at a time, that is, a generic risk assessment. The first proposal would see the use of PFAS in firefighting foams, the use of which has been a major source of pollution, particularly water contamination, prohibited completely. The other, more universal, proposed restriction on PFAS would strictly limit their use to applications where it is essential to society and where no alternative safer chemicals are available to fulfil the specific role. The European Chemicals Agency (ECHA) received 5600 comments from over 4400 organisations on the PFAS restriction proposal consultation in 2023. ECHA scientific committees will evaluate the proposed restrictions, along with comments from the consultation, throughout 2024.

A key task across Europe at present is to replace stockpiles of PFOA used in firefighting foams with safer alternatives and ensure that existing stockpiles of PFOA foams are managed in an environmentally sound manner. The EPA holds a register related to stockpiles of PFOA, a PFAS that was banned under the Stockholm Convention in 2019 but remains in a phase-out period (until July 2025) for certain uses. Those with stocks of PFOA must notify the EPA and provide details on the nature/use and storage conditions and confirmation of correct disposal. To date a total of approximately 498,000 kg of PFOA firefighting foam has been notified to the EPA via the online PFOA stockpile reporting system. Approximately 30% of this is reported as being still in use per the specific exemption. The remainder is reported as being in storage on site/awaiting disposal or as having been disposed of already. The EPA is working on checking and verification of this stockpile register. As part of this work, the EPA encourages various organisations and networks (e.g. industry trade associations, fire industry associations, local authority representatives) to raise awareness of the obligations and deadlines concerning stocks of PFOA.

13 The REACH Regulation ((EC) No. 1907/2006) is comprehensive legislation that aims to improve the protection of human health and the environment from the risks that can be posed by chemicals, while also enhancing the competitiveness of the EU chemicals industry. It also promotes alternative methods for the hazard assessment of substances to reduce the number of tests on animals. REACH has a very wide scope, as it applies to all chemical substances that are manufactured, imported, placed on the market or used within the EU, either on their own, in mixtures or in articles with intended release. Under the Chemicals Acts 2008 and 2010, the Health and Safety Authority is the lead competent and enforcement authority for REACH in Ireland.

European controls on chemicals. The EU has one of the most comprehensive chemical regulatory frameworks globally. The aim of chemical regulation at the EU level is to minimise the risks posed by the most harmful chemicals considered necessary, for example through reduction in human exposure and release to the environment, while striving to replace other harmful substances, thought to be non-essential.

EU Chemicals Strategy for Sustainability: Towards a Toxic-Free Environment. The European Green Deal is the overarching plan to transform the EU into a carbon-neutral and environmentally sustainable economy over the coming years. The Green Deal is supported by ambitious programmes such as the Zero Pollution Action Plan, the Circular Economy Action Plan and the Chemicals Strategy for Sustainability (CSS). Published in October 2020, the CSS supports the Green Deal initiative by aiming to better protect people and the environment from the harmful effects of chemicals. The strategy proposes actions needed to respond quickly and effectively to the challenges posed by harmful substances, with the aim that chemicals are produced and used in such a way that maximises their benefits to society while avoiding harm to humans and the environment. The strategy also seeks to boost innovation through the development and use of safer and more sustainable chemicals. In this regard, one of the key actions in the CSS, which has the potential to yield the greatest and longest-term effects is the 'safe and sustainable by design' approach. This approach emphasises the need for new chemicals and materials to be designed to be both safe and sustainable (for humans and the environment) not only at their design stage but also during their production and use and finally when they end up as waste.

As an action under the CSS, the EEA and ECHA have developed an indicator framework and online dashboard[14] that aim to monitor the drivers and impacts of chemical pollution and measure the effectiveness of chemicals legislation using a set of 25 quantitative indicators complemented by 22 signals providing additional insights (EEA, 2024). The first benchmarking assessment using the indicator framework has highlighted that the use of harmful chemicals is still growing but more slowly than the chemicals market overall. Moreover, the transition towards safer and more sustainable chemicals needs to be accelerated.

Market surveillance. Legislation covering restrictions and limits on certain hazardous substances in products (e.g. electrical equipment) is aimed at decreasing the general levels of hazardous chemicals in consumer products, thus reducing the risks posed by chemicals to consumers and the environment. This work also aims to improve recyclability, thereby supporting circular economy ambitions. Overall, market surveillance is important to maintain the proper functioning of the EU internal market by ensuring a high level of protection for consumers and their interests, including the environment. Market surveillance is carried out by public authorities to ensure that products on the market conform to applicable laws and regulations and to health and safety requirements.

14 www.eea.europa.eu/en/european-zero-pollution-dashboards/chemicals-strategy-for-sustainability (accessed 16 July 2024).

Other chemical contaminants. Other chemical contaminants of concern are as follows.

Pesticides. The widespread and excessive use of pesticides poses a considerable risk to soil health and water quality and is a significant contributor to biodiversity loss, particularly the reduction in insect populations that play a crucial role in ecosystems. Recent research on human exposure to pesticides across five European countries identified at least 46 pesticides and their metabolites in the urine of study participants, with at least two pesticides being detected in 84% of human samples analysed (Ottenbros *et al.*, 2023). In Ireland, 17 water supplies failed to meet the EU pesticide standard in 2022, a decrease from the 31 and 33 supplies that failed in 2021 and 2020, respectively.

The herbicide MCPA (2-methyl-4-chlorophenoxyacetic acid), which is commonly used in Ireland to control rushes, continues to be the most common source of the exceedances. There were four supplies on the Remedial Action List for pesticides at the end of 2022, down from six in 2021. All supplies on the Remedial Action List have catchment focus groups in place.

Phthalates. These are chemicals used in products including plastics, food packaging, rubber tubing, and some cosmetics and personal care products. Some phthalates interfere with the hormone system, sometimes slowing the neurological development of children. Phthalates are regulated under REACH and EU food contact material legislation. People can be exposed to phthalates by using products containing them and by consuming contaminated food. EPA studies have found phthalates in waste plastic in effluent from waste water treatment plants and from leachate from landfills (Allen *et al.*, 2021) as well as in rivers. Furthermore, some phthalates can build up in soils and end up in crops.

Microplastics. Growing levels of plastic production, use and disposal is exacerbating the already pervasive issue of plastic pollution seen in our environment. Many plastics do not biodegrade but instead break down over time, creating smaller fragments known as microplastics and nanoplastics (MNP). These small pieces of plastic are now found in the air we breathe and the food and drinking water we consume as well as in surrounding ecosystems. The health risks associated with exposure to MNP are beginning to be understood, with studies describing potential links with cardiovascular disease (Marfella *et al.*, 2024) and inflammatory bowel disease (Yan *et al.*, 2022). MNP are generally found in the environment as complex mixtures of chemicals: those that had been added during the manufacturing process and those adsorbed from the environment. Some of the common chemicals found in plastics such as phthalates, bisphenol A, flame retardants and POPs may leach out following ingestion (OECD, 2021). While concentrations of microplastic-associated chemicals may not currently represent a major exposure pathway relative to existing known exposure pathways, the known and suspected health effects (including endocrine disruption, carcinogenic and developmental toxicity and mutagenicity) warrant precautionary action. Under the EU REACH Regulation, the Commission has adopted measures to restrict intentionally added microplastics in many common products. Further proposals to reduce microplastic pollution are also in progress in as part of the Commission's ambitious target for the EU to reduce microplastic releases into the environment by 30% by 2030.

Hazardous waste. Appropriate hazardous waste management is fundamental to preventing human exposure to hazardous substances. Ireland generated 389,908 tonnes of hazardous waste in 2022. The management of these wastes is informed by the National Hazardous Waste Management Plan 2021–2027. The EPA has highlighted the need for a national take-back scheme for unused and expired human

medicines (EPA, 2020f). The Department of Health is currently developing a policy paper to inform the development of such a scheme, with the establishment of a national scheme planned by 2025. A nationwide scheme for the collection and transfer of farm hazardous wastes, including unused veterinary products and pesticides, is also being progressed by the Department of Agriculture, Food and the Marine (EPA, 2024f). While progress is being made, these take-back schemes have been delayed and progress towards their delivery is needed. There is a considerable focus at the EU level on improving the collection infrastructure for householders, with Member States required to establish the separate collection of hazardous waste generated by households by 1 January 2025.

Landspreading. The application of organic agricultural wastes such as animal manure and slurry to agricultural land is a widespread practice in Ireland and elsewhere. Organic wastes from urban waste water treatment facilities, domestic septic tanks and industrial sources such as food processing and brewing provide materials that, due to their high nutrient and organic matter content, are used as a fertiliser or soil improver on agricultural land. The recycling of these materials to land can offer an economically favourable means of contributing to the circularity of the waste streams. Organic wastes can, however, contain a range of contaminants including pathogens, metals, chemicals such as pesticides and medicinal residues, and microplastics. Sewage sludge in particular acts as a sink for persistent contaminants emanating from waste water, with levels of these contaminants determined by the influent received by the treatment facility from the surrounding catchment (EEA, 2021b). The adoption of the EU Sewage Sludge Directive (86/278/EEC) almost 40 years ago came about due to concerns over environmental and human health impacts from the application of sewage sludge on land. However, the requirements of this directive no longer match current needs in the context of current and emerging chemicals and contaminants of concern (EC, 2023). There is potential for these contaminants to enter the food chain, affecting human and animal health and also soil health and water quality. With multiple applications over many years, a build-up of contaminants may occur as well as changes in soil microbial communities, the latter of which may contribute to the evolution of AMR in the environment, thereby posing a further risk. Effective management and treatment practices and robust regulation are therefore essential to minimise risks to animal and human health.

The Food Safety Authority of Ireland published a report in 2008 on the food safety implications of organic agricultural wastes spread on land used for food production in Ireland (FSAI, 2008). A re-examination of recommendations from this 2008 report was performed in 2023, with many remaining relevant and, importantly, still requiring action.

Some EU Member States have gone beyond the Sewage Sludge Directive requirements and introduced limits for organic pollutants not restricted by the directive (EEA, 2021b). Additional limits were also introduced in Ireland. Some Member States have also restricted the use of sewage sludge in agriculture, allowing its use instead in nutrient and energy recovery (EEA, 2021b). There is the potential for the volume of sewage sludge to increase significantly as a result of improvements in treatment and increases in the urban population (e.g. waste water sludge generated nationally will increase by more than 80% by 2040 as new and upgraded waste water treatment facilities are established). A national assessment of sewage sludge in the agricultural setting is needed to gather evidence to inform Ireland's management and tracking systems for these materials in the future.

4. Climate change and health

The climate crisis is a human health crisis. It represents the single greatest health threat facing humanity and is also a 'threat multiplier' compounding and exacerbating many significant environmental and health challenges. For example, climate change is fuelling an increase in the incidence and severity of many infectious diseases. A recent global systematic study examining the interactions of climatic hazards linked to human pathogenic diseases found that 58% of 375 diseases examined have been aggravated by climate change (Mora *et al.*, 2022). In Ireland, flood hydrometeorology was shown to be associated with the incidence of gastroenteric infections caused by STEC/VTEC and *Cryptosporidium* spp. following the winter of 2015/2016, in which exceptional and widespread flooding was experienced (Boudou *et al.*, 2021). Ireland's warmer winters now also have the potential to increase the numbers and activity of ticks and to extend their lifespan. Ticks are efficient vectors that host and can transmit an increasing number of pathogens to humans, including Lyme disease (Lambert, 2022). At a European level, the ECDC has reported a large increase in the geographical spread of a species of mosquito across previously unaffected areas (ECDC, 2023). The mosquito, which is a known vector for many diseases including dengue fever and yellow fever has now established itself in 13 EU and EEA countries compared with only eight countries 10 years ago.

Climate change, combined with other challenges, such as population growth, urbanisation and globalisation, is narrowing the interface between humans and the natural world, bringing zoonotic diseases physically closer to us. We now live in an increasingly interconnected world, with over half the world's population residing in urban areas and billions of us taking airline flights every year, making us increasingly vulnerable to the threat posed by infectious diseases (Baker *et al.*, 2022). Continual degradation of our environment, coupled with climate change, increases the risk of emergence of disease from zoonotic reservoirs; the probability of us experiencing another extreme epidemic or pandemic similar to COVID-19 in our lifetime is currently estimated at 38%, which may double in years to come (Marani *et al.*, 2021).

High water levels at St Vincent's Bridge, Cork City

At a national level, we need to place human health and wellbeing at the forefront of our climate preparedness and action. We need to prioritise and fast-track the implementation of ambitious climate adaptation and mitigation measures that can deliver health co-benefits, particularly to those vulnerable populations most affected by climate change. Modelling has indicated the potential health gains that can be accrued from health-focused mitigation actions tackling emissions while simultaneously taking action on air pollution, active travel and diets (Hamilton *et al.*, 2021). There is a wealth of evidence on climate actions that can deliver health co-benefits. What is now required is a step change in the translation and implementation of practical actions at national and local levels to effect impactful and measurable change. COP28 (United Nations Climate Change Conference) in 2023 was the first to dedicate a day to focusing on health. We need to follow this global ambition and put health at the forefront of our national climate discussions and policies to safeguard current and future generations.

5. One Health approach

The ever-changing nature of our environment, as well as the many anthropogenic stressors placed on it, means that collaborative and cooperative action across the human–animal–environment nexus is needed to address the health challenges facing us. The One Health concept recognises that human, animal and environmental health are interlinked and interdependent, and it has become an important approach to global health. Collaboration between multiple disciplines and sectors is crucial to the success of the One Health approach.

Common One Health issues include zoonotic and vector-borne diseases, food safety, AMR and environmental pollution (e.g. air, water and chemical pollution). From a global standpoint, these areas already pose a considerable threat to health; however, a number of stressors are playing a substantial role in causing or exacerbating these issues. Land use change is causing habitat shrinkage or fragmentation, narrowing the interface between humans and the natural world, thereby increasing the likelihood of infectious agents jumping the species barrier – from wild animals to domestic animals and people. Biodiversity loss means that we are losing the essential buffer and critical dilution effect that can help shield us from harmful pathogens and disease transmission. In addition, climate change is changing the distribution of arthropod vectors of infectious diseases (such as mosquitos and ticks) and changing the frequency and the pattern of other food-borne and waterborne diseases. It has been estimated that there may be up to 700,000 viruses in mammals and birds that could be transmitted to humans (UNEP, 2021b).

The environment is a critical component of the One Health paradigm and functions as both a key reservoir of and a pathway for the transmission of harmful agents that can impact the health of humans and animals (Figure 14.13).

There is emerging international evidence for the economic benefit of using a One Health approach. The World Bank (World Bank, 2022) estimated the global cost of prevention using a One Health approach[15] to be US$10.3–11.5 billion per year, compared with the global cost for preparedness (monitoring and detecting disease spill-over) of US$30.1 billion per year. While the environment is a core part of the One Health triad, environmental considerations are often poorly represented, if not completely overlooked, which runs counter to the principles of a true One Health approach. The role of the environment, not only as a reservoir and pathway of harmful agents but also as a key determinant of human health and wellbeing, is evident when we look at the negative impacts of an unhealthy environment on people.

The quadripartite organisations – the Food and Agriculture Organization of the United Nations, the United Nations Environment Programme, the World Organisation for Animal Health and the WHO – launched a One Health Joint Plan of Action (2022–2026) as a framework for action to advance and sustainably scale up One Health. One of the six key interdependent actions included is 'integrating the environment into One Health'. The quadripartite group has also launched a guide that provides practical guidance for countries on how to adopt and adapt the One Health Joint Plan of Action at a national level. There is also an ambition as part of the Eighth Environment Action Programme that there is to be full integration of One Health approaches across all levels of policymaking (Decision (EU) 2022/591).

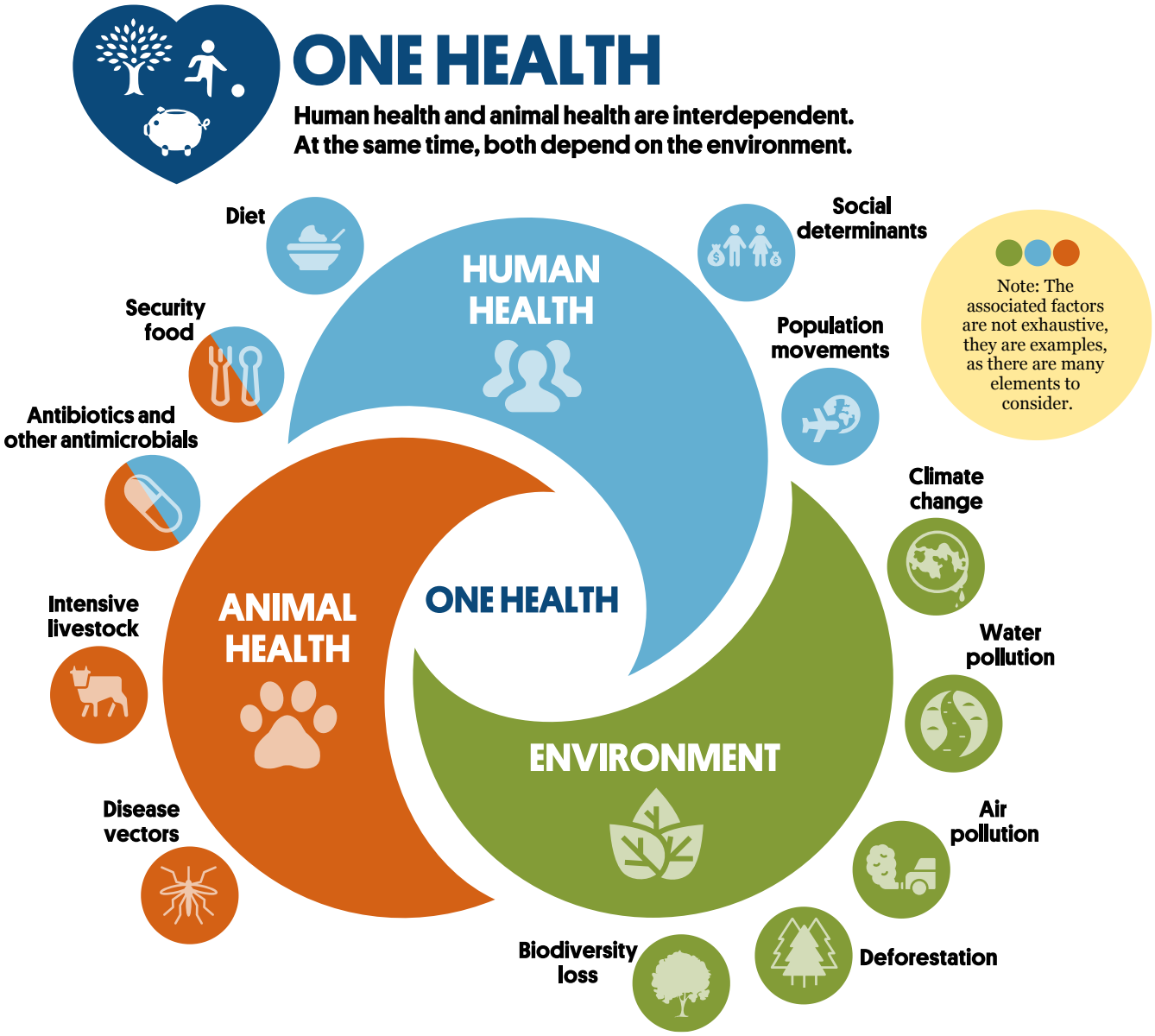
At the European level, five EU agencies – ECDC, ECHA, EEA, EFSA and the European Medicines Agency – have expressed their joint commitment to fully support the One Health agenda in Europe and have established a cross-agency task force to build stronger transdisciplinary cooperation among them.[16] In a joint statement issued in 2023 (EEA, 2023f), the five EU agencies outline that a One Health approach is necessary to address the multiple challenges faced by the EU across areas of human, animal and plant health, food safety, environmental sustainability and the climate crisis. They also outlined a commitment to ensure that relevant scientific advice from EU agencies is increasingly integrated and aligned with the One Health approach.

Ireland is also developing a more unified and holistic national approach to One Health with the recent establishment of a cross-government One Health Oversight Committee. It will be crucial that the work and activities of this committee ensure strong alignment with, and inclusion of, environmental considerations and actions, particularly in the context of our changing climate.

15 Prevention measures address drivers of emerging disease such as by improving farm biosecurity, strengthening animal health veterinary services, reducing deforestation and forest degradation, improving conservation and improving urban planning.

16 www.eea.europa.eu/en/topics/at-a-glance/health/cross-agency-knowledge-for-one-health-action-statement (accessed 16 July 2024).

Figure 14.13 Contributors to and dynamics within the One Health paradigm



Source: Adapted from ISGlobal, 2021

6. Conclusions

Our environment plays a crucial role as a determinant of our health. A good-quality environment providing clean air, clean water and productive soils will provide positive benefits for human and animal health. Conversely, a poor environment will negatively impact human and animal health. Reducing pollution, adapting to and mitigating climate impacts, and restoring ecosystems can have enormous benefits for our health and wellbeing. Healthier populations are also more resilient to climate impacts such as heatwaves.

The impact of environmental hazards and exposure is not equal across society, with vulnerable population groups, such as young and elderly people and those in disadvantaged communities, often being affected to a much greater extent than others. Efforts to assess and understand inequalities in exposure and in impact at a finer geographical scale in Ireland should be prioritised to allow us to assess how the inequality gap is changing over time.

Improving environmental quality can create healthier places for all members of society, regardless of age, socio-economic status and region. Health-centred spatial planning is also vital to enhance environmental quality and create connected and accessible spaces for people across all life stages. Healthy urban places can enable citizens to make more sustainable choices, live healthier lives and reduce hazardous environmental exposures they may be subject to.

While applied research and the continued collection and analysis of data are required to gain new knowledge and evidence, we already have enough knowledge and evidence in certain domains to allow us to take action against some of the most preventable environmental risks. We must prioritise and tackle those environmental hazards that we know are detrimentally affecting our health. For example, to better safeguard the public from exposure to the carcinogenic radioactive gas radon, which is causing approximately 350 new cases of lung cancer each year, we must shift our focus towards primary prevention measures in all new buildings in all parts of the country, irrespective of their radon risk designation. We are also acutely aware of the direct impacts of poor air quality on morbidity and mortality. We must plan for and take more immediate action in the short to medium term to accelerate achieving the WHO guideline limits included in the Clean Air Strategy. Further targeted policy measures will be required to ensure that improvements in air quality benefit those who are most exposed and/or most vulnerable to its effects. Similarly, a national noise policy statement and noise planning guidance are needed now more than ever to tackle the human health impacts of noise pollution. We have been aware of issues related to water quality for many years, particularly with regard to private drinking water supplies, which consistently underperform in quality compared with public supplies. Similarly, failure to fix faulty septic tanks is causing unnecessary risks to human health and the environment. Our changing climate will further compound already significant risks to human health, including those posed by infectious diseases. The persistence of many of these well-recognised issues and lack of meaningful progress on many indicates that our current approach to tackling these issues is not having the desired effect and points to a need to re-examine and step up our approach to many.

The right choice for society needs to be the easy choice. However, what might work for one sector of society may not work for another, meaning that we need to expand and tailor a suite of supportive interventions in policy areas, paying particular attention to those more vulnerable members of society for whom environmental inequalities are most evident. Enhancing the coherence between policies on population health, climate change and environmental quality, and recognising that multiple policy areas, from welfare to urban design, can help to reduce vulnerability and exposure to environmental health hazards, will be key. The Healthy Ireland Outcomes Framework, along with the WBF for Ireland, provide important national information by which progress in reducing inequalities in environmental exposure can be monitored. This work could be strengthened further by recognising the health implications of relevant environmental policies and implementing monitoring and evaluation of associated health outcomes and impacts on an ongoing basis.

Practices and choices in society are often driven by emerging areas of policy. It is essential that policy across all domains carefully considers measures in the context of our environment, our health and wellbeing, and health equity to ensure that there are synergistic outcomes and to avoid unintended consequences. For example, national retrofitting targets hope to bring us closer to becoming a sustainable, low-carbon and energy-efficient economy and society by retrofitting a substantial portion of our current building stock by 2030. In aiming to make our housing stock warmer and more comfortable while reducing energy demand and emissions, we must also ensure that ventilation is carefully considered to avoid any increase in concentrations of indoor pollutants and hazards, particularly radon gas.

As recognised at the beginning of the chapter, primary prevention is key if we want to see a reduction in the levels of disease and early death from harmful environmental exposures in our population. We know the issues and we know that they are modifiable, so it is now time to tackle them in a meaningful way to effect change. Addressing these risks means that people can be healthier and live longer. Creating healthy places free from environmental hazards is key to creating a healthier and fairer society in which everyone can thrive.

Key chapter messages

1. Our health and wellbeing is inextricably linked to our surrounding environment. The health benefits of a vibrant natural world are countless, providing us with breathable air, drinkable water, productive soils and spaces for us to spend time in and enjoy, enhancing both our physical and mental health and wellbeing. Reducing pollution, adapting to and mitigating climate impacts, and restoring ecosystems can have enormous benefits for our health and wellbeing. Solutions that can help tackle one issue can have multiple co-benefits for others. Implementation of solutions that can maximise benefits across multiple domains should be prioritised.

2. The harmful environmental exposures causing disease and early death are modifiable. People are healthier and live longer when we address issues such as air and water pollution, radon exposure, chemical exposure and greenhouse gas emissions.

3. The impacts of environmental hazards and exposures are not equal across society. More efforts are required to assess inequalities in both levels of exposure and impact at a finer geographical scale to determine whether measures implemented are helping to bridge the gap.

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