Chapter 14

Environment, Health and Wellbeing

Environment, Health and Wellbeing

1. Introduction

Our health and wellbeing are inextricably linked to our surrounding environment. In helping to prevent damage to our environment, we are, in turn, protecting our own health. Understanding the interconnections between environmental opportunities, threats and human health and wellbeing is vital and fundamental to developing good environmental and public health policy. The European Environment Agency recently published a comprehensive assessment of how the environment influences health and wellbeing in Europe (EEA, 2020a). It reports that 13 per cent of all deaths in the EU were attributable to the environment, and observe that the most vulnerable people in society are hardest hit by environmental stressors. While government policy can achieve aspects of environmental safeguarding and protection, active engagement and participation by Irish citizens is essential if real and meaningful change is to be made.

This chapter opens by reviewing our relationship with our environment. It then looks at specific health risk areas and emerging issues.

2. Health Benefits of our Natural Environment

Getting outdoors and using our 'green' and 'blue' spaces can offer a multitude of health benefits. These range from increasing our levels of wellbeing and physical activity to reducing stress, improving mental health and using these spaces for community interaction and enhanced social cohesion.

Ireland has an abundance of 'green spaces' – parks, forests, communal gardens and meadows – and 'blue spaces' – rivers, lakes, canals and coastlines. There is an ever-growing body of evidence showing that engagement and contact with the surrounding natural environment is associated with measurable improvements in the health and wellbeing of the population (Lovell *et al.*, 2018). Exposure to green spaces has been shown to have a positive influence on a range of health outcomes. These include a reduced prevalence of type II diabetes and stroke; reduced risk of cardiovascular disease and death; improved pregnancy outcomes including reduced risk of low-birth-weight babies; and lower levels of depression and depressive symptoms (Braubach *et al.*, 2017; Sarkar *et al.*, 2018; Twohig-Bennett and Jones, 2018). Similarly, exposure to blue spaces has demonstrated benefits for mental health and wellbeing and for levels of physical health (Gascon *et al.*, 2017). Research commissioned by the Environmental Protection Agency (EPA) in partnership with the Health Service Executive (HSE) and undertaken by the Economic and Social Research Institute and University College Dublin (UCD) confirms that a health dividend flows from engaging with our native landscape, our parks and our surface waters – our green and blue spaces (Dempsey *et al.*, 2018a; Grilli *et al.*, 2020; Scott *et al.*, 2020).

Topic Box 14.1 Environment, Health and Wellbeing – EPA Research Programme 2014-2020

Since 2016, the EPA has funded 80 or so new projects relevant to the Environment, Health and Wellbeing area: a commitment of €10.6 million. These projects were funded mostly under the Sustainability (Health and Wellbeing), Water (Safe Water) and Climate Pillars of the EPA Research Programme 2014-2020.

Examples of EPA-funded projects include research on:

- residential solid fuel use
- the impact of nitrogen dioxide on health with particular emphasis on vulnerable groups
- antimicrobial resistance and the environment
- noise and health: evidence from Ireland
- evaluating the health benefits derived from green and blue spaces
- sources, pathways and environmental fate of microplastics
- potential sources and environmental fates of certain phthalates and
- elucidating levels and pathways of human exposure in Ireland to POP-BFRs (brominated flame retardants restricted under the Stockholm Convention on persistent organic pollutants and PFOS (Perfluorooctane sulfonic acid).

More information is available at http://www.epa.ie/researchandeducation/research/

EPA research reports related to environment, health and wellbeing are available at http://www.epa.ie/pubs/reports/research/health/

Childhood exposure to the natural environment has positive effects on physical, cognitive and social development (Strife and Downey, 2009). In addition, evidence is now highlighting the significant lifetime benefits for health and wellbeing that childhood exposure to nature offers. A recent nationwide study from Denmark involving over 900,000 people demonstrated that children who grew up in the presence of high levels of green space had a much lower risk of developing mental health problems in adulthood than those who lived with the lowest levels of green space (Engemann *et al.*, 2019).

The mental health and wellbeing benefits of engaging with green and blue spaces are of particular importance given the increasing prevalence and burden of psychiatric disorders at both national and global levels. According to the most recent *Health at a Glance: Europe* report, which provides an analysis of the state of health of European Union (EU) citizens and of the performance of EU health systems, Ireland has one of the highest prevalences of mental health disorders in Europe (OECD and EU, 2018).

The Wider Benefits of Green Spaces for Individuals, Communities, Society and the Environment

The benefits of green spaces also go beyond those direct physical and mental health and wellbeing benefits that accrue.

Green infrastructure and vegetation such as trees and hedging reduce people's exposure to many environmental hazards and stressors brought about by the concentration of everyday human activity, the presence of artificial surfaces and the effects of climate change, particularly in urban areas. Specifically, green infrastructure and vegetation can help to reduce air pollution and, in some cases, improve air quality (Abhijith and Kumar, 2019), decrease temperatures associated with the urban heat island phenomenon and provide a cooling effect (Bowler *et al.*, 2010), and improve water quality and reduce flooding risk. Importantly, green spaces can provide quiet or tranquil places, protecting citizens against noise pollution from sources such as traffic, particularly in urban areas.

Our green and blue spaces also have social benefits, acting as hubs to strengthen community interaction and social cohesion and to reduce social exclusion. These social benefits can further enhance health and wellbeing. Spaces such as community gardens, allotments and urban parks can be particularly beneficial in this regard. Recent research from England found that people who spend more time outdoors in nature and those with a higher appreciation of nature were more likely to engage in a range of pro-environmental behaviours (Alcock *et al.*, 2020).

Topic Box 14.2 Preliminary Findings from the BlueHealth project – Irish Data Analysis

The BlueHealth project is an EU-funded Horizon 2020 research project investigating residential exposure to, and recreational contact with, 'blue' spaces (e.g. coasts, rivers and lakes) and a range of health and wellbeing outcomes.

This project explores the health-promoting potential of 'blue' spaces. Part of the project involves collecting data from representative samples of people in 18 countries, across four seasonal waves, about visits they made to blue spaces. In Ireland a total of 1059 people took part.

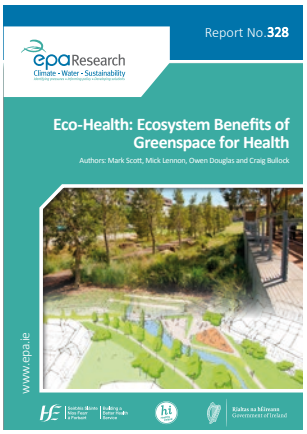
Preliminary analyses reveal that better general health appeared more prevalent in coastal areas, while psychological wellbeing (measured by the World Health Organization's WHO-5 wellbeing index) also appeared to be better in more coastal areas but not in greener areas. People who visited various types of blue space at least once a week were also more likely to have better health and psychological wellbeing. People who perceived 'a little' or 'a lot' of blue space within 10-15 minutes' walk from their home experienced better psychological wellbeing.

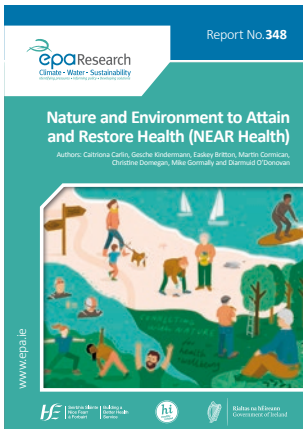
This research is ongoing and further valuable insights are expected. Find out more at: www.bluehealth2020.eu/projects/bluehealth-survey.

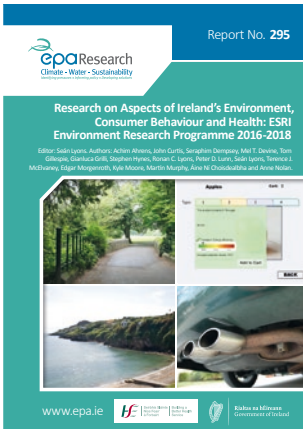
Providing health-promoting environments is therefore an essential requirement for healthy, thriving and inclusive communities. An investment in well-designed, good-quality and accessible green and blue spaces is an investment in public health; therefore, providing health-promoting environments in urban spatial planning should be viewed as a necessary and integral component. Under the government's National Planning Framework 2040 there is a welcome alignment of public health considerations and policy within the spatial planning framework, including commitments to:

- integrate public health policies, such as Healthy Ireland and the National Physical Activity Plan, with planning policies
- integrate safe and convenient alternatives to the car by prioritising the accessibility of walking and cycling in existing and proposed developments
- promote more sustainable forms of travel and activity-based recreation by further developing greenways, blueways and peat (brown) ways
- integrate green and blue infrastructure planning and the preparation of statutory land use plans
- support green and blue adaptation efforts to enhance resilience to climate change, such as creating green spaces and parks for the management of urban micro-climates
- ensure that the planning system will be responsive to our national environmental challenges and that development occurs within environmental limits, having regard to the requirements of all relevant environmental legislation and the sustainable management of our natural capital
- improve air quality and help prevent people being exposed to unacceptable levels of pollution in our urban and rural areas through integrated land use and spatial planning that supports public transport, walking and cycling as modes of transport preferable to the private car and that promotes energy-efficient buildings and homes, heating systems with zero local emissions, green infrastructure planning and innovative design solutions
- promote the proactive management of noise where it is likely to have significant adverse impacts on health and quality of life and support the aims of the Environmental Noise Regulations (S.I. 140/2006) through national planning guidance and noise action plans.

Importantly, many of the health-relevant actions under the National Planning Framework 2040 are also linked to and reinforced by the government's Climate Action Plan. It is essential that the ambitions of the National Planning Framework 2040 are realised through appropriate implementation and translation from national level through to regional and local levels, where local development plans and proposals are made. It is also important that, from the outset, urban environments and green and blue spaces are collaborative and inclusive in their design and implementation. This will ensure that the various needs of local stakeholders and end-users, of all ages, are appropriately considered and catered for. Spaces designed to support specific functions have a tendency to attract more limited user groups. By contrast, multifunctional areas incorporating spaces supporting active mobility, sports, physical activity, relaxation and opportunities for social interaction can provide an array of health benefits for multiple user groups (Grilli *et al.*, 2020; Scott *et al.*, 2020).







3. National Issues around Protecting our Environment, Health and Wellbeing

Drinking Water

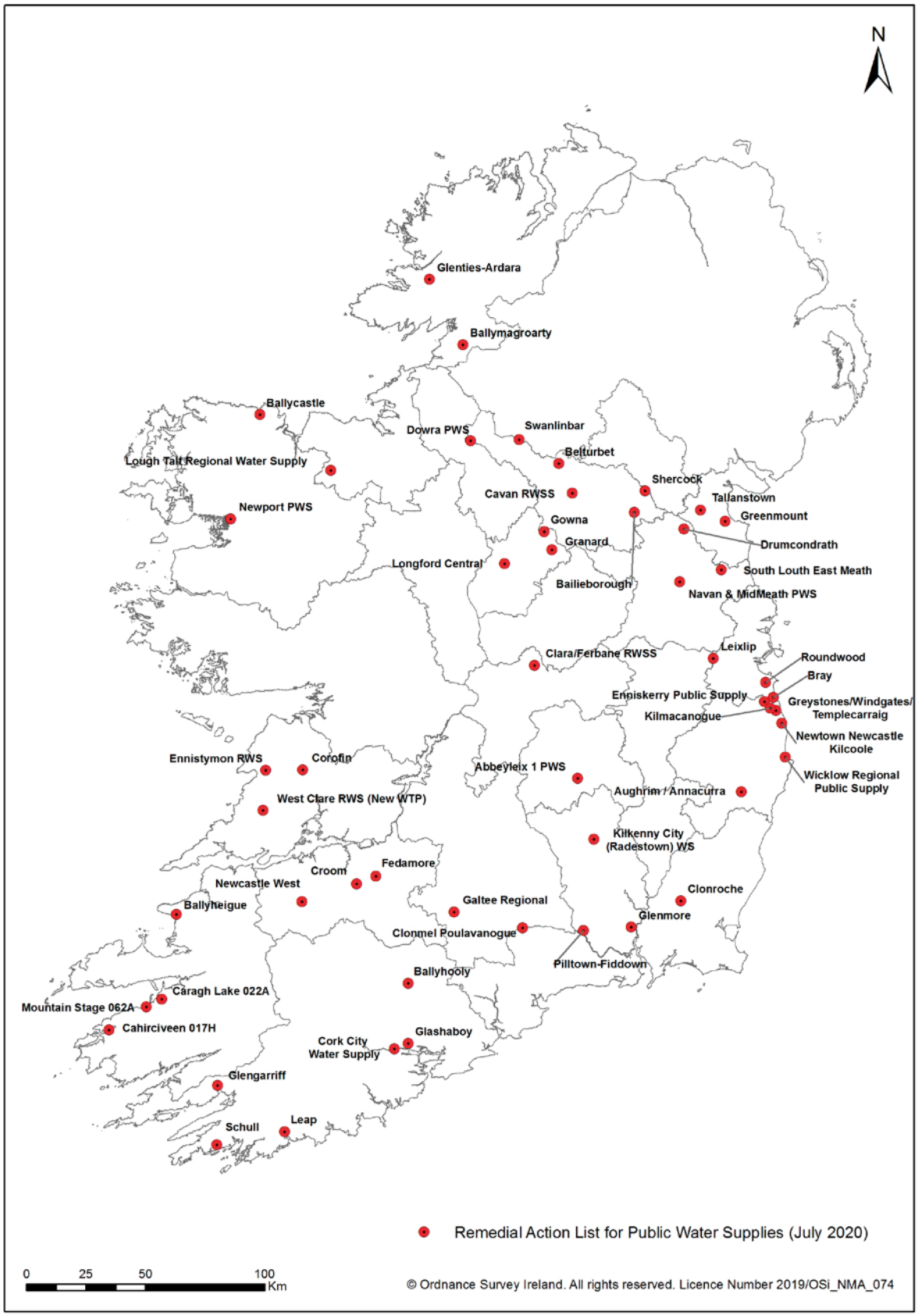
Safe drinking water is essential for public health. The microbiological quality of private water supplies remains inferior to that of public supplies. While most public water supplies are safe, further improvements are necessary to make sure that they stay safe in the future.

Safe drinking water is essential for public health. To be considered safe, water must not contain microorganisms and substances that could endanger health, such as pathogenic parasites, chemical contaminants or particulates. In addition to the standard monitored and regulated contaminants of drinking water, knowledge about further risks to water quality is emerging from a better understanding of the issues around new chemical formulations and the combined use of chemicals (adverse impacts of mixtures) and their occurrence in the environment, which is discussed later in this chapter.

Most public drinking water in Ireland is drawn from rivers and lakes (80%), and the remainder originates from groundwater boreholes (13%) and springs (7%). In 2019, Ireland had 787 public water supplies serving 1.3 million households.

The results of the 2019 drinking water monitoring programme for public water supplies shows 99.9 per cent compliance with the microbiological standards and 99.6 per cent compliance with the chemical standards, based on over 120,000 test results (EPA, 2020a). While this indicates that the majority of public water supplies are safe, further improvements are necessary to make sure that they stay safe in the future, thereby avoiding the risk of 'boil water notices' or 'do not consume notices'. In total, 67 boil notices were in place in 16 counties affecting 695,364 consumers in 2019. Of those boil water notices, 59 were in place for more than 30 days, meaning they are classed as long-term notices requiring investment in infrastructure to address. Two boil water notices for over 600,000 consumers in 2019 highlights the vulnerability of our drinking water supplies. Details on the reasons for the boil water notices, performance in fixing the supplies, along with the names of the supplies with boil water notices in place during 2019 are provided in the EPA report on *Drinking Water Quality in Public Supplies 2019* (EPA, 2020a). The overall compliance figures also mask slightly inferior results for a few individual parameters, notably trihalomethanes (THMs) at 96.1 per cent compliance, which is lower than in other European counties. The EPA has identified 52 supplies (as at July 2020) that are most in need of upgrading, replacement or improved operational control (Figure 14.1).

Figure 14.1 Public water supplies needing remedial action, July 2020 (Source: EPA)



Microbiological contamination

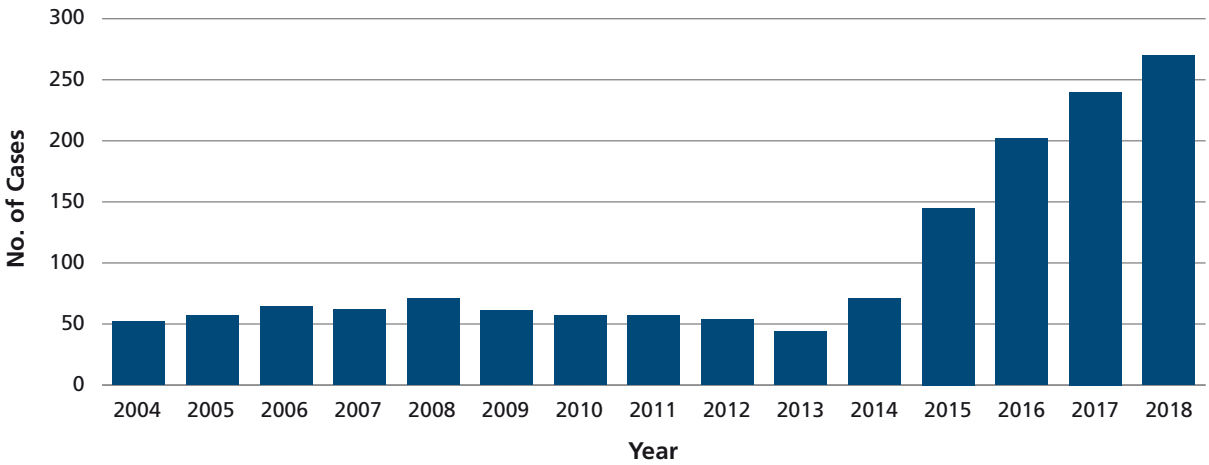
The most important indicators of the quality of drinking water are the microbiological parameters, in particular the bacterium *Escherichia coli* (*E. coli*) and enterococci. The presence of *E. coli* and enterococci in drinking water indicates that the water treatment plant is not operating adequately or that faecal contamination has entered the water distribution system after treatment. The incidence of *E. coli* in public water supplies has significantly reduced from 87 in 2007 to only seven in 2019 due to improvements in guidance, controls and management of disinfection at water treatment plants. The number of supplies with enterococci failures remains low, with only two in 2019 compared with six in 2018.

The microbiological quality of private water supplies remains inferior to that of public supplies. Many private wells are at risk of contamination from sources such as septic tanks, land-spreading of slurry, animals grazing near the wellhead, and chemical and fuel storage tanks. It is estimated that up to 30 per cent of private wells in operation in Ireland are contaminated with *E. coli* (EPA, 2017). Moreover, findings from EPA-funded research that assessed 212 private wells in four areas of the country found that only 35 per cent were properly protected against contamination (Gill *et al.*, 2018). Of particular concern is the continued and increasing prevalence of a particular strain of *E. coli* called Shiga-toxin/verocytotoxin-producing *E. coli* (STEC/VTEC), which produces a powerful toxin that can cause serious illness. Younger (< 4 years old) and older populations and those who are immunocompromised are particularly vulnerable to STEC/VTEC infection. Over the past decade, Ireland has consistently reported one of the highest incidences of STEC/VTEC in the EU, reporting ten times the EU average in 2017 (HSE HPSC, 2019a). Irish families are particularly vulnerable to this strain of bacteria because of the high proportion of rural dwellers who rely on private wells and septic tanks, the large cattle population and Ireland's diverse geology and climate.

Cryptosporidium and *Giardia* are genera of microscopic parasites found in human and animal waste that can cause gastroenteritis and persistent diarrhoea (contaminated water may come from lakes or ponds, swimming pools, drinking water or ice). While there is no overall trend for cryptosporidiosis in Ireland, the number of cases in 2018 (629 cases) was the highest reported since 2007. Ireland has consistently reported the highest crude incidence of cryptosporidiosis of any EU Member State since 2012. Contact with effluents from farm animals is the main risk factor for cryptosporidiosis. Health surveillance data show that people who are not served by public water supplies were over-represented in sporadic cases, relative to the distribution of households by water supply type nationally (HSE HPSC, 2019b).

Figure 14.2 shows the number of cases of giardiasis reported in Ireland between 2004 and 2018 (HSE HPSC, 2019c), showing a six-fold increase in the last 6 years. There were 270 cases reported in 2018, which is the highest reported incidence in Ireland but is similar to the reported incidence at EU level. According to the HSE, the increase in recent years is believed to be largely due to changes in laboratory practice for selecting stools for testing coincident with the introduction of newer, more sensitive molecular detection techniques. Much remains to be learned about the true epidemiology of giardiasis in Ireland, but it is clear that it causes a much larger burden of disease than previously thought.

Figure 14.2 Number of cases of giardiasis in Ireland 2004-2018 (Source: HSE HPSC, 2019c)



Trihalomethane contamination

THMs are formed when chlorine used in the disinfection of raw water reacts with naturally occurring organic matter in the water. The European Commission currently has an infringement case against Ireland because of the number of water supplies failing to meet the THM standard. In May 2020, the Commission issued a reasoned opinion stating that Ireland has failed to take the measures necessary to ensure THM compliance in 31 public water supplies and 13 private group water schemes. The Department of Housing, Local Government and Heritage is coordinating Ireland's response.

Lead contamination

Lead, which is a toxic compound, is found in drinking water when it dissolves from lead pipework, mains connections and plumbing fittings. The standard for lead in drinking water is 10 µg/l. Lead is very harmful to the development of the nervous system and can cause long-term damage to health. In June 2015, the Irish Government published a National Lead Strategy, which is overseen by the Department of Housing, Local Government and Heritage. While Irish Water is carrying out works to replace lead pipes and connections, the full extent of lead pipework in public buildings, such as schools and hospitals, and in state-owned buildings, such as local authority housing, is still unknown and there are no plans reported to carry out replacement works. Action is needed in this area to eliminate lead from drinking water.

Pesticide contamination

The term 'pesticides' includes a wide range of products, but in Ireland it is herbicides that pose the greatest threat to drinking water. The most commonly found pesticide is MCPA (2-methyl-4-chlorophenoxyacetic acid), which is used for rush control in grassland. Pesticides should not be present in drinking water and the Drinking Water Regulations S.I. 122/2014 (as amended) set standards that are considerably below the levels that would affect people's health. The drinking water standards for pesticides were exceeded in 27 supplies in 2019, which is an improvement in compliance with the standards for pesticides compared with 34 supplies with pesticides exceedances in 2018 and 48 supplies in 2017. There is some cause for optimism, as the EU statistical office, Eurostat, reports a 28 per cent reduction in pesticide sales in Ireland in the years 2011-2018 (Eurostat, 2020).

Emerging contaminants

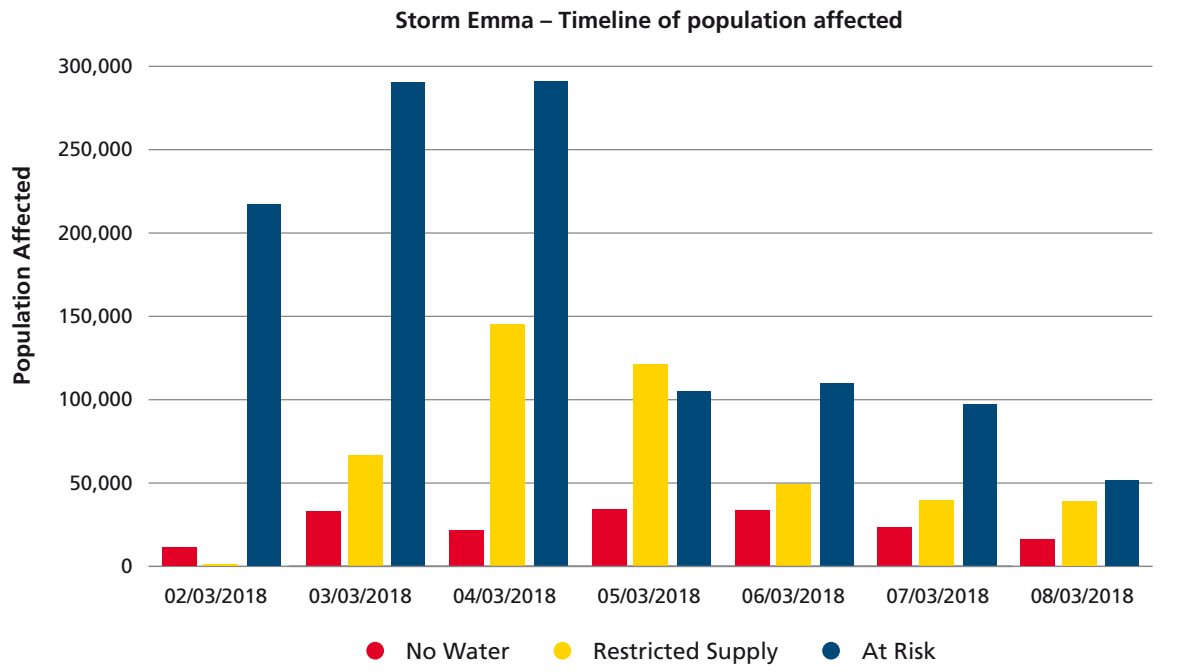
Although the impact of certain individual chemicals and biological vectors is known, people are also exposed in their daily lives to novel pathogens and complex mixtures of a wide variety of environmental chemicals. Concerns have grown about the 'cocktail effect', namely mixtures of chemicals that are present in the environment at low concentrations that, in combination, may cause harm (e.g. Quinn *et al.*, 2015; Hartmann *et al.*, 2018). Contaminants of concern that are undergoing assessment through research include nano-particles, persistent pharmaceuticals and per- and polyfluorinated alkyl substances (PFAS), which are a group of more than 4700 widely used synthetic chemicals that accumulate over time in humans and in the environment (EEA, 2019a), most of which are little understood. The EPA water monitoring programmes include those for the Sentinel monitoring of a wide range of substances, many of which would be considered substances of emerging concern. The emerging risks associated with chemical exposure is addressed in more detail later in this chapter.

Topic Box 14.3 Water Services, Extreme Weather and Climate Change

There is a need to improve the resilience of drinking water services.

During 2018, Ireland experienced extreme weather events that affected public water supplies and the delivery of water to consumers. In March, Storm Emma resulted in large amounts of snow and extremely cold weather. Schools, offices, shops and most public services were closed for several days, and people had difficulty leaving their homes to travel even short distances. Many water treatment plants were inaccessible and Irish Water could not respond to operational alarms and issues when they occurred. This particularly affected smaller supplies and, for example, nine supplies in Waterford were put on boil water notices as a precaution. Many people were also affected by water restrictions or had no water at all (Figure 14.3).

Figure 14.3 Storm Emma – Timeline and population affected by water restrictions (Source: Irish Water)



The summer of 2018 posed other challenges for drinking water supplies. High temperatures and no rainfall in June and July meant that Ireland experienced drought conditions. This, coupled with increased demand for water during that time, resulted in Irish Water introducing the first ever National Water Conservation Order nationwide hosepipe ban in July. The order remained in place until September 2018. Water demand and supply levels were monitored daily by Irish Water to ensure that water remained available for consumers, farmers, businesses and other services.

The challenges posed by these climate extremes in 2018 demonstrate the need to have resilient water supplies that can cope with short-term events such as snow, or longer term events such as a summer drought. Drinking water safety plans play an essential role, as they identify what could go wrong in advance, so that action can be taken to reduce the risk of problems arising or to lessen the impact if something does go wrong.

Urban Wastewater

Improvements are needed in urban wastewater collection and treatment to maintain water quality and thereby protect public health. Raw sewage from 35 towns and villages (the equivalent of 78,000 people) is currently being released into the environment every day.

Over one billion litres of wastewater are collected every day and treated at 1100 treatment plants before being discharged into the environment (EPA, 2020b). There are deficiencies in many public sewers and wastewater treatment plants thanks to a legacy of underinvestment. As a result, wastewater is one of the main threats to the quality of Ireland's rivers, lakes and estuaries, but it also poses a potential threat to public health. Public exposure to discharges, which can contain pathogens and pollutants such as microplastics, detergents and personal care products, may occur if those discharges are near bathing or recreational waters.

In October 2020, raw sewage from 35 towns and villages (the equivalent of 78,000 people) was still being released into the environment every day from urban areas as well as

from smaller coastal towns and villages. This is a reduction from 43 towns and villages discharging raw sewage when the EPA published *Ireland's Environment: An Assessment 2016*. The discharged raw sewage can contain harmful bacteria and viruses and pose a health risk to people who come into contact with it. It also threatens aquatic ecosystems and the amenity value of our waters.

The issue of nuisance odours is one about which the EPA frequently receives complaints regarding certain licensed sites, including wastewater works. Odour nuisance can negatively affect human health and wellbeing, particularly if people are exposed for extended periods (EPA, 2019). Almost half of the complaints received by the EPA annually about wastewater works relate to odour.

Domestic Wastewater Treatment Systems

Poorly designed, installed and maintained domestic wastewater treatment systems are a risk to public health.

In Ireland, there are an estimated 500,000 domestic wastewater treatment systems (DWWTS), i.e. septic tanks and more advanced packaged/filter treatment systems, treating wastewater from houses not connected to a public sewerage system. Owners of DWWTS are required to operate and maintain their systems so that they do not pose a risk to human health or the environment.

DWWTS that are properly designed, installed and maintained can provide long-term, effective treatment of domestic wastewater. However, DWWTS can result in reduced water quality and threaten public health if they are poorly constructed or not operated satisfactorily.

The *Domestic Waste Water Treatment Systems Inspections and Enforcement 2019* report (EPA, 2020c) details the findings of 1160 local authority inspections carried out in 2019. Nearly half (580) of the systems inspected did not meet the necessary standards, which is consistent with previous years' findings. The local authorities identified more serious issues with nearly 300 systems, which were found to be a risk to human health or the environment. Twenty-seven per cent of systems that failed in report years 2013-2019 had yet to be fixed in mid-2020. Failures are due to construction defects and householders not maintaining/cleaning out (desludging) systems. There is further information for householders on the EPA's website about how to check a DWWTS and take action if it is defective. The government's recently expanded septic tank grant scheme broadens the availability of grants and increases the amount of the maximum grant available to €5000.

Bathing Water

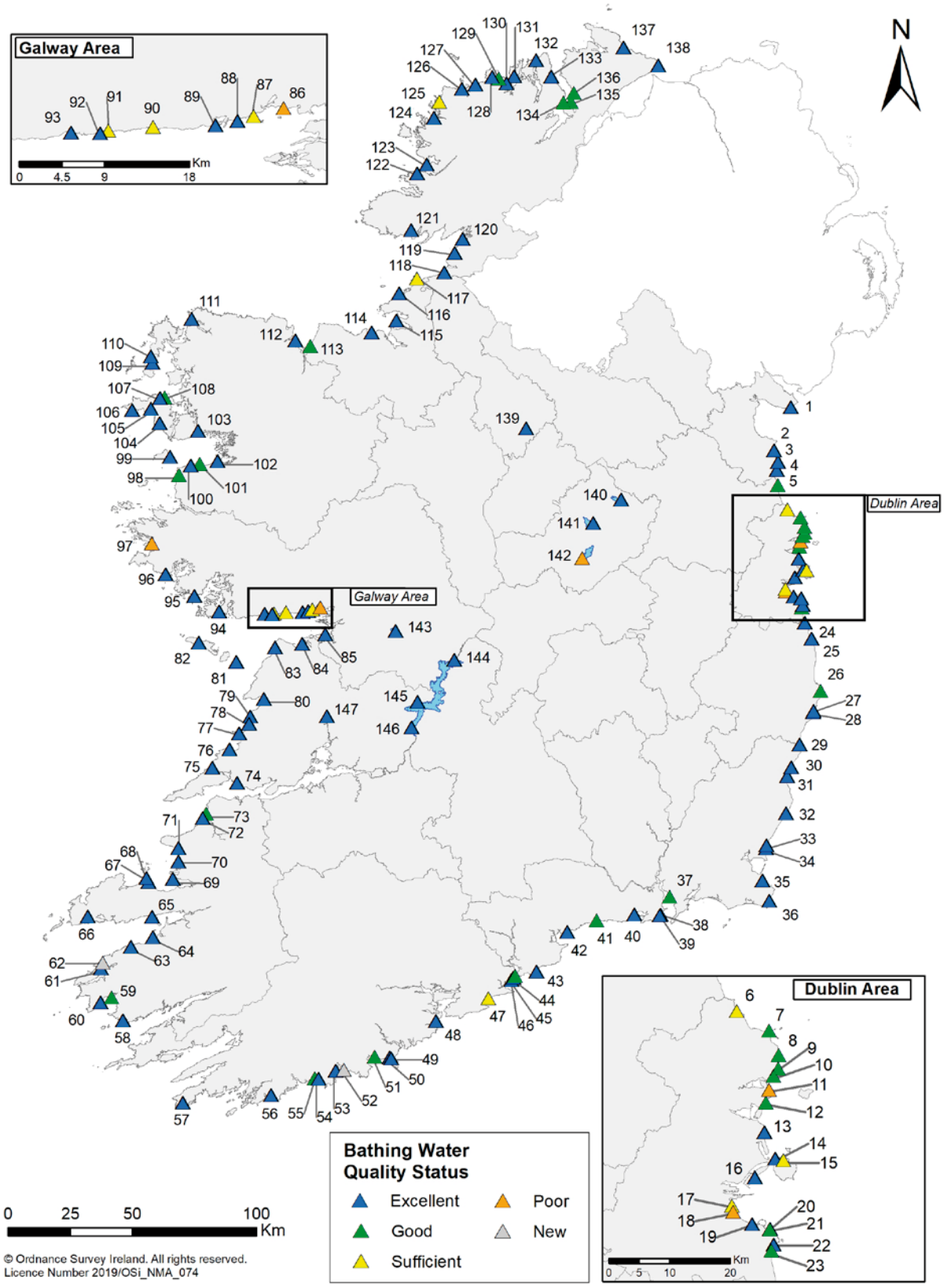
While nearly three-quarters of Ireland's bathing waters are classified as excellent, some urban beaches are under pressure, and Ireland ranks well below the EU average for excellent bathing water quality.

There are 147 bathing waters identified in Ireland under the Bathing Water Regulations: 138 on the coast and nine inland (Figure 14.4). Overall, the quality of bathing waters in Ireland improved in 2019, with 95 per cent of sites (140 of 147) meeting or exceeding the minimum required standard: this is up from 94 per cent in 2018 (EPA, 2020d). The 2019 results show that 107 (73%) were classified as 'excellent', up from 103 in 2018; 24 (16%) were classified as 'good', up from 22 in 2018; and nine (6%) were classified as 'sufficient', down from 12 in 2018. As in 2018, the water quality at five beaches was classified as 'poor'. They were Merrion Strand, Dublin; Portrane (the Brook) Beach, Dublin; Ballyloughane Beach, Galway; Clifden Beach, Galway; and Lilliput, Lough Ennell, Westmeath. When a bathing water is classified as poor, it means that there is a risk of periodic pollution, with the potential to cause illness such as stomach upset, skin rash and infections of the ear, nose and throat. Merrion Strand had been classified as 'poor' for 5 years in a row, meaning that this strand was declassified as a bathing water in 2020.

Three new bathing water sites, all in Dublin, were classified for the first time in 2019. They were the Forty Foot Bathing Place (classified as 'excellent'); White Rock Beach (classified as 'excellent'); and Sandycove Beach (classified as 'good'). Two additional beaches, Inchydoney East Beach, Cork, and Cúas Crom, Kerry, were added to the national bathing waters list in 2019 and will be classified following the 2020 bathing season.

The EPA bathing water quality report for 2019 (EPA, 2020d) notes that, in the case of 50 bathing water pollution incidents notified to the EPA in 2019, 54 per cent were linked to urban wastewater (sewage treatment) discharges, 18 per cent were linked to agricultural run-off and 12 per cent were linked to septic tank discharges.

Figure 14.4 Bathing water quality map of Ireland 2019 (EPA, 2020d)



Improvements in urban wastewater systems should continue to be made to limit the impact of wastewater on bathing waters and thereby reduce risks to public health. Local authorities should implement appropriate measures to increase the number of bathing waters classified as good or excellent and, where practical, consider designating more of the beaches that are regularly used by bathers. There are a number of ongoing environmental research projects that aim to improve knowledge and practice around bathing water quality and protection: the National University of Ireland (NUI) Galway PIER project, which is funded by the EPA; the County Wexford-led Duncannon Blue Flag Farming and Communities Scheme; and the Acclimatize project and the EU SwimProject, both involving UCD.

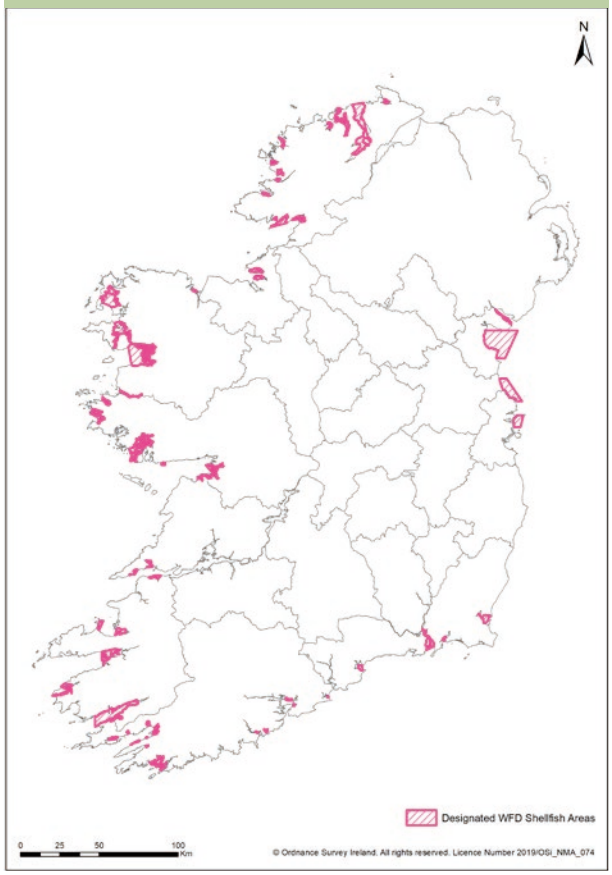
During the bathing season, the EPA's beaches.ie website (www.beaches.ie) shares the latest information on bathing water quality and any water restrictions in place for identified bathing waters, as well as information on a number of other monitored bathing waters.

Shellfish Waters

Live bivalve molluscs for human consumption, such as mussels, can be harvested only from shellfish production areas that meet specified water quality requirements.

Irish coastal waters provide ideal conditions for shellfish production, including oysters, mussels, cockles, scallops and clams. To support shellfish life and growth and to contribute to the high quality of edible shellfish products, the Quality of Shellfish Waters Regulations (S.I. No. 268 of 2006, as amended) required pollution reduction programmes to be developed for designated shellfish areas. Under these Regulations, there are 64 designated shellfish-growing areas in Ireland, which have specified physical, chemical and microbiological water quality requirements (Figure 14.5).

Figure 14.5 Designated shellfish-growing areas in Ireland (Source: EPA)



Norovirus is a leading cause of gastroenteritis in humans and is found in high concentrations in municipal wastewater. Bivalve molluscan shellfish such as oysters are filter feeders and can become contaminated with human pathogens including norovirus when produced in areas affected by municipal wastewater discharges. Wastewater treatment is a critical control to reduce the extent of pathogen discharge into aquatic environments. Disinfection is usually carried out using ultraviolet (UV) lamps, which kill or inactivate most of the bacteria and viruses in the water. Based on an assessment of Irish Water's annual monitoring returns, there are currently 18 towns in Ireland that have UV treatment in place at their wastewater treatment plants to protect shellfish waters.

To protect against illness, the Sea Fisheries Protection Authority and the Marine Institute, under service contract to the Food Safety Authority Ireland, operate a shellfish monitoring regime and analyse shellfish samples for the presence of biotoxins. The controls are such that consumption of Irish shellfish poses little risk to public health. However, illegal shellfish harvesting can present a risk to public health if contaminated shellfish makes its way into the food chain. Consumers and food businesses should purchase live bivalve molluscs only from suppliers

that are approved by the Sea Fisheries Protection Authority to place live shellfish on the market for human consumption.

A mapping application on Irish shellfish biotoxin and phytoplankton status is available on the Marine Institute's website.[1] This provides the latest information on shellfish safety data for shellfish producers, food business operators and consumers. The Marine Institute also publishes a weekly Harmful Algal Blooms (HAB) Bulletin to provide information on the potential development and current status of harmful and toxic algae in Irish coastal waters, which can enter the human food chain through shellfish consumption.

Air Quality

The burning of solid fuels for home heating and our current reliance on private conventionally fuelled vehicles cause much of Ireland's air pollution.

Air pollution is the most significant environmental contributor to the burden of disease worldwide, causing an estimated six to seven million premature deaths each year (UN Environment, 2019). In Ireland, there are an estimated 1300 premature deaths annually due to poor air quality (EEA, 2020b), due predominantly to fine particulate matter (with a diameter less than 2.5 µm, $PM_{2.5}$). There is no known safe level of air pollution. Even brief periods of exposure to high concentrations of air pollutants have a measurable adverse impact on health (WHO, 2006).

In general, Ireland's air quality is deemed good when assessed against EU air quality standards. However, monitoring in 2019 at a Dublin city centre monitoring site at St John's Road West found elevated nitrogen dioxide levels which shows that local urban air pollution issues needed to be tackled (Chapter 3). When compared with the more stringent WHO guideline values, which are set for the protection of human health, some challenges for certain air pollutants emerge, specifically emissions of fine particulate matter (EPA, 2020e). The burning of solid fuels for home heating, our current reliance on private conventionally fuelled (especially diesel) motor vehicles and emissions from agriculture are to blame for many of the air pollution issues that Ireland is currently experiencing. More extensive information on the contribution of these activities to air pollution and the steps to tackle emissions is given in Chapter 3; some specific actions are detailed in the paragraphs below.

Burning solid fuels such as coal, peat and wood products in our homes releases microscopic, airborne particles called particulate matter (PM), which are complex mixtures of various harmful chemicals. Those with underlying respiratory conditions, such as asthma and chronic obstructive pulmonary disease, are particularly vulnerable to air pollution. A switch from burning solid fuels by all households would ensure a better environment for those particularly vulnerable populations, such as children with asthma. Reducing our use of solid fuels for home heating would be a triple win in terms of the benefits it would afford: (1) it would improve the quality of air we breathe in our homes; (2) it would reduce the levels of outdoor air pollution, which exposes the wider population to pollutants such as PM; and (3) it could help limit carbon dioxide emissions, which are contributing to climate change.

An immediate national ban on 'smoky' coals is necessary if air quality and public health are to be significantly improved. A ban on the selling, buying and burning of 'smoky' coal is currently in force across several areas of the country and, from September 2020, the ban was extended to a further 13 towns[2] with populations over 10,000 people. However, nationwide coverage and implementation of the ban is essential if we are to seriously and proactively tackle this public health matter. To make real and effective reductions in the damaging effects and premature deaths caused by air pollution we need to move to cleaner and more efficient ways of heating our homes that reduce emissions of air pollutants and carbon dioxide. In addition, it will be crucial to ensure that the extension of this ban encourages a switch to cleaner alternatives, rather than from coal to other polluting solid fuels such as wet wood and peat. Another proactive step that should be implemented is an amendment to the Building Regulations to explicitly prohibit the inclusion of open fireplaces and solid fuel heating systems in all new houses, particularly those in urban areas.

1 http://webapps.marine.ie/HABs/BiotoxinMap

2 *Smoky coal will be banned in the following 13 towns from September 2020: Ashbourne, Ballina, Carrigtwohill, Castlebar, Cavan, Cobh, Enniscorthy, Killarney, Longford, Mallow, Midleton, Tramore, Tullamore.*

Measures to tackle transport-related air pollution must also be urgently adopted and implemented, e.g. by using cleaner alternatives to the private car such as cycling, walking, taking public transport, carpooling, moving to cleaner modes of public transport and expanding the electric car recharging network to encourage and support more environmentally friendly means of transport (EPA, 2020e). The importance of good spatial and urban planning is also essential in this regard to provide key infrastructure to allow and encourage more active travel by citizens.

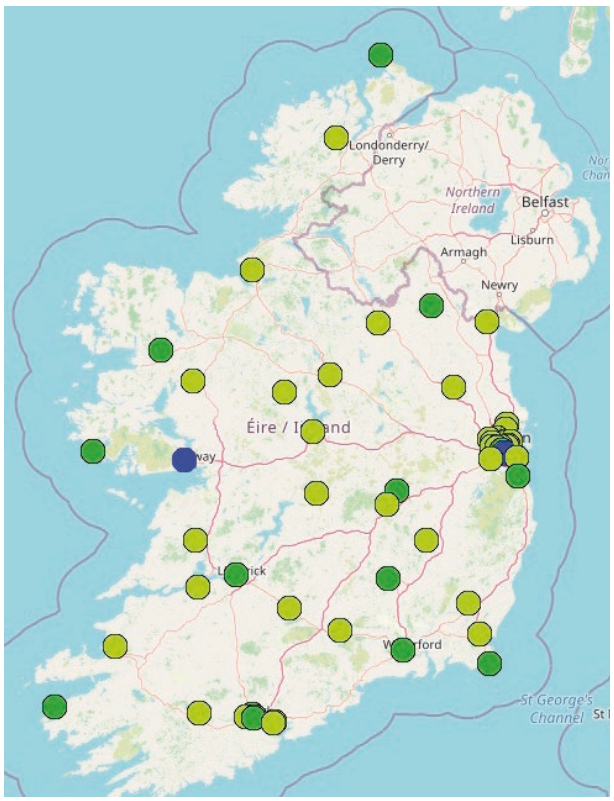
It is recognised that exposure to air pollution has an unequal impact on groups of society: the elderly, children, those in poor health and groups with lower socio-economic status are the most adversely affected (EEA, 2018). An analysis of air pollution and admissions to St. James's Hospital, Dublin, for respiratory and cardiovascular disorders identified a higher risk of mortality among those from lower socio-economic groups (Cournane *et al.*, 2017). This points to a need for more urgent focus on and action targeting the most at-risk groups of society to ensure that inequalities in exposure are adequately addressed by current and future policy, practice and interventions.

The EPA's Air Quality Index for Health (AQIH) provides a real-time (updates every 2-5 minutes) assessment of air quality across Ireland and categorises it on a scale of 1-10. The higher the reading, the poorer the air quality; a reading of 1-3 denotes good air quality in the area and a reading of 10 denotes very poor air quality in the area (Figure 14.6). The real-time analysis and heath advice messages provided by the AQIH for each region are a useful tool in helping to better protect people's health, particularly the health of those who may be quite sensitive to air pollution (e.g. adults and children with heart or lung conditions including asthma, older people).

An analysis undertaken by the EPA and the HSE's Public Health Team examined the relationship between short-term AQIH and acute hospital admissions in the Dublin region (unpublished data). The findings indicated that, when the AQIH was fair or poor in the region, there was an increase in admissions of individuals with asthma (estimated by the HSE to be approximately 470,000 people) and atrial fibrillation (irregular heartbeat, affecting > 3 per cent of the population over 50) (Smyth *et al.*, 2015), with a 70 per cent increase in same-day asthma admissions on days when poor air quality was reported. This piece of research demonstrates the benefit of the AQIH as a suitable short-term measure to raise people's awareness of air quality in their region and of the AQIH's potential to be used as a tool, particularly by those more vulnerable populations, to help them adequately prepare for, and reduce their exposure to, air pollution.

Figure 14.6 Air Quality Index for Health map and accompanying health messages for at-risk groups and the general population (Source: EPA)

		ACCOMPANYING HEALTH MESSAGES FOR AT-RISK GROUPS AND THE GENERAL POPULATION	
BAND	**INDEX**	**AT-RISK INDIVIDUAL ***	**GENERAL POPULATION**
Good	1 2 3	Enjoy your usual outdoor activities	Enjoy your usual outdoor activities
Fair	4 5 6	Adults and children with lung problems, and adults with heart problems, who experience symptoms, should consider reducing strenuous physical activity, particularly outdoors.	Enjoy your usual outdoor activities
Poor	7 8 9	Adults and children with lung problems, and adults with heart problems, who experience symptoms, should reduce strenuous physical activity, and particularly if they experience symptoms. People with asthma may find they need to use their reliever inhaler more often. Older people should also reduce physical exertion.	Anyone experiencing discomfort such as sore eyes, cough or sore throat should consider reducing activity, particularly outdoors
Very Poor	10	Adults and children with lung problems, adults with heart problems, and older people should avoid strenuous physical activity. People with asthma may find they need to use their reliever inhaler more often.	



Environmental Noise

The WHO has classified transport-related noise (from road, rail and air traffic) as the second leading environmental cause of ill health after air pollution, which highlights noise as a pollutant and health risk that needs more attention nationally.

The adverse effects on health of long-term exposure to excessive noise are of increasing concern, and the WHO has classified transport-related noise (from road, rail and air traffic) as the second leading environmental cause of ill health after air pollution (WHO, 2011). In Europe, at least 20 per cent of the population currently resides in areas where noise levels are deemed to be harmful to health. It is estimated that long-term exposure to noise contributes to 48,000 new cases of heart disease and 12,000 premature deaths every year, while 22 million people suffer severe annoyance and 6.5 million experience severe sleep disturbance. Moreover, it is estimated that 12,500 children may suffer learning impairment every year due to aircraft noise alone (EEA, 2019b).

In Ireland, most recent data indicate that 14.4 per cent of the urban population (equivalent to about 430,000 people, based on the Central Statistics Office 2016 census) are exposed to road noise levels above the Environmental Noise Directive (2002/49/EC) guideline values (EEA, 2019b). This indicates that a substantial portion of the population may be experiencing some adverse effects on health and wellbeing caused by noise. Transport-related noise impact is addressed in Ireland through the implementation of the Environmental Noise Directive, and Chapter 4 includes a more detailed overview of the requirements under that Directive and information on what is currently being done to tackle environmental noise.

From a human health and wellbeing perspective, the issue of environmental noise requires action on two fronts: firstly, the proactive management of noise that is likely to have a significant negative impact on health and wellbeing; and, secondly, the preservation and increased provision and accessibility to designated quiet areas, particularly in areas with a high population density. These are areas that are 'largely undisturbed by noise from traffic, industry or recreational activities' (EEA, 2014). Quiet areas are important in providing a haven of natural soundscape for citizens, particularly in urban areas, as well as benefiting biodiversity (EEA, 2014). Public parks and other green and blue spaces often represent more tranquil environments that not only provide a buffer against excessive urban noise but also provide a multitude of additional benefits that can improve our health and wellbeing, e.g. attenuating air pollution, reducing flood risk, reducing excessive temperatures.

Objective 65 of the government's National Planning Framework 2040 recognises environmental noise and proposes measures to more proactively manage noise given the anticipated urban growth (particularly residential) in the coming years. Effective implementation of this objective through national noise planning guidance and noise action plans, coupled with continued implementation of the Environmental Noise Directive, will be essential if meaningful progress is to be made in reducing the population's exposure to excessive environmental noise.

Chemicals in the Environment

People are chronically exposed to a multitude of environmental chemicals in their everyday lives from various sources and through multiple pathways posing potential risks to their health and their environment.

Today, many chemicals play a hugely beneficial role in our lives, e.g. medicines for treating illnesses, pesticides and herbicides used in agriculture, solvents used in the electronics industry, and substances used as flame retardants in furnishings. However, when chemicals end up in the wrong products or places, including our environment, they can cause harm. Currently, there are approximately 35,000 chemicals either manufactured in or imported into the EU in quantities greater than 1 tonne per year. Of these, about 60 per cent are considered, to some degree, to pose potential risks to human health and/or the environment. In general, there is limited knowledge of the nature and extent of the effects of chemical pollution on human health and the environment, and it has been suggested that the contribution of chemical pollution to the global burden of disease is likely to be underestimated (Landrigan *et al.*, 2017). With projected increases in the production of chemicals, continued emissions of hazardous and persistent chemicals and increased use of pharmaceuticals because of an ageing population, it is deemed unlikely that the burden chemicals put on health and the environment will decrease in the near future (EEA, 2019b).

People are chronically exposed to a multitude of chemicals in their everyday lives from various sources and through multiple pathways, e.g. consumption of contaminated food or water, breathing polluted air and dust, and direct contact with certain materials. The categories of chemicals to which the EU is paying particular attention are outlined in Topic Box 14.4.

Topic Box 14.4 Categories of chemicals of concern

Pharmaceuticals and veterinary products

Effective treatment of many illnesses depends on access to pharmaceuticals, yet pollution caused by some pharmaceuticals is of growing concern. The metabolic and/or chemical stability of certain pharmaceuticals means that the vast majority (up to 90% in some cases) of the active ingredient can be excreted unmetabolised and enter wastewater treatment plants and our environment. Of particular concern is the presence of antibiotics, which are extensively used in human and veterinary medicine. The release of these antimicrobials and of antimicrobial-resistant microbes from humans and animals into the environment can accelerate the development and dissemination of antimicrobial resistance, which is an issue of global concern.

Endocrine disruptors

Endocrine disruptors are chemicals that interfere with the normal working of the hormone systems of humans and animals. Hormones control a large number of vital body functions and processes such as energy levels, reproduction ability, regulation of growth and development and responses to stress and injury. Endocrine disruptors include a wide range of substances, e.g. some pharmaceuticals, pesticides and other industrial chemicals. Many endocrine disruptors, e.g. phthalates, have been used extensively in manufacturing products such as cosmetics, toys and fabrics. In 2018, the European Commission published a communication for a comprehensive European framework on endocrine disruptors (EC, 2018), which sets out a strategic approach to ensure that European citizens and the environment are protected from these chemical substances. It is anticipated that many of the actions proposed in the Communication will be incorporated into the Commission's proposed Chemicals Strategy, being developed as part of the commitments set out in the European Green Deal.

Persistent organic pollutants

Persistent organic pollutants (POPs) are substances that are chemically very stable, that bioaccumulate in the food web and that pose risks to human health and the environment. Most POPs are synthetic, e.g. pesticides (such as DDT) and flame retardants, while others are produced unintentionally e.g. dioxins (through activities such as the uncontrolled burning of waste). As their name suggests, these chemicals can persist for very long periods. Certain POPs such as the PFAS, which are extensively used as stain repellents in common household items and in firefighting foams, have been referred to as 'forever chemicals' given their highly persistent nature. Human exposure to certain POPs has been associated with adverse effects such as immunotoxicity and neurotoxicity (Gascon *et al.*, 2013). Ireland is a signatory to the United Nations Stockholm Convention, which sets out, *inter alia*, measures to eliminate the use and release of harmful POPs.

Ozone-depleting substances and fluorinated greenhouse gases

The ozone layer is a natural band of gas in the upper atmosphere (the stratosphere) protecting humans and other animal life from harmful UV radiation from the sun. A group of substances called ozone-depleting substances (ODSs), once widely used in refrigeration, air conditioning and firefighting systems, have depleted the ozone layer. The hole in the ozone layer caused by ODSs has resulted in higher than normal exposure to UV radiation in certain parts of the globe. The additional exposure to UV radiation can have a number of serious consequences for health such as increased risk of skin cancer and eye cataracts and suppression of the immune system. Consequently, the use of ODSs has been severely restricted and in some cases banned. It is notable that, from a climate change perspective, many of the substances introduced to replace ODSs have a very high global warming potential and are themselves being phased out under the F-gas Regulations (EU No 517/2014) and the United Nations Montreal Protocol.

Humans and other organisms in the environment are exposed to chemical mixtures that can interact and have additive or synergistic 'cocktail' effects, thereby exerting a greater impact than a single chemical in isolation. The risk assessment approach used under the chemicals legislation is primarily centred around single substances. A paradigm shift in the approach to risk assessment and regulation of chemicals is urgently needed – one centred more around chemical mixtures and families/groups of certain chemicals, thereby preventing regrettable substitutions (i.e. replacing a banned chemical with an alternative that may have similar or worse effects on health) (Swedish Government, 2019). While hugely challenging and complex, efforts are being made towards achieving this ambition. For example, the European Food Safety Authority (ESFA) recently published guidance on harmonised methodologies assessing the risks of combined exposure to multiple chemicals for human health, animal health and the environment (EFSA Scientific Committee, 2019). In addition, from a regulatory standpoint, there have been new restrictions on the placing on the market of articles containing four phthalates, which probably have serious effects on health because of their endocrine-disrupting properties.

However, the issue of legacy chemicals, i.e. those that are no longer used or manufactured but persist in the environment or are contained in old products, remains of concern, particularly in the context of Europe's ambition to achieve a more circular economy. From the chemical perspective, there is a risk of unintended adverse health impacts resulting from reusing or recycling products containing hazardous and/or legacy chemicals that were sold before restrictions were in place. These chemical substances can be difficult and costly to detect and remove. This issue and its role as a potential barrier to the circular economy has been explicitly recognised in the EU Action Plan for the Circular Economy (EC, 2015). The Action Plan is thus committed to 'the promotion of non-toxic material cycles and better tracking of chemicals of concern in products to facilitate recycling and improve the uptake of secondary raw materials'. This commitment to a toxin-free zero-pollution environment is also embraced in the EU Commission's current strategy, the European Green Deal. As part of the implementation of the Circular Economy Action Plan, the revised Waste Framework Directive (2008/98/EC), which came into force in 2018, tasked the European Chemicals Agency (ECHA) with establishing a database to collect information on products containing certain hazardous substances. Companies that produce, import or supply articles containing designated hazardous substances that are to be placed on the EU market must submit this information for inclusion in the database. Due to be rolled out in January 2021, it is anticipated that the SCIP database[3] [Substances of Concern In articles as such or in complex objects (Products)] will help to decrease the generation of waste containing hazardous substances, improve waste treatment operations and allow authorities to better monitor the use of substances of concern in articles and take appropriate action where needed.

Plastic Pollution

We are now in a situation in which plastic pollution has reached every corner of our planet and plastic is one of the most widespread and persistent environmental pollutants we face today.

Plastics are chemical polymers. The durability, adaptability and relatively low cost of plastic have seen its widespread use within modern society over the past 70 years, and plastic is now one of the most ubiquitously used materials in everyday life. However, the consequences of such mass production and extensive use, particularly in terms of waste management of plastics and the generation of plastic debris, were not anticipated. The result means that plastic pollution has reached every corner of our planet and plastic is one of the most widespread and persistent environmental pollutants we face today.

Of particular concern is the issue of microplastics – small plastic particles less than 5 mm in length. Microplastics can be intentionally manufactured as additives for various consumer products, such as cosmetics and cleaning products, but can also be formed from the breakdown of larger plastic products, shed from synthetic clothing during washing and produced by car tyres during abrasion while driving. The pathway by which such contaminants reach our water environment is relatively clear (e.g. urban run-off, industrial effluent discharges, breakdown of marine litter), but new research by Roblin *et al.* (2020) has identified the presence of microplastics in the air we breathe, including at remote locations on the west coast, implying the global nature of this challenge.

3 https://echa.europa.eu/scip-database

In addition to the consequences of physical ingestion of microplastics by marine and freshwater biota, and indeed humans, the role that microplastics play as a vehicle for, and potential source of, other harmful chemicals and microorganisms may be of particular concern from human and ecological health perspectives. Hazardous chemicals, including a wide range of endocrine disruptors, heavy metals and pathogenic bacteria, have been found to be associated with microplastics. Hazardous chemicals may have been intentionally or unintentionally added during the production process, may have arisen during the recycling process or may have been already present in the environment and simply absorbed onto the surface of the plastic (Gallo *et al.*, 2018). Humans are exposed to chemicals from plastic, and the potentially hazardous 'hitchhikers' they contain, many times a day by a number of routes.

In response to rising concern, the WHO recently undertook an extensive analysis of published research related to microplastics in drinking water and concluded that, of the three forms of potential hazards associated with microplastics (i.e. physical particles, chemicals and pathogenic bacteria as biofilms), the chemicals and microbial biofilms associated with plastic particles are currently of low concern for health (WHO, 2019). While there was insufficient evidence to draw firm conclusions on the hazard from and potential toxicity of the physical plastic particles themselves, they are currently not deemed to be a concern for health. The need for further research to advance our understanding and provide more accurate assessments of exposure to, and the health impact of, microplastics was highlighted.

As noted by the WHO, water suppliers have an additional role to play in implementing effective control measures and treatment processes that prioritise the removal of microbial pathogens and chemicals, as this will have the added benefit of simultaneously removing plastic particles.

Plans for restrictions on the use of plastics have already been initiated at national and EU level, e.g. the EU Single Use Plastics Directive (2019/904). At the request of the European Commission, ECHA has prepared a restriction dossier under the EU REACH Regulation (Regulation on the Registration, Evaluation, Authorisation and Restriction of Chemicals), which will target intentionally added microplastics in a wide range of consumer and professional products including paints, construction materials and medicinal products. If adopted, it is estimated that these restrictions could see a reduction in microplastic emissions of 400,000 tonnes over 20 years. Ireland's Department of Housing, Local Government and Heritage has legislated to prohibit the manufacture, import, export, sale and supply of certain personal care and cleaning products containing plastic microbeads.

Towards a Zero-pollution Ambition for a Toxic-free Environment

The vision of attaining a non-toxic environment is one that continues to be prioritised at a European level, most recently through the ambitions of the European Commission's European Green Deal.

Chemicals policies have spawned a wide range of regulations aimed at limiting damage to the environment and human health (Collins *et al.*, 2020). The ambitious vision of attaining a non-toxic environment is one that continues to be prioritised at a European level. The Seventh Environment Action Programme set out the EU's ambitious long-term vision of attaining a non-toxic environment by providing a safer, cleaner environment where the risks posed by chemicals are minimised.

Furthermore, as part of the European Commission's European Green Deal (EC, 2019), launched in December 2019, there will be a considerable step-up in action on chemicals. As part of this action, to ensure a 'toxin-free environment' and eliminate pollution, the Commission plans to present a chemicals strategy for sustainability that aims to better protect citizens and the environment from hazardous chemicals and also to encourage innovation in developing safer and more sustainable alternatives. A zero-pollution action plan for air, water and soil has also been proposed.

One area in which Ireland risks not achieving a zero-pollution and non-toxic environment is land-spreading of sewage sludge from wastewater treatment plants. Sewage sludge which is a thick, soft mix of solid and liquid matter left over from the treatment process, is rich in nutrients and is used as a soil enhancer or fertiliser on agricultural land. Irish Water estimates that the quantities of sewage sludge generated nationally (currently 58,630 tonnes dry solids) will increase by more than 80 per cent by 2040 as new wastewater treatment plants are established and existing ones upgraded.[4] While sewage sludge is treated before being spread on land to ensure that certain contaminants are removed, an EPA-funded research project (Healy *et al.*, 2017) found that many non-priority metals and contaminants of emerging concern (e.g. phthalates) that are potentially harmful to health, but are not currently legislated for, may be applied repeatedly to land, potentially accumulating in soils and entering the food chain and our surface waters through run-off.

The EPA routinely monitors surface waters across Ireland for a range of priority and priority hazardous substances, including herbicides, insecticides, polyaromatic hydrocarbons, solvents and metals, under its Water Framework Directive (2000/60/EC) monitoring programmes. Environmental quality standards (EQSs)

4 https://www.water.ie/projects-plans/our-plans/wastewater-sludge-management/Final-NWSMP.pdf

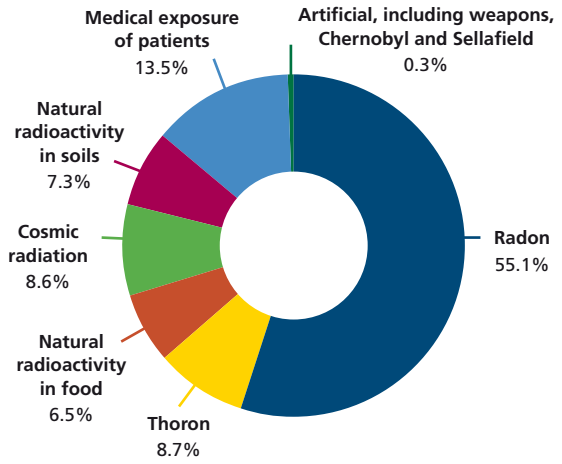
for each of these substances have been established at a European level. Work is commencing on identifying new chemicals of emerging concern of regional or local importance for Ireland (river basin-specific pollutants), which will establish national EQSs and new monitoring programmes.

Radioactivity

Exposure to radon is the most significant cause of exposure to radiation for the Irish public: other sources of radioactivity in the Irish environment do not pose a significant risk to public health.

Natural radioactivity in our environment is made up of both cosmic radiation, which originates in outer space, and geological radiation, which comes from the long-lived radionuclides present in rocks and soil from the time of the formation of the Earth. Artificial radiation in the environment originates from its use in medical diagnosis and treatment and the operation of nuclear power plants and reprocessing plants. Past accidents at nuclear installations and atmospheric nuclear weapons tests are also sources of artificial radionuclides in the environment. The most significant source of artificial radionuclides in the Irish marine environment is discharges from the Sellafield nuclear fuel reprocessing plant in Cumbria. However, the radiation exposure from Sellafield discharges represents only a very small fraction of the overall average annual dose received by a person in Ireland, as shown in Figure 14.7.

Figure 14.7 Sources of radiation. The most significant contribution to human exposure to radioactivity is from naturally occurring radon gas (Source: EPA)

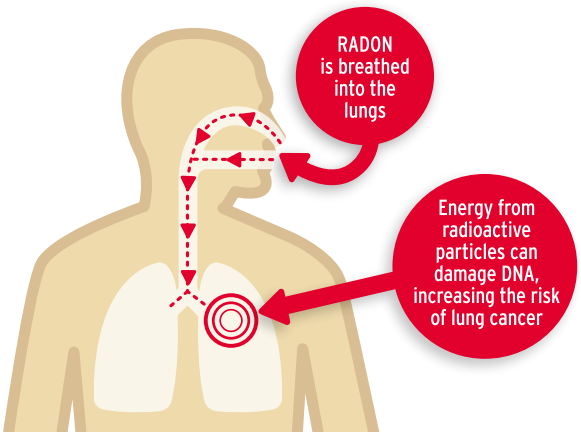


Radon

Indoor radon exposure remains a significant public health concern for the Irish population and is the second leading cause of lung cancer in Ireland.

Radon is a radioactive gas formed in the ground by the radioactive decay of uranium, which is present in all rocks and soils. Radon is diluted to very low concentrations outdoors; however, it can build up to high concentrations inside buildings. Ireland has a more significant radon problem than many of its European neighbours. This is mostly due to its geology and partially due to its climate. Radon is an invisible, colourless and tasteless gas that is carcinogenic and is linked to the development of 300 cases of lung cancer each year in Ireland (Figure 14.8) (Dempsey *et al.*, 2018b). It is also associated with certain kinds of skin cancer (Wheeler *et al.*, 2012).

Figure 14.8 Radon damages the lungs, increasing the risk of lung cancer (Source: EPA, www.radon.ie)



The EPA has tested over 60,000 homes and identified about 9000 homes that are above a level of natural radioactivity that is considered safe from the perspective of the occupier's health. However, it is estimated that about 160,000 homes are above this safe reference level in Ireland. High radon concentrations can be found in any part of the country; however, the EPA has categorised certain areas that are more prone to radon as high-radon areas. The EPA's interactive map, available at https://www.epa.ie/radon/, will show whether a building is in a high-radon area and provide information on testing and remediation.

The most cost-effective way of protecting the population against radon is the correct installation of passive prevention systems in new buildings. EPA-funded research reveals that implementing the building regulations relating to radon prevention has resulted in a 13 per cent reduction in average radon concentrations in Irish homes (McGrath and Byrne, 2019).

Topic Box 14.5 Radioactivity Monitoring Programme

Artificial radioactivity in the Irish environment has been routinely monitored since 1982. These data show that, although the levels of artificial radionuclides in the Irish environment are detectable, they are low and do not pose a significant risk to the health of the Irish population. The results of this monitoring are publicly available on the EPA's website.[5] The main elements of the EPA's radioactivity monitoring programme are outlined below.

The National Radiation Monitoring Network

This is a network of 21 stations across Ireland that constantly monitor radiation levels in the environment, with the support of Met Éireann, local authorities and the defence forces. Rainwater and aerosol samples from these stations are measured in the laboratory, while data from online gamma dose-rate monitors are sent live to the EPA's website and international reporting systems. This network ensures that Ireland receives the first measurements in the event of a radioactive 'cloud' reaching the country. The network plays an important role in the National Plan for Nuclear and Radiological Emergency Exposures.

The Marine Monitoring Programme

The EPA carries out its Marine Monitoring Programme to determine the levels of radioactivity in the marine environment. Samples of seawater, seaweed, sediment, fish and shellfish are collected from fixed locations around the coast, in the Irish Sea and from fishing ports. These data provide a baseline against which measurements can be compared and will enable elevated radiation values to be identified quickly.

Radioactivity in food products and drinking water

Samples of drinking water, milk, 'complete meals', cereals and individual foodstuffs are also collected and analysed for radioactivity. The data collected are used to calculate the radiation doses received by the Irish population from artificial radioactivity. These are small compared with those received as a result of natural radiation and do not constitute a significant health risk.

Non-ionising Radiation

According to the World Health Organization, no health effects have been identified for electromagnetic fields exposure at levels below the guidelines set for members of the public.

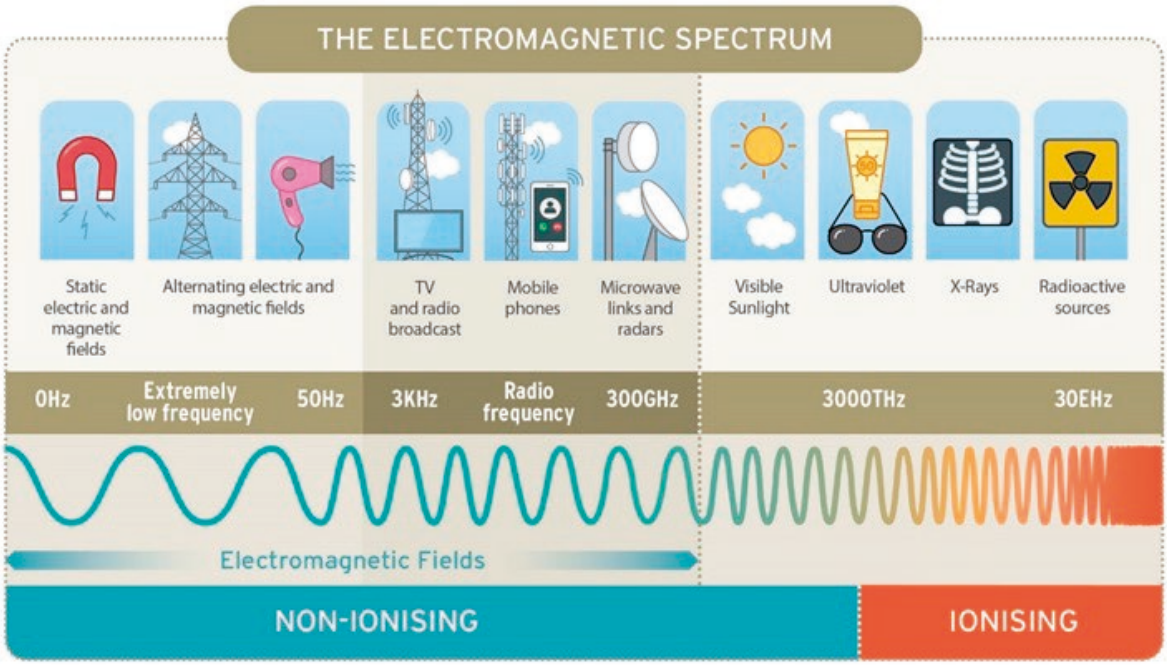
In May 2019, the EPA was given responsibility for monitoring public exposure to non-ionising radiation as well and providing advice to the Minister for the Environment, Climate and Communications and general information to the public. Non-ionising radiation is more commonly referred to as electromagnetic fields (EMFs), which are needed for all forms of telecommunications (mobile phones, Wi-Fi, Bluetooth, etc.) and are produced when electricity is generated, transmitted and used (Figure 14.9). Other bodies and agencies involved in this area of activity include the Department of Environment, Climate and Communications, Commission for Communications Regulation, Health and Safety Authority and ESB.

Typical EMF levels in Ireland are low and well below the levels set in the international recommendations for members of the public. The introductions of new technologies, such as 5G, may result in a slight increase but the total exposure is expected to remain low with no consequences for public health.

According to the WHO, no health effects have been identified for EMF exposure at levels below the guidelines set for members of the public. This conclusion is in line with the 2015 report *Electromagnetic Fields in the Irish Context*, prepared on behalf of the Irish Government by the National Institute for Public Health and the Environment of the Netherlands (RIVM, 2015). The effects of radiofrequency EMFs, including the frequencies used and envisaged for 5G, have been subject to significant research. No health effects have been shown at levels below the ICNIRP guidelines for members of the public; therefore, no consequences for public health are expected from exposure to 5G. The EPA works closely with the WHO on EMF issues, and has published a public information pamphlet on 5G (EPA, 2020f).

5 http://www.epa.ie/radiation/monassess/per/

Figure 14.9 Non-ionising radiation and the electromagnetic spectrum (Source: EPA)



OSPAR Monitoring of Radiation in the Marine Environment

Tracking discharges of radioactive substances and concentrations of radionuclides in the marine environment is covered in the OSPAR Convention.

Ireland is one of 16 Contracting Parties to the 1992 Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention). The Oslo-Paris Commission's 2010-2020 Strategy for the Protection of the Marine Environment of the North-East Atlantic has identified five areas of interest to maintain the region's ecosystem. One of these involves preventing the pollution of the North-East Atlantic by ionising radiation through progressive and substantial reductions in discharges, emissions and losses of radioactive substances. The EPA collates and reports data on annual discharges of radioactive substances from licensed facilities and annual concentrations of radionuclides in the marine environment. While levels of artificial radioactivity in the Irish marine environment remain detectable, they are low and broadly consistent with levels reported previously, posing no risk to the health of the Irish population.

4. Global Issues – Local Challenges

Ireland is not alone in working on developing solutions for some of the most significant environmental, health and wellbeing challenges it currently faces. Antimicrobial resistance, air pollution, climate change and urbanisation pose considerable threats to Irish society and the global population. While global action is often key to enabling a coordinated and accelerated response across nations, it is essential that national solutions and individual actions are developed in tandem to address issues at a local level.

Antimicrobial Resistance

The issue of antimicrobial resistance is now one of the most serious global concerns affecting human health. The environmental dimension of antimicrobial resistance is now receiving more attention.

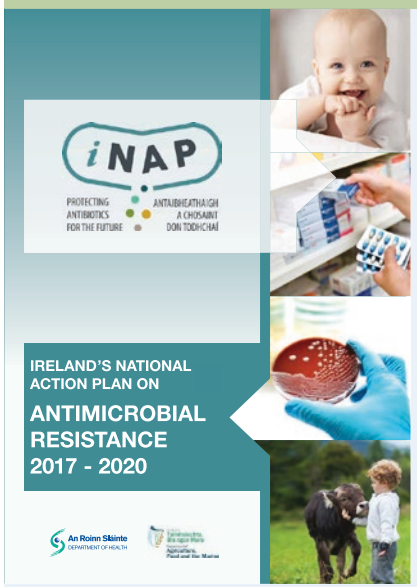
Widespread and excessive use, overuse and misuse of antimicrobial agents, particularly antibiotics, has significantly contributed to the development, spread and evolution of antimicrobial resistance (AMR) worldwide. AMR occurs when microorganisms such as bacteria, viruses and fungi develop the ability to resist the action of the drugs (antimicrobials such as antibiotics, antivirals and antifungals) designed to combat them and are capable of multiplying in their presence. Antibiotics enter the environment through discharges from human sewage treatment plants and septic tanks, as well as through farm animal excreta. It is unfortunately commonplace that antimicrobials that were relied on and effective 20 years ago now fail. The report on the O'Neill review of AMR (UK Government and Wellcome Trust, 2016) estimated that, by 2050, AMR infections may become the leading cause of deaths globally.

> *'A post-antibiotic era means, in effect, an end to modern medicine as we know it.' – Dr Margaret Chan, Former WHO Director-General*

The environmental dimension of AMR, as reported by Gaze and Depledge (2017), is not well understood, in particular the complexity of interactions in the wider environment. Our water, soil and air are extremely vulnerable to discharge and release of antimicrobials and resistant microorganisms, as well as other resistance-promoting chemicals, such as biocides and heavy metals, through various routes. They also represent important potential routes of transmission of AMR to humans, animals and the food chain. The pivotal role that the environment plays in the persistence and dissemination of AMR is now being recognised; however, the extent of its role represents a significant knowledge gap. Insights are lacking on its attributional role in the selection and spread of AMR, its impact on human, animal and ecological health and on management and remediation strategies to curb its further evolution.

AMR is of such concern at a national level that it has been identified as a strategic risk to Ireland's future wellbeing in the Irish Government's National Risk Assessment since it was first published in 2014. Ireland's first National Action Plan on AMR (iNAP; Figure 14.10) was published in 2017 (Government of Ireland, 2017) and recognises that joint coordinated action is needed to deal with the threat of AMR to public health, animal health and the environment. The plan represents an ambitious 3-year multi-stakeholder effort to implement actions to prevent, monitor and combat AMR across the health, agricultural and environmental sectors in Ireland, which is consistent with the requirement of a One Health approach to tackling the issue of AMR.

Figure 14.10 Ireland's first National Action Plan on AMR (iNAP) (Source: Government of Ireland, https://www.gov.ie/en/publication/ec1fdf-irelands-national-action-plan-on-antimicrobial-resistance-2017-2020/)



STRATEGIC OBJECTIVE 1:
Improve awareness and knowledge of AMR

STRATEGIC OBJECTIVE 2:
Enhance surveillance of antibiotic resistance and antibiotic use

STRATEGIC OBJECTIVE 3:
Reduce the spread of infection and disease

STRATEGIC OBJECTIVE 4:
Optimise the use of antibiotics in human and animal health

STRATEGIC OBJECTIVE 5:
Promote research and sustainable investment in new medicines, diagnostic tools, vaccines and other interventions

The first detection of the AMR bacteria carbapenemase-producing Enterobacterales (CPE) in European seawater was reported in Ireland in 2017 (Mahon *et al.*, 2017). Untreated sewage discharged in the area was found to be the likely source of the CPE detected in this study. CPE is currently one of the superbugs that is most difficult to treat and, in October 2017, it was declared a public health emergency in Ireland.[6] Sewage, which contains pooled urine and faeces from the surrounding population, is a significant transmission route of AMR to the environment. This finding again highlights the absolute urgency and increased pace required for Irish Water to address the major issue of untreated sewage from the equivalent of 77,000 people being released into the Irish environment every day.

In October 2019, the European Centre for Disease Prevention and Control and the European Commission's Directorate-General for Health and Food Safety carried out a country audit to review policies and activities relating to AMR in Ireland. The EPA, with support from the Department of Housing, Local Government and Heritage, arranged a dedicated environment-focused day that provided a broad overview of progress and goals in various areas relevant to the international audit delegation. The unpublished report concluded that: 'In general, the commitment of actors, in all sectors and at all levels, to the control of AMR in Ireland is a positive example for other countries. There has been progress in AMR control on many levels and, while AMR will likely remain a significant challenge for the country, there are several achievements to build upon for future actions.' More specifically for the environmental sector, the report concluded that: 'In relation to the environmental sector, the monitoring of watch list substances under the Water Framework Directive is being carried out. The competent authorities are also working to address the issues with the quality of the water supply, untreated wastewater and the correct disposal of medicines. Additionally, the environmental and veterinary sectors have undertaken multiple actions on awareness raising, surveillance of AMR and research.'

Monitoring antimicrobial use and resistance trends is vital to inform policy developments and monitor the impact of interventions over time. While there is established surveillance of antimicrobial use and AMR in the human and animal health sectors (Government of Ireland, 2019a), there is currently a lack of systematic surveillance of antimicrobials and AMR in the environment, other than the EU Water Framework Directive 'watch list', which all Member States currently undertake to monitor. This means that there are no baseline data on which to track changes or assess the extent of AMR in the environment. Ireland is not alone in this regard and has an opportunity to take action on this. A systematic surveillance system for AMR in the environment, integrated with existing human and animal surveillance systems, would be a solid basis for safeguarding the health of humans, animals and ecosystems against the threat of AMR.

6 https://www.hse.ie/eng/about/who/healthwellbeing/our-priority-programmes/hcai/european-antibiotics-awareness-day/public-health-emergency/

Climate Change

Climate change has a wide range of direct and indirect impacts on physical health, as well as psychological and wellbeing effects. There has been a considerably rise in 'eco-anxiety' among the public because of the magnitude of this issue.

Climate change is one of the greatest challenges facing the health of our society. Without action, climate change will undoubtedly have profound and wide-ranging impacts on human health and wellbeing and has the potential to challenge the substantial health gains we have achieved over recent decades (EASAC, 2019). Climate change can have direct impacts on health through physiological effects and injuries or death due to severe weather extremes such as heat waves, cold snaps, flooding, storms and increases in UV radiation levels affecting the occurrence of skin cancers. Indirect effects of climate change brought about by ecological changes can result in the spread of vector-borne and climate-sensitive infectious diseases, cause food and water insecurity, enhance the effects of aeroallergens (such as pollen and mould spores), increase the adverse impact of air pollutants and reduce air quality and cause population displacement (WHO, 2018). In addition to the physical health impacts, climate change is already having profound impacts on psychological wellbeing and mental health (Hayes *et al.*, 2018). These effects are particularly felt by those living in ecologically sensitive areas such as those prone to flooding. However, there is now also a recognised rise in 'eco-anxiety' among the general public, brought about by a sense of despair and distress around the scale and magnitude of the threat we face.

> *'The impact of climate change will be felt by every individual, household, and community across Ireland.'*
> *– Climate Action Plan, 2019*

The 2018 Intergovernmental Panel on Climate Change (IPCC) Special Report on global warming of 1.5°C (IPCC, 2018) highlighted that global warming is likely to reach 1.5°C above pre-industrial levels between 2030 and 2052, should temperature continue to rise at its current rate. There is considerable confidence that there will be a wide range of negative health consequences associated with such a rise in temperature, which could disproportionately affect vulnerable and disadvantaged populations (Ebi *et al.,* 2018). The 2015 Paris Agreement, which is frequently cited as potentially the strongest health agreement of this century, makes the 'right to health' a fundamental principle guiding action on climate change and sustainable development (WHO, 2018).

In addition to direct effects there are indirect health effects of climate disruption. Research by Flood *et al.* (2020) identifies that the likely future impacts of climate change in Ireland in terms of physical changes relate to temperature, precipitation and sea level rise, with the most prominent risks associated with projected increases in extreme weather conditions and an increased likelihood of river and coastal flooding. This research undertook a preliminary economic assessment of the potential impacts of climate disruption and has highlighted those risks with the potential to cause substantial disruptions to economic activity. These include the costs of disruptions to essential services including threats to critical infrastructure that supports health such as drinking water supply and treatment, and waste water treatment, and power supply.

From a national perspective, the government's National Adaptation Framework 2040 requires the preparation of sectoral adaptation plans, including a plan for the health sector.[7] The current plan will focus on a number of climate scenarios with profound health implications, namely increased exposure to UV radiation and the sun, worsening air pollution and severe weather events. Moreover, the government's Climate Action Plan,[8] launched in 2019, sets ambitious targets to achieve Ireland's, and the EU's, ambition to reach climate neutrality by 2050.

On an individual basis, there is much that can be achieved in our own households to help to combat climate change. These actions may also have a multitude of co-benefits for our health and wellbeing and for the wider environment. Simple actions include leaving cars at home and walking, cycling or taking public transport, considerably reducing the amount of food waste we generate by planning our meals and buying only what we need, consuming a more balanced diet rich in plant-based foods and eating less red and processed meats, as well as using cleaner fuels for home heating and improving the overall energy efficiency of our homes to reduce the need for heating.

7 https://assets.gov.ie/38322/fd5750277357421cb2472687e9b33d8f.pdf

8 https://www.gov.ie/en/publication/ccb2e0-the-climate-action-plan-2019/

Loss of Ecosystems and Biodiversity

Healthy ecosystems provide essential food and biomass, help maintain the quality of our water, soils and air, regulate floods, absorb greenhouse gases and protect us from increasingly extreme weather patterns.

Biodiversity matters for a whole variety of reasons: ethical, emotional, environmental and economic. It is the very foundation of our society and the basis of our economic success and wellbeing (EC, 2008). Despite many strategies and targets, Europe continues to lose biodiversity at an alarming rate and the aims of many policies will not be achieved (EEA, 2019b). The cumulative pressures of climate change, chemical use, emissions to air and water, exposure to noise, unsustainable resource use and excessive consumption, land use and urban expansion all act to increase vulnerability and accelerate deterioration. The World Economic Forum reports that biodiversity loss and ecosystem collapse are one of the biggest threats facing humanity in the coming decade (WEF, 2020). The health and wellbeing of our society and our economy depend on the services of our ecosystems; accordingly, the chronic degradation observed cannot be allowed to endure. In 2019 the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) published a major global assessment on the status of ecosystems and biodiversity. The IPBES Chair, Sir Robert Watson, noted that: 'The health of ecosystems on which we and all other species depend is deteriorating more rapidly than ever. We are eroding the very foundations of our economies, livelihoods, food security, health and quality of life worldwide.' (IPBES, 2019). The IPBES global assessment also reviews the health dividend provided by nature and the risks associated with damage to natural systems. Aside from the obvious dividends, such as clean air, clean water and food provision, it was noted, for example, that 70 per cent of cancer drugs are natural or synthetic products inspired by nature and that approximately four billion people rely primarily on natural medicines.

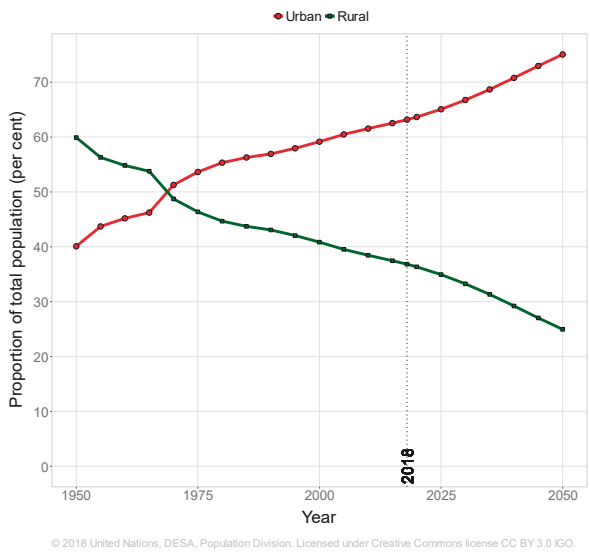
In May 2020 the European Commission published the latest EU Biodiversity Strategy for 2030, *Bringing Nature Back into our Lives* (EC, 2020), which pledges to show ambition to reverse biodiversity loss, lead the world by example and by action, and help agree and adopt a transformative post-2020 global framework at the 15th Conference of the Parties to the Convention on Biological Diversity. A principal ambition in this new EU strategy is that 'the world should commit to the net-gain principle to give nature back more than it takes'. The health dividend flowing from secure ecosystems and thriving diversity is recognised in Ireland's current National Biodiversity Action Plan 2017-2021 (DCHG, 2017) and also in its National Health Strategy, which notes that delivering a healthier future will result in people living in a health-promoting sustainable environment (Government of Ireland, 2013). In the public consultation for the National Risk Assessment (Government of Ireland, 2019b) biodiversity emerged as a key national risk and as one of the most important priorities cited by respondents.

Urbanisation

Urbanisation is one of the key demographic 'mega-trends' that is shaping and defining our future world.

It is estimated that, by 2050, two-thirds of the global population will live in urban centres. In Ireland, an estimated 63 per cent of the population currently lives in urban areas, and this number is set to rise to over 75 per cent by 2050 (UN, 2018) (Figure 14.11). The population is predicted to increase by 20 per cent to over 5.6 million by 2040 (ESRI, 2018).[9]

Figure 14.11 Predicted percentage of Ireland's population in urban and rural areas, 1950-2050 (Source: UN DESA, Population Division)



9 *From 2018 Revision of World Urbanization Prospects ©(2018) United Nations. Reprinted with the permission of the United Nations. https://population.un.org/wup/Country-Profiles/.*

Urbanisation can support the emergence of obesogenic environments, promoting more sedentary, inactive lifestyles and leading to an increase in obesity, a reduction in physical activity and increased prevalence of chronic diseases.

> *Obesogenic environment: 'the sum of influences that the surroundings, opportunities, or conditions of life have on promoting obesity in individuals or populations.' – Swinburn et al. (1999)*

Other health challenges arising from urbanisation include exposure to excessive noise and poor air quality. Moreover, increased urban living means that there may be fewer opportunities for engaging with our natural environment, which can in itself be detrimental to our physical and mental health. Strong health-centred urban design, policies and planning are therefore vital for Ireland's transition to more compact urban living. Planning policy and practice should commit to prioritising a modal shift away from the currently high dependence on private internal combustion engine-powered motor vehicles to amenities and networks that support more active travel and living. While the government's National Planning Framework 2040 moves towards aligning health considerations and policy within the spatial planning framework, local government has a vital role implementing programmes that promote active living at a community level. Given the rising level of urbanisation and population growth, coupled with the increasing public health burden of obesity and physical inactivity, it is critically important that health-centred design and planning is prioritised and appropriately implemented at local and national levels.

5. Conclusions

Interconnected Solutions

Our health and wellbeing are inextricably linked to our surrounding environment. Many of the issues we face that damage our environment and our health and wellbeing are closely interconnected. Harnessing the co-benefits of solutions is essential for effective and efficient environmental and health protection. Solutions that can help to address one issue can deliver substantial co-benefits for others. For example, providing integrated health-promoting environments in urban planning can promote more active travel, reduce air pollution through the use of fewer private vehicles, act as quiet areas buffered from environmental noise and improve the physical and mental health of those walking or cycling. Moreover, meeting the targets of the Paris Agreement would be expected to save over one million lives globally each year from the effects of air pollution alone by 2050 (WHO, 2018).

Environment Health in All Policies Approach

Developments in government policies have, in the past, led to tension and unintended consequences that have reduced the quality of our environment. Going forward, it is crucial that policies and measures are carefully formulated to maximise synergies, minimise unintended negative consequences and ultimately yield improvements and co-benefits for the environment and the health and wellbeing of our society. Importantly, an 'Environment Health in All Policies' approach should be adopted across government, whereby policies across all sectors must systematically consider the implications of decisions on the environment and human health, capture synergies and prevent negative impacts and inequity in exposures and outcomes. Including public health considerations and co-benefits in environmental policy development is a clear opportunity.

Individual Actions

From an individual perspective, greater action is needed at a household level to proactively tackle the various avoidable health consequences that we and our families face every day. Equally, as individuals, we need to engage more with our green and blue spaces as they offer a multitude of health and wellbeing benefits. While it is clear that the changes and action required to avert major challenges such as climate change, air pollution and plastic pollution use are no doubt beyond the immediate reach of the individual, the influence that individual action or choice can have on others may indeed help lay important foundations for further action and shift society's view of what is considered 'normal'. The importance of small individual actions must therefore not be underestimated.

Specific Environment and Health Challenges

The following are specific environment and health challenges.

- A switch away from solid fuel burning by all householders would ensure a better environment for those vulnerable populations in society, such as people, and particularly children, with asthma. It would also help to limit our carbon dioxide emissions, which are contributing to climate change.
- The incidence of STEC/VTEC in Ireland is the highest in Europe and the number of cases is growing year on year. A coordinated 'One Health' approach (i.e. recognising the interconnection between people, animals, plants and their shared environment) is urgently needed to tackle this issue, particularly in the light of climate change and increasing extreme weather events.
- Improvements are needed at public drinking water supplies identified by the EPA as in need of upgrading, replacement or improved operational control. There is also a need to improve resilience against weather events and climate extremes.
- Irish Water must urgently address the issue of untreated sewage from the equivalent of 78,000 people being released into the Irish environment every day. Wastewater facilities must be established, and infrastructurally and operationally improved, at a much faster pace.
- A formalised national take-back scheme for unused or expired human medicines and legacy contaminants is needed to offer a safe disposal mechanism to the public and prevent unnecessary environmental contamination.
- Consideration should be given to applying stricter limits and standards for a broader range of metals, chemicals and contaminants in sewage sludge, which are subsequently recycled to land, as a proactive step to protect our environment and human health from contaminants of existing and emerging concern.
- Systematic environmental surveillance of antimicrobial use and AMR and of emerging pollutants of concern is required to contribute to protecting human, animal and ecosystem health.
- Exposure to radon results in an estimated 300 cases of lung cancer each year. Research has shown that better building practices have resulted in a 13 per cent reduction in the average radon concentration in Irish homes and that stronger regulation is the most effective way of protecting the population from radon.

Chapter Highlights for Environment, Health and Wellbeing

A good-quality, well-protected environment has significant health and wellbeing benefits; research has shown that access to clean green and blue spaces in our environment is good for us. The provision of health-promoting environments in urban planning is central to Ireland's transition to more compact and urban living.

Greater individual action needs to be taken to proactively tackle avoidable health consequences linked to the environment. Actions include radon testing, testing private wells, maintaining septic tanks, eliminating use of smoky fuels, reducing wasteful consumption, preventing littering and making sustainable commuting decisions.

There are risks to our environment and our health from climate disruption, chemical exposure, and underinvestment in drinking water and wastewater treatment infrastructure. These risks must be addressed through state investment in targeted research, in monitoring and enforcement actions, and through investment by Irish Water in the necessary water services infrastructure.

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