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Healthier environment for healthier lives: impacts of the European Green Deal on human health

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This report has been written by Ian Keyte (WSP), Karina Reynolds (WSP), Natalie Sims (WSP), Will Cooke (WSP), ,Zhelyan Vichev (WSP)

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List of abbreviations

Abbreviation	Full definition
CAMS	Copernicus Atmosphere Monitoring Service
CDP	Carbon Disclosure Project
CLP	Classification, labelling and packaging of substances and mixtures
CO	Carbon monoxide
COM	Covenant of Mayors
COPD	Chronic pulmonary disease
COR	Committee of the Regions
ECDPC	European Centre for Disease Prevention and Control
EEA	European Environmental Agency
EFFIS	European Forest Fire Information System
END	Environmental Noise Directive
EPRS	European Parliament Research Service
EUR	Euro
EU	European Union
GHG	Greenhouse gas
HBM4EU	The Human Biomonitoring for EU
LEZ	Low emission zones
NO_2	Nitrogen dioxide
O_3	Ozone
PAH	Polycyclic aromatic hydrocarbons
PAN	Pesticide Action Network
PFAS	Per- and polyfluoroalkyl substances
PM	Particulate matter
RBMPs	River Basin Management Plans
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
SO_2	Sulphur Dioxide
SVHC	Substance of Very High Concern

UWWTD	Urban Wastewater Treatment Directive
WHO	World Health Organisation
YLD	Years lived with disability
ZPAP	Zero Pollution Action Plan

Summary

Local and regional action delivering the Green Deal

Climate change and environmental degradation are recognised as key existential threats to human health. The European Green Deal aims to address these threats, and its associated polices and targets act to improve the health and well-being of citizens across Europe. Actions taken at local or regional level, particularly in cities, are at the core of delivering the ambitions of the Green Deal. Reflecting on the types of local and regional action already taken and investigating successful examples where improvements to the environment and health have been achieved is essential. This can allow policy makers to share best practice and take well-informed and consistent approaches, leading to positive outcomes for the health of European citizens and ensure the aims of the Green Deal are achieved.

This report provides an overview of the main health determinants associated with climate change, pollution and environmental degradation, and presents 10 specific case studies where measures have been put in place at the local and regional level to address these issues. From these examples, and a review of publicly available evidence, a consideration of impacts from local and regional measures on environmental determinants and health is made. Key enabling factors and lessons learned are highlighted and recommendations made for local and regional policy makers (as well as action at national and EU level) to consider when developing measures addressing environmental risks and improving public health.

Health risks related to climate change and environmental degradation

This report investigates both the direct and indirect links between the environment and human health. Direct impacts include the health effects of exposure to pollutants in air or water, to noise pollution, and to light pollution. Indirect impacts are linked to the effects of climate change causing flooding, fires, and extreme temperatures, which can increase disease rates, and the impact of environmental degradation of ecosystems on food systems. Wider societal issues related to energy poverty, access to blue or green spaces, and social inequalities which can impact physical and mental health and wellbeing are also discussed.

Impacts of local action on public health

The ten case studies examples of local actions presented here aim, as possible, to cover a broad range of different types of measure (location, scale, pollution type/source, type of health impact targeted etc). However, given the wide range of different environmental determinants, it was not possible to cover all of these.

In practice it was observed that the evidence base for certain types of action (e.g. related to mobility, green space and traffic reduction measures) is generally wider than for other types of measure so these are covered more frequently than others.

In terms of a broader consideration of health improvements achieved from local and regional measures, one key observation from this report is that the specific consideration and estimates of the health impact from individual measures is not routinely or consistently done, or where measures have been in place relatively recently, direct measurement of health impacts has not yet been made. The direct (quantitative or qualitative) measurement of health impacts appears to be better established and more feasible for some types of pollution and types of measures than for others. For example, the health benefits of measures targeted at air and noise pollution and particularly those focused on traffic reduction are relatively well demonstrated compared to other types of pollution or environmental damage.

Key success factors and lessons learned

The development of successful measures at local or regional level that target environmental determinants to improve public health can be envisaged as comprising four key stages:

1. Identifying the scope and location of measures (inception phase);
2. Designing and strategising of measures (planning phase);
3. Executing and operating of measures (implementation phase); and
4. Monitoring of measures (assessment phase).

While there are important nuances between measures targeted at different type of environmental determinants, as well as local factors impacting measures in each specific region, this report has highlighted a number of key consistent success factors that are likely to be relevant across all types of measures. These can be broadly grouped into four key categories:

- **Assessment and research** – e.g. investigation and impact assessment to inform the location and focus of measures to target action where this will have most impact; identifying synergies between different type of actions; identifying key practical and logistical factors and constraints.
- **Policy** – e.g. an effective legislative infrastructure (at local, national and EU-level) or framework to incentivise, enable or mandate measures.
- **Funding** – e.g. including mechanisms that encourage, enable and support smart design and implementation of measures and support key stakeholders.
- **Communication** – e.g. including a constructive and transparent discourse with all stakeholders including the public; ensuring expected and measured impacts are communicated, both to the public and policy makers.

Recommendations for policy makers

This report demonstrates that the planning, design, implementation and monitoring of local or regional measures to address pollution, environmental degradation and climate-related risks requires action at multiple levels (local, national and EU-level) to achieve the maximum health benefits. Key recommendations have been highlighted at each level, including:

Local or regional authority actions

- Investigate and prioritise actions where these are most needed, based on the consideration of actual health impacts and vulnerable or 'high risk' groups.
- Collaborate and share information and best practice, both to the public and other regions across Europe.
- Conduct a detailed impact assessment at the beginning, which includes a consideration and analysis of expected health impacts.
- Establish a suitable infrastructure to communicate and consult with key stakeholders and wider public.
- Establish appropriate monitoring to measure impact.

National-level actions

- Implement national laws or regulatory frameworks to support, guide and/or stipulate the adoption of such measures at local level.
- Establish a means to support (e.g. with targeted funding and/or financial incentives) the implementation or uptake of measures by specific stakeholders identified as needing support.
- Support cities and/or regions by facilitating the exchange of best practice.

EU-level actions:

- Consider implementing or revising EU-level regulations to help drive and support Member States to take action to address pollution from a public health perspective.
- Develop EU-wide networks to share information and best practices at each stage of the process (planning, design, implementation and monitoring of impacts).

Introduction

Background

Climate change, pollution and environmental degradation are key existential threats to human health in Europe and across the world. The link between the environment and health includes both direct impacts (for example, related to exposure to pollutants in air or water, noise pollution, and light pollution) and indirect impacts. Indirect impacts are linked to the effects of climate change causing flooding, fires, and extreme temperatures which can increase disease rates, the impact of environmental degradation of ecosystems on food systems, as well as wider societal issues related to energy poverty, access to blue or green spaces, and social inequalities which can impact physical and mental health and wellbeing.[1]

In 2019, the European Green Deal[2] was launched with the ambition to address the threat posed by climate and environmental risks and achieve climate-neutrality; cut pollution; increase biodiversity; and improve the health and well-being of European citizens. It sets out a comprehensive package of policy initiatives and ambitious targets, for example, for climate, energy, industry, buildings and transport, to ensure its headline objectives can be met. This underlines the need for finding and implementing cost effective actions to protect European citizens from environmental threats to improve overall health and wellbeing across the whole of Europe.

Taking action at city and regional level in Europe is key to achieving both the wider ambitions of the Green Deal and specific targets and policy objectives set under it. Urban areas are an important focus point for action, as this is where a significant proportion of the population live (in 2021, 75% of the EU population were living in cities, towns, or suburbs).[3] Urban areas are also disproportionately affected by environmental pressures such as air pollution and noise pollution. As such, urban areas are where the sources, as well as impacts, of pollution may be most significant, and where measures to tackle the issues are likely to have the most direct impact on people's health. A number of EU-wide initiatives have

[1] European Environment Agency (2019). Healthy environment, healthy lives: how the environment influences health and well-being in Europe. Available at: https://www.eea.europa.eu/publications/healthy-environment-healthy-lives [Accessed 15/11/2023]

[2] European Commission (n.d.). The European Green Deal (Overview). Available at: https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en [accessed 25/09/2023]

[3] European Commission (2022). Urban-rural Europe – quality of life in rural areas. Available at: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Urban-rural_Europe_-_quality_of_life_in_rural_areas [accessed 15/11/2023]

already been established, including the Green City Accord[4], Urban Green Platform[5], and Green Deal Going Local Working Group[6] to enable and facilitate actions at local and regional level.

Policymakers in many cities and regions have already been adopting and implementing measures that aim to tackle pollution and climate related challenges with the goal of improving the health and wellbeing of their inhabitants. Local and regional policymakers will also be key in taking actions to achieve the goals and objectives of the Green Deal in the future. Those actions can take many forms, and vary in their type, scope, design, focus, and desired outcomes. For example, actions could be targeted towards the source of pollution and pathway of pollution (such as urban planning and infrastructure changes), education and guidance etc. It is important to reflect on the experiences in designing, planning, implementing, and monitoring the progress of these actions, in order to identify common challenges and successes. This will improve the understanding of the key factors and underlying policy and economic frameworks that will then enable future actions to be made in other cities and regions and to better deliver the ambitions of the Green Deal.

Objectives

The aims of this report are:

- To investigate and present the main health determinants associated with climate change, pollution and environmental degradation, and the key impacts at the local and regional scale in Europe;
- To highlight specific examples of actions taken at local and regional level aiming to address these issues and where improvements in the health and wellbeing of citizens have been demonstrated;
- To illustrate the key challenges and success factors associated with designing, planning, implementing and monitoring measures at local and regional scale, and demonstrate key aspects of best practice and lessons learned from these case studies (for the benefit of local and regional policymakers); and
- To identify the key enablers (e.g. policy and governance frameworks, capacity building instruments, financing and funding mechanisms etc.)

[4] European Commission (n.d.). Green City Accord. Available at: https://environment.ec.europa.eu/topics/urban-environment/green-city-accord_en [accessed 15/11/2023]
[5] European Commission (n.d.). Urban Greening Platform. Available at: https://environment.ec.europa.eu/topics/urban-environment/urban-greening-platform_en [accessed 15/11/2023]
[6] European Committee of Regions (n.d.). Green Deal Going Local. Available at: https://cor.europa.eu/en/engage/Pages/green-deal.aspx?utm_source=SharedLink&utm_medium=ShortURL&utm_campaign=Green%20Deal%20Going%20Local [accessed 15/11/2023]

that allowed these measures to be impactful in improving health.

It is further envisaged that the information presented in this report will provide the basis of producing additional materials that will help illustrate the importance of action at local and regional level in tacking climate change, pollution and environmental degradation, to improve the health of European citizens.

Approach

This report has been developed on the basis of a review of publicly available literature and consultation with a small number of expert stakeholders. The full details of the methodology used in developing this report, including the specific stakeholders consulted, are provided in Annex 1.

This report

This report is presented in the following sections:

- Section 1: Overview of the impacts of climate change, pollution and environmental degradation on human health;
- Section 2: Case studies highlighting 10 specific cases where action has been taken (or is planned) at local or regional level to tackle specific environmental issues with the aim of improving human health;
- Section 3: Assessment of the impact of implementing projects to address the climate, pollution and environment crises on human health;
- Section 4: Synthesis of critical success factors, challenges and lessons learned; and
- Section 5: Policy recommendations and guidelines for cities and regions for a successful evaluation of the health-related benefits of environmental and climate policies.

1. Environmental determinants of health – an overview for local leaders and policy-makers

1.1 Introduction

Public health is shaped by multiple factors, encompassing diverse environmental and social elements, i.e. risk factors / environmental health determinants. Environmental health determinants include both pollution and climate change. Pollution is a widespread issue, and exposure to environmental pollution has become a significant cause of adverse health effects.[7] Climate change-related factors such as extreme weather, flooding and extreme temperatures can also exacerbate health effects. Social factors, such as access to natural spaces and energy resources, can also significantly influence environmental determinants of health. Vulnerable groups (including children and the elderly) tend to be more sensitive to pollution exposure while those in lower socio-economic groups tend to be exposed to higher levels. Furthermore, the sources of pollution, and the routes and extent of exposure to humans varies significantly between countries.[8]

This section introduces the key environmental and societal determinants impacting human health and emphasises the critical role of policy actions in addressing these growing challenges. This summary is based on a review of literature sources in the public domain. A number of European and global organisations or agencies have extensively reviewed the impacts of environmental degradation on human health, including the European Environment Agency (EEA) and World Health Organisation (WHO). For each of the key environmental and societal determinants covered, key actions or policies at local or regional level that focus on these issues are also discussed. A number of key EU level policies that impact the environment and human health a presented in the following sub-sections.

1.2 Policy overview

1.2.1 European Green Deal

The European Green Deal[2], introduced by the European Commission in December 2019, sets out the EU's commitments to tackle climate change and environmental degradation. A key objective of the European Green Deal is to protect human health from environmental risks and impacts, such as pollution and

[7] The World Bank (n.d.). Pollution (Overview). Available at: https://www.worldbank.org/en/topic/pollution [accessed 04/10/2023]

[8] European Environment Agency (2019). Unequal exposure and unequal impacts: social vulnerability to air pollution, noise and extreme temperatures in Europe. Report No. 22/2018. Available at: https://www.eea.europa.eu/publications/unequal-exposure-and-unequal-impacts/ [accessed 20/09/2023]

environmental degradation.

1.2.2 EU policies and strategies related to the Green Deal

Numerous different initiatives, strategies, policies and laws have emanated from the European Green Deal framework. They represent EU-wide strategies which are often applicable to different sectors of the economy and support the aims of the Green Deal and to transition towards sustainability. The following policies are highlighted as their aims influence the health determinants outlined below.

The Farm to Fork Strategy

The Farm to Fork strategy aims to transform the EU's food system into a more sustainable, healthy, and environmentally friendly process of ensuring food security and safety to the population of the EU.[9] Under the Farm to Fork strategy, health determinates impacted by pollution and climate are tackled by adding controls on the chemicals that are used in farming practices. These controls aim to reduce chemical pollution of surrounding soils and water, and ultimately increase biodiversity. Fostering biodiversity also influences improvements in the climate, and can further lead to impacts on human health, such as a decrease is allergens and zoonotic diseases.

The Chemicals Strategy for Sustainability

The Chemicals Strategy for Sustainability aims to form a comprehensive approach to managing chemicals in the European economy in a more sustainable and safe way.[10] Its main objectives are to protect citizens and the environment, while boosting innovation and novel research in the chemicals sector through actions such as phasing out the most harmful chemicals used in consumer products and funding the development and uptake of safe and sustainable by design substances. Another key commitment highlighted in the strategy is the phasing out of Per- and polyfluoroalkyl substances (PFAS), e.g. through banning all PFAS in fire-fighting foams and other uses.

In terms of EU chemicals legislation, currently, chemical pollution is controlled primarily at the EU level with legislation such as the REACH regulation, the Classification, labelling and packaging of substances and mixtures (CLP) regulation, as well as specific legislation addressing biocides, pesticides,

[9] European Commission (n.d.). Farm to Fork Strategy. Available at: https://food.ec.europa.eu/horizontal-topics/farm-fork-strategy_en [accessed 25/09/2023]
[10] European Chemicals Agency (2020). Chemicals Strategy for Sustainability. Available at: https://echa.europa.eu/hot-topics/chemicals-strategy-for-sustainability#:~:text=The%20Commission's%20strategy%20provides%20an,chemicals%20when%20assessing%20chemical%20risks [accessed 25/09/2023]

cosmetics, etc. This legislation has been introduced to help mitigate the effects of chemicals and chemical pollution on human health. It is important to note that chemicals are primarily addressed in separate policy documents, adding a layer of difficulty for local and regional authorities to enact harmonised chemical pollution strategies.

Efforts of Member States to bring awareness to chemicals of concern and chemical pollution are ongoing, including the nomination of chemicals to the substances of very high concern candidate list, chemical restriction proposals under REACH, and nomination of persistent organic pollutants to the Stockholm Convention.

The EU Biodiversity Strategy for 2030

The EU Biodiversity Strategy has the aims to stop the loss of biodiversity and to restore ecosystems which have degraded in the past. It includes targets to protect and restore natural habitats, reduce pollution, and combat invasive species. The strategy also aims to build resilience of the European society towards forest fires, food insecurity, and disease outbreaks.[11]

The EU Zero Pollution Action Plan (ZPAP)

The EU Zero Pollution Action Plan (ZPAP) has set high targets for pollution reduction to meet a zero pollution vision by 2050 as a key deliverable of the European Green Deal.[12]

As a part of this, several 2030 targets have been set, including:

- Improve air quality to reduce premature deaths caused by air pollution;
- Improve water quality by reducing waste, plastic litter, and microplastics;
- Improve soil quality by reducing chemical pesticide use;
- Reduce the number of ecosystems where biodiversity is threatened by air pollution;
- Reduce the number of people disturbed by transport noise; and
- Significantly reduce waste generation.

This EU wide action plan relies heavily on regional and local policies and initiatives due to the vast biodiversity, climates, and lifestyles within the EU.

Air quality legislation

[11] European Commission (n.d.). Biodiversity strategy for 2023. Available at: https://environment.ec.europa.eu/strategy/biodiversity-strategy-2030_en [accessed 25/09/2023]
[12] European Commission (n.d.). Zero pollution action plan. Available at: https://environment.ec.europa.eu/strategy/zero-pollution-action-plan_en [accessed 15/11/2023]

The ZPAP (see above) sets a specific target for improving air quality to reduce the number of premature deaths caused by air pollution by 55% by 2030 (compared to 2005 baseline). At EU-level, there is a regulatory framework in place to tackle air pollution, which consists of three main pillars:

1. Legislation regulating concentrations of pollutants in ambient air (e.g. the EU Ambient Air Quality Directives (2008/50/EC and 2004/107/EC));
2. Legislation regulating total national emissions of air pollutants (e.g. the National Emission Ceilings Directive, (2001/81/EC)); and
3. Legislation regulating emissions from specific sources (e.g. from road transport, shipping, industry and energy generation).

For example, the EU Ambient Air Quality Directives set EU air quality standards[13] for 12 air pollutants[14], which take into account relevant World Health Organisation (WHO) standards, guidelines and programmes.[15] Member States are required to adopt air quality plans setting out measures to be taken to reduce the concentration of pollutants in areas where air quality standards are exceeded.

Environmental noise legislation

The ZPAP sets a specific target for reducing the share of people chronically disturbed by transport noise by 30%.

Within the EU, the main instrument used to identify and enable action on noise pollution is the Environmental Noise Directive (END) (2002/49/EC). The END requires Member States to publish both noise exposure maps and noise management actions plans on a 5-year basis. The END also recognises the need to preserve areas of good acoustic environmental quality, referred to as 'quiet areas', to protect the European soundscape.

The END sets legally binding obligations for reduction and management of environmental noise. The directive offers a common approach to avoiding and preventing exposure to environmental noise through the reporting of noise mapping and action planning. The noise mapping exercise is seen as a precursor for guiding the implementation of noise reduction measures which should aim to reduce the impact of noise. The Directive introduced two key indicators for annoyance and sleep disturbance, which, if exceeded, require action plans to be

[13] European Commission (n.d.). EU air quality standards. Available at: https://environment.ec.europa.eu/topics/air/air-quality/eu-air-quality-standards_en [accessed 15/11/2023]
[14] Sulphur dioxide, nitrogen dioxide / nitrogen oxides, particulate matter (PM10, PM2.5), ozone, benzene, lead, carbon monoxide, arsenic, cadmium, nickel, and benzo(a)pyrene.
[15] World Health Organization (2021). WHO Global Air Quality Guidelines. Available at: https://www.who.int/news-room/questions-and-answers/item/who-global-air-quality-guidelines [accessed 25/09/2023]

drawn up that are designed to reduce exposure and protect good quality areas not yet polluted by noise.[16]

Other EU legislation to regulate noise has been introduced for road, railway, aircraft, and even outdoor equipment. Several regulations for road noise which primarily focus on the use of approved tyres to reduce road noise have been introduced, along with railway noise regulations to impose quieter routes for freight routes and airport noise reduction measures have been enacted in the past 10 years. While these regulations are making a change, further change at the local and regional level is necessary to make significant impacts on noise pollution.

In 2023, the Commission published the third implementation report for the END and highlighted that actions to combat noise pollution needed to be intensified to meet the goals set out in the Zero Pollution Action Plan by 2030.

Water Directives

The ZPAP (see above) sets a specific target for improving water quality by reducing waste, plastic litter at sea (by 50%) and microplastics released into the environment (by 30%) by 2030 (compared to a 2005 baseline).

The EU is taking steps to address water quality through works such as the Water Framework Directive (2000/60/EC) and the Drinking Water Directive (EU/2020/2184). Water pollution has been linked to a number of acute and chronic health issues, such as diarrhoea, skin diseases, malnutrition, and even cancers.[17] An estimated 80% of disease and 50% of child deaths worldwide are related to poor water quality.

One of the main implementation tools of the Water Framework Directive are the River Basin Management Plans (RBMPs), which are legally binding local environmental objectives regarding water and water pollution.[18] The RBMPs are prepared at a River Basin District level providing a more regional level of insight due to the different conditions of each basin. Regional authorities are responsible for implementing monitoring programs for priority substances as well as additional substances of concern to ensure that water bodies achieve the minimum standard of the Water Framework Directive.

[16] European Commission (n.d.). Directive 2002/49/EC: Environmental Noise Directive. Available at: https://environment.ec.europa.eu/topics/noise/environmental-noise-directive_en [accessed 15/11/2023]
[17] Lin, L., Yang, H., and XU, X. (2022). Effects of water pollution on human health and disease heterogeneity: a review. Front. Environ. Sci (10). Available at: https://www.frontiersin.org/articles/10.3389/fenvs.2022.880246/full [accessed 25/09/2023]
[18] European Commission (n.d.). Directive 2000/60/EC: Water Framework Directive. Available at: https://environment.ec.europa.eu/topics/water/water-framework-directive_en#implementation [accessed 15/11/2023]

In terms of flooding the EU, the Commission brought the Floods Directive[19] into law. The Directive establishes a framework and aims to reduce the negative consequences of flooding on human health through the mapping of areas which are more susceptible to flooding and implementing prevention methods to limit the effects of flooding.

The Urban Wastewater Treatment Directive[20] (UWWTD) was also set in place in the EU to minimise the improper treatment of contaminated waters and their potential adverse effects. Namely, the directive aims to prevent the discharge of untreated urban wastewater into the environment because it can be contaminated with various harmful chemicals, bacteria, and viruses, which can be detrimental to human health and the environment. In October 2022, the directive was updated to feature further aspects aimed at protecting human health, such as the requirement for all EU countries to start monitoring different pathogens in wastewater.

The European Climate Law

The European Climate Law set a legally binding net zero greenhouse gas emission target for the EU by 2050 and a short-term goal of decreasing greenhouse gases by at least 55% (compared to 1990 levels) by 2030.[21] Setting the targets of the European Green Deal into law is a guarantor of the EU's commitment towards reducing environmental degradation and protecting human well-being and health.

1.3 Health determinants

1.3.1 Overview

Environmental pollution is linked to a range of disease outcomes, including cancer, cardiovascular disease, stroke, respiratory disease and neurological disorders. The links between environmental pollution and these health impacts are becoming increasingly well understood. These links have been investigated in a wide range of studies to investigate and estimate both the overall impact of pollution to the health of the European (and global) population at large, and the specific environmental determinants of different health effects. Several reviews of the information generated from across these studies have been published.

[19] European Commission (n.d.). Floods. Available at: https://environment.ec.europa.eu/topics/water/floods_en [accessed 25/09/2023]
[20] European Commission (n.d.). Urban wastewater. Available at: https://environment.ec.europa.eu/topics/water/urban-wastewater_en#review [accessed 25/09/2023]
[21] European Commission. European Climate Law. Available at: https://climate.ec.europa.eu/eu-action/european-climate-law_en [accessed 25/09/2023]

For example, The Lancet Commission on pollution and health, using data from the 2019 Global Burden of Diseases, Injuries, and Risk Factors Study[22], indicate that globally, pollution is responsible for approximately 9 million deaths per year, corresponding to one in six deaths worldwide.[23] At present, it is estimated that over 10% of annual premature deaths in the 27 EU Member States (EU-27) are related to environmental pollution. It is also estimated that the burden of environmental disease is unevenly spread across Europe, with the percentage of deaths attributable to environmental factors ranging from a low of 9 % in Norway and Iceland to 23 % in Albania and 27 % in Bosnia and Herzegovina.[1]

The EEA's Zero Pollution Monitoring Framework[24] provides an overview of links between different types of environmental pollution (air, noise, water, chemicals, soil) and health impacts. Recent EEA assessments have also highlighted the environmental determinants for specific health outcomes, including cancer[25] and cardiovascular disease.[26] These assessments indicate that exposure to air pollution, carcinogenic chemicals, radon, UV radiation, and second-hand smoke may be responsible for over one tenth of the total cancer burden in Europe, while environmental risks are estimated to cause over 18% of cardiovascular disease-related deaths in Europe.

In this section, three broad aspects of environmental degradation are discussed (pollution, climate and societal factors), and a brief summary of key information on the health determinants associated with each of these aspects is provided, based on a review of publicly available information.

1.3.2 Pollution - environmental and health impacts

Environmental pollution is a widespread issue and is a significant cause of human morbidity and mortality worldwide.[7] Pollution has reached dangerous levels globally, with recent studies estimating annual production and releases of pollution are increasing at a pace that outstrips the global capacity for monitoring and assessment.[27] Pollution can come in many diverse forms and from many

[22] GBD 2019 Disease and Injuries Collaborators (2020). Global burden of 369 diseases and injuries in 204 countries and territories, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019. Available at: https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(20)30925-9/fulltext [accessed 03/10/2023]
[23] Fuller, R. et al. (2022) Pollution and health: a progress update. Lancet Planet Health 2022; 6: e535–47. https://doi.org/10.1016/S2542-5196(22)00090-0 [accessed 03/10/2023]
[24] European Environment Agency (n.d.). Health Introduction. Available at: https://www.eea.europa.eu/publications/zero-pollution/health/health-introduction [accessed 25/09/2023]
[25] European Environment Agency (2022). Beating cancer – the role of Europe's environment. Available at: https://www.eea.europa.eu/publications/environmental-burden-of-cancer [accessed 09/25/2023].
[26] European Environment Agency (2023). Beating cardiovascular disease – the role of Europe's environment. Available at: https://www.eea.europa.eu/publications/beating-cardiovascular-disease [accessed 25/09/2023]
[27] Persson, L., et al. (2022). Outside the safe operating space of the planetary boundary for novel entities. Environmental science & technology, 56(3), pp.1510-1521. Available at: https://pubs.acs.org/doi/full/10.1021/acs.est.1c04158 [accessed 29/09/2023]

sources (e.g. pollution of the air and water, as well as harmful noise or light pollution).[28]

Air

Air pollution has been highlighted as the single largest environmental health risk in Europe with around 400,000 premature deaths attributed to air pollution in Europe in 2019.[29,30] The sources of air pollution include: residential, commercial and institutional energy consumption, agriculture, road transport, energy suppliers, manufacturing and extraction industries. Problem pollutants include particulate matter (PM), nitrogen dioxide (NO_2), ozone (O_3), sulphur dioxide (SO_2) and carbon monoxide (CO).[15] In 2020, there were an estimated 275,000 premature deaths in Europe from chronic exposure to fine particulate matter, 64,000 from chronic nitrogen dioxide exposure, 28,000 from acute ozone exposure.[31]

Exposure to air pollution has been linked to a number of diseases, including heart disease, stroke, chronic obstructive pulmonary disease, cancers, and respiratory infections. Increased levels of particulate matter pollution have also been linked to increased cases of neurological disorders, asthma, diabetes and obesity.[32] One recent global study has linked the increase of air pollution of $PM_{2.5}$ with rising antimicrobial resistance in over 100 countries studied.[33] In 2019, exposure to $PM_{2.5}$ led to around 176,000 years lived with disability (YLDs[34]) due to chronic obstructive pulmonary disease in 30 European countries.[29] Exposure to NO_2 led to 176,000 YLDs due to diabetes mellitus (also known as Type 2 diabetes) in 31 European countries in 2019. In 2019, 12,253 people across 23 European countries were admitted to hospital with lower respiratory infections resulting from acute exposure to ozone.**Error! Bookmark not defined.**

The Second Clean Air Outlook (COM(2021)3) presented the prospects for reducing air pollution in the European Union up to 2030, concluding that

[28] European Environment Agency (n.d.). Pollution. Available at: https://www.eea.europa.eu/en/topics/in-depth/pollution [accessed 29/09/2025]
[29] European Environment Agency (2023). How air pollution affects our health. Available at: https://www.eea.europa.eu/en/topics/in-depth/air-pollution/eow-it-affects-our-health [accessed 18/09/2023]
[30] European Environment Agency (2022). Air quality in Europe 2022. Available at: https://www.eea.europa.eu//publications/air-quality-in-europe-2022 [accessed 18/09/2023].
[31] European Environment Agency (2022). Health impacts of air pollution in Europe, 2022. Available at: https://www.eea.europa.eu/publications/air-quality-in-europe-2022/health-impacts-of-air-pollution [accessed 18/09/2023]
[32] World Health Organization (2022). Ambient (outdoor) air pollution. Available at: https://www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health [accessed 25/09/2023]
[33] Zhou, Z., Shuai, X., Lin, Z., Yu, X., Ba, X., Holmes, M.A., Xiao, Y., Gu, B. and Chen, H. (2023). Association between particulate matter (PM) 2.5 air pollution and clinical antibiotic resistance: a global analysis. The Lancet Planetary Health, 7(8), pp.e649-e659. Available at: https://www.thelancet.com/journals/lanplh/article/PIIS2542-5196(23)00135-3/fulltext [accessed 20/09/2023]
[34] Years of healthy life lost to disability

premature deaths due to air pollution could be reduced by around 55% in 2030 compared to 2005, if Member States implemented all measures agreed and announced under the existing EU legislation regulating sources of air pollution. The report shows that with the full implementation of all existing legislation, most Member States would be on track to fulfil the 2030 reduction commitments for key pollutants.

Noise

Noise is the second biggest driver of the environmental burden of disease in Europe after air pollution according to the WHO.[35] Long term exposure to environmental noise is estimated to cause 12,000 premature deaths and contribute to 48,000 new cases of ischaemic heart disease per year in Europe.[36] Prolonged exposure to noise can lead to several adverse effects, including cardiovascular diseases, reduced cognitive performance in children, severe annoyance, sleep disturbance and tinnitus.[35] It has been estimated that 6.5 million people suffer chronic high sleep disturbance and 22 million people suffer from chronic severe annoyance.[37]

Roads are the main source of environmental noise, with 20% of the EU population (equating to more than 100 million people) living on roads exposed to traffic noise levels that are harmful to health.[37] Other sources of noise include railways, aviation and industry.

The 2017 evaluation of the END[38] noted that the implementation arrangements vary widely between Member States, from highly centralised to highly decentralised, including a combination of approaches. Overall, implementation is shown to be severely delayed, with more than 20% of the required noise maps and around 50% of the action plans for the current five-year reporting cycle still not supplied by Member States, 3 years or more after they were due.

Furthermore, it is suggested that the number of people exposed to high levels of noise has not decreased, and millions of people remain exposed to noise levels harmful to health. It is also expected that the health impacts are most likely to be

[35] World Health Organisation (2011). Burden of disease from environmental noise – quantification of healthy life years lost in Europe. Available at: https://www.who.int/publications/i/item/9789289002295 [accessed 27/09/2023]
[36] European Environment Agency (n.d.). Noise. Available at: https://www.eea.europa.eu/themes/human/noise/noise-2 [accessed 27/09/2023]
[37] European Environment Agency (2019). Environmental Noise in Europe. Available at: https://www.eea.europa.eu/publications/environmental-noise-in-europe/ [accessed 20/09/2023]
[38] European Commission (2017). COM/2017/0151 final: Report from the Commission to the European Parliament and the Council on the implementation of environmental noise directive in accordance with Article 11 of Directive 2022/49/EC. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52017DC0151 [accessed 25/09/2023].

underestimated, with new WHO evidence demonstrating effects at levels below the obligatory END reporting thresholds.

Light

Light pollution is the excessive or inappropriate use of outdoor artificial light and can be harmful to both human health and wildlife. The key sources contributing to light pollution are streetlamps, security lighting illuminating construction sites or business buildings, floodlights used for sports facilities or on offshore oil platforms and advertisement lighting.[39] An estimated >80% of the global population and more than 99% of the people resident in Europe live under light-polluted skies.[40]

Impacts of light pollution include alternation of the natural day-night circadian clock metabolism.[41] This in turn can result in adverse biological effects in plants, animals and humans as the physiology can frequently depend on cues given by the natural day-night cycle or seasonal patterns.[42] Health impacts of exposure to light pollution have been linked to insomnia, sleep disorder, early-onset diabetes, obesity, and certain cancers.[43,44,45,42]

Water

Clean, safe, and readily available water is critical for public health, whether it is used for consumption, recreational purposes, domestic uses or for food production. Pollutants in water bodies arise from a range of sources, including agriculture, industry, urban wastewater treatment, households, and the transport sector. Ability to achieve good chemical status of water bodies in the EU under

[39] Gaston, K.J., Davies, T.W., Bennie, J. and Hopkins, J. (2012). Reducing the ecological consequences of night-time light pollution: options and developments. Journal of Applied Ecology, 49(6), pp.1256-1266. Available at: https://besjournals.onlinelibrary.wiley.com/doi/10.1111/j.1365-2664.2012.02212.x [accessed 03/10/2023]

[40] Widmer, K., Beloconi, A., Marnane, I., and Vounatsou, P (2022). ETC HE Report 2022/8: Review and Assessment of Available Information on Light Pollution in Europe. Available at: https://www.eionet.europa.eu/etcs/etc-he/products/etc-he-products/etc-he-report-2022-8-review-and-assessment-of-available-information-on-light-pollution-in-europe [accessed 27/09/2023]

[41] National Institute of General Medical Sciences (n.d.). Circadian Rhythms. Available at: https://nigms.nih.gov/education/fact-sheets/Pages/Circadian-Rhythms.aspx [accessed 29/09/2023]

[42] Dalimin, M.N., Mohamed, M. and Bakar, M.A. (2019). A brief overview on light pollution. In IOP Conference Series: Earth and Environmental Science (Vol. 269, No. 1, p. 012014). IOP Publishing. Available at: https://iopscience.iop.org/article/10.1088/1755-1315/269/1/012014/meta [accessed 25/09/2023]

[43] Walker, W.H., Bumgarner, J.R., Walton, J.C., Liu, J.A., Meléndez-Fernández, O.H., Nelson, R.J. and DeVries, A.C. (2020). Light pollution and cancer. International Journal of Molecular Sciences, 21(24), p.9360. Available at: https://www.mdpi.com/1422-0067/21/24/9360 [accessed 25/09/2023]

[44] Lamphar, H., Kocifaj, M., Limón-Romero, J., Paredes-Tavares, J., Chakameh, S.D., Mego, M., Prado, N.J., Baez-López, Y.A. and Diez, E.R. (2022). Light pollution as a factor in breast and prostate cancer. Science of The Total Environment, 806, p.150918. Available at: https://www.sciencedirect.com/science/article/abs/pii/S0048969721059969 [accessed 25/09/2023]

[45] Chepesiuk, R. (2009). Missing the dark: health effects of light pollution. Environ Health Perspect.; 117(1): A20–A27. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2627884/ [accessed 25/09/2023]

the Water Framework Directive is affected by a small number of substance groups (e.g. mercury, polycyclic aromatic hydrocarbons (PAHs), polybrominated diphenyl ethers).[46]

Poor water quality can cause a range of adverse human health impacts. Chemical contamination in water, including from arsenic, fluoride, lead, or nitrates, poses serious threats to public health. Heavy metals can cause a range of adverse effects, with young people being particularly vulnerable, and exposure can lead to developmental delays and cognitive impairments.[47,48,49] For adults, risks can include increased blood pressure, cardiovascular problems and cancer.[50,51] However, emerging contaminants such as per- and polyfluoroalkyl substances (PFAS) and microplastics are of increasing concern.[52,53]

Chemical pollution

Chemicals are used in a range of sectors including health, energy, transport, and housing and have a critical contribution to well-being and high living standards, as well as providing solutions to support both the green and the digital transitions for today's economy and society.[10] Chemicals with hazardous properties however can cause adverse effects to humans and the environment.[54] Chemical pollution has been linked to numerous health impacts such as neurological and genetic

[46] European Environment Agency (2018). European Waters - assessment of status and pressures. EEA Report No 7/2018. Available at https://www.eea.europa.eu/publications/state-of-water [accessed 27/09/2023]
[47] Badeenezhad, A., Soleimani, H., Shahsavani, S., Parseh, I., Mohammadpour, A., Azadbakht, O., Javanmardi, P., Faraji, H. and Babakrpur Nalosi, K. (2023). Comprehensive health risk analysis of heavy metal pollution using water quality indices and Monte Carlo simulation in R software. Scientific Reports, 13(1), p.15817. Available at: https://www.nature.com/articles/s41598-023-43161-3 [accessed 25/10/2023]
[48] Lamas, G.A., Bhatnagar, A., Jones, M.R., Mann, K.K., Nasir, K., Tellez-Plaza, M., Ujueta, F., Navas-Acien, A. and American Heart Association Council on Epidemiology and Prevention; Council on Cardiovascular and Stroke Nursing; Council on Lifestyle and Cardiometabolic Health; Council on Peripheral Vascular Disease; and Council on the Kidney in Cardiovascular Disease (2023). Contaminant Metals as Cardiovascular Risk Factors: A Scientific Statement from the American Heart Association. Journal of the American Heart Association, p.e029852. Available at: https://www.ahajournals.org/doi/10.1161/JAHA.123.029852 [accessed 25/09/2023]
[49] World Health Organisation (2023). Lead poisoning. Available at: https://www.who.int/news-room/fact-sheets/detail/lead-poisoning-and-health [accessed 27/09/2023]
[50] Rahman, H.H., Niemann, D. and Munson-McGee, S.H. (2022). Environmental exposure to metals and the risk of high blood pressure: a cross-sectional study from NHANES 2015–2016. Environmental Science and Pollution Research, 29(1), pp.531-542. Available at: https://pubmed.ncbi.nlm.nih.gov/34331653/ [accessed 29/09/2023]
[51] Kim, H.S., Kim, Y.J. and Seo, Y.R. (2015). An overview of carcinogenic heavy metal: molecular toxicity mechanism and prevention. Journal of cancer prevention, 20(4), p.232. Available at: https://pubmed.ncbi.nlm.nih.gov/26734585/ [accessed 25/09/2023]
[52] European Investment Bank (2023). Microplastics and micropollutants in water, contaminants of emerging concern. Available at: https://www.eib.org/en/publications/20230042-microplastics-and-micropollutants-in-water [accessed 04/10/2023]
[53] Wee, S.Y. and Aris, A.Z. (2023). Revisiting the "forever chemicals", PFOA and PFOS exposure in drinking water. npj Clean Water, 6(1), p.57. Available at: https://www.nature.com/articles/s41545-023-00274-6 [accessed 27/09/2023]
[54] United Nations Environment Programme (2019). Global Chemicals Outlook II – from legacies to innovative solutions: implementing the 2030 agenda for sustainable development. Available at: https://www.unep.org/explore-topics/chemicals-waste/what-we-do/policy-and-governance/global-chemicals-outlook [accessed 04/10/2023]

disorders, endocrine disruption which can have long term effects on fertility, and cancers.

PFAS

PFAS are a chemical class of compounds estimated to cover at least 10,000 specific chemical substances.[55] They are used in a variety of sectors due to their unique and desirable properties (e.g. non-stick, water repellence and anti-grease) and so are found in a range of products (e.g. food packaging, textiles). They have high chemical and thermal stability, and as a result they are highly persistent in the environment.

Exposure to PFAS occurs through oral ingestion (e.g. through food and water), inhalation of indoor air, and contact with other contaminated media.[56] PFAS have been associated with adverse human effects, including altered immune and thyroid function, liver disease, insulin dysregulation, kidney disease, adverse reproductive and developmental outcomes, and cancer.[57] A number of PFAS are listed under the Registration, Evaluation, Authorisation and Restriction of Chemicals regulation (REACH) as substances of very high concern (SVHCs).[58]

Microplastics

Plastics are resistant to chemical and biological degradation, and due to their durability they tend to have long lifespans in the environment. Microplastics are miniscule fragments of plastic materials of less than 5 nm, they can be formed as a breakdown of larger plastic items, or they can be intentionally added in the micro-form to products (e.g. microplastics in cosmetics).[59]

Microplastics can be ingested by both wildlife and humans, entering the food

[55] European Chemicals Agency (2023). Annex XV Restriction Report: Proposal for a restriction – Per- and polyfluoroalkyl substances (PFASs). Available at: https://echa.europa.eu/documents/10162/f605d4b5-7c17-7414-8823-b49b9fd43aea [accessed 15/11/2023]
[56] Sunderland, E. M. (2019). A review of the pathways of human exposure to poly- and perfluoroalkyl substances (PFASs) and present understanding of health effects. J Expo Sci Environ Epidemol (29):3 p 131-147. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6380916/ [accessed 25/09/2023]
[57] Fenton, S.E., Ducatman, A., Boobis, A., DeWitt, J.C., Lau, C., Ng, C., Smith, J.S. and Roberts, S.M. (2021). Per-and polyfluoroalkyl substance toxicity and human health review: Current state of knowledge and strategies for informing future research. Environmental toxicology and chemistry, 40(3), pp.606-630. Available at: https://setac.onlinelibrary.wiley.com/doi/full/10.1002/etc.4890 [accessed 03/10/2023]
[58] European Chemicals Agency (n.d.). Candidate list of substances of very high concern for authorisation. Available at: https://echa.europa.eu/candidate-list-table [accessed 15/11/2023]
[59] European Chemicals Agency (n.d.). Microplastics, hot topics. Available at: https://echa.europa.eu/hot-topics/microplastics [accessed 15/11/2023]

chain and accumulating within the body.[60,61] In humans, microplastics have been found in various organs, including the placenta[62] and they also have been found in blood.[63] One study has shown infants with 10-20 times higher microplastic concentrations in their stools than adults.[64] Microplastics have been shown to have adverse impacts on human cells.[65] Microplastic exposure may cause oxidative stress, inflammatory lesions and increased uptake or translocation for other chemicals of concern, among other adverse impacts.[66] Furthermore, uptake of microplastics in the body will depend on a number of factors, including surface functional groups, size and shape, which further complicates understanding microplastic exposure. Microplastics can be sources of exposure to other chemicals added to the plastic, which can have toxic properties (e.g. plastic additives added or other functions).

Pesticides

A recent EEA briefing[67] highlights that European agricultural production relies on high volumes of chemical pesticides to maintain crop yields, but also that widespread pesticide use is a major source of pollution. For example, pesticides are known to contaminate water, soil and air, driving biodiversity loss, and leading to pest resistance. People can be exposed to pesticides through diet due to pesticide residues on food, in particular fruits and vegetables but also food

[60] Yuan, Z., Nag, R. and Cummins, E. (2022). Human health concerns regarding microplastics in the aquatic environment-From marine to food systems. Science of the Total Environment, 823, p.153730. Available at: https://www.sciencedirect.com/science/article/pii/S0048969722008221 [accessed 20/09/2023]

[61] United Nations Environment Programme (2021). From pollution to solution – A global assessment of marine litter and plastic pollution. Available at: https://www.unep.org/resources/pollution-solution-global-assessment-marine-litter-and-plastic-pollution [accessed 25/09/2023]

[62] Ragusa, A., Svelato, A., Santacroce, C., Catalano, P., Notarstefano, V., Carnevali, O., Papa, F., Rongioletti, M.C.A., Baiocco, F., Draghi, S. and D'Amore, E. (2021). Plasticenta: First evidence of microplastics in human placenta. Environment international, 146, p.106274. Available at: https://www.sciencedirect.com/science/article/pii/S0160412020322297 [accessed 29/09/2023]

[63] Leslie, H.A., Van Velzen, M.J., Brandsma, S.H., Vethaak, A.D., Garcia-Vallejo, J.J. and Lamoree, M.H., (2022). Discovery and quantification of plastic particle pollution in human blood. Environment international, 163, p.107199. Available at: https://www.sciencedirect.com/science/article/pii/S0160412022001258 [accessed 29/09/2023]

[64] Zhang, J., Wang, L., Trasande, L. and Kannan, K. (2021). Occurrence of polyethylene terephthalate and polycarbonate microplastics in infant and adult feces. Environmental Science & Technology Letters, 8(11), pp.989-994. Available at: https://pubs.acs.org/doi/abs/10.1021/acs.estlett.1c00559 [accessed 29/09/2023]

[65] Danopoulos, E., Twiddy, M., West, R. and Rotchell, J.M. (2022). A rapid review and meta-regression analyses of the toxicological impacts of microplastic exposure in human cells. Journal of Hazardous Materials, 427, p.127861.Available at: https://www.sciencedirect.com/science/article/abs/pii/S0304389421028302?dgcid=author [accessed 29/09/2023]

[66] Prata, J.C., da Costa, J.P., Lopes, I., Duarte, A.C. and Rocha-Santos, T. (2020). Environmental exposure to microplastics: An overview on possible human health effects. Science of the total environment, 702, p.134455. Available at: https://www.sciencedirect.com/science/article/abs/pii/S0048969719344468 [accessed 29/09/2023]

[67] European Environment Agency (2023). How pesticides impact human health and ecosystems in Europe. Available at: https://www.eea.europa.eu/publications/how-pesticides-impact-human-health [accessed 25/09/2023]

products of animal origin[68].

In terms of human health, while it is not yet possible to derive estimates of the burden of disease from pesticides in Europe, either for the general population or for specific groups. strong or suspected links have been established between exposure to pesticides and increased risk of several chronic diseases such as cancer, and heart, respiratory and neurological diseases. To better understand human exposure to pesticides in Europe, the European Human Biomonitoring Initiative (HBM4EU) conducted a large-scale human biomonitoring survey in adults and children across five European countries between 2014 and 2021. In total, at least 46 pesticides and their metabolites were identified[69], with at least two pesticides detected in 84% of the samples collected.[70]

1.3.3 Pollution - local and regional policy

Overview

Alongside the aforementioned EU policies and strategies (Section 1.1), local and regional policies play a key role in reducing pollution. While pollution is a global issue, individual regions and communities experience pollution differently, such as high levels of noise or air pollution in heavily trafficked or industrialised areas or light pollution in busy cities. Local areas are combating pollution by introducing enhanced waste programs (such as better recycling or using energy from waste plants) to decrease chemical pollution, changing traffic patterns to reduce air and noise pollution, and making adjustments to everyday life.

Air Quality

The Partnership on air quality[71] has been working on national proposals and funding sources to reduce air pollution and improve citizen health at city level. The main objective of the Partnership is to place the healthy city higher on the EU agenda and to help attain healthy urban environments. Four concrete topics were formulated to focus on: Modelling city-specific situations; Mapping of regulatory instruments and funding; Recommendations on air quality good practices; and Guideline for cities' air quality action plans.

[68] European Human Biomonitoring Initiative (HBM4EU) (2022). Substance report — pesticides. Available at: https://www.hbm4eu.eu/wp-content/uploads/2022/07/Pesticides_Substance-report.pdf [accessed 04/10/2023]
[69] Huber, C. et al. (2022). A large scale multi-laboratory suspect screening of pesticide metabolites in human biomonitoring: from tentative annotations to verified occurrences', Environment International 168, 107452 Available at: https://pubmed.ncbi.nlm.nih.gov/35994799/ [accessed 19/09/2023]
[70] Ottenbros, I., et al. (2023). Assessment of exposure to pesticide mixtures in five European countries by a harmonized urinary suspect screening approach', International Journal of Hygiene and Environmental Health 248, 114105. Available at: https://pubmed.ncbi.nlm.nih.gov/36563507/ [accessed 29/09/2023]
[71] European Commission (n.d.). Urban agenda for the EU – air quality. Available at: https://futurium.ec.europa.eu/en/urban-agenda/air-quality/pages/about [accessed 04/10/2023]

A key example of action taken at a local/regional level to address pollution is the development of Low Emission Zones (LEZs) to address air pollution in cities. To fight air pollution caused by PM and NO_x, a number of European cities have implemented LEZs covering targeted areas of the city area. For example, LEZs have been designated in Paris, Bucharest, Berlin, Barcelona, Milan, Athens, Krakow, Madrid, and Lisbon.[72]

The specific way in which these LEZs operate varies between cities, but a common feature is that these areas only permit the entry of vehicles meeting specific emission standards. LEZs have managed to achieve both a significant reduction in PM and NO_x, which has benefitted the health of local residents. Through lowering emissions, and hence exposure of local residents to air pollutants, the LEZs also contribute to the goals of the Green Deal. A specific case study of one example LEZ is included in Section 2.

In Małopolska Poland, a LIFE Integrated Project has replaced more than 50,000 solid fuel boilers and carried out 14,700 controls of compliance with the anti-smog resolution as actions to improve the air quality under the Air Quality Plan for Małopolska.[73]

Noise

Local and regional actions to tackle noise, particularly from transport (road, rail, aviation) are also critical in terms of achieving the targets set under the Green Deal. At EU level, the END sets legally binding obligations for Member States for the mapping and the reduction and management of environmental noise. Noise mapping is seen as a precursor for guiding the implementation of noise reduction measures to reduce the impact of noise upon the affected population. This therefore guides action targeted at specific local level to address the problem and improve public health. Examples of specific actions taken to reduce noise pollution and exposure to noise at local level have been highlighted by the EEA.[37,74]. In particular, these highlight actions focussed on the emissions source (particularly traffic) such as the redesign of the vehicles, the transport infrastructure and/or the traffic circulatory system.

[72] European Parliamentary Research Service, EPRS (2021). EU policy on air quality: Implementation of selected EU legislation European Implementation Assessment. Available at: https://www.europarl.europa.eu/RegData/etudes/STUD/2021/654216/EPRS_STU(2021)654216_EN.pdf [accessed 04/10/2023]

[73] CoR (n.d.). Małopolska in a healthy atmosphere. Available at: https://cor.europa.eu/EN/regions/Pages/eir-map.aspx?view=stories&type=greendeal [accessed 25/09/2023]

[74] European Environment Agency (2022). Outlook to 2030 — Can the number of people affected by transport noise be cut by 30%? Available at: https://www.eea.europa.eu/publications/outlook-to-2030 [accessed 25/09/2023]

These local policies and actions, along with many others, take the first steps in reducing environmental pollution. Local policies that were enacted before the Green Deal may not specifically aim to address human health, however the aforementioned local policies and actions contribute to a decrease in levels of pollution and hence have long-term impact on the health of local communities in Europe.

Chemicals

Local actions are also targeted towards addressing the public health risk associated with hazardous chemicals. For example, to lower the release of chemicals into the environment and public spaces, cities around the EU have become "pesticide-free towns".[75] This is a network created by Pesticide Action Network Europe (PAN Europe), which connects cities that have banned (or are planning to ban) the use of pesticides in public spaces and which promotes other cities to do the same. Banning the use of pesticides in public spaces is in line with the objectives of the EU Green Deal.

The Italian region of Tuscany has also begun to identify measures to reduce plastic pollution through the "Arcipelago Pulito" project, which in 2018 was approved as a memorandum of understanding in Decision No. 160/2018.[76]

1.3.4 Climate - environmental and health impacts

Climate change, caused by rising greenhouse gas (GHG) emissions, is one of the greatest threats of the 21st century due to its widespread consequences such as droughts, severe wildfires, rising sea levels, flooding, catastrophic storms, and declining biodiversity, etc.[77] These, and other consequences, can lead to sudden and/or unprecedented conditions in different parts of the world.
It is well established that climate change poses multiple threats to human health and well-being in Europe, for example by causing (or exacerbating) extreme weather events, such as devastating floods, extensive wildfires or intense and long-lasting heatwaves, as well as climate-sensitive infectious diseases and allergies[78]. This section of the report discusses four key categories within the wider issues of climate-related health impacts.

Floods

[75] Pesticide Action Network Europe (2022). Pesticide free towns. Available at: https://www.pan-europe.info/campaigns/pesticide-free-towns [accessed 25/09/2023]
[76] Plastic in the sea, https://cor.europa.eu/EN/regions/Pages/eir-map.aspx?view=stories&type=greendeal
[77] United Nations (n.d.). What Is Climate Change?. Available at: https://www.un.org/en/climatechange/what-is-climate-change [accessed 25/09/2023]
[78] European Environment Agency (2022). Climate change as a threat to health and well-being in Europe: focus on heat and infectious diseases. Available at: https://www.eea.europa.eu/publications/climate-change-impacts-on-health [accessed 15/11/2023]

Floods are natural disasters, which are one of the most threatening hazards to the livelihoods of people around the world.[79] As the effects of climate change have been shown to be increasing in all regions of the world[80], floods are expected to become more frequent and more severe. This is because climate change is expected to lead to a rise in sea levels and to bring more intense rainfall[81], which could both affect the number and severity of flooding events. In Europe, the frequency of flooding has been increasing over the last few years, with a tenth of the urban population in Europe living in a flood risk zone. Floods can destroy infrastructures, buildings and livelihoods, whilst also costing the European economy more than €170 billion (equivalent to almost a third of the total damage from natural disasters).[82]

Apart from the physical damage that floods can have on the environment and on urbanised areas, they can also pose a threat to human health. Namely, one global review indicates that the most common health impacts related to floods are water-borne diseases and mental health problems.[83] The study specifies that floods can increase the risk of exposure to contaminated water, which can lead to diarrhoea, respiratory problems, and skin diseases. Additionally, the review explains that the social disruption and the financial losses associated with the impacts of floods are linked to post-traumatic stress disorders, anxiety, psychological distress, and decreased overall mental health.

In the EU, about 10% of the population is at risk of flooding and this risk is expected to as much as double by the end of the century.[84] This is concerning, because, for example, the 2021 flooding events in Belgium, Germany, Luxembourg, and the Netherlands resulted in at least 212 deaths, which could be considered as the deadliest weather-related floods in Europe in more than 50 years.[85]

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[79] The World Bank (2022). Flood risk already affects 1.81 billion people. Climate change and unplanned urbanisation could worsen exposure. Available at: https://blogs.worldbank.org/climatechange/flood-risk-already-affects-181-billion-people-climate-change-and-unplanned [accessed 25/09/2023]
[80] Climate Change 2022: Impacts, Adaptation and Vulnerability (2022). IPCC. Available at: https://www.ipcc.ch/report/ar6/wg2/ [accessed 25/09/2023]
[81] IPCC (2021). Climate change widespread, rapid, and intensifying. Available at: https://www.ipcc.ch/2021/08/09/ar6-wg1-20210809-pr/ [accessed 25/09/2023]
[82] European Environment Agency (2023). Wet and dry. Available at: https://www.eea.europa.eu/publications/europes-changing-climate-hazards-1/wet-and-dry-1 [Accessed 14/11/2023]
[83] Lee, J., Perera, D., Glickman, T., & Taing, L. (2020). Water-related disasters and their health impacts: A global review. Progress in Disaster Science, 8, 100123. Available at: https://www.sciencedirect.com/science/article/pii/S2590061720300600 [accessed 25/09/2023]
[84] European Environment Agency (2020). Urban adaptation in Europe: how cities and towns respond to climate change. Available at: https://www.eea.europa.eu/publications/urban-adaptation-in-europe [accessed 25/09/2023]
[85] Climate ADAPT (n.d.) Flooding. Available at: https://climate-adapt.eea.europa.eu/en/observatory/evidence/health-effects/flooding/flooding [accessed 25/09/2023]

Wildfires

Wildfires are another phenomenon that is likely going to be exacerbated due to the effects of climate change. This is because climate change is likely to affect the factors that contribute to the occurrence of wildfires, such as temperature, humidity, and moisture in the natural space.[86] In other words, climate change will create warmer and drier conditions which will increase wildfire risk in many regions around the world.[87] In Europe, the Mediterranean countries like Portugal, Spain, Italy, Greece, and France are the most prone to future wildfire occurrences.[88]

It was indicated that 2022 was the second-worst wildfire season in the EU since 2000 when the Copernicus' European Forest Fire Information System (EFFIS) records began[89]. EFFIS observed fires in 45 countries in 2022. These countries suffered around 17,000 fires that burnt 1.6 million hectares (ha). As wildfire smoke contains fine particulate matter and polycyclic aromatic hydrocarbons it can be toxic to humans.[90] The most common adverse health effects as a result to wildfire exposure are respiratory infections, asthma, chronic obstructive pulmonary disease, and all-cause mortality.[91] Moreover, similar to floods, wildfires can bring financial losses and can threaten the safety of one's community and close ones. Therefore, wildfires are associated with causing post-traumatic stress disorders, depression, and anxiety even years after the occurrence of a wildfire event.[92]

Extreme temperatures

The latest reports show that global warming is happening faster than previously thought.[81] As evidenced by the 2023 summer, which was reported as the hottest

[86] NOAA (2023). Wildfire climate connection. Available at: https://www.noaa.gov/noaa-wildfire/wildfire-climate-connection [accessed 25/09/2023]
[87] CSSR (2017). Chapter 8: Droughts, Floods, and Wildfire. https://science2017.globalchange.gov/chapter/8/ [accessed 25/09/2023]
[88] European Commission (2020). Climate change and wildfires. Available at: https://joint-research-centre.ec.europa.eu/system/files/2020-09/09_pesetaiv_wildfires_sc_august2020_en.pdf [accessed 25/09/2023]
[89] European Commission (2023). The EU 2022 wildfire season was the second worst on record. Available at: https://joint-research-centre.ec.europa.eu/jrc-news-and-updates/eu-2022-wildfire-season-was-second-worst-record-2023-05-02_en [accessed 25/09/2023]
[90] Aguilera, R., Corringham, T. W., Gershunov, A., & Benmarhnia, T. (2021). Wildfire smoke impacts respiratory health more than fine particles from other sources: observational evidence from Southern California. Nature Communications, 12(1). Available at: https://www.nature.com/articles/s41467-021-21708-0 [accessed 25/09/2023]
[91] Grant, E., & Runkle, J. D. (2022). Long-term health effects of wildfire exposure: A scoping review. The Journal of Climate Change and Health, 6, 100110. Available at: https://www.sciencedirect.com/science/article/pii/S2667278221001073 [accessed 25/09/2023]
[92] To, P., Eboreime, E., & Agyapong, V. I. O. (2021). The Impact of wildfires on Mental Health: A scoping review. Behavioral Sciences, 11(9), 126. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8466569/ [accessed 25/09/2023]

summer on record, globally[93], heatwaves (and other extreme temperature events) are happening more regularly and are becoming more intense.

According to the WHO, in 2022, extreme heat claimed more than 60,000 lives in the WHO European region.[94,95] Extreme heat affects vulnerable groups e.g. the elderly and infants most significantly.[96] Excessive heat may not only lead to direct adverse health effects, but can also worsen chronic conditions and alter human behaviour.[97] Similar effects might also be found for extreme cold events, such as a decreased ability for the body to fight off infections. For example, a literature review found that both extreme heat and cold are linked to cardiorespiratory or metabolic disease, and suicide or other types of injury.[98]

Disease

Climate change can have significant impacts on the prevalence and distribution of infectious diseases. For example, the rising temperatures in previously colder regions of the world expands the reach of disease-carrying vectors, like mosquitoes and ticks, which could expose more people to infectious diseases such as malaria and dengue fever.[99] Moreover, more severe precipitation and extreme weather events can contaminate local water sources, which could lead to waterborne diseases such as diarrhoea, and cholera.[100]

Exposure to filamentous fungi (mould), growing indoors when sufficient moisture is available is also associated health problems associated with building moisture and biological agents. The most important effects are increased prevalence of respiratory symptoms, allergies and asthma as well as perturbation of the

[93] Summer 2023: the hottest on record (2023). Copernicus. Available at: https://climate.copernicus.eu/summer-2023-hottest-record [accessed 25/09/2023]
[94] This is a region consisting of 53 countries on the European continent https://gateway.euro.who.int/en/country-profiles
[95] World Health Organisation (2023). Climate crisis: extreme weather. Available at: https://www.who.int/europe/emergencies/situations/climate-crisis-extreme-weather [accessed 25/09/2023]
[96] European Environment Agency (2023). Extreme weather: floods, droughts and heatwaves. Available at: https://www.eea.europa.eu/en/topics/in-depth/extreme-weather-floods-droughts-and-heatwaves [accessed 25/09/2023]
[97] World Health Organisation (2018). Heat and Health. Available at: https://www.who.int/news-room/fact-sheets/detail/climate-change-heat-and-health [accessed 25/09/2023]
[98] The Lancet. (2021). Health in a world of extreme heat. The Lancet, 398(10301), 641. Available at: https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(21)01860-2/fulltext [accessed 25/09/2023]
[99] Mora, C., McKenzie, T., Gaw, I. M., Dean, J. M., Von Hammerstein, H., Knudson, T. A., Setter, R. O., Smith, C. Z., Webster, K. M., Patz, J. A., & Franklin, E. C. (2022). Over half of known human pathogenic diseases can be aggravated by climate change. Nature Climate Change, 12(9), 869–875. Available at: https://www.nature.com/articles/s41558-022-01426-1 [accessed 25/09/2023]
[100] Kurane, I. (2010). The effect of global warming on infectious diseases. Osong Public Health and Research Perspectives, 1(1), 4–9. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3766891/ [accessed 25/09/2023]

immunological system.[101]

Allergies

The rising temperatures due to climate change have resulted in an expanded pollen season globally, resulting in increased allergies and asthma.[102] Pollens have also been associated with chronic obstructive pulmonary disease, stroke, myocardial infractions, and even an increased suicide mortality.[103] However, the full extent of those risks has remained poorly explored and quantified in the literature to date and more research is required in the future.[99]

1.3.5 Climate – local and regional policy

On the local level, policies related to climate change adaptation and mitigation are becoming increasingly popular. A key example of a successful European initiative is the Covenant of Mayors (CoM) for Climate & Energy[6], which brings together local and regional authorities who voluntarily commit to implementing the EU's climate and energy objectives. The initiative was launched by the European Commission in 2008 and now counts over 11,000 signatories representing 341 million citizens. CoM signatories pledge to adopt an integrated approach to tackling mitigation and adaptation to climate change, to report their CO_2 emissions and reduce them by 40% by 2030. Currently, there are over 8,000 local regions with published action plans[104] and over 3,000 local regions with published monitoring reports.[105]

Furthermore, as of September 2023, 93 cities/municipalities of the EU reported to the Carbon Disclosure Project (CDP) that their jurisdiction has a climate action plan or strategy that addresses mitigation, adaptation, and/or energy.[106] In comparison, the number of replies received from EU local authorities to the same question in 2022 was 82.[107] Importantly, while this data is indicative, it likely does not capture the full scope of policies and action implemented on the local scale in the EU.

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[101] World Health Organization (2009). WHO guidelines for indoor air quality : dampness and mould. Available at: https://www.who.int/publications/i/item/9789289041683 [accessed 15/11/2023]
[102] Asthma and Allergy Foundation of America, (n.d.). Climate Change and Health. Available at: https://aafa.org/asthma-allergy-research/our-research/climate-health [accessed 25/10/2023]
[103] Signh, A.B., and Kumar, P. (2022). Climate change and allergic disease: An overview. Front Allergy (3). Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9606573/ [accessed 15/11/2023]
[104] https://eu-mayors.ec.europa.eu/en/action_plan_list
[105] https://eu-mayors.ec.europa.eu/en/monitoring_report_list
[106] CDP (2023). 2023 Europe, Middle East, and Africa Dataset. Available at: https://data.cdp.net/Governance/2023-Europe-Middle-East-and-Africa-Dataset/7ajd-tmm8 [accessed 25/09/2023]
[107] CDP (2023). 2022 Europe, Middle East, and Africa Dataset. Available at: https://data.cdp.net/Governance/2022-Europe-Middle-East-and-Africa-Cities-Dataset/7nc6-py49 [accessed 25/09/2023]

The French region of Occitanie launched the Green Deal for Occitanie in mid-2020, with a heavy focus on tackling climate change through projects such as supporting the transition to hydrogen heavy vehicles within the EU.[108] In a similar effort to combat climate change, the municipalities and regions of Denmark have launched the DK2020 initiative. The initiative aims to develop climate plans to achieve the 1.5ºC Paris Agreement objective, as well as upgrade existing climate work in Denmark and modelling best practices.[109] Undertaking climate change efforts at the local and regional levels is critical in the larger climate change picture, and highlighting best practices to share with other regions and local authorities continues to bolster these efforts.

To prevent wildfires that were very common in the region at the end of the last century, the Catalonian region in Spain implemented a fire management policy in the early 2000s.[110] The policy was based on prescribed burning of specific forest areas and focused on design, execution, and education. After six years, the policy was evaluated to be successful in preventing large forest fires. Through the protection of forests which are carbon sinks, this policy also supports the Green Deal.

1.3.6 Societal factors – environmental and health impacts

Green and blue spaces

Access to green (i.e. covered by vegetation) and blue (i.e. bodies of water) spaces, including for example, parks, urban forests, tree-lined streets and riverbanks, play a direct and indirect role in improving both mental and physical health and improving well-being.[111] The WHO recommends that all people reside within 300m of green space.

Studies have demonstrated that access to green space significantly reduces diastolic blood pressure, salivary cortisol, and heart rate, along with decreased

[108] CoR (n.d.). Green Deal for Occitanie: reinventing our social model. Available at: https://cor.europa.eu/EN/regions/Pages/eir-map.aspx?view=stories&type=greendeal [accessed 19/09/2023]
[109] CoR (n.d.). DK2020. Available at: https://cor.europa.eu/EN/regions/Pages/eir-map.aspx?view=stories&type=greendeal [accessed 25/09/2023]
[110] Alcasena, F.J., Rodrigues, M., Vega-Garcia, C. (2019) Wildfire management in Catalonia: A proposal towards a long-term comprehensive strategy. Available at: https://efi.int/sites/default/files/images/facing%20forest%20fires%202019/Cristina%20Vega_Wildfire%20management%20in%20Catalonia.pdf [accessed 25/09/2023]
[111] Green and blue spaces and mental health: new evidence and perspectives for action, WHO Regional Office for Europe, 2021. Available at: https://iris.who.int/bitstream/handle/10665/342931/9789289055666-eng.pdf [accessed 19/09/2023]

incidences of diabetes.[112] Studies have also shown improved mental health with green spaces (tree cover density, distance from green space, percentage of green areas).[113,114] Higher exposure to coastal blue space has been linked with lower rates of depression.[115]

Green and blue spaces are particularly beneficial for the health and well-being of certain socio-economic and demographic groups, in particular children, the elderly, and people of lower socio-economic status[116]. For example, there have been positive correlations observed between the proximity of children to green space and levels of physical activity.[117] Children living in areas with less greenness exposure had an increased likelihood of being overweight.[118] A study has also demonstrated that proximity to park-green spaces had higher levels of physical activity in over 65-year-olds living in Spain.[119]

Energy poverty

Energy poverty is a lack of access to sustainable modern energy services and products. Energy and health have been highlighted by WHO to be inextricably linked.[120] It has been estimated that globally, 2.4 billion people lack access to clean fuels and technologies for cooking.[120]

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[112] Twohig-Bennett, C. and Jones, A. (2018). The health benefits of the great outdoors: A systematic review and meta-analysis of greenspace exposure and health outcomes. Environmental research, 166, pp.628-637. Available at: https://www.sciencedirect.com/science/article/pii/S0013935118303323 [accessed 25/09/2023]

[113] Dzhambov, A.M., Markevych, I., Hartig, T., Tilov, B., Arabadzhiev, Z., Stoyanov, D., Gatseva, P. and Dimitrova, D.D. (2018). Multiple pathways link urban green-and bluespace to mental health in young adults. Environmental research, 166, pp.223-233. Available at: https://www.sciencedirect.com/science/article/abs/pii/S0013935118303025 [accessed 25/09/2023]

[114] Andrusaityte, S., Grazuleviciene, R., Kudzyte, J., Bernotiene, A., Dedele, A. and Nieuwenhuijsen, M.J. (2016). Associations between neighbourhood greenness and asthma in preschool children in Kaunas, Lithuania: a case–control study. BMJ open, 6(4), p.e010341. Available at: https://bmjopen.bmj.com/content/6/4/e010341 [accessed 25/09/2023]

[115] Dempsey, S., Devine, M.T., Gillespie, T., Lyons, S. and Nolan, A. (2018). Coastal blue space and depression in older adults. Health & place, 54, pp.110-117. Available at: https://pubmed.ncbi.nlm.nih.gov/30261351/ [accessed 25/09/2023]

[116] European Environment Agency (2022). Who benefits from nature in cities? Social inequalities in access to urban green and blue spaces across Europe. Available at: https://www.eea.europa.eu/publications/who-benefits-from-nature-in [accessed 25/09/2023]

[117] Nordbø, E.C.A., Raanaas, R.K., Nordh, H. and Aamodt, G. (2019). Neighborhood green spaces, facilities and population density as predictors of activity participation among 8-year-olds: a cross-sectional GIS study based on the Norwegian mother and child cohort study. BMC public health, 19(1), pp.1-22. Available at: https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-019-7795-9 [accessed 29/09/2023]

[118] Petraviciene, I., Grazuleviciene, R., Andrusaityte, S., Dedele, A. and Nieuwenhuijsen, M.J. (2018). Impact of the social and natural environment on preschool-age children weight. International journal of environmental research and public health, 15(3), p.449. Available at: https://pubmed.ncbi.nlm.nih.gov/29510565 [accessed 29/09/2023]

[119] Machón, M., Vrotsou, K., Larrañaga, I. and Vergara, I. (2020). Proximity to facilities and its association with the health-related habits of functionally independent older adults. International Journal of Environmental Research and Public Health, 17(22), p.8677. Available at: https://pubmed.ncbi.nlm.nih.gov/33238364/ [accessed 25/09/2023]

[120] World Health Organisation (n.d.). Energy and health – health topic. Available at: https://www.who.int/health-topics/energy-and-health#tab=tab_1 [accessed 18/09/2023]

Energy poverty has been reported to negatively impact on health, wellbeing, social inclusion, and quality of life. This is due to inadequate comfort and sanitary conditions, poor air quality and exposure to harmful chemicals and materials. Furthermore, significant psychological stress can be caused over unaffordable energy bills.

The ability to access clean and sustainable energy in homes is critical to protect people from household air pollution (e.g. polluting stoves and coal-based fuel). Globally, household air pollution from polluting stoves and fuels are a cause of 3.2 million deaths annually.[121] Household air pollution exposure leads to diseases such as stroke, ischaemic heart disease, chronic pulmonary disease (COPD) and lung cancer.[122]

Also access to clean and reliable energy in health-care facilities is critical to ensure the delivery of essential health care services for disease prevention and treatment. An estimated 1 billion people globally are served by health facilities that do not have electricity.[123]

In the EU it has been reported that the number of people who were unable to keep their homes adequately warm increased from 6.9% in 2021, to 9.3% in 2022.[124] This equates to over 41 million Europeans unable to keep their homes adequately warm in 2022.[125] This has been partially attributed to the COVID-19 pandemic, the surge in energy prices and the Russian invasion of Ukraine in 2022.[126] Furthermore, almost 7% of the EU population had arrears on their utility bills, and almost 15% lived in dwellings with leak, damp or rot in 2020, with the poorest European households spending 8.3% of their expenditure on energy in 2018.[126] At the same time, despite the increasing social importance of access to energy in the EU, policies to address this issue have been perceived as challenging and there has been a call for new approaches to do so.[127]

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[121] World Health Organisation (2022). Household air pollution. Available at: https://www.who.int/news-room/fact-sheets/detail/household-air-pollution-and-health [accessed 20/09/2023]
[122] World Health Organisation. (2022) Household air pollution. Available at: https://www.who.int/news-room/fact-sheets/detail/household-air-pollution-and-health [accessed 20/09/2023]
[123] World Health Organisation (2023). Electricity in health-care facilities. Available at: https://www.who.int/news-room/fact-sheets/detail/electricity-in-health-care-facilities [accessed 20/09/2023]
[124] Eurostat (2023). Inability to keep home adequately warm - EU-SILC survey. Available at: https://ec.europa.eu/eurostat/databrowser/view/ILC_MDES01/default/table?lang=en [accessed 29/09/2023]
[125] European Parliament (n.d.). Energy poverty in the EU, policy briefing. Available at: https://www.europarl.europa.eu/RegData/etudes/BRIE/2022/733583/EPRS_BRI(2022)733583_EN.pdf [accessed 03/10/2023]
[126] European Commission (n.d.). Energy poverty in the EU. Available at https://energy.ec.europa.eu/topics/markets-and-consumers/energy-consumer-rights/energy-poverty-eu_enm [accessed 29/09/2023]
[127] Filčák and Živčič (2017). Energy poverty and multi-dimensional perspectives of social inequalities and policy challenges. Available at: https://www.jstor.org/stable/26591979 [accessed 29/09/2023]

1.3.7 Societal factors - local and regional policy

Urban green space

Improving the quantity (and quality) of urban green spaces at a local or regional level has been an ongoing measure in a number of EU countries for many years. For example, in 2009 Novara, Italy began afforestation measures, followed by a petition to plant over 10,000 trees with trees now covered roughly eight hectares[128].

However, access to green and blue spaces differs across Europe, with cities in the north and west of Europe generally have more total green space than cities in southern and eastern Europe. The provision of publicly accessible green space is also location specific and varies between cities, with less and lower quality green space typically found in communities of lower socio-economic status.[116] This highlights the importance of targeted action at local and regional level to reduce inequalities in access to high-quality green space in order to maximise the health and well-being benefits.

Furthermore, urban green spaces are becoming recognised as contributors to sustainability in international frameworks and European policies, which link directly to action at city or region level. For example, the EU's 2030 biodiversity strategy[11] encourages bringing nature back into cities and emphasises the importance of developing urban greening plans in larger cities and towns to include measures to create biodiverse and accessible urban forests, parks and gardens; urban farms; green roofs and walls; treelined streets; urban meadows; and urban hedges.

While green and blue spaces have shown to have a significant positive impact on human health, especially mental health[129], the type of action taken at local and regional level varies quite significantly in terms of approach and scope. A range of example case studies have been highlighted by the EEA[116] and specific examples (as per the categories of health determinants above) are explored in Section 2 of this report.

Energy poverty

To combat energy poverty, the "Hauts-de-France Pass Renovation" policy was started in 2014 and is now implemented in 12 territories of the Hauts-de-France

[128] CoR (n.d.). Urban forestation: Strada Prelle. Available at: https://cor.europa.eu/EN/regions/Pages/eir-map.aspx?view=stories&type=greendeal [accessed 25/09/2023]
[129] Barton, J. and Rogerson, M. (2017). The importance of greenspace for mental health. BJPsyc Int. Nov; 14(4): 79-81. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5663018/ [accessed 15/11/2023]

region[130]. Its aim is to renovate residential buildings and to allow owners to repay for the renovation through the savings in their post renovation energy savings. Through enabling homes to use less energy, this policy compliments the EU Green Deal.

[130] Hauts-de-France Pass Renovation, Energy Poverty atlas. Available at: https://atlas.energypoverty.eu/node/534 [accessed 25/09/2023]

2. Case studies: EU Cities and region's experiences

2.1 Overview

For this report, ten case studies were identified and developed to better understand and demonstrate the measures taken on a local and regional scale to improve human health by addressing climate change, pollution, and environmental degradation.

The process for identifying and developing case studies in the study is outlined in Annex 1 of this report. In summary, the case studies were selected from a long list of suggestions provided by initial stakeholder responses. A final list is presented below. This list aimed to achieve a balance between the geographic scope of the measure, the scale of the measure, the pollution type/source concerned, and the type of health impact concerned. In practice, given the wide range of different types of environmental impacts on health that exist (as detailed in Section 1), and with a limited timescale available to gather and assess information, it has not been feasible to cover a 'full' range measures.

The following subsections provide an overview of ten case studies identified from the information gathered that were determined to be the most promising case studies, i.e. most relevant to the agreed case study structure and selection criteria.

2.2 Case Study #1: Rotterdam Walks 2025 (Netherlands)

Title	Rotterdam Walks 2025
Location	Rotterdam, Netherlands
Geographic scale	City-level and neighbourhood-level (population of ~1,000,000 people)
Timescale	2021 – 2025
Description of the initiative	The project aims to improve the walking infrastructure of the city, to raise awareness for a more active life and to engage new urban developments. It represents a city-wide urban mobility plan that puts walking as a top priority. Its ultimate goal is to increase people's physical and mental health and overall quality of life. To do this, the project focuses on improving the linking routes to rivers, green spaces, and to the green-blue network of city canals and parks. As such, the ambition of the project is to motivate people to walk further and more often, and to improve the overall quality of time spent in important places for pedestrians.

Organisation of the initiative	The project team is coordinated by local authority representatives of different departments of the city (the mobility department, the city maintenance department, the health department, and the department which is responsible for the accessibility of the city) which work with other stakeholders like urban planners and healthcare professionals.
Financials	Source of funding: The source of funding for the project comes from the mobility department, the department for public space, housing and environment, and the health department of the city. Overall budget: So far, €100,000 have been allocated to the project.
Impacts	Expected outcomes: Improvements in overall health through increased modal share for more active modes of transport. Observed impacts: An example of a sub-project that the initiative organisers have worked on was one to increase the ease of access to green spaces for a local community. Namely, they made improvements to the walking infrastructure that allows the local community, and especially elderly people, to reach a local park. This also improved the spaces dedicated for bicycle parking in order to not obstruct the path for pedestrians. The project team have developed a map of the city that gauges whether walking on specific streets in Rotterdam is healthy or unhealthy (based on the level of greenery of the street and the potential exposure to noise and heat of pedestrians). A "walking monitor" which predicts what the walking intensities in specific areas of the city are going to be, depending on nearby amenities, the density of houses, the width of local sidewalks, the amount of green in the streets, and other factors. This map and monitor are to be used in future planning in the city.
Co-benefits/synergies	Through encouraging more walking around the city, the project can contribute to the reduction of greenhouse gas emissions (e.g. fewer cars being used in the city). It can also foster a stronger local community and better quality of life through providing people with an inclusive and accessible place where they can socialise and stay active.
Trade-offs	Since cycling is very popular in the city, the project has been faced with the task of balancing the needs of pedestrians and of cyclists. As such, this has led to additional burdens such as

	launching an information campaign for cyclists to make sure that they use the specified bicycle parking spaces instead of parking them in non-designated spaces.
Key challenges	With the trade-off mentioned above between cyclists and pedestrians, naturally, one of the main challenges of the project is managing the limited amount of available public space to accommodate both groups. There are many difficulties in ensuring that the pedestrians and cyclists do not "compete" for the new infrastructure. For example, citizens raise issues when there are plans to alter large cycle paths in the city. Another important challenge is ensuring a steady flow of investment, which aligns policy objectives with budget availability. In general, the initiative is still relatively new, and it demands a deeper and more structural change to be done in the city. As such, the project team are still trying to gather more budget (especially from national government) through proving that the project is successful.
Success factors	One of the key successes of this project was bringing the different departments of the municipality to work together through a clear call to action. A successful strategy was to identify key people through research within the different departments who might be interested in an initiative like this (regardless of their seniority). In this way, they managed to establish connections between like-minded individuals across departments and create a shared vision and support for the project. Another key success was that the project has observed a substantial involvement and interest of the local community.
Transferability	The project is likely to be transferable to other cities with similar size and infrastructural characteristics. However, smaller scale improvements of infrastructure to key green/blue spaces for local communities is likely transferable to smaller cities too.
References/ Data sources	https://www.rotterdam.nl/lopen https://activemobility.soigneuragency.com/ https://665ea41b-deee-40ce-9521-2f6046798b81.filesusr.com/ugd/241361_b7c5c1006b734ba2aae0689ed8028102.pdf

	https://7520151.fs1.hubspotusercontent-na1.net/hubfs/7520151/Walking%20and%20cycling%20data_Ramboll_2022.pdf

2.3 Case Study #2: Good Move Plan (Brussels, Belgium)

Title	Good Move Plan
Location	Brussels, Belgium
Geographic scale	The capital region of Brussels (19 municipalities) (population of ~200,000 people)
Timescale	2020 – 2030
Description of the initiative	The regional mobility policy aims to improve the quality of life in the boroughs of Brussels with a goal of influencing the travel habits of residents by creating a "closer city" where walking and cycling are encouraged. It includes more than 50 actions (e.g. creating more peaceful boroughs and increasing pedestrian pathways) which were split into six focus areas (e.g. improving the quality of life of residents and organising transport networks to ensure efficient services). The initiative encompasses changes for three factors: territory, behaviour, and governance. It introduced a 30 km/h speed limit in 2021 throughout Brussels.
Organisation of the initiative	"Brussels Mobility", which is part of the regional government, initiated the project. However, there are 19 separate municipalities in the city in which local authorities can make independent decision on the project uptake (there is currently varying support for the project among municipalities). Depending on the municipality, various departments are involved in the delivery process. "Beliris", a publicly-owned company (by the Brussels-Capital Region and the federal authorities), is responsible for carrying out the construction work.
Financials	Source of funding: The funding is obtained through the budgets allocated to the various entities throughout Brussels, such as "Brussels Mobility", the municipalities, "Beliris", "Brussels Environment", etc. Overall budget: The total budget allocated to the project, so far, has been around €12 million. €6.4 million was

	allocated between 2020 and 2021 and another €5.7 million was allocated until the end of 2023.
Impacts	Expected outcomes: The main impacts of the project are decreased road speed, average journey time, level of traffic. This is expected to bring health benefits through stimulating a more active life, through decreasing noise and air pollution, and through decreasing the number of road accidents. Observed outcomes: The 'Good move Plan' study reported that: • there was a 20% reduction of car traffic; • there" was an increase in cyclist traffic of 36% (Modijefsky, 2023). • 90% of all roads were limited to 30 km/h; • there was a 9% decrease in speed on all roads even where the new speed limit was not introduced, with the number of instances of speeding also reducing; • there was no significant increase in average journey times; • there was an increase in the number of pedestrianised areas and public spaces (e.g. new squares); and • there was a reduction in road fatalities (Figg, 2023). From a citizen satisfaction survey about the changes that were implemented, positive feedback was received. However, it is important to note that, as of now, the feedback has only been received from municipalities where there was already wide support for the measure before it being implemented.
Co-benefits/synergies	The visions for the project align with the regional development plan, the sustainability urban mobility plans, and the city administration. As such, this is likely to lead to improved collaboration between different city entities. Moreover, with the reduction of car traffic, there could be reductions in greenhouse gases.
Trade-offs	Reduced car travel convenience, due to the inclusion of one-way traffic streets or limited car access zones. .
Key challenges	In the past, within some municipalities, there was backlash over the proposed and/or implemented changes which led to a wide unacceptance of the project by the

	public. As such, in some other municipalities, this has led to the freezing of implementation or even the removal of the actions already implemented by the project. After this, it became increasingly difficult to convince municipalities to take up the project.
Success factors	The communication with members of the public to display that commuting time did not change alongside the change in transport helped encourage the members of the public. This included a consultation with a range of stakeholders showing the reasoning behind the initiative (Figg, 2023). The planning and thought put into the action plan also allowed a smooth transition throughout the project, with no stalling or interference, leading to more cooperation from the members of the public.
Transferability	Some of the policies which were implemented (such as decreasing the speed limit) are technically easily transferrable to many other cities and regions. However, the budget allocated in Brussels is significant, so transferability will likely relate to cities of similar size/population (e.g. other EU capitals).
References/Data sources	https://mobilite-mobiliteit.brussels/en/good-move https://mobilite-mobiliteit.brussels/sites/default/files/2021-03/GOODMOVE_summary.pdf Figg, 2023. Brussels City 30 – changing the mobility model for a calmer city with safe roads and less noise. Available at: https://www.eltis.org/resources/case-studies/brussels-city-30-changing-mobility-model-calmer-city-safe-roads-and-less Modijefsky, 2023. One year Good Move in Brussels city: 25% less car-traffic and 36% more bicycles. Available at: https://www.eltis.org/in-brief/news/one-year-good-move-brussels-city-25-less-car-traffic-and-36-more-bicycles

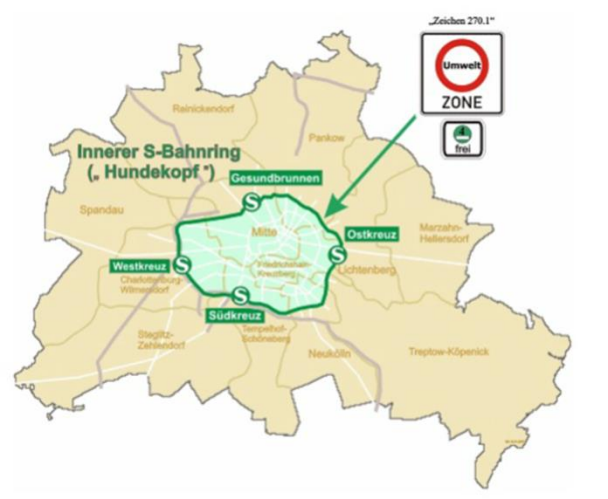
2.4 Case Study #3: Greening of North East Inner City (Dublin, Ireland)

Title	Greening of North East Inner City (Dublin)
Location	Dublin, Ireland
Geographic scale	Local residential area within core city limits (population of ~500,000 people)
Timescale	2018-2026
Description of the initiative	This project has the aim of increasing the level of green canopy, green space, and green infrastructure and to improve the local well-being and the local environment of Dublin. It responds to a recommendation set out by a 2017 report which states that streetscapes need to be improved in response to high levels of anti-social behaviour in that area.
Organisation of the initiative	The project was initiated by the Parks and Landscape Services of the Dublin City Council. It also required the collaboration with the Central Area Office (one of the five administrative areas in the city) and "ÁIT Urbanism + Landscape" Ltd (a landscape architecture and urban design company).
Financials	Source of funding: the project is mainly funded through the "Community Enhancement Programme" of the Department of Rural & Community Development of Ireland. Overall budget: the total funding that has been received for the project between 2018 and 2023 is about €2.5 million.
Impacts	Expected outcomes: In terms of environmental benefits, the project seeks to improve air and water quality, to lower noise pollution, to mitigate the impacts of extreme events, and to enhance biodiversity. When it comes to health, through the provision of open green infrastructure, the project aims to help with the mental health and well-being of the local residents, to encourage physical activity, and to promote social interaction. Observed outcomes: Over the years, around a 40% increase in tree coverage (about 370 additional trees)

	was observed within the local area. A number of landscape refurbishment works in different areas around the city were also carried out, more than 10 thousand flowers were planted, and a public park (Diamond Park) was regenerated.
Co-benefits/synergies	The project builds on two previous strategies developed by the city, it supports carbon/pollutant capture, and some of the areas of the project scope link with new cycle routes and other associated public area works. Moreover, the benefits of the project can be of particular help to socially and economically disadvantaged individuals who would usually not have access to good public spaces.
Trade-offs	Since the project is focused on one area within the city, it might create disproportionality concerns. Namely, citizens living in this area might have disproportionate access to green spaces, compared to citizens living outside this area.
Key challenges	The project was interrupted by COVID-19 and thus some of the public consultations and funding had to be put to a halt.
Success factors	The local consultations are carried out successfully and often result in a co-created vision. For example, in 2023, a new, regenerated park (Diamond Park) opened in Dublin where the Dublin City Council and the local community worked together to promote, plan, design, and develop the park. The other success factor is that the speed of implementation allowed for a visible change to be noted in a short time span.
Transferability	To support the improvement in physical health, mental health, and community-belonging, other cities can also focus on improving their green infrastructure, irrespective of the scale/size of the city.
References/Data sources	https://www.dublincity.ie/residential/parks/strategies-and-policies/greening-strategies/neic-greening-strategy https://dklm7jhs8nu2s.cloudfront.net/general/20170218MulveyReport.pdf?mtime=1508163948

	https://councilmeetings.dublincity.ie/mgConvert2PDF.aspx?ID=40546 https://www.neic.ie/publications https://janethorner.ie/post/greening-plans-for-the-north-inner-city/

2.5 Case Study #4: Berlin – LEZ (Germany)

Title	Berlin – LEZ
Location	Berlin, Germany
Scale	City [partial] (population of ~3,500,000 people)  Source: Figure: Low Emission Zone in Berlin (EPRS, 2021). The green area represents the Low Emission Zone: https://urbanaccessregulations.eu/
Timescale	2008 onwards
Description of the initiative	Triggered by non-compliance with EU air quality standards for PM_{10}[131] and NO_2, along major roads, a Low Emission Zone was introduced in two stages in Berlin from 2008.The Low Emission Zone covers about 88 km^2 (approx. 10% of total city area) with approx. 1.1 million inhabitants. The Low Emission Zone permits only vehicles (passenger cars, Light Goods Vehicles and Heavy Goods

[131] Particulate mater with a diameter of less than 10µm

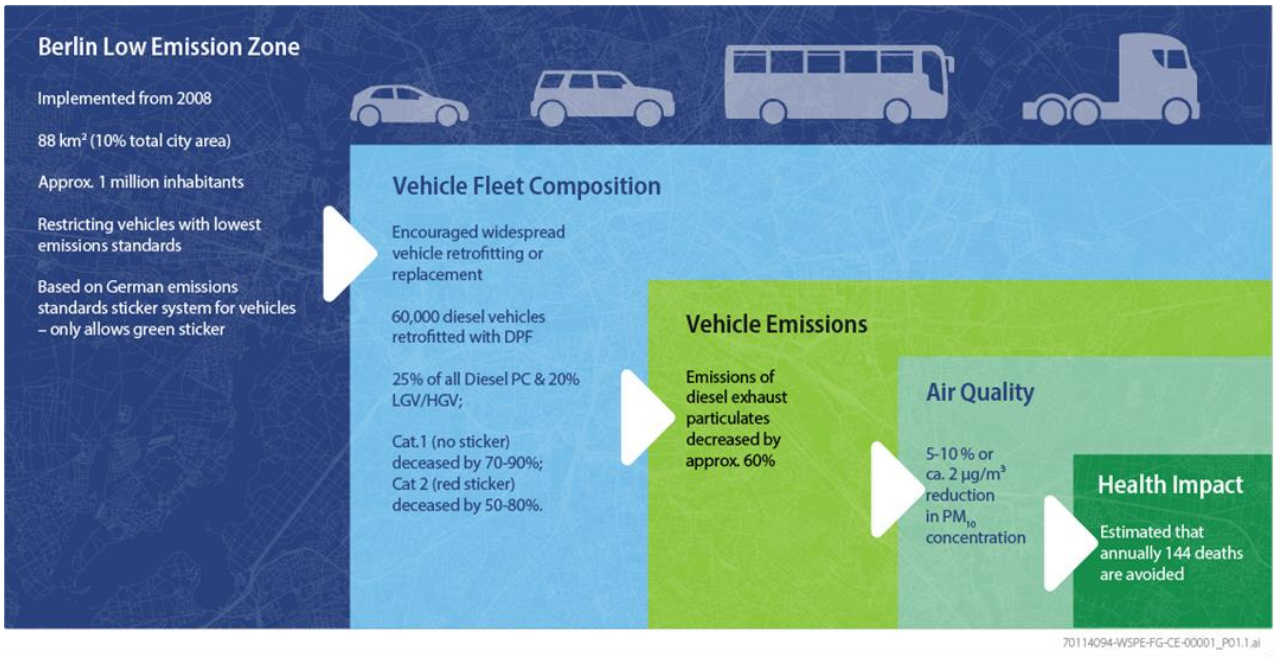
	Vehicles) in the Low Emission Zone that meet specific "Euro" emission standards. • Stage 1 from 2008: banned all vehicles with red stickers (see section below). • Stage 2 from 2010: only allowed vehicles with green stickers to drive in the Low Emission Zone . Compliance was mainly achieved through retrofitting of existing vehicles (e.g. with diesel particulate filters).
Organisation of the initiative	The legal basis for the Low Emission Zone was national legislation, which assigns vehicles to specific emission categories and allows driving restrictions based on the emission intensity of individual vehicles. Emission categories are indicated by colored stickers on its windshield: from red (highest emission) to green (lowest emission). Administration and implementation of the Low Emission Zone was at the local authority level; enforcement by police and parking officers, with fines issued for non-compliant vehicles. Some exemptions were allowed – e.g. for doctors, disabled vehicles, the fire brigade, military, police and ambulances.
Financials	The 'funding' required for the implementation of the measure mainly included regular local authorities costs (e.g. salaries) related to setting up and enforcing regulations (as this measure was enacted as part of a pre-existing national regulation on vehicle labelling (see above)). Namely, the measure was administered by local authority staff and enforced by police as part of their 'standard' remit. Some additional funding was needed for the retrofitting scheme for older vehicles.
Impacts	See below. Impact(s) assessed compared to business-as-usual conditions 2007 baseline (i.e. before implementation of the Low Emission Zone) (see Lutz, 2015) include: • **Traffic flows** - No measurable impact on traffic flows, but the turnover of the vehicle fleet towards cleaner vehicles speeded up considerably. • **Vehicle fleet composition** - More 60,000 diesel vehicles retrofitted with diesel particulate filters (25% of all Diesel PC & 20% Light Good Vehicles/Heavy Good Vehicles); decrease in

	category 1 (no sticker) vehicles by 70-90%; decrease in category 2 (red sticker) vehicles by 50-80%. • **Vehicle emissions** - Emissions of diesel exhaust particulates [across the whole fleet] decreased by approx. 60% (2007-2015). • **Air quality** - 5-10 % or ca. 2 μg/m³ reduction in PM_{10} concentration; and 10 few exceedance days (> 50 μg/m³) for PM_{10}. • **Health impact –** it is estimated that annually 144 deaths are avoided by the Low Emission Zone in Berlin (Cyrys et al. 2014).
Co-benefits/synergies	The LEZ helped to accelerate the 'clean up' of the vehicle fleet both inside and outside the Low Emission Zone , which had wider environmental benefits outside of the LEZ (such as the reduction of greenhouse gases).
Trade-offs	A survey found that LEZs can temporarily decrease residents' life satisfaction (measured in the scale of 1 to 10) by around three percent despite positive health impact. This was only observed in the short-term (first year) and the reason and magnitude of the effect were different according to individual circumstances (e.g. diesel car owners were affected more likely due to the stricter diesel car standards and younger people were affected more than older individuals likely due to the reduction in the level of mobility).
Key challenges	The main challenges for the LEZs were: • Getting 'buy in' from all stakeholders, e.g. getting support from commercial enterprises and vehicle manufacturers, was challenging. • There was limited policy acceptance from some stakeholders – e.g. suggesting that mobility restrictions and the associated adjustment costs reduce acceptance. • Assessing the case for proposed exemptions was laborious and time consuming.
Success factors	• Setting of ambitious emissions criteria for road vehicles (both at national and local level) prior to Low Emission Zone implementation. • An appropriate/ proportionate transition period between adoption and practical implementation so

	drivers can adapt in a suitably short time scale to deliver emission reduction. • The exemptions allowed were considered proportionate, limited, and well-defined. • LEZ was applied to an area large enough to generate a renewal rate of the vehicle fleet and to avoid detrimental effects in adjacent areas by undesired traffic re-routing generated by the Low Emission Zone. • Good monitoring was in place to measure the impacts of the LEZ on the different aspects (i.e. traffic flows; measured air quality (concentrations) (before and after). • Good communication with key stakeholders e.g. through stakeholder roundtables –with chamber of commerce, manufacturers, national government, researchers
Transferability	This measure is transferable to most/any city in Europe. LEZs are a very common air quality measure across Germany and elsewhere Europe.
References	https://www.berlin.de/sen/uvk/en/environment/air/low-emission-zone/ Cyrys. J., Peters,A. Soentgen, Jens, Wichmann, E. H. (2014). LEZ reduce PM10mass concentrations and diesel soot in German cities. Journal of the Air & Waste Management Association,64(4):481–487, 2014 DOI: 10.1080/10962247.2013.868380 DIW Berlin (2022) LEZ improve air quality and health but temporarily decrease life satisfaction; https://www.diw.de/sixcms/detail.php?id=diw_01.c.838212.de European Parliamentary Research Service, EPRS (2021). EU policy on air quality: Implementation of selected EU legislation European Implementation Assessment. Gu,J., Deffner,V. Küchenhoff, H. (2022). Low emission zones reduced PM10 but not NO2 concentrations in Berlin and Munich, Germany. J Environ Manage,

	15;302(Pt A):114048. doi: 10.1016/j.jenvman.2021. Lutz, M. (2015). Low Emission Zones in Europe: Access restriction criteria, vehicle identification essentials for implementation. Available at: https://iki-alliance.mx/download/LEZ-Martin-Lutz.pdf

Figure 1 The impact of the Berlin LEZ on health[1]



[1] Graphic developed by the WSP project team, based on data in Lutz (2015) and Cyrys et al. (2014).

Key:

- Heavy Goods Vehicle (HGV),
- Light Goods Vehicle (LGV)
- Category 1 (Cat 1),
- Category 2 (Cat 2),
- Microgram per cubic meter (µg/m³).

2.6 Case Study #5: Botkyrka - adapting to the impacts of heat waves (Sweden)

Title	Botkyrka - adapting to the impacts of heat waves
Location	Botkyrka, Sweden
Geographic scale	Municipality-level (population of ~90,000 people)
Timescale	Implemented in 2010
Description of the initiative	In 2010, the Botkyrka municipality experienced prolonged high temperatures, which impacted the whole population but was particularly serious for elderly persons, including those living in retirement and nursing homes. In response, the local authorities created a tool to map how many people in the municipality were particularly vulnerable to heatwaves and where they lived. They used the knowledge to start working to increase the level of preparedness for heatwaves in the municipality. Nurses in the regions who care for the elderly population highlight the risks of heat exposure for their patients and raise concerns where necessary. This allows the implementation of mitigation measures for heat (such as investing in cooling equipment).
Organisation of the initiative	The Botkyrka municipality, the Swedish Defence Research Agency; the "Health and care administration" group of stakeholders; the Statistics and Real Estate departments; and Botkyrkabyggen AB are responsible for organising the initiative. The municipality is responsible for operating the initiative currently.
Financials	Source of funding: Municipality budget.. Overall budget: costs can be estimated at around €100,000, which were mainly related to paying the salaries of local authorities. Additional small funding is required on a case-by-case basis, whenever a home may need cooling equipment.
Impacts	Expected outcomes: Botkyrka aimed at improving its preparedness to heatwaves, considering both the current occurrence of these events and their future increase in magnitude and intensity due to climate change. Observed outcomes: During the 2018 heatwave, the municipality was far better prepared and equipped than

	in previous situations (e.g. including fans and paddling pools for elderly people to keep cool).
Co-benefits/synergies	The project supports the climate adaptation plans of Sweden and the project was adopted by other municipalities around the country too.
Trade-offs	No trade-offs have been identified in the literature or during the consultation process.
Key challenges	The success of the project can vary depending on the age of people's homes and the cooperation of the person(s). For example, individuals may require large investments to refurbish their homes, which is not always possible for the targeted individuals. As such, there is a risk that the service provided is not sufficient for the person. In addition, there are cases where people refuse to receive help, even though they are in need of help.
Success factors	A success factor of the project was that the different departments of the local authorities were able to cooperate successfully and were able to receive wide support for the project from the general public due to its focus on the most vulnerable people.
Transferability	With its relatively small budget, the project is transferable to many municipalities around the EU.
References/Data sources	https://climate-adapt.eea.europa.eu/en/metadata/case-studies/adapting-to-the-impacts-of-heatwaves-in-a-changing-climate-in-botkyrka-sweden/#solutions_anchor https://www.smhi.se/klimat/klimatanpassa-samhallet/exempel-pa-klimatanpassning/atgarder-vid-varmeboljor-i-botkyrka-1.115850 https://www.foi.se/rapportsammanfattning?reportNo=FOI-R--3387--SE

2.7 Case Study #6: Stuttgart ventilation corridors (Germany)

Title	Stuttgart ventilation corridors
Location	Stuttgart, Germany
Geographic scale	City-level (population of ~635,000 people)
Timescale	Implemented in 2008
Description of the initiative	Stuttgart is susceptible to poor air quality due to the combination of its geographic location (a basin valley with low wind speeds) and its heavy industrial activities and traffic. In response to this, the city developed a climate atlas that maps temperatures and cool air flows in and around the city. This information helped in the development of planning and zoning regulations (e.g. limiting the construction of buildings near green areas, establishing a minimum distance between buildings, requirements for green roofs, etc.) to establish a network of corridors that guide the air flow from nearby valleys into the city. They also connect to green space areas around the city and reach local neighbourhoods. Thus, the ventilation corridors aim to improve the air quality of the city and to protect the health of its citizen from the impacts of climate change.
Organisation of the initiative	The climate atlas was developed by the "Verband Region Stuttgart" (the association of regional cities and municipalities) and the city of Stuttgart. There was also collaboration between the Office for Environmental Protection of the city (who helped in analysing the information in the atlas) and the Planning and Renewal team (who implemented the strategy).
Financials	Source of funding: a combination of municipal and federal budget. Overall budget: the initial budget that was allocated to the project amounted to around €250,000. However, since then the city has invested tens of millions of euros in climate adaptation and greening programmes that build upon this initiative.
Impacts	Expected outcomes: compiling detailed information about the area's topography, climate and land use allows for precise planning for different areas, which together

	aim to improve air quality and mitigate the urban heat island effect. Observed outcomes: Over 39% of Stuttgart area is protected, green areas (urban forests, trees in parks and in streets) were expanded (more than 60% of the land area in the city is green open space) and ventilation corridor areas were preserved from urban expansion.
Co-benefits/synergies	The ventilation corridor project spurred further investment in green areas and climate adaptation strategies. Moreover, other cities (including some outside of Germany, such as Kobe in Japan) have also been motivated by this project and implemented similar strategies.
Trade-offs	The zoning regulations mean that there are fewer opportunities for expanding real estate and thus, for example, they drive prices of homes up.
Key challenges	The key challenge for the project was to strike a balance between factors such as losing on tax revenue due to zoning regulations, facilitating the housing needs of the city, and the need for fresh air and heat wave protection.
Success factors	The project demonstrated the advantages to a municipality of having in-house climatic research capacity. It also exhibited a close collaboration between the Office for Environmental Protection (analysis of information, provision of recommendations) and the City Planning and Renewal team.
Transferability	The project is transferable to cities with similar geographic characteristics like Stuttgart.
References/Data sources	https://climate-adapt.eea.europa.eu/en/metadata/case-studies/stuttgart-combating-the-heat-island-effect-and-poor-air-quality-with-green-ventilation-corridors https://www.ebrdgreencities.com/policy-tool/green-ventilation-corridors-stuttgart-germany-2/ https://www.regreen-project.eu/wp-content/uploads/GREEN-CORRIDORS-IN-STUTTGART.pdf

	https://oppla.eu/casestudy/21264

2.8 Case Study #7: Planting of trees in city district Red Houses (Zadar, Croatia)

Title	Planting of trees in city district Red Houses
Location	Zadar, Croatia
Geographic scale	District-level (population of ~1,500 people)
Timescale	Started and finished on: May 16th 2022
Description of the initiative	The project planted trees in the Red Houses district in the city of Zadar (a new residential district lacking appropriate greenspace) with the aim of improving the overall health of local residents. The main reason for this was due to the variable weather conditions observed in the region, with flooding and heatwaves becoming an increasing issue. As such, the local authorities wanted to plant 33 trees as a nature-based solution which slows down the flow of rainwater and absorbs it, reduces the erosion of soil, and provides shade to protect people from the urban heat island effect.
Organisation of the initiative	The initiative was initiated by the local authorities in the city of Zadar. The city's company for public greenery "Nasadi" was responsible for the project implementation. Help and support were also received by the AgriculturalFood and Veterinary High School "Stanko Ožanić" and the mayor of Zadar.
Financials	Source of funding: Funding was received from the "Grow green" project (Horizon 2020 programme) and own (city budget) funding was also used. Overall budget: €8,000 (€6,800 from the "Grow green" project)
Impacts	Expected outcomes: The project's predicted impacts were improvement of health conditions, reduction of air pollution, increase of green spaces, heat stress mitigation, and reduction of global warming by reducing carbon dioxide emissions.

	Observed outcomes: The stakeholders reported that there is no measurable metrics related to this project, but that it led to improvement of living conditions.
Co-benefits/synergies	The support for the project has resulted in the development of a map which indicates parts of the city that are in most need of similar measures and is to be used in future policy implementation.
Trade-offs	No trade-offs have been identified in the literature or during the consultation process.
Key challenges	The stakeholders mentioned no challenges but noted that the usual challenge when planting trees is the lack of available space. There was a concern about maintaining the trees after planting (including potential diseases that could damage the trees). Although with increasing demand and popularity, the funding for this has been sourced.
Success factors	The success factors identified by the stakeholders were the availability of financial resources and the availability of some public area for tree planting. Also, a key success was the encouraging interest and participation of the community for increasing the green space in their local area. Namely, on the day of the implementation of the project, the local community gathered and helped to plant all the trees in the district even though they were not requested to do so. The success behind the participation of the community was that planting trees is a relatively simple measure that people can get behind.
Transferability	The project is transferable to cities that have available public area for planting trees. In addition, it's a relatively low-cost and simple measure that can be replicated within both small and large cities.
References/Data sources	https://growgreenproject.eu/wp-content/uploads/2022/11/GrowGreen_Zadar.pdf https://www.grad-zadar.hr/vijest/opce-vijesti-28/posadena-33-stabla-na-crvenim-kucama-7564.html

2.9 Case Study #8: Super-Grätzl Favoriten: Vienna's Superblock pilot project (Austria)

Title	Super-Grätzl Favoriten: Vienna's Superblock pilot project
Location	Vienna, Austria
Geographic scale	Neighbourhood-level (population of ~3,000 people)
Timescale	Pilot phase: Mid 2022 – Autumn 2023 Implementation phase: Autumn 2023 – Summer 2025
Description of the initiative	Motivated by the Superblocks in Barcelona, Vienna piloted a similar concept in its city to benefit the overall health and well-being of citizens through more green spaces, road safety and recreational spaces. The pilot phase of the project has already taken place where a new transport organisation was implemented in a specified neighbourhood within the city and a temporary pedestrian zone was created in a disadvantaged neighbourhood. The next steps are to start developing the permanent structural changes (e.g. road design) and the greening of the area. The project was initiated in response to the effects of climate change, and in particular, the extreme heat events that Vienna is facing and going to face in the future.
Organisation of the initiative	The Urban Development and Planning department took charge of the pilot phase of the project and worked together with various departments around the city. For the full project, other departments (responsible for the road design of the city) have taken the lead, but the Urban Development and Planning department remains as a moderator. They are implementing project management practices and software to track the achievement of different milestones for the project and its progress as a whole.
Financials	Source of funding: the budget source comes from European Union funds (the European Regional Development Fund), national funds (around 10-20% of whole budget because it was a pilot), and regional funds. However, in the future, the separate districts within the city will be responsible for the funding.

	Overall budget: The pilot phase, along with the feasibility study carried out beforehand costed around €235,000. For the full implementation, this will cost around €7-8 million for this neighbourhood (for one block). This budget might not be possible for future blocks, so they will use the knowledge of the pilot phase to see how they can find a balance when it comes to costs.
Impacts	Expected outcomes: The project aims to combat extreme climate change (e.g. through the reduction of the urban heat island effect), to increase the number of green spaces, to decrease noise and air pollution, and to improve health in terms of promoting active mobility. Observed outcomes: A study on the effects of the pilot phase was carried out in September - October 2023 but is currently under evaluation. Among other things, the study measures the change in well-being of local citizens. However, changes in air pollution, noise pollution, and health outcomes have not been directly measured as the area of the block is small and they decided that they could not make adequate conclusions.
Co-benefits/synergies	The project also applied circular economy practices by using old trash cans as pots for trees, which are used to prevent cars from disobeying traffic rules in the superblock. Moreover, it has had a social impact where the local citizens feel proud to be a part of a superblock neighbourhood, which has created a stronger sense of community.
Trade-offs	When implementing the pilot phase there were some concerns raised by the fire department, the police, and the waste collectors in terms of the ease of access to the superblock to carry out their duties.
Key challenges	The stakeholders reported a few main challenges related to the project implementation. For instance, since it was a "top-down" project they had to convince the local residents that this project is designed to help them rather than harm them. Moreover, to their surprise, they did not receive as much critique about the parking spots they needed to remove to facilitate the pilot phase, but rather due to fears of potential noise that could be created from people socialising on the newly installed benches in the

	block. Finally, since there are different local authorities for each district, in some areas it might be more difficult to convince the authorities to implement the superblock project than in others, which may cause inequalities in distribution of benefits.
Success factors	The success factors were the public acceptance, the collaboration between stakeholders, and the creation of a shared vision. The organisers also used multiple languages in their information campaign, which was successful in informing as many people as possible about their intervention. Moreover, using project management practices and software (more typical for the private sector) proved to be an efficient way of coordinating the different tasks to be done by the different departments and to track its progress.
Transferability	On the city-scale (full implementation), the project is relatively large and thus only transferable to cities with similar size/population. However, on the block-scale (pilot), it might be possible to implement in smaller cities too.
References/Data sources	https://www.wien.gv.at/stadtplanung/supergraetzl-favoriten

2.10 Case Study #9: Mazovia for clean air (Poland)

Title	Mazovia for clean air
Location	Mazovia Voivodeship, Poland
Geographic scale	Province level (population of ~5,500,000 people)
Timescale	Initiated in 2019 and ongoing
Description of the initiative	Mazovia for clean air is a financial instrument aimed at supporting municipalities within the Mazovia Voivodeship. It comes in the form of financial assistance for air protection projects related to monitoring the compliance with the provisions of the anti-smog resolution (introduced by the Polish government in 2017), carrying out educational and informational campaigns, purchasing and installing public electric vehicle charging stations, increasing the municipality's investment potential in reducing low emissions, and wet cleaning/washing the streets of the municipalities. The project was initiated to achieve better air quality in a short period of time compared to the national air quality plan that spanned over 20 years before seeing results. To get funding from the project, stakeholders must apply through an open tender competition, guaranteeing that their project can be executed within one year. The Mazovia Voivodeship then decides which projects they can fund by evaluating them through a set of prespecified evaluation criteria.
Organisation of the initiative	The project was initiated and is led by the local authorities part of the Marshal's Office of the Mazovia Voivodeship (Mazovia province).
Financials	Source of funding: Province budget Overall budget: Since 2019 the policy has had a total budget of around 60 million zlotys (€14 million) which was spread over 902 projects. Most recently, in 2023, 10.4 million zlotys (around €2.2 million) was allocated to the support program for 131 projects. However, the funding varies each year depending on previous success and the number of eligible projects.
Impacts	Expected outcomes: The project aims to reduce the overall risk of respiratory tract disease, to improve air quality, and to reduce energy consumption.

	Observed outcomes: Reduction of PM_{10} levels and reduction in the number of people with respiratory tract disease. Although measuring the impacts is difficult. There are slow improvements seen in the areas where the project has been carried out. However, municipalities within the province have now been successful in achieving 88% of the educational goals of the programme (carrying out campaigns on air quality, energy efficiency and modernisation of heating equipment), 74% of the heating control goals (verifying whether residential heating is compliant with the regulations), and 86% of the wet cleaning goals (using wet cleaning devices for municipal cleaning).
Co-benefits/synergies	The stakeholders reported that the project contributes to limiting energy losses, to fostering change of heating measures for individuals and local governments, to raising awareness and increasing citizen participation, and to protecting the local environment, biodiversity, health, and quality of life. Moreover, since the project has been successful, they are expanding to feature measures to diagnose and counteract energy poverty.
Trade-offs	There were no trade-offs noted by the stakeholder for the implementation of the project.
Key challenges	The stakeholders reported that the main challenges that they faced were insufficient financial resources to realise all submitted projects/measures – projects were rated based on an evaluation system and they had to receive a certain number of points to be accepted. There was also an issue that the projects which were selected for the plan had to be carried out on a year basis, as this was the only way they sourced budgeting.
Success factors	The success factors listed by the stakeholders were that there was a dedicated budget, clear rules and regulations, an efficient project evaluation system, high involvement of employees, and a big interest from local governments.
Transferability	Since the project captures many different measures, the transferability will depend on the measure itself, as well as its scope/targeted population.
References/Data sources	https://mazovia.pl/pl/bip/zalatw-sprawe/ekologia-i-srodowisko/mazowsze-dla-czystego-powietrza-2023/

2.11 Case Study #10: Healthy street programme (Hungary)

Title	Healthy Streets Programme
Location	Budapest, Hungary
Geographic scale	Regional/Province level (population of ~100,000 – 500,000 people)
Timescale	Planned for 2024-2026
Description of the initiative	The Healthy Streets Programme has been planned as part of the Hungarian council's efforts to tackle climate change after Budapest declared a climate emergency in 2019. One of the goals for tackling climate change is healthier streets. The programme follows on from the 'London Model' and sets goals for both Budapest and its districts. The project aims to improve green spaces, air quality and quality of life for those in and around the city and its districts. To do this, each of the 23 districts of Budapest will propose initiatives (such as planting biodiverse trees) to tackle those issues and will compete for funding. Therefore, the budget will be spread among the districts who propose measures that can bring the most positive impacts.
Organisation of the initiative	The municipality of Budapest is responsible for replicating and leading the initiative. However, once the budget has been allocated, each local district will be responsible for executing its measure in collaboration with the municipality.
Financials	Source of funding: EU Cohesion Fund Overall budget: Next year in 2024, after the elections have happened in Hungary, €60 million will be allocated to the project. This budget is to be spread among different projects which are to be implemented by 2026.
Impacts	Expected outcomes: The project aims to improve air quality and limit pollution around the city of Budapest and its districts. Other positive impacts include rainwater retention to help during prolonged periods of drought, through increased fields, ponds and number of plants that are good at upholding water. This will be done with a focus on nature-based solutions.

	Observed outcomes: There can be no observed outcome until the project has been fully implemented.
Co-benefits/synergies	By increasing the amount of green spaces/biodiversity of trees and plant species, ecosystems could form with species re-entering the city and inhabiting the green areas.
Trade-offs	The policymakers anticipate that there could be a trade-off in terms of trying to prioritise different mobility modes instead of individual private car transport (such as removing parking spaces to build cycling lanes).
Key challenges	The expected challenges of the project are mainly related to public consultation, especially as some of the local communities oppose the changes being made. This is due to the issues around mobility throughout the districts and the city, with cars being pushed out of the city. There has already been an issue with the media. Unjustified articles are sometimes posted in order to deter people from the project.
Success factors	The stakeholder mentioned that there were 18 measurement tools which are used to assess 10 indicators (e.g. traffic volume, air pollution, tree registers). However, the 10 indicators vary, with some being a lot easier to measure than others (e.g. air quality over human wellbeing).
Transferability	Since this project is targeting the capital city of Hungary, which has a large population density, it is likely that it can also be carried out in other major cities. For example, the London project which this was based on.
References/Data sources	Since this project has not been innitiated, there are no information sources that can be referenced here. The details were obtained purely from the consultation with stakeholders.

3. Assessment of the impact of implementing projects to address the climate, pollution and environment crises on human health

3.1 Overview

This section of the report assesses the impacts of Green Deal related projects in terms of addressing climate change, pollution and environmental degradation, and the associated effects on human health. This assessment uses key insights from the gathered case studies, as well as additional evidence on other initiatives and projects, to assess the actual impacts of various projects. The discussion is presented according to the key categories of environmental determinants as covered in Section 1.

3.2 Impacts – environmental pollution and health

Environmental pollution has long been a detriment to human health. The case studies highlighted in Section 2 of this report provide information on the practices that local and regional authorities are implementing to combat further environmental pollution to help mitigate effects on human health, and in many cases, measurably improve human health.

3.2.1 Air pollution

As discussed in Section 1, air pollution is a significant health determinant within the EU. Local and regional authorities have taken steps to reduce air pollution on a local level to improve the overall air quality of the EU, as well as their citizens' health. The case studies in Section 2 that highlight practices to improve air quality are discussed below. There is currently limited evidence of the impacts on health and the environment highlighted within the case studies regarding air pollution, with the most evidence available for LEZ programmes.

A key local action identified in this study for tackling air pollution is the implementation of LEZs. This report has presented one case study (Case Study #4) of the implementation of a LEZ in a European city (Berlin, Germany), however LEZs are now well-established as a means of improving air quality in many cities across Europe (see reviews by EPRS, 2021; Holman et al., 2015), although they are typically more common in Western Europe compared to Eastern Europe[132]. It is estimated that between 2019 and 2022, the total number of active LEZs in Europe rose from 228 to 320 (increase of 40%) and by 2025, 507 LEZs

[132] Euro Cities (2023). Eastern European cities welcome first low-emission zones. Available at: https://eurocities.eu/latest/eastern-european-cities-welcome-first-low-emission-zones/ [accessed 03/10/2023]

will be in place in Europe (increase of 58% increase compared to June 2022)[133]. A 2019 literature review by Transport & Environment (T&E)[134] found that many LEZs deliver strong reductions of the principal air pollutants (e.g. PM and NO_x).

As discussed by Sarmiento et al. (2022), some empirical studies show that LEZs have a positive impact on the health of LEZ residents, for example through reductions in the number of hospitalisations due to circulatory or respiratory conditions, and the amount of medication required. For example, the effects of LEZs on the health of residents were investigated, focusing on hypertension as a risk factor for cardiovascular diseases. Following the introduction of an LEZ, the likelihood of developing hypertension decreases by 4.6 %, with the likelihood for 60- to 80-year-olds decreasing by up to 8%. Additionally, a separate calculation shows that the adoption of LEZs has prevented at least 94,000 cases of hypertension throughout Germany[135].

However, in practice, relatively few studies have been conducted to provide quantitative estimations of the health impact resulting from the implementation of LEZs in European cities. The case study (Case Study #4) of Berlin, Germany (see Section 2) is one example where quantitative estimates have been made on the positive effect such a measure has make. The 'link' between what the measure does and what it achieves (in terms of its impact on health), is relatively well-established and simple to demonstrate in the case of LEZs (see Section 2):

I. Measure put in place to target emissions source/pathway
II. Impact observed on emission source
III. Impact observed (or estimated) on total emissions of pollutants
IV. Impact observed (or estimated) on air pollution concentration
V. Impact estimated/calculated on human health.

Each aspect can be estimated quantitatively using a combination of direct measurement/monitoring and/or numerical calculations/modelling:

- Impact on source e.g. traffic flows/fleet composition – monitored directly
- Emissions – estimated using established emission factors
- Air quality / concentrations – established using routine air quality monitoring data and/or dispersion modelling

[133] Clean Cities (2022) The development trends of low- and zero-emission zones in Europe, https://cleancitiescampaign.org/research-list/the-development-trends-of-low-and-zero-emission-zones-in-europe/ [accessed 03/10/2023]
[134] Transport & Environment. (2019). Low-Emission Zones are a success – but they must now move to zero-emission mobility. Available at:: https://www.transportenvironment.org/discover/low-emission-zones-are-success-they-must-now-move-zero-emission-mobility/ [accessed 25/09/2023]
[135] Sarmiento, L., Wägner, N., Zaklan, A. (2022) Low emission zones improve air quality and health but temporarily decrease life satisfaction. Available at: https://www.econstor.eu/bitstream/10419/252286/1/1799623661.pdf [accessed 25/09/2023]

- Health impact – estimated based on emission/concentration reduction and impacted population, calculated for example using set 'damage costs' (a set of monetary impact values per tonne of emission) e.g. as developed by the UK[136] , or concentration–response functions, for example as developed by the WHO[137].

It is also noted that several LEZs in Europe (e.g. Amsterdam, Brussels) are implemented with the aim of achieving the WHO Air Quality guidelines[15] for key pollutants (which are set with reference to the specific impacts these pollutants have on public health). Therefore, it follows that the expected impacts on air quality in such cities will have a direct positive influence of public health. The impact of LEZs across Europe is highly variable – each LEZ has its own specific objectives and approach. It has been demonstrated (both in the case study outlined in Section 1, and other studies) that this is largely attributable to how the LEZ is designed (see Section 4).

Taking a different approach to improving air quality, Stuttgart, Germany implemented ventilation corridors in 2008 (Case Study #6). This project aimed to combat Stuttgart's geographic location and heavy industrial activities and traffic through the development of a climate atlas to map temperatures and cool air flows. This information was then used to inform the development of planning and zoning regulations to create air flow corridors into the city from nearby valleys. The project demonstrated the advantages of having in-house capabilities to do climate research. On the other hand, the zoning regulations that have been put in place due to the climate mapping have restricted the ability to expand real estate and have resulted in higher home prices. Despite these zoning restrictions, the development of ventilation corridors has been an overall success for Stuttgart and has significantly improved various environmental aspects within the area, however the impact on human health has not been sufficiently detailed.

The Mazovia for clean air project (Case Study #9) is a financial instrument aimed at supporting the municipal governments in Poland to understand air protection projects. These projects include compliance monitoring for antismog, educational and informational activities, investing in potential emissions reductions, and purchasing and installing infrastructure to encourage green vehicles. The key success of this project has been the achievement of better air quality since 2019 than other initiatives in the previous 20 years. While measuring the impacts of all

[136] Defra (2023). Air quality appraisal: damage cost guidance. Available at: https://www.gov.uk/government/publications/assess-the-impact-of-air-quality/air-quality-appraisal-damage-cost-guidance#annex-a

[137] World Health Organisation (2013). Health risks of air pollution in Europe – HRAPIE project. Recommendations for concentration–response functions for cost–benefit analysis of particulate matter, ozone and nitrogen dioxide. Geneva: World Health Organisation (WHO). Available at: https://www.who.int/europe/publications/i/item/WHO-EURO-2013-6696-46462-67326 accessed 27/09/2023]

measures under this project has been difficult, there has been a reduction in the PM_{10} levels and the number of people with respiratory tract diseases since the introduction of project. The key challenge reported thus far has been insufficient funding to undertake all submitted projects and measuring, and only providing funding for one year at a time to projects. This has slowed progress towards improving air quality, and therefore has resulted in limited evidence of the impacts on human health.

The Greening of North East Inner City in Dublin, Ireland, (Case Study #3) set out to increase green space and infrastructure to improve air quality. While there has been a 40% increase in tree coverage since the start of the project, the project was interrupted by COVID-19 and the outcomes on air quality have not been measured. Zadar, Croatia (Case Study #7) undertook a similar project to focus on planting trees, however with a different motivation. It is noted that the increased green spaces are expected to decrease overall air pollution, however the effects have not been measured within these initiatives.

A number of case studies identified in Section 2 also had indirect impacts on air quality. For example, the Good Move Plan in Brussels (Case Study #2) did not originally set out specifically to improve air quality, but rather encourage mobility. Through this initiative, there has been a noticeable decrease in traffic, and while not specifically measured, it is estimated that air quality has improved due to a decrease in emissions. The Super-Grätzl Favoriten pilot project in Vienna (Case Study #8) has also indirectly improved air quality by decreasing the traffic within the superblock. However, these changes to air quality can be difficult to measure. The superblock project in Vienna noted that there was an attempt to measure changes in air quality, but due to the small scale of the project it was challenging to get reliable data to show a measurable change.

3.2.1 Noise pollution

Noise pollution has increasingly become a concern within the EU with increasing aircraft and railway traffic around residential areas, as well as traditional road noise, and is now the second most important environmental disease factor in the EU.

From 2014-2018, the WHO conducted a review of scientific evidence for the health effects of noise pollution and provided a series of maximum noise levels for road, railway, and aircraft for both day and night. Using these thresholds, the European Commission commissioned a further study of the 447 million EU citizens and found that 167 million citizens are exposed to harmful road noise, 36

million to railway noise, and 15 million to aircraft noise[138]. There is no specific data on how the measures to decrease noise pollution have impacted human health due to the difficulties in monitoring the effects as well as a lag in time between the implementation of the measures and the ability to measure the impacts on human health.

The END is a key legislative link between EU and national legislation and remained the main digital assessment of noise health impacts and the outputs of the Directive have helped make effective decisions at the local, regional, national and EU level. In 2021 it was found that there is overall a better understanding of noise health than previously among Member States, and noise pollution is on track to be reduced by 45% by 2030 as part of the Zero Pollution Action Plan.

As is evident in the case studies presented in section 2, there is not a large focus on preventing noise pollution currently. In the studies, reduction of noise pollution was considered a secondary effect of the initiatives and changes were not well measured (if at all). In the Vienna Super-Grätzl Favoriten pilot project (Case Study #8), it was expected that there would be a decrease in transport noise pollution due to changes in traffic patterns, however no formal measurements have been taken. Citizen feedback to the project team revealed that there has been a significant increase in human noises due to the placement of benches in the new public spaces. As mentioned above, measurements on the impacts of the initiative on human health are difficult to measure, and after consulting with a local university, the project team decided to not pursue noise pollution measurements.

The Good Move plan in Brussels (Case Study # 2) and the Greening of North East Inner City in Dublin (Case Study # 3) expected that the initiatives would have some impact on the reduction of noise pollution, however neither of these initiatives have measured the impacts on noise pollution.

3.2.2 Water pollution

The case studies presented in Section 2 do not cover water pollution measures or the direct impacts of measures that have been taken to address water pollution at local or regional level to improve human health. It has been indicated, however, that a broad range of measures are already available in Europe at the local or regional level to improve the state of Europe's water bodies, including water retention measures; nature-based solutions and land use change measures.[70] It is indicated that, driven by EU legislation (particularly the WFD and UWWTD, see

[138] European Commission (2023). Report from the Commission to the European Parliament and Council on the Implementation of the Environmental Noise Directive in accordance with Article 11 of Directive 2002/49/EC. Available at: https://environment.ec.europa.eu/system/files/2023-03/COM_2023_139_1_EN_ACT_part1_v3.pdf [accessed 15/11/2023]

Section 1), point source pollution discharges to European waters have markedly decreased over recent decades as a result of improved purification of urban waste water and reduced industrial discharges.

For example, while there is limited data on the impacts on human health and the environment, a number of actions are expected to have had a positive effect, including measures taken to improve the technologies uses to treat waste as well as the construction and adaptation, expansion, optimisation of existing treatment plants, connection of households to sewerage systems and the consolidation and the closure of ineffective treatment plants. Furthermore, measures have been put in place to achieve stricter requirements, such as lower targets for concentrations of specific pollutants in the wastewater discharged by the responsible authority.[139]

In terms of diffuse sources of water pollution, a number of measures have highlighted, for example that to reduce diffuse nutrient pollution through more sustainable or innovative agricultural practices, or eliminating particular applications close to surface water or groundwater (for example the banning od pesticides in French cemeteries[140]). This study has not been identified examples of where observed impacts on health have been measured or estimated as the result of such local/regional measures being implemented.

3.2.3 Chemical pollution

The case studies presented in Section 2 do not cover measures targeting chemicals or the direct impacts of measures that have been taken at local or regional level to improve human health relating to chemical. At EU-level an assessment has been made demonstrating the positive impact of EU chemicals legislation on human health and the environment more broadly, quantifying and monetising the impacts achieved for a wide range of different health and ecosystem end points.[141] While this demonstrates the positive impact taking action on chemical pollution has had on human health in Europe, in the present study, relatively few actions or measures specifically targeted at chemicals at the local or regional level have been identified.

One example identified is an initiative of 11 cities within Belarus, Estonia, Finland, Germany, Latvia, Lithuania, Poland and Sweden to reduce emissions of

[139] European Environment Agency (2021). Drivers of and pressures arising from selected key water management challenges: A European overview. EEA Report No 9/2021. Available at: https://www.eea.europa.eu/publications/drivers-of-and-pressures-arising [accessed 15/11/2023]
[140]European Environment Agency (2023). Banning pesticide use in French cemeteries. Available at: https://www.eea.europa.eu/publications/how-pesticides-impact-human-health/banning-pesticide-use-in-french-cemeteries [accessed 15/11/2023]
[141] European Commission (2016). Study on the cumulative health and environmental benefits of chemical legislation. Available at: https://op.europa.eu/en/publication-detail/-/publication/b43d720c-9db0-11e7-b92d-01aa75ed71a1/language-en [accessed 15/11/2023]

hazardous chemicals into the Baltic Sea. The initiative focuses on small-scale pollution emitters, with the substances of focus taken from the list of Water Framework Directive priority substances. The cities were able to identify sources of pollution and bring public awareness to the situation, allowing for the reduction of chemical pollution into the waters[142]. Evidence of observed health impacts from this work have not been published.

Several examples of actions taken at local or regional levels to reduce the usage, release and/or exposure to pesticides have also been highlighted. In addition to the pesticide-free towns initiative (as discussed in Section 1) the EEA briefing on pesticides[67] has highlighted several actions targeted at improved agricultural practices, guidance or local action to reduce exposure. In relatively few cases have these actions measured the impact on health, however one initiate in Cyprus has demonstrated the reduction in children's exposure to pesticides and their associated health impacts[143].

In practice, it has been highlighted that measuring health impacts of chemicals (and by extension the impacts of measures to reduce emissions and/or exposure to chemicals) is very challenging. For example, an analysis of evidence on the benefits & costs of REACH[144] highlighted a number of challenges and data gaps that must be addressed to improve the assessment of impacts of chemicals relating to health, including:

- Limited quantification and monetisation of health benefits, with only a subset having been quantified and monetized due in part to a lack of good cause and effect and exposure data.
- Limited evidence on the impacts caused from chemical exposure, the mixture effects of low concentrations of several chemicals – so called cocktail or combination effects.
- Limited data on impacts to ecosystem services or how risk travels across systems (systemic risks).

The Umweltbundesamt (2020) assessment also highlighted need for improved biomonitoring in Europe in order to understand the impacts of chemicals. In recent years, the flagship European programme, Human Biomonitoring for EU (HBM4EU) aimed to bring together scientists, chemical risk assessors,

[142] European Environment Agency (2020). The European Environment State and Outlook 2020. Available at: https://www.eea.europa.eu/publications/soer-2020/chapter-10_soer2020-chemical-pollution [accessed 15/11/2023]

[143] European Environment Agency (2023). Reducing children's exposure to pesticides by providing organic food in Cypriot schools. Available at: https://www.eea.europa.eu/publications/how-pesticides-impact-human-health/reducing-childrens-exposure-to-pesticides [accessed 15/11/2023]

[144] Umweltbundesamt (2020). Development of REACH – Review of evidence on the benefits & costs of REACH. Available at: https://www.umweltbundesamt.de/sites/default/files/medien/5750/publikationen/2021_01_28_texte_06-2021_reach_weiterentwicklung_ap_2.pdf [accessed 15/11/2023]

Commission services, and EU and national agencies to enhance chemical safety. The project identified priority chemical substances and provided information on the hazards to humans, exposure pathways, and legislation status among other information. The results of this study are expected to help target actions for reducing exposure and health effects associated with chemicals, both at EU, national and local levels.

3.3 Impacts – climate and health

In Europe, the climate has been changing at an extremely fast rate, with increases in 'extreme' weather conditions in areas which never experienced them before. The impact of these weather conditions can lead to a decrease in health for multiple population groups. The change in climate could see a change in frequency of weather events, including an increase in floods, extreme temperatures, diseases and allergies. The health impacts of climate change can vary in terms of longevity and severity.

The case studies highlighted in Section 2 on this report provide mitigation measures for these climate change impacts, which aim, among other things, to decrease the health impacts on the general population for several regions and climates in Europe. It is worth noting that not all of the impacts of climate change highlighted in this section of the report have been correlated to a specific case study mentioned in this report.

Metrics for measuring the impact of climate change are also difficult to assign, with the impacts of climate change varying, and the extreme nature of the events. The main metric is therefore usually the prevention of the impact as a first instance, followed by the protection of life for those affected by the events.

3.3.1 Floods

The case studies outlined in section 2 of the report highlight the risk of flooding and the impacts this can have on health. For example, the Croatian case study in Zadar (Case Study #7) highlights the importance of green spaces in urban areas. The planting of tree species (which are adjusted to the climate), can lead to an increased water uptake and retention in areas which normally have non-permeable surfaces. This nature-based solution also has several other positive impacts, including the improvement of air quality and the health of local people.

Since the planting of the trees in the region back in March 2022, it has been difficult to measure the impacts that the planted trees have had for flood

prevention.[145] This highlights the need for further studies into the correlation with tree plantation and flood prevention.

The case study in Zadar (Case study #7) was not solely focused on the reduction of flooding, with the impacts being secondary. However, the effectiveness of flood prevention through tree plantation is hard to validate, as numerous other factors could be affecting the level of flooding including rainfall, saturation of soil, vegetation coverage and location of rivers around the city. Studies in the UK have presented evidence showing that there is little correlation between the level of tree coverage and river discharge, and that it is hard to prove the effects that tree coverage has on flood risk mitigation.[146] It is likely that the main impacts of planting trees to prevent flooding would come from upstream planting, where the trees would buffer the volume of water entering the upstream catchments.[147]

In terms of other studies for flood mitigation, the case studies in Rotterdam, Netherlands (Case study #1); Vienna, Austria (Case study #8) and Dublin, Ireland (Case study #3), could all potentially mitigate flooding in built up urban areas to some extent. All three of the studies promote the usage of green spaces in cities, which would lead to the removal of impermeable surfaces, and an increase in the levels of water that can be retained in the cities. This is dependent on the underlying geology and the absorption of water from the species planted in the cities.

3.3.2 Extreme Temperature

Extreme temperatures are highly driven by the effects of climate change, with Europe experiencing a range of extreme weather events, including heatwaves and extreme colds. Heatwaves pose the greatest risk to Europe, especially the southern part of the continent, and the capital cities which are built up and prone to the urban heat island effect.[148] The impact of implementing green spaces to these areas can potentially reduce this effect, with 0.5-2ha causing up to 0.3°C temperature reduction over a 40m radius.[149]

The case studies in section 2 of the report cover a range of mitigating factors for

[145] Floodlist (2023). Croatia – Flooding in Multiple Counties After Record Rain, Authorities on Alert as Rivers Rise. Available at: https://floodlist.com/europe/croatia-floods-may-2023 [accessed 15/11/2023]
[146] CIWEM (2018). Is planting trees the solution to reducing flood risks? Available at: https://onlinelibrary.wiley.com/doi/epdf/10.1111/jfr3.12484 [accessed 15/11/2023]
[147] Confor (2016). FORESTRY AND FLOODING. Available at: https://www.confor.org.uk/media/246067/confor-37_forestryandfloodingreportfeb2016.pdf [accessed 15/11/2023]
[148] European Union (n.d.) Extreme weather. Available at: https://civil-protection-knowledge-network.europa.eu/eu-overview-risks/natural-disaster-risks/extreme-weather [accessed 15/11/2023]
[149] Aran, F., Garcia, E., Solgi, E and Mansournia, S. (2019). Urban green space cooling effect in cities. *Heliyion*, 5(4), e01339 Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6458494/ [accessed 15/11/2023]

extreme heats. In Botkyrka, Sweden (Case study #5). Through measures such as implementing fans/paddling pools, there was an improvement of health for the elderly population. These benefits were not quantified.

In Vienna, Austria (Case study #8), the Superblock project was introduced to combat the extreme heat caused by the 'urban heat island' effect which causes the absorption and retention of heat in built up areas. The main method introduced to combat this is through the implementation of green areas. The green areas can cycle the trapped air in the city and provide shelter for when there are intense periods of heat. Although there are currently no effects noted for the project, it is presumed that there will be a decrease in heat stress in the city.

The case studies in Rotterdam, Netherlands (Case study #1); Dublin, Ireland (Case study #3) and Zadar, Croatia (Case study #7) all have an indirect impact on helping to mitigate/deal with extreme heats, with the cities increasing their green spaces. The green spaces implemented could reduce the 'urban heat island' effect. The increase in trees could also lead to shade and shelter from the warmer climate which is a good method of protection from extreme heat via shade.

In Europe, the Euroheat project quantifies the health effects that heat can have on populations in cities. And looks to improve the preparedness of the health systems in cities and how well they respond to protect health. From this project, action plans have been made in countries such as Portugal, England, Austria and North Macedonia to help protect those populations that are most vulnerable to heat.[150]

The case studies highlighted in section 2 are mainly focused on the impacts of heat in urban areas with less relevance on extreme cold weather conditions. From a relevant search, a lack of information of studies/ initiatives conducted on the impacts of extreme cold weather conditions in Europe was identified.

3.3.3 Disease

Due to the increasing change in climate in Europe, disease transmission/cases could emerge as a potential threat for Europe. Infectious diseases like malaria, dengue fever or West Nile fever may increase in transmission in the future with warmer climates including the Northern regions. The main route of transmission is the wider distribution of mosquitos species that act as a carrier for the listed diseases, and the growing number of travel-imported cases.[151]

[150] ClimateADAPT (n.d.) Heat health action plans. Available at: https://climate-adapt.eea.europa.eu/en/metadata/adaptation-options/heat-health-action-plans [accessed 15/11/2023]
[151] European Environment Agency (2022). Heatwaves, spread of infectious diseases due to climate change growing health threats to Europeans. Available at: https://www.eea.europa.eu/en/newsroom/news/heatwaves-spread-of-infectious-diseases [accessed 15/11/2023]

Those working in forestry, agriculture and emergency services are the most susceptible of being affected by these introduced diseases. The increase in warming sea waters is also leading to dangerous pathogens such as Vibrio bacteria which is found in fish and shellfish. One metric to measure this would be the monitoring of species in areas where diseases are likely to be prevalent. This could help the development of early warning systems for populations to get vaccinated and species controls to be introduced.[151 above]

The case studies identified in Section 2 do not cover any mitigating factors for the increase in these diseases. While not specific to the avoidance of disease caused by climate change effects, the EU has some initiatives that aim to generally prevent the risks of disease transmission. In general, the European Commission has the 'EU Civil Protection Mechanism'[152] which looks at the prevention, preparedness and response to disasters from Member States through the strengthening of cooperation. The European Centre for Disease Prevention and Control (ECDPC) also tracks and holds case definitions for each infectious disease covered by EU surveillance (under Commission Implementing Decision (EU) 2018/945).[153] The ECDPC also has the epidemiological surveillance network, which contains around 50 infectious diseases. Member States can report to the network so that diseases can be monitored, this includes climate-sensitive diseases.[154]

3.3.4 Allergies

Allergens in Europe cover a wide range of impacts on human health. Both the increase of mould and pollen are having adverse effects on human health such as allergic rhinitis and allergic asthma. Currently one quarter of individuals in developed countries are affected by allergies, with this number expected to increase with the impacts of climate change.[155]

The case studies in Section 2 of this report do not cover the responses to the increase in allergens observed in Europe. For pollen, the European Aeroallergen Network and the Copernicus Atmosphere Monitoring Service (CAMS) both provide data on daily pollen concentrations forecast and allergy risk assessments

[152] European Commission (n.d.). EU Civil Protection Mechanism. Available at: https://civil-protection-humanitarian-aid.ec.europa.eu/what/civil-protection/eu-civil-protection-mechanism_en [accessed 15/11/2023]
[153] European Centre for Disease Prevention and Control (n.d.). EU case definitions. Available at: https://www.ecdc.europa.eu/en/all-topics/eu-case-definitions [accessed 15/11/2023]
[154] European Environment Agency (2022). Climate change as a threat to health and well-being in Europe: focus on heat and infectious diseases. Available at: https://www.eea.europa.eu/publications/climate-change-impacts-on-health [accessed 15/11/2023]
[155] Paudel, B., Chu, T., Chen, M., Sampath, V., Prunicki, M and Nadeau, K. (2021). Increased duration of pollen and mold exposure are linked to climate change. *Sci Rep*, 11(12816). Available at: https://www.nature.com/articles/s41598-021-92178-z [accessed 15/11/2023]

for European countries.[156] Controlling the health effects of pollen allergies is very difficult, with the risks depending on the sensitivity of a person. Therefore, the best method for mitigating the risk is through the monitoring and the raising of awareness for when pollen levels are going to be high.[156]

A lack of initiatives were found for the prevention of health impacts of mould. Although, the impacts of mould and the increase of mould alongside climate change in Europe has been noted in several studies.[155][157][158] It should be noted that the WHO released a list of fungal priority pathogens to drive further research and policy interventions to increase the global response to fungal infections. It shall be seen how this impacts Europe.[159]

3.4 Impacts – societal challenges

3.4.1 Access to green and blue spaces

Improving the availability and quality of urban green and blue spaces has been utilised as a policy that can help address multiple issues at the same time. For example, green and blue spaces have been recognised as a key element within cities that can bring both significant health benefits to local communities and improvements in the local environment (e.g. through reducing air pollution).[116]

At the same time, green and blue spaces have an important societal aspect that goes hand in hand with the human health and environmental benefits. For example, they can serve as a place for communities to gather, to use for physical exercise and recreation, and to socialise on a daily basis. This is very important as the share of the population living in urban areas in the EU is projected to grow to 83.7% in 2050[160]. As such, with many people in urban areas, there will be an increasing need of green and blue spaces for citizen to utilise and to form stronger and better communities.

Some of the case studies presented in Section 2 also emphasise the important contribution of green and blue spaces for societal well-being and health. For example, the project undertaken in Dublin (Case Study #3) was initiated to tackle

[156] Climate-ADAPT (n.d.). Pollen. Available at: https://climate-adapt.eea.europa.eu/en/observatory/evidence/health-effects/aeroallergens/pollen [accessed 15/11/2023]
[157] Euronews (2023). The Last of Us 'minus the zombie part': How fungi are becoming supercharged by climate change. Available at: https://www.euronews.com/green/2023/02/07/the-last-of-us-minus-the-zombie-part-how-fungi-could-become-supercharged-by-climate-change [accessed 15/11/2023]
[158] Moretti, A., Pascale, M., Logrieco, A. (2019). Mycotoxin risks under a climate change scenario in Europe. Available at: https://www.sciencedirect.com/science/article/abs/pii/S0924224417304090 [accessed 15/11/2023]
[159] World Health Organisation (2022). WHO fungal priority pathogens list to guide research, development and public health action. Available at: https://www.who.int/publications/i/item/9789240060241 [accessed 15/11/2023]
[160] European Commission (2020). Urbanisation in Europe. Available at: https://knowledge4policy.ec.europa.eu/foresight/topic/continuing-urbanisation/urbanisation-europe_en

the high levels of anti-social behaviour that were documented in the area. As such, one of the essential tools the project utilised was to engage the community through consultations and to give them ownership of the ideas and decisions to be made in the area. For example, the regeneration of Diamond Park in the city allowed the local community to work in collaboration with the city council of Dublin at all stages of the process – the promotion, the plan, the design, and the development of the park. This created a sense of community from the very start of the redevelopment and allowed citizens to develop a park that is most suitable to their needs. According to the literature, weaker community belonging is associated with poorer general and mental health[161]. Therefore, even though no metrices were in place to measure this, this intervention has likely had a positive contribution to the overall health of the local community.

In Zadar (Case Study #7), the main aims of the project were to plant trees in order to address potential future climate change impacts such as floods and heatwaves. Nevertheless, the project managed to foster a strong community participation through the initiative. The policymakers reported that, without being prompted, the local community went out on the day of the planting of the trees and helped the developers to do their job. This collaboration between the community members is what likely has contributed to improved mental and general health of the local citizen.

3.4.2 Social inequalities

According to data from Eurostat, in the EU in 2021, 22% of people living in cities and 20.8% of people living in towns and suburbs were at risk of poverty or social exclusion[162]. Moreover, it has been found that large cities in the EU are characterised by higher inequalities than smaller ones[163], especially those in western Europe[164]. In addition, cities in general may be characterised with other types of inequalities that may not necessarily be related to income such as inconsiderate infrastructure for elderly people.

Consequently, a challenge associated with introducing policies on a local/regional scale is about making sure that no members of the local communities are left behind in terms of the potential benefits that the intervention aims to bring. In particular, while policies should aim to benefit everyone equally, there might be

[161] Michalski et al. (2020). Relationship between sense of community belonging and self-rated health across life stages. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7585135/ [accessed 15/11/2023]
[162] Eurostat (2020). Urban-rural Europe – income and living conditions. Available at: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Urban-rural_Europe_-_income_and_living_conditions [accessed 15/11/2023]
[163] Lenzi and Perucca (2023). Economic inequalities and discontent in European cities. Available at: https://www.nature.com/articles/s42949-023-00104-1 [accessed 15/11/2023]
[164] European Commission (2019). Social segregation. Available at: https://urban.jrc.ec.europa.eu/thefutureofcities/social-segregation#the-chapter [accessed 15/11/2023]

a need to target disadvantaged groups of people (e.g. low income earners, elderly people, etc.) specifically to make sure that their needs are not neglected. In this way, it can be guaranteed that the issues surrounding the inequalities in health and quality of life in Europe, which have been partially a result of national and local government policy agendas[165], do not get exacerbated.

For example, the "Rotterdam Walks 2025" project (Case Study #2) aimed to create a more pedestrian-oriented city which would induce people to walk more and hence improve their health. Importantly, in one of their first initiatives, the policymakers focused on assisting the elderly people of a local community to have equal opportunities as everyone else. Namely, through improving the infrastructure, the policymakers made it easier for elderly people to reach a nearby park. While they did not measure specific health improvements, they found out that elderly people were able to reach the park easier and did so more often. This suggests that the elderly people of the local community experienced a healthier lifestyle than before, through more physical activity and access to a green space.

Similarly, the project in Botkyrka (Case Study #5) had a specific focus on people from elderly homes, retirement homes, nursing homes and preschools as they are amongst the most vulnerable groups towards extreme heats in society. The early warning system that was set up by the municipality, the investments in cooling equipment (such as fans), and the instructions provided to staff working in those institutions have been successful in protecting the health and safety of those groups through increased understanding and preparedness towards heat waves. Therefore, this programme has contributed towards lowering the health inequality caused by extreme heat events within the municipality.

The "Super-Grätzl Favoriten" project in Vienna (Case Study #8) also tackled the issue of inequality in society. Firstly, the pilot project was initiated in a neighbourhood that can be considered more disadvantaged in terms of income levels and amenities. As such, the policymakers are aiming to close the health and quality of life gap between more advanced neighbourhoods and the one they chose. Secondly, the policymakers used multiple languages in their information campaign to accommodate the diversity of the population within the neighbourhood and to make sure nobody is excluded from understanding the initiative. Nevertheless, according to the representatives in Vienna, each district can decide whether it wants to implement the project. As such, there is a concern that, regardless of potential benefits, refusal of uptake by the local authorities might lead to an unequal distribution of those benefits in the city.

[165] Lawrence (2012). Urban Health Challenges in Europe. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3764275/ [accessed 15/11/2023]

3.4.3 Mental wellbeing

In general, it has been shown that compared to living in rural areas, urban areas are associated with much worse mental health outcomes for its citizens[166]. For example, one literature review suggests that living in an urban environment in Europe exacerbates the risks of anxiety disorders, psychotic disorders, and substance abuse[167]. Therefore, as good mental health is essential for happy, fulfilled, and productive lives, countries around Europe have started to put more emphasis on mental well-being than in the past.[168]

Namely, one of the key types of policies that aims to promote mental health in cities has been related to improving the access and quality of green and blue spaces. This is because, for example, exposure to urban green spaces has not only been associated with improving mental health outcomes and stress in general, but that also with a greater effect on people of lower socio-economic status.[116]

Improving the mental wellbeing of its citizen was exactly among the main aims of the projects carried out in Dublin (Case Study #3) and Rotterdam (Case Study #2) which focused on both improving the access of people to green and blue spaces and on improving the spaces themselves. Apart from stimulating physical activity, from the very beginning, both projects had the aim of helping with the mental health and well-being of residents. In Dublin, the focus was put on a region of the city where high levels of anti-social behaviour were reported, and in Rotterdam people were accommodated to benefit from green and blue spaces more easily. While neither city measured the improvements in mental health quantitatively, the expanded greenery and the improved access likely contributed to the overall mental wellbeing of the residents.

3.4.4 Energy poverty

Energy poverty, which is predominant amongst vulnerable groups of people (e.g. low-income earners, elderly, etc.), can affect those groups disproportionately during extreme cold and heat temperatures, as it is associated with causing negative health impacts[169]. Meanwhile, as mentioned in Section **Error! R eference source not found.**, policies to handle energy poverty in the EU have

[166] Gruebner et al. (2017). Cities and Mental Health. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5374256/ [accessed 15/11/2023]
[167] Imre (2014). Urbanicity and Mental Health in Europe: A Systematic Review. Available at: https://semmelweis.hu/ejmh/2014/12/10/urbanicity-and-mental-health-in-europe/ [accessed 15/11/2023]
[168] OECD (2018). Promoting mental health in Europe: Why and how?. Available at: https://www.oecd-ilibrary.org/docserver/health_glance_eur-2018-4-en.pdf?expires=1699999282&id=id&accname=guest&checksum=898973C51A9F9BBB8FB3529895697D40 [accessed 15/11/2023]
[169] Polimeni et al. (2022). Energy Poverty and Personal Health in the EU. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9517150/ [accessed 15/11/2023]

been challenging in the past and there is a need for new approaches in the future.

Indeed, none of the case studies identified by this report had a specific focus on addressing energy poverty directly. However, despite its focus towards lowering air pollution, the "Mazovia for clean air" project (Case Study #9) is planned to have an energy poverty tackling aspect to it. For example, as the city of Warsaw has banned coal burning for domestic heating to improve the air quality, coal-fired household heating needs to be phased out. Therefore, the policymakers are planning on expanding their project with diagnosing and counteracting energy poverty. As such, the previous success of the policy has allowed it to expand and to provide protection to the most vulnerable groups of people from incurring disproportionate costs.

4. Synthesis of critical success factors, challenges and lessons learned

4.1 Overview

The case studies presented in Section 2 of this report have provided insights from a number of specific measures taken across European cities or regions to combat pollution- and climate-related risks, with the aim of improving public health. These highlight the factors that were considered critical in ensuring the measures developed have been successful and how these have ensured (or will ensure) delivery of the best possible benefits to human health in the targeted locations.
This section of the report highlights these key lessons learned and success factors for policy makers and local or regional level, for the development of future measures.

For purposes of this report, the development of measures at local or regional level are viewed as a cyclical process, which can broadly been divided into 4 key stages:

1. Identifying the scope and location of measures (inception phase);
2. Designing and strategising of measures (planning phase);
3. Executing and operating of measures (implementation phase); and
4. Monitoring of measures (assessment phase).

This section of the report provides a brief overview of the key success factors and lessons learned, including the main challenges encountered and how these were overcome at each of these stages. It is emphasised that these case studies only constitute a small fraction of the different actions taken at local and regional level across Europe to address the wide range of environmental determinants impacting human health. For example, the EUGreenDeal map[170], provided by the CoR shows how EU cities and regions are taking action to decarbonise and where the well-being and health of citizens and of nature are protected and improved. The map contains over 300 different individual measures across Europe. While this section provides an overview of the key challenges, success factors and important lessons learned from the information gathered and assessed from this study, it should not be considered an exhaustive or comprehensive overview.

4.2 Identifying the scope and location of measures (inception phase)

The (crucial) first step in developing a measure targeting improvements in public health and a local or regional level is to determine the specific location and target

[170] https://cor.europa.eu/en/regions

of that measure. Through the case studies presented in Section 2, and the wider literature review conducted in this study, a number of key success factors and lessons learned can be highlighted to policy makers.

In the course of this study, three common approaches have been identified for describing why policymakers may decide to design and scope and/or locate a measure aimed at improving the health outcomes of local residents (i.e. the initiation of the measure). Each of those ways comes with its own success factors and challenges:

1. **Responding to climatic/environmental (human-induced) events** – According to policymaker input, it was indicated that one of the motivators for initiating a policy is to either directly prevent or stop adverse events from occurring to the local community. This was the case for the policies undertaken in Berlin (Case Study #4) and in Mazovia (Case Study #9) (due to the elevated air pollution), in Botkyrka (Case Study #5) (due to the elevated risks of heat waves in the future), in Brussels (Case Study #2) (due to the elevated air and noise pollution), in Croatia (Case Study #7) (due to the elevated risks of floods and heatwaves in the future), and in Stuttgart (Case Study #6) (due to elevated air quality and risk of urban heat island effect). One of the key challenges in designing these types of initiatives that was highlighted, is related to identifying how to strike a balance between the interests of the people and how to target the most vulnerable groups of people amongst society. However, a common success factor that was suggested, is that these projects are easily relatable and have a clear, easy to understand message. Consequently, the stakeholders reported that it was less difficult to obtain support and funding for them at the inception phase.
2. **Responding to recommendations/other policies** – Another reported motivating factor, related to the one outlined in the first part above, is when other aspects beyond natural phenomena signal that there is a need for a change at the local level. Namely, this is what happened in two of the case studies but under different circumstances – e.g. in Dublin (Case Study #3), due to a recommendation made by a report about the antisocial behaviour in the region, and in Rotterdam (Case Study #2) due to a survey carried out among the population in the city about walking habits. Nevertheless, both initiatives were accepted widely in the inception phase, which can be attributed to the evidence presented backing up the need for a measure. However, reportedly, a key challenge that came with both these projects was to ensure that, even at the inception phase, impacts on different groups of people will not be at the expense of others. Therefore, it is suggested that a key success factor associated with the inception phase, is in ensuring a robust evidence base for determining where local action is needed, and in particular to ensure this is directly linked to health-related impacts on the local population.

3. **Drawing on previous success** – The final group of policies that were identified by this report were motivated by the success of similar policies in other parts of the world. In Vienna, the "Super-Grätzl Favoriten" project (Case Study #8) was motivated by the success of the Barcelona superblocks policy[171] and the Budapest "Healthy Street" programme (Case Study #10) was motivated by its London equivalent[172]. According to the stakeholders, the key challenge that comes with similar projects is related to the mixed acceptance by local authorities at the inception phase, despite the successes of their counterparts. As such, it was indicated that in these situations, one needs to be able to supply sufficient levels of evidence to support their case. The key success factor associated with this type of project inception, is therefore the facilitation of effective communication and knowledge exchange between cities or regions in different countries. On the other hand, however, it was reported that the public is much more open those types of initiatives. Therefore, what was suggested to work well in the inception phase is convincing the local authorities that the goals of the policymakers and the wants of the people are aligned.

Another key factor at the inception phase for local or regional measures to improve health is the need to target measures where they will have the greatest impact (i.e. where exposure to pollutants is greatest). This can often be informed or dictated with reference to national and/or international (EU, WHO) level regulatory frameworks or guidance. In the case of LEZs – as discussed in Section 2 (Case study #4 on Berlin, Germany), measures are typically initiated in areas where air pollution levels are above limit values set at EU and/or national level. This will also apply to noise, where noise mapping can identify specific locations where action needs to be taken. It is also noted that in many cases, multiple environmental pollution issues will exist simultaneously (e.g. a common cause of air pollution and noise pollution is transport sources), hence there are opportunities to identify measures that have synergistic impacts.

In the case of LEZs, it has also been noted that in some cases, national laws are coming into force (e.g. in France, Spain and Poland) that will mandate or support the adoption of measures. For example, adopted in 2021, the French climate and resilience law ("Loi Climat & Résilience") makes LEZs compulsory for cities with more than 150,000 inhabitants (i.e about 42 cities). The existence of underlying local, national or EU-level policies or legislation that help support or mandate actions is therefore an important factor in achieving significant health benefits from local actions.

[171] Postaria (2021). Superblock (Superilla) Barcelona—a city redefined. Available at: https://www.citiesforum.org/news/superblock-superilla-barcelona-a-city-redefined/ [accessed 15/11/2023]
[172] TFL (2017). Healthy Streets for London. Available at: https://content.tfl.gov.uk/healthy-streets-for-london.pdf [accessed 15/11/2023]

4.3 Designing and strategizing of measures (planning phase)

The second key stage in the process is then for local or regional level policy makers to determine what a measure will actually do, and how it will operate in practice. While this can be a challenging aspect to contemplate several aspects of this process have been highlighted in the case studies, demonstrating how local or regional policy makers can successfully approach this stage.

For example, LEZs, such as the case study of Berlin, Germany (see Section 2, Case study #4) and other examples[134], demonstrate how the overall 'design' of a measure (including, area, the sources targeted, timescales etc.) is essential to ensuring the success in terms of achieving reduction in pollution and positive health impacts. From this and other examples of LEZ implemented, researchers have identified several determining factors that are important:

- The size of the LEZ is important because it determines the residents who will be directly impacted.
- A level of stringency is important, with more restrictive measures shown to be more impactful, hence setting ambitious emission reduction criteria is an important factor.
- An appropriate/ proportionate transition period between the adoption and practical implementation, finding a balance between achieving relatively quick and effective pollution reduction and a measure that is achievable in practice.
- Clarity and predictability of policies is also considered important, in order for users to fully understand the requirements and to adapt their behaviour appropriately.

As for the other case studies identified by this report, a number of common success factors were indicated by them. For example, one of the key successes that was suggested had to do with the diversity of professional backgrounds of people working on the policy. More specifically, many stakeholders reported that the involvement of multiple departments for their policy helped in executing a successful planning phase. As suggested by the policymakers, this is mostly because the inclusion of a wider range of stakeholders tends to create a sense of a "shared vision", which motivates people to be involved with the project in further stages. The stakeholders from Rotterdam (Case Study #2) even recommended contacting people in other departments already at the inception phase.

Another similar success factor that policymakers reported to work is to expand the "shared vision" to the local communities. For example, policymakers recommended giving responsibilities to the representatives of the community

(like in the case of Dublin (Case Study #3)) and involving them in key steps of the planning process. In cases of relatively more "simple" measures (like the tree planting in Zadar (Case Study #7), policymakers report that it is easier to involve the local communities, as it easier to explain what the planning phase entails. If the measure is more complicated, the people responsible for the Vienna project (Case Study #8) recommended planning an information campaign in multiple languages.

Consulting stakeholders is often a key aspect of this phase because it allows policymakers to gather a representative understanding of the actions that must be undertaken to conduct a well-informed and inclusive policy. The planning phase also sets future plans, goals, and objectives about the project which are used to guide the execution phase. Many of the case studies presented in Section 2 have suggested that effective engagement with relevant industry stakeholders is essential to achieve success, for example where measures require uptake (and in some cases innovations in) technical measures to reduce pollution. In these cases, engagement and 'buy in' from commercial enterprises, as well as the wider public is important, for example to understand and address any technical, practical or economic barriers that may prevent or delay the implementation of such measures, and establish ways to address those issues (e.g. to establish funding mechanisms to support implementation of the measure). This was demonstrated in the Berlin LEZ case study where a key part of the success was attributed to engaging and coordinating with key stakeholders.

Linked to this, the case studies presented in Section 2 have highlighted the importance of conducting an initial impact assessment at the planning stage before implementing the measure. This has been highlighted as a means of articulating the expected benefits of the measure to the wider public and could be seen as a means of ensuring better engagement and support for such measures. An example of this is the engagement materials prepared by Brussels[173] in the development of an LEZ. There are relatively few cases identified in this report where such impact assessments include a direct consideration of the expected impacts on human health. Stakeholders consulted as part of this report have reflected that inclusion of information on expected health benefits would be a valuable tool in ensuring public engagement and support in the development of pollution control measures such as LEZs.

Considering the common challenges during the planning phase among the ten case

[173] Bruxelles Mobilite et al. (2019). Expected effects from the low emissions zone on car fleet and air quality in the Brussels region. Available at: https://lez.brussels/medias/lez-note-en-vdef.pdf?context=bWFzdGVyfGRvY3VtZW50c3w4NzEwNjI3fGFwcGxpY2F0aW9uL3BkZnxkb2N1bWVudHMvaGFiL2gzYy84ODAxNjI2Njg1NDcwLnBkZnxlNGNhYmZmYThmYjQ0MTczODE3MmU3MzYyYzc2ODdiOGZjYWFkOGYyNzNjZWM4OTA4MmJiYmU2NTgwMGVhOGFl [accessed 15/11/2023]

studies outlined in Section 2, one common challenge, for example where the deployment of equipment or 'infrastructure' is required, is the logistical issue of the availability of space, e.g. as demonstrated by case studies involving the planning of trees. In those cases, the policymakers suggested to actively communicate and consult with the local communities to make sure that all points of view have been considered adequately. In this way, stakeholders reported that a balance between the needs of the different citizens can be reached more easily.

Another important challenge with the planning phase of many of the policies was budgetary constraints. While those policies have not been deprived from adequate funding, many policymakers found it difficult to spread it across the different aspects of the policy that they wanted to cover.

4.4 Executing and operating of measures (implementation phase)

The implementation phase requires an effective coordination between the different stakeholders and the policymakers, an establishment of clear roles and responsibilities, and an effective allocation of the predefined budget. As such, this phase is crucial for turning plans into tangible outcomes which satisfy the general interests of the local communities.

As identified by the case studies presented in Section 2, the implementation phase is the step that policymakers found most challenging. However, there were a number of factors that helped in the successful execution of their goals. For example, one of the main recommendations by policymakers was to have a clear division of tasks, especially when working with multiple departments at the same time. This involves trying to follow the schedule set out in the planning phase and making sure that all stakeholders comply with the prespecified rules. The policymakers from Vienna (Case Study #8) even recommended using project management software, to establish clear project milestones and tasks, and to track project progress more efficiently. In the cases like those in Dublin (Case Study #3) and Zadar (Case Study #7), sharing task ownership with the local community reportedly also helped in the successful implementation of the policy.

One of the main challenges related to the implementation phase, depending on the measure and its trade-offs, concerns public acceptance. It has been demonstrated through the case studies provided in Section 2, that ensuring and maintaining a good communication with the public at large is a critical success factor as this helps ensure a good understanding and support for actions at the implementation stage and prevents public backlash and lack of acceptance.

For example, in cases like in Brussels (Case Study #2), the project might receive backlash from the wider population which may bring it to a halt and cause a

reconsideration of its strategy. Reportedly, the project introduced too many changes at a fast pace and there was a lack of time for the communities to accept them. As such, a key challenge for local policies is to strike a balance between effective communication, speed of implementation, and level of impact.

Finally, other unexpected challenges may also arise. In cases like in Austria (Case Study #8), where some people opposed having many benches near their homes rather than the removed parking space, there is clearly the need for better and earlier engagement with stakeholders to identify and address such issues. In other cases, for example in Dublin (Case study #3) (where the COVID-19 pandemic impacted the project) and in Botkyrka (Case Study #5) (where public participation and support was limited), those challenges are more difficult to handle.

In the case of LEZs (see Berlin, Germany, Case Study #4), at the implementation phase, one success factor highlighted is to implement and enforce a measure to allow appropriate exemptions or derogations, while still aiming to keep the measure as strict as possible, to ensure a proportionate impact. Making such decisions and finding an appropriate balance has been highlighted as being a slow and laborious process in this case, hence investigating ways to share knowledge and experience on that aspect could support development of future measures.

4.5 Monitoring of measures (assessment phase)

The key purpose of the monitoring phase concerns the effectiveness and magnitude of the impacts brought by the implemented policies. During this stage, local and regional policymakers must actively monitor and evaluate the outcomes of the implementation phase and measure whether the prespecified goals and objectives of the planning phase have been met. The monitoring activities often constitute the collection and analysis of relevant data that is usually compared to predefined performance indicators that are used to determine the "success" of the policy. Among other things, stakeholder feedback and public surveys are also common tools used during this phase, as they can serve as valuable evidence about the effectiveness of the policy.

According to the policymakers, one of the key strategies for successful monitoring is to be able to follow the monitoring plan set out in the planning phase and to communicate its results efficiently. Reportedly, this is especially important for projects such as those in Rotterdam (Case Study #1) and Brussels (Case Study #2), which are still ongoing and would require additional funding in the future. Namely, if the results show a positive impact, the policymakers reported that local authorities are likely to be more open to expanding the project further. For example, in Brussels, despite the initial backlash received by the public, the project demonstrated positive results and currently, more local authorities are

agreeing to its expansion. Moreover, despite that the project has not started, the policymakers in Budapest suggested that another success factor is to learn from previous projects. Namely, since the project is similar to its London counterpart[172], they were able to assess its success factors in terms of monitoring and to build upon them for their own monitoring planning.

Monitoring can also come with its own set of challenges. For example, in Vienna (Case Study #8), the policymakers had planned to measure the resulting air and noise pollution reduction of their policy. However, consultations with experts from a local university, revealed that there are technical difficulties in robustly monitoring these sources of pollution. Namely, it was suggested that since it is a small-scale project, interferences from wind (which could bring in air pollutants) or excessive noise (which can be caused by local pedestrians) can skew the results too much. Similarly, in Zadar (Case Study #7), the policymakers decided that measuring project impacts might be difficult due to its small scale. Finally, some policymakers highlighted that a challenge that comes with measuring the satisfaction of local citizen is related to gathering a representative sample of people and opinions. Nevertheless, in those cases, a general survey of local people can be conducted even though the results could be less robust.

Nevertheless, two key observations should be highlighted in this report:

1. Many of the case studies presented in Section 2 are either still ongoing or were completed recently, therefore limited insight has been gained this far to their impacts.

2. In most cases, it appears the assessment of the impact of measures does not make a (quantitative) assessment on the health benefits achieved. As discussed in Section 3, the ability to make robust assessment of health impact varies considerably between different environmental determinants.

However, some insights have been gained from examples where the measure was implemented 10+ years ago (such as in Berlin (Case Study #4)), allowing for sufficient time to assess impact, and where the focus was on air pollution where the ‘link’ between impact of a measure and health benefit is more well established (see Section 3). As demonstrated by the Berlin LEZ case study (Section 2) a key path to success is where established monitoring systems are in place to be able to measure and demonstrate the impact the measure has on the emissions, concentration and exposure to specific pollutants – and hence demonstrate (either directly or indirectly) the impact achieved on public health in reality. Utilising pre-existing networks and finding cost-effective means of achieving this is key to achieving that.

4.6 Summary

An overview of the key success factors or lessons learned from this study are presented in Table 1. The development of successful measures at local or regional level that target environmental determinants to improve public health can be envisaged as comprising four key stages (inception, planning, implementation and monitoring). Each of these steps is crucial to the success of measures in achieving their goals and this report draws out key enabling factors associated with each stage. While there are important nuances between measures targeted at different type of environmental determinants, as well as local factors impacting measures in each specific region, this report has highlighted a number of key consistent factors. These can be broadly grouped into four key categories:

1. **Assessment and research** – e.g. investigation and impact assessment to inform the location and focus of measures to target action where this will have most impact; identifying synergies between different type of actions; identifying key practical and logistical factors and constraints.
2. **Policy** – e.g. a supportive and effective legislative infrastructure (at local, national and EU-level) or framework to incentivise, enable or mandate measures.
3. **Funding** – e.g. including mechanisms that encourage, enable and support smart design and implementation of measures and support key stakeholders.
4. **Communication** – e.g. including a constructive and transparent discourse with all stakeholders including the public; ensuring expected and measured impacts are communicated, both to the public and policy makers.

It is also important to view this as a cyclical process, where the experience and knowledge from implementing a particular measure and observing the impacts achieved, are fed back into the overall process to help make adjustments to existing approaches or inform the design of new measures (e.g. in the same location, or other regions across Europe).

Table 1 Summary of critical success factors, challenges and lessons learned

Phase	Key success factors/lessons learned
Inception	• Presence of underlying national/EU level legislation to guide (or mandate) where action should be taken, i.e. triggered by specific criteria (e.g. emissions, pollution levels). • Strong understanding and mapping of pollution and population exposure at local level, to ensure decision making on where action is needed is made with a robust evidence base • Good communication of existing experience and best practice between countries and regions.
Planning	• Conducting detailed impact assessment that includes the consideration of impact on human health. • Investigation of synergies for actions targeted at different environmental/health impacts. • Inclusion and engagement with a wide range of stakeholders, including the general public • Consideration of all practical and logistical factors and constraints that could impact success. • Achieving the best possible balance between an ambitions/stringent design and targets of a measure (in terms of health), which is also proportionate, achievable and enforceable in practice and receives support from the full range of stakeholders involved (including the public).
Implementation	• Coordination and cooperation between different actors involved with delivering the measure. • Continuous public engagement and provision of support to ensure 'buy in' to ensure public participation and that maximise impacts (i.e. on public health). • Implementation and enforcement that is effective but proportionate and supports vulnerable groups.
Assessment	• Ensuring an effective framework and infrastructure is in place to monitor impact, both on pollution and public health are measured (or estimated) effectively and consistently. • Communicating results, both to the public and to other counties and regions effectively. • Using the results of this monitoring to feedback into the decision-making process and inform the re-design of the measure or the design of future measures.

5. Recommendations

5.1 Overview

Based on the information presented in Section 2, 3 and 4, and with reference to the conclusions made in other studies that have investigated local-level actions to address pollution and improve human health (e.g. Clean Cities, 2022[174]) a number of recommendations for action can be made.

It is evident from the discussion in the report, that the planning, design, implementation and monitoring of local or regional measures to address pollution, environmental degradation and climate-related risks requires action at multiple levels (local, national and EU-level) in order for those measures to achieve the maximum health benefits for the target population.

This section provides a brief summary of key recommendations at each level, focussing mainly on the direct actions that policy makers at city or regional level should take, but also the actions at national or EU level that can best support local or regional action. Figure 2 presents an overview of key recommendations for each of the four key stages of developing measures to improve public health.

5.2 Actions at city/regional level

- Local or regional authorities should **investigate and prioritise actions where these are most needed** (i.e. where they will have the most impact on public health). This should be based on a thorough mapping of both environmental conditions (e.g. concentration of pollutants) and the level of population exposure in that city or region. This initial assessment should be based on a consideration of the actual health impacts of the local population, rather than simply the emission or concentration targets for policy compliance.

- Cities and regions across all European countries should find effective ways to **collaborate and share information and best practice**. Establishing platforms or forums to facilitate this will be essential so successes in one area of Europe can be replicated or used to achieve improvements in health in other cities or regions.

- Local or regional policy makers' decisions on where and when to develop

[174] Clean Cities (2022). The development trends of low- and zero-emission zones in Europe https://cleancitiescampaign.org/research-list/the-development-trends-of-low-and-zero-emission-zones-in-europe/ [accessed 15/11/2023]

measures should, for example, pay particular consideration to **vulnerable or 'high risk' groups** within the community (for example the children, elderly and more socially deprived neighbourhoods).

- Actions taken by local or regional policy makers should begin with the conducting of a **detailed impact assessment**, which includes a consideration and analysis (quantitative or qualitative) of expected health impacts. The results of this assessment should be communicated effectively to the public to build better understanding and support of local actions to combat pollution.

- For successful delivery across all stages of measure development, local policy makers should establish a suitable **infrastructure to communicate and consult with key stakeholders and wider public** – e.g. creating public forums or events to promote engagement and encourage and facilitate better discourse in the inception, design, implementation, enforcement and monitoring of measures. This should pay particular attention to specific sensitivities for the location in question (e.g. demographics, language, vulnerable groups).

- To help ensure the success of the measure is accurately measured, and the impact on health is estimated, local authorities must establish the **appropriate monitoring is in place**. This should also then be fed back into the decision-making process when designing new measures or making adjustment to existing measures.

5.3 Actions at national level

National-level actions should be adopted to better support local and regional policy makes in the development of measures to combat pollution and improve public health in specific regions. These could include:

- Implementing national laws or regulatory frameworks to support the adoption of such measures at local level, for example by stipulating measures should (or must) be taken under specific conditions (e.g. level of pollution, exposure of a specified number or proportion of the population or specific vulnerable groups).

- Establishing a means to support (e.g. with targeted funding and/or financial incentives) the implementation or uptake of measures by specific stakeholders identified as needing support, in order to better support the planning, design, implementation, enforcement and monitoring of such measures.

- Supporting cities and/or regions by facilitating the exchange of best practice around development of local measures to address and monitor specific types of pollution.

For example, information campaigns about the clear health benefits of LEZs could be one option for mitigating the impact on people's well-being, as information on these societal benefits of environmental measures could positively influence their acceptance.

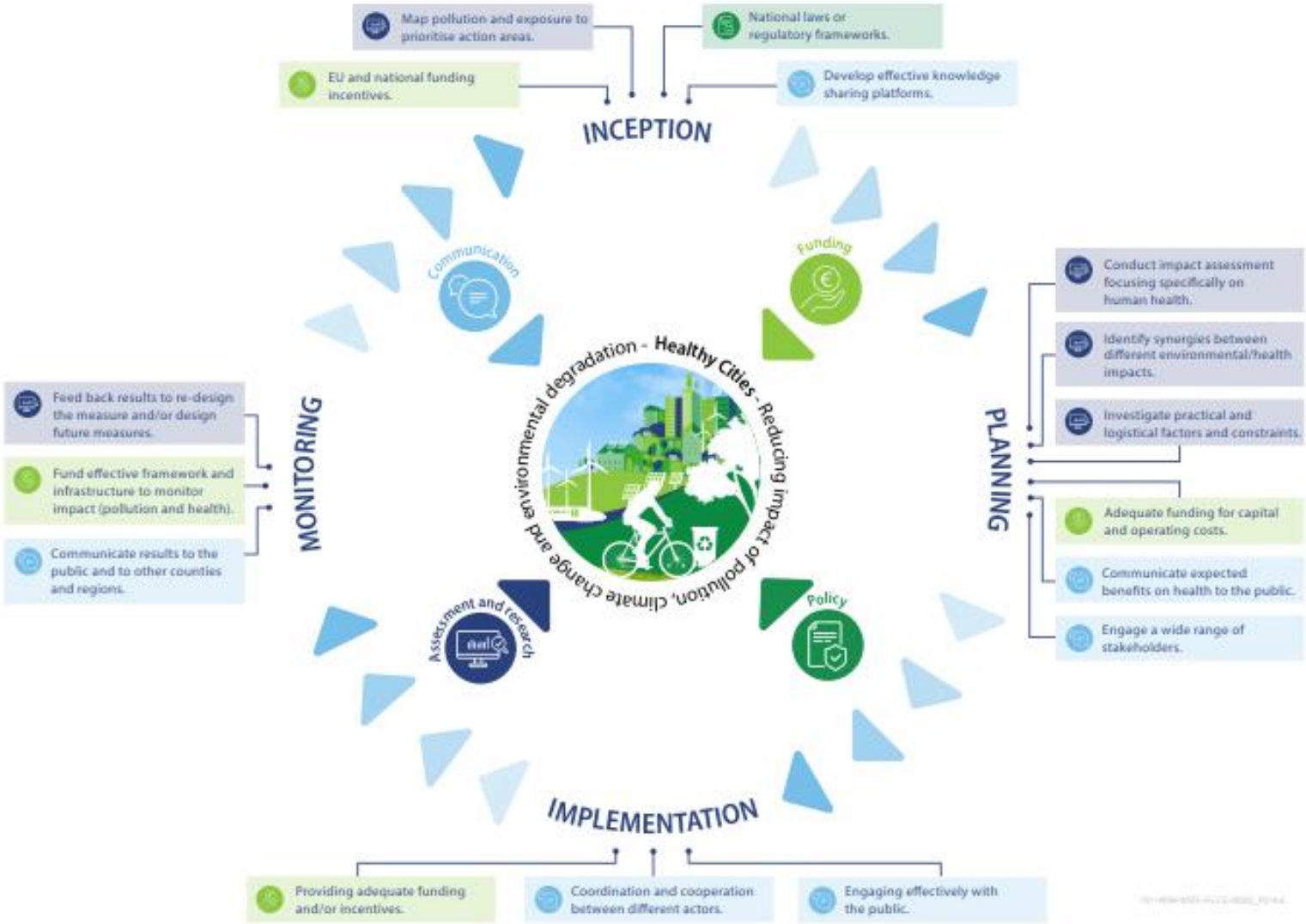
5.4 Actions as EU level to support cities

Cities or regions can also be better supported at EU-level in the development of measures to combat pollution and improve public health. For example:

- Consider implementing or revising EU-level regulations to help drive and support Member States to take action to address pollution from a public health perspective, e.g.
    - Specific emissions/concentration targets; requirement for mapping/action plans for particular environmental risks.

- Develop EU-wide networks to share information and best practices at each stage of the process (planning, design, implementation and monitoring of impacts). This is particularly important in the context of measuring and communicating impacts on health.

Figure 2 **Recommendations for each stage of the developing measures**



5.5 Data gaps and uncertainties

This report presents the findings from a relatively short-term study involving the gathering of data from publicly available literature and consultation with a small number of stakeholders, to develop a series of illustrative case studies (See section 1.3; Annex 1). As discussed in Section 4, it is emphasised that these measures represent a small fraction of the actions known to have been implemented at local or regional level across Europe. The results presented here should therefore not be seen as an exhaustive list of available measures, or a representative selection of the type, scope or location of all measures, neither as a comprehensive overview of the challenges and success factors involved across all measures. Rather these insights are intended to pinpoint key common themes or observations in different locations that will help inform the design and development of further measures to combat pollution and environmental degradation.

Some specific environmental impacts were not covered in the case studies (e.g. climate related diseases, spread of allergens). This should not be interpreted as these determinants representing less significant issue, or less attention being paid to these issues in Europe more broadly, but simply a reflection that limited data was identified for these actions in the course of this report. A further issue encountered throughout this assignment was that many of the actions investigated are still in progress or only recently completed, hence there was limited insights into the measured impacts at this stage.

Similarly, throughout this report, identifying examples where quantitative assessments have been made regarding the impact of specific measures on human health, has been challenging. The approach and methodology for making such assessments appears to be better developed for some environmental pollution risks (e.g. air pollution) than for others (e.g. climate related diseases). For example, the links (and underlying data sets) to estimate health impact from other measured metrics or variables are shown to be relatively strong for air and noise, but is shown to be more challenging for other impacts. A longer-term study should be considered to investigate these aspects in more detail, and gain a more comprehensive understanding of the actions developed and the impacts observed.

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Annex 1

Overall approach

The process for researching, scoping, and developing the case studies for this work involved the following steps:

(1) An initial review of publicly available sources (reports, publications, databases, and web pages) was conducted to scope initial suggestions for appropriate case studies.

(2) This was further complimented by direct communication with key stakeholders to gather initial suggestions for appropriate case studies.

Case study structure

The aim was to identify 8-10 case studies depending on the amount and quality of information available. The structure of the case studies was agreed between the project team and the CoR, as follows:

Title	Each case study given a short indicative title
Location	City/Region, Country
Geographic scale	Local or Regional
Timescale	Start year – End year
Financials	Overall costs and source of funding
Description of the initiative	Includes summary details of: • The specific type/source of pollution targeted. • The health impact(s) targeted. • The nature and scale of the intervention – i.e., the type of action; specific details on how this worked, what was done. • The target population – e.g., general public, vulnerable groups.
Organisation of the initiative	Includes details of: • The key players involved – e.g., local authorities, NGOs, research institutions, public – and who was responsible for which roles and how the organisational structure was arranged. • The policy framework and governance structure involved.

	• The sequential steps in planning, organising, and delivering the initiative, and how the results were measured. • The financial mechanisms involved • The technical assistance/capacity building involved.
Impacts	• Any quantitative measure of impact – reduction in emissions/release to the environment, pollution concentration/frequency, Exposure levels, number of people/area impacted, the measure of health outcomes. • Any qualitative information instead of / to contextualise further the quantitative information presented.
Co-benefits/synergies	Wider (socio-economic) benefits of the measure – e.g., • Employment. • Social inequalities. • Public engagement/understanding.
Key challenges	Summary of key barriers or challenges that needed to be addressed to deliver positive impacts – to consider: • Cooperation between different players. • Public/industry participation. • Logistical/infrastructure issues. • Financial barriers.
Success factors	Summary of the key enabling factors (and combination of factors) that led to successful implementation of the initiative and positive health outcomes.
Transferability	Indication of if/which aspects of delivering the initiative can be transferred to other areas or if this is unique to this case – to consider: • Geographical/meteorological factors. • Specific pollution sources (common or location-specific). • Governance/financial factors.
References/Data sources	• All literature sources. • All stakeholder information cited. • Acknowledge any organisations/individuals. involved in developing the case study.

A ‘selection criteria’ to inform the development alternatives and provide a basis for determining if suggested case studies should be taken forward for inclusion in this study was developed:

Criterion	Description
Country	Aiming to include 1/3 of CoR countries / and ideally to include good geographical range.
Scale of measure	Local or Regional – aim to include a distribution of both.
Pollution type/source	Aim to include a range types of pollution types – air, water, chemicals, noise, heat extremes, floods etc. as well as social issues e.g. access to green space or energy poverty.
Type of health impact	Physical/mental wellbeing - aim to include a distribution of both.
Timescale of measure	Prioritise project that have finished (ideally in the past ~5 years) and where assessment of impact has been made.
Level of data available	Indication there are data available (ideally quantitative).

The initial identification of potential case studies was aided by the direct interaction with stakeholders. To gather information from stakeholders, a set of scoping questions were developed (mirroring the case study structure detailed above) and selected stakeholders were contacted by email.

All case studies compiled from the literature search and the suggestions sent by stakeholders were compiled and tabulated in an Excel sheet to allow the information to be screened against the information requirements/selection criteria.

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