Urban sustainability in Europe

A stakeholder-led process

European Environment Agency

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Layout: Formato Verde

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Luxembourg: Publications Office of the European Union, 2021

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The EEA would like to acknowledge the support of the members of the EEA urban stakeholder group that contributed to the study design, scrutinised the research findings via multiple in-person and virtual stakeholder meetings and provided constructive feedback that supported the development of this report. This group included some institutional stakeholders from the European Commission that supported this project since its inception, including the Directorate-General for Climate Action (Christofer Ahlgren, Elina Bardran, Sandro Nieto-Silleras), Directorate-General for the Environment (Benjamin Casper, Joanna Drake, Nicole Wanders-Wengler), Directorate-General for Regional and Urban Policy (Laura Liger, Pia Laurila, Zelijka Zgaga), Directorate-General for Research and Innovation (Maria Yeroyanni) and the Joint Research Centre (Carlo Lavalle, Pilar Vizcaino-Martinez). It also involved the European Economic and Social Committee (Stella Brozek-Everaert).

Other members of the EEA urban stakeholder group included AmbienteItalia (Lorenzo Bono, Iliriana Sejdullahu), C40 (Julia Lipton, Simon Kjaer Hansen), Council of European Municipalities and Regions (Axelle Griffon, Pedro Bizarro), Ellen MacArthur Foundation (Amelia Kuch, Maja Johannesen), Eurocities (Joana Cruz, Louise Coffineau), GEHL for people (Kristian Skovbakke Villadsen), ICLEI (Barbara Anton, Mark Hidson, Wolfgang Teubner), International Federation for Housing and Planning (Andreia Fidalgo), ISPRAmbiente (Anna Chiesura), IST Lisbon Engineering University (Manuel Pinheiro), MISTRA Cities at Chalmers University of Technology (Jan Riise), NOVA Information Management School (Miguel Castro Neto), OECD (Oriana Romano, Tadashi Matsumoto), People- Environment Research Group at University of A Coruna (Adina Dumitru), Research Centre for Urban and Regional Food Systems at Cardiff University (Roberta Sonnino), Strong Cities in a Changing Climate (Birgit Georgi), UN-Economic Commission for Europe (Ivonne Higuero), UN-Habitat (Annika Lenz, Frederic Saliez), WHO (Matthias Braubach).

The EEA would also like to recognise all the cities that supported this work: Barcelona, Cornellà de Llobregat, Essen, Freiburg, Gabrovo, Ghent, Glasgow, Hamburg, Horst aan de Maas, Lahti, Leuven, Lisbon, Ludwigsburg, Malmö, Mechelen, Mikkeli, Nantes, Nijmegen, Oslo, Reykjavík, Stockholm, Tallinn, Torres Vedras, Växjö, Vitoria-Gasteiz, Umeå.

The EEA would like to acknowledge the essential contribution of the European topic centres (ETCs): ETC-Air pollution, transport, noise and industrial pollution (Alena Bartonova, Cristina Guerreiro, Jaume Fons-Esteve), ETC-Biological diversity (Aurélien Carré), ETC-Climate change impacts, vulnerability and adaptation (Margaretha Breil, Silvia Medri), ETC-Climate change mitigation and energy (Hai-Ying Liu, Konstantin Geiger), ETC-Urban, land and soil systems (Andreas Littkopf, Gundula Prokop, Mirko Gregor, Sara de Maio, Stefan Kuhn, Thomas Soukup) and ETC-Waste and materials in a green economy (Minna Kulju). Several EEA national focal points representatives also supported the work now presented (Gabriella Simeone, Marton Miklos, Patrick Kenny, Tadhg O'Mahoney, Tanya Vladimirova, Wolf-Ott Florian, Zita Marta Geller).

We would like to acknowledge the support of several EEA experts (Aleksandra Kazmierczak, Almut Reichel, Ana Maria Ribeiro de Sousa, Andreas Understaller, Eulalia Peris, Evrim Ozturk, Ioannis Bakas, Javier Esparrago, Ybele Hoogeveen).

COVID-19 preamble

The coronavirus crisis has had wide-ranging impacts on cities and is likely to remain deeply intertwined with efforts to transition towards more environmentally sustainable urbanisation patterns for years to come. However, the research for this report and the development of the EEA's approach to urban environmental sustainability was largely finalised before the coronavirus emerged in Europe.

We know that cities have been at the forefront of the health crisis from the very beginning, not only bearing the worst impacts but also becoming essential actors in proactively and innovatively addressing the health emergency, as well as dealing with the wider social and economic ramifications. It is clear that city, national and EU budgets will come under strain as a result of the economic crisis, which may result in reduced budgets for core environmental initiatives in the years ahead.

At the same time, many policies that have been implemented primarily to deal with the health emergency will also have long-term environmental benefits (e.g. improved active travel infrastructure), and there is a growing movement of cities in Europe actively committing to a green recovery from the crisis — supported by initiatives at the EU level, such as the European Green Deal.

As regards cultural shifts, similar uncertainties exist. While people may be more attuned to the importance of clean air and high-quality green spaces, we are also seeing, for example, growth in single-use plastics, and a renewed preference for the use of private cars over public transport, which may have serious environmental consequences.

What is clear is that, for most Europeans, the pandemic has caused abrupt changes in daily routines that will have far-reaching consequences for cities. For many urban dwellers, working from home has become the new normal, video conferences have replaced face-to-face meetings (and related business travel), online shopping is taking over from physical retail, and people are becoming better acquainted with their immediate neighbourhoods and local green spaces.

The coronavirus crisis is clearly a challenge of unprecedented proportions, while also offering a window of opportunity that may accelerate sustainability transformations in cities. From the perspective of both research and practice, it is clear that there is a long agenda of issues that will have to be tackled in the months and years ahead. These include, for example, what a green recovery looks like for different cities; the meaning of urbanity and the appropriate mix of land uses; new requirements for the design of the public realm and green spaces; opportunities and challenges presented by new modes of transport; changes in urban functions (e.g. homes becoming the hub of day-to-day life and office buildings being converted to housing); the impact on local business and service providers (e.g. less inner-city footfall); the role of technology and digital futures; urban and regional production and value chains; and considerations of new forms of urban decision-making.

While current efforts are rightly focused on tackling the immediate challenges posed by the pandemic, it is important to swiftly put in place recovery pathways that align with wider sustainability objectives. The EU's ambition of climate neutrality by 2050 and its European Green Deal must stay on track, while continuing to recognise the profound societal changes we are undergoing.

Moving forward, it will be ever more important to ensure a fair transition for all while rebuilding our economies sustainably. Cities are at the centre of future environmental challenges, and therefore there is an urgent need for European cities to shift towards a more integrated approach to addressing persistent, systemic environmental challenges. The EU also has a key role in promoting sustainable urban development, a role clearly recognised by the EU Urban Agenda. This has important implications for cities when it comes to the transformation of systems that will be required to tackle the climate and ecological crisis in the years to come.

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1 Why is the EEA interested in cities?

1.1 The European context

Europe is a highly urbanised continent: it is estimated that the share of the EU population living in urban areas is currently 74 %, and this is predicted to rise to 80 % in 2050 (EEA, 2019a). Historically, the urban population in Europe has been growing over the last half-century. Much of this growth has been in towns and suburbs, especially in newly developed residential areas surrounding existing cities (Nabielek et al., 2016). However, since 2000, an increasing number of European cities (e.g. in Austria, Belgium, Denmark, Finland, Germany, Hungary, the Netherlands and Sweden) have had higher annual population growth in their urban cores than in their commuting zones (OECD, 2018; Salvati et al., 2019).

The urban landscape of Europe is characterised by a diversity of small, medium and large cities (Nabielek et al., 2016). There are just over 800 cities in the EU with more than 50 000 inhabitants (Heinelt, 2017). The majority of these, almost 700, are small and medium-sized cities (between 50 000 and 250 000 inhabitants) (Nabielek et al., 2016). At the other end of the scale, there are 26 cities in the EU with a population of more than one million. One in eight Europeans live in these largest cities (EC, 2012). Of these cities, only Paris and London can be considered megacities — high-density metropolises of more than 10 million inhabitants (EC and UN-Habitat, 2016).

Europe's varying urban structure is a product of many underlying factors, including the historical development of settlements, their location and geographical characteristics, and their function and various political, demographic and economic developments. However, while overall Europe is highly urbanised there is both a high degree of heterogeneity among its cities and also varying levels of urbanisation from country to country. Many urban regions have numerous towns and cities in close proximity — a polycentric structure — others are characterised by a single large city, often the capital city, dominating its surroundings — a monocentric structure. There are also some examples of a more linear urban pattern, for example along the Mediterranean and Adriatic coasts (Nabielek et al., 2016).

In general, western and northern Europe are more urbanised than the rest of Europe. The most urbanised region of Europe is an area forming a pentagon with its apexes in London, Paris, Milan, Munich and Hamburg. In countries such as Belgium, Germany, the Netherlands and the United Kingdom, more than three quarters of the population lives in urban areas. In contrast, other countries, such as Poland, Romania, Slovakia and Slovenia, are less urbanised, with more than 40 % of the population living in rural areas (Nabielek et al., 2016).

1.2 The urban environmental challenge

Europeans have adopted an urban lifestyle partly to benefit from the amenities cities provide, such as cultural, educational and health services, as well as the economic opportunities cities offer as the engines of Europe's economy. However, cities do not operate in isolation: they rely on the regions outside the city to meet their demand for resources, such as energy, water and food, and to dispose of and disperse waste and emissions (EEA, 2017a).

This context poses a significant challenge: how to accommodate more people in urban areas while reducing the impact on the environment and being resilient to a changing climate, and at the same time improving the quality of life of urban residents. Meeting this challenge and achieving the objective of urban sustainability — i.e. efficient and smartly planned, designed, renovated, managed and governed cities — is likely to require a radical transformation of the current model of urban development and a more people-oriented approach (EEA, 2017a).

Some of the main environmental challenges facing European cities include the emissions they produce, levels of air and noise pollution, increasing energy use, the consumption of water and materials, land take and habitat fragmentation (see Table 1.1, which includes examples of the challenges cities face). Urban areas are major consumers of energy and account for 60-80 % of global energy consumption (UN-Habitat, 2019). The consumption of water varies considerably across European cities, from an average consumption in Madrid of 263 litres per person per day and 164 litres per day in London to 100 litres per day in Copenhagen (Carranza and Bueno, 2018; Greater London Authority, 2020; IWA, 2020). On average, households across

Table 1.1 Examples of potential challenges facing cities

Environmental challenges	Other challenges with environmental implications or that can increase vulnerability to environmental challenges
• Heat waves	• Urban sprawl
• Sea level rise	• Overcrowding and population density
• Severe storms and flooding	• Inadequate or absent infrastructure
• Water consumption and shortages/droughts	• Community severance (a physical and psychological barrier created by, for example, roads or rail infrastructure)
• Forest fires	• Road congestion
• Air pollution	• Social exclusion and inequality
• Water pollution	• Unemployment rates
• Ground contamination	• Lack of affordable housing
• Noise pollution	• Insufficient public services
• Light pollution	• Non-communicable diseases (e.g. heart disease, cancer, asthma, diabetes)
• Energy consumption and shortages	• Poor mental health
• Clean drinking water	• Demographic change
• Timber, mineral and other natural resource and material consumption and shortages	• Health pandemics
• Land/soil erosion	
• Food shortages/access to food	
• Solid waste processing	
• Solid waste disposal	
• Sewage treatment and disposal	
• Stormwater management	
• Habitat fragmentation	
• Decline of native species/natural habitats	
• Land take	
• Lack/loss of green space	
• Lack/loss of ecologically productive land	

European cities use nearly three times more water (144 litres per person per day) than the minimum required for basic human needs (50 litres per person per day) (EEA, 2018a).

Although emissions of air pollutants have declined in recent years, almost 20 % of the EU's urban population lives in areas where air pollutant concentrations exceed at least one EU air quality standard (e.g. $PM_{2.5}$ (particulate matter with a diameter of 2.5 µm or less), PM_{10} (PM with a diameter of 10 µm or less), O_3 (ozone), NO_2 (nitrogen dioxide)) (EEA, 2019a). Urban areas are also responsible for at least 70 % of global carbon emissions (EEA, 2019b).

As a result of land take, urban areas may severely hamper ecosystem functioning and the delivery of ecosystem services (EEA, 2016a). The increase in land take for urban development is an ongoing process across Europe, with the total urban area expanding by approximately 6.7 % between 2000 and 2018 at the expense of agricultural and semi-natural areas. Urban areas consumed 0.6 % of all arable land and permanent crops, 0.5 % of all pastures and mosaic farmland, and 0.3 % of all grasslands. In the EU-27 and the UK, between 2000 and 2018, urban sprawl converted 0.5 % of all pastures and mosaic farmland and 0.3 % of all grassland into artificial surfaces (EEA, 2016b).

Cities are at the centre of future environmental challenges, and therefore there is an urgent need for European cities to shift towards a more integrated approach to addressing persistent, systemic environmental challenges. The EU has a key role in promoting sustainable urban development; however, it is city

administrations that are likely to be best placed to take local action to tackle and resolve many of these issues (EEA, 2017a). They are crucial in improving waste and water management, public transport and efficient use of land by implementing integrated urban planning (EEA, 2015). Furthermore, city networks and associations are becoming increasingly important in shaping global climate and sustainability agreements (EEA, 2020a).

Despite the central role of urban authorities, they cannot tackle the complex challenges of urban sustainability transitions without the support of regional, national and supranational governments. Alongside this need for multi-level governance across the traditional structures of government, there is also a recognition that the governance of transitions requires a redrawing of the boundaries between the state and society (Ehnert et al., 2018). This does not mean that government institutions do not continue to play an important role, but rather that effective governance of complex sustainability issues relies on collaboration with stakeholders from science, business and society (EEA and Eionet, 2016).

European citizens are deeply concerned about climate change and the environment and believe that their actions to protect the environment matter (EC, 2017). This suggests that more proactive involvement of EU institutions and Member States in environmental matters is possible, together with stronger engagement and support of citizens and local stakeholders for measures taken by the EU and national governments (EEA, 2019a).

1.3 Cities as complex systems

As Table 1.1 indicates, many systemic social, environmental and economic challenges are concentrated in urban areas. Yet cities can also help provide solutions to these challenges. As well as being economically important and being home to almost three quarters of European citizens, cities are 'hubs of creativity, innovation and learning' that are 'crucial for transitions … with the capacity to effect systemic change at local scales and to share ideas through city networks' (EEA, 2019a). Urban areas also face particular vulnerabilities that necessitate transformative adaptation (EEA, 2019a, 2020b). Cities and city authorities are well placed to develop and implement the integrated solutions that the transition to a low-carbon, resilient, resource-efficient economy requires.

Cities can be seen as 'distinct systems that can be transformed' (EEA, 2019a), and within cities are nested interconnected production and consumption sub-systems such as those for energy, food and mobility. Cities are as a result frequently conceptualised as complex systems, which are unpredictable and dynamic. Urban sub-systems interact in bilateral and multilateral positive (i.e. reinforcing) and negative (i.e. conflicting) ways (Rode, 2019). These interactions lead to a range of outcomes for urban residents, the environment and the economy. These include intended outcomes, such as access to employment and services, sufficient and affordable food, or reliable energy supplies. However, there will also be negative impacts and interactions between the systems, for example air and noise pollution from traffic, and damage to or loss of habitats and green space from infrastructure development. Indeed, many urban problems arise as a direct result of the disregard, by policymakers and planners, of conflicting relationships between urban sub-systems (Rode, 2019).

Cities also depend on their hinterlands and on national and international connections for food, water, energy and other supplies. People, resources and goods flow in and out of cities, and, through the activities happening in cities, waste and pollution (e.g. to air and water) is dispersed within and beyond city boundaries.

Cities and urban authorities in the EU often control significant budgets (Heinelt, 2017) and can set all or some of their own policy and strategy. They have responsibility for local services such as water, mobility, energy and waste. It is increasingly recognised that 'cities are key players in implementing the EU's goals in terms of a low-carbon economy … and resource efficiency. They are crucial in improving waste management, public transport, water management and, through integrated urban planning, the efficient use of land' (EEA, 2019a). However, given the complex nature of urban systems, decision-makers in cities and urban authorities 'require strategies to embrace complexity and analytical devices to better understand the problems and develop courses of action' (Rode, 2019).

1.4 The role of cities in European environmental policy

The influence of cities in EU policymaking has been increasingly recognised over the last few decades, including through the establishment of the Committee of the Regions in 1994 and the signing of the Leipzig Charter in 2007 and culminating in the EU Urban Agenda, established following the Pact of Amsterdam in June 2016. While cities do not have a formal role in decision-making at the EU level, municipal administrations can influence decisions, as they are a key source of expertise and offer legitimacy to the EU given their proximity to citizens. Once EU legislation is transposed into Member State law, cities often have a key role in its implementation, particularly as many individual countries in the EU have granted cities and regions constitutional powers of self-governance. Cities also often control significant budgets, and municipal administrations represent an important part of the 'state-at-work' in many EU Member States (Heinelt, 2017).

In parallel with this increasing recognition of the role of cities in Europe, and not unconnected, has been a trend towards strengthening urban governance. This has been coupled with an expansion of a range of networks, organisations and initiatives across European cities and their metropolitan areas (JRC, 2020), such as EuroCities and ICLEI (Local Governments for Sustainability) Europe. There has also been an increasing commitment from European cities on the global stage working through large networks, such as the United Cities and Local Governments (UCLG), Metropolis, the C40 Cities Climate Leadership Group and the Global Covenant of Mayors, and given an extra momentum and focus by the Sustainable Development Goals (SDGs) and their implementation — SDG 11 in particular. For example, many local governments in Europe have made a political commitment to climate change adaptation by joining international initiatives, with over a quarter of the population in the 38 EEA member and collaborating countries living in the local authorities committed to adaptation under the Covenant of Mayors for Climate and Energy (EEA, 2020b). This is empowering cities, facilitating greater cooperation and knowledge exchange, and has accelerated the demand for the devolution of fiscal, political, and administrative powers and responsibilities to cities from central governments (JRC, 2020).

Taking the example of adaptation to climate change, by following the 2013 EU strategy Member States have recognised the importance of adaptation in the urban context and many identify local governments as the implementers of adaptation (EEA, 2020b). Local-level adaptation planning or climate change risk assessments are mandatory in some countries, and several hundred cities have benefited so far from EU funding for adaptation-related research, knowledge exchange, and the planning and implementation of measures. Many cities have organised their own mutual support and knowledge sharing through networks at the international, national or regional scale (EEA, 2020b).

1.5 The EEA's stakeholder-led approach to understanding and assessing urban environmental sustainability

Recognising the transversal and complex nature of urban sustainability research and practice, in 2017 the EEA launched a work stream on understanding and assessing urban environmental sustainability. Figure 1.1 illustrates this work in the context of the timeline of other key initiatives and the EEA's state and outlook reports (SOERs).

The EEA's urban environmental sustainability work has incorporated a broad stakeholder-led process involving both internal and external experts, including:

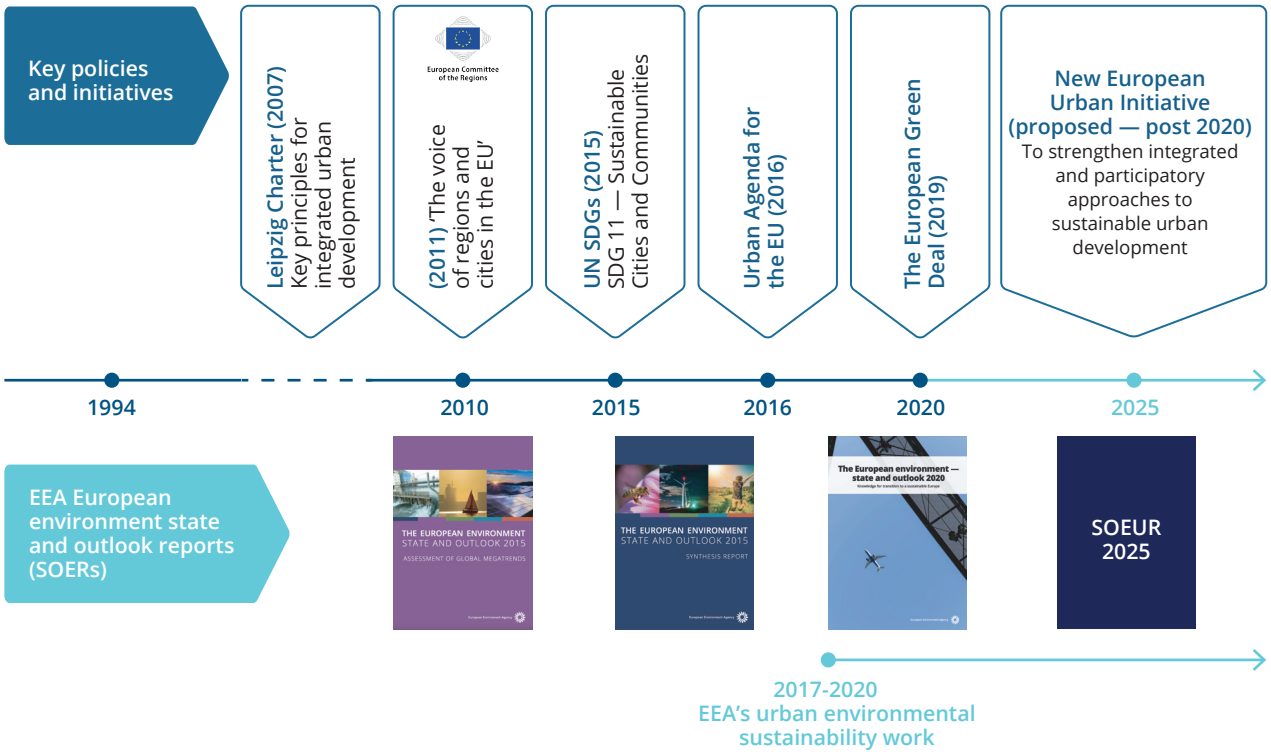
- a request for information and sources (2017) as part of the work to build a knowledge base on urban environmental sustainability (see Section 2.2);
- a series of external stakeholder workshops and meetings held in December 2017, November 2018, November 2019 and December 2020, each bringing the EEA and external stakeholders together to inform and co-create a conceptual framework for urban environmental sustainability (see Chapter 3) and to help develop and implement assessments of environmental sustainability (see Chapter 4), including analysis of urban nexuses (see Section 4.2) and analysis of the drivers and barriers (see Section 4.3);
- an online survey of European cities (2019), and interviews (2020) with selected pioneering city authorities, to explore and assess the key drivers of and barriers to urban sustainability transitions (see Section 4.3); and
- throughout there have also been specific inputs to and consultation and feedback on draft reports and assessments from a range of stakeholders, and in particular the European Environment Information and Observation Network (Eionet), including the European Topic Centres (ETCs), which have also acted in their capacity as strategic co-creation partners, scientific advisers and networkers.

This approach, including a thorough internal (EEA) co-creation process and the series of external stakeholder workshops, has ensured an excellent degree of participation and helped build credibility for the work. Figure 1.2 illustrates the key internal and external stakeholder engagement events held as part of the EEA's work on urban environmental sustainability.

1.5.1 The EEA's urban environmental sustainability outputs

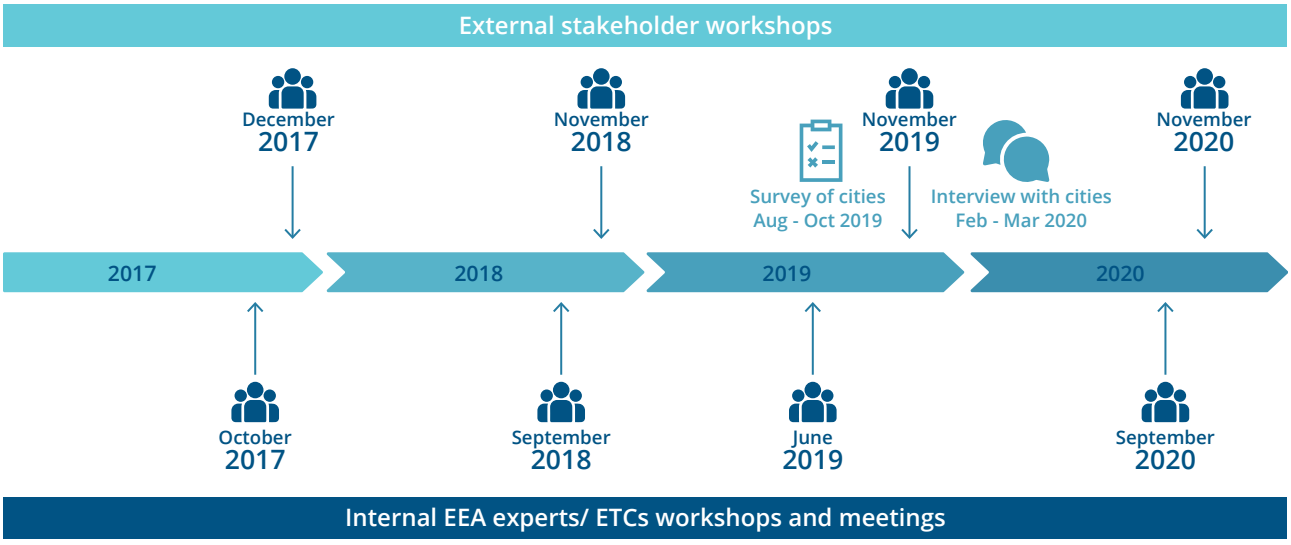
An overview of the EEA's initial urban environmental sustainability outputs in 2020 and 2021 is illustrated in Figure 1.3. This shows how this methodology report and the glossary support the other main assessment and reporting outputs.

Figure 1.1 **The EEA's work on urban environmental sustainability within the context of other key policy initiatives and state and outlook reports**



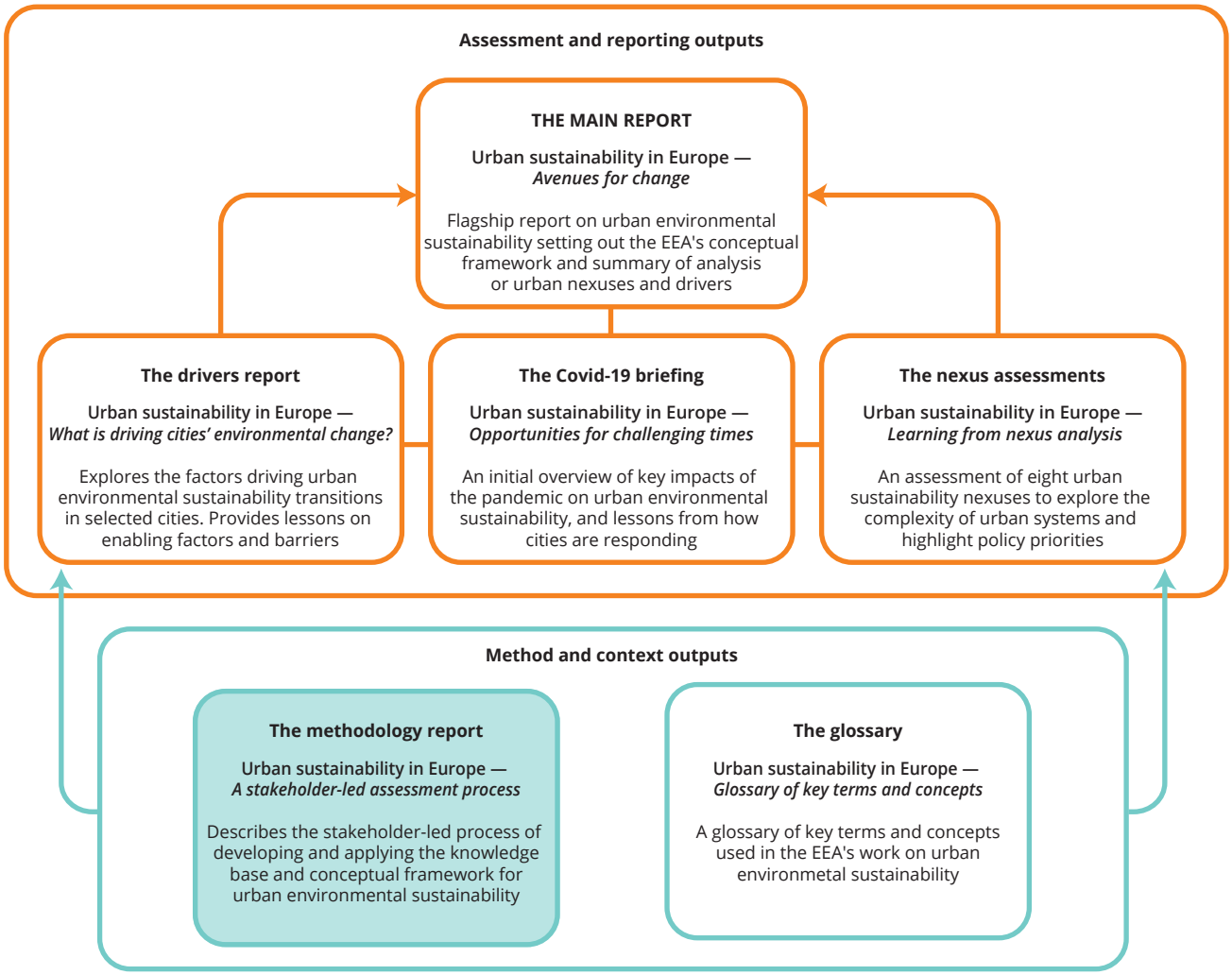
Source: EEA.

Figure 1.2 **Key stakeholder engagement events held as part of the EEA's work on urban environmental sustainability**



Source: EEA.

Figure 1.3 **The EEA's reports and outputs on urban environmental sustainability transitions being published in 2020 and 2021**



Source: EEA.

2 Building a knowledge base on urban environmental sustainability

2.1 EEA activities on the urban environment

The EEA regularly assesses the urban environment in Europe — for example, assessing the trends in land take and consumption and environmental quality. *The European environment — state and outlook 2020* (SOER 2020) creates a new mandate for the EEA to work at the urban level. While the main conclusions are targeted at the broader country/institutional level, they nonetheless express the relevance of other scales of action such as cities. SOER 2020 calls for urgent action in several key areas and affirms the need for 'enabling transformative change [that] will require that all areas and levels of government work together and harness the ambition, creativity and power of citizens, businesses and communities' (EEA, 2019a).

SOER 2020 builds on SOER 2015, which concluded that 'Living well within environmental limits will require fundamental transitions in core societal systems, including food, energy, mobility, urban, fiscal and finance systems. To achieve such purpose, profound changes in dominant practices, policies and thinking are needed.' This will require fundamental transitions in core societal systems, including the urban system, and this will necessitate profound changes in dominant practices, policies and thinking.

In recent years the EEA has produced a range of outputs (e.g. reports, tools and online repositories) that provide indicators and case studies at the EU city level and at the national/regional level. These cover a range of urban environmental topics including climate, air and noise pollution, resource use, energy and transport. A summary of key recent EEA activities on urban environmental sustainability is presented in Table 2.1.

Table 2.1 Overview of the EEA's activities on urban environmental sustainability

Selected key reports and sources	Summary of data/indicators/examples available
Urban adaptation in Europe: How cities and towns respond to climate change (EEA, 2020b)	• Provides an up-to-date evidence base on adaptation planning and actions in the local and urban contexts. • Summarises the scientific evidence on climate- and weather-related hazards facing European cities and their impacts. • Includes many case studies of urban adaptation in Europe.
Healthy environment, healthy lives: How the environment influences health and well-being in Europe (EEA, 2019c)	• Provides a knowledge base to support the development of integrated policies that address the environment, health and well-being nexus. • While the report does not specifically focus on the urban environment, many of the issues and data are highly pertinent to it and it includes case studies from cities. • Some issues, such as the accessibility of green space across Europe, focus specifically on the urban environment.
Air quality in Europe: 2019 report (EEA, 2019d)	• Includes indicators on population exposure to main groups of air pollutants ($PM_{2.5}$, PM_{10}, O_3, NO_2) in urban and suburban areas across Europe.

Table 2.1 Overview of the EEA's activities on urban environmental sustainability

Selected key reports and sources	Summary of data/indicators/examples available
Europe's urban air quality: Re-assessing implementation challenges in cities (EEA, 2018b)	• Provides data on exposure to air pollution in cities, including from main source sectors. Also gives examples of implemented and planned measures to address air pollution in some EU cities.
Environmental noise in Europe: 2020 (EEA, 2019e)	• Includes indicators on population exposure to unhealthy levels of environmental noise inside urban areas (day-evening night-noise level L_{den} ≥55 dB; night-noise level L_{night} ≥50 dB).
The first and last mile: The key to sustainable urban transport. Transport and environment report 2019 (EEA, 2019b)	• Provides data and case studies on urban mobility. Key indicators include passenger-km by transport mode, hours lost in congestion per city and data on transport emissions for a medium-sized city.
Unequal exposure and unequal impacts: Social vulnerability to air pollution, noise and extreme temperatures in Europe (EEA, 2018c)	• Provides indicators on population exposure to different risks in urban areas, including noise, air pollution and extreme temperatures. Information is also included on other factors such as housing conditions.
Financing urban adaptation to climate change (EEA, 2017b)	• Includes 11 case studies of financing urban adaptation.
Urban adaptation to climate change in Europe 2016 (EEA, 2016c)	• Includes case studies with examples of indicators on climate, impact, social vulnerability and resilience, as well as community engagement.
Rivers and lakes in European cities (EEA, 2016d)	• Provides case studies of best practice on managing rivers and lakes in urban areas to reduce flood risk and improve accessibility for residents.
Urban sprawl in Europe (EEA, 2016b)	• Provides indicators for measuring urban sprawl, including weighted urban proliferation; percentage of built-up area; dispersion of built-up areas; land uptake per person (per inhabitant or job); utilisation density; and urban permeation.
Soil resource efficiency in urbanised areas (EEA, 2016e)	• Includes data and case studies on costs of soil degradation in Europe.
Urban sustainability issues: What is a resource-efficient city? (EEA, 2015)	• Provides data sources to be used for assessing the metabolism of cities.
Biodiversity Information System for Europe (BISE) [a]	• Provides data and information on biodiversity in Europe, including risks from land use change, pollution and fragmentation.
EU Climate-ADAPT platform [b]	• Provides a wide range of indicators and data related to urban adaptation that are categorised into three groups: 1. exposure indicators: provide information about the level of exposure to climate impacts; 2. sensitivity indicators: provide information about the susceptibility of cities to climate impacts, via population composition, spatial planning or physical conditions; and 3. response capacity indicators: provide information about characteristics that help to reduce or overcome the impacts.
Copernicus Urban Atlas [c]	• Various indicators on urban fabric (e.g. data for functional urban areas).
European Air Quality Index [d]	• Displays up-to-date information on air quality in individual countries, regions and cities. The index is based on concentration values for PM_{10}, $PM_{2.5}$, O_3, NO_2 and SO_2.

Notes: [a] https://biodiversity.europa.eu

[b] https://climate-adapt.eea.europa.eu

[c] https://www.copernicus.eu/en/use-cases/urban-atlas

[d] https://airindex.eea.europa.eu/Map/AQI/Viewer

NO_2, nitrogen dioxide; O_3, ozone; $PM_{2.5}$, fine particulate matter; PM_{10}, particulate matter; SO_2, sulphur dioxide.

The EEA's work on urban sustainability is framed in terms of its core environmental sustainability remit. The work is therefore not trying to capture the breadth of all the economic, social and environmental dimensions of urban sustainability, but instead it concentrates on the EEA's environmental perspective on urban sustainability. However, the need to break out of separate 'economic', 'social' and 'environment' silos is reflected in EU policy initiatives such as the Seventh Environment Action Programme (7th EAP), EU biodiversity strategy for 2030 (EC, 2020) and the European Green Deal (EC, 2019). The 7th EAP, for example, has an explicit focus on improving the environment, in order to benefit health and well-being, and creating a resource-efficient, green and competitive low-carbon economy (EU, 2013). The European Green Deal emphasises the need for 'intense coordination to exploit the available synergies across all policy areas' to address the complex and interlinked social, environmental and economic challenges (EC, 2019). The EEA is therefore interested in questions that touch on the breadth of sustainability, but from a clear environmental perspective — for example, will air pollution be a more serious issue for a larger elderly urban population? And what impact will climate change have on key infrastructure and assets upon which the economies of cities depend?

2.2 Existing urban environmental sustainability knowledge base

As part of understanding the availability of data and information on urban environmental sustainability and where there are key gaps, a review of possibly relevant data sources, indicators and case studies was undertaken. This principally focused on those sources where data and indicators and examples are managed or owned by relevant pan-European agencies (e.g. Eurostat, European Commission) and updated frequently. Other sources, including from external European and international organisations and initiatives, as well as academic and peer-reviewed research papers, were also considered (see Table 2.2).

From the review of sources, it is evident that there is an abundance of quantitative data on the environmental quality, land use, biodiversity and resilience thematic areas in an urban context. For example, urban land use is distinguished as a specific topic in several of the sources reviewed such as the Copernicus Urban Atlas providing data on green urban areas. Other topics with readily available data/indicators and examples are climate change adaptation, transport and energy. A key source of case studies on climate adaptation is the Climate-ADAPT platform ([1]). The sources of information identified from the review also suggest that there is a good representation of case studies for some topics such as stakeholder engagement and community initiatives.

In contrast, in some thematic areas, such as urban agriculture and food systems, there are more limited sources of data or indicators and examples. Considering their broad scope, these topic areas do not have a unique source, data set or indicator that would provide sufficient information for the purposes of a comprehensive assessment of urban sustainability. Therefore, it is likely to be necessary to draw on a selection of multiple sources of data or indicators and examples to provide the evidence on certain thematic areas. Another common issue among various sources of data and indicators is that the scale is incompatible with the required urban focus. Across the sources there are indicators and data that fit within a specific thematic area; however, they are not necessarily available specifically for urban areas or to common boundaries, thus currently limiting their utility in the assessment of urban environmental sustainability.

It is important to note that assessments related to some topics would require both qualitative and quantitative evidence. For example, assessing the quality of life aspects in urban environments through quantitative indicators that look at physical environment will not provide a comprehensive characterisation of this issue. Improving the quality of the environment by itself does not improve the quality of life of individuals. Furthermore, 'good-quality' public space is not an objective description. It will mean different things to different people.

The review also highlights some of the challenges in terms of the information likely to be available for urban sustainability assessment. These include infrequent updates and lack of standardisation of cross-country data for cities, resulting in limited comparability, which is acknowledged by Eurostat (Eurostat, 2020a). Another challenge is the lack of a consistent use of definitions between data sources. For example, the data in Eurostat's urban audit (Eurostat, 2020b) applies the Organisation for Economic Co-operation and Development-European Commission definition of a city (EC, 2012). In contrast, the Urban Ecosystem Europe (UEE) report introduces urban indicators categorised into six different themes and applied in 32 EU cities of various sizes — metropolitan areas, big cities, medium-sized cities and medium-small cities (Berrini and Bono, 2008; EC, 2015).

([1]) https://climate-adapt.eea.europa.eu

Table 2.2 Overview of sources relevant to urban environmental sustainability and their scope

Type of source	Summary of data/indicators/ examples available	Examples of key sources
European Commission sources (e.g. EU Urban Agenda, Eurostat, Horizon 2020 projects)	The various European Commission sources provide indicators and case studies at the EU city level as well as at national or international level. These sources provide a range of both qualitative and quantitative information that varies in spatial scope (i.e. size of cities covered) as well as thematic areas (socio-economic, land use, climate, environmental, resource use, technology/innovation and transport). The Eurostat sources in particular provide indicators for urban settings across various topics including quality of life, noise pollution, air quality, housing, wastewater treatment, economic activity, water consumption and waste production and land use.	• Eurostat urban audit ([a]) • Eurostat quality of life indicators ([b]) • The European Green City Index ([c]) • Urbact good practices database ([d]) • The urban data platform ([e]) • The European Green Capital Award ([f]) • European Green Leaf Award ([g]) • Reference Framework for Sustainable Cities ([h]) • The urban agenda partnerships ([i]) • Eurobarometer survey 419: *Quality of life in European cities* ([j]) • The Green City Accord ([k])
Sources from external European organisations and initiatives on sustainable development (e.g. Covenant of Mayors, ICLEI, UN)	The various reports, tools and online repositories provide indicators and case studies on EU cities across various topics including governance, engagement, social aspects, land use, resilience, resource use, climate, environment, health, biodiversity, energy and transport.	• OECD Resilient Cities project ([l]) • Urban Adaptation Support Tool — Covenant of Mayors ([m]) • Oppla nature-based solutions — city case studies providing examples of the multiple benefits delivered by nature-based solutions ([n]) • World Health Organization report — *Environmental health inequalities in Europe* ([o]) • Convention on Biological Diversity — the City Biodiversity Index ([p]) • ICLEI/WWF One Planet City Challenge ([q]) • IEA reports (e.g. *IEA Energy technology perspectives 2017*) ([r])

Notes:
([a]) https://ec.europa.eu/eurostat/web/cities/data/database
([b]) https://ec.europa.eu/eurostat/statistics-explained/index.php/Quality_of_life_indicators
([c]) https://assets.new.siemens.com/siemens/assets/api/uuid:fddc99e7-5907-49aa-92c4-610c0801659e/european-green-city-index.pdf
([d]) https://urbact.eu/good-practices/home
([e]) https://urban.jrc.ec.europa.eu/#/en
([f]) https://ec.europa.eu/environment/europeangreencapital
([g]) https://ec.europa.eu/environment/europeangreencapital/europeangreenleaf
([h]) http://rfsc.eu
([i]) https://ec.europa.eu/regional_policy/en/policy/themes/urban-development/agenda
([j]) https://data.europa.eu/euodp/en/data/dataset/S2070_419_ENG
([k]) https://ec.europa.eu/environment/topics/urban-environment/green-city-accord_en
([l]) https://www.oecd.org/fr/gov/politique-regionale/resilient-cities.htm
([m]) https://climate-adapt.eea.europa.eu/knowledge/tools/urban-ast/step-0-0
([n]) https://oppla.eu/nbs/case-studies
([o]) https://www.euro.who.int/en/publications/abstracts/environmental-health-inequalities-in-europe.-second-assessment-report-2019
([p]) https://www.cbd.int/subnational/partners-and-initiatives/city-biodiversity-index
([q]) https://wwf.panda.org/our_work/our_focus/projects/one_planet_cities/one_planet_city_challenge
([r]) https://www.iea.org/analysis
IEA, International Energy Authority; ICLEI, Local Governments for Sustainability; OECD, Organisation for Economic Co-operation and Development; Oppla, the EU repository of nature-based solutions; UN, United Nations; WWF, World Wide Fund for Nature.

3 A conceptual framework for urban environmental sustainability

3.1 Developing the conceptual framework

Urban systems are inherently complex (see Section 1.3), as is the concept of urban environmental sustainability. If we are to understand what factors may influence the transition towards urban environmental sustainability, it is important to improve understanding of the concept. Hence, a conceptual framework for urban environmental sustainability has been developed.

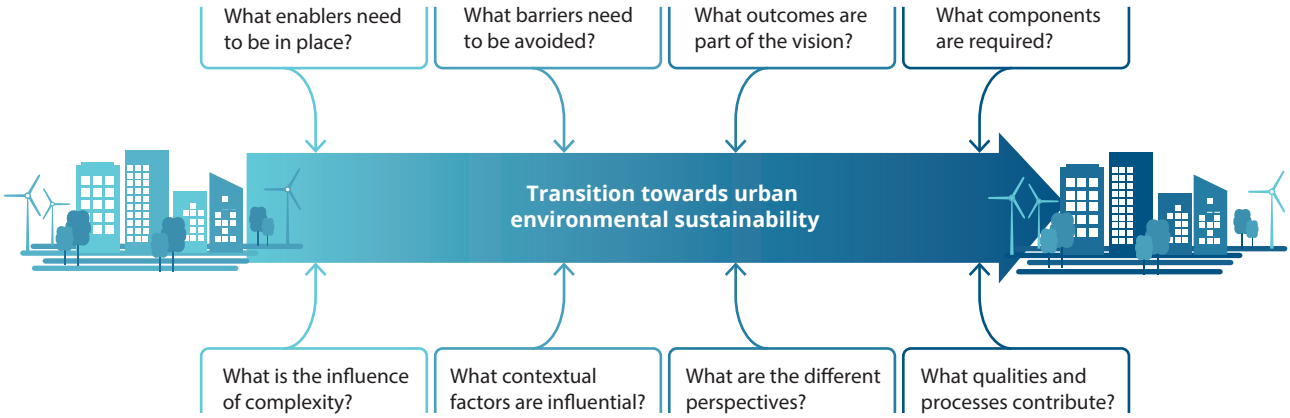
A conceptual framework attempts to explain a phenomenon. It seeks to map out a theoretical structure of assumptions, components, principles, etc., that holds together the ideas comprising a broad concept. In the case of urban environmental sustainability, it is important to understand what factors — whether they be components or variables acting as enablers or barriers, for example — need to be in place or avoided to facilitate the transition towards urban environmental sustainability.

The logic behind the development of a conceptual framework is that it is required to understand complexity and provide a framework for consistent assessment and analysis. Breaking down a concept into components also enables analysis to consider interrelationships between individual components while maintaining perspective on the whole concept, which is important in helping to understand a complex system.

For the EEA, a conceptual framework will help provide a clear structure to its thinking and a narrative under which to have a coherent approach to its urban environmental sustainability assessments (see Figure 3.1), including in terms of:

- the key components and outcomes that should define a vision of environmental sustainability in an urban context in Europe; and
- the components required to support the transition of European cities towards a more sustainable future, particularly focusing on urban environmental sustainability.

Figure 3.1 **Illustration of the need for a conceptual framework to help understand what influences the transition towards urban environmental sustainability**



Source: EEA.

Given the complexity and interdependence of urban systems, it is acknowledged that attempting to categorise distinct elements is reductionist and potentially oversimplistic. However, a simple model or framework should help us to understand these complex concepts and will assist the EEA to develop its knowledge base and inform its assessments.

The development of the conceptual framework was informed by a knowledge review of EEA and other literature, a review of key EU policy frameworks, and feedback from stakeholders throughout. Early in the process of developing the framework, four types of cities were identified: the resilient city, the circular city, the green city and the inclusive city. This model was further developed in 2017 and tested both with internal (EEA) stakeholders and with external stakeholders at events in Copenhagen in December 2017 and November 2018. A meta-analysis of drivers of sustainability transitions was also completed to further understand the factors supporting urban environmental sustainability and to consider the extent to which benchmarking may be possible.

Between 2017 and 2020 several iterations of the proposed conceptual framework were developed in collaboration with stakeholders, both internal (EEA) and external. The starting point was the EEA's initial four broad categories of sustainable city, which were complemented with two further categories (the healthy city and the low-carbon city). Following the results of the knowledge review, the original approach was to upgrade the initial categories by adding further lenses of analysis, introducing the notion of enabling factors and developing assessment topics. This 'taxonomy' approach, comprising different 'levels' of urban sustainability components served the purpose of bringing richness to the relatively simplistic initial model while keeping track of the essential features of such a model and aligning it with environment and climate policies.

The proposed conceptual framework is presented in Section 3.3, which includes a description of the framework components: six lenses, six enabling factors and 19 building blocks. The conceptual framework has provided the focus for the urban nexus approach and analysis and the analysis of drivers of urban environmental sustainability transitions (see Chapter 4).

3.2 Defining urban environmental sustainability

There is no agreed definition of urban sustainability, or of what a sustainable city might look like. However, there is broad agreement on what contributes to urban sustainability. The World Urban Forum affirmed in 2002 that the creation of sustainable cities required addressing economic, social, environmental and governance issues in an integrated way (UN-Habitat and DFID, 2002). More recently, Sustainable Development Goal (SDG) 11 — make cities inclusive, safe, resilient and sustainable — seeks to maintain cities in a way that continues to create jobs and prosperity without straining land and resources (UN, 2020). This includes the sustainability of the linkages between cities and their rural hinterland as well as natural areas, both terrestrial and marine.

Reflecting the EEA's mandate to help its member and cooperating countries make informed decisions about improving the environment, integrating environmental considerations into economic policies and moving towards sustainability, the focus of this report is on urban sustainability from an environmental perspective. The EEA's approach to urban environmental sustainability acknowledges that social and economic dimensions are important, but focuses primarily on environmental issues in urban areas. These include air and water pollution, noise pollution, green spaces providing space for people and nature, biodiversity loss, resource efficiency, and mitigation measures to reduce greenhouse gas emissions and manage the impacts of climate change. Such environmental issues also underpin and support the social and economic health of cities, and as noted in Section 1.3 cities can be seen as complex systems in which all elements of sustainability interact.

Furthermore, the systemic interlinkages between environmental sustainability and broader sustainability are explicitly recognised and considered in the conceptual framework (see Section 3.3) and related assessments (see Chapter 4). This is in line with the EEA's focus on sustainability transitions, which reflect the need for fundamental change in core societal systems (EEA, 2019f).

Overall, urban environmental sustainability is intended to be a broad concept. It is the EEA's preferred term for capturing the breadth of its interests. As a foundation for future cities, it is a term that includes encouraging revitalisation and transition of urban areas and cities to improve liveability, promote innovation and reduce environmental impacts while maximising economic and social co-benefits. Urban environmental sustainability is likely to be reflected in the extent to which the following characteristics are seen or can be developed in cities (Moir et al., 2014; EBRD, 2016; GPSC, World Bank, 2018):

- a relatively compact and densely populated mixed-use urban form that creates efficiency gains;
- a secure and healthy urban environment where both people and nature can thrive;
- safe and high-quality public spaces, with good quality, affordable, accessible and healthy housing for residents;
- inclusive access to services and jobs within walking distance or reachable by short and convenient public transport seamlessly integrated with active transport (walking and cycling) infrastructures;
- clean energy and smart technologies harnessed to increase well-being, reduce environmental impact and protect ecosystems;

- efficient and circular use of resources (water, energy, land, materials) and adaptive solutions to energy and water demands;
- environmental, natural and physical assets preserved and enhanced for future generations;
- resilient against and adapted to the growing impacts and risks from climate change and natural hazards;
- local governance with the capacity to carry out its functions with active participation from citizens.

Thus, in addition to the environmental dimension, urban environmental sustainability also has a 'human-centred' dimension, enhancing and changing how people live, interact and engage with cities.

3.3 The conceptual framework overview and components

3.3.1 Overarching conceptual framework

Figure 3.2 presents the overarching conceptual framework for urban environmental sustainability. The framework is based around four main components. These are:

- **Lenses** — a range of perspectives on urban environmental sustainability that represent priority issues or concerns reflecting the EEA's environmental remit and can be used to guide and focus assessment and analysis.
- **Context** — the range of current and historical physical, social and institutional characteristics that create and shape the setting in which a specific city exists, develops and functions. Each city's context will have a considerable influence on the transition to urban environmental sustainability.
- **Enabling factors** — relatively high-level forces that can facilitate (drivers) or hinder (barriers) the transition towards urban environmental sustainability.
- **Building blocks** — key qualities that contribute to urban environmental sustainability. Depending on the context and enabling factors, different building blocks will be required to transition towards urban environmental sustainability.

Each of these components is described in more detail in the following sections.

3.3.2 Lenses on urban environmental sustainability

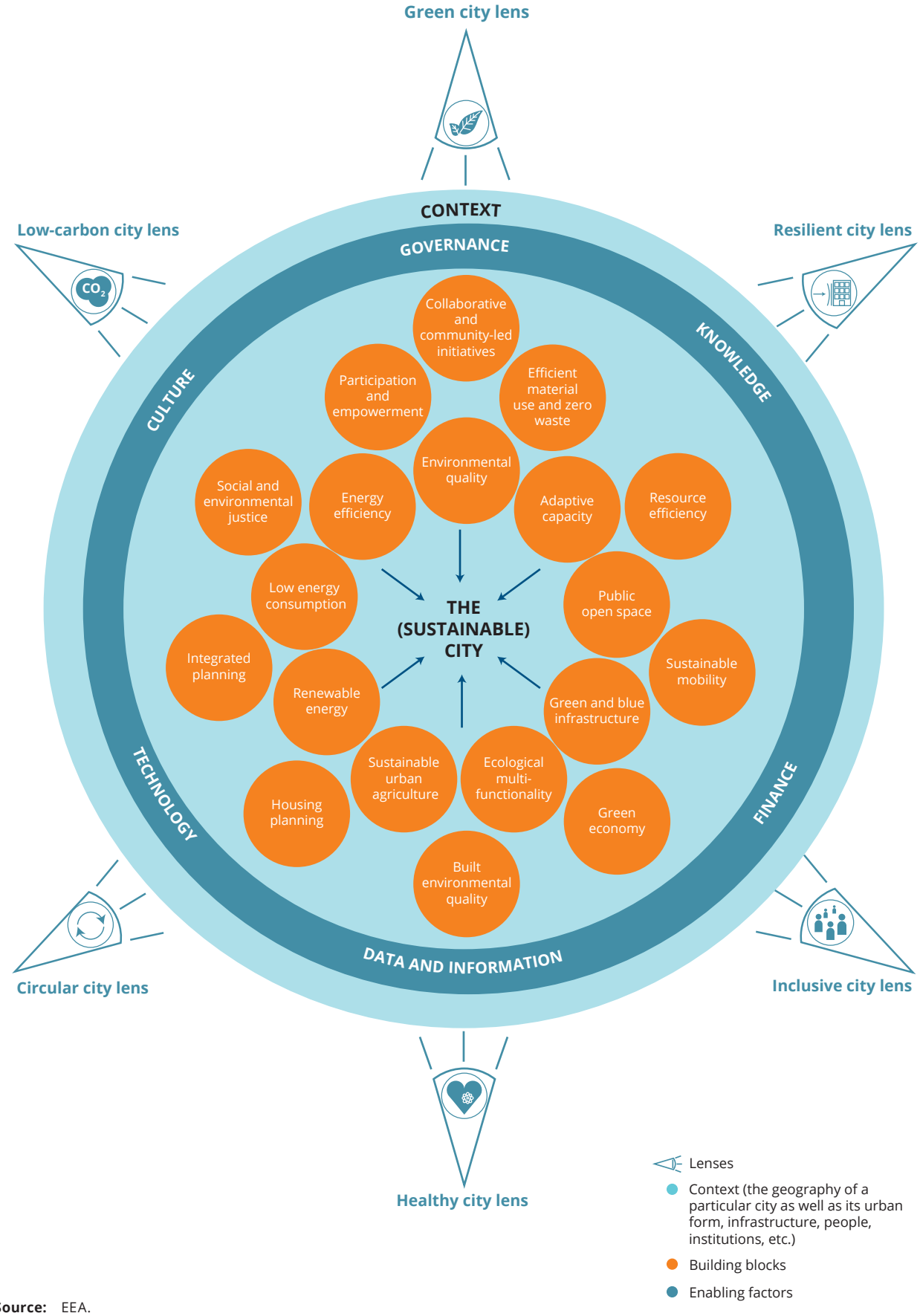
The six lenses represent headline perspectives on urban environmental sustainability reflecting the EEA's environmental remit. They also cover the key elements of relevant EU environment and climate policies and frameworks. These perspectives are not conflicting and may overlap, and together they mutually reinforce the transition towards urban environmental sustainability. The lenses provide a high-level frame to guide more nuanced assessment and analysis, for example at the level of building blocks or collections of building blocks. The six urban environmental sustainability lenses are presented and described in Figure 3.3.

There is a range of other terms and formations of cities that are used in the literature and by different organisations and could represent additional lenses, such as 'smart cities', 'future cities', 'liveable cities', 'compact cities' and 'garden city' (Moir et al., 2014). These terms and frameworks are often relatively broad and can overlap; are sometimes associated with certain contexts, geographies or disciplines; and can have hybrid or ambiguous meanings. In developing the lenses, the intention was to convey a relatively clear and simple set of perspectives on urban environmental sustainability that capture the EEA's priority interests given its remit (see also Section 3.2). The selected lenses are not trying to replace or replicate these other terms and framings, which have equal validity and could be used in combination with the lenses. There will also be links between some of the enabling factors and buildings blocks in the EEA's conceptual framework and these other terms and frameworks. Aspects of these terms and frameworks also emerge through the analysis of urban nexuses and drivers the approach to which is described in Chapter 4.

Taking the example of compact cities, they have long been considered to have a range of potential benefits, which include dense development patterns, better accessibility of local services and jobs, short intra-urban distances and efficient public transport systems, that make positive contributions to the efficiency of infrastructure investment and reducing energy consumption and carbon dioxide (CO_2) emissions, as well as contributing to knowledge diffusion and economic growth (OECD, 2020). This concept clearly has some overlaps with the characteristics of urban environmental sustainability described above, but the lenses aim to provide a more disaggregated set of perspectives to aid analysis rather than a holistic formation of future cities.

In relation to COVID-19, there are emerging studies that investigate the correlation of cases of and deaths from the virus with both the population size and density of functional urban areas. But it is important to note in the context of compact cities that it is not density alone that make cities potentially vulnerable to the effects of COVID-19 but the structural economic and social conditions of cities that make them more or less able to implement effective policy responses. For instance, cities marked by inequalities, inadequate housing conditions and a high concentration of urban poor are potentially more vulnerable than those that are better resourced, less crowded and more equal (OECD, 2020).

Figure 3.2 **Conceptual framework for urban environmental sustainability**



Source: EEA.

Figure 3.3 The urban environmental sustainability lenses

Source: EEA.

3.3.3 Context

Context is defined as the range of current and historical physical (e.g. geographical, environmental), social and institutional characteristics that create and shape the setting in which a specific city exists, develops and functions. These characteristics influence the ability of a city to transition to environmental sustainability.

These characteristics may include:

- geographical location (e.g. coastal, mountainous) and natural assets;
- climatic conditions;
- city size and urban form (e.g. level of compactness, ratio between green and built space, the relationship between urban, peri-urban and rural areas);
- demographics, including level of inequality, gentrification and poverty;
- structure of the economy;
- existing infrastructure (e.g. public transport network, utilities);
- institutional arrangements;
- other unique aspects that form the complex system of an individual city.

3.3.4 Enabling factors

Enabling factors are relatively high-level forces that facilitate or hinder environmental sustainability. Enabling factors can influence the degree of initiation and continuation of some types of action. Each enabling factor is associated with clusters of characteristics that act as drivers or barriers to the transition towards urban environmental sustainability. They are likely to be specific to a particular city based on its unique characteristics (e.g. the governance, cultural or other characteristics of a city). Although the drivers associated with an enabling factor are not sufficient by themselves to ensure that sustainability transitions will be initiated, they will support this process, and their associated barriers may hinder, retard or constrain such development (Lee and Klassen, 2008). Specific drivers may help initiate and motivate individuals or organisations to take action to achieve certain objectives, and conversely specific barriers may have a negative influence on or constrain taking action.

Six enabling factors have been identified — culture, knowledge, data and information, technology, governance, and finance — which help frame the transition towards achieving urban environmental sustainability. Table 3.1 provides a description of each enabling factor and lists some of the associated drivers or barriers.

Table 3.1 Enabling factors for environmental sustainability

Factor	Description	Examples of drivers for/barriers to environmental sustainability transition in cities
Culture 	Characteristics, patterns of behaviour and understanding of/attitude to issues shared by a particular group of people in urban areas and learned by socialisation ([a]). All cities have their own specific cultural and historical settings. Actions to achieve urban environmental sustainability need to recognise, adapt to or draw on culture to improve the design and implementation of new policy measures.	• Willingness by local government and/or the general public to adopt new behaviours and practices • Values and attitudes to environmental sustainability within local government and/or the general public • Framing of environmental sustainability in public discourse • Level of sensitivity of local government to local culture (e.g. traditions, diversity, inclusiveness, heritage, religion) • Level of public engagement • Social and economic power dynamics
Knowledge 	Key insights into urban environmental sustainability processes and their management and options for action held by individuals within a group or among groups ([b]). Knowledge supported by the education system, research, innovation, networks and training is essential to identify appropriate solutions to urban environmental sustainability issues.	• Education system • Research and innovation • Skills in local government and workforce • Communication and knowledge sharing between different levels of government • Communication and knowledge sharing within local government • Level of awareness of environmental sustainability • Level of shared understanding of sustainability issues in local government • Knowledge management and dissemination • Networks of cities and peer-to peer learning
Data and information 	Data are raw, unorganised facts in various forms on relevant issues, whereas information is data processed, organised and/or structured so as to make it useful for forming knowledge on a subject, issue, event or process relevant to achieving the urban environmental sustainability transition ([c]). Accessible, relevant, compatible, clearly presented and easy to understand data and information are central for identifying and promoting sustainable urban solutions, and for measuring and monitoring progress towards the urban environmental sustainability transition.	• Data and information collection practices (e.g. statistical services, qualitative and quantitative data collection) • Data and information sharing practices (e.g. open data) • Accessibility of data and information (e.g. formats and ease of accessing) • Presentation and communication of data and information (e.g. analysis and linking data to policy outcomes) • Quality (e.g. robustness, reliability, relevance, comparability, compatibility) of data and information • Scale of available data (e.g. national, regional, local)
Technology 	Technologies used to facilitate or support practices, processes and behaviours with different forms and in various areas of technological development, including education, construction, transport, energy, and information and communications. Technological innovation, and making better use of technology, can facilitate sustainability transitions in governance and various sectors by making urban systems more efficient, reducing resource use, supporting better-informed decision-making processes, and monitoring and implementation of relevant policies.	Technology within different sectors such as such as transport, energy, land management, buildings, water, waste and health: • Information and communications technology (ICT) • Big data analytics • Low-carbon technologies (electric vehicles, solar photovoltaic panels, smart metres, etc.) • Technologies for environmental monitoring (e.g. air quality monitors)

Table 3.1 Enabling factors for environmental sustainability (cont.)

Factor	Description	Examples of drivers for/barriers to environmental sustainability transition in cities
Governance 	The interaction between the formal institutions and those in civil society. Governance refers to a process whereby actors in society wield power, authority and influence and enact policies and decisions concerning public life and social upliftment ([d]). Public engagement, soft governance, transparency, accountability and integrated decision-making processes involving all relevant sectors, stakeholders (e.g. civil society platforms) and levels of government is crucial to support urban sustainability transitions.	National and sub-national: • Distribution of state powers and the level of political decentralisation • International treaties and EU laws, standards and regulations • National laws, standards and regulations • Sub-national laws, standards and regulations • National taxes, subsidies or other economic instruments • Sub-national taxes, subsidies or other economic instruments • Actions and policy objectives of the national/state government Local: • Local government overall vison and strategic plans • Individual political leadership • Election cycles/term times • Level of civic engagement and public participation • Implementation of local governance innovations • Measurable targets and monitoring of policy objectives • Level of coordination and integration of environmental sustainability with other sectors • Trade-offs between environmental sustainability and other objectives • Planning culture and practices • Models of public service delivery (public, private, public-private partnership)
Finance 	Management of public/government money and the process of acquiring funds through traditional (e.g. taxes, public-private partnerships) and innovative (e.g. micro-contributions/crowd-funding, land value capture) financial mechanisms to support green investments and the transition towards urban environmental sustainability. Note that financing typically refers to how upfront costs of building infrastructure, etc., are met, while funding refers to how it is paid for over its life cycle ([e]). Access to sufficient, sustainable finance from various sources is necessary to develop, deliver and maintain sustainable and high-quality urban infrastructure and services, and to support other programmes or actions for urban environmental sustainability transitions.	• Level of fiscal decentralisation • Level of own-source revenues (e.g. local taxes, fees, charges) • Level of multilateral funding (e.g. European Regional Development Fund; United Nations Multilateral Fund) • Level of bilateral funding (e.g. from donor countries) • Level of national/state government public funding for environmental sustainability • Level of regional/local funding for environmental sustainability • Level of private sector funding for environmental sustainability • Level of public investment in research and development • Level of private investment in research and development • Level of funding for infrastructure projects (both private and public sources) • Level of funding for public service operations and maintenance (both private and public sources)

Notes: ([a]) This definition draws on one set out by the Center for Advanced Research on Language Acquisition: http://carla.umn.edu/culture/definitions.html

([b]) This definition draws on the EEA MDIAK framework addressing monitoring, data, information, assessments and knowledge https://www.eea.europa.eu/publications/europes-environment-aoa/chapter1.xhtml

([c]) This definition draws on SMILE, developed by Imperial College, Loughborough University and the University of Worcester: https://www.gcu.ac.uk/library/smile/searching/whydoweneedinformation/whatisinformation

([d]) This definition draws on https://www.gdrc.org/u-gov/governance-understand.html

([e]) This definition draws on https://www.instituteforgovernment.org.uk/explainers/funding-infrastructure

3.3.5 Building blocks

Building blocks are defined as key qualities or inputs required to transition towards urban environmental sustainability. A total of 19 building blocks have been identified (see Figure 3.4).

Depending on the perspective or lens, collections of a few of the building blocks are likely to be particularly relevant as part of an analysis of urban environmental sustainability. Similarly, building blocks can cut across and be relevant to several of the lenses.

Figure 3.4 Building blocks of urban environmental sustainability

Environmental quality — A healthy and clean urban environment, including good water, air, land and soil quality and keeping pollution, including noise pollution, within strict limits.

Adaptive capacity — Urban systems with the capacity to be resilient, adaptive and responsive to a variety of chronic stresses and acute shocks, reducing vulnerability to climate change and extreme events.

Public open space — Good-quality and accessible public open space for all citizens to help to reinforce local identity and civic pride and support social inclusion, community cohesion, health and well-being.

Green and blue infrastructure — An interconnected network of natural and semi-natural areas, green or blue spaces and features that deliver a wide range of benefits to urban citizens while also enhancing biodiversity and helping to restore local ecosystems.

Ecological multifunctionality — Healthy urban biodiversity, ecology and ecological networks that benefit urban ecosystem services and enhance the resilience of the urban system.

Sustainable urban agriculture — Integration of sustainable urban agriculture and food systems within cities, including the growing, processing and distribution of food and other products in and around cities.

Renewable energy — High proportion of cities' energy needs produced from decentralised renewable sources ranging from small plants to community and household microgeneration produced close to its point of use.

Low energy consumption — Low energy consumption and demand from citizens and cities, achieved through pro-environmental behaviours and practices that use less energy.

Energy efficiency — Energy used efficiently to reduce emissions of greenhouse gases and other pollutants, reduce energy costs for citizens and cities, and help ensure security of energy supply.

Efficient material use and zero waste — Materials and products used efficiently through reuse and recycling with the goal of eliminating the generation of waste.

Resource efficiency — Natural resources used efficiently and operating within the limits of the planet to bring about economic benefits and promote healthier lives and job creation.

Sustainable mobility — A well-connected urban environment based on public and active transport accessible to all, including those socially and economically disadvantaged.

Green economy — An inclusive economy that is low-carbon, resource-conserving, diverse and circular and results in improved human well-being and social equity while significantly reducing environmental risks and ecological scarcities.

Built environment quality — High-quality buildings, public spaces and supporting physical infrastructure, such as water supply, energy networks and transport systems, that are built to last, properly integrated with the wider urban system and effectively support sustainable urban living.

Housing quality — High-quality housing stock that delivers good environmental performance and healthy homes for residents.

Integrated planning — Integrated, long-term spatial planning and design that delivers healthy, accessible, compact, economically competitive cities and sustainable, multifunctional urban peripheries that also effectively manage urban sprawl.

Social and environmental justice — Social and environmental justice that protects the most vulnerable and disadvantaged and gives them access to a good-quality environment.

Participation and empowerment — Empowerment of stakeholders and citizens in relevant aspects of decision-making and knowledge creation through timely engagement and meaningful participation across all sectors of society.

Collaborative and community-led initiatives — Community-led and decentralised networks, initiatives and partnerships that foster social innovation and enhance resilience and cohesion.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4
Applying the conceptual framework in assessments of urban environmental sustainability

4.1 Operationalising the conceptual framework

The conceptual framework is intended to be used to structure assessments and analysis of cities from the perspective of environmental sustainability. Such analyses could be top down by institutions such as the EEA or bottom up by individual municipalities or cities. The conceptual framework can be used to identify potential analytical tools (e.g. indicators and supporting data sets, assessment methodologies, case studies) as part of the analysis. This in turn will provide the basis for the EEA's current and future urban environmental sustainability assessments.

Given the complexity and interactions between processes and policies within urban systems, the components of the conceptual framework are intended to provide a pragmatic means of structuring analysis, for example by focusing on specific building blocks. Analyses can also be focused using the lenses, such that a particular perspective (e.g. low-carbon city or healthy city) is selected to provide a logical framing of the analysis and a means of managing the complexity involved.

The EEA approach to the analysis of urban environmental sustainability is based around mixed methods, creating narratives that draw on both qualitative and quantitative data. The EEA is developing two initial approaches to urban sustainability assessment, drawing on the conceptual framework: urban nexus analysis and analysis of drivers and barriers (learning from the experience of pioneering cities). The approach used in each of these analytical models is described below in sections 4.2. and 4.3.

4.2 Urban nexus analysis

4.2.1 The nexus concept and urban nexus approach

The European environment — state and outlook 2020 stresses that achieving sustainability transitions requires coherence across policy domains and scales. Policymaking and action are often developed in silos, addressing specific sectors or issues, with contrasting objectives (EEA, 2019a). Likewise, research and knowledge development are frequently compartmentalised along disciplinary boundaries. This means that misalignment and conflicts are inevitable, and it limits shared understanding of systemic challenges and responses that reflect fully the 'barriers, opportunities, trade-offs and co-benefits associated with systemic change' (EEA, 2019a). There is a need for 'policies that embrace the inherent interconnectedness of systems components, interactions across systems, and links between economic, social and environmental goals' (EEA, 2019a).

This is certainly the case in cities and metropolitan areas and their peripheries, where the complexity of interactions between socio-economic and environmental factors present significant challenges for improving quality of life while minimising environmental pressures and resource depletion. However, urban areas also provide opportunities for positive systemic change. What is needed is better coordination and prioritisation of policymaking and action across sectors. Prioritisation is particularly important here, as 'total integration' of everything with everything as part of political processes is impossible. Recognising and prioritising critical interrelationships that have not been addressed appropriately is a key first step for better integrated policymaking (Rode, 2018). By considering priority

interlinkages between systems and policy areas, environmental, social and economic trade-offs and co-benefits ([2]) can be identified (Rode, 2018; EEA, 2019a).

One approach to thinking about the interactions between systems and policies is by using a nexus approach. Box 4.1 provides more information on the nexus concept, nexus approach and analysis. A nexus is defined as the interlinkages and interrelationships between two or more systems (e.g. food and energy) or policy areas. Nexus analysis refers to the identification and analysis of the interactions, interrelations and interdependencies among sectors and policies or other interventions. The nexus approach refers to proactive and integrated policy engagement with such interrelated sectors resulting in a new approach to policymaking and action. In an urban context this means considering together two or more urban policy areas in order to address a specific urban environmental sustainability problem or to advance a policy objective. By identifying priority synergies, co-benefits and trade-offs, opportunities can be identified for better coordinated and integrated policymaking and action.

Considering urban issues in this way is intended to improve understanding of interactions and enable more coherent and effective policy and other interventions that can identify and minimise trade-offs and 'reduce environmental pressures ... realising potential co-benefits for human health and well- being' (EEA, 2019a). A nexus approach can help decision-makers choose the most appropriate policy measures or other actions to help identify cost-effective interventions and minimise hidden or unanticipated costs. Cost-effectiveness is defined (EC, 2014) as either, for a given outcome (e.g. a percentage reduction in air pollution), minimising the net-present value of costs or, for a given cost, maximising the relevant outcome(s). In the context of urban environmental sustainability, cost-effectiveness also considers the co-benefits of an intervention (e.g. the health benefits of meeting a primary objective of reduced air pollution).

In summary, the potential benefits of conducting nexus analysis for urban environmental sustainability are to:

- help manage the complexity of urban systems by identifying critical interrelationships, co-dependencies and trade-offs between selected aspects of urban environmental sustainability and/or desired policies and other interventions;
- identify and assess specific counteracting and reinforcing policies and other interventions and their outcomes;
- improve understanding of how to achieve multiple outcomes and objectives together and take advantage of co-benefits;
- identify opportunities for improved policy integration and efficacy by jointly considering multiple objectives and desired outcomes;
- through the above, help to identify cost-effective urban sustainability policy and action.

Interactions and dependencies with policy at different scales

EU cities often have a degree of autonomy in their governance and budgetary arrangements. The analysis of urban sustainability nexuses focuses in particular on policymaking and action that cities can directly influence and control. The extent of this control will vary between cities and metropolitan areas, depending on factors such as their size and the governance arrangements in different countries; however, the analysis aims to draw out lessons that can have broad relevance. The intention is to explore how policies and actions can be better coordinated and prioritised by city authorities (and within cities) to help achieve urban sustainability outcomes.

Although cities can be seen as representing complex systems in themselves (at the level of the city or functional urban area), they also have interrelationships and interdependencies across different scales. Figure 4.1 illustrates policy integration operating at different scales. In the EU, high-level policy, targets and visions are set at the EU level, and Member States have their own urban policy and regulatory frameworks, including those implementing EU directives. Some countries have governance at a regional scale, and below this sits city- and sub-city-level governance. As illustrated in Figure 4.1, policy integration can therefore be viewed:

- vertically — policy areas operating across different scales or levels (e.g. EU, national, city); and
- horizontally — different policies or actions implemented and interacting with each other at a particular scale or level.

The nexus analysis considers both of these types of integration. Each nexus recognises the importance of EU and national policy frameworks and targets, while the analysis focuses on the identification and assessment of horizontal

([2]) A co-benefit is where the delivery of one policy area or intervention can help achieve outcomes in another policy area. For example, an intervention to encourage active travel (walking and cycling) could have a main objective of improving public health but might have co-benefits in terms of reducing congestion and air and noise pollution, thus improving quality of life.

policy interactions. The aim is to help move towards more integrated policymaking and interventions in cities, and in this way to support the transition to urban environmental sustainability. In Figure 4.1 this is illustrated by the red triangle, highlighting as an example the nexus between the transport, housing and energy policy areas, which operate at the city level (horizontal integration) but are influenced by and need to be integrated with higher-level policy and in turn will influence lower spheres (vertical integration).

Box 4.1 The nexus concept and its use in an urban context

The term 'nexus' by definition refers to the interlinkages or connections between two or more elements. A 'nexus approach' implies considering explicitly these connections or interlinkages between resources or sectors and the implications of these in, for example, the context of a strategic or policy goal (Magic Nexus, 2018). Hoff (2011) puts the nexus approach in the context of system efficiency over sector productivity: 'The nexus focus is on system efficiency, rather than on the productivity of isolated sectors.' The Food and Agriculture Organization of the United Nations considers the nexus as a 'conceptual approach to better understand and systematically analyse the interactions between the natural environment and human activities, and to work towards a more coordinated management and use of natural resources across sectors and scales' (FAO, 2014).

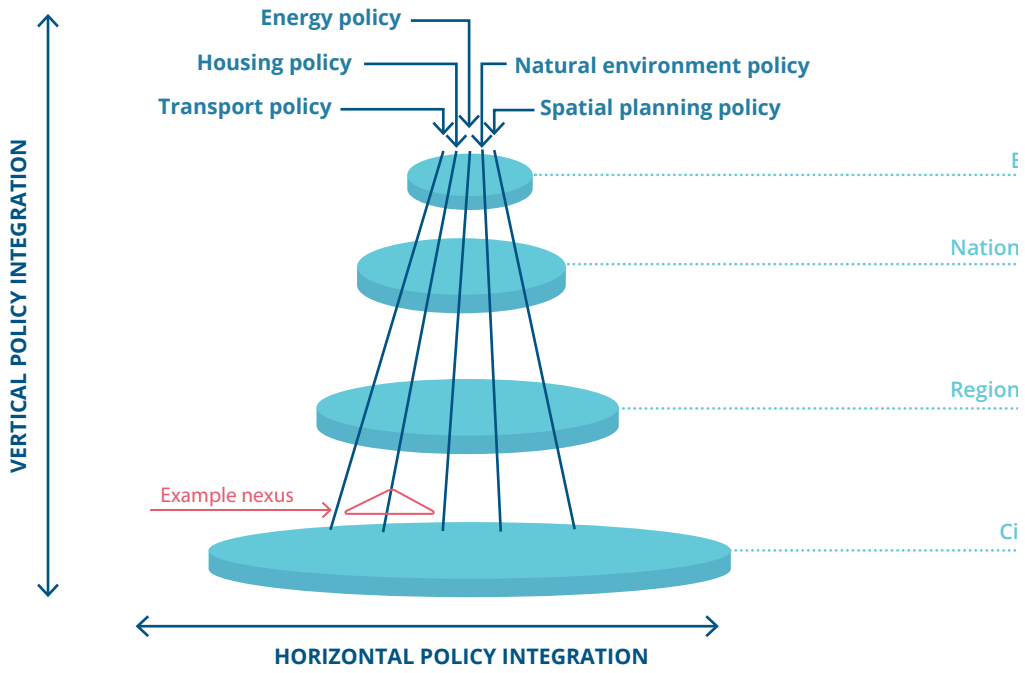
The nexus approach therefore explicitly recognises synergies and trade-offs as necessary for the development of response options. The approach helps ensure the sustainability of the environment and people's livelihoods, facilitating more integrated and cost-effective policymaking, planning, implementation, monitoring and evaluation.

The European environment — state and outlook 2020 introduces the concept of the 'resource nexus'. This recognises that 'links between … systems arise because of their shared reliance on natural systems, both as a source of resources and as a sink for wastes and emissions'. This shared reliance means that 'addressing problems in one area may simply shift the burden to other systems'. A resource nexus approach can also help highlight the interdependence of production and consumption systems, and their cumulative impacts (e.g. on ecosystems). Achieving the transition to a low-carbon, resource-efficient economy 'will require that the interlinkages across systems are considered and the trade-offs and co-benefits identified' (EEA, 2019a).

The focus of existing definitions of the nexus approach are predominantly on resource efficiency and the management of scarcity. However, in an urban context a different focus may be appropriate. UNESCAP (2016) discusses the urban nexus as focusing on the interlinkages among various elements and their 'conversion pathways' — extraction, supply, distribution, end use and disposal — in consumption and production chains of socio-economic sectors. Furthermore, UNESCAP (2016) suggests that a city serves as a nexus, or focal point, that connects and is shaped by economic, technological and social forces. UNESCAP (2016) and Lehman (2018) propose an 'intra-urban nexus' and a 'nested urban nexus', the former focusing 'solely on what is urban in the nexus framing' including urban metabolism, infrastructure and human security, while the latter recognises that nexus dynamics need to be understood in the context of driving and constraining forces at both lower and higher scales, meaning that nexus analysis at a city level will need to consider developments at other scales, e.g. global, regional or national policy developments, and ecosystems at sub-national and regional levels.

Local Governments for Sustainability and GIZ defined the use of urban nexus analysis as an 'approach that guides stakeholders to identify and pursue possible synergies between sectors, jurisdictions, and technical domains, so as to increase institutional performance, optimise resource management, and service quality' (ICLEI and GIZ, 2014). Rode (2018) discusses urban nexus as helping to facilitate a move away from the 'functionally segregated city and its simplistic view of the relationship between urban life and city design' towards an approach that can 'better address the complexities, interrelationships and co-dependencies … characteristic of city systems'. Rode (2018) in particular focuses on what is seen as 'the critical nexus' of urban form and transport, which provides a good illustration of the nexus approach in practice, as 'both elements need to be dealt with jointly to provide accessibility to people, goods and ideas in cities'.

Figure 4.1 **Vertical and horizontal policy integration**



Source: EEA.

4.2.2 Methodological approach to the analysis of urban nexuses

Drawing on the conceptual framework (see Chapter 3), a literature review and stakeholder input, eight priority urban sustainability nexuses were identified and selected. Table 4.1 presents an overview of these nexuses. The eight nexuses were selected to cover a range of key urban sustainability objectives and to reflect the main topics addressed by EU environmental and climate policies. They also highlight some of the most critical interrelationships between sectors, which are currently not considered appropriately as part of policymaking and action. They are not, however, intended to be comprehensive, as a great many other sustainability objectives and critical interrelationships exist, and in meeting these objectives a very large number of critical policy interactions or nexuses could be identified.

The overall aim of the urban nexus analysis is to explore critical interlinkages and interrelationships between two or more policy areas that need to be considered together in order to advance an urban sustainability objective. The selected urban nexuses are intended to be examples of how this analysis approach could be used in practice to identify existing challenges to achieving urban sustainability objectives and opportunities to move towards better coordinated and integrated policymaking and action.

Each nexus is framed around meeting a high-level urban sustainability objective (e.g. climate resilience, food security) that is systemic in nature and requires coordinated policymaking and action. Meeting these nexus objectives could require interventions in a large number of policy areas. However, for the nexus analysis in each case, three interlinked policy areas were selected to help identify examples of key interactions, challenges and opportunities for prioritisation and coordination of policy and interventions. Different or additional policy areas could be selected to broaden the analysis or to focus on other policy priorities. However, the selection for this analysis is intended to represent some of the key areas in which coordinated policy is required. Although different cities may use different terminology and have divergent levels of authority or autonomy, the selected policy areas are intended to be representative of strategy, policy and other interventions commonly seen in cities. For example, in areas such as housing, transport, waste management or spatial planning, specific policies, standards and budgets are often set at a municipal or city level.

The assessment draws on the conceptual framework by considering actions in the context of the 'building blocks' of urban sustainability that are relevant to the key policy areas in each nexus. Each nexus analysis also explores one example of a challenge and the actions to address it in more detail. By focusing the analysis in this way, the intention is to facilitate a more detailed assessment than would be possible if a larger number of challenges and actions were considered. Of course, each nexus has many potential challenges and associated actions and these will differ from city to city.

The nexus analysis is based on an assessment of what challenges cities typically face in meeting urban sustainability objectives, which critical interrelationships are currently

'under-serviced' and how action can be better coordinated and/or prioritised across the selected policy areas. In doing so, the analysis can identify co-benefits and trade-offs and help to improve the cost-effectiveness of interventions.

Although no hierarchy of nexuses is intended, some do represent higher-level or more overarching sustainability objectives, while others are more specific. For example, meeting the high-level nexus objective of 'climate resilience' relates to other nexus objectives, in particular 'quality of life', 'urban accessibility', 'environment and health' and 'food security'. These relationships are in themselves complex and bi-directional. For example, improving 'urban accessibility' or 'environment and health' through the creation, enhancement or change in use of green infrastructure can also enhance a city's resilience to climate change ('climate resilience' nexus). Nexuses that primarily relate to 'environment and society' are grouped together in Table 4.1.

Likewise, the objective of 'closing the loop' in a city implies moving to a more circular urban economy, in which products, materials, built assets and land are kept in use while maintaining their value, and waste generation is minimised. Closing the loop represents a high-level nexus, and achieving other nexus objectives, in particular 'sustainable buildings' and 'clean energy', will contribute to meeting the higher-level objective of a circular urban economy and vice versa. Nexuses that primarily relate to 'resources and energy' are grouped together in Table 4.1.

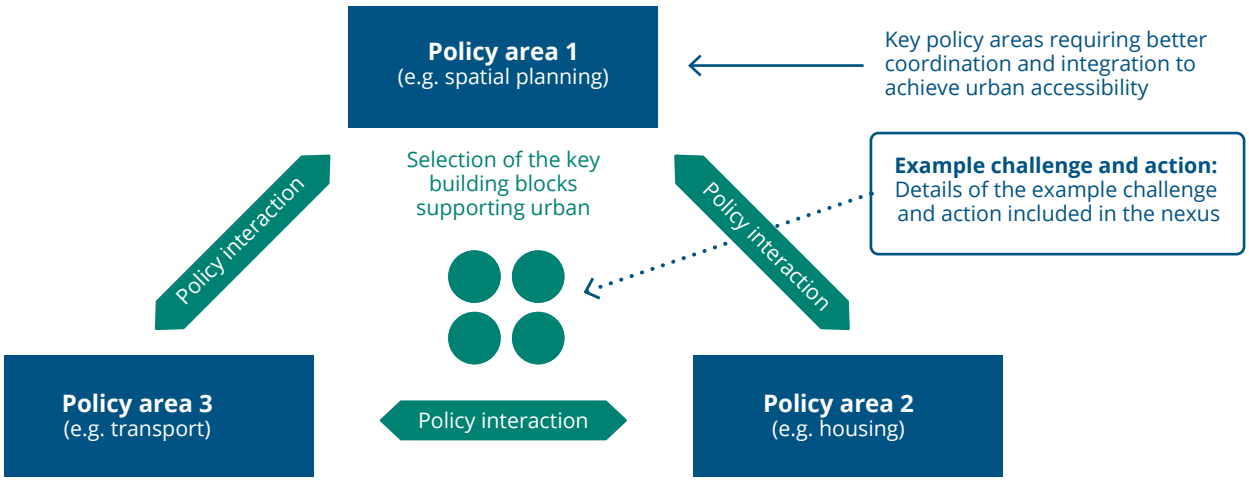
Table 4.1 Overview of the eight example nexuses

Urban sustainability objective — the 'nexus objective'	Key interlinked policy areas that need to be considered to achieve the nexus objective	Example challenges and the actions to address them
	Environment and society nexuses	
Climate resilience	• Spatial planning • Green infrastructure • Built environment	Managing urban flood risk by using nature-based solutions
Quality of life	• Urban design • Spatial planning • Nature and biodiversity	Increasing access to green space through integrated land use planning
Urban accessibility	• Spatial planning • Transport • Housing	Increasing urban density through transit-oriented development
Environment and health	• Environment • Green infrastructure • Transport	Improving air quality by creating car-free cities
Food security	• Urban food • Spatial planning • Waste management	Promoting urban agriculture through small-scale innovation projects
	Resources and energy nexuses	
Closing the loop	• Resources and materials • Waste management • Green economy	Reducing waste, encouraging reuse and boosting local economies through 'urban resource centres'
Clean energy	• Built environment • Spatial planning • Energy	Decentralising energy production by using clean energy sources
Sustainable buildings	• Resources and materials • Built environment • Urban design	Reducing resource consumption in building construction and use by adopting innovative design, materials and systems

A template was used to develop each example nexus analysis, based on which each nexus analysis includes:

- an introductory section setting out **why the nexus objective is important** for urban sustainability and summarising key relevant EU and international policy frameworks;
- a **nexus figure** that presents visually the interlinked selected policy areas that the nexus is based around, as well as the key building blocks relevant to meeting the nexus objective (see Figure 4.2, a template nexus figure);
- an overview of the main **challenges and actions** for cities in meeting the nexus objective (including policy and a range of other interventions);
- identification of potentially relevant **indicators** for the nexus;
- an assessment of one selected **example interrelated area of policy and action**, including case studies from European cities;
- a summary of the **lessons** learned in achieving the nexus objective; and,
- a list of sources of additional **information and existing networks** relevant to the nexus.

Figure 4.2 Template nexus figure



4.3 Drivers and barriers analysis — learning from the experience of pioneering cities

This analysis explores some of the key factors that are driving or hindering environmental sustainability transitions in selected European cities, in the hope that their experiences can provide useful lessons for other urban areas. These results are presented in the EEA report *Urban Sustainability in Europe: What is driving cities' environmental change?* (EEA, 2020c). Given the EEA's remit and interests, the focus of this research is on urban **environmental** sustainability transitions. Where the term 'sustainability transitions' is used in this report the principal focus is on the environmental dimension of sustainability transitions within an urban context.

4.3.1 Methodological approach to the analysis of drivers and barriers

The analysis was based on a mixed methods approach that combined a literature review, a survey of European cities and semi-structured interviews with seven case study cities to deepen and contextualise the survey results. The mixed methods approach was designed to provide a well-rounded picture of the different factors that are driving environmental sustainability in European cities today.

The survey was conducted with a selection of 'frontrunner' or pioneering cities that have either won or been selected as finalists in the European Green Capital Awards (EGCA) or the European Green Leaf Awards (EGLA). It was structured around a series of potential drivers and barriers — actions that are 'supporting or inhibiting' transitions to urban environmental sustainability. These were in turn grouped under 'context' (i.e. distinct context of every city) and the set of six enabling factors including governance, culture, finance, knowledge, data and information, and technology, as defined within the conceptual framework (see Chapter 3). An initial set of drivers related to each enabling factor was proposed and then tested and refined through discussion and feedback from the EEA and external stakeholders. The initial list was then supplemented through a review of the academic and grey literature to identify examples of the identification and/or assessment of drivers of and barriers to urban sustainability transition around the world.

A total of 26 out of the 40 eligible cities (65 %) responded to the survey. The geographical spread of the cities that responded broadly mirrored the distribution of all 40 winners and finalists of the EGCA and EGLA. Cities in eastern Europe were the least represented, followed by those in southern Europe. Most of the city representatives who completed the survey worked in environment and climate change departments.

After completing the survey, representatives of seven of these cities (Cornellà de Llobregat, Gabrovo, Leuven, Lisbon, Mikkeli, Stockholm and Tallinn) were interviewed to achieve a more nuanced understanding of what drives urban environmental sustainability transitions in some European cities. Figure 4.3 shows all of the eligible cities, including those that responded to the survey and those for which an interview was carried out.

This is a relatively small-scale pilot study to test the approach, and the results should therefore not be seen as capturing the full spectrum of drivers and barriers experienced by the case study cities. Given the relatively limited scope of this study, these findings should be seen as an entry point to a wider conversation about the drivers of and barriers to urban sustainability transitions rather than a definitive overview of the multitude of complex and interrelated factors that shape sustainability outcomes in European cities.

Figure 4.3 **European Green Capital and European Green Leaf Award winners and finalists and survey respondents**

Reference data: ©ESRI

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Urban sustainability in Europe — A stakeholder-led process

2021 — 37 pp. — 21 x 29.7 cm

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