UNITED NATIONS ECONOMIC COMMISSION FOR EUROPE
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Europe's Environment

The Seventh Pan-European Environmental Assessment

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FOREWORD

The seventh pan-European environmental assessment gives an insight into the progress achieved in environmental protection, a cornerstone of life and human health, but also highlights the numerous challenges that need to be tackled by the whole of society. The successes are far fewer than the setbacks and failures to make progress. The assessment therefore provides much food for thought for ministers attending the Ninth Environment for Europe Ministerial Conference (Nicosia, 5–7 October 2022).

We are faced with a triple planetary crisis of climate change, biodiversity loss and pollution and waste that is being compounded in our region by the invasion of Ukraine. A step change in our economies and behaviours is needed if we are to get on track for achieving the Sustainable Development Goals.

The assessment shows that success is possible with the right instruments and the political will. To take the example of emissions to the air, releases of nitrogen and sulfur oxides have dropped in much of the region and the consumption of hydrofluorocarbons has almost ceased.

However, ambient fine particulate matter concentrations exceed air quality guidelines across the pan-European region, despite improvements in its western half. Emissions of greenhouse gases have only dropped marginally since the Eighth Environment for Europe Ministerial Conference (Batumi, Georgia, 8–10 June 2016). Stagnant emissions reflect the failure to control energy consumption or to invest sufficiently in renewables – the proportion of renewables in the energy mix is rising more slowly than the increase in total final energy consumption.

The assessment also highlights remaining challenges related to environmental topics such as fresh water, waste management and chemicals, biodiversity and environmental monitoring and data availability, and tackles the two themes of the Nicosia Conference: (a) greening the economy in the pan-European region: working towards sustainable infrastructure; and (b) applying principles of circular economy to sustainable tourism. In broad terms, tourism is not circular, and infrastructure is not sustainable. However, the assessment does point the way to how progress may be achieved and monitored when working towards sustainable infrastructure and applying principles of circular economy to sustainable tourism.

In all areas, policy and technological solutions are available. For sustainable infrastructure, the assessment recommends making use of existing tools to promote sustainable infrastructure development, including the United Nations Economic Commission for Europe Protocol on Strategic Environmental Assessment and the United Nations Environment Programme International Good Practice Principles for Sustainable Infrastructure. Economic and financial incentives need to be employed and favourable conditions established to implement a life cycle approach and circular economy strategies.

For sustainable tourism, the assessment underlines the need for cooperation between the numerous stakeholders, the application of circular economy principles across the tourism value chain, access to knowledge, information and finance for small and medium-sized enterprises operating in the tourism sector, and the integration of circular economy principles into tourism-related legislation, policies, plans and strategies. The promotion of domestic tourism and the use of more environmentally friendly means of transport are other areas that require urgent attention.

We therefore invite ministers, policymakers and ordinary citizens to read the assessment and act upon its recommendations speedily and holistically.

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Under-Secretary-General of the United Nations
and Executive Secretary of the United Nations
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PREFACE

The seventh pan-European assessment reports on the state of the environment for the period until the end of 2021. It is intended to inform discussions and decision-making by ministers during the Ninth Environment for Europe Ministerial Conference (Nicosia, 5–7 October 2022). It is the latest in a series of assessments dating back to 1995, with the last one having been presented to the Eighth Environment for Europe Ministerial Conference (Batumi, Georgia, 8–10 June 2016). On that occasion, the assessment took the form of the regional assessment of the Global Environment Outlook.

At its twenty-fifth session (Geneva, 13–15 November 2019), the United Nations Economic Commission for Europe (ECE) Committee on Environmental Policy requested the ECE secretariat and the United Nations Environment Programme (UNEP), working in close cooperation with the European Environment Agency, to prepare a limited indicator-based and thematic assessment.[1]

The Committee agreed on the scope of the assessment, covering both environmental topics – atmospheric air and the ozone layer; climate change and greenhouse gas emissions; fresh water; coastal waters, marine ecosystems and seas; biodiversity and ecosystems; land and soil; chemicals and waste; and environmental financing and public spending on environmental protection – and the two themes selected for the Nicosia Conference: (a) greening the economy in the pan-European region: working towards sustainable infrastructure; and (b) applying principles of circular economy to sustainable tourism.

To facilitate the work of ministers, a summary for policymakers has been added that picks out a series of key issues and recommendations from the body of the assessment report. The summary for policymakers was welcomed by the Committee on Environmental Policy at its most recent special session (Geneva, 9–12 May 2022).[2]

The assessment benefited from the work of numerous specialists, who drafted and reviewed its different parts, bringing with them knowledge and perspectives from across the ECE region, supplemented by expertise from the United Nations system and other international organizations.

The Committee and the secretariat reiterate their appreciation to those member States that provided financial contributions to support preparation of the seventh pan-European environmental assessment, namely Austria, Germany, the Netherlands, Norway, Serbia and Switzerland. They also express their thanks to the many experts who provided comments on the draft assessment and to the ECE Working Group on Environmental Monitoring and Assessment for overseeing the preparation of the assessment.

1 ECE/CEP/2019/15, para. 37 (k) (ii).

2 ECE/CEP/S/2022/2, para. 26 (d), advance edited version available at https://unece.org/node/364855.

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ABBREVIATIONS AND ACRONYMS

BACA	Batumi Action for Cleaner Air
BIG-E	Batumi Initiative on Green Economy
DMC	domestic material consumption
DRR	disaster risk reduction
ECE	United Nations Economic Commission for Europe
EEA	European Environment Agency
EMEP	Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe
EPR	environmental performance review
ESD	education for sustainable development
FAO	Food and Agriculture Organization of the United Nations
GDP	gross domestic product
GHG	greenhouse gas
IMF	International Monetary Fund
IOM	International Organization for Migration
ITF	International Transport Forum
IWRM	integrated water resources management
KBA	key biodiversity area
MDB	Multilateral Development Bank
MF	material footprint
MPA	marine protected area
MEA	multilateral environmental agreement
NbS	nature-based solutions
NGO	non-governmental organization
ODP	ozone-depleting potential
ODS	ozone-depleting substance
OECD	Organisation for Economic Co-operation and Development
PA	protected area
PM	particulate matter
SEA	strategic environmental assessment
SEIS	Shared Environmental Information System
SOC	soil organic carbon
UNCCD	United Nations Convention to Combat Desertification
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEF	United Nations Children's Fund
VOC	volatile organic compound
WHO	World Health Organization

SUMMARY FOR POLICYMAKERS

A. Introduction

The secretariat of the United Nations Economic Commission for Europe (ECE) and the United Nations Environment Programme (UNEP) have prepared a limited indicator-based and thematic pan-European environmental assessment upon the request of the ECE Committee on Environmental Policy, as input to the Ninth Environment for Europe Ministerial Conference (Nicosia, 5–7 October 2022).[3]

The seventh pan-European environmental assessment reports that progress has been achieved in environmental protection in certain areas, but significant shortcomings remain and pose a threat to the health of both people and the environment in the pan-European region. The summary for policymakers highlights a series of key issues and recommendations from the body of the assessment report. The assessment covers the period until the end of 2021. The trends shown by arrows in tables 1–19 indicate the improvement (green, upwards arrow) or worsening (red, downwards arrow) of the situation, not an increase or decrease in an indicator value. The reader is encouraged to turn to the thematic assessments to learn more.

B. Key messages and recommendations

1. Atmospheric air and the ozone layer

Countries in the pan-European region are expanding policies to tackle air pollution. Some progress has been made, but increased effort is needed (see table 1). The health impact of long-time exposure to fine particulate matter (PM) with a diameter less than 2.5 µm ($PM_{2.5}$) in 41 European countries was reduced by 13 per cent in the period 2009–2018 and that of nitrogen oxides (NO_x) by 54 per cent. However, the number of premature deaths due to ground-level ozone exposure increased in that period by an estimated 24 per cent, possibly caused by higher mean temperatures. The phasing out of hydrochlorofluorocarbons present as coolant in refrigerators and air-conditioning systems remains incomplete, especially in countries with economies in transition.

Recommendations

Governments in the pan-European region should develop additional technical and organizational measures to achieve target 3.9 of the Sustainable Development Goals, especially for $PM_{2.5}$ and ground-level ozone. Key responses are the sharpening and application of best available techniques to prevent emissions of PM, NO_x and hydrocarbons by industry and emissions reduction from traffic (by implementing Euro-6 and Euro-7 measures). All countries should update ambient air quality standards to align them with World Health Organization (WHO) guidelines. Governments should contribute to the adequate replenishment of the Multilateral Fund for the Implementation of the Montreal Protocol in order to accelerate the phasing out of hydrochlorofluorocarbons globally.

3 Throughout the assessment, where feasible and relevant, the following subregions are referred to: (i) European Union, comprising 27 member States; (ii) Western Europe, comprising Andorra, Iceland, Israel, Liechtenstein, Monaco, Norway, San Marino, Switzerland and the United Kingdom of Great Britain and Northern Ireland; (iii) Central Asia, comprising Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan; (iv) Eastern Europe, comprising Armenia, Azerbaijan, Belarus, Georgia, the Republic of Moldova, the Russian Federation and Ukraine; and (v) South-Eastern Europe, comprising Albania, Bosnia and Herzegovina, Montenegro, North Macedonia, Serbia and Türkiye. The assessment does not include Canada and the United States of America.

Table 1 Status and trends for selected indicators for air quality and the ozone layer

Indicator	European Union	Western Europe	Central Asia	Eastern Europe	South-Eastern Europe	Pan-European region
Ambient $PM_{2.5}$ ($\mu g/m^3$ in 2016)	☹ (13)	☹ (11)	☹ (25)	☹ (12)	☹ (35)	☹ (16)
Emissions of SO_x, NO_x and $PM_{2.5}$ (2015–2019)	↗↗↗	↗↗↗	→↘→	↗↗↘	↘↗↘	↗↗→
Consumption of HCFCs, ODP g per capita (2010–2019)	☺	☺	😐 ↗	😐 ↗	😐 ↗	😐 ↗

Sources: For ambient $PM_{2.5}$ ($\mu g/m^3$ in 2016), WHO, Global Health Observatory, "SDG Indicator 11.6.2 Concentration of fine particulate matter ($PM_{2.5}$)". Available at www.who.int/data/gho/data/indicators/indicator-details/GHO/concentrations-of-fine-particulate-matter-(pm2-5) (accessed on 7 May 2021); for emissions of SO_x, NO_x and $PM_{2.5}$ (2015–2019), Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP), Centre on Emission Inventories and Projections (CEIP), "Officially reported emissions data", available at https://www.ceip.at/data-viewer-1 (accessed on 10 February 2022).

Notes: Trend is ↗ improving (emissions falling), → stable or ↘ worsening; status of $PM_{2.5}$ concentration is ☹ (exceeds the 2005 WHO air quality guideline of 10 $\mu g/m^3$ and the subsequent (2021) stricter limit of 5 $\mu g/m^3$); status of consumption of hydrochlorofluorocarbons is ☺ (phased out) or 😐 (below but close to target). European Union net consumption of hydrochlorofluorocarbons has been below zero since 2010; Western Europe except Israel has had zero consumption since 2015; Azerbaijan and Belarus achieved zero consumption in 2019 and Kyrgyzstan did so in 2020. Regarding ambient $PM_{2.5}$ ($\mu g/m^3$ in 2016), regional values are population weighted. No data for Liechtenstein. Corresponds to Sustainable Development Goal indicator 11.6.2.

Abbreviations: HCFCs, hydrochloroflurocarbons; ODP, ozone-depleting potential.

2. Greenhouse gas emissions

All countries in the pan-European region have committed to reducing greenhouse gas (GHG) emissions, but net emissions in the region are still rising. Efforts and achievements are unevenly distributed throughout the region. Reductions, which are mostly achieved in the western part of Europe (2014–2019), are offset by the increase in emissions in the rest of the region (see table 2). National commitments under the Paris Agreement were renewed by 35 countries in the region with more ambitious targets. However, some countries still do not have firm, quantifiable commitments or mechanisms to follow the progress towards them, resulting in significant data gaps.

Recommendations

Governments in the pan-European region should enhance their commitments in nationally determined contributions under the Paris Agreement, commit to economy-wide absolute emission reduction targets and regularly report on their progress towards implementation and achievement of their targets. They should also establish the conditions for medium- and long-term sustainable mobilization of funds for climate action, by both accelerating the use of available regional and global funds and mechanisms and creating national financial instruments.

Table 2 Status and trends for selected indicator on greenhouse gas emissions

Indicator	European Union	Western Europe	Central Asia	Eastern Europe	South-Eastern Europe	Pan-European region
GHG emissions (2014–2019) (percentage change)	↗ (-4.3)	↗ (-10.8)	–	↘ (+2)	↘ (+10.2)	↗ (-1.2)

Source: United Nations, Department of Economic and Social Affairs, Statistics, "Global SDG Indicators Data Platform", SDG Indicators Database. Available at https://unstats.un.org/sdgs/unsdg (accessed on 2 February 2022).

Note: Trend is ↗ improving (emissions falling), → stable or ↘ worsening. Insufficient data for Central Asia, where emissions are rising.

3. Decarbonization

Decarbonization is becoming a strong narrative across the pan-European region, but action is lagging behind. The use of renewables was increased in 29 countries in the pan-European region in the period 2013–2017, but the region still largely relies on fossil fuels – some 78 per cent on average of the total final energy consumption comes from fossil fuels (see table 3). The penetration of renewables in the energy mix is rising more slowly than the increase in the total final energy consumption in the region.

Recommendations

Governments in the pan-European region should eliminate or reform harmful subsidies and incentives and develop effective positive incentives to deepen decarbonization, by shifting promotion of investments towards renewable energy.

Table 3 Status and trends for selected indicator on renewable energy share

Indicator	European Union	Western Europe	Central Asia	Eastern Europe	South-Eastern Europe	Pan-European region
Renewable energy share in total energy consumption (2014–2018) (latest rate, percentage)	→ (18)	↗ (18)	↗ (4)	→ (4)	→ (14)	→ (13)

Source: 2019 Energy Balances (United Nations publication, Sales No. E.22.XVII.5).

Note: Trend is ↗ improving, → stable or ↘ worsening.

4. Fresh water quantity and quality

Water quantity has an asymmetric space and time distribution in the pan-European region and climate change is delivering additional challenges with impacts on human health through various water-related phenomena such as floods, droughts, waterborne diseases and biodiversity changes in aquatic ecosystems. Anthropogenic pressures, including through hydromorphological alterations and barriers, amplify water asymmetry by constraining fresh water quality (see tables 4 and 5) and aquatic biodiversity, as well as directly impacting resources through withdrawal. River basins, lakes and aquifers are subject to multiple stressors. Diffuse pollution and urban and industrial wastewater discharges remain significant in many locations and persistent organic contaminants are of greater public health concern. Science is advancing to provide solutions and foster new processes and technologies to face these negative impacts.

Recommendations

Whenever fresh waters and aquatic ecosystems are at risk, the best available technology should be applied to ameliorate the situation. Some examples of high readiness solutions include water conservation measures and conventional mitigation approaches, plus measures for resource protection and more efficient water use, such as digitization and precision agriculture, nature-based solutions (NbS) for water retention basins or in riparian zone restoration, and the use of new methods for environmental flow regimes. The potential of non-conventional water sources should be explored. Table 4 indicates the extent of good ambient water quality in bodies across the region.

Table 4 Status and trends for selected indicator on ambient water quality

	Bodies of water with good ambient water quality, for countries with data available (national value ranges by subregion) Percentage					
Year	European Union	Western Europe	Central Asia	Eastern Europe	South-Eastern Europe	Pan-European region
2017	34–100	80–100	-	96	6–94	6–100
2020	41–99	61–100	64	89–96	31–88	31–100

Source: United Nations, "Global SDG Indicators Data Platform" (accessed on 8 February 2022).

Note: Based on the available information, with no data produced for several countries in 2017 and 2020 and different countries having data in each year. Insufficient data for Central Asia in 2017.

Table 5 Status and trends for selected indicators for safely managed drinking water or sanitation services

	Proportion of population using safely managed drinking water or sanitation services Percentage					
Indicator	European Union	Western Europe	Central Asia	Eastern Europe	South-Eastern Europe	Pan-European region
Drinking water, 2016–2020 (latest rate, percentage)	↗ (97.8)	→ (99.3)	↗ (69.6)	↗ (79.9)	↘ (78)	↗ (90.4)
Sanitation, 2016–2020 (latest rate, percentage)	↗ (90.5)	↗ (95.9)		↗ (61.5)	↗ (70)	↗ (81.4)

Source: United Nations, "Global SDG Indicators Data Platform" (accessed on 10 February 2022).

Note: Trend is ↗ improving, → stable or ↘ worsening. No data for some countries. Insufficient sanitation data for Central Asia.

5. Fresh water – financing

Financing of water-related projects under the international climate agenda has been limited and setting up bankable projects is difficult. Financing models are highly susceptible to technical and governance insufficiencies and have been restrained by local and regional crises during the past decade.

Recommendations

Economic sustainability in water resources management should be pursued and innovative financing mechanisms are still required. Natural and human-made infrastructure development may use several financing tools (e.g. fair water pricing, ecological payments, cost recovery and incentives) but a clear legal framework is vital for success.

6. Integrated water resources management and transboundary water cooperation

Increasing challenges to water resources management indicate that fragmented governance practices are unlikely to succeed in the long term. Granular information is important for better knowledge and involving public and private actors is becoming fundamental to successful water policy and good decision-making. Transboundary management of shared rivers, lakes and aquifers remains a challenge (see table 6). The problem is acute when upstream water abstraction or retention is significant and downstream countries lack alternative water sources. Despite some good examples, cooperation and participatory processes for water protection, allocation and other practical achievements are not implemented as deeply as they could be in the pan-European region.

Recommendations

Integrated water resources management should be pursued, involving a balance between human water needs and water's availability for nature. Water policy should enhance its interdisciplinarity and transdisciplinary character to maximize societal impact. Therefore, the water–food–energy–ecosystems nexus should strengthen an anticipatory policy approach to combining short-term projects with a long-term vision for the pan-European region. Water resources management is more efficient at the basin level and good governance is required to bring success to technology and financing. This integrated approach is even more critical in international rivers, lakes or aquifers where floods or droughts are likely to occur. Co-management should be pursued towards environmental protection and benefit-sharing within an efficient and resilient transboundary cooperation framework in the subregions, as envisaged by the ECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention).

Table 6 Status and trends for selected indicator on transboundary basin area with an operational arrangement

	Transboundary basin area with an operational arrangement, 2020 Percentage					
	European Union	Western Europe	Central Asia	Eastern Europe	South-Eastern Europe	Pan-European region
For rivers and lakes	89	84	91	55	80	83
For aquifers	90	59	..	73	51	43

Source: United Nations, "Global SDG Indicators Data Platform" (accessed on 1 February 2022).

Note: Based on the available information, with no data produced for several countries. No reported arrangements for aquifers in Central Asia.

7. Biodiversity and ecosystems

The status of ecosystems remains a cause for concern, with no evidence of a clear positive trend. Only a minority of the habitats assessed at the European Union level have a good conservation status, and the overall picture is likely to be similar in the remainder of the region. The relative share of the particularly biodiversity-rich primary and intact forests has been stable at a very low level over the same period. Forest fragmentation remains an important pressure. There are significant variations in the proportion of sustainable fish stocks. The Mediterranean Sea and the Black Sea remain highly overfished, whereas signs of recovery of fish stocks can be observed in the North-East Atlantic Ocean and the Baltic Sea as a result of improved management decisions (see also point 10 below). Land continues to be taken for urban and infrastructure development in the pan-European region, but the rate of land take has decreased in most EEA member countries and even reversed in Eastern Europe (see table 7; see also point 9 below).

Recommendations

Governments in the pan-European region should establish the conditions for medium- and long-term sustainable mobilization of funds for biodiversity and other environmental components, by both accelerating the use of available regional and global funds and mechanisms and creating national financial instruments. Governments should also eliminate or reform subsidies and incentives for products and activities that lead to biodiversity loss and develop effective positive incentives to mainstream biodiversity conservation across sectors and policies, promoting biodiversity conservation and sustainable use of resources. Furthermore, Governments should ensure that trends in forest area remain positive and take additional measures to safeguard the remaining primary and intact forests and their ecological functionality, for example, by promoting management standards aimed at preserving high-conservation-value forest and by preventing forest fragmentation and thus enhancing forest connectivity. It is essential that there are sufficient areas with natural quality, not limited to protected areas (PAs), to ensure functional biodiversity (area-based biodiversity conservation).

Table 7 Status and trends for selected indicator on land take

Indicator	European Union	Western Europe	Central Asia	Eastern Europe	South-Eastern Europe	Pan-European region
Land take 2012–2018 as proportion of total land area (percentage)	↗ ☹ (0.05)	↘ ☹ (0.06)	↗ ☹ (0.15)	↗ ☺ (-0.23)	↘ ☹ (0.15)	↗ ☹ (0.08)

Sources: EEA, "Land take in Europe", 13 December 2019. Data from several national statistical offices outside the EEA cooperating countries.
Notes: trend is ↗ improving (if 2012–2018 rate was lower than 2006–2012 rate), or ↘ worsening; status is ☺ (negative) or ☹ (positive). No data for several countries.

8. Protected areas

The protected area (PA) estate in the pan-European region has almost tripled, and the overall forest area in the ECE region has increased by 33.5 million ha over the past 30 years. The coverages of terrestrial and marine PAs have increased over the period since 2000 and are 13.6 per cent and 9.2 per cent, respectively, for the overall pan-European area (below the respective 17 per cent and 10 per cent goals in Aichi Target 11). Marine protected areas (MPAs) have grown in area by 66 per cent and terrestrial PAs by 22 per cent over the past five years (see table 8). Despite progress in terrestrial and marine PAs, overall biodiversity loss continues to occur.

Recommendations

Governments in the pan-European region should consolidate and improve the extended protected area network in the region through investment in management effectiveness, ecological representativeness and connectivity, i.e. making sure that protected areas are connected to each other to foster movement of fauna and that they represent the variety of ecosystems in the country. Further efforts are needed, in particular in Eastern and South-Eastern Europe, to achieve the target of conservation of 10 per cent of coastal and marine areas in the pan-European area.

Governments in the pan-European region should ensure the goal of protecting at least 30 per cent of Earth's land and marine surface areas by 2030, in accordance with a global movement championed by the High Ambition Coalition for Nature and People. Moreover, transformative approaches to governance and management – going beyond traditional protected areas to include, for example, other areas that qualify as Other Effective Area-Based Conservation Measures or Conserved Areas – are essential to expand the protected and conserved area estate.

Table 8 Status and trends for selected indicators on protected areas

Indicator	European Union	Western Europe	Central Asia	Eastern Europe	South-Eastern Europe	Pan-European region
Terrestrial area protected, 2021 (percentage)	↗ ☺ (26.1)	↗ ☺ (27)	↗ ☹ (9)	↗ ☺ (11.5)	↗ ☹ (7.4)	↗ ☹ (13.6)
Marine area protected, 2021 (percentage)	↗ ☺ (15.2)	↗ ☺ (17.1)	↗ ☺ (31.9)	↘ ☹ (2.3)	↗ ☹ (1.8)	↗ 😐 (9.2)

Sources: IUCN, World Database on Protected Areas. Available at ProtectedPlanet.net (accessed on 10 February 2022); UNEP World Conservation Monitoring Centre.

Notes: trend is ↗ improving, or ↘ worsening; status is ☺ (area nominally meets Aichi Target 11 of 17 per cent of terrestrial and inland water, 10 per cent of marine areas) or ☹ (does not meet) or 😐 (below but close to target).

9. Land use and soil

Land use and land-use change dynamics in the pan-European region continue to be mainly driven by agriculture. Erosion can be further reduced in most affected areas by implementing conservation agriculture.[4] Conservation agriculture practices in the pan-European region may also play an important role in carbon sequestration, water regulation, biodiversity and raising soil productivity by increasing soil organic carbon (SOC) content. In Eastern Europe, the average rate of soil erosion decreased over the last 30 years following massive cropland abandonment and climate change. In the Russian Federation, the total amount of washed soil and the rate of erosion have been reduced by 56.1 per cent and 15 per cent respectively in the last 30 years due to the widespread abandonment of cropland and lower spring run-off. Though land take has decreased in most EEA member countries, land continues to be taken for urban and infrastructure development in the pan-European region and soil sealing remains an issue of concern. (See table 9 for indicators proposed in the assessment.)

Recommendations

Governments in the pan-European region should provide better guidance to farmers on using soil conservation methods in areas of degraded (eroded) soils. Policies should also maintain a judicious balance between soil organic carbon (SOC) accumulation for higher crop productivity and SOC storage for climate change mitigation, in line with initiatives that aim, for example, to boost carbon storage in agricultural soils by 0.4 per cent each year. Measures should also address the conversion of natural to agricultural ecosystems and the degradation of habitat quality due to biodiversity-unfriendly agricultural practices, for example, through more targeted use of subsidies and other incentives for sustainable agriculture. Furthermore, Governments should take measures consistently to reduce land take further and develop and implement policies to tackle soil sealing.

4 According to the Food and Agriculture Organization of the United Nations (FAO), conservation agriculture is a farming system that promotes minimum soil disturbance (i.e. no tillage), maintenance of a permanent soil cover and diversification of plant species. It enhances biodiversity and natural biological processes above and below the ground surface, which contribute to increased water and nutrient use efficiency and to improved and sustained crop production (see FAO, "Conservation Agriculture" (n.d.)).

Table 9 Status and trends for selected indicators on land and soil

Indicator	European Union	Western Europe	Central Asia	Eastern Europe	South-Eastern Europe	Pan-European region
Proportion of land that is degraded, 2005–2019 (net land with improvement, percentage)	↗ (39)	↗ (31)	↗ (18)	↗ (26)	↗ (51)	↗ (28)
Soil organic carbon content, 2005–2019 (net land with improvement, percentage)	↘ (-0.2)	→ (0)	↗ (+0.7)	↗ (+0.7)	↗ (+0.4)	↗ (+0.5)

Source: Conservation International.

Notes: trend is ↗ improving, → stable or ↘ worsening. Land may be improving but still degraded. No data for several countries.

10. Marine protection

Marine pollution, from both land-based (e.g. nutrients, plastic and chemicals) and sea-based (e.g. plastic and oil) sources, continues to be an urgent problem in most sea regions. Beach and marine litter, dominated by plastic, is recognized as a major global threat to coastal and marine ecosystems in most areas, including remote and less-populated areas such as the Barents Sea (see table 10). At the same time, climate-induced changes in coastal and marine ecosystems are occurring with as yet unknown impact, such as an increase in sea surface temperatures of about 0.2°C per decade in the North Atlantic and 0.5°C per decade in the Black Sea (since 1981) and observed acidification of surface water, at a rate of approximately 0.02 pH units per decade, in the sea regions surrounding the European Union (and across the global ocean). A holistic and circular ecosystem-based approach across the different economic sectors and their value chains will be essential to the management of coastal waters and marine ecosystems that addresses the combined effects of multiple pressures and progressively integrates social, economic and governance aspects.

Such an approach applies equally to the use of nature-based solutions (NbS) in sustainable infrastructure for enhancing coastal resilience and being able to withstand the effects of climate change, and to the transition to sustainable coastal and maritime tourism as part of the recovery after the coronavirus (COVID-19) pandemic. The Mediterranean Sea and the Black Sea remain highly overfished, whereas signs of recovery of fish stocks can be observed in the North-East Atlantic Ocean and the Baltic Sea as a result of improved management decisions.

Recommendations

Governments in the pan-European region should take urgent action to reduce key pressures to halt and reverse the degradation of coastal waters, marine ecosystems and seas (see also points 7 and 8 above). They should also increase efforts to complement inventories of the number of items of beach and marine litter with information on composition and sources of litter to enable them to design more effective measures, in particular where subregional measures are deemed necessary. Governments should work with the tourism sector along its value chain, recognizing the sector's high impact in coastal areas and the interconnectedness of the land and the sea for the marine ecosystem.

Table 10 Status and trends for selected indicators for marine protection

Indicator	Baltic Sea	Black Sea	Mediterranean Sea	North-East Atlantic
Number of items on beach per 100 m of shoreline, median 2014–2019	78	652	428	105
Assessed marine fish stocks of good environmental status, 2018, percentage	13	0	0	44

Sources: For number of items on beach, Ahmet E. Kideys and Mustafa Aydın, *Marine Litter Watch (MLW) European Beach Litter Assessment 2013–2019*, ETC/ICM Technical Report, 2/2020 (Magdeburg, European Topic Centre on Inland, Coastal and Marine waters, 2020); for marine fish stocks of good environmental status, EEA, "Marine Messages II: Navigating the course towards clean, healthy and productive seas through implementation of an ecosystem-based approach", EEA Report, No. 17/2019 (Luxembourg, Publications Office of the European Union, 2019).

11. Waste management

While the waste management hierarchy assigns the highest priority to waste prevention, waste generation continues to rise across the region. Even where there is strong political commitment to developing a circular economy, such as in the European Union and other Western European countries, the generated waste quantities are growing. Recycling rates differ significantly among the countries and are particularly low in Eastern Europe and Central Asia. Municipal waste recycling rates above 45 per cent exist only in a few European Union countries and Switzerland. Progress is being achieved in all subregions, but slowly. The average volume of electrical and electronic equipment waste (e-waste), which contains both hazardous and precious components, is stabilizing in the region as a whole, but continues to increase rapidly in the economically less mature subregions (see table 11). E-waste collection and recycling are highly deficient across all subregions; the recovery rates are low.

Recommendations

Governments in the pan-European region should support waste prevention in production and consumption, and repair, refurbishment and remanufacturing, including through financial incentives such as tax relief, in order to reduce waste. These waste prevention efforts would improve resource efficiency. Governments should also equip public administrations with a skilled work force, ready to engage with all sectors of society, and to increase broad access to reliable and detailed information, in order to achieve sound management of chemicals and waste. The countries of the region should establish a resource-oriented, pan-European e-waste management partnership aimed at the effective collection and sound handling of recyclables to enable the recovery of valuable resources. One urgent priority is the recovery of secondary resources from e-waste, especially in view of the rapidly growing quantities across Eastern Europe, South-Eastern Europe and Central Asia.

Table 11 Status and trends for selected indicators for waste management

Indicator	European Union	Western Europe	Central Asia	Eastern Europe	South-Eastern Europe	Pan-European region
E-waste generation per capita, 2019 (kg)	↗ ☹ (18)	↗ ☹ (23)	↘ 😐 (7)	↘ ☹ (10)	↘ ☹ (9.9)	→ ☹ (15)
Total waste per capita, 2018	↘	↘	↘	↘	↘	↘

Source: For e-waste generation, Vanessa Forti and others, *The Global E-waste Monitor 2020: Quantities, Flows and the Circular Economy Potential* (Bonn, Geneva and Rotterdam, United Nations University, United Nations Institute for Training and Research, International Telecommunication Union (ITU) and International Solid Waste Association (ISWA), 2021); for total waste per capita, national statistics for the European Union, Iceland, Liechtenstein, Norway, the United Kingdom of Great Britain and Northern Ireland (hereafter the United Kingdom), and South-Eastern Europe except Albania: Eurostat data, accessed 20 May 2021; for other countries, national data published by countries' statistical entities, accessed May–July 2021.

Note: Trend is ↗ improving, → stable or ↘ worsening; status of e-waste generation is 😐 (at the global average of 6.95 kg per capita in 2019) or ☹ (above the global average rate). No data for Andorra, Liechtenstein, Monaco, San Marino, Tajikistan and Uzbekistan. Limited or no data for some of the countries.

12. Chemicals

Chemicals play a vital role in the economy and are essential in paving the way towards green economy, but it remains difficult to capture what is full human exposure to hazardous chemicals (see table 12). Chemicals and waste management are at the heart of many solutions to the current challenges that countries face in their transition to a net-zero-GHG-emissions and sustainable economy.

Recommendations

Governments in the pan-European region should strengthen their waste and chemicals management systems. Governments should strive to further advance full and coherent implementation of multilateral environmental agreements (MEAs), including the Protocol on Pollutant Release and Transfer Registers to the Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters (see also point 18 below).

Table 12 Status and trends for selected indicators for safely managed drinking water or sanitation services

Indicator	European Union	Western Europe	Central Asia	Eastern Europe	South-Eastern Europe	Pan-European region
Reporting under Basel, Rotterdam and Stockholm Conventions* (average for 2015–2019, percentage)	↘ (82)	↘ (51)	↘ (33)	↘ (57)	↗ (75)	↘ (68)

Source: United Nations, "Global SDG Indicators Data Platform" (accessed on 18 May 2021).

Notes: * Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal; Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade; Stockholm Convention on Persistent Organic Pollutants. Trend is ↗ improving or ↘ worsening.

13. Minerals and materials

Minerals, too, are critical for the transition to a net-zero-GHG-emissions and sustainable economy, in particular those used in electrical and electronic gear and batteries. Over the past half-century, the extraction of minerals has tripled globally, with the extraction and processing of natural resources accounting for over 90 per cent of biodiversity loss and water stress and about 50 per cent of climate change impacts. An important and as yet unexploited opportunity exists to harness economic value for the pan-European region and reduce the region's dependency regarding the sourcing of critical raw materials, which are bottlenecks in the shift towards resilient future economies (see table 13).

Recommendations

Governments in the pan-European region should adopt a circular – or resource-efficient – economy approach and strengthen the management of raw materials, including, for example, through application of the United Nations Framework Classification for Resources and the United Nations Resource Management System. They should enforce clear legal frameworks to assess and minimize the environmental impact of extractive industries and, overall, limit extraction of raw materials and minerals to prevent biodiversity loss, water stress and climate change impacts.

Table 13 Status and trends for selected indicator on material footprint

Indicator	European Union	Western Europe	Central Asia	Eastern Europe	South -Eastern Europe	Pan-European region
Material footprint, tons per capita, trend since 2000 (2017)	↘ (23.3)	↗ (24.6)	↘ (10.4)	↘ (9.8)	↘ (16.2)	↘ (18.5)

Sources: UNEP, "World Environment Situation Room", available at https://wesr.unep.org/downloader (Sustainable Development Goal indicators 8.4.1 and 12.2.1) (accessed on 11 January 2022); for populations, ECE Statistical Database. Available at https://w3.unece.org/PXWeb2015/pxweb/en/STAT/ (accessed on 1 February 2022).

Note: Trend is ↗ improving or ↘ worsening. No data for Andorra, Liechtenstein, Monaco, and San Marino. Population of Turkmenistan 2010–2017 uses figure for 2009; population of the Russian Federation 2014–2017 uses figure for 2013.

14. Disaster risk reduction

About 65 per cent of the population in the pan-European region is covered by local disaster risk reduction (DRR) strategies.[5] Only 15 countries in the region reported that all their local authorities are implementing such strategies under Sustainable Development Goal target 13.1, while 23 countries – which jointly represent one quarter of the region's population – do not report on that target (see table 14).

Recommendations

Governments in the pan-European region should strengthen the awareness of potential hazards, including natural and, in particular, climate hazards, especially among poorer communities, and establish conditions to report regularly on Sustainable Development Goal target 13.1 and under the Sendai Framework for Disaster Risk Reduction 2015–2030.

5 Local governments are determined by the reporting country for the corresponding Sustainable Development Goal indicator (11.b.2), considering subnational public administrations with responsibility to develop local DRR strategies.

Table 14 Status and trends for selected indicators on disaster risk reduction

Indicator	European Union	Western Europe	Central Asia	Eastern Europe	South-Eastern Europe	Pan-European region
Countries with local DRR strategies	→ ☺	↗ 😐	↗ 😐	↗ 😐	→ ☹	↗ 😐
Countries reporting under SDG target 13.1	😐	☹	😐	😐	😐	😐

Source: United Nations, "Global SDG Indicators Data Platform" (accessed on 17 September 2021).

Abbreviation: SDG, Sustainable Development Goal.

Note: Trend is ↗ improving, or → stable (or no trend information); status of countries with local DRR strategies is ☺ (majority of countries reporting report 100 per cent of local governments implementing DRR strategies), 😐 or ☹ (majority of countries reporting report less than 5 per cent of local governments); status of reporting is ☺ (all countries reporting), 😐 or ☹ (less than half of countries reporting).

15. Finance and public spending on environmental protection

In all countries across the pan-European region for which data are available, environmental tax revenues and government expenditures on environmental protection, closely following gross domestic product (GDP) growth, have increased since 2000. However, in terms of percentage of GDP, public expenditure for environmental protection (with a maximum of around 0.8 per cent) is much lower than environmental tax revenues, implying that revenues from environmental taxes are not necessarily earmarked for reducing environmental damage. Nonetheless, environmental expenditures for environmental protection made by Governments are only a subset of total environmental protection expenditures in each country. Green bonds have emerged as a tool for financing environmentally friendly projects, by both the private sector and Governments. Despite the negative impacts of fossil fuels on the environment, all countries continue to implement fossil fuel subsidies to varying degrees. International Monetary Fund (IMF) projections suggest that these subsidies will remain in place at least until 2025, with implicit subsidies increasing until that time (see table 15).

Recommendations

Governments should favour the development of green finance and consider spending on environmental protection in the wider context of environmental and public finance. Environmental taxes should be used to decrease different kinds of pollution, and the income generated should be primarily used to finance environmental protection public expenditures. Governments should use subsidies only when they are really necessary, as they always distort markets and increase public sector deficit. Governments should also periodically reconsider environmental subsidized finance in the light of the "polluter pays" principle and regularly perform impact assessment analysis of such funding, so that the funds can produce genuine value added. Furthermore, Governments should envisage green bonds, in particular, through a series of policies including demonstration issuance, dissemination of clear guidelines for green bonds issuance and implementation of favourable regulatory policies, as complementary tools for environmental financing alongside more traditional ones such as taxes and fees. National environmental policies across the pan-European region should aim at phasing out harmful subsidies and transitioning towards greener energy sources quickly.

Table 15 Status and trends for selected indicators on environmental finance

Indicator	European Union	Western Europe	Central Asia	Eastern Europe	South-Eastern Europe	Pan-European region
Government environmental protection expenditures, as proportion of GDP, 2015–2019 (latest rate, percentage)	↘ (0.73)	↘ (0.67)	↗ (0.17)	↗ (0.22)	↗ (0.45)	↘ (0.58)
Total fossil fuel subsidies, 2015–2020 (percentage change)	↗ (-19)	↗ (-32)	↘ (+37)	↗ (-1.2)	↘ (+32)	↗ (-3.2)

Source: International Monetary Fund (IMF) "Government Policy Indicators", Climate Change Dashboard. Available at https://climatedata.imf.org/pages/go-indicators (accessed on 11 February 2022).

Note: Trend is ↗ improving (increasing percentage of GDP spent on governmental environmental protection, or declining fossil fuel subsidies) or ↘ worsening. The subregional governmental environmental protection expenditures are simple unweighted averages across the countries. Values for environmental protection expenditures are simple unweighted averages across the countries. No data for several countries.

16. Sustainable infrastructure

Sustainable infrastructure investment has been recognized as one of the strategies with the greatest impact in terms of building back better in the post-COVID pandemic recovery. There is a recent common understanding that sustainability solutions should be incorporated as early as possible into the strategic planning phase. However, most countries in the pan-European region have yet to develop mechanisms to incorporate sustainability considerations (such as climate risk) and externality accounting (e.g. the cost of pollution, ecosystem services or biodiversity protection) into the cost–benefit analysis of large infrastructure projects, while this analysis is not a legal requirement in many countries. Access to basic drinking water services is consistently above 90 per cent across the pan-European subregions, except in rural Tajikistan, where access is below 75 per cent. Sanitation access ranges, for example, from 82.3 per cent in rural Eastern Europe to 99.5 per cent in urban South-Eastern Europe and Western Europe, the average being 96.3 per cent. The pan-European region shows full access to electricity, and countries have at least 83.8 per cent coverage of third-generation telecommunications. The challenges are currently to guarantee that there is an increase in sustainable infrastructure, using nature-based solutions (NbS), resource efficiency, recycling and reuse, in an environmentally responsible, socially inclusive and economically viable way. It is important to guarantee that the needs of all stakeholders are identified and addressed, and that infrastructure is conceived to be flexible in its use, interconnected and able to employ real-time information to adapt to the changing conditions (including climate risk, changes in service demand and migration patterns). (See table 16 for an indicator proposed in the assessment.)

Recommendations

Governments should participate in a pan-European effort to create a common understanding of what sustainable infrastructure means and define a common strategy to quantify progress across nations. Governments should make use of existing tools to promote sustainable infrastructure development, including the ECE Protocol on Strategic Environmental Assessment and the UNEP International Good Practice Principles for Sustainable Infrastructure, and devote additional resources to achieving the institutional and technical capacity necessary for the planning, design, execution, operation and decommissioning of sustainable infrastructure projects. They should build upon United Nations Environment Assembly resolutions on sustainable and resilient infrastructure (UNEP/EA.5/Res.9) and nature-based solutions (NbS) for supporting sustainable development (UNEP/EA.5/Res.5), adopted by Member States. Governments should also deploy economic and financial incentives – in the short and medium terms – to support the implementation by the private sector of NbS in infrastructure projects. Further, they should promote investment in

sustainable infrastructure more broadly. Moreover, Governments should establish favourable conditions to implement a life-cycle approach and circular economy strategies aligned with or similar to the Pan-European Strategic Framework for Greening the Economy in sustainable consumption and production patterns, or other initiatives, such as the European Union taxonomy.

Table 16 Status and trends for selected indicator on the Corruption Perceptions Index, 2020

Indicator	European Union	Western Europe	Central Asia	Eastern Europe	South-Eastern Europe	Pan-European region
Corruption Perceptions Index, 2020	↗ (64)	↘ (76)	↗ (28)	↗ (40)	↘ (38)	↗ (55)

Source: Transparency International, Corruption Perceptions Index, 2020, available at www.transparency.org/en/cpi/2020/index.

Note: Trend is ↗ improving or ↘ worsening over period 2012–2020, with 0 being the highest and 100 being the lowest level of corruption. Simple average of national values per subregion. No data for Andorra, Liechtenstein, Monaco and San Marino.

17. Sustainable tourism and circular economy

A pan-European circular tourism economy will be more resilient to and better equipped to cope with future crises, be they economic, health related or consequences of the environmental challenges that the region faces. This is essential for the sustainable development of tourism and the transition to green travel and can contribute to the achievement of the Sustainable Development Goals (such as Goals 6, 7, 8, 11, 12, 13, 14 and 15). With the rapid growth of tourism prior to the COVID-19 pandemic, its impacts were growing despite efficiency improvements, increasingly contributing to environmental crises, biodiversity loss and social issues. A return to business as usual after the pandemic must therefore be avoided through a transformation to sustainable tourism. Circularity is a major strategy for the transformation, the recovery of the sector and sustainable development overall and will contribute to more resilient societies and economies. The application of circular principles in tourism is, however, still in its infancy, apart from individual cases.

Key areas in and subsectors of tourism that have a strong relationship to both the Sustainable Development Goals and the circular economy are: energy use and emissions in transport, accommodation (including cooling) and restaurants; waste management for destinations, accommodation and restaurants (including food waste and plastics); water consumption and generation of wastewater in general; and resource usage in building and construction, for interiors and in amenities. Opportunities may be most straightforward in construction and operations of accommodation facilities and restaurants, including waste management. Tourism, under the condition of its sustainable development, has the potential for long-lasting positive impacts beyond the sector itself, due to its interlinkages with other economic activities and the direct producer–consumer interaction. Indicator development for the monitoring of circularity in tourism has yet to overcome data availability challenges and definitional issues (see table 17 for indicators used in the assessment). The development and accessibility of data on circular economy in the tourism sector is an essential step to enable evaluation of the most effective and high impact investments in sustainable tourism and to facilitate large-scale private sector and multilateral investments in sustainable tourism business models.

Recommendations

Governments should work with tourism destination management organizations, cities and regions to plan the transition to circular business models. Governments are responsible for key policies in local public services, such as transport, solid waste disposal, water and energy, all of which affect tourism operations, investments, economic growth and environmental quality. The COVID-19 pandemic demonstrated acutely the supply challenges present due to fragmented and complex tourism value chains. In seeking resilience, Governments and tourism businesses

should therefore be moving towards shortened supply chains, collaborative infrastructure and enhanced resource efficiency, as well as sustainable consumption and production patterns. Governments should also facilitate access to knowledge, information and finance on circularity for small and medium-sized enterprises (SMEs) operating in the tourism sector, as well as for the promotion of domestic and regional tourism, with the scaling up of sustainable mobility and climate positive tourism models. Further, Governments should integrate circular economy principles in tourism-related legislation, policies, plans and strategies, especially with a view to achieving Sustainable Development Goals and biodiversity and climate agenda targets. Making a circular transition a priority with trackable goals and an allocated budget is critical for the sustainability of the sector. Sustainable investment and finance for the tourism sector should be included in national or local plans. Private and public stakeholders should integrate circular economy principles into their sustainability strategies and set clear targets that can be quantified and monitored. Governments can pilot circularity in tourism by tackling specific issues such as plastic pollution. Such an approach would help industry stakeholders better understand and operationalize concepts of circularity and value chain coordination and replicate them at a later stage on other topics and operations. This could be done through participation in multi-stakeholder voluntary initiatives such as the Global Tourism Plastics Initiative.

More generally, Governments should increase responsible travel to natural areas in accordance with the principles of ecotourism, thus uniting conservation, communities and sustainable travel. ECE member States need to select specific key-impact tourism indicators to be included in ECE statistical databases. Indicators for circular economy in tourism should be aligned with those being developed for the monitoring of sustainable development in tourism and be compatible with the Sustainable Development Goals and climate objectives, as well as being in line with the United Nations World Tourism Organization (UNWTO) Statistical Framework for Measuring the Sustainability of Tourism (SF-MST).

Table 17 Status and trends for selected indicators on circular economy and sustainable tourism

Indicator	European Union	Western Europe	Central Asia	Eastern Europe	South-Eastern Europe	Pan-European region
Renewable energy share in total energy consumption, 2014–2018 (latest rate, percentage)	→ (18)	↗ (18)	↗ (4)	→ (4)	→ (14)	→ (13)
Percentage domestic tourism of total trips by nationals, 2019	73	54	90	79	89	73
Percentage air transport of all inbound trips, 2019	36	79	13	21	56	41

Source: For air transport of all inbound trips and domestic tourism of total trips, UNWTO, Eurostat; for renewable energy share, United Nations, *2019 Energy Balances*.

Note: Trend is ↗ on average improving, or → on average stable; limited data for domestic trips (all of the European Union, but only Norway and Switzerland in Western Europe, Tajikistan in Central Asia, Armenia, Azerbaijan and Georgia in Eastern Europe, and North Macedonia and Türkiye in South-Eastern Europe) and inbound trips by air (only 13 European Union members, Iceland, Israel and the United Kingdom in Western Europe, Kyrgyzstan and Uzbekistan in Central Asia, not the Republic of Moldova or the Russian Federation in Eastern Europe, and only Albania, Bosnia and Herzegovina and Türkiye in South-Eastern Europe).

18. Environmental governance

The environmental governance system in the pan-European region remains partly fragmented in terms of applied policies, institutions, the harmonization of legislation and the participation of the 54 countries in MEAs, which is incomplete. The assessment of state and trends and policy recommendations in the thematic chapters of this report indicates the need to strengthen the environmental governance system and existing policies in the region and to make adjustments to address substantive gaps. Gaps also remain in the implementation of good environmental governance, including in relation to public participation, transparency, responsiveness, effectiveness and efficiency, with implications for the environment and health of the region (see table 18).

Education for sustainable development (ESD) equips people with knowledge and skills to give them opportunities to lead healthy and productive lifestyles in harmony with nature and with concern for social values, gender equity and cultural diversity. Such education also endows people with capacities to play an active role in environmental governance. Countries described progress in ESD between rounds of reporting in 2014 and 2018 in all subregions. Across countries reporting, 78 per cent of the agreed criteria were met in 2018 for ensuring that policy, regulatory and operational frameworks support the promotion of ESD.

Recommendations

Governments, the private sector, academia and citizens must work together to achieve the Sustainable Development Goals, including in a transboundary context. They should explore new partnerships on topics such as circular economy, sustainable infrastructure, resource efficiency and waste management. Further, Governments in the pan-European region should:

(a) Consider joining multilateral environmental agreements to which they are not yet party so as to enhance the coherence and harmonization of policies and legislation;

(b) Use the Pan-European Strategic Framework for Greening the Economy as a framework for commitments on circular economy, resource efficiency and sustainable infrastructure development, including through promoting nature-based solutions, and finance should be redirected to these areas in support of a just transition and the effectiveness of such investments needs to be monitored and evaluated;

(c) Assure public participation in planning and implementation of actions, gender mainstreaming and public access to reliable and timely information in order to make successful outcomes more likely;

(d) Ensure effective public access to information, participation in decision-making, protection of environmental defenders and access to justice in environmental matters, as provided, for example, by the Aarhus Convention[6] and its Protocol on Pollutant Release and Transfer Registers;

(e) Develop and invest in capacities and education for sustainable development in responsible authorities, the private sector and civil society in order to ensure the transition to sustainable development;

(f) Seek to enhance science–policy linkages and the rapid deployment of innovative solutions, while investing in digitization.

Other recommendations in this assessment provide further details on steps to be taken to improve governance.

6 Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters.

Table 18 Status and trends for selected indicators on environmental governance

Indicator	European Union	Western Europe	Central Asia	Eastern Europe	South-Eastern Europe	Pan-European region
Countries party to 12 nominated MEAs (percentage)	93	47	40	68	81	76
Countries with legislation or regulations on mandatory corporate sustainability reporting (percentage)	100	56	20	29	50	70

Sources: For parties to MEAs, United Nations Treaty Collection and websites of treaties; for mandatory corporate sustainability reporting, Carrots & Sticks, "Sustainability reporting instruments worldwide". Available at www.carrotsandsticks.net/ (accessed on 12 February 2022).

Note: The 12 MEAs are eight ECE environmental treaties, three global chemicals conventions and the Convention on the Conservation of Migratory Species of Wild Animals. There are no data for several countries in Central Asia, Eastern Europe and South-Eastern Europe.

19. Monitoring and information management

Availability and access to information and knowledge to support government decision-makers, the private sector, industry and the public to make impact-oriented choices is improving but continues to be challenging, in some sectors more than others. This is a challenge to measuring progress towards policy targets in the pan-European region, including for emerging policy developments such as circular economy or sustainable infrastructure, as revealed during this assessment. This assessment reveals data gaps across the region in almost all areas, with data available for some countries but not others or no recent data available. Data for some indicators needed for this assessment are not routinely collected, in particular those for emerging policies, including the two conference themes.

While, according to the Final review report on the establishment of the Shared Environmental Information System (SEIS) (ECE/CEP/AC.10/2021/6), such national systems have been successfully established in all countries in Europe and Central Asia, the systems vary in form and regularity regarding their updates and content. Gaps remain that need to be addressed, including regarding compliance with all principles and pillars of the SEIS and the full production and sharing of all data flows associated with the ECE environmental indicators. Monitoring gaps, in terms of both data availability and quality, were identified during the assessment for the region. Examples include:

(a) Air and climate change: Gaps remain for the measurement and analysis of fine particulate matter ($PM_{2.5}$) and the quality of data varies widely for emissions. Data sets on GHG emissions remain incomplete for some countries;

(b) Noise: The assessment does not address noise due to the lack of data across the pan-European region. The World Health Organization (WHO) has identified long-term noise exposure as an important public health issue and the second most significant environmental cause of ill health after air pollution in Western Europe and the European Union;

(c) Fresh water: The use of geographic information systems needs to be strengthened, in particular at the transboundary level, and there is a need to enhance water statistics. Ecological water quality assessment and the identification of hydromorphological pressures require knowledge not yet available everywhere in the region. The monitoring of emerging contaminants requires more attention throughout the pan-European region. Monitoring and data are incomplete for production of certain indicators;

(d) Coastal waters, marine ecosystems and seas: Challenges remain regarding the spatial and temporal data coverage and data gaps remain, for example, for the amounts, composition and sources of beach and marine litter in parts of the region;

(e) Biodiversity and ecosystems: Data gaps remain for the production of certain indicators, including the ECE indicators "Terrestrial protected areas" and "Land uptake", in particular for countries outside the European Union. Comparability of data is another issue that was noted;

(f) Land and soil: Data gaps were identified for the indicator "Prevalence of stunting among children aged under 5 years, per cent";

(g) Chemicals and waste: No set of impact-oriented chemical indicators is regularly monitored across the region. There is also a lack of information regarding the impact of chemicals on the efficiency and economic viability of circular economy schemes. Gaps remain regarding capacities and data availability for certain indicators, including "Total waste generation per capita", "E-waste generation per capita" and "Recycling rate of municipal solid waste";

(h) Environmental financing: There is a severe lack of quantitative data on environmental financing for countries of Central Asia and South-Eastern Europe and there is an urgent need to improve data-collection systems;

(i) Sustainable infrastructure: Significant data gaps have been identified, both in the social, environmental, institutional, economic and financial indicators proposed and when quantifying the contribution (positive or negative) of infrastructure development based on the indicators. A common definition of the term "sustainable infrastructure" is lacking, with implications for quantifying progress in the region;

(j) Circular economy and sustainable tourism: The impacts of tourism have long been measured from an economic angle and it is now pressing to redefine how success is also measured across social and environmental dimensions, with circular economy indicators playing a key role. There are currently no indicators across the region that give explicit information on tourism's uptake of circular economy principles and practices and, for several general circularity aspects, classification definitions differ between States, though the UNWTO Statistical Framework for Measuring the Sustainability of Tourism (SF-MST) should help. Even mainstream tourism statistics tend to suffer from a lack of availability of data and being highly context sensitive, while detailed statistics needed for accurate circularity monitoring are absent;

(k) While an SEIS has been established, national systems vary in form and regularity regarding their updates and content. Gaps remain that need to be addressed, including regarding the full establishment of the SEIS in line with all its principles and pillars. The gaps identified indicate that countries still need assistance to fully implement the SEIS principles and pillars and for the full production and sharing of all data flows associated with the ECE environmental indicators and other indicator frameworks, including the Sustainable Development Goal indicators (see table 19).

Recommendations

Governments in the pan-European region should:

(a) Bring policy and science together to develop and implement appropriate and standardized pan-European methods and systems for monitoring and information management, including through the application of new technologies, to fill data gaps for improved decision-making and ensure timely availability of information for the public;

(b) Employ the ECE Revised Guidelines for the Application of Environmental Indicators (for completed parts, see ECE/CEP–CES/GE.1/2021/4), provide the ECE set of environmental indicators in accordance with the principles and pillars of the SEIS and adopt indicators to cover noise and emerging policymaking themes of importance;

(c) Promote the use of appropriate and standardized methods for monitoring air pollution emissions and the public availability of monitoring data in the pan-European region, while also strengthening cooperation and national investment to fill monitoring gaps in countries with economies in transition;

(d) Invest in data collection and information processing, as knowledge is instrumental for decision-making and water policy design (e.g. water accounts, ecosystem assessment and indicators). The continuous improvement of monitoring and communication technologies is a top priority in terms of a water information system for the pan-European region;

(e) Increase efforts to complement inventories of the number of items of beach and marine litter with information on composition and sources of litter to enable the design of more effective measures. Joint efforts should be taken where subregional monitoring measures are deemed necessary;

(f) Establish a region-wide chemicals- and waste-impact-oriented monitoring scheme, as a part of cooperation between science and policy, in order to build up a better picture and address the adverse impacts of chemicals on human health and the environment;

(g) Improve data-collection systems on environmental financing, for example, on environmental expenditures, throughout the region to clarify and report on which entities spend money on the environment, how much they spend and in pursuit of what objectives and who finances these expenditures;

(h) Develop a common definition of the term "sustainable infrastructure" in the pan-European region. This would enable reporting on and quantifying of progress across countries and subregions (see also point 16 above);

(i) Select some specific key-impact tourism indicators to be included in ECE statistical databases. Indicators for circular economy in tourism should be aligned with those being developed for the monitoring of sustainable development in tourism (particularly with those that are most promising) and be compatible with Sustainable Development Goals. Circular economy indicator development could follow the approach adopted by the UNWTO initiative towards a Statistical Framework for Measuring the Sustainability of Tourism and data and statistics should be produced according to statistical standards by the various data producers involved;

(j) Assist countries to fully implement the SEIS principles and pillars and the full production and sharing of all data flows associated with the ECE environmental indicators and employ, as appropriate, the updated Recommendations on the more effective use of electronic information tools developed under the auspices of the Aarhus Convention;

(k) Enhance synergies and interoperability between national and international systems in order to streamline environmental monitoring and reporting, reduce reporting requirements for countries and improve readability and efficiency, from indicator methodologies to data-flow reporting;

(l) Continue digitization of environmental monitoring systems and use of new technologies for enhanced high-quality data production in support of regular assessments and policymaking;

(m) Consider implementing pollutant release and transfer registers and the SEIS in synergy.

Table 19 Status and trends for selected indicator on the Shared Environmental Information System

Indicator	European Union	Western Europe	Central Asia	Eastern Europe	South-Eastern Europe	Pan-European region
SEIS established, 2011–2021	😐↗	😐↗	😐↗	😐↗	😐↗	😐↗

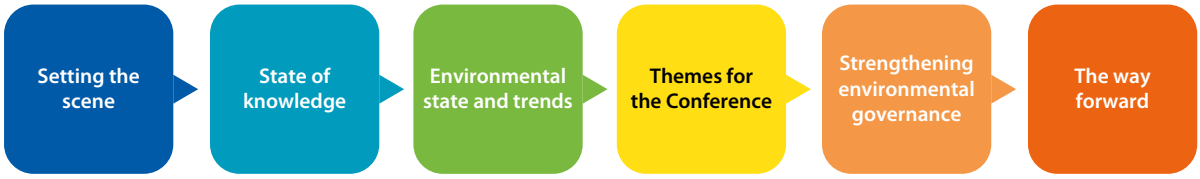
Source: ECE/CEP/AC.10/2021/6.

Note: Trend is ↗ on average improving; SEIS established but with gaps in the alignment with the principles and pillars 😐.

I.
SETTING THE SCENE

The present pan-European environmental assessment is structured as shown in figure 1. This first chapter provides an overview of the regular assessment of the state of the environment in the pan-European region, together with the mandate for the present assessment. It also summarizes national reporting and progress in establishing an SEIS. The chapter concludes with an overview of environmental policies in the region.

Figure 1 Structure of the assessment



Throughout the assessment, where feasible and relevant, the following subregions are referred to:

(a) European Union, comprising 27 member States;

(b) Western Europe, comprising Andorra, Iceland, Israel, Liechtenstein, Monaco, Norway, San Marino, Switzerland and the United Kingdom;

(c) Central Asia, comprising Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan;

(d) Eastern Europe, comprising Armenia, Azerbaijan, Belarus, Georgia, the Republic of Moldova, the Russian Federation and Ukraine;

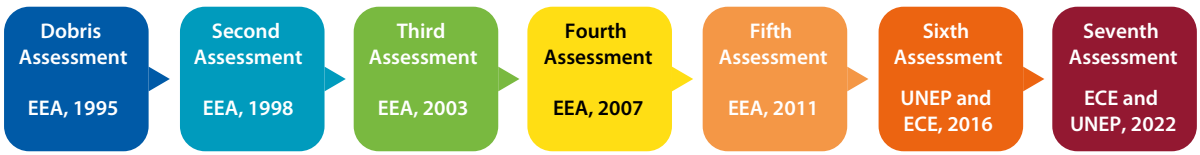
(e) South-Eastern Europe, comprising Albania, Bosnia and Herzegovina, Montenegro, North Macedonia, Serbia and Türkiye.

A. Regular assessment of the state of the environment

This section begins by looking at the past Environment for Europe Ministerial Conferences and associated pan-European environmental assessments (see figure 2). It then presents the mandate for this assessment, explains the selection of the themes for the next Conference and describes the use of the SEIS as a basis for this assessment.

1. History of the state-of-the-environment assessments

Figure 2 Timeline of state-of-the-environment assessments



The First Ministerial Conference within the Environment for Europe process was held in 1991 at Dobris Castle in the then Czechoslovakia. It was the first all-European conference of ministers responsible for the environment and international organizations working in Europe, building upon the Stockholm Conference of 1972 but also the accelerating political transition in 1990–1991. The Conference discussed ways of strengthening cooperation to protect and improve the environment and called on the Commission of European Communities to prepare, in cooperation with ECE, a report describing the state of the environment in Europe. That report was to become the

first pan-European environmental assessment – Europe's Environment: the Dobris Assessment, of 1995 – though the geographical scope was focused on Central and Eastern Europe.

The Second Environment for Europe Ministerial Conference was held in 1993 in Lucerne, Switzerland. Though the first report on the state of the environment had yet to be produced, the environmental programme for Europe had been developed and the broad strategy contained in the Environmental Action Programme for Central and Eastern Europe was endorsed by the Conference, as was an ECE report on Elements for a Long-term Environmental Programme for Europe.

The Third Environment for Europe Ministerial Conference was held in Sofia, Bulgaria, in 1995. The Sofia Conference saw the publication of *Europe's Environment: The Dobris Assessment, which assessed Europe's environment as a whole for the first time. The report's findings were of immediate concern to the Conference, since they demonstrated the need for far-reaching action in a number of environmental sectors.*

The Fourth Environment for Europe Ministerial Conference took place in Aarhus, Denmark, in 1998. This might be termed the first pan-European conference. *Europe's Environment: The Second Assessment set the scene for the Conference, identifying the main areas of achievement and concern in the state of the European environment. Based on its findings, ministers decided to strengthen support within the Environment for Europe process for the newly independent States and those countries of Central and Eastern Europe that were not part of the European Union's accession process. Europe's Environment: The Second Assessment did not cover Central Asia, for which the report Sub-regional Integrated Environment Assessment: Central Asia*[7] *was prepared by the countries in the subregion.*

The Fifth Environment for Europe Ministerial Conference took place in Kyiv, Ukraine, in 2003. It concluded with the adoption of the Ministerial Declaration, which underlined the importance of the Environment for Europe process as a tool to promote environmental protection and sustainable development in the region, thus contributing to wider peace and security. *Europe's Environment: The Third Assessment*[8] *covered all countries of the Caucasus, Central Asia and Eastern Europe for the first time. Ministers noted that the three assessment reports on the state of the environment produced by the EEA had helped to identify major threats and challenges for the development of regional environmental policies and laid the ground for the preparation of the Environmental Programme for Europe.*

The Sixth Environment for Europe Ministerial Conference took place in Belgrade, Serbia, in 2007. The Conference noted the fourth assessment report on the state of the environment (*Belgrade Assessment)*[9] *and some improvements in the state of the environment at the pan-European level and in some subregions and countries but were particularly concerned by the report's negative findings. Two further assessments were presented to the Conference: First Assessment of Transboundary Rivers, Lakes and Groundwaters*[10] *and Policies for a Better Environment: Progress in Eastern Europe, Caucasus and Central Asia.*[11]

The Seventh Environment for Europe Ministerial Conference took place in Nur-Sultan (then Astana), Kazakhstan, in 2011. It welcomed the report *Europe's Environment: An Assessment of Assessments,*[12] which covered all environmental assessments produced in the region. To keep the pan-European environment under review, ministers decided to establish a regular process of environmental assessment and develop the SEIS across the region. This would serve multiple policy processes, including MEAs, and include capacity-building of countries in the Caucasus, Central Asia

7 International Fund for saving the Aral Sea, Interstate Commission on Sustainable Development Scientific-Information Center and United Nations Environment Programme (UNEP), *Sub-regional Integrated Environment Assessment: Central Asia* (Ashgabat, 2007).

8 Prepared by the European Environment Agency (EEA) with the support of countries and ECE and in cooperation with UNEP and other international organizations.

9 Prepared by the EEA with the support of countries, the European Commission and ECE, and in cooperation with other partners.

10 ECE, 2007.

11 OECD, 2007. Summary for policymakers available at https://www.oecd.org/env/outreach/39271802.pdf.

12 Coordinated and produced by the EEA in cooperation with the countries, the Regional Environmental Centres (RECs), multilateral environmental agreement (MEA) secretariats, ECE and international organizations. EEA, 2007.

and Eastern and South-Eastern Europe to monitor and assess their environment. The ministers invited the EEA and its partners to develop an outline of how these actions could be performed. In addition, the *Second Assessment of Transboundary Rivers, Lakes and Groundwaters*[13] was presented to the Conference.

The Eighth Environment for Europe Ministerial Conference took place in Batumi, Georgia, in June 2016. Ministers welcomed the launch of the European regional assessment of the Global Environment Outlook, as the regular pan-European environmental assessment. The report entitled *Global Environment Outlook: GEO-6: Global Environment Outlook: Regional Assessment for the Pan-European Region*[14] was built on existing national, subregional and thematic assessments, including *The European Environment: State and Outlook 2015*.[15]

2. Mandate for this assessment

The series of assessments of the state of the environment in the pan-European region provide up-to-date and policy-relevant information on interactions between the environment and society. The assessments were a consistent feature of the Environment for Europe process from 1995 to 2016. The 2009 reform of that process identified the pan-European assessment as one of the three substantive documents to be prepared for each Ministerial Conference, together with up to two theme-specific reports.[16]

Following the Seventh Environment for Europe Ministerial Conference (Nur-Sultan, 2011), responsibility for drafting the assessment shifted from the EEA to UNEP and ECE.

During the Eighth Environment for Europe Ministerial Conference (Batumi, 2016), the launch of the European regional assessment of the Global Environment Outlook as the regular pan-European environmental assessment was welcomed.

Following the Eighth Environment for Europe Ministerial Conference, the ECE Committee on Environmental Policy adopted the revised mandate and terms of reference of the Working Group on Environmental Monitoring and Assessment for the period 2017–2021. The Working Group was tasked by the Committee with leading a process of consultation on the regular pan-European environmental assessment for consideration by the Committee and leading up to the next Environment for Europe Ministerial Conference.

At its twenty-fifth session (Geneva, 13–15 November 2019), the Committee on Environmental Policy: welcomed the information provided by the secretariat and UNEP on the next pan-European environmental assessment; selected option 3 from among the options for the next pan-European environmental assessment set out in document ECE/CEP/AC.10/2019/6, subject to availability of resources; requested the secretariat and UNEP, working in close cooperation with the EEA, to prepare a limited indicator-based and thematic assessment and to regularly inform the Bureau of progress made; and encouraged all Member States to provide the necessary funding to enable the preparation of the assessment. The Committee selected the two following specific themes for the ministerial conference and, consequently, the assessment: (a) greening the economy in the pan-European region: working towards sustainable infrastructure; and (b) applying principles of circular economy to sustainable tourism.

13 ECE, 2011.

14 UNEP and ECE, 2016.

15 EEA, 2015.

16 ECE/CEP/S/152, annex I, para. 12 (a) and (d).

B. State of knowledge and the Shared Environmental Information System

Access to reliable, robust, comparable and timely data is crucial to monitoring progress towards policy targets in the pan-European region and to helping policymakers make informed decisions for the benefit of people in the region. The COVID-19 pandemic has amplified the need for timely, reliable and comparable data throughout the region. Regular national reporting on the state of the environment and the establishment of an SEIS in Europe and Central Asia are important contributions to making use of the available data to help policymaking and are described in the following section.

1. Reporting on the state of the environment

Regular reporting on the state of the environment in the countries of the pan-European region provides comprehensive and targeted information about environmental conditions, trends and pressures in each of the countries. Such reports provide a strategic view to shape policy and action. National integrated state-of-the-environment reports, having a sound evidence base, inform and provide knowledge for decision-makers and the public and to engage readers and influence their behaviour.

Most of the countries in the pan-European region have respective national legislation in place, review the state of the environment on a regular basis and prepare integrated national state-of-the-environment reports covering several thematic areas, such as energy, transport, health and the environment, and/or indicator-based national state-of-the-environment reports based on associated environmental indicators.

The importance of national state-of-the-environment reporting is also confirmed by the Aarhus Convention,[17] which requests each party to the Convention to publish and disseminate a national report on the state of the environment, including information on the quality of the environment and information on pressures on the environment, at regular intervals not exceeding three or four years.

Within the framework of the final review of the establishment of an SEIS in Europe and Central Asia, ECE member States in the pan-European region were asked to provide information on the regularity and type of reports they produce. The reports vary in regularity, content and form but all support the transition to a more sustainable use of resources and the protection of the environment for the well-being of human life. Table 20 provides an overview of whether national integrated state-of-the-environment reports or indicator-based state-of-the-environment reports are produced on a regular basis.

Table 20 National state-of-the-environment reporting

	Integrated state-of-the-environment reports		Indicator-based state-of-the-environment reports	
Country	Regular production of reports?	Year of latest report	Regular production of reports?	Year of latest report
Albania	Yes	2019	No	2018
Andorra	..	..	Yes	2019
Armenia	No	2011	Yes	2020
Austria	Yes	2019	Yes	2019
Azerbaijan	No	2019	No	..
Belarus	Yes	2019	Yes	2019

17 Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters.

	Integrated state-of-the-environment reports		Indicator-based state-of-the-environment reports	
Country	Regular production of reports?	Year of latest report	Regular production of reports?	Year of latest report
Belgium (regions)	Yes	2019	No	2012
Bosnia and Herzegovina	Yes	2012	No	..
Bulgaria	Yes	2021	Yes	2019
Croatia	No	..	Yes	2019
Cyprus	No	2015	No	..
Czechia	Yes	2018	Yes	2020
Denmark	Yes	2014	Yes	..
Estonia	Yes	2013	Yes	2019
Finland	Yes	2018	Yes	2020
France	Yes	2019	Yes	2020
Georgia	Yes	2017	Yes	2017
Germany	Yes	2019	Yes	2020
Greece	Yes	2019	Yes	..
Hungary	Yes	2017	Yes	2020
Iceland	Yes	2019	Yes	2019
Ireland	Yes	2020	Yes	2020
Israel	Yes	2019	..	2010
Italy	Yes	2019	Yes	2019
Kazakhstan	Yes	2019	Yes	2018
Kyrgyzstan	No	2012	..	..
Latvia	Yes	2016	Yes	2019
Liechtenstein	No	2021	Yes	2015
Lithuania	Yes	2020	Yes	2020
Luxembourg	No	2003	..	2018
Malta	Yes	2018	Yes	2011
Monaco	Yes	2018	Yes	2018
Montenegro	Yes	2019	Yes	2017
Netherlands	Yes	2020	Yes	2019
North Macedonia	Yes	2020	Yes	2018
Norway	Yes	2020	Yes	2020
Poland	Yes	2018	No	2001
Portugal	Yes	2019	Yes	2019
Republic of Moldova	Yes	2011	Yes	2018
Romania	Yes	2019	Yes	2018
Russian Federation	Yes	2019	Yes	2019
San Marino	..	..	Yes	2020
Serbia	Yes	2019	No	2016

Country	Integrated state-of-the-environment reports		Indicator-based state-of-the-environment reports	
	Regular production of reports?	Year of latest report	Regular production of reports?	Year of latest report
Slovakia	Yes	2018	Yes	2020
Slovenia	No	2010	Yes	2020
Spain	Yes	2019	Yes	2019
Sweden	Yes	2020	Yes	2020
Switzerland	Yes	2018	Yes	2018
Tajikistan	No	..	..	..
Türkiye	Yes	2016	Yes	2017
Turkmenistan	No	..	No	..
Ukraine	Yes	2015	No	..
United Kingdom	Yes	2020	Yes	..
Uzbekistan	No	..	No	..

Key: 2019–2021 2016–2018 2013–2015

Note: .. = no data

This assessment has used available information and reports to the extent possible, including the above-mentioned national reports on the state of the environment. Another source of information was *The European Environment: State and Outlook 2020* produced by EEA[18] and drawing on the Global SDG Indicators Data Platform.

2. Progress achieved in establishing a Shared Environmental Information System in Europe and Central Asia

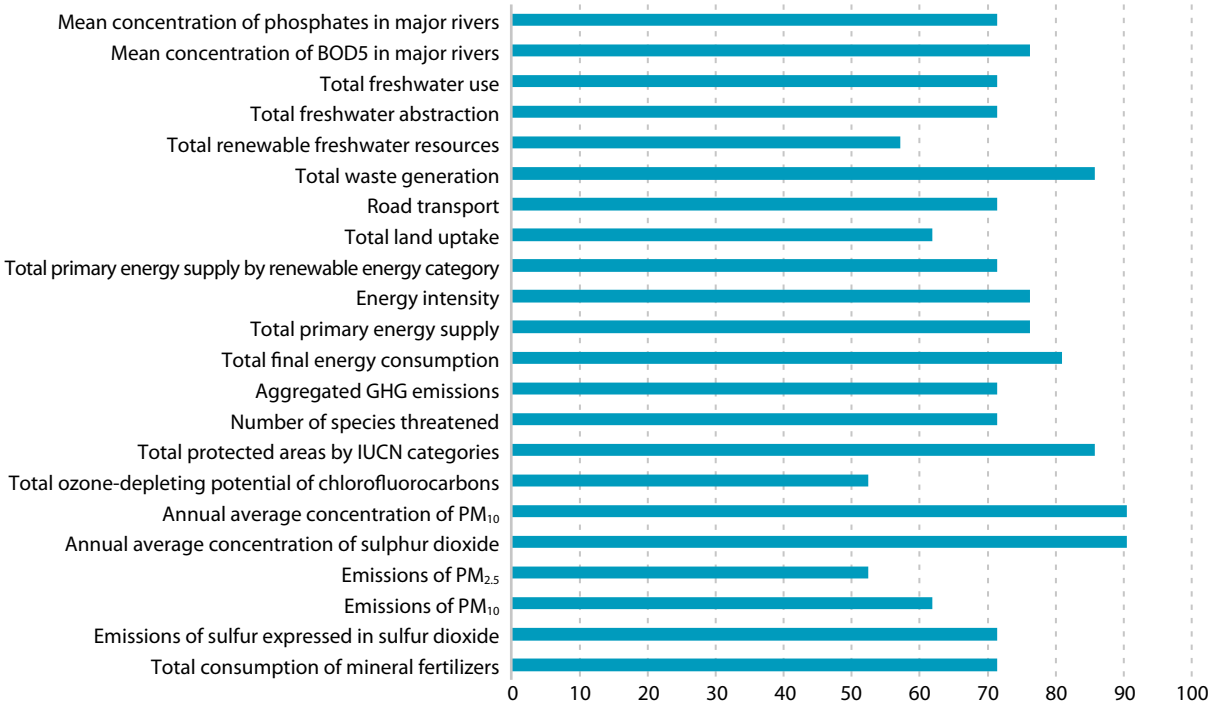
At the Seventh Environment for Europe Ministerial Conference (2011), ministers requested that a Shared Environmental Information System (SEIS) be developed to underpin a regular environmental assessment process across the pan-European region. This was reiterated by ministers at the Eighth Environment for Europe Ministerial Conference (2016).

Since then, overall, the SEIS has been successfully established in Europe and Central Asia. All member States have, to varying degrees, made progress regarding the establishment of a national system during recent years and in making environmental information available and accessible, including for use in regular assessments such as the seventh pan-European environmental assessment (see figure 3 on availability and accessibility of data flows on national systems as reported by 21 member States that participated in the final review report on the establishment of the SEIS by submitting their self-assessments).

According to the final review report on the establishment of the SEIS (ECE/CEP/AC.10/2021/6), national systems vary in form and regularity in terms of their updates and content and gaps remain that need to be addressed, including regarding the full establishment of the system in line with all SEIS principles and pillars. The gaps identified indicate that countries still need assistance to fully implement the principles and pillars and to enable the full production and sharing of all data flows associated with the ECE environmental indicators beyond 2021. The final review report is based on the Assessment Framework of the Shared Environmental Information System (ECE/CEP-CES/GE.1/2019/3) and mainly on the replies provided by 21 member States to the call on reporting sent to all countries in Europe and Central Asia in 2020, complemented by additional research.

18 EEA, *The European Environment: State and Outlook 2020: Knowledge for Transition to a Sustainable Europe* (Luxembourg, Publications Office of the European Union, 2019).

Figure 3 Ready online availability and accessibility of data flows on a national platform, data flows with reply "yes" (Percentage)



Note: The figure provides an overview of ready online availability and accessibility of 18 data flows that were the subject of the final review report on the establishment of an SEIS in Europe and Central Asia. Percentages were calculated based on replies provided by 21 countries that submitted a self-assessment for the final review. The countries that reported are Albania, Austria, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, France, Georgia, Germany, Kazakhstan, Montenegro, North Macedonia, the Republic of Moldova, Romania, Serbia, Slovakia, Spain, Sweden, Switzerland and Uzbekistan.

Abbreviation: IUCN, International Union for Conservation of Nature.

Further reviews of the implementation of the SEIS according to its principles would help to address gaps and, by doing so, ensure that it supports regular assessments and reporting in the region.

The final review report also recommends that the establishment of the SEIS and the production of relevant data flows that underpin the ECE environmental indicators be harmonized and aligned with the revised ECE environmental indicators. They should also be aligned with the United Nations Framework for the Development of Environmental Statistics and monitoring and assessment processes at the regional and global levels, including in the context of the 2030 Agenda for Sustainable Development and a green and circular economy, to enhance their policy relevance. The present assessment also recommends that the list of ECE indicators be expanded to include other relevant themes, such as "Coastal waters, marine ecosystems and seas".

Based on the countries' replies during the final review of the establishment of the SEIS, for each data flow, limitations in comparing the data flow across countries and the region were assessed. The results from the 21 submissions show limitations in 44 per cent of cases due in part to the fact that several countries did not provide links to the data flows or information on the time series. The current assessment confirmed these challenges and noted comparability issues, for example, between data on "Land uptake and land take data from European Environment Agency member and cooperating countries" and data from other countries in the pan-European region. The reasons for this lack of comparability of data from other ECE member States include limited availability of reliable remote-sensing data and consistent criteria to analyse them, the continuity of national monitoring efforts and shifts in land classification in

the early 2000s in some member States. It is therefore recommended to continue investing in consistent land-cover classifications – ideally aligned with the Corine Land Cover system – and monitoring capacity, agree on consistent national information to be fed into the SEIS and carefully retrofit actual land-cover categories to past data, in order to obtain reliable trend information.

Furthermore, the final review report recommends continuation of the digitization of environmental monitoring systems and use of new technologies for enhanced high-quality data production in support of regular assessments and policymaking. This was also confirmed throughout the development of the pan-European assessment.

The efforts to establish an SEIS, including the strengthening of content, infrastructure or cooperation between authorities to ensure the flow of data, also contributed to the implementation of the Aarhus Convention, in particular the pillar on access to information, as noted during a reporting exercise under the Aarhus Convention by parties. Parties reported that, while obstacles remain (e.g. lack of interoperability of databases and incomplete and fragmented data that lead to providing incomplete information), significant progress in ensuring that environmental information is available in electronic databases that are easily accessible to the public through public telecommunication networks has been achieved. Numerous effective electronic tools are being further developed in this area, such as electronic databases, publicly accessible governmental electronic services, websites and information portals, which are routinely updated and improved. However, additional steps are needed throughout the region, in particular regarding pollution and emissions registers.

The development of the pan-European assessment revealed additional data and knowledge gaps for core environmental issues throughout the pan-European region. The availability of and access to information and knowledge to support government decision-makers, industry and the public to make impact-oriented choices is improving but continues to be challenging, in some sectors more than others. This is a challenge to measuring progress towards policy targets in the pan-European region (see table 21), including for emerging policy developments such as circular economy or sustainable infrastructure, as revealed during this assessment.

Monitoring gaps, in terms of both data availability and quality, have been identified during the assessment for the region. Examples include the following (see also chapters III and IV):

(a) Air and climate change: Gaps remain, especially for the measurement and analysis of fine particulate matter ($PM_{2.5}$). The quality of emissions data varies widely. There are also gaps in data availability because not all countries in Eastern, South-Eastern and Western Europe and Central Asia submitted emission inventories. Data sets on GHG emissions remain incomplete for some countries in the region;

(b) Fresh water: There are gaps in geographic information systems, in particular at transboundary level, and there is a need for enhancing water statistics. Ecological water quality assessment or the identification of hydromorphological pressures requires knowledge that is not yet available everywhere in the region and the monitoring of emerging contaminants is an issue. Monitoring and data are incomplete for production of certain indicators;

(c) Coastal waters, marine ecosystems and seas: New developments and technologies related to monitoring and data production are not yet sufficiently applied and challenges remain regarding the spatial and temporal data coverage. Data gaps, for example, related to the amounts, composition and sources of beach and marine litter in parts of the region, were noted;

(d) Biodiversity and ecosystems: Data gaps remain for the production of certain indicators, including the ECE indicator "Land uptake", in particular for countries outside the European Union. Comparability of data is another issue that was noted;

(e) Chemicals and waste: No set of chemicals impact-oriented indicators is regularly monitored across the region. Gaps remain regarding data availability from a number of countries for certain indicators, including

"Total waste generation per capita", "E-waste generation per capita" and "Recycling rate of municipal solid waste";

(f) Environmental financing: There is a severe lack of quantitative data on environmental financing for countries of Central Asia and South-Eastern Europe. This hinders attempts to evaluate progress in environmental protection and environmental financing. The lack of reliable data also implies that investment and operational costs of meeting environmental objectives cannot be calculated in a robust way and used in policy development. There is an urgent need to improve data collection systems, for example, for data on environmental expenditures;

(g) Sustainable infrastructure: Significant data gaps have been identified in both the social, environmental, institutional, economic and financial indicators proposed and when quantifying the contribution (positive or negative) of infrastructure development and the achievement of the indicators proposed in this assessment. Furthermore, a common definition of sustainable infrastructure is lacking in the pan-European region; thus, reporting on and quantifying progress across countries and subregions is a challenge;

(h) Circular economy and sustainable tourism: Indicator development for sustainable tourism, let alone for monitoring circularity, is still evolving but is hampered by various issues. There are currently no indicators across ECE member States that give explicit information on tourism's circular state. On several general circularity aspects, classification definitions differ between countries. Even mainstream tourism statistics tend to be incomplete and suffer from varying definitions, while detailed statistics needed for accurate circularity monitoring are absent. Digitization holds promise for better and more uniform measurement and monitoring but depends on availability of uniform and relevant data on circular economy in tourism.

Accordingly, Governments in the pan-European region are recommended to:

(a) Bring policy and science together to develop and implement appropriate and standardized pan-European methods and systems for monitoring and information management, including through the application of new technologies, to fill data gaps (including data gaps on the gender-environment nexus) for improved decision-making and ensure timely availability of the information for the public;

(b) Employ the revised ECE Guidelines for the Application of Environmental Indicators, provide the ECE set of environmental indicators in accordance with the principles and pillars of the SEIS and adopt indicators to cover emerging policymaking themes of importance;

(c) Assist countries to fully implement the SEIS principles and pillars and the full production and sharing of all data flows associated with the ECE environmental indicators and other indicator frameworks, including the Sustainable Development Goal indicators, and employ, as appropriate, the updated Recommendations on the more effective use of electronic information tools (ECE/MP.PP/2021/2/Add.2) developed under the auspices of the Aarhus Convention;

(d) Consider implementing pollutant release and transfer registers and the pan-European SEIS in synergy;

(e) Continue digitization of environmental monitoring systems and the use of new technologies for enhanced high-quality data production in support of regular assessments and policymaking.

Further recommendations related to monitoring and information management on the specific environmental themes are provided in chapters III and IV.

Table 21 Implications of monitoring and data gaps for measuring progress towards policy targets

Topic with monitoring and data gaps	Examples of policies and targets with measurement impacted
Air	Convention on Long-range Transboundary Air Pollution; United Nations Framework Convention on Climate Change; Vienna Convention for the Protection of the Ozone Layer; Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters (Aarhus Convention) Sustainable Development Goal targets related to air quality and health and climate change
Fresh water	Water Convention Sustainable Development Goal targets related to freshwater quantity, quality and health and climate change
Coastal waters, marine ecosystems and seas	Convention on Biological Diversity Sustainable Development Goal targets related to coastal waters, marine ecosystems and seas
Biodiversity and ecosystems	Convention on Biological Diversity Sustainable Development Goal targets related to coastal waters, marine ecosystems and seas
Land and soils	Convention on Biological Diversity; United Nations Convention to Combat Desertification Sustainable Development Goal targets related to land and soil
Chemicals and waste	Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade; Minamata Convention on Mercury; Convention on Long-range Transboundary Air Pollution and its Protocols; Convention on the Protection and Use of Transboundary Watercourses and International Lakes Protocol on Water and Health; Convention on the Transboundary Effects of Industrial Accidents Sustainable Development Goal targets related to waste and chemicals
Sustainable infrastructure	Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention) and its Protocol on Strategic Environmental Assessment; Convention on the Transboundary Effects of Industrial Accidents Sustainable Development Goal targets related to sustainable infrastructure
Circular economy and sustainable tourism	Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention) and its Protocol on Strategic Environmental Assessment; Air Convention; Convention on Biological Diversity

C. Environmental policies in the region

This section explores global, regional and subregional policy frameworks that are at play in the pan-European region. The policies, but also their objectives, goals, targets and indicators, all play a role in driving action by countries. Among the most relevant global instruments are the MEAs (see table 22), the United Nations Environment Assembly and the 2030 Agenda for Sustainable Development. Notable regional frameworks are the Environment for Europe ministerial process and the European Environment and Health process. Major elements at the subregional level include the European Union's environmental policy and legislation, the European Union accession process and environmental and sustainable development policies emanating from the Commonwealth of Independent States.

Global policy frameworks

The 2030 Agenda for Sustainable Development provides the overarching policy framework for sustainable development and integrated environmental policy. The 17 universal Sustainable Development Goals and 169 targets of the 2030 Agenda[19] provide policy objectives at all levels with the overall aim to eradicate poverty, along with the economic, social and environmental dimensions of sustainability. The Agenda addresses underlying issues related to governance, institutions, peace and international collaboration. It includes dedicated targets to focus progress on core environmental issues, including under Goal 6 on water, Goal 7 on energy, Goal 12 on consumption and production patterns and Goal 13 on climate action, and more than 90 environment-related indicators to measure progress on the implementation of the Agenda. Governments have also adopted national targets and indicators.

19 UNEP has determined that more than 86 of the 169 targets directly concern the environment.

The Sendai Framework for Disaster Risk Reduction 2015–2030 aims to substantially reduce disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of people, businesses, communities and countries. It includes a set of seven global targets, which are indirectly related to the environment, and sets four priority actions, each of which has an environmental dimension. It includes activities at the local, national, regional and global levels.

The Strategic Plan for Biodiversity 2011–2020, including the Aichi Biodiversity Targets, has set the global framework for action to preserve biodiversity for the past decade. The Plan identifies five strategic goals, each having between three and six targets. The post-2020 global biodiversity framework was to be adopted in 2022. The Sustainable Development Goals also include targets and indicators related to biodiversity.

The global MEAs, such as the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement, the Convention on Biological Diversity (CBD), the Convention to Combat Desertification (UNCCD), and those on specific pollutants (such as persistent organic pollutants (POPs), mercury and ozone-depleting substances (ODSs)) and waste, also drive environmental policy within the ECE region, alongside regional MEAs, including through the setting of legally binding limits. The rapid uptake of the global agreements emphasizes their political importance at the international level.

Table 22 Key multilateral environmental agreements[20]

Treaty	Categories	Number of parties in pan-European region (globally)
Vienna Convention for the Protection of the Ozone Layer		54 (198)
Montreal Protocol on Substances that Deplete the Ozone Layer	Climate and Atmosphere	54 (198)
London, Copenhagen, Montreal, Beijing and Kigali Amendments		
United Nations Framework Convention on Climate Change	Climate and Atmosphere	54 (197)
Kyoto Protocol	Climate and Atmosphere	53 (193)
Paris Agreement	Climate and Atmosphere	54 (191)
United Nations Convention to Combat Desertification	Biological Diversity, Land and Agriculture, Drylands	54 (197)
Convention on Biological Diversity	Biological Diversity	54 (196)
Cartagena Protocol on Biosafety	Biological Diversity, Land and Agriculture	47 (173)
Nagoya–Kuala Lumpur Supplementary Protocol	Biological Diversity, Land and Agriculture	27 (49)
Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization	Biological Diversity, Land and Agriculture	33 (132)
Convention concerning the Protection of the World Cultural and Natural Heritage	Biological Diversity, Marine and Freshwater, Land and Agriculture	54 (194)
Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal	Chemicals and Waste	53 (188)
Basel Protocol on Liability and Compensation	Environmental Governance, Chemicals and Waste	0 (12)
Stockholm Convention on Persistent Organic Pollutants	Chemicals and Waste	50 (184)

20 Not including the Holy See, but including the European Union, among the parties in the pan-European region.

Treaty	Categories	Number of parties in pan-European region (globally)
International Plant Protection Convention	Biological Diversity, Land and Agriculture	48 (184)
Convention on International Trade in Endangered Species of Wild Fauna and Flora	Biological Diversity	53 (183)
Convention on Wetlands of International Importance (Ramsar Convention)	Biological Diversity, Land and Agriculture, Marine and Freshwater	52 (170)
Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade	Chemicals and Waste	44 (164)
International Convention for the Prevention of Pollution from Ships	Marine and Freshwater	45 (160)
International Treaty on Plant Genetic Resources for Food and Agriculture	Biological Diversity, Land and Agriculture	40. (148)
Minamata Convention on Mercury	Chemicals and Waste	37 (132)
Convention on the Conservation of Migratory Species of Wild Animals	Biological Diversity	48 (132)
Agreement on the Conservation of African-Eurasian Migratory Waterbirds	Biological Diversity	40 (82)
Convention on Long-range Transboundary Air Pollution, and its Protocols, including:	Chemicals and Waste, Climate and Atmosphere	49 (51)
Protocols on Heavy Metals	Chemicals and Waste, Climate and Atmosphere	33 (35)
Protocols on Persistent Organic Pollutants	Chemicals and Waste, Land and Agriculture	33 (34)
Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters (Aarhus Convention)	Environmental Governance	47 (47)
Protocol on Pollutant Release and Transfer Registers	Environmental Governance, Chemicals and Waste	38 (38)
Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention)	Environmental Governance	44 (45)
Protocol on Strategic Environmental Assessment	Environmental Governance	33 (33)
Convention on the Protection and Use of Transboundary Watercourses and International Lakes	Biological Diversity, Marine and Freshwater	41 (46)
Protocol on Water and Health	Chemicals and Waste, Biological Diversity, Marine and Freshwater	27 (27)
Convention on the Transboundary Effects of Industrial Accidents	Chemicals and Waste, Climate and Atmosphere, Biological Diversity, Marine and Freshwater, Land and Agriculture	41 (41)
Barcelona Convention, and its Protocols	Chemicals and Waste, Biological Diversity, Marine and Freshwater	15 (22)
Agreement on the Conservation of Small Cetaceans of the Baltic, North-East Atlantic, Irish and North Seas	Biological Diversity	10 (10)
Framework Convention on the Protection and Sustainable Development of the Carpathians, and its Protocols	Biological Diversity, Land and Agriculture	7 (7)

Note: Categories are according to www.InforMEA.org (accessed on 8 September 2021). The specified number of parties is to the parent treaty if protocols are referred to but not listed separately. Agreements adopted within the Environment for Europe process are indicated in bold.

The United Nations Environment Assembly provides an overarching, global structure for environmental governance, bringing emerging issues to the attention of the global community. It sets priorities for global environmental policies and develops international environmental law. Through its ministerial declaration and resolutions, the Assembly also provides leadership, catalyses intergovernmental action on the environment and contributes to the implementation of the 2030 Agenda.

Regional policy frameworks

Environment for Europe ministerial process

At the regional level, the Environment for Europe process and its Ministerial Conferences, which aim to harmonize environmental quality and policies in the pan-European region and secure the region's peace, stability and sustainable development, have provided the primary policy framework over the past three decades. The Lucerne Declaration adopted by Ministers of Environment in 1993 sets out the political dimension of the Environment for Europe process. The 1995 Sofia Declaration underlined the urgent need for further integration of environmental considerations into all sectorial policies, so that economic growth takes place in accordance with principles of sustainable development.

At the 2011 Ministerial Conference in Nur-Sultan, a series of policy commitments were decided, including to: improve environmental protection and promote sustainable development in the ECE region; reiterate the importance of the involvement of civil society, including business, women, non-governmental organizations (NGOs) and other groups, in decision-making to improve the environment; pursue implementation of the principles of integrated water resources management, an ecosystem approach and the integration of ecosystem values in economic accounting; improve water management and strengthening transboundary cooperation; and pursue completion and implementation of a 10-Year Framework of Programmes on Sustainable Consumption and Production.[21]

Outcomes of the Nur-Sultan Ministerial Conference were reviewed in Batumi, Georgia, in 2016, including through the consideration of a final report on the implementation of the Astana Water Action, a report on progress in establishing the SEIS and a report on 20 years of environmental performance reviews (EPRs).[22] The Batumi Conference also:

- Endorsed the voluntary Pan-European Strategic Framework for Greening the Economy and invited ECE member States and other stakeholders to implement it;
- Welcomed the Batumi Initiative on Green Economy (BIG-E), which consists of voluntary commitments to operationalize the Strategic Framework;
- Endorsed the voluntary Batumi Action for Cleaner Air (BACA) and welcomed the initiatives launched by interested countries and other stakeholders aimed at improving air quality and protecting public health and ecosystems.

The Conference also committed to: improve environmental protection, advancing sustainable development, implementing the Sustainable Development Goals and providing access to essential services; enhance ecosystems and ecosystem services as part of ecological infrastructure and improving the sustainable use of natural resources; lead the transition to green economy, direct investments and trade to support a green and inclusive economy and work towards the full internalization of externalities that cause the loss of or damage to natural capital; foster a circular economy, transparent and responsible business practice and eco-innovation, and further work towards cleaner and more resource-efficient production processes; develop the human capital for green and decent jobs and increase the availability of such jobs; improve air quality for a better environment and human health, strengthen the role of civil society in addressing air pollution and its impacts and ensure adequate monitoring of and public access to relevant information on air pollution; strengthen and scale up education for sustainable development (ESD); promote effective public participation in decision-making to improve the environment and promote sustainable development;

21 Declaration: "Save water, grow green!" (ECE/ASTANA.CONF/2011/2/Add.1).

22 ECE/BATUMI.CONF/2016/10, ECE/BATUMI.CONF/2016/8 and ECE/BATUMI.CONF/2016/INF/5, respectively.

and develop partnerships with civil society organizations in the region and create favourable conditions for their operation.[23]

The fulfilment of commitments made under BIG-E and BACA, both at the Conference and subsequently, have been monitored, notably through a mid-term review carried out by the Committee on Environmental Policy in January 2019. The evaluation was based upon reports on the implementation of each of the three Batumi instruments and MEAs in support of the 2030 Agenda, and on activities to support countries in their efforts to green their economies, establishment of the SEIS and the third cycle of EPRs.[24] The evaluation demonstrated harmonization and improvement of relevant data flows and the quality of selected environmental indicators and use of data flows for multiple purposes. The evaluation has also highlighted the progress achieved in implementing voluntary commitments by the member States and organizations participating in BIG-E and BACA. It noted that, since 2017, the Sustainable Development Goals and targets were being included in EPRs. The Committee welcomed the commencement of activities to assist reviewed countries in the implementation of recommendations emerging from their EPRs.

The Committee noted that countries still need assistance in fully implementing the principles and pillars of the SEIS and in the regular production and sharing of relevant data flows associated with the ECE environmental indicators by 2021. The Committee also recognized the need to allocate sufficient resources for MEAs to assist Governments to achieve Sustainable Development Goals.

European Environment and Health Process

The European Environment and Health Process started in Frankfurt, Germany, in 1989. The Second Conference, in Helsinki, Denmark, in 1994, was followed in 1995 by the publication *Concern for Europe's Tomorrow: Health and the Environment in the WHO European Region*, a comprehensive survey on environmental health in Europe. In 1999, the Third Conference, held in London, adopted the Protocol on Water and Health to the ECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes. At the Fifth Conference, in Parma, Italy, in 2010, Governments of the 53 member States of the WHO European Region set clear targets to reduce the adverse health impact of environmental threats in the next decade. At the Sixth Conference, in Ostrava, Czech Republic, in 2017, member States committed to develop national portfolios for action that should address the need to accelerate progress on health and environment and, in particular, the environment-related health goals and targets of the 2030 Agenda.[25] The next ministerial conference is planned for 2023.

Other regional processes

Other important processes and instruments include the ECE Steering Committee on Education for Sustainable Development, the Transport, Health and Environment Pan-European Programme (THE PEP) and the ECE environmental performance review (EPR) programme.

The THE PEP is a tripartite pan-European policy framework, which brings together the transport, health and environment sectors on an equal footing. It is jointly serviced by ECE and the WHO Regional Office for Europe.

The THE PEP held its fifth High-level Meeting in 2021 and adopted the Vienna Declaration, "Building forward better by transforming to new, clean, safe, healthy and inclusive mobility and transport". A historic milestone and core part of the Vienna Declaration was the first Pan-European Master Plan for Cycling Promotion.

Working together under the THE PEP Framework, member States have been advancing the implementation of the 2030 Agenda on several fronts and across numerous goals and targets, including those related to health, energy efficiency, the protection of climate and the environment, the quality of urban life and equity.

23 Declaration: "Greener, cleaner, smarter!" (ECE/BATUMI.CONF/2016/2/Add.1).

24 For details, see the report of the Committee on Environmental Policy on its twenty-fourth session (ECE/CEP/2019/2).

25 Declaration of the Sixth Ministerial Conference on Environment and Health, available at https://apps.who.int/iris/handle/10665/347444.

Subregional policy frameworks

Among the frameworks below the regional level, the policies of the European Union, including its accession process, have been among the strongest drivers of policy change. Subregional environmental agreements also play a significant role because of their binding provisions for their parties; these include the Alpine Convention, the Framework Convention on the Protection and Sustainable Development of the Carpathians, the Framework Convention on Environmental Protection for Sustainable Development in Central Asia and a whole series of regional seas agreements, such as the Convention for the Protection of the Mediterranean Sea Against Pollution (Barcelona Convention).

At the European Union level, the European Green Deal promotes a holistic approach and sets out a roadmap for climate neutrality by 2050 with sustainability as the new standard for all policies. It includes a Biodiversity Strategy 2030, Zero Pollution Action Plan, "Farm-to-Fork", Sustainable and Smart Mobility Strategy and transition to a circular economy as ambitious directions for the European Union and beyond, acknowledging the ecological continuity and inclusion of its immediate neighbourhood. Further approaches include the *Transition Pathway for Tourism* report,[26] which was developed together with industry and civil society. The Biodiversity Strategy provides a plan to protect nature and reverse the degradation of ecosystems and is instrumental for measuring ecosystem health and halting biodiversity loss across ecosystems, including marine ecosystems. It runs concurrently with the global process under the Convention on Biological Diversity for the elaboration of the post-2020 Global Biodiversity Framework.

26 European Commission, *Transition Pathway for Tourism* (Brussels, 2022). Available at https://ec.europa.eu/docsroom/documents/49498.

II.

REGIONAL CONTEXT AND DEVELOPMENTS AS DRIVERS OF ENVIRONMENTAL CHANGE

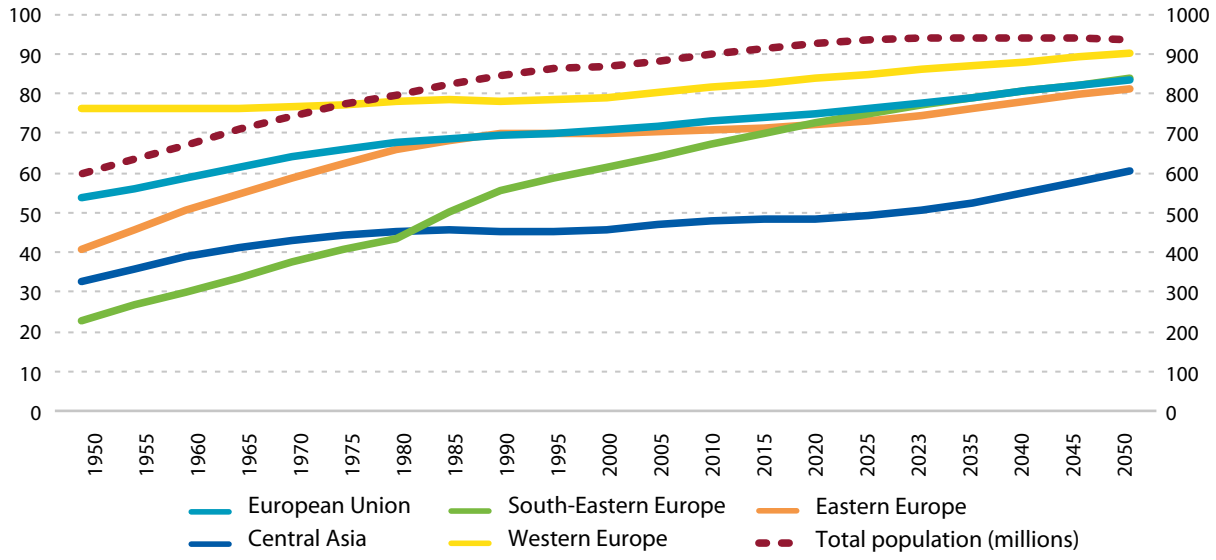
The period since 1990 has seen dramatic socioeconomic and political changes in the pan-European region that have increased pressure on the natural environment and are driving environmental change. This section looks at four clusters of drivers:[27]

- An urbanizing and more coastal population
- A more prosperous society with increased use of resources
- Shifting energy production and use
- An increasingly mobile society (which also addresses tourism in detail).

1. An urbanizing and more coastal population

The region's population has grown slowly, by about 6.5 per cent, between 1990 and 2015 (compared with about 38 per cent globally), from 784.8 million in 2000 to 829.9 million in 2015,[28] and is expected to rise by only 2.7 per cent relative to 2015, before declining after 2040. The region is becoming more urban, with forecasts indicating 50 to 80 per cent of the population living in urban areas by 2050 (figure 4).

Figure 4 Proportion of the population living in urban areas, 1950–2050, as forecast from 2020
(Percentage (left axis) and Total population in millions (right axis))



Source: United Nations, Department of Economic and Social Affairs, World Urbanization Prospects: The 2018 Revision (New York, 2019).

Currently, the high concentration of human activities in urban territory causes 70 per cent of the global GHG emissions and growing air, water and soil pollution and nuisance by noise and congestion. Besides, the impacts of rapid and unplanned urbanization could affect the likelihood of conflict over limited resources. This situation has sparked the development of sustainable infrastructure, and innovative approaches to spatial planning, mobility and energy consumption (e.g. smart cities and smart grids or networks). Sustainable infrastructure is strongly promoted by climate

27 Other clusters of drivers are presented in *Drivers of Change of Relevance for Europe's Environment and Sustainability*, EEA Report No. 25/2019 (Luxembourg, Publications Office of the European Union, 2020); and Paul Ekins, Joyeeta Gupta and Pierre Boileau, eds., *Global Environment Outlook: GEO-6: Healthy Planet, Healthy People* (Cambridge, UK, Cambridge University Press, 2019), chap. 2.

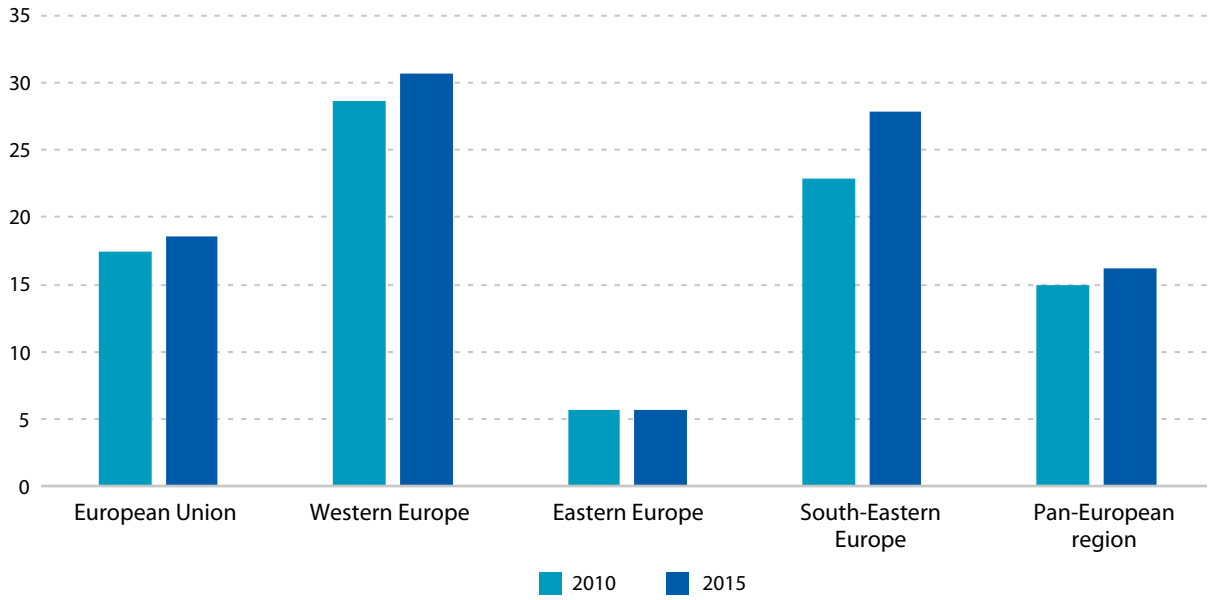
28 United Nations, Department of Economic and Social Affairs, Population Division, "World Population Prospects 2019". Available at https://population.un.org/wpp/Download/Standard/Population/.

policies in order to enable greater resilience to extreme weather events. The New Urban Agenda promotes a smart-city approach that makes use of opportunities from digitization, clean energy and technologies, as well as innovative transport technologies, thus providing options for inhabitants to make more environmentally friendly choices.

The population living within 10 km of the coast in the coastal countries of the pan-European region has increased by 10 per cent between 2000 and 2015 (see figure 5) – a faster rate than that of the overall population – from 133.6 to 147.7 million.[29] Projections indicate that, by 2050, 71 per cent of the global population will live in coastal zones.[30]

High-density populated coastal areas are characterized by elevated urban footprints, associated with an increased strain on infrastructure, where environmental pressures such as wastewater discharges or sewage overflows and waste generation are exacerbated. Coastal urbanization results in land consumption, degradation of landscapes, coastlines, and habitats, and increased pressure on coastal ecosystems. These pressures are further amplified by the development of tourism, often concentrated in coastal areas and in the summer months, as is the case of the Mediterranean region.[31] Coastal countries face increased challenges in achieving sustainable development and the conservation of coastal and marine areas, more so in view of climate change. Several regions and cities in the pan-European region are experiencing rapid population growth and currently lack the capacity to face these mounting pressures.

Figure 5 **Proportion of population living within 10 km of the coast, 2010 and 2015** (Percentage)



Source: For coastal population, OECD.Stat; for total population, ECE Statistical Database.

Notes: Monaco population figures are for 2008 and 2016; for Turkmenistan, figures are for 2009; for the Russian Federation, figures for 2013 are used instead of 2015.

29 OECD.Stat, "Sustainable Ocean Economy – Indicators by country." 2020. Available at https://stats.oecd.org/index.aspx?datasetcode=OCEAN.

30 Jan-Ludolf Merkens and others, "Gridded population projections for the coastal zone under the Shared Socioeconomic Pathways", *Global and Planetary Change*, vol. 145 (2016): 57–66.

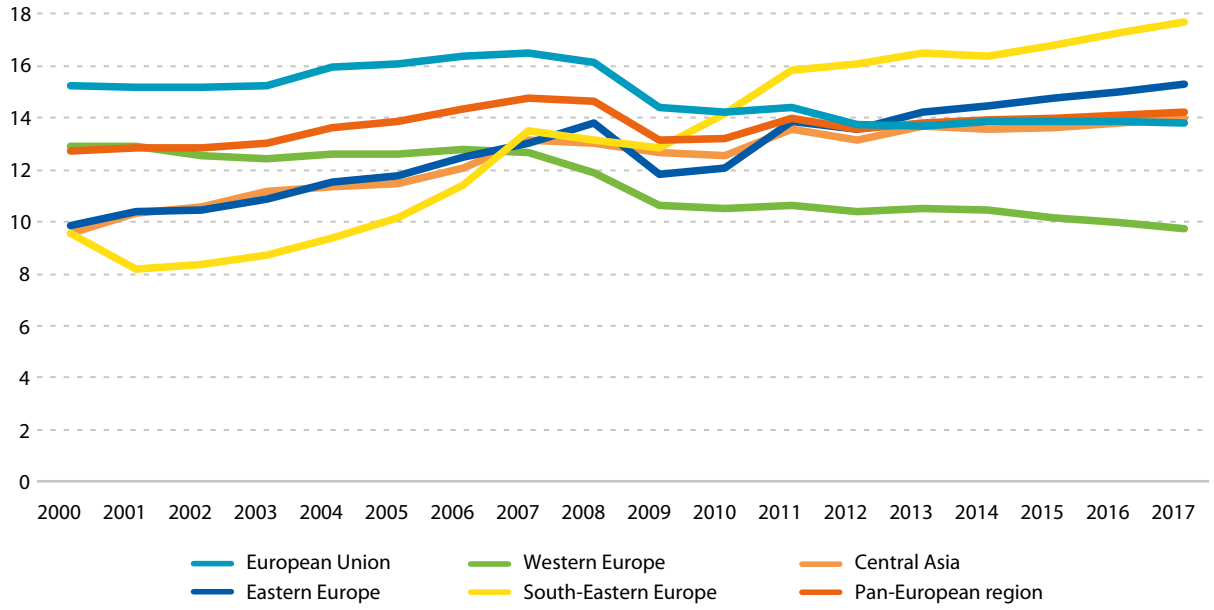
31 UNEP/Mediterranean Action Plan (MAP) and Plan Bleu, *SOED 2020: State of the Environment and Development in the Mediterranean* (Barcelona, 2020).

2. A more prosperous society with increased use of resources

Growing populations with higher incomes in the coming decades will drive a strong increase in global demand for goods and services, as noted in the Organisation for Economic Co-operation and Development (OECD) report *Global Material Resources Outlook to 2060*.[32] The report concludes that technological developments will help decouple growth in production levels from material inputs, and the greatest opportunities may lie in countries with less-developed technology at present. However, the decrease in resource intensity may be slower than growth in GDP, thus driving up resource use. OECD forecasts for the period 2011–2060 signal increases in material use and GDP respectively of 1.5 and 2.5 times in Eurasia[33] and 1.8 and 2.5 times in Europe, while material intensity is expected to drop from 0.9 tons/$ to 0.5 tons/$ in Eurasia and from 0.4 tons/$ to 0.3 tons/$ in Europe.

The material footprint, i.e. the amount of materials extracted from the environment used to reply to final demand of an economy, and the domestic material consumption (DMC), i.e. the amount of materials produced or processed in a country, show that, although countries with higher populations use more resources, on a per capita basis wealthier countries stand out as the largest relative consumers. Figure 6 indicates the extent of DMC, and figure 7 the material footprint, in the pan-European region in the recent period.

Figure 6 **Domestic material consumption, 2000–2017** (Tons per capita)



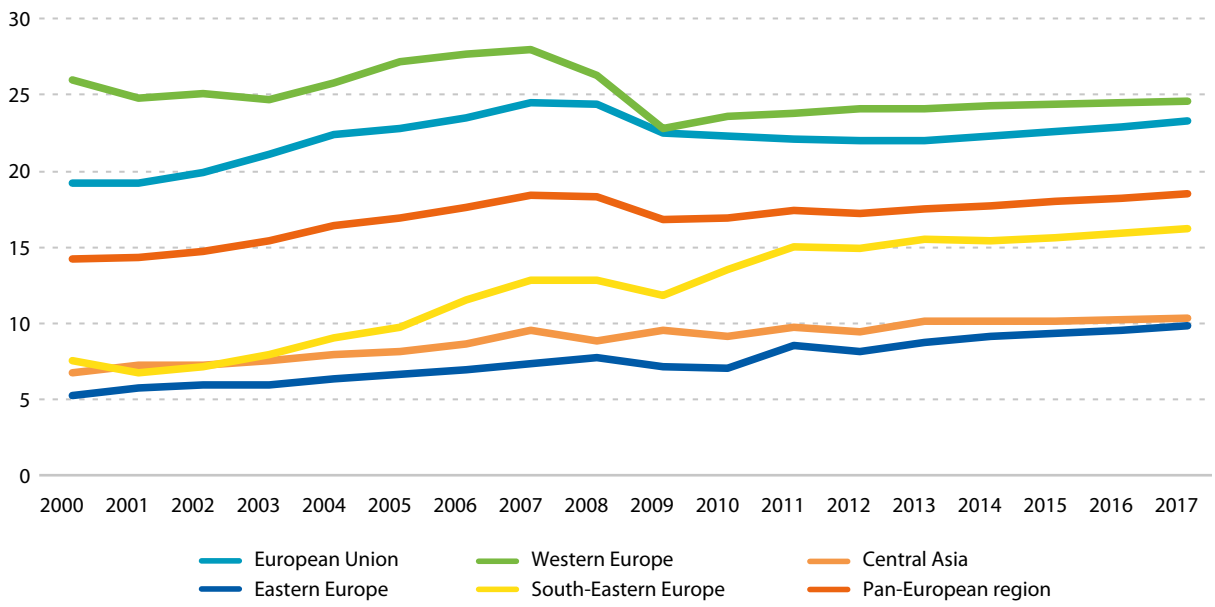
Sources: United Nations, "Global SDG Indicators Data Platform", Indicator 12.2.2 (total figures) (accessed on 10 December 2021); for population data, ECE Statistical Database (accessed on 1 February 2022).

Notes: No data for Andorra, Liechtenstein, Monaco and San Marino, nor for Montenegro and Serbia in the period 2000–2005. Population of Turkmenistan 2010–2017 uses figure for 2009; population of the Russian Federation 2014–2017 uses figure for 2013.

32 OECD, *Global Material Resources Outlook to 2060: Economic Drivers and Environmental Consequences* (Paris, 2019).

33 Central Asia, the Caucasus, Eastern Europe, South-Eastern Europe and Andorra, Bulgaria, Croatia, Cyprus, Latvia, Lithuania (though it became an OECD member in 2018), Malta, Romania, the Russian Federation and San Marino.

Figure 7 **Material footprint, 2000–2017** (Tons per capita)



Sources: UNEP, "World Environment Situation Room", Indicator 8.4.1/12.2.1 (total figures) (accessed on 15 December 2021); for population data, ECE Statistical Database.

Notes: No data for Andorra, Liechtenstein, Monaco and San Marino. Population of Turkmenistan 2010–2017 uses figure for 2009; population of the Russian Federation 2014–2017 uses figure for 2013.

The ecological footprint,[34] an indicator that compares demand for nature to available biocapacity, indicates that larger countries with less intensive industry tend to still have a positive balance, but many countries of the world are in deficit, either by consumption or due to production. Across the pan-European region, national footprints far exceed global biocapacity (about 1.7 tons per person) in all countries except Tajikistan.

34 Global Footprint Network, https://www.footprintnetwork.org/our-work/ecological-footprint/.

Prosperity in the region has led to vastly developed infrastructure, continuing extraction of natural resources and the expansion and intensification of agriculture[35] (including in countries outside the region but feeding the pan-European region), which have increased pressure on land.

Besides, some 40,000 to 60,000 industrial chemicals are commercially traded worldwide and this trade is expected to grow significantly in the future.[36] Chemicals are used in, for example, agriculture, health care and the manufacturing of items such as electronics, textiles, furniture and toys, and a high proportion are hazardous; for example, in the European Union in 2016, 62 per cent belonged to categories classified as hazardous to human health and 35 per cent were hazardous to the environment.[37] The generation of large amounts of waste is also linked to inefficient use of resources as part of unsustainable consumption and production practices in current societies. Besides the problems caused by hazardous waste, other waste streams cause losses of materials and energy and aggravate pressures on the environment, for example, by the introduction of microplastics into food chains, affecting biodiversity and human health.

Single-occupancy housing is an indicator of a more prosperous society, with a resulting increase in material and energy use per capita. In the period 2000–2019, this indicator grew in the region, though there has been a decline in a few countries, especially since 2010 (see table 23).

A general increase in personal wealth is also a main driver for the development of coastal tourism, including the construction of luxury resorts and hotels, other facilities and infrastructure.

Table 23 One-person households, selected countries, 2000–2019 (Thousands)

Country	2000 Number	2005 Number	2010 Number	2015 Number	2019 Number	Percentage change
Ireland	289	319	382	390	526	82
Israel	301	333	387	439	530	76
Italy	5 037	5 937	6 997	7 910	8 308	65
Austria	977	1 199	1 300	1 418	1 480	51
Finland	857	965	1 040	1 112	1 221	42
Netherlands	2 272	2 449	2 670	2 868	3 038	34
Switzerland	1 121	no data	1 275	1 276	1 371	33
Estonia	195	180	201	211	258	32
Germany	13 750	14 695	16 195	16 875	17 557	28
Azerbaijan	117	123	131	140	145	24
United Kingdom	6 954	7 230	7 591	7 743	8 197	18
Denmark	905	950	993	1 011	1 034	14
Georgia	144	139	144	139	163	13
Sweden	2 029	2 057	2 264	1 753	1 879	-7
Uzbekistan	184	226	155	136	158	-14
Ukraine	3 698	3 896	4 006	3 022	2 897	-22

Source: ECE Statistical Database (accessed on 1 February 2022).

35 Agricultural intensification refers to any practice that increases productivity per unit of land area at some cost in labour or capital inputs. One important dimension of agricultural intensification is the length of fallow period (i.e. letting land lie uncultivated for a period) and whether the management approach uses ecological or technological means.

36 Ekins, Gupta and Boileau, eds., *Global Environment Outlook: GEO-6: Healthy Planet, Healthy People*.

37 EEA, "Consumption of hazardous chemicals", 26 November 2019, available at www.eea.europa.eu/airs/2018/environment-and-health/production-of-hazardous-chemicals.

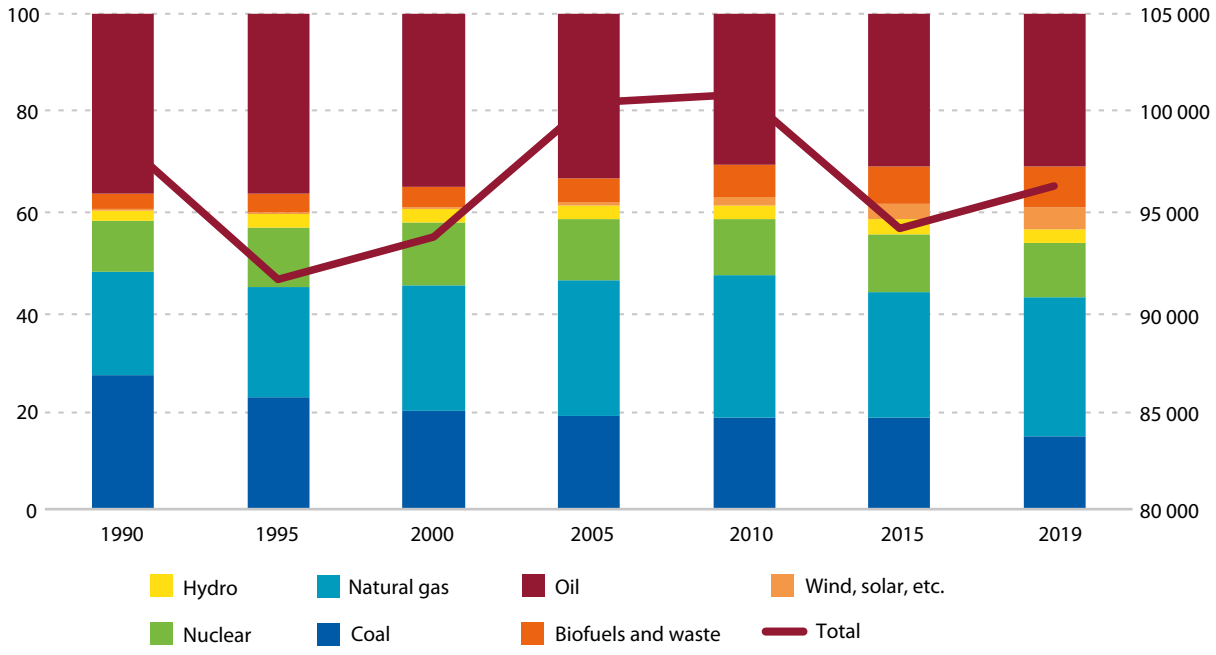
3. Shifting energy production and use

Despite industrial production increasing by 25 per cent from 2000 to 2010 and by 20 per cent from 2010 to 2018, total energy sources have hardly shifted since 1990 (see figure 8) (although there was a 3 per cent drop to 2017). This indicates an increase in energy efficiency. In parallel, the energy mix has changed but fossil fuels, such as coal, oil and natural gas, have only decreased from 84 per cent in 1990 to 74 per cent of net energy production, while hydro, wind, solar, biofuels and waste grew from 5 to 14 per cent. Figures point to 44 per cent less coal and 9 per cent less crude oil, but 21 per cent more gas, and total consumption of fossil fuels increased by 2.4 per cent in the period 2015–2017. Besides, the relative use of nuclear power increased by 5 per cent, hydropower increased by 17 per cent, wind and solar increased by 11 times and biofuels and waste doubled.

The change in energy mix has also led to a stabilization in CO_2 emissions from the region, though with significant geographical variations (see figure 9). However, the reductions in GHG emissions necessary to limit global temperature rise to 2ºC, let alone 1.5ºC, are still not on the horizon.

New trends are expected in electricity consumption. The European Union aims to have at least three million electric vehicle chargers by 2030, a threefold increase in comparison with today. This trend, however, will promote material pressure, such as on lithium for batteries. Hydrogen fuel cells are an emerging industry.

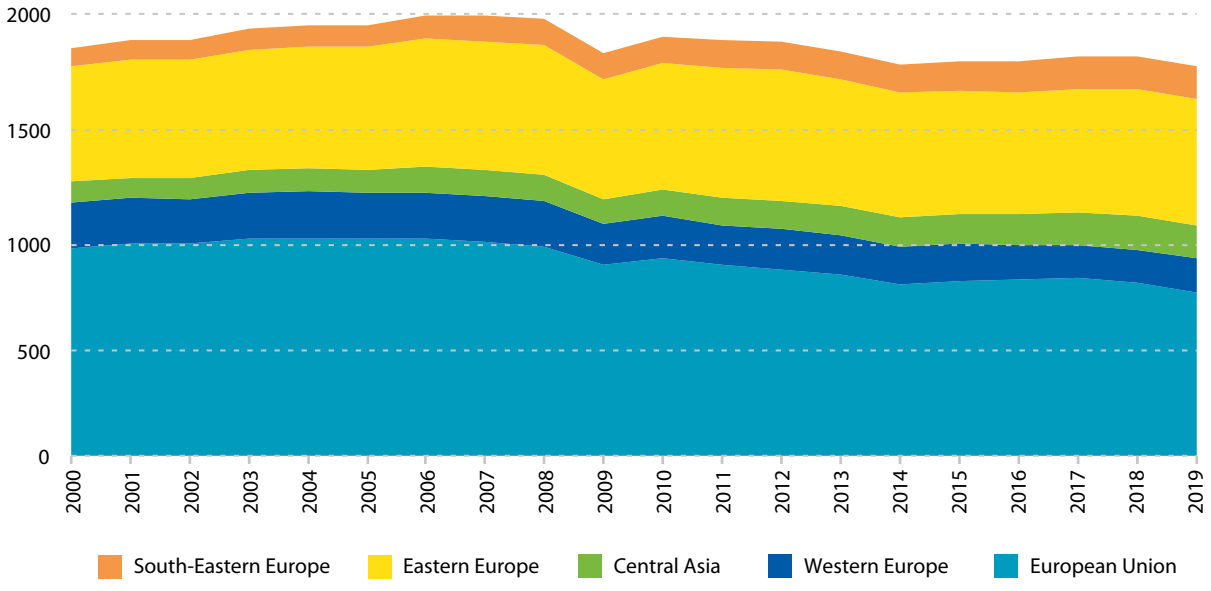
Figure 8 Energy sources, net of imports and exports, pan-European region, 1990–2019
(Percentage by source (left axis) and Total in petajoules (right axis))



Source: International Energy Agency (IEA), "Data and Statistics". Available at https://www.iea.org/data-and-statistics/data-browser?country=WORLD&fuel=Energy%20supply&indicator=TESbySource (accessed on 7 February 2022).

Note: No data for Andorra, Liechtenstein, Monaco and San Marino.

Figure 9 Territorial fossil CO_2 emissions by subregion, 2000–2019 (Millions of tons of CO_2)



Source: Pierre Friedlingstein and others, "Global Carbon Budget, 2020".[38]

Note: Monaco included with France; San Marino included with Italy.

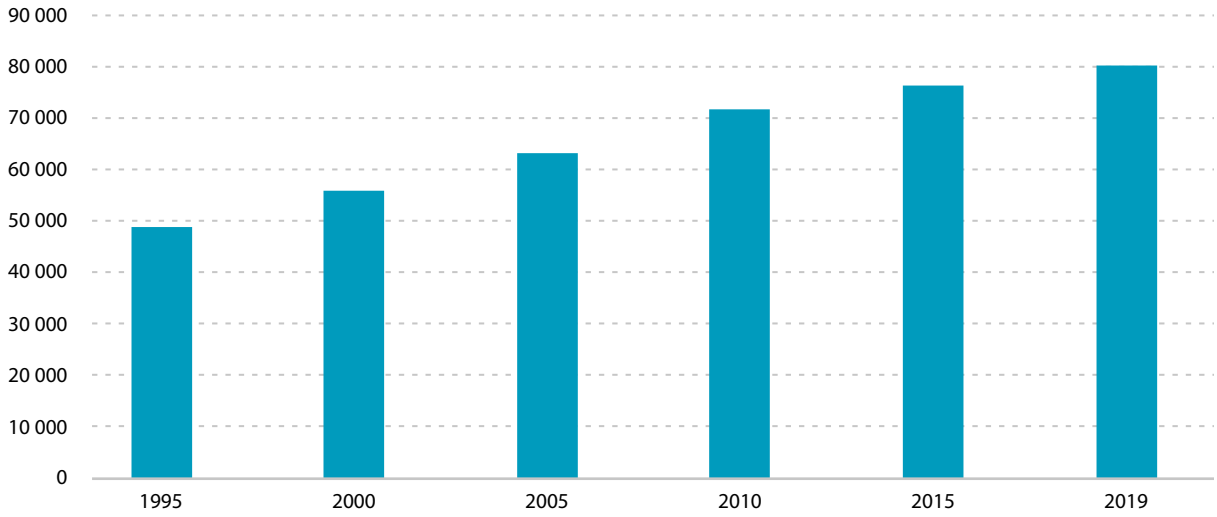
38 Pierre Friedlingstein and others, "Global Carbon Budget 2020", *Earth System Science Data*, vol. 12, No. 4 (2020), pp. 3269–3340.

4. An increasingly mobile society

The transport of persons and goods is among the most important drivers for the environment, with effects ranging from GHG emissions to material consumption and pollution, to issues related to the ocean and atmosphere.

Infrastructure, including for transport, has seen continued growth. For example, the length of motorways has continued to grow, though at a slower rate than formerly (see figure 10). At the same time, motor transport has continued to see growth, which has accelerated in some countries. However, Finland was able to decrease motor vehicle movements between 2010 and 2017, since which time they have remained stable. Norway and Sweden have also seen zero growth since 2017 (see table 24). Land-based public transportation has been increasing and railway passenger traffic has grown (see figure 11). However, this trend – among others – has likely been reversed by the effects of the COVID-19 pandemic.

Figure 10 Motorway length, pan-European region excluding Central Asia and Eastern Europe, 1995–2019
(Kilometres)



Source: ECE Statistical Database, "Transport". Available at https://w3.unece.org/PXWeb/en (accessed on 2 February 2022). No data for Albania, Belgium, Bosnia and Herzegovina, Bulgaria, Greece, Iceland, Malta, Montenegro, San Marino and Serbia. Interpolation used to fill gaps in data for Andorra, Denmark, Israel, Italy, Latvia, Liechtenstein, Monaco, Norway, Spain, Switzerland and the United Kingdom.

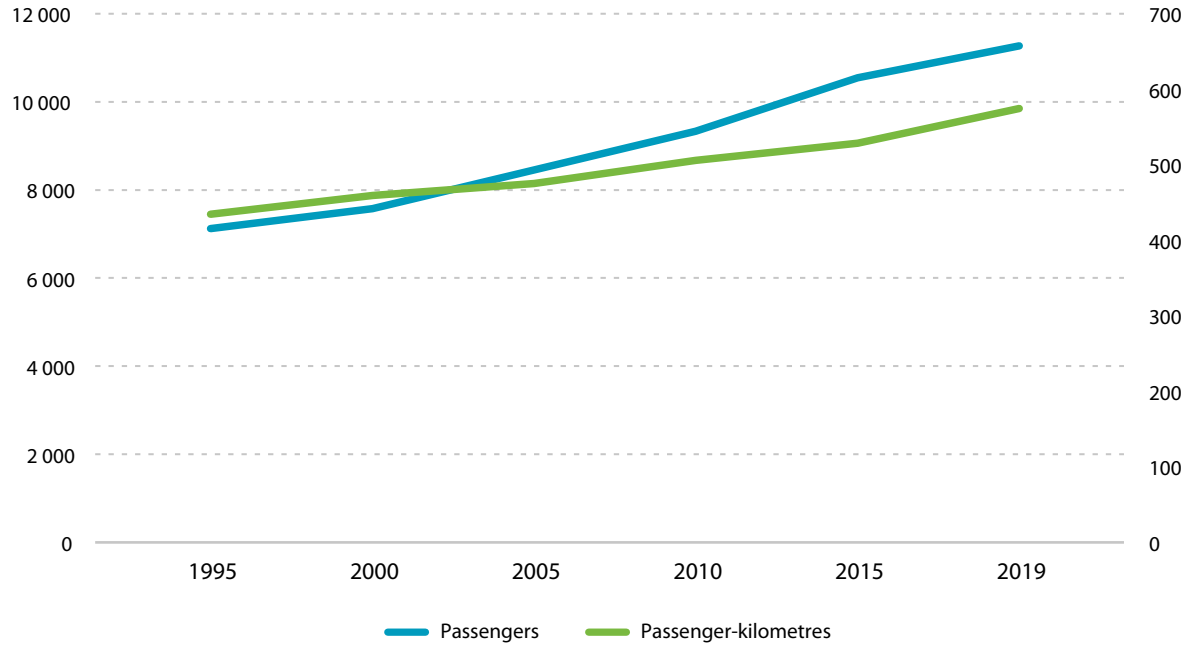
Table 24 Motor vehicle movements on national territory, irrespective of country of registration, selected countries, 2000–2019 (Millions of vehicle-kilometres)

	2000	2010	2017	2019	Change 2000 to latest Percentage
Türkiye	56 151	80 124	127 997		128
Estonia	6 441	8 355	10 811	11 659	81
Slovenia	13 346	17 826	21 346	21 886	64
Norway	32 669	43 847	46 791	47 065	44
Austria	65 143	75 957	86 854		33
Czechia	40 490	46 381	54 558	56 401	39
Hungary	32 974	no data	43 016	46 416	41
Switzerland	52 873	60 036	67 822	69 265	31
Sweden	69 667	76 836	83 896	83 723	20
Spain	208 508	241 131	244 661	252 055	21
France	525 787	560 429	606 042	622 988	18
Netherlands	126 660	130 192	139 850	142 259	12
Finland	46 710	54 715	51 386	51 548	10
United Kingdom	478 376	495 917	526 423		10

Source: ECE Statistical Database, "Transport" (accessed on 2 February 2022).

Note: Latest data for Czechia and Slovenia are from 2018, posted in 2019 column.

Figure 11 Railway passenger traffic, national and international, 1995–2019
(Millions of passengers (left axis) and Billions of passenger-kilometres (right axis))



Source: ECE Statistical Database, "Transport" (accessed on 2 February 2022). Interpolation used to fill gaps in data for numbers of passengers in Belarus, Denmark, Germany, Greece, Israel, Luxembourg, Norway, Portugal, the United Kingdom and Uzbekistan. Insufficient or no data on numbers of passengers for Albania, Andorra, Armenia, Belgium, Georgia, Kyrgyzstan, Liechtenstein, Monaco, Montenegro, the Russian Federation, San Marino, Serbia, Tajikistan and Turkmenistan, which together accounted for approximately 2,000 million passengers in 1995 and 1,100 million passengers in 2019. Interpolation used to fill gaps in data for passenger-kilometres in Azerbaijan, Belarus, Bosnia and Herzegovina, Denmark, Germany, Greece, Israel, Kazakhstan, the Netherlands, Norway, the Republic of Moldova, Ukraine, the United Kingdom and Uzbekistan. Insufficient or no data on passenger-kilometres for Andorra, Armenia, Belgium, Georgia, Kyrgyzstan, Liechtenstein, Luxembourg, Monaco, Montenegro, the Russian Federation, San Marino, Serbia, Tajikistan and Turkmenistan, which together accounted for approximately 200 billion passenger-kilometres in 1995 and 150 billion passenger-kilometres in 2019.

According to the International Energy Agency (IEA),[39] aviation CO_2-equivalent emissions rose rapidly, at an average annual rate of 2 per cent during the period 2000–2019, with commercial passenger flight activity since 2000 rising 5 per cent annually. The energy intensity of commercial passenger aviation has decreased 2.8 per cent per year on average, but improvements have slackened over time. This is due to operational and technical efficiency measures adopted by commercial airlines, including new aircraft purchases. But most (over 99.5 per cent) aviation relies on jet kerosene, and sustainable alternatives will need many years to be developed on a mass scale.[40]

Maritime transport remains the main gateway to the global marketplace, with around 90 per cent of all goods moved across the world by ships.[41] Map 1 shows the vast scale of the shipping sector globally, with a focus on the pan-European region, highlighting the most important and busiest ports and the most used shipping routes. Transport of oil and chemicals predominates in the North Sea, the southern parts of the Caspian Sea and inland transport from the Azov Sea. The Mediterranean Sea also hosts major oil transportation lanes, notably with oil shipments through two of the six major oil chokepoints worldwide, the Suez Canal/SUMED Pipeline and the Turkish straits, which together

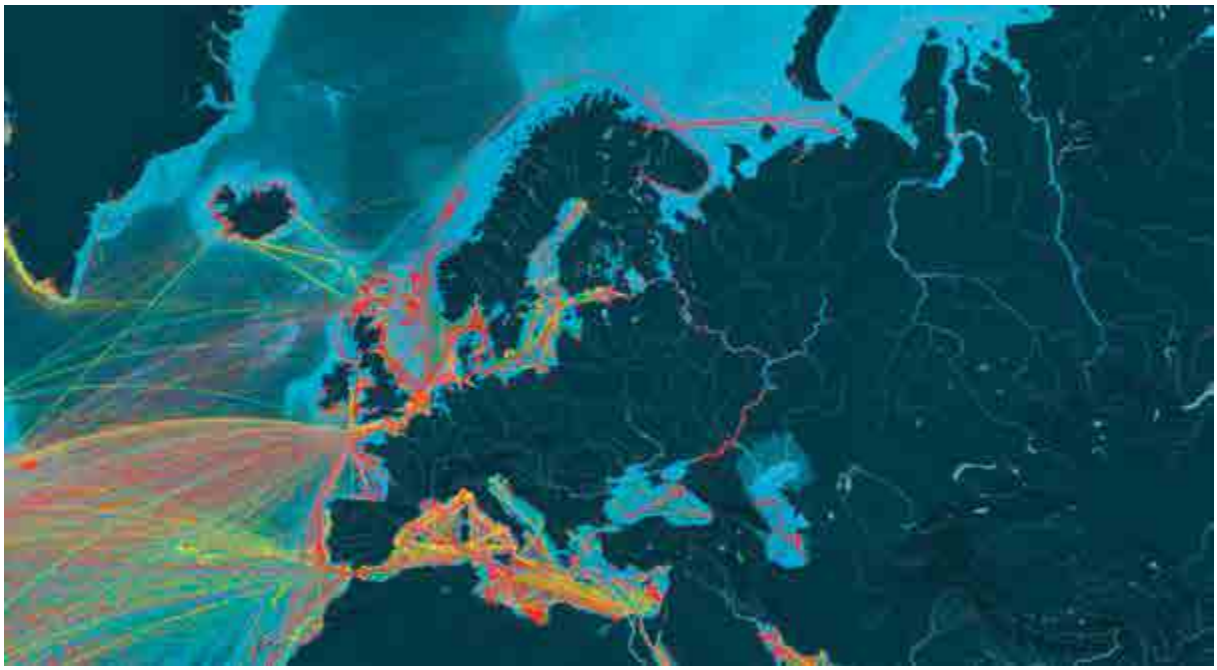
39 International Energy Agency (IEA), "Tracking aviation 2020", Tracking report June 2020.

40 According to the same report, near- to mid-term priorities include implementing fiscal and regulatory measures that promote exploitation of operational and technical efficiency and managing the investment risks derived from developing and deploying clean-sheet airframes, new engines and propulsion systems, and for production of low-lifecycle-GHG-emissions sustainable aviation fuels.

41 OECD, "The ocean: ocean shipping and shipbuilding".

accounted for 13.24 per cent of the world's seaborne oil trade in 2015.[42] The increasing container volumes and ship sizes have exacerbated the need to improve port infrastructure and move towards deep-water terminals better able to process larger and more efficient ships.

Map 1 **Movements of ships in the global merchant fleet in the pan-European region during 2012** (the most recent year with complete data)



Source: www.shipmap.org, courtesy of https://www.kiln.digital/.

Notes: Colour code: yellow: container (e.g. manufactured goods); blue: dry bulk (e.g. coal, aggregates); red: tanker (e.g. oil, chemicals); green: gas bulk (e.g. liquefied natural gas); purple: vehicles (e.g. cars).

Tourism is a vital economic sector for certain Mediterranean countries (the Mediterranean region hosted around 27 per cent of global international tourism in 2017), as well as other coastal tourism hotspots. The contribution of tourism to climate change is estimated to be 8 per cent,[43] and transport is responsible for the majority (75 per cent) of tourism emissions. Travel distance and modal choice are the key determining factors in tourism transport emissions. The combination of strong increases in transport speed and low fares through the development of air transport were the main drivers of overconsumption of travelled distances.[44] Aviation has become a key driver of overall tourism emissions.

42 UNEP/MAP and Plan Bleu, *SOED 2020*.

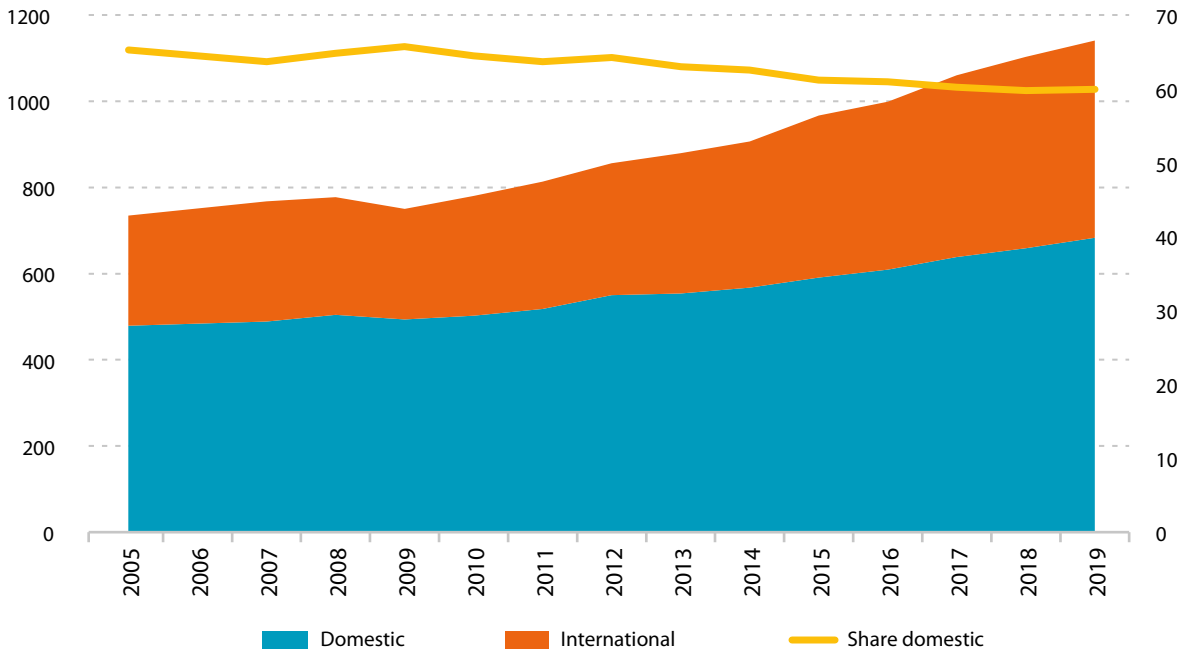
43 Manfred Lenzen and others, "The carbon footprint of global tourism", *Nature Climate Change*, vol. 8 (May 2018).

44 P.M. Peeters, "Tourism's impact on climate change and its mitigation challenges: How can tourism become 'climatically sustainable'?", PhD dissertation, Delft University of Technology, 2017.

Figure 12 shows the development of both domestic and international tourism arrivals at all accommodation types for the 28 European Union countries in 2019 (latest data available).[45] Tourism arrivals grew continuously between 2005 and 2019, except for the year 2009 in response to the 2008 economic crisis. The figure also shows the share of domestic arrivals to be consistently above 60 per cent but slowly declining. Only during the economic crisis in 2008 did the share of domestic tourism increase.

The participation of European Union citizens in tourism shows a slow downward trend. This means that the increased consumption of tourism in the European Union is by a slightly decreasing number of people. Both the benefits and the impacts of tourism are becoming less equally distributed over the population.

Figure 12 **Growth of domestic and international arrivals at European Union accommodation (all types), 2005-2019** (Million arrivals per year (left axis) and Percentage (right axis))



Source: Eurostat, "Arrivals at tourist accommodation establishments [TOUR_OCC_ARNAT]", Data Browser. Available at https://ec.europa.eu/eurostat/databrowser/view/TOUR_OCC_ARNAT/default/table?lang=en&category=tour.tour_inda.tour_occ.tour_occ_a (accessed on 10 February 2022) – 28 countries, including the United Kingdom.

Currently, the environmental impacts of tourism are not systematically measured. This failure to measure affects every indicator relevant for the circular economy. The tourism system consists of accommodation, activities, transport at the destination and transport between the source markets and the destinations. For many circular economy indicators, such as waste and water treatment, tourism will not deviate too much from the national performance, simply because a 100 per cent circular economy country will also provide a 100 per cent circular tourism destination. However, the role of tourism is important as long as a country does not yet have a 100 per cent circular economy. Also, the larger the resource requirements (energy, water, land use, food), the more difficult it will be to reach full circularity.

45 In this and the following paragraph, we discuss drivers and pressures on the natural environment based on the development of tourism in the European Union. No comparable data from other subregions of the pan-European region could be found.

At the global level, a few studies show the shares of tourism impacts and the trends. For instance, one paper[46] shows the projected trends between 1900 and 2050 for energy use, water use, land area, food and CO_2 emissions. It states that, in 2010, the global tourism system required: "c.16,700 PJ of energy, 138 km^3 of fresh water, 62,000 km^2 of land, and 39.4 Mt of food, also causing emissions of 1.12 Gt CO_2. Despite efforts to implement more sustainable forms of tourism, analysis indicates that tourism's overall resource consumption may grow by between 92 per cent (water) and 189 per cent (land use) in the period 2010–2050. To maintain the global tourism system consequently requires rapidly growing resource inputs, while the system is simultaneously becoming increasingly vulnerable to disruptions in resource flows."

The above figures are for the global domestic plus international tourism system, but it is likely that tourism in the pan-European region accounts for a share proportionate to the number of trips in the pan-European region of global trips.

The situation is different for climate change. The impact of tourism on climate is mainly (75–80 per cent) caused by transport between home and destination, and the largest share is from air transport, even though only some 20–25 per cent of all trips are by air. An important gap in tourism measurement is measuring the distances tourists travel per transport mode. The most recent study on the subject is from 2004.[47] Air transport statistics are more detailed, but only in terms of number of passengers, not passenger-kilometres. The number of passengers carried per year in the European Union increased between 2009 and 2019 by 52–56 per cent, but fell back to 40 per cent of the 2009 value in 2020, and 28 per cent of the 2019 level due to the pandemic. Taking the United Nations World Tourism Organization (UNWTO) definition of a tourist (International Recommendations for Tourism Statistics, ST/ESA/STAT/SER.M/83/Rev.1), and thus including leisure, visiting family and friends and business trips that comprise at least one night's stay, most (over 90 per cent) air transport is tourism related. Tourism takes around 10 per cent of other transport modes. As transport statistics use rather different trip purpose definitions, data using the UNWTO tourism definition are very difficult to extract.

The main drivers of the tourism system are GDP per capita levels, and cost and speed of transport. The average number of trips per capita in a country, region or city follows a surprisingly linear relationship with GDP per capita, but with a cap at about five trips per year per capita.[48] So the total number of trips in the pan-European region will develop proportionally to the population size and the differentiated GDP per capita.

However, destination choices and transport modes and distances travelled depend not only on GDP per capita but also on the cost and travel times of the supplied transport systems.[49] These choice processes are very complex because people do not only react to the speed and cost of the transport mode of their choice but are also affected by the perceived cost and speed of other transport modes. Furthermore, the destination choice, and particularly the distance a tourist is prepared to travel, depends highly on the speed and cost of the transport system provided. Therefore, the main drivers of how tourism is shaped and what its impacts are on circularity are the speed and cost of the whole complex of infrastructure (infrastructure, software, marketing, etc.) of car, bus, train, ferry and air transport and their relationships and connectedness.

46 Stefan Gössling and Paul Peeters, "Assessing tourism's global environmental impact 1900–2050", *Journal of Sustainable Tourism*, vol. 23, No. 5 (2015).

47 P.M. Peeters, T. van Egmond and N. Visser, "European tourism, transport and environment: second draft deliverable 1 for the DG-ENTR MusTT project, NHTV Centre for Sustainable Tourism and Transport: final draft" (Breda, 2004).

48 P.M. Peeters and M. Landré, "The emerging global tourism geography – an environmental sustainability perspective", *Sustainability*, vol. 4, No. 1 (2012).

49 The statements in this paragraph are all based on P. M. Peeters, "Tourism's impact on climate change and its mitigation challenges."

Legislative drivers with respect to the environment are diverse and sometimes complex. The main drivers for infrastructure are resource and energy use and emissions of nitrogen oxides ($NO_{x)}$ and particulate matter (PM). Climate policies can also have a strong impact on the cost and even speed of transport systems. Both shipping and air transport are hard-to-abate sectors,[50] meaning these sectors do not have many options to mitigate and have not implemented any at scale. For tourism, zero emissions are achievable for buildings, surface transport and short-distance ferries. For railways in particular, there are several national systems that are already almost entirely running on renewables (e.g. in Austria, the Netherlands, Sweden and Switzerland). The environmental impact of different modes of transport depends, however, on various factors, including the number of passengers by means of transport, electrification of railways and production of energy. Electric cars potentially become zero emissions as soon as electricity production reaches that goal. The resources for batteries are still a potential barrier to significant uptake of electric cars, as, despite increasing attempts at recycling, the total battery capacity needed is challenging for circular resource use,[51] which is not a problem with rail transport. Overall, less frequent travel and shorter distances combined with efforts to get more tourists travelling by more environmentally friendly means should have the highest priority. In the European Union and partly beyond, there are already tools available to compare the energy consumption, CO_2 and exhaust atmospheric emissions for planes, cars and trains for passenger transport, to allow consumers to make informed and environmentally friendly travel decisions.[52]

For aviation, decarbonization is still in the initial development phase. Apart from the less than 0.5 per cent mixing alternative (bio-)fuels, only business-as-usual improvements of aircraft efficiency have been achieved. Currently, developments in advanced waste-based fuels and synthetic e-fuels are picking up speed in several countries. E-fuels potentially reach zero emissions for flights using 100 per cent of these fuels. However, the renewable energy input for producing such fuels is very high. Current processes run at some 20 per cent efficiency,[53] which means that the energy use of flight-based tourism will increase by a factor of five if this is not improved. But even with large-scale efficiencies expected by experts, of up to 60 per cent,[54] the e-fuel aviation system might consume about 20 per cent of all renewables expected up to 2050. Clearly, such a share of renewable energy of 20–25 per cent for tourism alone might not be societally justifiable. This limitation is a substantial one to the growth of aviation and an additional argument to shift as much as possible towards less frequent travel, shorter distances and the use of more environmentally friendly means of transport. It will change the geographical spread of tourism towards more domestic, more short-haul and a smaller share of long-haul travel, and a more circular operating industry, while ensuring that tourism remains an important economic sector in many countries.

50 Energy Transitions Commission (ETC), *Mission Possible: Reaching Net-zero Carbon Emissions from Harder-to-abate Sectors by Mid-century* (London, 2018).

51 See, for example, C.M. Costa and others, "Recycling and environmental issues of lithium-ion batteries: advances, challenges and opportunities", *Energy Storage Materials,* vol. 37 (May 2021).

52 See, for example, Ecopassenger, http://ecopassenger.org.

53 Personal communication in extension to information given by Atmosfair at https://www.atmosfair.de/en/air_travel_and_climate/flugverkehr_und_klima/sorgenfrei-fliegen-mit-e-kerosin/.

54 See, for example, Patrick Schmidt and others, "Power-to-liquids as renewable fuel option for aviation: a review", *Chemie Ingenieur Technik*, vol. 90, No. 1-2 (January/February 2018).

III.

ENVIRONMENTAL STATE AND TRENDS

INTRODUCTION

This chapter discusses the environmental state, trends and policy responses, using the ECE set of environmental indicators,[55] Sustainable Development Goal indicators and other indicator frameworks as appropriate. The indicators used have been selected based on the following criteria: policy relevance; soundness of the methodology, preferably based on national sources; data availability; and coverage of pressures, state and impacts. The chapter addresses eight environmental themes:

- Atmospheric air and the ozone layer
- Climate change and greenhouse gas emissions
- Fresh water
- Coastal waters, marine ecosystems and seas
- Biodiversity and ecosystems
- Land and soil
- Chemicals and waste
- Environmental financing and public spending on environmental protection.

For each theme, key messages and policy recommendations are presented based on an assessment of the state, trends and outlook towards meeting policy objectives. Key messages and recommendations derived from the assessment are provided also in the summary at the beginning of this assessment. Links are provided to circular and green economy, sustainable development and the two conference themes.

A. Atmospheric air and the ozone layer

1. Key messages and recommendations

Key messages

The health impact of long-term exposure to fine particulate matter with a diameter less than 2.5 µm ($PM_{2.5}$) in 41 European countries was reduced by 13 per cent in the period 2009–2018 and that of nitrogen oxides (NO_x) by 54 per cent. However, the number of premature deaths due to ground-level ozone exposure increased in that period by an estimated 24 per cent, possibly caused by higher mean temperatures.[56]

The Montreal Protocol on Substances that Deplete the Ozone Layer (Montreal Protocol) has had positive effects on human health and the environment. The phasing out of hydrochlorofluorocarbons present as coolant in refrigerators and air conditioning systems remains incomplete, especially in countries with economies in transition.

Emissions measurement and ambient air pollution monitoring have improved in the past decade, with more appropriate equipment, advanced portable sensors and network strategies leading to greater efficiency and lower costs of ground-level monitoring stations, and they are increasingly available.[57] In the pan-European region, there are still monitoring gaps, especially in the measurement and analysis of fine PM.

55 For a list and guidance, see "Guidelines for the application of environmental indicators", at https://unece.org/guidelines-application-environmental-indicators.

56 EEA, "Air quality in Europe – 2020 report", EEA Report, No. 9/2020 (Luxembourg, Publications Office of the European Union, 2020).

57 Real-time air polluting concentrations and air pollution indices are available and are published on maps by different providers (e.g. IQAir, see http://iqair.com). Since 2015, the European Copernicus Atmosphere Monitoring Service (http://atmosphere.copernicus.eu) has provided continuous satellite data and information on atmospheric composition. The Service tracks air pollution, solar energy, GHGs and climate forcing globally.

Countries in the region are expanding policies to tackle air pollution. The evaluation and fitness check of existing European Union air quality legislation in 2019,[58] for example, led to proposals to strengthen provisions on monitoring, modelling and air quality plans to achieve cleaner air. The European Union air quality standards will, as a result of a fitness check, be revised to align them more closely with the World Health Organization (WHO) Air Quality Guidelines, which were updated in 2021.[59] The Russian Federation is implementing the "Clean Air" project,[60] which provides for significant reduction of pollutants in 12 large industrial centres by 2024, as well as a radical modernization of the State system for monitoring air pollution in these cities.

Recommendations

Cooperation should be enhanced so that non-European-Union countries in the region could have the possibility to benefit from the experience on the European Union zero-pollution action plan.[61]

Governments should develop additional technical and organizational measures to achieve target 3.9 of the Sustainable Development Goals, especially for fine particulate matter and ground-level ozone. The collection and analysis of data disaggregated by age and sex is a crucial step in support of policy formulation. Key responses are the sharpening and application of best available techniques to prevent emissions of particulate matter, nitrogen oxides and hydrocarbons by industry, emissions reduction from traffic (by implementing measures for Euro-6 and Euro-7 emissions standards) and, for example, by applying higher standards for domestic heating appliances.

Governments should contribute or urge donors to contribute to the adequate replenishment of the Multilateral Fund for the implementation of the Montreal Protocol in order to accelerate the phasing out of hydrochlorofluorocarbons globally.

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58 European Commission, "Fitness check of the Ambient Air Quality Directives", Commission Staff Working Document, SWD(2019) 427 final (Brussels, 2019).

59 WHO, *WHO Global Air Quality Guidelines: Particulate matter ($PM_{2.5}$ and PM_{10}), Ozone, Nitrogen Dioxide, Sulfur Dioxide and Carbon Monoxide* (Bonn, WHO European Centre for Environment and Health, 2021).

60 Full information on the project is available at https://rpn.gov.ru/activity/fresh-air/info/.

61 European Commission, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Pathway to a Healthy Planet for All: EU Action Plan: "Towards Zero Pollution for Air, Water and Soil", COM(2021) 400 final.

Governments should promote the use of appropriate and standardized methods for monitoring air pollution emissions[62] and the public availability of monitoring data in the pan-European region, while also strengthening cooperation and national investment to fill monitoring gaps in countries with economies in transition.

2. Context

Emissions of substances such as sulfur dioxide (SO_2), carbon monoxide (CO) and lead (Pb), which were problematic in the second half of the twentieth century, have been reduced worldwide. Others, such as PM, NO_x and ammonia (NH_3), have increased in many areas. In the past 40–50 years, policy measures to reduce air pollution have been developed at the national level and through successful international cooperation, such as the ECE multilateral environmental agreements (see chapter I) or European Union directives and guidelines. Since 2016, 27 countries and various organizations have submitted commitments to the Batumi Action for Cleaner Air.[63]

For the pan-European region, the Convention on Long-range Transboundary Air Pollution (Air Convention), with its 51 parties and various protocols, has initiated actions, founded on scientific arguments, to deal with the long-term challenges of air pollution. The 1999 Protocol to Abate Acidification, Eutrophication and Ground-level Ozone, as amended in 2012, is the leading instrument for setting national emissions ceilings for SO_2, NO_x, NH_3, volatile organic compounds (VOCs) and $PM_{2.5}$ to be achieved by 2020 and beyond. As black carbon (soot, a short-lived climate pollutant) is included in the PM fraction, climate co-benefits are also achieved. Other key protocols of the Air Convention are the Protocol on Heavy Metals and the Protocol on Persistent Organic Pollutants. Based on the emissions data from the European Pollutant Release and Transfer Register (E-PRTR), the EEA has estimated that, in 2017, emissions of air polluting substances and GHGs have cost society between 277 and 433 billion euros (2–3 per cent of EU GDP). Of the 11,655 facilities reporting in the E-PRTR, just 211 large industrial sites caused 50 per cent of the aggregated damage cost.

Air quality in the pan-European region remains moderate and unhealthy for sensitive groups in many regions, particularly in urban and industrial areas, despite some sizable reductions in ambient concentrations, and air pollution is still considered the most important environmental risk to human health. At present, PM, nitrogen dioxide (NO_2) and ground-level ozone (O_3) are the substances that have the most serious impacts on human health, even when concentrations do not exceed current established limit values.[64]

3. Status, main trends and recent developments

Air pollution in Europe has generally decreased in European Union and Western European countries in recent decades and increased in the countries of Central Asia and Eastern Europe, mainly through economic growth. Joint efforts of national and regional authorities have not yet led to all desired results, as some air quality standards are still exceeded, especially in urban areas.

The health impact of long-time exposure to $PM_{2.5}$ in 41 European countries was reduced by 13 per cent in the period 2009–2018 to 417,000 premature deaths (4.8 million years of life lost). For NO_x, the health impact was reduced by 54 per cent to 55,000 premature deaths (624,000 years of life lost) in the same period. However, the number of premature deaths due to ground-level ozone exposure increased in this period by an estimated 24 per cent to 20,600 (247,000 years of life lost), possibly caused by higher mean temperatures.[65]

62 For example, as described in European Union Best Available Techniques reference documents and their equivalents in the Russian Federation.

63 Available at https://unece.org/baca.

64 EEA, "Air quality in Europe – 2020 report".

65 Ibid.

In the Russian Federation, the number of cities with high and very high air pollution decreased by 70 per cent in the period 2010–2019 (based on air pollution indices). The Government of the Russian Federation has instructed the authorities in big cities such as Moscow and St. Petersburg to develop a road map to set up restrictions for heavily polluting traffic (under Euro-3).[66] In other countries of Central Asia and Eastern Europe, there have been similar developments in the field of fuel quality. In Uzbekistan, over 50 per cent of private cars and trucks use cleaner natural gas as fuel.[67]

The global BreatheLife campaign,[68] led by WHO, UNEP and the Climate and Clean Air Coalition, was launched in 2016 and calls on Governments to commit to achieving the WHO Air Quality Guidelines targets in 2030. The aim of the campaign is to halve the number of air-pollution-related deaths by 2030, while helping to slow the pace of climate change. Within the Coalition, more than 70 States have founded a voluntary partnership with intergovernmental organizations, NGOs, cities and financial and business institutions, aimed at reducing emissions of short-lived climate pollutants (black carbon, methane, hydrofluorocarbons and tropospheric ozone). The WHO Guidelines were revised in 2021 and recommend air quality levels for the six pollutants for which evidence is most advanced in terms of health effects from exposure. When action is taken on these so-called classical pollutants – particulate matter (PM), ozone (O_3), nitrogen dioxide (NO_2) sulfur dioxide (SO_2) and carbon monoxide (CO) – it also has an impact on other damaging pollutants.

66 Konstantin Fomin, "How Russian cities are cleaning up their air", Greenpeace, 30 April 2019.

67 *Environmental Performance Reviews: Uzbekistan – Third Review* (United Nations publication, Sales No. E.20.II.E.26).

68 See https://breathelife2030.org.

The Second European Union Clean Air Forum (2019) discussed differences between the European Union air quality guidelines and their mostly more stringent WHO equivalents (the 2005 version at that time) and ways to close this gap. The European Union clean air policy framework to abate air pollution includes three pillars: air quality standards, national emission ceilings for key pollutants and emission limit values for key sources of pollution. The 2019 fitness check of the European Union Ambient Air Quality Directive[69] showed that not all the Directive's targets have been met and that the gap to achieve air quality standards is wide in some cases, thus requiring improvement of existing legislation. In specific cases, stricter emission ceilings in the National Emission Ceilings Directive[70] or more stringent emission limit values in the Industrial Emissions Directive[71] and for mobile sources could be necessary to meet the policy challenge to achieve all European Union air quality standards as a first step to achieving their WHO equivalents in 2030. In 2021, the European Commission adopted a Zero Pollution Action Plan.

The EEA and the European Commission launched the European Air Quality Index in 2017, which provides online information on the air quality situation, based on measurements from more than 2,000 air quality monitoring stations across Europe. An interactive map shows the local air quality situation at station level, based on five key pollutants: $PM_{2.5}$, PM_{10}, ground-level ozone, NO_2 and SO_2.

At the global level, the United Nations General Assembly adopted resolution A/RES/74/212 on the International Day of Clean Air for blue skies (first held on 7 September 2020). UNEP, in collaboration with the Climate and Clean Air Coalition and WHO, coordinated activities for the International Day, to raise public awareness, demonstrate the connection with the Sustainable Development Goals and promote and facilitate solutions for air protection.

4. Indicators

Emission of pollutants into the atmospheric air (ECE, pressure indicator)

Within the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP), 43 of the 51 parties to the Air Convention submitted their emission inventories in 2020. Nevertheless, the quality of data varies widely, generating uncertainty. Experts and modellers are working on a solution towards establishing a harmonized emissions methodology.

In the period 2000–2019, emissions of the main pollutants (SO_2, NO_x, NH_3, non-methane VOCs, PM_{10}, $PM_{2.5}$, PM_{coarse} and black carbon) have shown a major decoupling from economic growth and an absolute decrease in the western part of the region. In the countries of Central Asia and Eastern Europe, emissions have increased since 2000, but these emissions are often based on expert estimates extrapolated from GDP growth trends, due to the lack of plausible reporting. Figures 13 and 14 show strong decreases in emissions of SO_2 and NO_x, while decreases for $PM_{2.5}$ are much smaller (see figure 15).

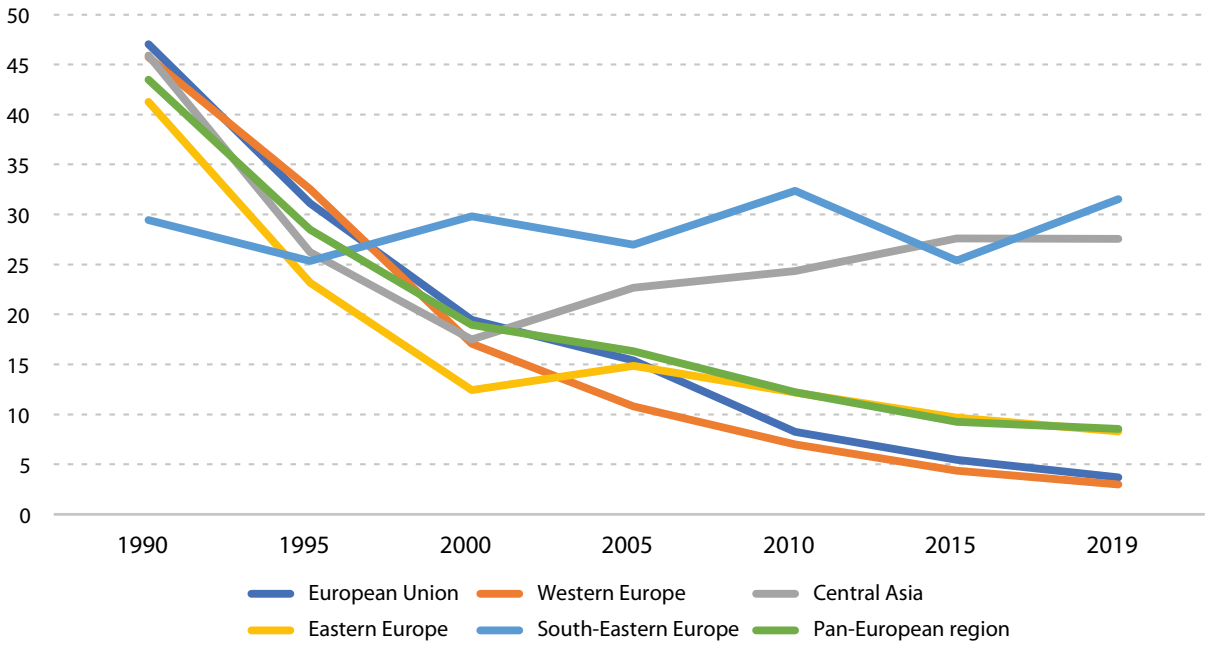
The largest decoupling between economic growth and production and air polluting emissions in recent decades has occurred in the energy-producing sector and manufacturing industry. Emissions from the road and non-road transport sector also decreased considerably as a consequence of stringent emission standards set at the European Union level and also, with some delay, in the pan-European region. The agriculture and waste sectors had significantly lower reductions in emissions. The residential, commercial and institutional sector did not reduce its emissions very much, except for SO_2 emissions.

69 Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe, *Official Journal of the European Union*, L 152, vol. 51 (11 June 2008), pp. 1–44.

70 European Union Directive 2016/2284 of the European Parliament and of the Council of 14 December 2016 on the reduction of national emissions of certain atmospheric pollutants, amending Directive 2003/35/EC and repealing Directive 2001/81/EC, *Official Journal of the European Union*, L 344, vol. 59 (17 December 2016), pp. 1–31.

71 Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control), *Official Journal of the European Union*, L 334, vol. 53 (17 December 2010), pp. 17–119.

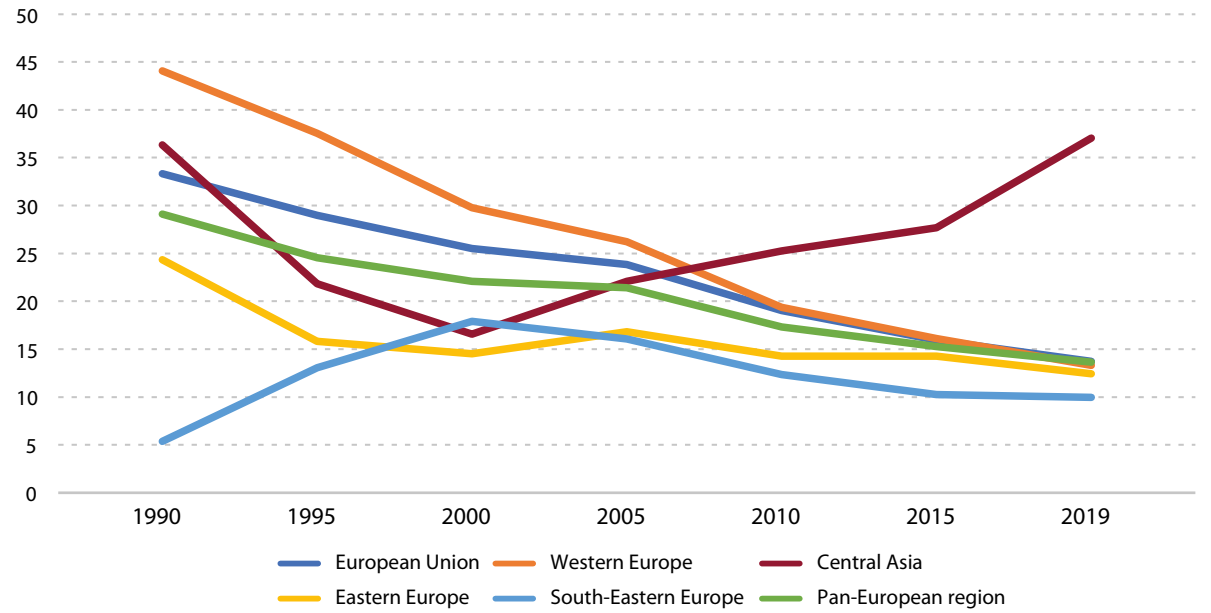
Figure 13 Emission trends for SO_2, 1990–2019 (Kilograms per capita per annum)



Source: EMEP, CEIP, "Officially reported emissions data" (accessed on 17 September 2021); for population data, ECE Statistics Database, 2019 or latest (accessed on 1 February 2022).

Notes: No data for Andorra, Bosnia and Herzegovina (except 1992), Israel and San Marino; for Central Asia, data only for Kazakhstan and Kyrgyzstan; gaps for Armenia, Azerbaijan, Belarus and Ukraine; Azerbaijan and Kyrgyzstan use 2017 data instead of 2019 data.

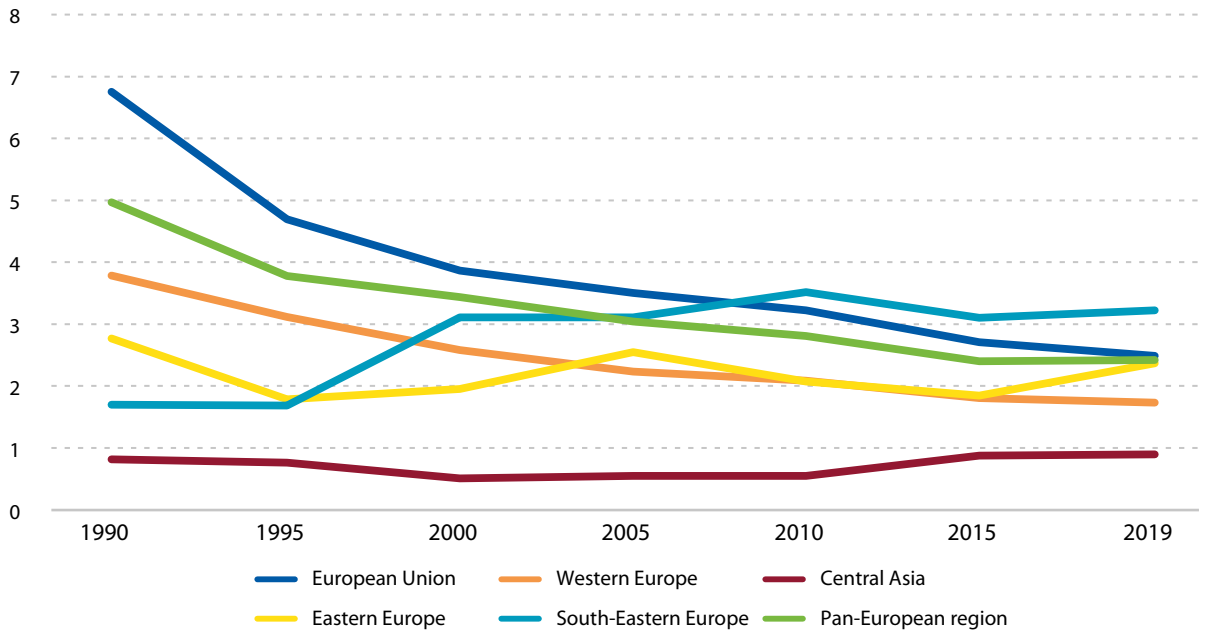
Figure 14 Emission trends for NO_x, 1990–2019 (Kilograms per capita per annum)



Source: EMEP, CEIP, "Officially reported emissions data" (accessed on 17 September 2021).

Notes: No data for Andorra, Bosnia and Herzegovina, Israel and San Marino; for Central Asia, data only for Kazakhstan and Kyrgyzstan; gaps for Armenia; Azerbaijan and Kyrgyzstan use 2017 data instead of 2019 data.

Figure 15 Emission trends for $PM_{2.5}$, 1990–2019 (Kilograms per capita per annum)



Source: EMEP, CEIP, "Officially reported emissions data" (accessed on 17 September 2021).

Notes: No data for Andorra, Bosnia and Herzegovina, Israel and San Marino; no data for 1992 and 1995 for Estonia, Hungary, Slovenia and Spain; for Central Asia, data only for Kazakhstan and Kyrgyzstan; gaps for Armenia, Belarus, the Russian Federation and Ukraine; Azerbaijan and Kyrgyzstan use 2017 data instead of 2019 data.

Ambient air quality in urban areas (ECE, state indicator)

Improvements in air quality monitoring and reporting in the past 15–20 years make it possible to assess and report air quality trends in a qualitative, sound statistical way. Long-term records of concentrations of the limited number of air polluting substances regulated in the European Union Ambient Air Quality Directive are available for European Union member States, Iceland, Norway, Switzerland and the United Kingdom.[72] Countries in Central Asia and some Eastern European countries perform reporting of air quality by a different method in the form of air pollution indices, in which three different indicators are used to assess air quality. These indicators make it possible to characterize both short-term air pollution and the chronic impact of air pollution on public health and the environment. The assessment of air quality in the countries of Central Asia and Eastern Europe also includes specific pollutants for which hygiene standards have been established (more than 700 substances, for 160 of which State regulation measures are applied). The air quality category established by a set of indicators considers the main pollutants for each city, as assessed relative to standards. Assessments for specific pollutants that make the greatest contribution to air pollution levels in cities are regularly published online.

SO_2 concentrations show the largest decrease of the main pollutants in the pan-European region over the past 20 years, with mean European Union values showing a 70 per cent reduction at traffic monitoring stations and 85 per cent reduction at monitoring stations in urban background and industrial areas. In the past few years, the decrease of SO_2 concentrations has slowed. For ambient NO_x concentrations in the European Union, the mean reduction of 25–35 per cent over the past 20 years is similar for all station types, with rural stations having the largest decrease. The phasing out of combustion engines in automobiles is expected to accelerate the decrease of NO_x concentrations in

72 Augustin Colette and Laurence Rouïl, "Air quality trends in Europe: 2000–2017: assessment for surface SO_2, NO_2, Ozone, PM_{10} and $PM_{2.5}$", Eionet Report, No. ETC/ATNI 2019/16 (Kjeller, Norway, European Topic Centre on Air Pollution, Transport, Noise and Industrial Pollution, 2020).

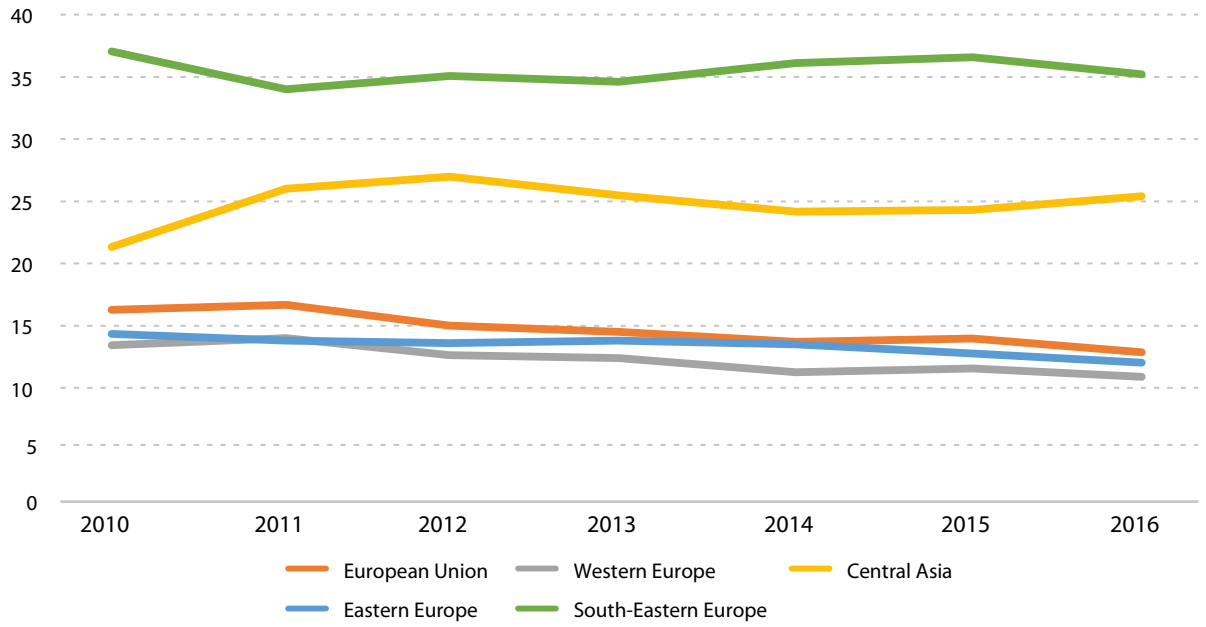
urban and suburban stations in the next 10 years. Annual mean ground-level ozone trends in Europe over the past 20 years did not show significant trends or else increased by around 20 per cent for traffic stations, with 25 per cent of these sites showing increases of 40 per cent or more, while high ozone peaks have decreased by about 10 per cent except at traffic stations. The increase of mean ozone concentrations is coupled with the reduction of NO_x and VOC emissions. From 2000, annual mean PM_{10} concentrations in Europe have decreased by 40–50 per cent for all stations, with the largest reduction at industrial monitoring stations, while the reduction of $PM_{2.5}$ was around 30 per cent (measured relative to 2008). Regional differences occur with seasonal peaks of PM concentrations in areas where mostly wood is used for domestic heating, such as South-Eastern Europe, Eastern Europe and Central Asia. Figure 16 illustrates the changes in $PM_{2.5}$ concentrations in the period 2010–2016.

Consumption of ozone-depleting substances (ECE, response indicator)

Ozone-depleting substances (ODSs) are being phased out, although certain limited essential uses are still allowed, such as laboratory use and firefighting in special cases. Consumption of ODSs in the 27 member States of the European Union (production, plus imports, minus exports and destruction) has been negative since 2012, falling from 343,000 ozone-depleting potential (ODP) tons in 1986.[73] In the countries of Central Asia and Eastern Europe, the consumption of ODSs fell from 243 to 34 tons and in the Russian Federation from 684 to 287 tons in the period 2014–2019.[74] Figure 17 provides an overview of hydrochlorofluorocarbon consumption per capita in the period 2010–2019.

The emission of ODSs today has been reduced by 98 per cent compared with 1990 levels. Obligations for parties to the Montreal Protocol are the gradual phase-out of production and consumption of the controlled substances according to specific timelines, reporting of data on the production, use, import and export to the Ozone Secretariat and establishing an import and export licensing system.

Figure 16 Concentrations of fine particulate matter ($PM_{2.5}$) by subregion, 2010–2016 (µg/m³)



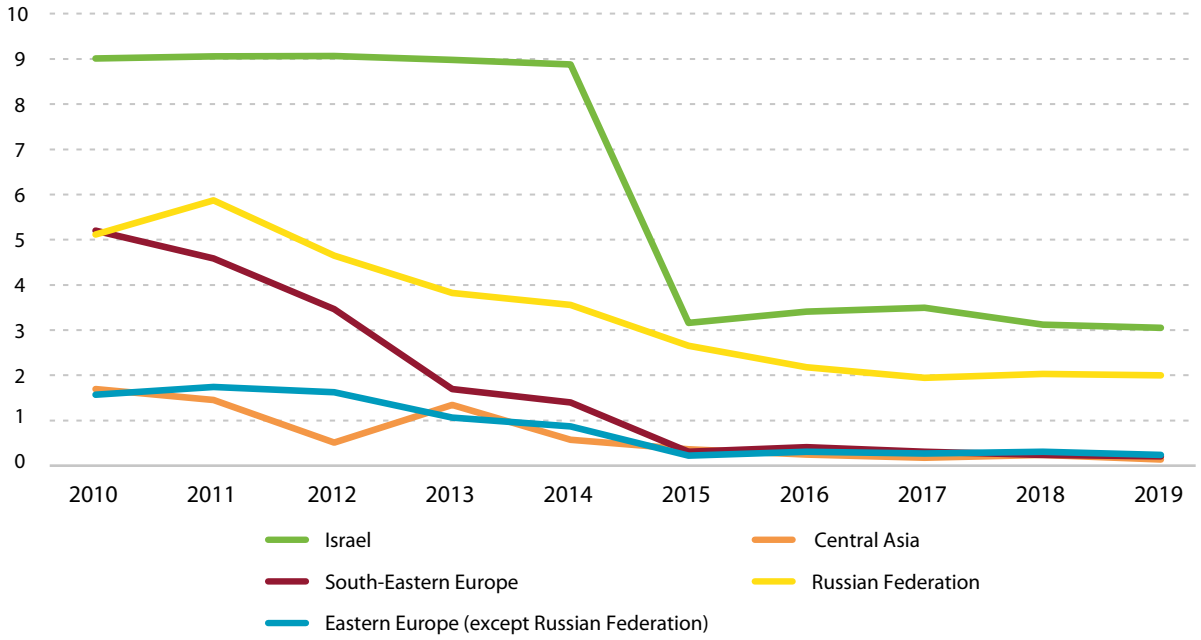
Source: WHO, Global Health Observatory. Available at www.who.int/data/gho/data/indicators/indicator-details/GHO/concentrations-of-fine-particulate-matter-(pm2-5) (accessed on 7 May 2021).

Notes: Regional values are population weighted. No data for Liechtenstein. Corresponds to Sustainable Development Goal indicator 11.6.2.

73 European Commission, "Evaluation of Regulation (EC) No 1005/2009 of the European Parliament and of the Council of 16 September 2009 on substances that deplete the ozone layer", Commission Staff Working Document, SWD(2019) 406 final/2 (Brussels, 2020).

74 See http://ozone.unep.org.

Figure 17 Consumption of hydrochlorofluorocarbons, 2010–2019 (ODP grams per capita)



Source: UNEP Ozone Secretariat, "Data in tables", Country Data. Available at https://ozone.unep.org/countries/data-table (accessed on 17 September 2021).

Notes: European Union net consumption below zero since 2010; Western Europe except Israel has zero consumption since 2015, Azerbaijan and Belarus achieved zero consumption in 2019, Kyrgyzstan achieved zero consumption in 2020.

In the countries of Central Asia and South-Eastern and Eastern Europe, the consumption of chlorofluorocarbons was phased out completely in the period 2005–2010. Consumption of hydrochlorofluorocarbons has been reduced in the period 2014–2019 from 90 to 27.5 tons ODP (Central Asia and Eastern Europe), from 14.5 to 12 tons ODP (South-Eastern Europe excluding Türkiye) and from 124 to 8.5 tons ODP (Türkiye). For the implementation of the Kigali amendment to the Protocol, Belarus, Kazakhstan, Tajikistan and Uzbekistan follow the same rules as the Russian Federation.

5. Case studies

Three possible sources for case studies are suggested. The first is *Measures to Green the Post-Pandemic Recovery*, recently published by the Issue-based Coalition on Environment and Climate Change, which includes interesting examples under the categories "Transport and Mobility, Climate Action" measure 10 (Chisinau), "Transport, Air Quality, Climate Action" measure 11 (Milan, Amsterdam, Ukraine and Belarus) and "Transport and Mobility, Air Quality, Biodiversity Action" measure 13 (Barcelona (Spain)).[75] The second and third sources are the City of London Corporation's Air Quality Strategy 2019–2024[76] and a case study from South-Eastern Europe under the UNEP regional air quality policy update report for the pan-European region (forthcoming).

75 Issue-based Coalition on Environment and Climate Change, *Measures to Green the Post-Pandemic Recovery* (n.p., 2021).

76 City of London Corporation, "Air Quality Strategy", 18 May 2022.

B. Climate change and greenhouse gas emissions

1. Key messages and recommendations

Key messages

In spite of the commitments related to the reduction of GHG emissions, expressed by all countries in the pan-European region, net GHG emissions in the region are still rising.

Efforts and achievements are unevenly distributed throughout the region. Reductions, which are mostly achieved in the western part of Europe (2014–2018), are three times less than the increase in emissions in the rest of the region.

National commitments under the Paris Agreement were renewed by 35 countries in the region with more ambitious targets. However, some countries still do not have firm, quantifiable commitments or mechanisms to follow the progress towards them, which results in significant data gaps.

While decarbonization becomes a new narrative for Europe, there is a widening gap between rhetoric and action. The use of renewables was increased in 29 countries in the pan-European region in the period 2013–2017, but the region still largely relies on fossil fuels – some 78 per cent of the total final energy consumption on average comes from fossil fuels. The penetration of renewables in the energy mix rises more slowly than the increase in the total final energy consumption in the region.

The estimated population covered by local disaster risk reduction (DRR) strategies in the pan-European region is about 65 per cent. Only 15 countries in the region reported that all their local authorities are implementing DRR strategies under Sustainable Development Goal target 13.1, while 23 countries, which jointly represent one quarter of the region's population, do not report on that target.

Recommendations

Governments in the pan-European region should enhance their commitments under the nationally determined contributions under the Paris Agreement, undertake economy-wide absolute emission reduction targets and regularly report on their progress towards implementation and achievement of their targets.

Governments should establish the conditions for medium- and long-term sustainable mobilization of funds for climate action, by both accelerating the use of available regional and global funds and mechanisms and creating national financial instruments.

Governments should deepen decarbonization by shifting promotion of investments towards renewable energy.

Governments should strengthen awareness of potential hazards, including natural and, in particular, climate-related hazards, especially among poorer communities, and establish conditions to report regularly on Sustainable Development Goal target 13.1, under the Sendai Framework for Disaster Risk Reduction 2015–2030 and on Adaptation Communications and National Adaption Plans under the Paris Agreement.

2. Context

Within the scope of global climate action, all countries of the pan-European region have committed to cut their GHG emissions to limit the increase in global temperature to 1.5°C, as stated in the Paris Agreement.

According to the International Energy Agency (IEA) in 2018,[77] despite a slowing trend, global energy demand may still expand by 30 per cent between 2017 and 2040. Energy use is expected to continue to be the main cause of anthropogenic GHG emissions. The European Union has defined its pathway to decarbonization, with the long-term vision to reduce its GHG emissions by 80–95 per cent by 2050 compared with 1990. In that context, several European Union member States have already stated their intention to phase out coal and lignite completely between 2025 and 2035. Such an objective may be too ambitious and difficult for countries that rely heavily on coal. The countries in the region are in very different situations in terms of their fossil fuel reserves and renewable energy potentials, technological capacities, energy demand patterns, infrastructure and labour and capital markets. While

77 IEA, *World Energy Outlook 2018* (n.p., 2018).

the decarbonization process brings an impetus for development of new low- and zero-carbon technologies, it is necessary to address energy poverty and a just transition.

Urgent adaptation approaches that are systemic, multidimensional and transformative are required to address the impacts of climate change, especially on the most vulnerable communities. The development of local adaptation strategies is increasing throughout Europe. As at April 2019, more than 1,900 local authorities in the EEA member and collaborating countries have made commitments related to adaptation within the Covenant of Mayors for Climate and Energy.[78] A further challenge is to implement those strategies.

3. State, main trends and recent developments

Emissions of GHGs in the pan-European region increased by 1 per cent in the period 2014–2018, while the average carbon footprint per person rose by 0.2 per cent. The Climate Action Progress Report of the European Union, "Kick-Starting the Journey Towards a Climate Neutral Europe", states that, in 2019, GHG emissions were down by 24 per cent from 1990 levels[79] and that the European Union remains on track to achieve its target of reducing GHG emissions by 20 per cent by 2020.

According to the most recent data from IEA,[80] the COVID-19 pandemic generated a 6 per cent overall decline in global energy-related GHG emissions in 2020, hitting a low in April that year. However, in December 2020, global emissions were 2 per cent, or 60 million tons, higher than they were in the same month a year earlier. Globally, financing for climate action has increased substantially, but it continues to be surpassed by investments in fossil fuels.

While renewables are increasing, so is energy demand. The share of modern renewable energy[81] in global final energy consumption has stayed around 10 per cent since 2010. Adding traditional uses of bioenergy, the share of all renewable energy in total final energy is 18 per cent.[82] The IEA report *Net Zero by 2050: A Roadmap for the Global Energy Sector*[83] sets out more than 400 milestones which include, from today, no investment in new fossil fuel supply projects and no further final investment decisions for new unabated coal plants. The pathway calls for annual additions of solar photovoltaic energy to reach 630 GW by 2030 and of wind power to reach 390 GW. Together, this is four times the record level set in 2020. The Roadmap also sets as targets that, by 2035, there will be no sales of new internal combustion engine passenger cars and, by 2040, the global electricity sector has already reached net zero emissions. Included in the Roadmap is a major worldwide push to increase energy efficiency, resulting in improvements in the global rate of energy efficiency averaging 4 per cent per year through 2030 – about three times the average over the last two decades.

The European Union set a new target for increasing renewable energy in final energy consumption to at least 32 per cent by 2030, while non-European Union parties of the Energy Community (Albania, Bosnia and Herzegovina, Georgia, Montenegro, North Macedonia, the Republic of Moldova, Serbia and Ukraine) could not agree on new targets for decarbonization, renewables and energy efficiency for 2030.

The share of energy from renewable sources used in transport activities in the European Union reached 10.2 per cent in 2020,[84] meaning that the 10 per cent target for renewable energy use in transport by 2020 was met. Technological

78 EEA, *The European Environment: State and Outlook 2020*.

79 According to the approximated GHG inventory of the EEA. See EEA, "EU on track to meet greenhouse gas emissions and renewable energy 2020 targets, progress in 2019 shows more ambitious long-term objectives are reachable", 30 November 2020.

80 IEA, "After steep drop in early 2020, global carbon dioxide emissions have rebounded strongly", 2 March 2021.

81 Modern renewables are all renewable energy sources except traditional use of biomass (traditionally used in developing countries for heating and cooking).

82 International Renewable Energy Agency (IRENA), *Global Renewables Outlook: Energy Transformation 2050* (Abu Dhabi, 2020).

83 IEA, *Net Zero by 2050: A Roadmap for the Global Energy Sector*, rev. ed. (n.p., 2021).

84 Eurostat, "Renewable energy statistics: Highlights". Available at https://ec.europa.eu/eurostat/statistics-explained/index.php/Renewable_energy_statistics#:~:text=In%202019%2C%20renewable%20energy%20represented,of%20gross%20final%20energy%20consumption (accessed on 20 June 2022).

development can enable a switch from fossil-fuelled vehicles to clean vehicles. Electric vehicles combined with renewable electricity generation are seen as a promising approach to decarbonize a substantial fraction of road transportation. However, electric vehicles represent only 0.2 per cent of the European Union's total vehicle fleet and, if they continue to penetrate the market at the current growth rate, it will take around 60 years for them to reach 50 per cent of the current passenger car fleet.[85] At the global level, the share of renewables in the transport sector was 3.3 per cent in 2017, the majority of which was consumed in the form of liquid biofuels, predominantly crop-based ethanol and biodiesel.

The pan-European region is attractive to tourists from all over the world and the carbon footprint of tourism is significant. The application of the principles of circular economy in the tourism sector in country or in resort could reduce the footprint a little, but the major burden remains from travelling itself.

4. Indicators

Greenhouse gas emissions (ECE indicator)

The indicator shows the extent to which countries have achieved their specified goals for emissions and the response to country policies for achieving the emissions target.

Table 25 shows available GHG emissions data for pan-European subregions for the period 2014–2019. The overall changes in the pan-European region, both positive and negative, are highly dependent on "big players", i.e. highly industrialized, populous countries.

During the period 2014–2019, GHG emissions were reduced in the European Union by about 12 Mt of CO_2 equivalent, mostly in Germany but with an increase of emissions in 12 other European Union member States (see figure 18). Non-European-Union high-income countries also achieved emissions reduction, with the United Kingdom accounting for 95 per cent of reductions. In Eastern Europe, the increase in GHG emissions is dominated by an increase in the Russian Federation, while Ukraine reduced emissions by over 30 Mt of CO_2 equivalent. The trend in South-Eastern Europe and Central Asia is dominated by an increase in GHG emissions in Türkiye and Kazakhstan, respectively, while data is not available for several countries.

Table 25 Total greenhouse gas emissions (without land use, land-use change and forestry), 2014–2019
(Millions of tons of CO_2 equivalent)

Subregion	2014	2015	2016	2017	2018	2019	Trend
European Union	3 778	3 826	3 829	3 855	3 767	3 616	↘
Western Europe	710	696	670	650	649	633	↘
Eastern Europe	2 492	2 441	2 462	2 483	2 562	2 542	↗
South-Eastern Europe	459	473	499	525	522	506	↗
Pan-European region	**7 790**	**7 795**	**7 821**	**7 901**	**7 898**	**7 694**	→

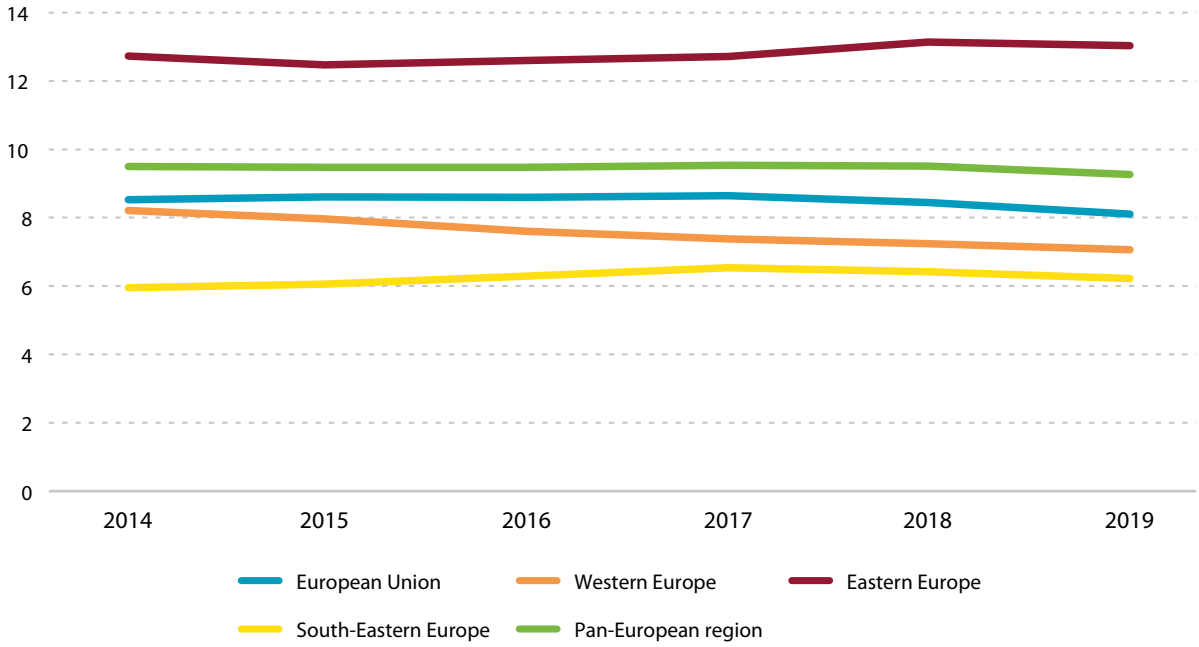
Legend: ↗ – increase in GHG emissions; → – no change; ↘ – reduction in GHG emissions.

Source: United Nations, "Global SDG Indicators Data Platform" (accessed on 2 February 2022).

Note: In Western Europe, no data for Andorra and San Marino; in Central Asia, data only for Kazakhstan, so not shown (represents 25 per cent of the subregion's population); in Eastern Europe, data only for Belarus, the Russian Federation and Ukraine (together representing 91 per cent of the population); in South-Eastern Europe, data only for Türkiye (alone accounting for 84 per cent of the population). In Israel, 2018 data used for 2019.

85 Simone Tagliapietra and Georg Zachmann, "Addressing Europe's failure to clean up the transport sector", *Policy Brief*, No. 2 (2018).

Figure 18 Greenhouse gas emissions (without land use, land-use change and forestry) per capita, 2014–2019
(Tons of CO_2 equivalent)



Source: United Nations, "Global SDG Indicators Data Platform", Indicator 13.2.2 (accessed on 2 February 2022); for population data, ECE Statistical Database (accessed on 1 February 2022).

Note: Population data for 2018 are used also in 2019; for Monaco, 2016 data are used across the period; for the Russian Federation, 2013 data are used across the period. For further notes on CO_2 emissions, see table 26 on total CO_2 emissions.

Renewable energy share in the total energy consumption (Sustainable Development Goal indicator 7.2.1)

The renewable energy share in total final consumption is the percentage of final consumption of energy that is derived from renewable resources. Table 26 shows this indicator by subregion for the period 2014–2018.

Although the consumption of energy from renewable sources in the pan-European region rose between 2014 and 2018 to 1.3 petajoules, the share of renewables stayed the same due to a parallel rise in consumption of energy from non-renewable sources.

The renewable energy share in the total energy consumption varies from 4 per cent in Eastern Europe and Central Asia to 18 per cent in the European Union and Western Europe. The average share for the whole pan-European region is 13 per cent. Only Western Europe saw a stable rising trend in the five-year period 2014–2018.

To remain on the 1.5°C pathway requires the share of renewable energy in primary supply to increase globally at an annual growth rate, from 0.25 per cent to 2 per cent.[86]

86 IRENA, *World Energy Transitions Outlook: 1.5°C Pathway* (Abu Dhabi, 2021).

Table 26 Renewable energy share in total energy consumption, 2014–2018 (Percentage)

Subregion	2014	2015	2016	2017	2018	Trend
European Union	18	18	18	18	18	→
Western Europe	15	16	16	17	18	↗
Central Asia	3	4	4	4	4	↗
Eastern Europe	4	4	4	4	4	→
South-Eastern Europe	14	15	15	13	14	→
Pan-European region	**13**	**13**	**13**	**13**	**13**	→

Legend: ↗ – increased share of renewables; → – no change in share of renewables

Source: United Nations, Department of Economic and Social Affairs, Statistics Division, *Energy Balances*.

Proportion of local governments that adopt and implement local disaster risk reduction strategies in line with national disaster risk reduction strategies (Sustainable Development Goal indicator 13.1.3)

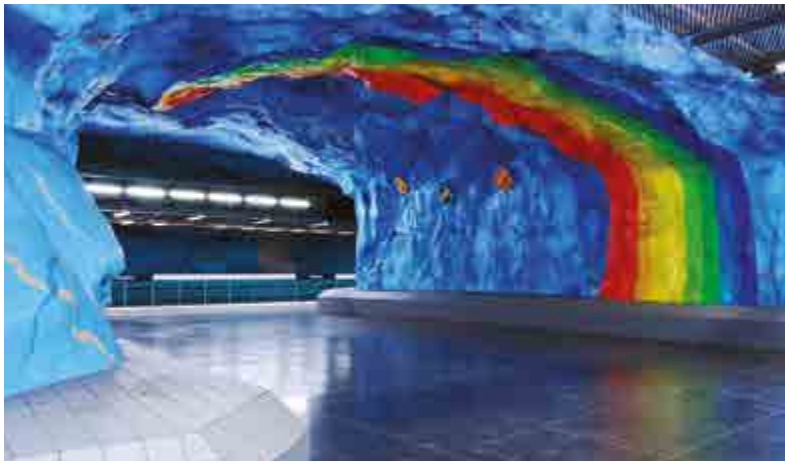
The Sendai Framework aims at increasing the proportion of local governments that adopt and implement local DRR strategies. Data on Sustainable Development Goal indicator 13.1.3 for the period 2015–2019 indicate that 31 countries from the pan-European region reported having such strategies, covering 41,850 local communities (see table 27). More than 600 cities in the pan-European region (out of 4,360 cities globally) participate in the "Making Cities Resilient" initiative coordinated by the United Nations Office for Disaster Risk Reduction.[87] Moreover, 9,919 local communities from 33 countries of the pan-European region participate in the Global Covenant of Mayors for Climate and Energy initiative. In 2018, about 41 per cent of the European Union population was living in municipalities that are signatories of the Covenant of Mayors for Climate and Energy.

Table 27 Country behaviour regarding local disaster risk reduction strategies, 2019 (Number of countries)

Subregion	In the subregion	Not reporting	Having less than 5 per cent of local governments implementing DRR strategies	With a stable trend	With a rising trend	Having 100 per cent of local governments implementing DRR strategies
European Union	27	13	4	1	0	9
Western Europe	9	5	0	1	1	2
Central Asia	5	2	0	0	2	1
Eastern Europe	7	2	1	0	2	2
South-Eastern Europe	6	1	4	0	0	1
Pan-European region	**54**	**23**	**9**	**2**	**5**	**15**

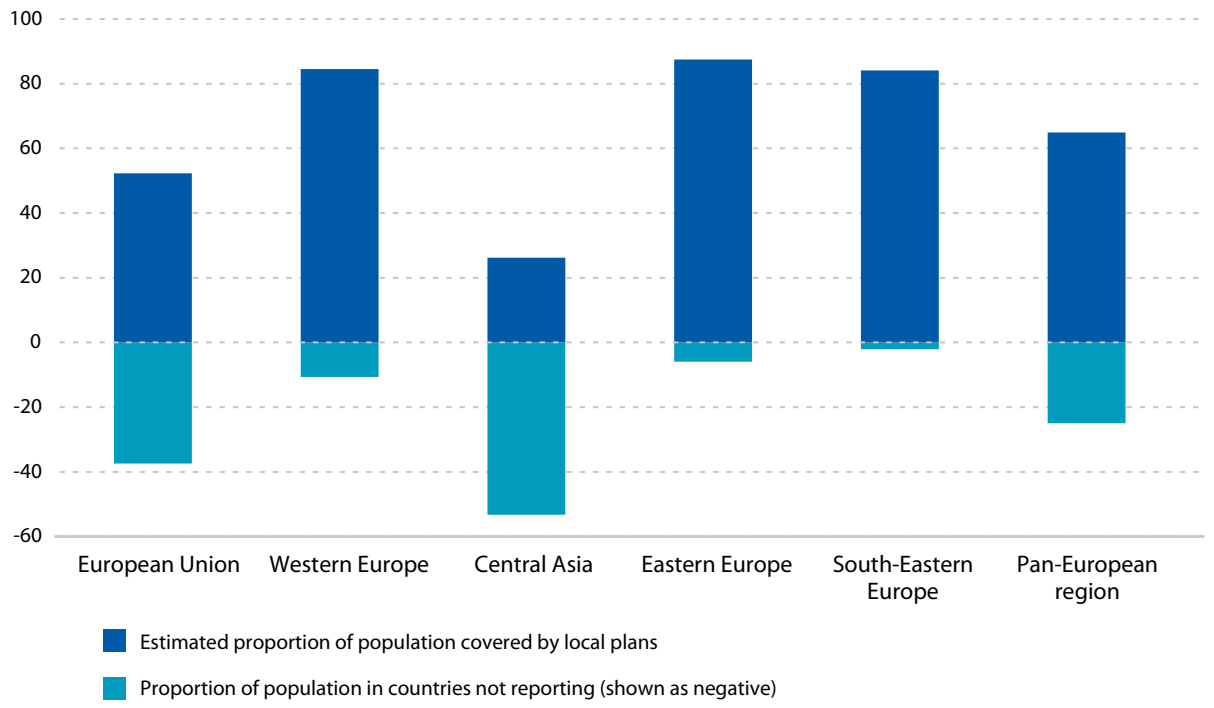
Source: United Nations, "Global SDG Indicators Data Platform".

87 See https://www.unisdr.org/campaign/resilientcities/cities.



It is estimated that 65 per cent of the population in the pan-European region is covered by local DRR strategies, due to the large populations of those countries that do have strategies (e.g. France, Germany, the Russian Federation, Türkiye, Ukraine and the United Kingdom). More than 80 per cent of the population are covered in Eastern and South-Eastern Europe, as well as in Western Europe (85 per cent), while less than 26 per cent are covered in Central Asia (see figure 19).

Figure 19 Estimated proportion of population covered by local disaster risk reduction strategies, or for which no data is available, 2019 (Percentage)



Sources: United Nations, "Global SDG Indicators Data Platform", Indicator 13.2.2 (accessed on 17 September 2021); for population data, ECE Statistics Database, 2019 or latest (accessed on 1 February 2022).

Note: The estimated proportion of the population covered by local plans is the estimated population covered by plans divided by the subregion's total population.

5. Case studies

Fossil-fuel free Stockholm 2040

Stockholm, the capital of Sweden, aims to be fossil-fuel free by 2040. As the city's strategy document explains, "Stockholm's ambition is to be totally fossil-fuel free by 2040 at the latest, precluding the use of fossil fuels within the city's geographical boundaries. However, the municipal authorities recognize that it may prove difficult to eliminate fossil fuels in the aviation and international shipping industries, and that some fossil-based plastics will still be incinerated in heating plants in 2040. Nevertheless, climate neutrality or zero net emissions can be achieved by compensating for these residual effects, for example by investing in carbon sinks. Climate neutrality permits the use of fossil fuels provided that CO_2 emissions are offset by measures that in some way bind the carbon or carbon dioxide."[88]

The plan is that, by 2040, natural gas will be entirely phased out of the city's energy grid and heating system, replaced primarily by biogas. The district heating company has decided to phase out fossil fuels by 2030. To increase the use of renewable energy in transportation from the current 16 per cent to 100 per cent by 2040, the city plans to double the capacity of the public transport system, while improving walking and bicycling infrastructure.

Covenant of Mayors

The Covenant of Mayors is the initiative launched by the European Commission in 2008 with the ambition to gather together local governments voluntarily committed to achieving the European Union's climate and energy targets. With about 2,000 cities gathered in 2010, the European Commission launched the Covenant of Mayors East initiative that now operates in Armenia, Azerbaijan, Belarus, Georgia, the Republic of Moldova and Ukraine. Nowadays, the Global Covenant of Mayors for Climate and Energy is the largest movement of local governments committed to going beyond their own national climate and energy objectives. There are 9,919 members from 33 countries of the pan-European region participating in this initiative. During the Climate Summit in Paris, the European Commission announced the geographical extension of the Covenant of Mayors for Climate and Energy, with new regional offices in Sub-Saharan Africa, North and South America, Japan, India, China and South-East Asia.

C. Fresh water

1. Key messages and recommendations

Key messages

Access to clean fresh water is vital for human dignity and economic development. Water is a cornerstone of life, nature conservation and biodiversity. Moreover, interlinkages and trade-offs between water and other sectors will become deeper and stronger during the coming decade and beyond.

Water quantity has an asymmetric space and time distribution in the pan-European region. Climate change is delivering additional challenges in terms of precipitation patterns and temperature; all future climate scenarios indicate that extreme hydrological events will be longer and more frequent and intense. Climate change has an impact on human health through many water-related phenomena: floods, heatwaves, droughts, waterborne diseases and biodiversity changes in wetlands and aquatic ecosystems. These phenomena have gender-differentiated impacts, with poor people, women and children facing increased vulnerability.

Anthropogenic pressures amplify water asymmetry by constraining freshwater quality and aquatic biodiversity. Indeed, despite increasing efforts on source control, diffuse pollution and urban and industrial wastewater discharges remain significant in many locations. In addition, persistent organic contaminants are under increasing surveillance because of greater public health concern. Therefore, river basins, lakes and aquifers are subject to multiple stressors

88 City of Stockholm, *Strategy for a Fossil-fuel Free Stockholm by 2040* (Stockholm, City Executive Office, 2016).

that threaten their physical, chemical and ecological conditions and the services they provide. At the same time, science is advancing to provide solutions and foster new processes and technologies to face these negative impacts.

Financing of water-related projects under the international climate agenda has been limited; setting up bankable projects is difficult. Financing models are highly susceptible to technical and governance insufficiencies and have been restrained by local and regional crises during the past decade.

Increasing challenges in water resources management indicate that fragmented governance practices are unlikely to succeed in the long term. Involving public and private actors is becoming fundamental to successful water policy. In this framework, information is a pillar of good governance. Granularity of information is important for better knowledge and to provide the link between the micro and macro levels, supporting good decision-making.

Transboundary management of shared rivers, lakes and aquifers remains a challenge. The problem is acute when upstream water abstraction and/or retention is significant and downstream countries lack alternative water sources. Despite some good examples, cooperation and participatory processes for water protection, allocation and other practical achievements are not implemented as deeply as they could be in the pan-European region.

Recommendations

Integrated water resources management should be pursued, involving a balance between human water needs and water's availability for nature. Water policy should enhance its interdisciplinarity and transdisciplinary character to maximize societal impact, including by taking into account sex- and age-differentiated effects. Therefore, the water–food–energy–ecosystems nexus should strengthen an anticipatory policy approach to combining short-term projects with a long-term vision for the pan-European region.

While progress has already been achieved in reducing use of (drinking) water in various countries, more needs to be done. Whenever fresh waters and aquatic ecosystems are at risk, the best available technology should be applied to ameliorate the situation. In addition to water conservation measures and conventional mitigation approaches, measures for resource protection and more efficient water use are coming on the water market and should be applied. For instance, digitization and precision agriculture can be applied in irrigated crop production, thus reducing water consumption and agrochemical wastage. Nature-based solutions (NbS) can be used in water retention basins or in riparian zone restoration. New methods for environmental flow regimes are available. Non-conventional water sources deserve proof-of-concept opportunities. These are just some examples of high readiness solutions that can be applied in the pan-European region.

Economic sustainability in water resources management should be pursued and innovative financing mechanisms are still required. Natural and human-made infrastructure development may use several financing tools (e.g. fair water pricing, ecological payments, cost recovery and incentives) but a clear legal framework is vital for success.

Good governance is required to bring success to technology and financing. In more cases than might be expected, effective implementation requires social engagement and the consideration of cultural dimensions. Besides, water resources management is more efficient at the basin level. This integrated approach is even more critical in transboundary rivers, lakes or aquifers where floods or droughts are likely to occur. Co-management should be pursued towards environmental protection and benefit-sharing within an efficient and resilient transboundary cooperation framework in the transboundary basins, as envisaged by the ECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention).

Knowledge is instrumental for decision-making and water policy design. Therefore, investment in data collection and information processing is essential (e.g. water accounts, ecosystem assessment and indicators). The continuous improvement of monitoring and communication technologies is a top priority in terms of a water information system for the pan-European region.

2. Context

Sustainable use of fresh waters is a continuous challenge from an anthropocentric perspective. Drinking water, agriculture, industrial production, energy production, transportation and leisure are just some of the human activities with an impact on water resources. There are systemic and complex non-linear interconnections between main driving forces, the pressures acting on freshwater ecosystems, the associated effect on water condition and status and the relationship with policy objectives.[89] Therefore, water strategies aim at shifting from sectoral interventions towards a more integrated resource-use approach.[90] Currently, the mindset in water resources management embraces integration of food, energy and nature policies, giving water its vital binding role. This paradigm requires an improved water governance perspective and evidence-based knowledge to design and implement effective and efficient water policies.[91] Furthermore, water is instrumental across all levels of government, civil society, business and the broader range of stakeholders for promoting human rights, gender equality and poverty decrease.[92]

Legislation is a pillar of water governance systems. Public policies encourage sustainable use of fresh waters using command and control measures and measures to reduce contamination at source. The European Union has a comprehensive legal framework for protection of fresh waters, from mandatory urban wastewater treatment targets to freshwater conservation and aquatic ecosystems protection.[93] The European Union water *acquis* is having a significant impact in the pan-European region countries.[94]

Nevertheless, diffuse and point source contamination with nutrients, recalcitrant organics and toxic substances, as well as hydrological and morphological stressors, remains in the pan-European region, hindering achievement of water policy objectives. Ecological river status at larger scale is determined by not one but multiple stressors; thus, water resources protection and water allocation processes are more efficient at river basin scale.[95] Attention should be paid to emergent contaminants; new health concerns require stringent limits and further monitoring of surface waters and groundwaters to safeguard drinking water quality in the pan-European region.[96]

On top of existing pressures in freshwater resources management, climate change is becoming the key driving force on water management. Indeed, although water is not directly referred to in the Paris Agreement, it is the top priority for most of the adaptation actions laid out in the nationally determined contributions and is closely related to other priority areas.[97] Climate scenarios foresee that precipitation will have higher peak intensities in the pan-European region, particularly at mid- and high latitudes where the precipitation mean value will also rise.[98] An

89 Joachim Maes and others, "Mapping and assessment of ecosystems and their services: an analytical framework for mapping and assessment of ecosystem condition in EU: discussion paper: final January 2018", Technical Report, No. 2018 – 001 (Luxembourg, Publications Office of the European Union, 2018); B. Grizzetti and others, "Human pressures and ecological status of European rivers", *Nature Scientific Reports*, vol. 7 (2017).

90 Claudia Pahl-Wostl, Anik Bhaduri and Antje Bruns, "The Nexus of water, energy and food: an environmental governance perspective", *Environmental Science and Policy*, Editorial special issue, vol. 90 (December 2018), pp. 161–163.

91 Aziza Akhmouch, Delphine Clavreul and Peter Glas, "Introducing the OECD Principles on Water Governance", *Water International*, vol. 43, No. 1 (2018), pp. 5–12.

92 Alberto Matenhauer Urbinatti and others, "The conceptual basis of water-energy-food nexus governance: systematic literature review using network and discourse analysis", *Journal of Integrative Environmental Sciences*, vol. 17, No. 2 (2020), pp. 21–43.

93 George Tsakiris, "The status of the European waters in 2015: a review", *Environmental Processes*, vol. 2 (2015), pp. 543–557.

94 Osman Özdemir, Deputy Expert, General Directorate of Water Management, Türkiye, "Water management in Turkey: River Basin Protection Action Plans and River Basin Management Plans", Personal communication, Istanbul, Turkey, 20 May 2015; Şermin Delipınar and Mehmet Karpuzcu, "Policy, legislative and institutional assessments for integrated river basin management in Turkey", *Environmental Science and Policy*, vol. 72 (June 2017), pp. 20–29; *Environmental Performance Reviews: Bosnia and Herzegovina – Third Review* (United Nations publication, Sales No.: E.18.II.E.21).

95 Sebastian Birk and others, "Impacts of multiple stressors on fresh-water biota across spatial scales and ecosystems", *Nature Ecology & Evolution*, vol. 4 (2020), pp. 1060–1068.

96 UNEP and ECE, *Global Environment Outlook: GEO-6: Assessment for the Pan-European Region* (Nairobi, 2016); National Institute for Public Health and the Environment of the Netherlands (RIVM), "Sanitation in the pan-European region: draft summary of findings of a scoping study" (2019).

97 Ingrid Timboe, Kathryn Pharr and John H. Matthews, *Watering the NDCs: National Climate Planning for 2020: How Water-aware Climate Policies Can Strengthen Climate Change Mitigation and Adaptation Goals* (Corvallis, Oregon, Alliance for Global Water Adaptation, 2020).

98 Abdullah Kahraman and others, "Quasi-stationary intense rainstorms spread across Europe under climate change", *Geophysical Research Letters*, vol. 48, No. 13 (July 2021).

intense precipitation phenomenon is the driver of floods, while land impermeabilization (soil sealing) without green infrastructures fosters flash floods.[99] At the same time, severe water shortages will intensify in low latitudes and mid-latitude continental interiors, namely, in the Mediterranean zone.[100]

Financing is a key aspect to support strategies and programmes of measures and, as was recently highlighted, "while water is the central element and enabler for adaptation, the latter attracted only 5 per cent of all climate finance … and just over one fifth of all climate finance from developed countries for developing countries".[101] The situation is assumed to be the same throughout the pan-European region, or even worse in non-European-Union countries. The fact is that water managers have always faced traditional difficulties regarding cost-recovery goals.[102] The practical difficulties are substantial. For instance, in water-intensive agriculture it is still necessary to determine the appropriate cost-recovery measures and the exemptions deemed socially acceptable.[103] This is not an excuse to stop critical thinking on the use of economic incentives towards inclusive and responsible water resources management. The

99 Reza Ramyar, Aidan Ackerman and Douglas M. Johnston, "Adapting cities for climate change through urban green infrastructure planning", *Cities*, vol. 117 (October 2021).

100 Ove Hoegh-Guldberg and others, "Global Warming of 1.5°C", in *IPCC Special Report on impacts of global warming of 1.5°C above pre-industrial levels in context of strengthening response to climate change, sustainable development, and efforts to eradicate poverty* (Valérie Masson-Delmotte and others, eds), pp. 175–312 (Cambridge University Press, 2022).

101 OECD, "Aligning and scaling up financing flows for water security and climate action", background paper for the 8th Roundtable on Financing Water, focused on Climate Action in partnership with the U.S. Government, online, 23–24 September 2021, Session 2: Water as a lever for climate action: the investment opportunity.

102 Frank A. Ward and Manuel Pulido-Velazquez, "Incentive pricing and cost recovery at the basin scale", *Journal of Environmental Management*, vol. 90, No. 1 (January 2009), pp. 293–313.

103 Alfonso Expósito, "Irrigated agriculture and the cost recovery principle of water services: assessment and discussion of the case of the Guadalquivir River basin (Spain)", *Water*, vol. 10, No. 10 (2018).

European Union Water Framework Directive[104] (art. 9) was a starting point for stronger economic considerations and cost-recovery principles in the water sector. However, it is undetermined how cost recovery exactly contributes to the attainment of sustainable and equitable water use.[105]

In this framework, although water is always a major national issue, its management is more complex by far if rivers, lakes or aquifers are shared with other countries. Regarding transboundary waters, understandably, assessments often differ from State to State but, ultimately, such waters are common resources. In the pan-European region, 52 countries share transboundary rivers, lakes and aquifers and the Water Convention was designed to provide the region with the appropriate framework, notwithstanding bilateral or multilateral agreements. International cooperation is much needed regarding flood events and drought periods, where downstream countries are most at risk and vulnerable to upstream decisions. In general, water allocation mechanisms in transboundary waters are mostly seen from the supply side. However, demand-side approaches or benefit-sharing can complement supply-focused solutions towards integrated water resources management.[106]

Link to conference themes

The development and implementation of sustainable infrastructure and nature-based solutions (NbS) in the framework of freshwater resources conservation can bring multiple benefits for society, the economy, the environment and human well-being. Multifunctional NbS align to meet societal and biodiversity needs, while making the best use of resources and limiting trade-offs.[107]

Circular water economy principles should be prioritized in the tourism and leisure industry. Tourism development considering water resources optimization and recovery of valuable products has the potential to support all Sustainable Development Goals.[108] As highlighted by one researcher, "The strongest relationships and synergies between circular economy practices and Sustainable Development Goal targets lie within Sustainable Development Goal 6 (clean water and sanitation), … and Sustainable Development Goal 15 (life on land)",[109] and these indicators are evaluated below. It is essential to guarantee that water services are dimensioned considering sectoral needs, namely, food, energy, ecosystems or human dynamics (e.g. tourism). Circular economy practices associated with closed-loop systems for wastewater recycling and reuse, and recycling of sewage sludge[110] will be indispensable in achieving Sustainable Development Goal 6 (clean water and sanitation). Infrastructure will need to be refurbished and optimized and innovative infrastructure designed to fully enable advanced circular economy practices.[111] One example is urine-diverting toilets for phosphorus recovery in decentralized systems.

3. State, main trends and recent developments

Renewable freshwater resources are asymmetric in the pan-European region. Fresh water abstracted as a proportion of renewable freshwater resources has a significant national variability. Currently, the problem is worrisome in several countries; Cyprus is the country with the highest water scarcity, but Greece, Italy, Malta, Portugal and Spain in the

104 Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy, *Official Journal of the European Communities*, L 327, vol. 43 (22 December 2000), pp. 1–73.

105 Petra E. Lindhout, "A wider notion of the scope of water services in EU water law: boosting payment for water-related ecosystem services to ensure sustainable water management?", *Utrecht Law Review*, vol. 8, No. 3 (November 2012), pp. 86–101.

106 *Handbook on Water Allocation in a Transboundary Context* (United Nations publication, Sales No. E.21.II.E.10).

107 University of the West of England, Science Communication Unit, *Science for Environment Policy: Future Brief: The Solution is in Nature*, 24 (Luxembourg, Publications Office of the European Union, 2021).

108 Fabrice Sorin and Stefán Einarsson, *Circular Economy in Travel and Tourism: A Conceptual Framework for a Sustainable, Resilient and Future-Proof Industry Transition* (n.p., CE360 Alliance, 2020).

109 Patrick Schroeder, Kartika Anggraeni and Uwe Weber, "The relevance of circular economy practices to the Sustainable Development Goals", *Journal of Industrial Ecology*, vol. 23, No. 1 (February 2019), pp. 77–95.

110 Andreas N. Angelakis and Shane A. Snyder, "Wastewater treatment and reuse: past, present, and future", *Water*, vol. 7, No. 9 (September 2015), pp. 4887–4895.

111 International Water Association, *Water Utility Pathways in a Circular Economy* (2016).

European Union, as well as Armenia, Azerbaijan and Türkiye, are of concern.[112] In addition, climate change will impact most countries where negative water availability is already present. Therefore, except for the Scandinavian Peninsula and some small areas in Central Europe, under pessimistic scenarios, river run-off production is projected to reduce all over Europe, but more so in southern countries.[113] On the other hand, heatwaves increase forest fires, which in turn have a negative impact on aquifer recharge and surface water quality. More countries suffered large forest fires recently than was ever recorded before, including in northern pan-European countries (for instance, the Russian Federation recorded its most severe forest fires in 2021, in Siberia;[114] Sweden experienced its worst fire season ever in 2018).[115]

Freshwater and ecosystems biodiversity problems are still quite relevant in the different subregions of the pan-European region. Even if a mild indicator such as "proportion of bodies of water with good ambient water quality"[116] is considered, 76 per cent of the countries in the pan-European region presented more than 60 per cent of water bodies at "good water quality" level in 2020. This value is similar to the 2017 value, indicating that more should be done to improve water quality. However, if a more demanding water quality assessment indicator is used, like those used in the European Union zone, just 40 per cent of surface water bodies achieved "good ecological status" and 38 per cent had "good chemical status" in 2015.[117] A similar pattern can be seen regarding the "good chemical status" of European Union groundwater bodies. In fact, the initial European Union policy target of achieving "good ecological status" for all water bodies was not met and was postponed, with 2027 being the final deadline.

Despite the threats, aquatic biodiversity areas display an irregular distribution in pan-European subregions, while hydromorphological impacts due to existing or planned water reservoirs remain an environmental challenge. Furthermore, extreme weather events, namely, floods, may trigger technological accidents and severe water contamination. Mining activities are an example where extreme weather events may result in technological accidents in several pan-European region countries (e.g. Kazakhstan, Romania and Tajikistan). Accidents have potential cross-border effects, but transnational impacts are often disregarded in river basin management plans, even though the ECE Convention on the Transboundary Effects of Industrial Accidents and the Water Convention require contingency planning and the adoption of measures to minimize the risk of accidental pollution in transboundary basins.

Access to safely managed drinking water services in the pan-European region is higher than 70 per cent, on average, with no significant changes in recent years. The European Union and Western Europe subregions present the best results (98 per cent and 99 per cent respectively). The Central Asia subregion presents a lower, but still relatively high, average value (70 per cent). This may explain why access to basic and safely managed water services increased globally by 10 per cent during the period 2000–2015, but in the pan-European region by not more than 4 per cent in the same period.[118] Besides, the presence of emerging contaminants, such as certain veterinary and human pharmaceuticals, brominated flame retardants, microplastics and anti-fouling biocides, should be increasingly monitored in the pan-European region.[119]

112 Although Uzbekistan and Turkmenistan are known to rank amongst the countries with most significant water scarcity issues, no data is currently available to calculate the assessed indicators for these countries.

113 Lamprini V. Papadimitriou and others, "High-end climate change impact on European runoff and low flows – exploring the effects of forcing biases", *Hydrology and Earth Systems Science*, vol. 20, No. 5 (May 2016), pp. 1785–1808.

114 UNECE, "Forest restoration is key to prevent the multiplication of wildfires and strengthen climate action", news article, 27 August 2021, available at https://unece.org/media/news/359313.

115 EEA, "Forest fires in Europe", 18 November 2021.

116 United Nations Statistics Division (UNSD), "Metadata repository", SDG Indicators. Indicator 6.3.2. – Proportion of bodies of water with good ambient water quality". Available at https://unstats.un.org/sdgs/metadata/ (accessed on 27 January 2022).

117 Teresa Ferreira, Lidija Glovevnik, and Rafaela Schinegger, "Water stressors in Europe: new threats in the Old World", in *Multiple Stressors in River Ecosystems: Status, Impacts and Prospects for the Future*, Sergi Sabater, Arturo Elosegi and Ralf Ludwig, eds. (n.p., Elsevier, 2018).

118 UNEP and ECE, *Global Environment Outlook: GEO-6*.

119 RIVM, "Sanitation in the pan-European region".

Nevertheless, more fine data reveal additional asymmetries at the national level. There are large differences in sanitation services and wastewater collection and treatment within the pan-European region.[120] Indeed, it is projected that, on average, 38 per cent of the population, or 344 million people, in the pan-European region do not have access to safely managed sanitation services, with unequal situations among subregions. The European Union and Western Europe have better values (more than 90 per cent) while Eastern Europe and South-Eastern Europe have considerably lower values. Furthermore, ageing sewerage infrastructure represents an additional financial challenge. The European Union estimated that it will be necessary to invest about €25 billion annually to rehabilitate and construct new sewers and wastewater treatment plants. Consolidated figures for Eastern Europe and Central Asia are likely to illustrate an even higher need.[121] Lastly, non-conventional water sources should be expanded; wastewater recycling or grey water recycling seems to be a well-accepted strategy only for water conservation. However, less than 3 per cent of treated wastewater in the European Union was reused in 2017.[122] Other non-conventional sources of water in arid zones can be considered (e.g. grey water, rain and atmospheric water harvesting, desalination of brackish waters), but water efficiency measures should be considered first.

The way forward regarding water nexus is not without risks. The food production sector is very important from the social perspective and deserves special attention. Progress is slow for diffuse pollution abatement in agriculture; excessive nitrate concentrations still affect over 18 per cent of the area of groundwater bodies. Reconciling environmental flows with irrigated cropland practices is an example of how burdensome a nexus trade-off can be.[123] Aquifer capacity to mitigate inter-annual or frequent droughts will be diminished by over-abstraction of groundwaters.[124] Thus, a better strategy is the use of smart technologies and improved water management systems. The adoption of water-efficient crops, practices to reduce transpiration, precision agriculture and digitization, agricultural reservoirs and rainwater harvesting for irrigation should be encouraged.[125] However, adaptation should be encouraged as much as mitigation, which is easily accepted by farmers. Other solutions are becoming viable, not just for agriculture, among which nature-based solutions (NbS) deserve increasing attention for freshwater protection and biodiversity conservation. NbS may play a role in protecting natural catchment areas against diffuse pollution, catalysing social benefits and landscape integration also in urban areas.[126]

The climate crisis is very much a water crisis, so good water governance is increasingly mandatory. Good water governance means a participatory and transparent approach, especially when it comes to trade-offs between different sectors or, even more necessary, between countries. Regarding transboundary waters, only 20 countries in the pan-European region have all their shared waters covered by operational arrangements, 19 of them being State parties to the Water Convention. Interestingly, most countries alleged that arrangements incorporate groundwaters, but it is not evident how effective transboundary aquifer co-management is implemented.[127]

Spatial, sectoral and temporal information are all crucial to obtaining knowledge, devising strategies and monitoring water actions. Therefore, water management means having data and updated information, transparency and Government–stakeholder dialogue. Around the pan-European region, there is a positive trend regarding information and communication technologies, connecting science and policy. Many geographic information systems are well

120 UNEP and ECE, *Global Environment Outlook: GEO-6*; *Handbook on Water Allocation in a Transboundary Context*.

121 RIVM, "Sanitation in the pan-European region".

122 Ibid.

123 Jonas Jägermeyr and others, "Reconciling irrigated food production with environmental flows for Sustainable Development Goals implementation", *Nature Communications*, vol. 8 (2017).

124 Zbigniew W. Kundzewicz and others, "Fresh water resources and their management", in *Climate Change 2007: Impacts, Adaptation and Vulnerability: Working Group II Contribution to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Martin Parry and others, eds., (Cambridge, UK, Cambridge University Press, 2007).

125 Rüdiger Schaldach and others, "Current and future irrigation water requirements in pan-Europe: an integrated analysis of socio-economic and climate scenarios", *Global and Planetary Change*, vols. 94–95 (August–September 2012), pp. 33–45.

126 University of the West of England, Science Communication Unit, *Science for Environment Policy: Future Brief: The Solution is in Nature*.

127 Annukka Lipponen and John Chilton, "Development of cooperation on managing transboundary groundwaters in the pan-European region: the role of international frameworks and joint assessments", *Journal of Hydrology: Regional Studies*, vol. 20 (December 2018), pp. 145–157.

established at the river scale, even if more must be done, namely, at the transboundary level. On a country basis, information granularity in the pan-European region exists at different levels; heterogeneous territorial realities in some countries may hide local and regional water weaknesses and water statistics are required. Other difficulties are due to conceptual reasons: ecological water quality assessment or the identification of hydromorphological pressures requires knowledge not yet available in some regions.

4. Indicators

Water services, including water supply and sanitation (selected Sustainable Development Goal indicators)

Sustainable Development Goal indicators 6.1.1 (Proportion of population using safely managed drinking water services) and 6.2.1 (Proportion of population using safely managed sanitation services …) belong to the group of indicators that were defined for the purpose of guaranteeing the availability and sustainable management of water and sanitation for all (Goal 6). More specifically, indicator 6.1.1 intends to contribute to achieving universal and equitable access to safe and affordable drinking water for all, by 2030 (target 6.1), with indicator 6.2.1 being used to contribute to achieving access to adequate and equitable sanitation and hygiene for all and ending open defecation, paying special attention to the needs of women and girls and those in vulnerable situations, by 2030 (target 6.2). Based on the information available in the SDG Indicators Database[128] – which contains global, regional and country data and metadata on the official indicators – the average values for these indicators were calculated for each one of the subregions included in the pan-European area. The values obtained for the indicators are presented in table 28.

It should be noted that, in order to be consistent over time with the other indicators analysed within this assessment, it was decided to focus the analysis on 2017, since information was available for all the indicators, with the exception of Sustainable Development Goal indicator 15.3.1 (Proportion of land that is degraded over total area), for which there are base data only for 2015. The year 2017 was also selected because it is the closest available year to 2015. Thus, the evaluation of the indicators selected in this chapter has an identical or close time frame, providing uniformity in time of analysis. Nevertheless, for some of the indicators, when available, as is the case for indicators 6.1.1 and 6.2.1, the latest values accessible in the SDG Indicators Database were calculated (i.e. 2020) to perceive any trend in the values throughout time (see table 28), with an improving trend apparent for indicator 6.2.1 in all subregions except Central Asia, where data is lacking.

Table 28 Proportion of population using safely managed drinking water and sanitation services (Percentage)

	Indicator 6.1.1 (Proportion of population using safely managed drinking water services)			Indicator 6.2.1 (Proportion of population using safely managed sanitation services)		
Subregion	2016	2018	2020	2016	2018	2020
European Union	97.7	97.8	97.8	89.6	90.1	90.5
Western Europe	99.3	99.3	99.3	95.5	95.7	95.9
Central Asia	68.7	69.3	69.6	-	-	-
Eastern Europe	79.7	79.8	79.9	60.0	60.8	61.5
South-Eastern Europe	78.3	78.0	78.0	67.3	69.9	70.0
Pan-European region	**90.3**	**90.4**	**90.4**	**80.2**	**81.0**	**81.4**

Source: United Nations, "Global SDG Indicators Data Platform", accessed 10 February 2022.

Note: No information available for Czechia (all years), or for indicator 6.1.1 for Croatia and Türkiye (all years), or for indicator 6.2.1 for any country in Central Asia except Kyrgyzstan, the Republic of Moldova (all years), Azerbaijan (2020) and Bosnia and Herzegovina (2019–2020).

128 See https://unstats.un.org/sdgs/unsdg.

ECE indicator C14 (population connected to wastewater treatment)

ECE indicator C14 (population connected to wastewater treatment) is included in the list of environmental indicators developed by the ECE Working Group on Environmental Monitoring and Assessment and the Joint Task Force on Environmental Statistics and Indicators.[129] The indicator refers to the percentage of the resident population whose wastewater is treated at a wastewater treatment plant. It should be noted that, in fact, some countries do not provide information for this indicator. Therefore, it was not possible to perform the analysis of the indicator by subregion. However, it is possible to verify that, for 2017 (the latest year for which information is available for this indicator), there is some variability in the values provided by some pan-European region countries.

France, Latvia, Malta, Monaco and the Netherlands are the countries with the highest proportion of the population connected to wastewater treatment (above 90 per cent). Most countries with available information are above 70 per cent. Azerbaijan and Albania are the countries with the lowest values (20 per cent and 17 per cent, respectively, in 2017). However, some countries did not provide information and even the "wastewater treatment" concept is not

129 ECE, "Indicators and reporting".

straightforward because the degree of treatment or on-site decentralized systems are not explicit. Nevertheless, it is possible to highlight a global trend of improvement when compared with the situation observed a decade ago, with a stabilization trend over recent years.

Freshwater resources quality and quantity (selected Sustainable Development Goal indicators)

Indicator 6.3.2 (Proportion of bodies of water with good ambient water quality) also belongs to the group of indicators that were defined to achieve Sustainable Development Goal 6. More specifically, it is an indicator that intends to improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally, by 2030 (target 6.3). The indicator tracks the percentage of water bodies (rivers, lakes and groundwater) in a country with good ambient water quality. For the purpose of global reporting (level 1 of the indicator), overall water quality is estimated based on an index that incorporates data on five core parameter groups (oxygen, salinity, nitrogen, phosphorus and acidification), which inform on major water quality impairments present, including in the pan-European region. The methodology calls for in situ measurements of these water quality parameters from surface waters and groundwaters as appropriate.

This indicator was evaluated for 2017 and 2020. Based on the available information, it was found that no data were produced for several countries in the pan-European region. Thus, it was decided to present only the available values (see figure 20). The global trend regarding the proportion of bodies of water with good ambient water quality is towards stabilization. Even so, it is possible to identify some worsening in a few countries over the time period.

Water governance (selected Sustainable Development Goal indicators)

Sustainable Development Goal target 6.5 calls for the implementation of integrated water resources management at all levels, including through transboundary cooperation as appropriate, by 2030. Indicator 6.5.2 measures the second part of target 6.5, monitoring the proportion of transboundary basin area within a country with an operational arrangement for water cooperation. Arrangements are "operational" when there is a joint body, meetings between countries take place and information is exchanged at least once a year, and joint or coordinated management plans or objectives for the basin(s) have been set. Figure 21 presents the results of this indicator for 2017 and 2020 for countries in the pan-European region. Nearly half the countries have reached (and maintained) transboundary water management cooperation for all their basins over recent years. It is also worth noting that some countries with the worst performance are slowly improving.

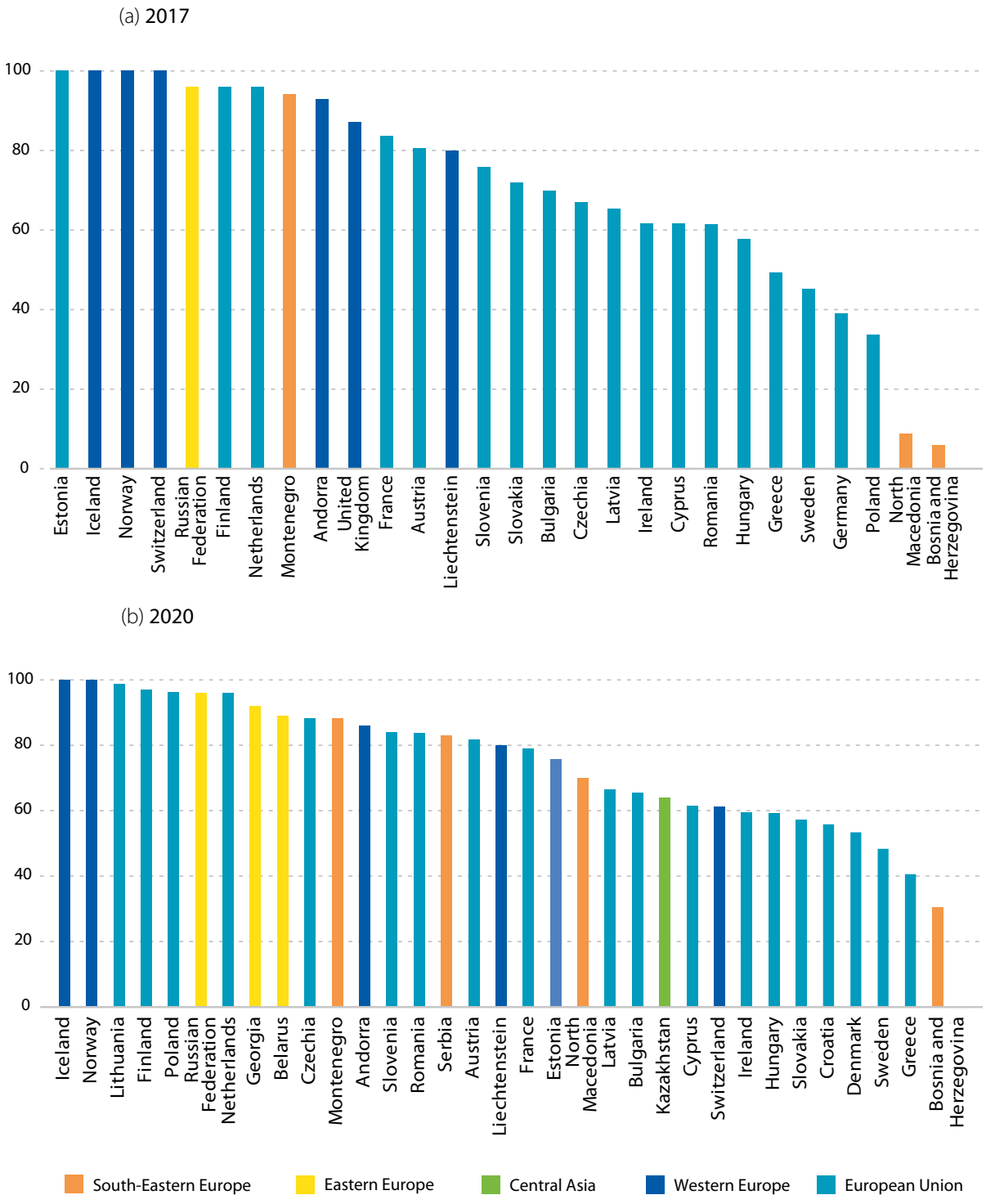
5. Case studies

Nature-based solutions: from watershed protection to flood control: two contrasting cases

One type of investment that is not sufficiently considered consists of protecting, sustainably managing and restoring watersheds. These are natural infrastructures that can filter and recharge water supplies to ensure the provision of water for cities and other users, including farmers, industry and the environment itself. Land use within catchment areas has a major influence on determining whether watersheds are healthy and can deliver these environmental services. An average of €5.5 billion per year was committed to restoring and conserving watersheds in Europe over the period 2014–2020 and an estimated 99 per cent of funding for these investments came from public sources. Some water service providers and cities have engaged with upstream parties in their source water catchments to support change in agriculture and forestry practices or to build artificial wetlands. But these investments have remained limited, due to regulatory barriers, high risk perception or a general lack of appreciation for what such investments can achieve. Nature-based solutions (NbS) can be a feasible approach for supporting drinking water protection for many cities. According to a recent analysis, they have broad potential: 63 cities demonstrating high feasibility potential for at least one NbS and pollutant type.[130]

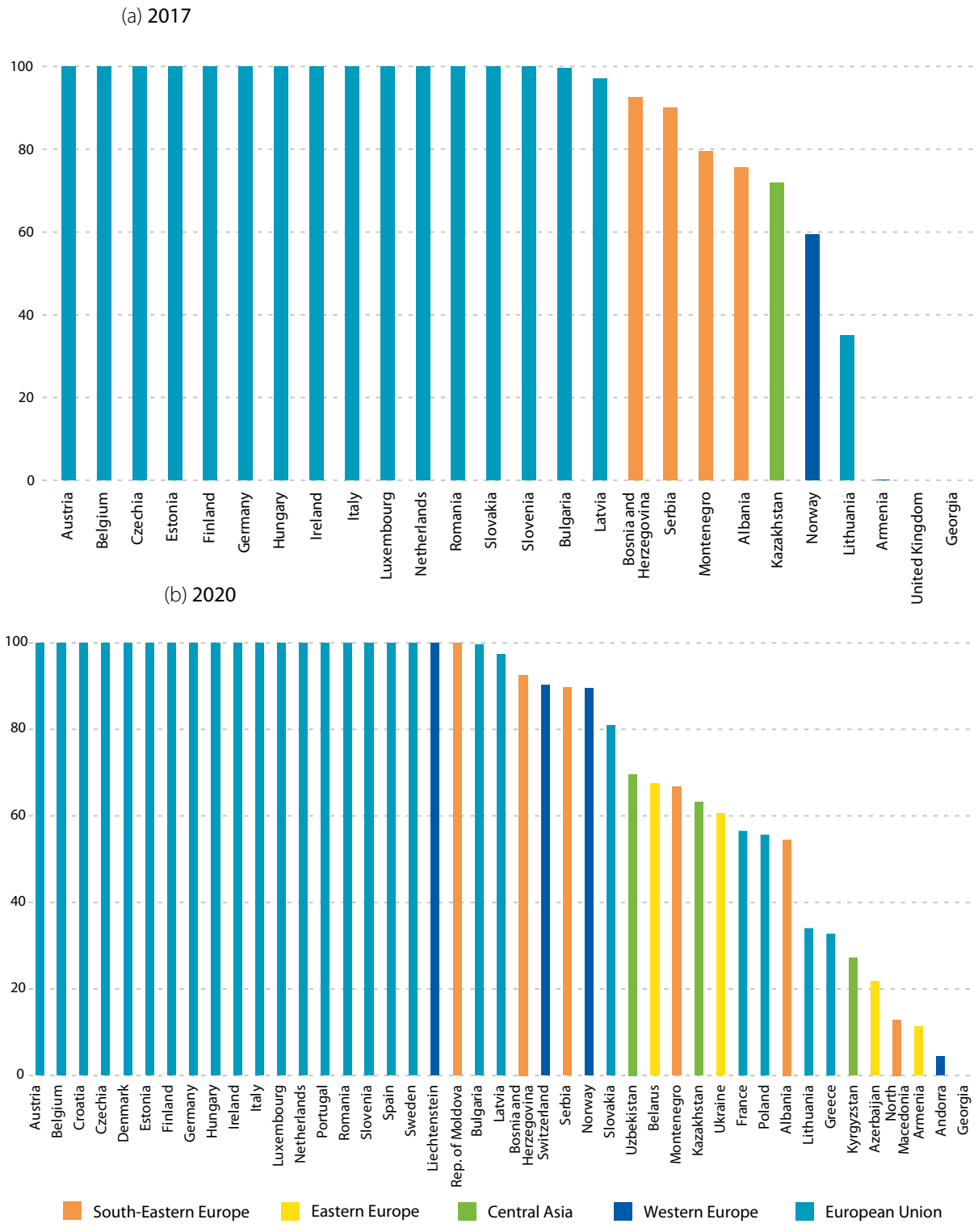
130 Adapted from: Sophie Trémolet and Nathan Karres, *Resilient European Cities: Nature-based Solutions for Clean Water* (London, The Nature Conservancy, 2020).

Figure 20 Proportion of bodies of water with good ambient water quality (Sustainable Development Goal indicator 6.3.2) for countries having data available, 2017 and 2020 (Percentage)



Source: United Nations, "Global SDG Indicators Data Platform" (accessed on 25 January 2022). More information on the methodology for indicator 6.3.2 can be found under https://unstats.un.org/sdgs/metadata/?Text=&Goal=6&Target= and https://www.sdg6monitoring.org/indicator-632/. Reporting countries only.

Figure 21 Proportion of transboundary basin area with an operational arrangement for water cooperation, 2017 and 2020 (Percentage)



Source: United Nations, "Global SDG Indicators Data Platform", Indicator 6.5.2 (accessed on 25 January 2022).

Climate change, soil sealing and flood risks may be addressed using NbS and citizen engagement. The Glinščica river basin in Slovenia is within the borders of the city of Ljubljana. The expansion of Ljubljana in the lowlands of the Glinščica river basin has increased the amount of impervious surface which, coupled with a rise in groundwater level and more torrential rain, has resulted in periodic flooding in parts of the city. To develop NbS that would be effective at lowering the flood risk while addressing other societal challenges, a participatory design process was instigated to gather the risk perception of individuals and institutions in the area. This was done through workshops in which the risk perceptions of individuals were recorded. The stakeholders were then involved in co-designing and assessing a dynamic model capable of measuring the effectiveness of NbS to deal with floods under a business-as-usual scenario, but also to enable participants in the workshop to look at the potential effects of specific measures on both flood risk reduction and co-benefits.[131]

D. Coastal waters, marine ecosystems and seas

1. Key messages and recommendations

Key messages

Marine pollution, from both land-based (e.g. nutrients, plastic, chemicals) and sea-based (e.g. plastic, oil) sources, continues to be an urgent problem in most sea regions. Beach and marine litter, dominated by plastic, is recognized as a major global threat to coastal and marine ecosystems in most areas, including remote and less populated areas, for example, the Barents Sea.

Among the climate-induced changes in coastal and marine ecosystems are increasing sea surface temperatures, by about 0.2°C per decade in the North Atlantic and 0.5°C per decade in the Black Sea (since 1981), and observed reductions in surface water pH (i.e. acidification), at a rate of approximately 0.02 pH units per decade, in the sea regions surrounding the European Union (and across the global ocean), except for variations near coasts, with as yet unknown impact.

Marine key biodiversity areas (KBAs) coverage by protected areas (PAs) in most littoral ECE member States increased during the period 2000–2019. However, the coverage of marine protected areas (MPAs) in 20 of the 37 littoral countries in the pan-European region lags behind the Convention on Biological Diversity Aichi target 11 (conserving at least 10 per cent of coastal and marine areas), being 6.7 per cent for the overall pan-European area.

Geographically, there are significant variations in the proportion of sustainable fish stocks. The Mediterranean Sea and Black Sea remain highly overfished, whereas signs of recovery of fish stocks can be observed in the North-East Atlantic Ocean and the Baltic Sea as a result of improved management decisions.

A holistic and ecosystem-based approach to the management of coastal waters and marine ecosystems that addresses the combined effects of multiple pressures is progressively integrating social, economic and governance aspects. Such an approach applies equally to the use of NbS in sustainable infrastructure for enhancing coastal resilience and its climate-proof functionalities, and to the transition to "blue" sustainable tourism as part of the post-COVID pandemic recovery.

Recommendations

Governments at all levels (local, national and regional) should take urgent action to reduce key pressures to halt the degradation of coastal waters, marine ecosystems and seas. Climate change, biodiversity loss and pollution threats are intricately connected and constitute the "triple planetary crisis".

131 Adapted from: University of the West of England, Science Communication Unit, *Science for Environment Policy: Future Brief: The Solution is in Nature.*

Further efforts are needed, in particular in Eastern and South-Eastern Europe, to achieve the target of conservation of 10 per cent of coastal and marine areas in the pan-European area. The target has already been achieved in most of the European Union.

The theme "Coastal waters, marine ecosystems and seas", associated indicators and data flows should be included as a theme within the ECE set of environmental indicators. Promising new developments related to data (e.g. earth observation, artificial intelligence, citizen monitoring, models and novel in situ measurements) should be considered to improve spatial and temporal coverage, including the need for long-term time-series data to understand climate-change impacts.

Policymakers should increase efforts to complement inventories of the number of items of beach and marine litter with information on composition and sources of litter, to enable the design of more effective measures. In particular, joint efforts should be taken where subregional measures are deemed necessary, as in the Caspian Sea, where there is no reliable information on the presence or amount of litter discharged into the coastal or marine environment.

2. Context

Oceans play a critical role as a climate regulator and buffer to climate change effects, which comes at the expense of their productivity and the health of marine ecosystems. The ubiquitous degradation of coastal waters, marine ecosystems and oceans is a clear manifestation of the triple planetary crisis and the intricately connected threats of climate change, biodiversity loss and pollution.[132] At the global level, two thirds of the oceans are significantly impacted by human activities that generate multiple pressures, ranging from excessive inputs of nutrients and hazardous substances (including plastics, microplastics and nano-plastics), unsustainable fishing (including illegal, unreported and unregulated (IUU) fishing) and habitat destruction due to coastal development (including for tourism) to extraction of natural resources. Other detrimental environmental changes associated with climate change include ocean warming, acidification and deoxygenation, impacting the diversity and abundance of marine species.

Blue economy, which is steadily growing and poses sustainability challenges, involves income-generating activities in the ocean, such as the harvesting of food, shipping, seabed mining, offshore hydrocarbon exploration and exploitation, tourism and recreation. Interest in seabed mining is on the rise, fuelled in part by the increased demand

132 UNEP, *Making Peace with Nature: A Scientific Blueprint to Tackle the Climate, Biodiversity and Pollution Emergencies* (Nairobi, 2021).

for minerals and rare earth elements,[133] such as the cobalt needed in batteries for electric vehicles, as a climate change mitigation measure.

The systematic nature of these challenges calls for the use of integrated and ecosystem-based management approaches, supported by spatially based assessments and the analysis of multiple pressures and cumulative impacts.[134]

Despite the pan-European sea regions having specific ecological and socioeconomic characteristics and governance structures, there are a number of similarities among them in terms of key trends and the challenges they face. The assessment follows a combined approach, by integrating existing knowledge available at the sea region level and national data reported under Sustainable Development Goal 14 "Conserve and sustainably use the oceans, seas and marine resources for sustainable development".

The pan-European area includes 37 littoral ECE member States[135] and the following sea regions: Baltic Sea, Black Sea, Caspian Sea, Mediterranean Sea and North-east Atlantic Ocean.[136] With the exception of the Caspian Sea, extensive knowledge and information on these sea regions is available in publications and indicators maintained by the EEA and the governing or implementing bodies of the Regional Seas Conventions.[137] Other sea (sub)regions included in the assessment area, such as the Aral Sea, Barents Sea, East Siberian Sea, North Sea and Norwegian Sea, are not systematically discussed.

Information on the Caspian Sea is mainly available in the report, *Caspian Sea: State of the Environment* (2019), produced under the Tehran Convention.[138] Of the 37 littoral countries in the pan-European region, 22 are member States of the European Union. The new European Union Biodiversity Strategy 2030 is instrumental for measuring ecosystem health and halting biodiversity loss across ecosystems, including marine ecosystems. In parallel, the Marine Strategy Framework Directive (Directive 2008/56/EC; Commission Decision 2017/848) aims at achieving or maintaining "good environmental status" in the four European Union regional seas by protecting and restoring the marine environment and phasing out pollution. The Maritime Spatial Planning Directive (Directive 2014/89/EU) makes a key contribution to the Marine Strategy Framework Directive on aspects related to the use and management of ocean space.

There is a direct link between the theme of coastal waters, marine ecosystems and seas and the two conference themes. For example, the use of NbS in sustainable infrastructure enhances coastal resilience and its climate-proof functionalities. At the same time, this approach addresses multiple issues, such as rising sea levels, flood protection and coastal erosion that causes loss of land, assets and livelihoods, while harmonizing coastal development with habitat and ecological protection.

With more than half of the European Union's tourist accommodation establishments located in coastal areas, maritime and coastal tourism is a pillar of the blue economy, in particular in the Mediterranean region, which hosts about

133 All 17 rare earth elements (or rare earth metals) are metals. They are vital components in many current applications, such as communication technology, mobility and energy technology, but are difficult to extract. In the pan-European region, there are deposits in Denmark, Finland, Greece, Norway, the Russian Federation and Sweden.

134 EEA, "Multiple pressures and their combined effects in Europe's seas", 7 December 2020.

135 The 37 littoral ECE member States in the pan-European region are (in alphabetic order, with the 22 European Union member States marked in **bold**): Albania, Azerbaijan, **Belgium**, Bosnia and Herzegovina, **Bulgaria, Croatia, Cyprus, Denmark, Estonia, Finland, France**, Georgia, **Germany, Greece**, Iceland, **Ireland**, Israel, **Italy**, Kazakhstan, **Latvia, Lithuania, Malta**, Monaco, Montenegro, **the Netherlands,** Norway, **Poland, Portugal, Romania**, the Russian Federation, **Slovenia, Spain, Sweden**, Türkiye, Turkmenistan, Ukraine and the United Kingdom.

136 The sea (sub)regions covered by the North-east Atlantic Ocean are the Barents Sea, Bay of Biscay, Celtic Sea, Greenland Sea, Iceland Sea, North Sea and Norwegian Sea.

137 Convention on the Protection of the Marine Environment of the Baltic Sea Area (Helsinki Convention, also known as the HELCOM Convention); Convention on the Protection of the Black Sea against Pollution (Bucharest Convention); Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (Barcelona Convention); and Convention for the Protection of the Marine Environment of the North-East Atlantic (known as the OSPAR Convention).

138 Interim Secretariat of the Framework Convention for the Protection of the Marine Environment of the Caspian Sea (Tehran Convention), *Caspian Sea: State of the Environment* (Interim Secretariat and GRID-Arendal, 2019).

one third of world tourism.[139] The prospects of maritime and coastal tourism have been severely impacted by the COVID-19 pandemic, together with many other closely connected sectors. The post-pandemic recovery is expected to boost ambitions and trends towards more sustainable tourism.

3. State, main trends and recent developments

Marine pollution originating from land-based sources includes discharges from municipal waste, mainly in the form of plastic litter, and wastewater and discharges from industrial activities. Huge investments in large-scale projects to either construct new or modernize wastewater treatment plants has led to a general decrease in the discharge of untreated wastewater into the sea, in particular in certain areas of the Black Sea,[140] Caspian Sea[141] and Mediterranean Sea.[142] The semi-enclosed Baltic and Black Seas are historically known for their high sensitivity to eutrophication, the enrichment of water by the nutrients nitrogen and phosphorus, as a result of limited exchange of water with outside seas.

Marine litter pollution includes beach, floating and seafloor litter, litter in biota and microlitter – pieces of plastic less than 5 mm in diameter, known as microplastics. Microplastics are of growing concern because they accumulate in the food web, posing a risk to marine biota and human health. Marine litter has been observed throughout the pan-European area, including the less-populated Barents Sea area.[143] Most of the litter comes from land-based sources, except in the North-East Atlantic where sea-based litter is equally important.[144] No reliable information on the volumes of litter discharged into the coastal or marine environment of the Caspian Sea is available, although this is considered a pressing issue.[145]

Fishing is one of the main pressures affecting the sustainability, health, productivity and resilience of marine ecosystems. Overexploitation of commercial fish and shellfish stocks continues across the sea regions in the pan-European area. The state of fisheries has improved significantly in the North-East Atlantic and the Baltic Sea, with clear signs of recovery of commercial fish and shellfish stocks since the early 2000s. On the other hand, the situation remains critical in the Mediterranean Sea and the Black Sea, with no signs of improvement. This is due to elevated fishing pressures, significant knowledge gaps on the status of fish and shellfish stocks and the difficulties in the Mediterranean Sea in adopting management measures for a single stock.[146] The Caspian Sea has also seen declining fish stocks,[147] as a result of overfishing and unregulated fishing. IUU fishing is one of the factors that negatively impacts the local economies and coastal livelihoods, as well as being a threat to marine ecosystems.

A drastic decline in marine biodiversity is observed, at a faster rate than for land species. The Red List assessments for the European Union sea regions show that, of the 1,196 marine species assessed, 9 per cent are threatened and 3 per cent are near threatened. Birds, mammals and turtles are particularly at risk, with over 20 per cent of species

139 UNEP/MAP and Plan Bleu, *SOED 2020*.

140 J. Slobodnik and others, "Summary of EMBLAS Project Finding, Gaps and Recommendations." EU/UNDP Project: Improving Environmental Monitoring in the Black Sea– Selected Measures (EMBLAS-Plus) – Agreement ENI/2017/389-859 (2021).

141 Tehran Convention, *Caspian Sea: State of the Environment*.

142 EEA and UNEP/MAP, "Technical assessment of progress towards a cleaner Mediterranean: monitoring and reporting results for Horizon 2020 regional initiative", EEA Report, No. 08/2020 (Luxembourg, Publications Office of the European Union, 2021).

143 For example, Bjørn E. Grøsvik and others, "Assessment of marine litter in the Barents Sea, a part of the joint Norwegian–Russian ecosystem survey", *Frontiers in Marine Science*, vol. 5 (March 2018).

144 EEA, "State of Europe's seas", EEA Report, No. 2/2015 (Luxembourg, Publications Office of the European Union, 2017).

145 Tehran Convention, *Caspian Sea: State of the Environment*.

146 WISE – Marine: Marine Information System for Europe, https://water.europa.eu/marine; EEA, "Marine messages II: Navigating the course towards clean, healthy and productive seas through implementation of an ecosystem-based approach", EEA Report, No. 17/2019 (Luxembourg, Publications Office of the European Union, 2019).

147 Tehran Convention, *Caspian Sea: State of the Environment*.

being threatened.[148] Eighteen species of sturgeon from all over Europe and Asia assessed in the Red List were found to be threatened. The Beluga sturgeon in the Caspian Sea is listed as critically endangered, along with all the other commercially important Caspian Sea species, which are the main producers of wild caviar.[149]

The resilience of marine ecosystems is further reduced by changes in ocean temperature and oxygen content, and ocean acidification as a result of anthropogenic climate change. Such changes in environmental conditions indicate that significant systemic changes are taking place in the European Union sea regions.[150] Increases in sea surface temperature lead to changes in species' distribution ranges),[151] abundance and seasonality, affecting marine food webs.

Political awareness of the role of oceans in achieving climate targets is on the rise, with more Governments committing to more ambitious ocean agendas. The European Union Biodiversity Strategy for 2030 highlights the need for expanding protection of the European Union sea regions to 30 per cent, creating ecological corridors to help reverse biodiversity loss and contribute to climate change mitigation and resilience.[152] A proposal for legally binding instruments on restoration is also included as part of the European Union Restoration Plan. At the global level, 51 countries, including 17 ECE member States,[153] have pledged to protect at least 30 per cent of marine areas by 2030, under the Global Ocean Alliance 30by30.[154] Following an extensive participatory process (3rd International

148 EEA, "Marine messages II".

149 International Union for Conservation of Nature (IUCN), "Sturgeon more critically endangered than any other group of species", 18 March 2010.

150 WISE – Marine: Marine Information System for Europe.

151 EEA, "Changes in fish distribution in European seas", 18 November 2021.

152 European Commission, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, On a New Approach for a Sustainable Blue Economy in the EU Transforming the EU's Blue Economy for a Sustainable Future, COM(2021) 240 final.

153 As at 21 July 2021, these are: Armenia, Belgium, Croatia, Cyprus, Denmark, Finland, France, Germany, Italy, Luxembourg, Monaco, Montenegro, Norway, Portugal, Spain, Sweden and the United Kingdom.

154 See www.gov.uk/government/topical-events/global-ocean-alliance-30by30-initiative/about.

Ocean Governance Forum, April 2021), the European Union is revising its International Ocean Governance Agenda – an integral part of the European Green Deal and the European Union's response to Sustainable Development Goal 14 (regarding life below water). Other initiatives at the regional or global level address awareness of marine litter pollution, sustainable blue economy and conservation efforts. Understanding of the seas continues to improve through the deployment of innovative sensors and autonomous observation platforms, enabling the expansion of observation programmes through better coordination and integration.

4. Indicators

Sustainable Development Goal 14 provides an appropriate indicator framework for the purpose of the pan-European assessment of coastal waters, marine ecosystems and seas.[155]

Marine pollution: beach litter density

This indicator provides the number of litter items on a 100 m stretch of beach of European Union sea regions (table 29 and figure 22). No data is available for the Caspian Sea.

The data is derived from the citizen-science-based EEA Marine Litter Watch database (2014–2019). The values are consistent with beach litter densities provided in regional assessments, in particular for the Baltic and Black Seas. Plastic is the most abundant type, comprising around 70–83 per cent of marine litter, exceeding 90 per cent in some areas.

Most assessments are not able to draw conclusions on time trends in marine litter. This is due to the survey limitations and methodological challenges in interpreting marine litter data. The abundance of beach litter is highly influenced by water currents, prevailing winds and the exposure of the beach.[156]

Table 29 Number of beach litter items and plastic composition, 2014–2019

Sea region	Number of items on beach per 100 m of shoreline, median for the period [a]	Plastic composition
Baltic Sea	78	70 per cent of beach litter
Black Sea	652	83 per cent of beach litter
Mediterranean Sea	428	95–100 per cent of total floating marine litter; 50 per cent of seabed marine litter
North-East Atlantic	105	Over 90 per cent of beach litter in some areas

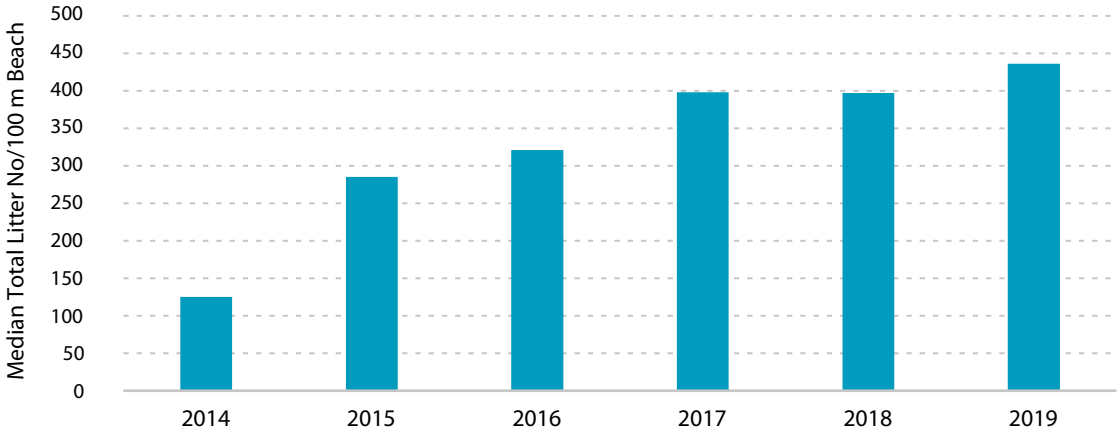
Source: Kideys and Aydın, *Marine Litter Watch (MLW) European Beach Litter Assessment 2013–2019.*

Note: [a] Only EEA monitoring data from sea beaches under Marine Litter Watch.

155 The context for the selection of the following indicators is provided above and supplemented with more information in an appendix to be made available online.

156 European Commission, MSFD Technical Subgroup on Marine Litter, *Guidance on Monitoring of Marine Litter in European Seas. A Guidance Document within the Common Implementation Strategy for the Marine Strategy Framework Directive* (Luxembourg, Publications Office of the European Union, 2013).

Figure 22 Evolution in median beach litter numbers for the four sea regions surrounding the European Union combined, 2014–2019 (Number per 100 m of beach)



Source: Kideys and Aydın, *Marine Litter Watch (MLW) European Beach Litter Assessment 2013–2019*.

Note: Monitoring data only. No data for the Caspian Sea.

Fisheries: Proportion of fish stocks within biologically sustainable levels

This indicator is based on data held by the Food and Agriculture Organization of the United Nations (FAO) for Sustainable Development Goal indicator 14.4.1 (Proportion of fish stocks within biologically sustainable levels), which measures the sustainability of the marine capture fisheries by their abundance.[157] Table 30 shows the proportion of marine fish stocks within biologically sustainable levels, supplemented with data for the four European Union sea regions on the proportion of assessed stocks meeting the primary criteria for the Marine Strategy Framework Directive's "good environmental status".

Table 30 Proportion of marine fish stocks within biologically sustainable levels, 2017 (Percentage)

			Proportion of assessed stocks meeting specified criteria			
FAO Major Fishing Area [a]	Proportion of stocks within biologically sustainable levels	Sea region [b]	Both GES criteria	Either of the two GES criteria	At least one of the two GES criteria	Neither of the two GES criteria
Mediterranean and Black Seas	37.50	Mediterranean Sea	0	6.1	6.1	93.9
		Black Sea	0	14.3	14.3	85.7
North-East Atlantic, including Baltic Sea	79.31	Baltic Sea	12.5	50.0	62.5	37.5
		North-East Atlantic	44.1	38.2	82.3	17.7

Sources: [a] FAO, *The State of World Fisheries and Aquaculture 2018 – Meeting the Sustainable Development Goals* (Rome, FAO, 2018), available at www.fao.org/3/I9540EN/i9540en.pdf; [b] EEA, *Marine Messages II*.

Notes: GES = good environmental status. GES primary criteria: achieving (a) a fishing mortality and (b) a reproductive capacity compatible with having population biomass levels above those capable of producing the maximum sustainable yield.

157 A fish stock whose abundance is at or greater than the level that can produce the maximum sustainable yield is classified as biologically sustainable. In contrast, when abundance falls below the maximum sustainable yield level, the stock is considered biologically unsustainable.

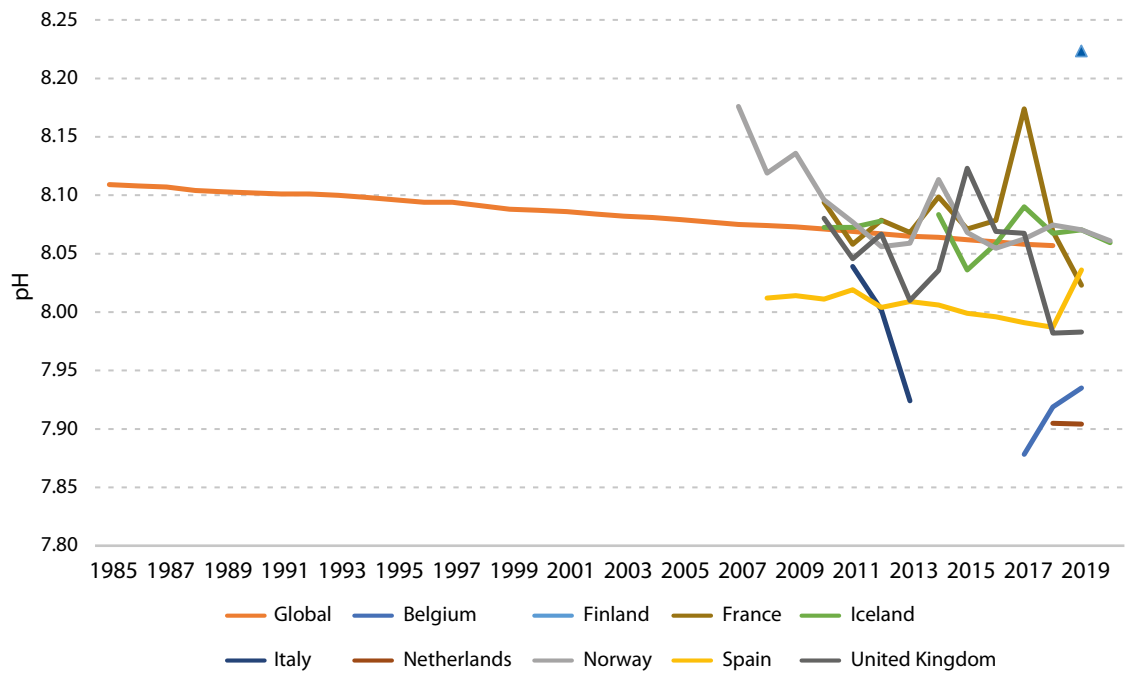
Both sources confirm that there are significant differences between regions. The Mediterranean Sea and Black Sea remain highly overfished, whereas signs of recovery of fish stocks can be observed in the North-East Atlantic and the Baltic Sea as a result of improved management decisions.

Climate change impacts: Average marine acidity (pH) measured at agreed suite of sampling stations

This indicator combines data reported by ECE littoral countries under Sustainable Development Goal target 14.3.1 (Average marine acidity (pH) measured at agreed suite of representative sampling stations), superimposed on the global annual average of surface ocean pH for the period 1985–2018. The purpose of this indicator is to monitor the carbon system by measuring four parameters: pH, total dissolved inorganic carbon, carbon dioxide partial pressure and total alkalinity. The Government of each country decides which sites to select, as long as the same sites are measured regularly to capture the changes in the parameters' values. When at least half of coastal nations report values, regional values can be aggregated.

Observations of ocean acidification over the past 35 years have shown an increase in acidity by 0.052 pH units (see figure 23). At the national scale, the trend is more complex, with significant variations near the coast. Long-term observational records, especially in the coastal zones, are required to identify the ocean acidification signals.

Figure 23 **Global annual average of surface ocean pH taken from the Copernicus Marine Service and based on a reconstruction method using in situ data and remote sensing data, as well as empirical relationships, 1985–2019** (pH units)



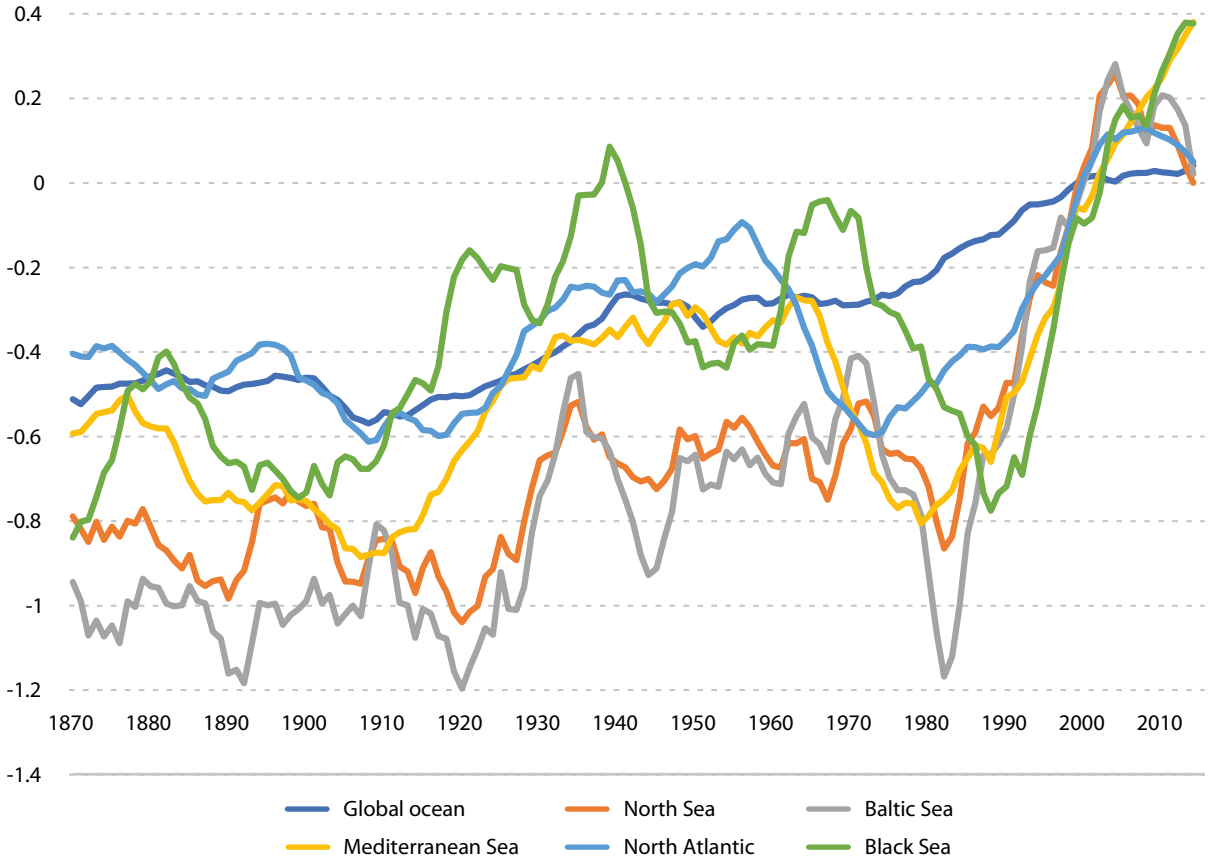
Sources: EEA, "Yearly mean surface seawater pH reported on a global scale", 24 June 2020; United Nations, "Global SDG Indicators Data Platform", target 14.3 national data (except for Belgium) (accessed on 29 April 2021); for Belgium, Flanders, Institute for Nature and Forest Research, "Background Nature Report 2020". Available at https://www.vlaanderen.be/inbo/backgroundindicatoren/noordzee-oceaanverzuring (accessed on 17 September 2021).

Climate change impacts: average sea surface temperature anomaly

This indicator shows the annual average sea surface temperature (in °C), referenced to the average temperature between 1993 and 2012 in the global ocean and four pan-European seas.

All sea regions have warmed considerably since 1870 (see figure 24). The warming has been evident since the late 1970s and particularly rapid since 1998. Since 1981, marking the beginning of the satellite era, for which more comprehensive data is available, the trend in sea surface temperature rise has been between around 0.2°C per decade in the North Atlantic and 0.5°C per decade in the Black Sea. According to the Intergovernmental Panel on Climate Change,[158] the average sea surface temperature has increased by 0.6°C since 1850. Depending on the emissions scenario, sea surface temperature is projected to continue to increase, albeit more slowly than air temperature over land.

Figure 24 Time series of annual average sea surface temperature, referenced to average temperature between 1993 and 2012 (°C)



Source: WISE – Marine: Marine Information System for Europe, available at https://water.europa.eu/marine.

158 Intergovernmental Panel on Climate Change (IPCC), *The Ocean and Cryosphere in a Changing Climate: Special Report of the IPCC*, Hans-Otto Pörtner and others, eds., (Cambridge, UK, Cambridge University Press, 2022).

Responses: coverage of protected areas in relation to marine areas

This indicator shows the coverage of marine protected areas (MPAs) in relation to the area of the Exclusive Economic Zone (see table 31).

Table 31 Marine protected area coverage

Subregion	Littoral ECE member States	MPA coverage (percentage)
European Union	Belgium, Bulgaria, Croatia, Cyprus, Denmark, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Malta, Netherlands, Poland, Portugal, Romania, Slovenia, Spain, Sweden	15.2
Western Europe	Iceland, Israel, Monaco, Norway, United Kingdom	17.1
Central Asia	Kazakhstan, Turkmenistan	31.9
Eastern Europe	Azerbaijan, Georgia, Russian Federation, Ukraine	2.3
South-Eastern Europe	Albania, Bosnia and Herzegovina, Montenegro, Türkiye	1.8
Pan-European region		**9.2**

Source: UNEP World Conservation Monitoring Centre.

A total of 10.8 per cent of the surface of European Union seas was designated as MPAs by the end of 2016, implying that the bloc has reached the global Aichi Biodiversity Target 11.[159] However, that MPA coverage is more than six times higher in coastal waters than in offshore waters, meaning that not all biodiversity features are adequately represented in the MPA network.[160] The greatest growth in PAs and other effective area-based conservation measures over the last 10 years has been in marine and coastal areas as compared with terrestrial areas.[161] However, MPA coverage currently stands at 7.74 per cent at the global level and only 6.7 per cent in 2018 at the pan-European level, both falling short of the 10 per cent coverage target.

5. Case studies

"The Black Sea is recovering but chemical and marine litter pollution are still a major issue"[162]

This case study relates to the period until and including 2021. For decades, the Black Sea has been the European Union's most polluted sea region. In the 1990s, the Black Sea experienced unprecedented degradation when widespread nutrient loading caused a large dead zone. The main sources of nutrients were run-off from the agricultural sector (fertilizers and livestock waste) and domestic and industrial wastes. Three rivers – the Dniester, Dnipro and Danube – are the main sources of nutrient, chemical and litter pollution in the Black Sea. The contaminants monitoring programme conducted under the EMBLAS series of projects revealed extremely high concentrations of chemicals in offshore waters, biota, fish and mussels. Water samples showed traces of caffeine, medicine and illicit drugs, with

159 By 2020, at least 17 per cent of terrestrial and inland water areas and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscape and seascape.

160 See EEA, "Marine protected areas", 29 October 2018.

161 UNEP-WCMC and IUCN, *Protected Planet Report 2020* (Cambridge, UK, and Gland, Switzerland, 2021).

162 BBC News, "The Black Sea: Can Europe's most polluted sea be saved?", 2 December 2019.

pharmaceuticals, especially antibiotics, posing the biggest threat. The number of floating items (90.5 items/km^2) is the highest among European Union seas and almost twice that in the Mediterranean Sea. Sediment samples taken from the seafloor were found to contain microplastics.

Over the past 20 years, the Danube River has been the subject of a massive clean-up operation financed by the European Union. The construction of wastewater treatment plants along the river has prevented the discharge of raw wastewater into the river, leading to an improvement in water quality over the last 15 years. Other improvements have included reductions in industrial and agricultural discharges. The ecosystem in the north-western shelf of the Black Sea is recovering, as witnessed by the return of once-abundant red seaweed *Phyllaphora*. This is a clear example of a "source-to-sea" approach to coastal and marine management.

"A green and blue recovery for coastal and maritime tourism in the Mediterranean"[163]

In 2019, the Mediterranean basin welcomed more than 400 million international tourists, and the tourism sector accounted for up to 15 per cent of regional GDP. Tourists are attracted by landscapes and rich biodiversity, cultural heritage and traditional lifestyles, coupled with favourable environmental conditions, such as a mild climate, beaches and clear seawater.

While being one of the global biodiversity hotspots,[164] the region is also subject to critical levels of habitat loss from unsustainable exploitation of resources, pollution, climate change and invasive marine species. The negative environmental impacts of tourism on the coastal and maritime areas originate mainly from the construction and operations of built infrastructures (resorts, residencies, ports and marinas, facilities, etc.) and from maritime or coastal recreational activities (nautical tourism, golf courses, water sports, etc.). The high spatial and temporal variations of tourism, which is predominantly concentrated along the coastal strip and peaks during the summer season, boosts the amount of potentially mismanaged waste, as well as discharges of inadequately treated urban wastewater. More than 75 per cent of the annual waste production is generated during the summer.

A key challenge is to promote "blue" sustainable tourism practices in coastal and marine areas, promoting positive externalities for the environment, workers and local communities. The Mediterranean tourism sector has been hard hit in 2020 by travel restrictions due to the COVID-19 pandemic. It is now at a crossroads: will it go back to previous

163 Jérémie Fosse and others, *The Future of Mediterranean Tourism in a (Post) Covid World: Back to Mass Tourism or Leapfrog Towards Sustainability* (Barcelona, Eco-union, 2021); EEA and UNEP/MAP, "Technical assessment of progress towards a cleaner Mediterranean"; UNEP/MAP, *Mediterranean Strategy for Sustainable Development 2016–2025 Investing in Environmental Sutainability to Achieve Social and Economic Development* (Valbonne, Plan Bleu, Regional Activity Centre, 2016); Plan Bleu, "MED Sustainable Tourism community" (n.d.).

164 A biodiversity hotspot is an area characterized as being of exceptional biodiversity value and having a large number of endemic species.

trends of unsustainable growth and mass tourism or leapfrog towards more sustainable tourism patterns? The massive investments provided by the ambitious, green and inclusive recovery plans offer a unique opportunity to recover better, by transforming the tourism sector and contributing to a more prosperous region. These measures should be multifold, involving various actors and benefiting the environmental, social and economic dimensions.

E. Biodiversity and ecosystems

1. Key messages and recommendations

Key messages

Overall forest area in the pan-European region has increased by 33.5 million ha[165] over the past 30 years. Except for in the Russian Federation, the relative share of the particularly biodiversity-rich primary forests has stayed stable at about 3 per cent of total forest area between 2000 and 2020.[166] Forest fragmentation remains an important pressure.

Beyond forests, the status of ecosystems remains a cause for concern, with no evidence of a clear positive trend. Only a minority of the habitats assessed at the European Union level are of good conservation status, and the overall picture is likely to be similar beyond the European Union.

The protected area (PA) estate in the pan-European region has almost tripled over the past 30 years, and key policy targets related to PAs have been met in the region.

Land continues to be taken for urban and infrastructure development in the pan-European region. While land take has decreased in most EEA member countries, and even reversed in Eastern Europe, land take and soil sealing remains an issue of concern in many countries.

Recommendations

Governments should ensure that trends in forest area remain positive. They should take additional measures to safeguard the remaining primary forests and their ecological functionality, for example, by promoting management standards aimed at preserving high-conservation-value forest and by enhancing forest connectivity.

Governments should make efforts to consolidate and improve the extended protected area network within the ECE region through investment in management effectiveness, ecological representativeness and connectivity. The whole range of governance types should be used, and other effective area-based conservation measures should be used to further consolidate area-based conservation networks.

Governments should take measures to reduce land take further and consistently.

Governments should also address the conversion of natural to agricultural ecosystems and the degradation of habitat quality due to biodiversity-unfriendly agricultural practices through, for example, more targeted use of subsidies and other incentives as part of the measures.

Governments should mainstream biodiversity conservation across sectors and policies, to eliminate or reform harmful subsidies and incentives, and to develop effective positive incentives for biodiversity conservation and sustainable use.

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165 ECE, "Forest area in UNECE region continues to increase, says FAO report, but greater efforts needed to protect these fragile ecosystems", 23 July 2020.

166 This trend might be negative if the share of primary forests in the Russian Federation, which is also one of the top three countries in the world in terms of area of primary forest, were included. However, there are no official statistics on primary forests available for the Russian Federation.

2. Context

Issues at stake

Biodiversity, which encompasses diversity within species, between species and of ecosystems, plays an essential role in maintaining Earth's life-support systems, enabling nature-based solutions to societal challenges and maintaining quality of life. Ecosystem services are recognized as a basis for sustainable socioeconomic development.

The pan-European region is characterized by its strong overlap with the Palearctic region and its extensive biomes of boreal coniferous and temperate deciduous forests, temperate grasslands and deserts, Mediterranean forest and Arctic tundra, as well as important marine ecosystems. It comprises the largest continuous forest, grassland and peatland ecosystems on Earth. These act as critical carbon sinks, provide ecosystem services and underpin the region's economies.

Policy objectives and challenges

The global policy framework for biodiversity in a broad sustainable development context is defined by the relevant Sustainable Development Goals, particularly Goals 15 and 14.

The countries of the pan-European region cooperate under various multilateral environmental agreements (MEAs). The main MEA on biodiversity is the 1992 Convention on Biological Diversity. Its last Strategic Plan for Biodiversity ran from 2011 to 2020 and was built around the Aichi Biodiversity Targets.[167] Other relevant MEAs include the 1979 Convention on the Conservation of Migratory Species of Wild Animals, the 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora, the 1971 Convention on Wetlands of International Importance especially as Waterfowl Habitat and the 1979 Convention on the Conservation of European Wildlife and Natural Habitats.

The main policy challenge related to biodiversity is to ensure its effective conservation and sustainable use. This implies addressing the drivers and root causes of pressures on species and terrestrial, marine and other aquatic ecosystems, including oceans, and increasingly requires restoration. Strategies include putting in place ambitious policy mixes (regulatory approaches, economic instruments and voluntary approaches), mainstreaming biodiversity across economic and sectoral policies, eliminating illegal exploitation and trade in elements of biodiversity and eliminating illegal, unreported and unregulated (IUU) fishing. Enforcement of existing legislation and regulation to end illegal activities is critical in this regard. Biodiversity conservation and restoration also requires reforming and removing environmentally harmful subsidies and strengthening the role of biodiversity-relevant taxes, fees and charges.

3. State, main trends and recent developments

Strategic Plan of the Convention on Biological Diversity has only been partly fulfilled and biodiversity loss continues

At the global level, only six of the 20 Aichi Biodiversity Targets – as the main concretization of Sustainable Development Goals 14 and 15 – have been partly achieved, and none has been fully achieved, according to the *Global Biodiversity Outlook5*.[168]

For the pan-European region, ECE environmental indicator D-3 on forests and other wooded land shows that efforts to curb deforestation and forest degradation have been met with success. This has been accompanied by a relative increase in planted forest.

Large, undisturbed ecosystems – both forest and other types, including wetlands – continue to decline globally. Trends in ecosystems and habitats within the pan-European region may be similar: within the European Union,

167 A post-2020 global biodiversity framework is expected to be agreed in 2022.

168 Secretariat of the Convention on Biological Diversity, *Global Biodiversity Outlook 5* (Montreal, 2020).

only 15 per cent of habitat assessments are of good conservation status, with 81 per cent being of poor or bad conservation status.

The conversion of land from natural to non-natural land cover types is one of the pressures contributing to ecosystem loss and degradation. The intensity of this land take has declined in most, but not all, countries of the pan-European region over the past 20 years, as is also shown by ECE indicator E-1 on land uptake.

Species extinction risk is still increasing, although conservation efforts likely prevented an even steeper increase. Twenty-four per cent of species in well-understood taxonomic groups will continue to edge towards extinction unless the drivers of their decline are dramatically reduced. Climate change is emerging as an additional pressure on biodiversity, interacting with pre-existing pressures. Species richness continues to decline in agricultural landscapes and production forests; agricultural practices are among the main drivers of biodiversity loss at the global and pan-European levels. Although, over the period 2005–2015, European production forests have become more diverse in tree species composition, recent research alerts that overall tree species richness is increasingly at risk in Europe, prominently through invasive species.[169]

The same trends may be true for the pan-European region; the report "State of nature in the EU"[170] noted a deterioration of the average conservation status of bird populations. Species associated with agricultural areas display a particularly negative trend.

169 Ministerial Conference on the Protection of Forests in Europe (FOREST EUROPE), *State of Europe's Forests 2020* (Zvolen, Slovak Republic, 2020).

170 EEA, "State of nature in the EU: results from reporting under the nature directives 2013–2018", EEA Report, No. 10/2020 (Luxembourg, Publications Office of the European Union, 2020).

Protected area coverage has increased, but the effectiveness of protected areas in contributing to conservation goals needs to be further enhanced

PAs remain a key instrument for reducing biodiversity loss. The area of terrestrial and marine PAs has grown significantly in the pan-European region. Marine protected areas (MPAs) are also supported by ECE indicator D-1 on terrestrial protected areas. Meanwhile, there remains considerable room for improvement of the representativeness, connectivity and management effectiveness of protected areas, and for enhanced enforcement of existing protected area legislation.

There is a need for a broader policy response to biodiversity loss, reflecting its repercussions for human well-being and sustainable development

Biodiversity mainstreaming into policies, poverty reduction and development planning has largely been an insular rather than a systematic effort in most countries over the past 10 years. One positive example has been the rise of environmental-economic accounting in some countries. Overall, little progress has been made over the past decade in eliminating, phasing out or reforming subsidies and other incentives that are potentially harmful to biodiversity, and in developing positive incentives for biodiversity conservation and sustainable use. This also broadly applies to the pan-European region.

Resource mobilization for biodiversity improved in only some countries between 2010 and 2020. The mobilized resources are still not sufficient to meet financial needs and are still outweighed by financial support for activities harmful to biodiversity. This is also true in the forestry context, including regarding reforestation. In contrast, understanding of funding needs and gaps has improved, at least in some countries.

The status and trends of biodiversity and ecosystem services are of fundamental importance for human health and well-being and for sustainable development. Encroachment of human settlements onto natural systems and wildlife trafficking disrupt the self-regulatory capacity of these ecosystems, increase the frequency of human–wildlife contacts and can lead to the spread of infectious diseases.[171] WHO convened a global study to assess the origins of the SARS-CoV-2 virus.[172]

The theme of the Ninth Environment for Europe Ministerial Conference (Nicosia, 5–7 October 2022), "Greening the economy in the pan-European region: working towards sustainable infrastructure", responds to the need to mainstream the environment, including biodiversity and ecosystems, across sectors. This conference theme is directly related to indicator E-1 (land take), as increasing the environmental sustainability of infrastructure development relies partly on reducing its spatial footprint.

Tourism is both dependent on and affects the state of biodiversity in the areas where it occurs. By "applying principles of circular economy to sustainable tourism", the ecological footprint of touristic activities in biodiversity-rich touristic areas – including pressures related to waste production, eutrophication and resource overexploitation – is reduced. In turn, this enables the provision of cultural ecosystem services and thereby enhances the human well-being benefits and broader development opportunities of these areas. An increase in responsible travel to natural areas in accordance with the principles of ecotourism may unite conservation, communities and sustainable travel.

4. Indicators

Terrestrial protected areas (ECE indicator): overall moderate-to-good status

This indicator shows the overall area of nationally designated terrestrial PAs in absolute terms and as a share of the countries' total areas. Figure 25 gives this information for all ECE member States combined for the period 1990–2019. Data availability for this indicator is very good for EEA member countries and cooperating countries, and fair to good for most other countries.

171 WHO Regional Office for Europe, *Nature, Biodiversity and Health: An Overview of Interconnections* (Copenhagen, 2021).

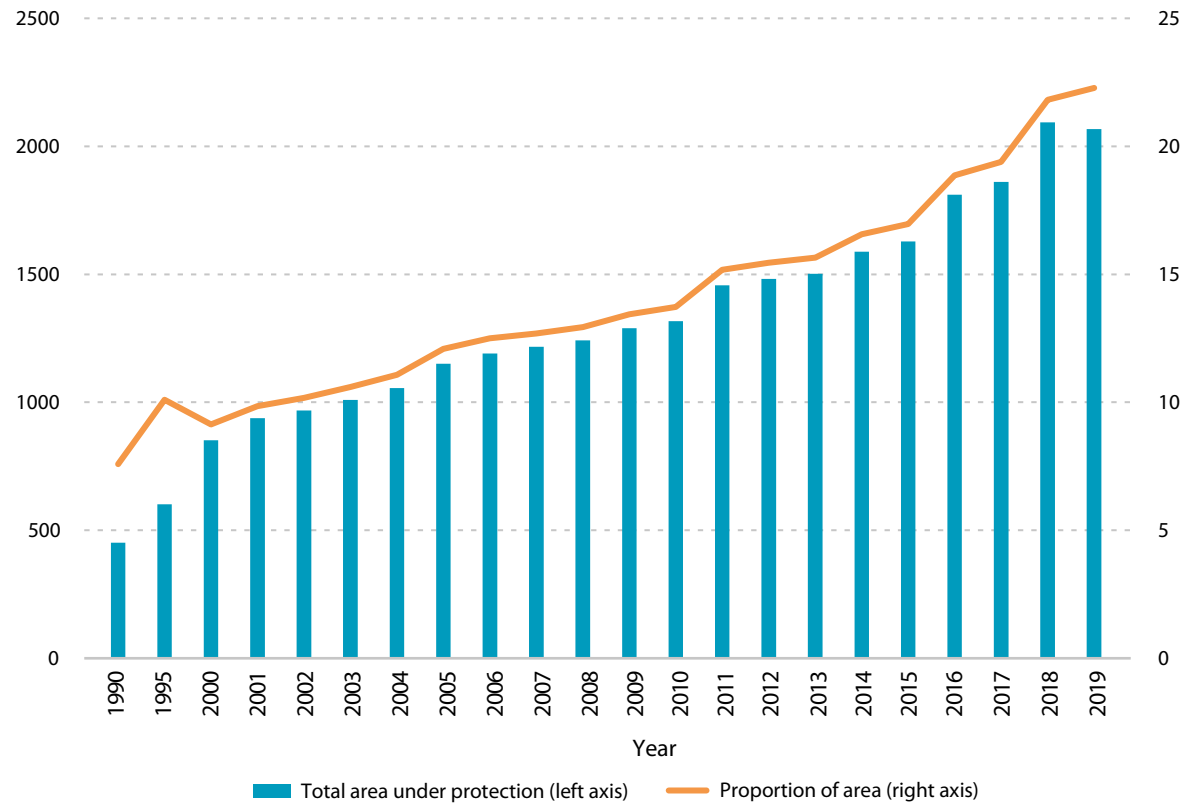
172 WHO, "WHO-convened Global Study of Origins of SARS-CoV-2: China Part: Joint WHO-China Study 14 January-10 February 2021: Joint Report", available at https://www.who.int/emergencies/diseases/novel-coronavirus-2019/origins-of-the-virus.

The area extent of PAs in the pan-European region has risen strongly over the past 30 years and increased by 60 per cent over the past 10 years. The share of PAs in the European Union and Western Europe is now significantly above the Aichi Target 11 of 17 per cent, but lower rates prevail in the other subregions (see figure 26). A more ambitious goal of protecting at least 30 per cent of Earth's land and marine surface areas by 2030 is now being championed by the High Ambition Coalition for Nature and People. The degree or effectiveness of protection of biodiversity within PAs, or their overall contribution to reducing global biodiversity loss, depend on the effectiveness of PA management.

Forests and other wooded land (ECE indicator): overall moderate-to-good status

This indicator shows the total area of forests and other wooded land, its ratio to the overall area of the countries, the share of forest areas that are natural and planted, the contribution of forests designated for production, soil or water protection and the protection of ecosystem services and biodiversity. Figures 27 and 28 show these statistics for all pan-European countries combined[173] for 10-year intervals over the period 1990–2020.

Figure 25 Protected areas: total area under protection and share of country area, selected countries, 2000–2019
(Thousands of km² (left axis) and Percentage (right axis))

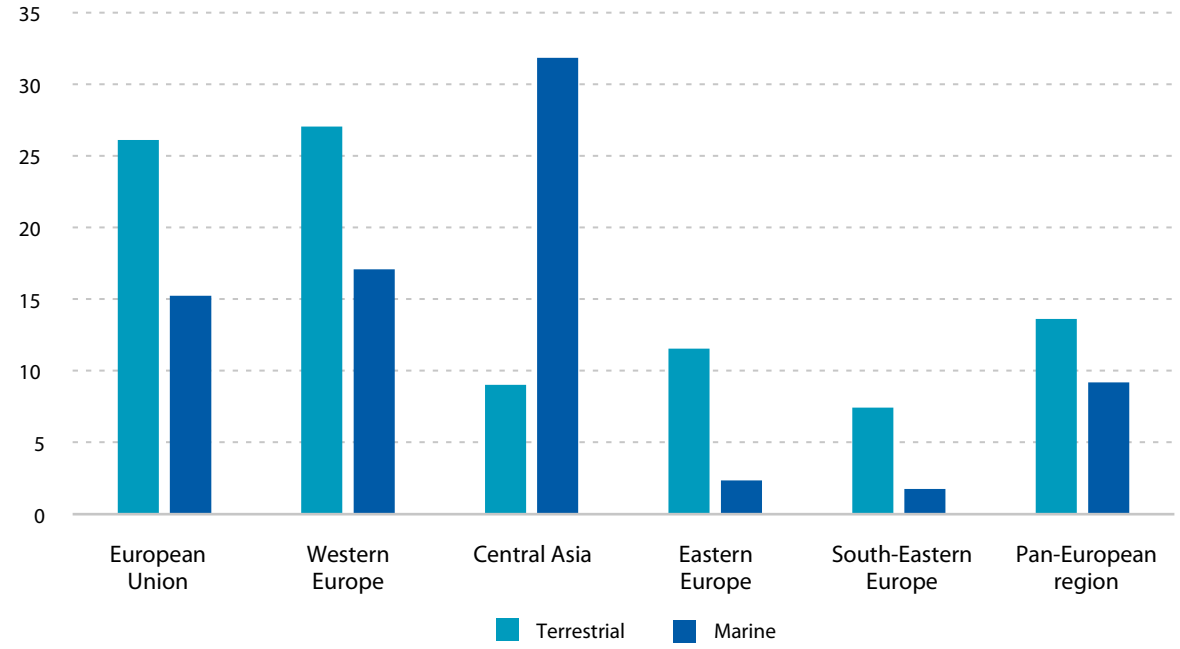


Source: National data sets.

Notes: Data only for EEA member countries and cooperating countries, Kazakhstan, the United Kingdom and the countries of Eastern Europe, excluding the Russian Federation.

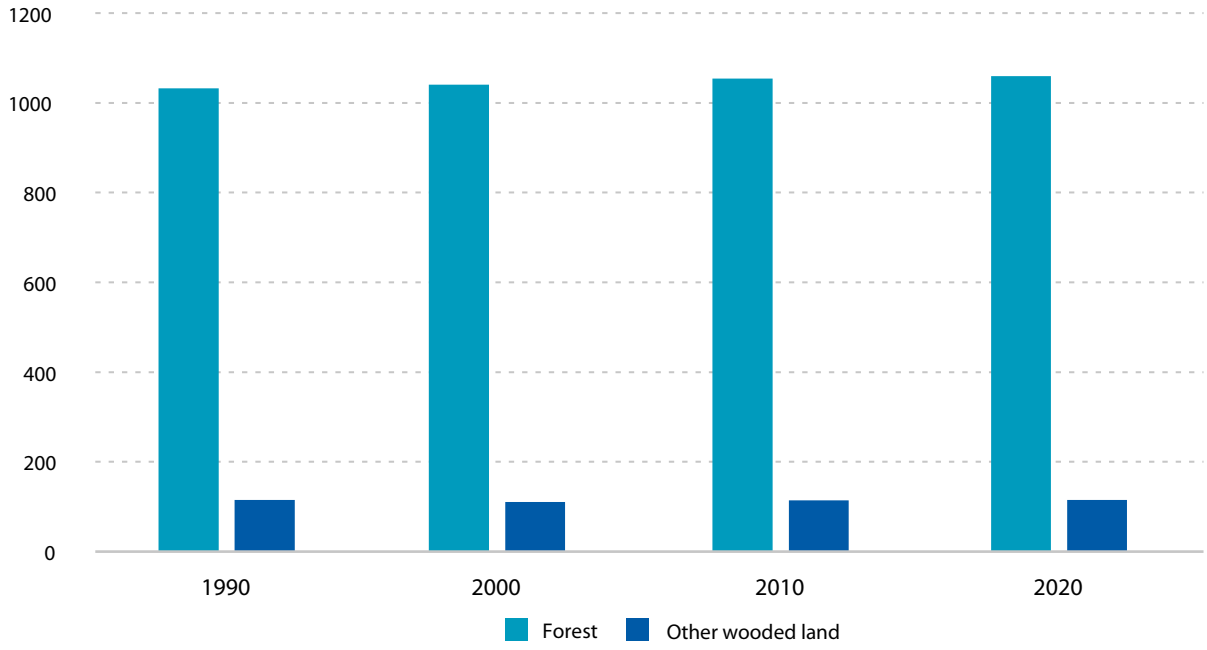
173 The Russian Federation alone accounts for 77 per cent of the ECE region's forest area.

Figure 26 Proportion of terrestrial and marine areas protected, 2021 (Percentage)



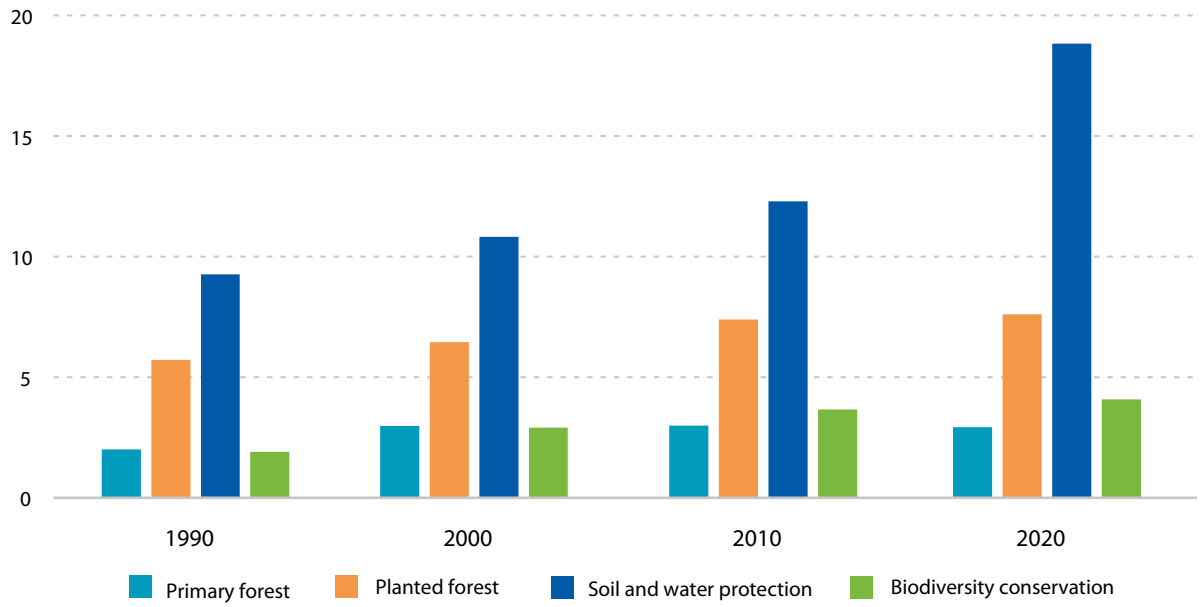
Source: IUCN, World Database on Protected Areas (December 2021 release); UNEP World Conservation Monitoring Centre.

Figure 27 Total area of forest and other wooded land, 1990–2020 (Millions of hectares)



Source: National data sets; FAO Global Forest Resources Assessment, available at https://fra-data.fao.org/ (accessed 26 January 2022).

Figure 28 Share of primary and planted forest and share of forest area designated for soil and water protection or biodiversity conservation, 1990–2020 (Percentage)



Source: National data sets; FAO Global Forest Resources Assessment, available at https://fra-data.fao.org/ (accessed 26 January 2022).
Note: No primary forest data for the Russian Federation.

The data for this indicator (see figures 27 and 28) were sourced also from Global Forest Resources Assessments of the Food and Agriculture Organization of the United Nations (FAO). Data availability for ECE member States from this source is good to very good.

Forest area has increased by 2.6 per cent since 1990, and by 0.5 per cent since 2010. The share of forest area has increased by 1 per cent to 39.2 per cent over the past 30 years. Other wooded land has changed little and contributes another 4.3 per cent, as of 2020. This means that the pan-European region has met target 15.1 of the Sustainable Development Goals and Aichi Target 5 in quantitative terms.

The share of primary forests, which tend to be particularly biodiversity rich, remained stable at a low 3 per cent of total forest area between 2000 and 2020. Planted forests became absolutely and relatively more important, increasing from 5.7 per cent in 1990 to 7.6 per cent in 2020. However, this does not mean that expansion of planted forest typically occurs at the expense of primary forest; as noted in the previous paragraph, the total forest area increased.

Over the past 30 years, forest designation has seen a diversification from a narrow focus on production in 1990 to a broader spectrum, including protection of soil, water and biodiversity. This diversification of forest designations can be interpreted as a management response aimed at improving the quality of existing forests, including from a biodiversity conservation perspective. Forest areas designated for water and soil protection more than doubled, from 9.3 to 18.8 per cent, and those for biodiversity conservation doubled from 1.9 to 4.1 per cent.

Land uptake (ECE indicator): overall moderate-to-poor status

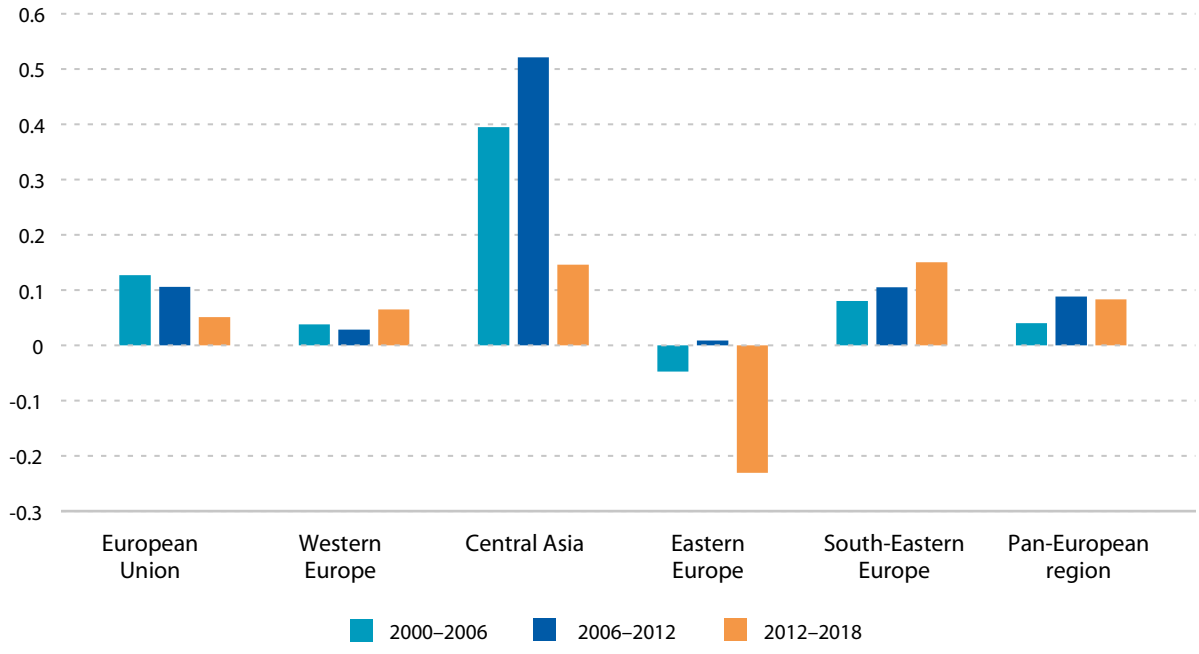
A modified version of ECE indicator E-1, based on EEA indicator "Land take in Europe" (i.e. net conversion of land from non-artificial to artificial land-use categories), has been used in this assessment. The indicator shows only part of the overall relationship between land-use changes and biodiversity. While agriculture is considered a non-artificial use, pressures on biodiversity from habitat loss or degradation are often associated with conversion to agricultural land or change of agricultural practices.

The indicator results are most conclusive for EEA member countries and cooperating countries, while there are some gaps regarding data completeness and consistency of land take data from other ECE member States. Figure 29 shows the indicator for three six-year intervals from 2000 to 2018 for the different subregions.

Net land take continues in all subregions, though the rate is decreasing. Land take figures for the countries that joined the European Union since 2004 peaked in the period 2006–2012 (0.11 per cent) and declined thereafter (0.09 per cent in the period 2012–2018), possibly reflecting the adoption of European Union policies and standards. Land uptake in other ECE member States decreased substantially in the period 2012–2018. This trend shows considerable variability across EEA countries and there are countries where land take rates continued to increase over the entire 2000–2018 period.

Land uptake and land take data from EEA member countries and cooperating countries are difficult to compare with those from other countries. This is due to differences in methodology between EEA members and cooperating countries, on the one hand, and between EEA members and other ECE member States, on the other. The reasons for this lack of comparability of data from other ECE member States include limited availability of reliable remote-sensing data and consistent criteria to analyse them, the continuity of national monitoring efforts and also, apparently, shifts in land classification in the early 2000s in some member States. This highlights the need to continue investing in consistent land-cover classifications – ideally aligned with the Corine Land Cover system – and monitoring capacity, agree on consistent national information to be fed into the Shared Environmental Information System (SEIS) and carefully retrofit actual land-cover categories to past data in order to obtain reliable trend information.

Figure 29 **Land take across three six-year time periods by subregion, 2000–2018** (Percentage of total land area)



Source: National data sets; European Environment Agency Land take and net land take dashboard, available at https://www.eea.europa.eu/data-and-maps/dashboards/land-take-statistics (accessed on 17 September 2021).

Notes: In Western Europe subregion, no data for Andorra, Israel, Monaco and San Marino; in Central Asia, data only for Kazakhstan and Uzbekistan; in Eastern Europe, no data for Georgia and Ukraine, no data for Armenia and the Republic of Moldova in the first period, no data for the Russian Federation in the third period. A negative percentage indicates a return or abandonment of the land.

5. Case studies

Enhancing area-based biodiversity conservation by recognizing other effective area-based conservation measures

Other effective area-based conservation measures are areas under management not primarily dedicated to biodiversity conservation, but where management nevertheless contributes to improved biodiversity status. Examples include cultural heritage areas, military training areas and sustainably managed production forests that generate biodiversity benefits. These sites, which occupy a significant share of the area in many countries, went largely unrecognized in the past and attracted only limited resources and efforts to enhance their biodiversity benefits. This started to change with the 2010–2020 Strategic Plan for Biodiversity under the Convention on Biological Diversity and the inclusion of other effective area-based conservation measures in Aichi Target 11 and is likely to be further enhanced in the post-2020 global biodiversity framework.

Other effective area-based conservation measures represent a significant but largely untapped opportunity to extend and consolidate area-based conservation networks in the pan-European region. They could contribute greatly to extending overall ecological representation, linking up existing PAs and engaging additional actors to contribute to better biodiversity status.

For the European Union and countries with European Union association or partnership agreements transposing European Union water legislation into national legislation, the Water Framework Directive[174] and Floods Directive[175] have the potential to result in land and water management that would be in line with criteria for other effective area-based conservation measures. National forest categories of many States of Northern Eurasia, the Caucasus and Central Asia, such as "protective forest" (i.e. forest with the purpose of protecting groundwater reserves or protecting against landslides on slopes), also generate substantial biodiversity benefits and might be recognized as other effective area-based conservation measures.

ECE member States should systematically explore and use the emerging designation of other effective area-based conservation measures to further consolidate their area-based conservation networks.

174 Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy, *Official Journal of the European Union*, L 327, vol. 43 (22 December2000), pp. 1–73.

175 Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks, *Official Journal of the European Union*, L 288, vol. 50 (6 November 2007), pp. 27–34.

International cooperation to control pressures from linear infrastructure to migratory mammals in Central Asia

Many of the iconic migratory mammals of the Central Asian steppes, such as the Saiga antelope, the goitered gazelle and the khulan, are globally threatened, partly owing to significant pressure from habitat fragmentation and degradation along linear infrastructure, for instance roads and railways, pipelines and fences. This is directly relevant to the first conference theme, "Greening the economy in the pan-European region: working towards sustainable infrastructure".

To reduce and mitigate these pressures, ECE member States in Central Asia are cooperating on various initiatives under the Convention on the Conservation of Migratory Species of Wild Animals, including the Memorandum of Understanding concerning Conservation, Restoration and Sustainable Use of the Saiga Antelope and the Central Asian Mammals Initiative. These are aimed at removing barriers to migration, developing and supporting regional ecological networks and, ultimately, preserving animal migrations in the Central Asian region as one of the last global "migration hotspots".

The ECE member States in the Central Asian region should continue their cooperation to plan and manage linear infrastructure in such a way that impacts on migratory mammals are minimized.

F. Land and soil

1. Key messages and recommendations

Key messages

Land use and land-use change in the pan-European region continue to be mainly driven by agriculture, but the situation varies from country to country. In Eastern Europe and Central Asia, agricultural production is rising and rapidly approaching levels seen in the Soviet era, while domestic demand has fallen, due to a drop in livestock inventory. The current land-use dynamic shows only a moderate increase of the sown area in fertile soil (steppe and forest-steppe) zones and no sign of agriculture recovering in marginal (forest) areas. At the same time, the utilized agricultural area in the European Union is expected to continue declining smoothly towards 2030, though at a slower pace than in the past decade.[176] Land take in the European Union slowed down but remains an issue. Between 2000 and 2018, 78 per cent of land take in the European Union affected agricultural areas, i.e. arable land and pastures, and mosaic farmland. The main drivers for land take and soil sealing in the European Union during this period were industrial and commercial land use as well as extension of residential areas and construction sites.[177]

Soil organic carbon (SOC) content, the carbon stored in soil organic matter, is the most important element of soil and soil health, due to its role in improving aeration, water retention, nutrient supply, soil biodiversity and climate change mitigation. Soils with high carbon content are likely to be more productive and better able to filter and purify water. SOC plays a big role in climate change, presenting both a threat and an opportunity to help meet the targets of the Paris Agreement.[178] For example, in Eastern Europe, large-scale land abandonment switched agricultural land from being a small source of atmospheric CO_2 to a significant sink of atmospheric CO_2. Conservation agriculture practices in the pan-European region may play an important role in carbon sequestration, maintaining or raising soil productivity, and sustaining important soil functions (such as water regulation and biodiversity).

Land erosion is one of the results of land-use dynamics, and it shows different characteristics throughout the region. Field measurements in European Union countries show an average rate of soil erosion of 0.2–3.2 t ha^{-1} $year^{-1}$ on a per-country basis. In Eastern Europe, the average rate of soil erosion has decreased over the past 30 years following massive cropland abandonment and climate change. In the Russian Federation, the total amount of washed soil and the rate of erosion have been reduced by 56.1 per cent and 15 per cent respectively in the past 30 years, due to the widespread abandonment of cropland and lower spring run-off. In Central Asia, wind erosion is a dominant type of land degradation, but the contribution of irrigated and rainfed cropland is limited by their relatively small area and relatively low rate of erosion. Erosion can be further reduced in most affected areas by implementing conservation agriculture.

The European Union, following changes in production, awareness-raising and consumer behaviour, is increasingly focusing on food safety by developing local, organic, genetically-modified-organism-free or other types of certified production,[179] which results in more sustainable agriculture practices. Eastern Europe and Central Asia feel the need to prioritize self-sufficiency in key foodstuffs, which might lead to less sustainable agriculture practices.

176 Land abandonment in the European Union might reach 4.2 million ha, or 3–4 per cent of current utilized agricultural area, by 2030, see Carolina Perpiña Castillo and others, "Agricultural land abandonment in the EU within 2015–2030", JRC Policy Insights (Ispra, Italy, European Commission, 2018).

177 EEA, "Land take in Europe", 13 December 2019.

178 FAO, Global Soil Partnership, "Soil organic carbon" (n.d.), available at https://www.fao.org/global-soil-partnership/areas-of-work/soil-organic-carbon/en/.

179 European Commission, Directorate-General Agriculture and Rural Development, *EU Agricultural Outlook for Markets and Income, 2019–2030* (Luxembourg, Publications Office of the European Union, 2019).

Recommendations

The pan-European countries should increase efforts to provide better guidance to farmers on using soil conservation methods in areas of degraded (eroded) soils. There are already simple models (based on the Universal Soil Loss Equation)[180] allowing farmers to explore different options to decrease the rate of erosion on their plots at an economically acceptable cost; however, these methods cannot be used at larger scale or with all types of soils and further research and development is required.

Policymakers should strive to maintain a judicious balance between SOC accumulation for higher crop productivity and SOC storage for climate change mitigation, as this is critical for mainstreaming global sustainable initiatives such as "4 per thousand".[181]

The pan-European policy in respect of land resources should ensure reduction of land degradation and develop and implement policies to tackle soil sealing. Furthermore, Governments should focus on consumers' rights to healthy (i.e. free from pesticides and antibiotic, hormone or steroid residues) food, a healthy environment (including animal welfare), stable food prices and low household expenditures on food. This could be achieved by promoting environmentally sound agriculture practices and a reliable food supply (of domestically produced and imported items) and redirecting investments to storage facilities and transportation where needed.

In a situation of intense rural exodus, more active measures should be implemented to reverse the depopulation trend through the diversification of incomes, such as by developing rural tourism and attracting new settlers. Recognizing the biodiversity value of low-intensity farmland, the European Union provides agroenvironmental subsidies in support of farming in marginal areas, but the economic impact of existing European Union programmes in support of rural tourism is modest, while their effects depend on the specific characteristics of the areas.

180 The Universal Soil Loss Equation model is used to calculate potential erosion on fields as a result of a combination of "predisposing factors" such as rainfall pattern, topography, soil texture, cropping systems and management practices. The target audience of the model is farmers who can use the Universal Soil Loss Equation guideline (in a simple table format) to receive advice for their routine practices (A.J. Jones and others, *Universal Soil Loss Equation: A Handbook for Nebraska Producers*, Nebraska Cooperative Extension Service EC 88-116 (n.p., University of Nebraska-Lincoln, 1987)).

181 The "4 per thousand" initiative is a voluntary action initiative adopted at the 2015 Paris Climate Change Conference that aims to boost carbon storage in agricultural soils by 0.4 per cent each year.

2. Context

Being parties to the United Nations Convention to Combat Desertification (UNCCD), European and Central Asian countries share an ambition to achieve Land Degradation Neutrality (LDN) by 2030. An offsetting scheme is a new component of the LDN approach, meaning that land degradation should be compensated by the restoration or rehabilitation of degraded lands elsewhere. Yet the methodology related to the LDN target is not fully developed.

Most (1,500 Gt) terrestrial carbon is held in soils – more than twice as much as in vegetation or the atmosphere. The soils in EEA member countries hold around 5 per cent of the global SOC pool, whereas the Russian Federation alone holds about 21 per cent. The increase of SOC in pan-European soils can positively contribute to the mitigation of GHG emissions globally, but nearly 75 per cent of the territory of the Russian Federation lies in the permafrost zone, whose SOC reserve is susceptible to decomposition upon climate warming, thus contributing to the enhanced emission of GHGs.

EEA member countries recognize agriculture as essential for maintaining biodiversity of extensive farmland biotopes and early successional habitats, such as heathland and meadows. The biodiversity of low-intensity farming land can be higher than that of rewilded, semi-natural and forested areas, and farmers in those areas are producers of both food and ecosystem services. Therefore, the abandonment of such areas is perceived in the European Union as a serious threat to biodiversity. Depopulation (or "desertification") of rural settlements, and not just cropland abandonment, needs to be reversed.

While soil has multiple roles, including for the water cycle, regulation of nutrients and pollution and as habitat, a primary human use of land and soil resources is food production. Soil underpins 90 per cent of all food, feed and fibre production. The European Union and Western Europe are observing a shift in production and consumer behaviour towards local, organic, genetically-modified-organism-free and other types of certified production. The resulting changes in agriculture should be spread over the rest of the pan-European region into subregions where the consumer's right to healthy food is not clearly articulated in food security strategies.

3. State, main trends and recent developments

Land and soil degradation is a concern, including in the pan-European region, and demand for land is increasing. Land degradation is often caused by a combination of factors such as poor land management, unsustainable agricultural practices, pollution and deforestation. The 2021 European Union Soil Strategy for 2030 sets out a framework and concrete measures to protect and restore soils and ensure that they are used sustainably. It sets a vision and objectives to achieve healthy soils by 2050, with concrete actions by 2030.[182] The Strategy sets out measures related to soil and circular economy, among other issues, and suggests a safe, sustainable and circular use of excavated soil and limiting land take and soil sealing with the circular use of land. Revitalizing and/or remediating land, including from industrial sites and contaminated land, presents an opportunity for sustainable urban development and to reduce pressure on undisturbed land resources.[183]

Healthy soils are crucial for food production. In most EEA member countries, information about SOC is obtained from local soil surveys undertaken by various national or regional institutions, making comparison of the data difficult. The most comprehensive SOC observation network, in England and Wales (the United Kingdom), shows loss of SOC in all types of ecosystems and land-use classes. The reason for loss is probably increasing decomposition of organic matter with higher temperatures caused by climate change.

Support from the European Union Common Agricultural Policy could slow the process of cropland abandonment and rural depopulation in the bloc, but it is not expected to reverse it. In Eastern Europe and Central Asia, about

182 European Union, "Soil Strategy for 2030" (n.d.).

183 WHO, Regional Office for Europe, *Urban Redevelopment of Contaminated Sites: A Review of Scientific Evidence and Practical Knowledge on Environmental and Health Issues* (Copenhagen, 2021).

58 million ha of cropland were abruptly abandoned during the 1990s and are unlikely to be fully restored because of rapid depopulation of marginal rural areas and because no support policy like the Common Agricultural Policy exists in these countries.

Numerous field studies show a significant reduction in soil erosion on no-tilling land; moreover, carbon sequestration after no tilling is higher than after conventional ploughing. However, there are no explicit national or regional policies in respect to conservation agriculture. Conservation agriculture in the pan-European region demonstrates very limited growth (e.g. 2.5 million ha of no-tilling arable land in the European Union) compared with other world regions. Farmers face a trade-off immediately after adopting no tilling: on the one hand, crop yields are often lower, while on the other, production costs decrease due to limited use of machinery and fertilizers and less working time per unit area. Farmers following a no-tilling approach often resort to high and regular applications of herbicides, though longer term benefits can arise from certified organic produce.

Rural tourism can be important for revitalization of abandoned rural settlements. Shifting policymakers' concern from cropland abandonment to "desertification" of thousands of villages throughout the pan-European region is necessary, as low yields are unlikely to be the reason for villages to be left, while an intense demographic rural exodus can certainly cause land negligence. Due to the development of new communication technologies, isolation and lack of employment opportunities are no longer reasons for abandoning small rural and mountainous villages, as the response to the COVID-19 pandemic has amply demonstrated with the temporary relocation of urban dwellers to rural areas.[184] An analysis of numerous existing projects for recovering abandoned villages in Italy shows that, among different approaches, rural tourism has the largest potential to succeed.[185]

4. Indicators

Proportion of land degraded

Land degradation and erosion is identified by the European Parliament as "probably the most significant environmental problem in Europe".[186] Most research on land degradation assesses territories in terms of potential risk of erosion because field measurement of actual erosion rates is difficult to conduct, especially at a larger scale. At the global level, the UNCCD assessment methodology consists of all three subindicators: land cover change, land productivity change and carbon stocks. Parties to the UNCCD provide information on the total area of degraded land and level of confidence of assessment,[187] though Conservation International provides complete coverage using remotely sensed data (see map 2 and figure 30).

Topsoil organic carbon content

The Soil Framework Directive[188] called for the delineation of the areas in Europe threatened by a decline in soil organic matter below a definite critical level and for elaboration of appropriate measures to avoid the decline. The "critical" concentration of SOC at 2 per cent (or 3.4 per cent of soil organic matter according to a standard conversion ratio) is the most cited threshold in policy documents. The European Commission Roadmap to a Resource Efficient Europe[189] proposed a goal that SOC levels should not decrease overall and should increase for soils currently with less than

184 OECD, "Policy implications of Coronavirus crisis for rural development", 16 June 2020.

185 Kristen Elizabeth Sloan, "Reawakening 'ghost towns': alternative futures for abandoned Italian villages", PhD dissertation, University of Wollongong, 2018.

186 SoCo Project Team, "Addressing soil degradation in EU agriculture: relevant processes, practices and policies: report on the project 'Sustainable Agriculture and Soil Conservation (SoCo)'", JRC Scientific and Technical Reports (Luxembourg, Office for Official Publications of the European Communities, 2009).

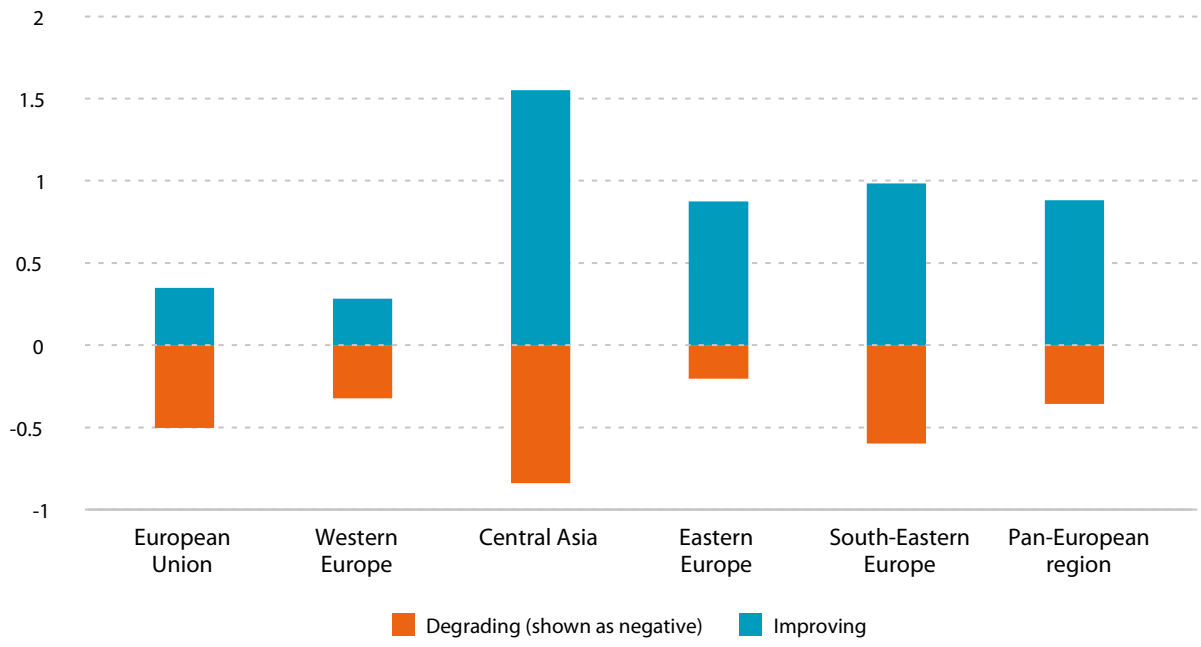
187 ICCD/CRIC(17)/2.

188 Adopted in 2006 but withdrawn by the European Commission in 2014.

189 European Commission, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Road Map to a Resource Efficient Europe, COM(2011) 571 final.

2 per cent SOC by 2020.[190] Recent scientific publications refer to the importance of clay ratio in soil organic matter rather than the strict 2 per cent SOC concentration requirement.[191] Figure 31 and map 3 illustrate the variation in SOC across the region, with 20 g/kg SOC being equivalent to the 2 per cent threshold (coloured green in map 2). Figure 31 shows the proportion of soil that is improving or degrading across the region.

Figure 30 Proportion of area with improving or degrading soil organic carbon content, 2005–2019 (Percentage)

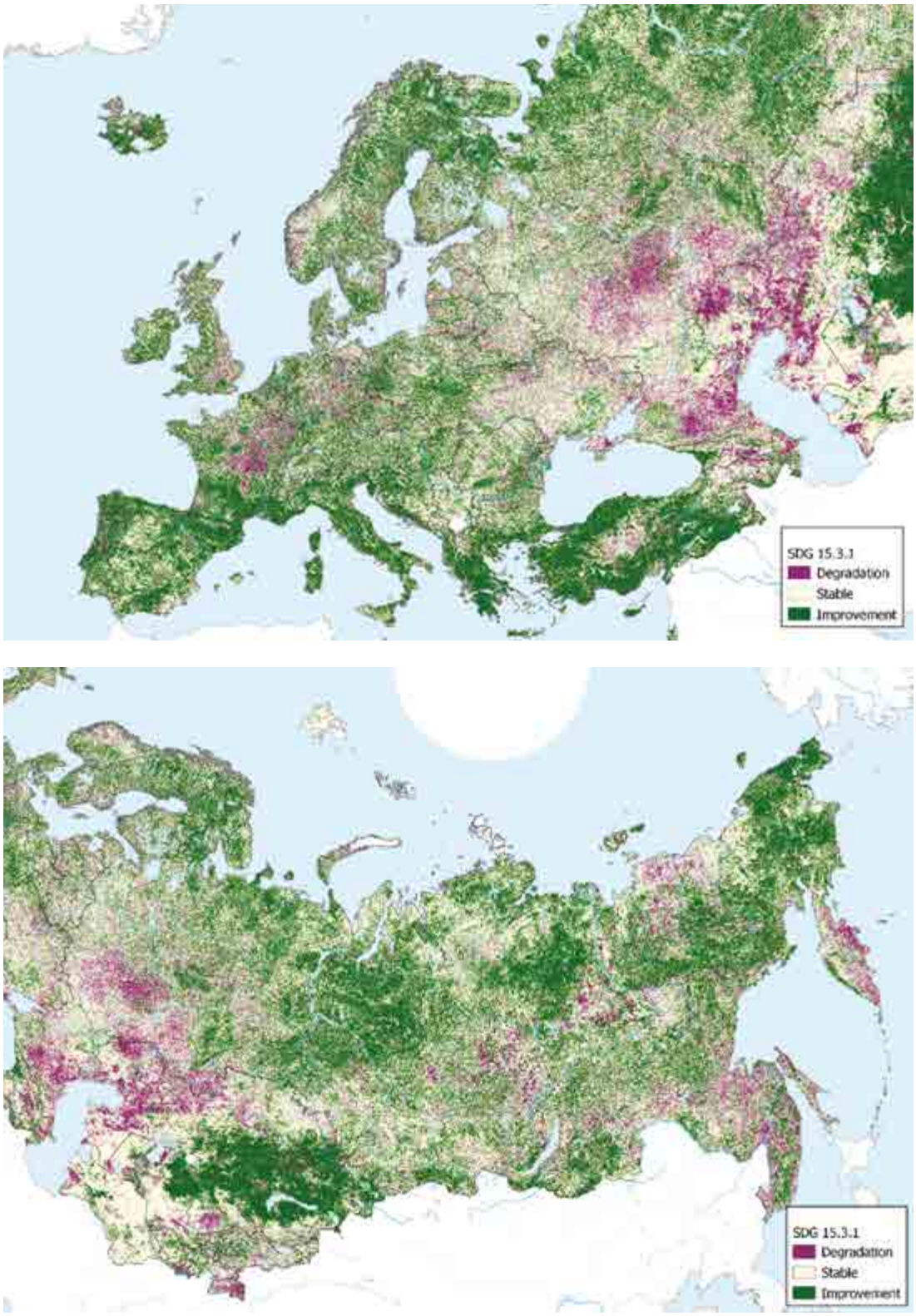


Source: Conservation International.

190 Panos Panagos and others, "Estimating soil organic carbon in Europe based on data collected through an European network", *Ecological Indicators*, vol. 24 (January 2013), pp. 439–450.

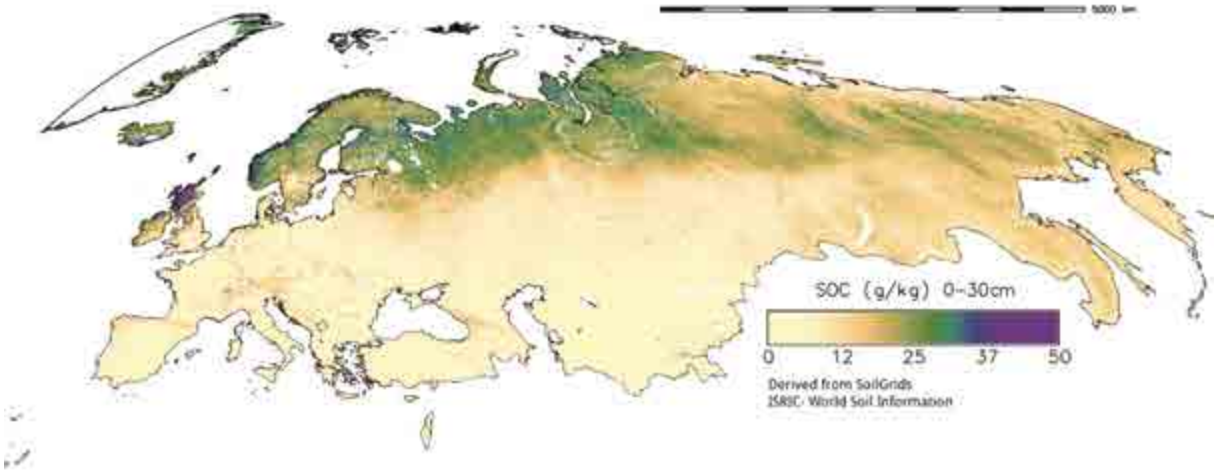
191 Alice Johannes and others, "Optimal organic carbon values for soil structure quality of arable soils. Does clay content matter?", *Geoderma*, vol. 302 (September 2017), pp. 14–21; Jonah M. Prout and others, "What is a good level of soil organic matter? An index based on organic carbon to clay ratio", *European Journal of Soil Science*, vol. 72 (2021), pp.2493–2503.

Map 2 Trends in land degradation in the pan-European region, 2005–2019



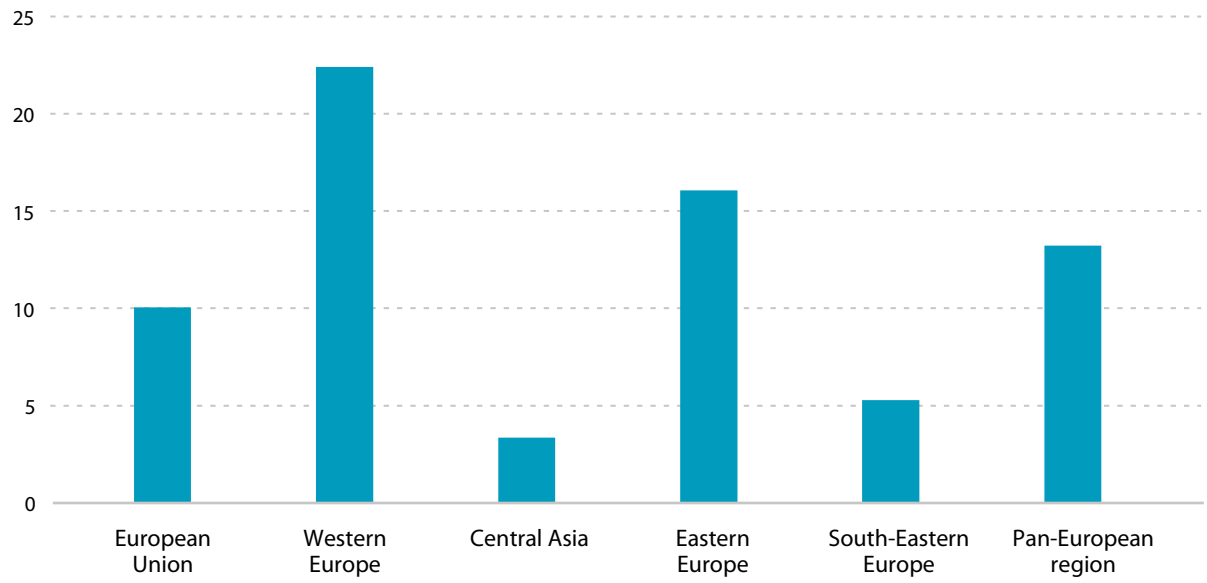
Source: Conservation International.

Map 3 Soil organic carbon content, 0–30 cm, 2020 (Grams per kilogram)



Source: Derived from SoilGrids 2021, courtesy of ISRIC – World Soil Information.

Figure 31 Soil organic carbon content by subregion, weighted average 0–30 cm, 2020 (Grams per kilogram)



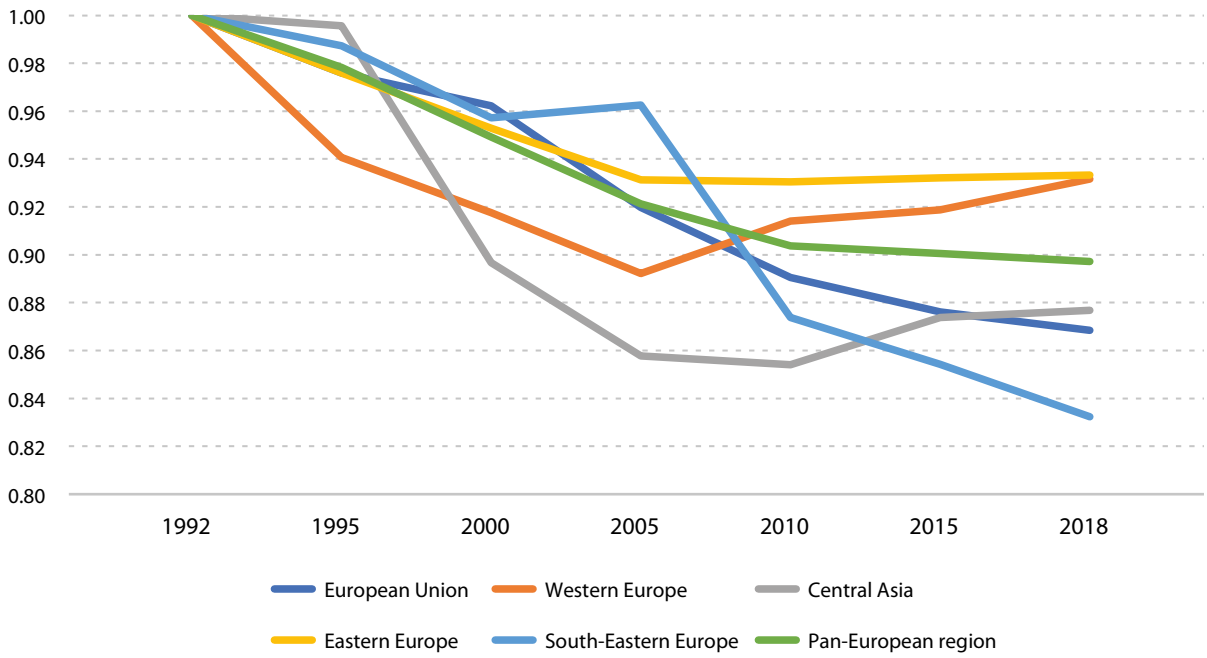
Source: Derived from Poggio and others, "SoilGrids 2.0" (2021),[192] courtesy of ISRIC – World Soil Information.

192 Laura Poggio and others, "SoilGrids 2.0: producing soil information for the globe with quantified spatial uncertainty", *SOIL*, vol. 7, No. 1 (June 2021), pp. 217–240.

Cropland area

There is no definite threshold for agricultural land dynamic, although any decrease of cropland is regarded by default as negative in terms of food security. In the past decade, the long-term trend of a decline in cropland continued in the European Union, though at a slower pace. Moreover, in recent years, a positive trend is observed (see figure 32). However, the positive trend may reverse in the next decade.[193] Interestingly, in Eastern Europe and Central Asia, current land-use dynamics also showed some increase of sown area, especially in productive areas of Kazakhstan, the Russian Federation and Ukraine, until 2021.

Figure 32 Cropland area, 1992–2018 (1992=1)



Source: FAO, FAOSTAT, "Land Use", available at www.fao.org/faostat/en/#data/RL.

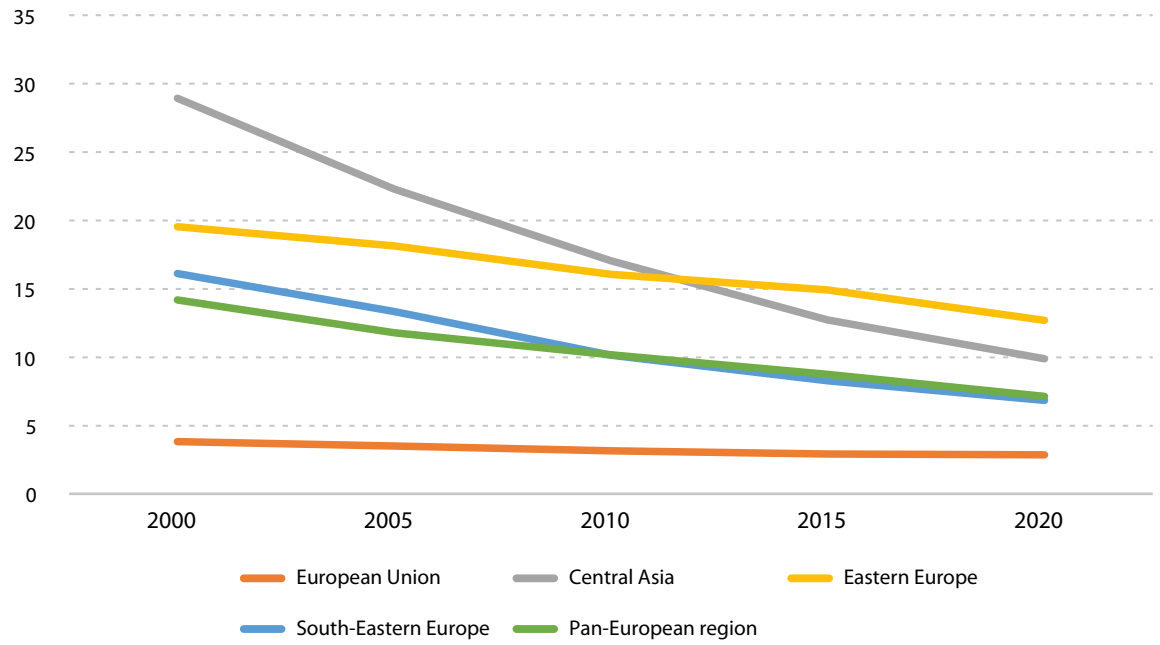
Prevalence of stunting among children aged under five years

The malnutrition rate among children aged under five years is an indicator of food security and safety. The indicator is especially important for monitoring progress in the quality of food diet in Eastern Europe and Central Asia. Figure 33 demonstrates the impressive progress made this century. The post-Soviet countries can be classified into three broad categories in terms of food and nutrition security: (a) those primarily affected by undernutrition and micronutrient deficiencies (Kyrgyzstan, Tajikistan and Uzbekistan); (b) those facing the triple burden of malnutrition, characterized by residual undernutrition, persisting micronutrient deficiencies and increasing rates of obesity (Kazakhstan); and (c) countries primarily affected by overnutrition (the Russian Federation).[194]

193 Cristian Andronic and others, "The challenge of land abandonment after 2020 and options for mitigating measures" (Brussels, European Parliament, Policy Department for Structural and Cohesion Policies, 2020).

194 Saule Burkitbayeva, Johan Swinnen and Nele Warrinnier, "Food and nutrition security in Eurasia: evolution, shocks and policies", *Russian Journal of Economics*, vol. 6, No. 1 (March 2020), pp. 6–25.

Figure 33 Prevalence of stunting among children aged under 5 years, 2000–2020 (Percentage)



Source: United Nations Children's Fund (UNICEF), WHO and World Bank Joint Child Malnutrition Estimates (JME) Expanded Database: Stunting (Survey Estimates), April 2021, New York, Malnutrition in Children. Available at https://data.unicef.org/topic/nutrition/malnutrition/.

Notes: No data for Western Europe (non-European Union), the Russian Federation and Türkiye. Within European Union, data only for Belgium, Bulgaria, Czechia, Estonia, Germany, Greece, the Netherlands, Poland, Portugal and Romania.

5. Case studies

Portuguese *montado* and Spanish *dehesa*: surviving farming in a marginal environment

The Common Agricultural Policy supports marginal farming by providing for agroenvironmental subsidies in the framework of its second pillar, on rural development. About 4 per cent of the European Union subsidies are directed to agriculturally Less Favourable Areas, which are supposed to have a high level of biodiversity.[195] Some experts challenge this policy, wishing to see subsidies for marginal land without connection to farming activities.[196] However, there are a few positive examples of farming on marginal lands leading to both environmental and economic benefits. Two of the best examples come from the Portuguese *montado* and the Spanish *dehesa*. These agroforestry systems are dominated by cork oak and holm oak woodland, which produce cork as a forestry product and acorns for livestock breeding, respectively. In between trees, farmers seed pastures and cereals. The biodiversity of these systems is very high and they have retained many of the main characteristics of the original vegetation. Also, many of these farms are economically viable because of this multifunctionality and their large operational spatial scale.[197]

195 European Commission, Directorate-General for Agriculture and Rural Development, *Rural Development in the European Union: Statistical and Economic Information Report 2013* (Luxembourg, Publications Office of the European Union, 2013).

196 Thomas Merckx and Henrique M. Pereira, "Reshaping agri-environmental subsidies: from marginal farming to large-scale rewilding", *Basic and Applied Ecology,* vol. 16, No. 2 (March 2015), pp. 95–103.

197 T. Pinto-Correia, N. Ribeiro and P. Sá-Sousa, "Introducing the *montado*, the cork and holm oak agroforestry system of Southern Portugal", *Agroforestry Systems,* vol. 82, No. 2 (April 2011), pp. 99–104.

G. Chemicals and waste

1. Key messages and recommendations

Key messages

The management of chemicals and waste is at the heart of many solutions to the current challenges faced as a part of the transition to a zero-carbon and sustainable economy. In the pan-European region, often either capacities to make well-informed decisions on chemicals and waste issues are lacking or expertise is not well integrated into decision-making processes. Government decision-makers, industry and the public do not have easy access to information and knowledge that will support the making of impact-oriented choices.

Chemicals play a vital role in the economy today and are essential in paving the way towards green economy. However, it remains difficult to fully capture the exposure of humans to hazardous chemicals. No set of impact-oriented indicators is regularly monitored across the region. There is also a lack of information regarding the impact of chemicals on the efficiency and economic viability of circular economy schemes such as recycling.

While the waste management hierarchy assigns the highest priority to waste prevention, waste generation continues to rise across the region. Even where there is strong political commitment to a circular economy, such as in the European Union and other western European countries, the quantities of waste generated are growing.

A specific challenge is electrical and electronic equipment waste (e-waste), which contains both hazardous and precious components. Average e-waste generation is stabilizing in the region as a whole but it continues to increase rapidly in the economically less mature subregions. E-waste collection and recycling are highly deficient across all subregions; the recovery rates are low. Thus, an important opportunity is being missed to harness economic value for the region and to reduce the region's dependency regarding the sourcing of critical raw materials, which are bottlenecks in the shift towards resilient future economies.

Recycling rates differ significantly among countries in the region and are particularly low in Eastern Europe and Central Asia. Municipal waste recycling rates above 45 per cent exist only in a few European Union countries and Switzerland. Progress is being achieved in all subregions, but slowly.

Recommendations

ECE member States should increase efforts to equip public administrations with a skilled work force, ready to engage with all sectors of society, and to increase broad access to reliable and detailed information, in order to achieve sound management of chemicals and waste. Governance of chemicals and waste must be made fitter for the challenges of today and the years of transition of economies that lie ahead, by better balancing risks and opportunities.

Governments should strive to further advance full and coherent implementation of multilateral environmental agreements (MEAs), including the Protocol on Pollutant Release and Transfer Registers to the Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters (Aarhus Convention). Administrations should make efforts to establish a region-wide, impact-oriented, gender-responsive monitoring scheme, as a form of cooperation between science and policy, to build up a better picture of the adverse impacts of chemicals on human health and the environment, and to address them.

ECE and its member States should work on establishing a mechanism across countries and sectors to identify and share benchmarks and good practices for resource efficiency in production processes. Sharing of knowledge will allow decision-makers at all levels to tap into the potential gain from using existing good practices.

The countries of the region should establish a resource-oriented, pan-European e-waste management partnership, which would aim at the effective collection and sound handling of recyclables to enable the recovery of valuable resources. An urgent priority is the recovery of secondary resources from e-waste, especially in view of the rapidly growing quantities across Eastern Europe, South-Eastern Europe and Central Asia.

Governments should support waste prevention, repair, refurbishment and remanufacturing, including through financial incentives such as tax relief, in order to reduce waste. These waste prevention efforts would improve resource efficiency. Furthermore, Governments in the pan-European region should adopt a circular – or resource-efficient – economy approach and strengthen management of raw materials, including, for example, through application of the United Nations Framework Classification for Resources and the United Nations Resource Management System.[198]

2. Context

Usage of chemicals and the occurrence of waste are tightly interwoven with standards of living and economic prosperity. An estimated 40,000 to 60,000 industrial chemicals are commercially traded worldwide[199] and used, for example, in agriculture, health care and the manufacturing of items such as electronics, textiles, furniture and toys. Chemicals also have a major role to play in the transition towards green economy, since they represent building blocks of resource-efficient technologies and products.[200] However, some chemicals cause risks to the environment and human health. Chemicals released into air, water and soil can influence individual species, alter biodiversity and undermine the resilience of ecosystems. Harmful exposure to chemicals can negatively affect human health through a broad range of implications, including damage to immune, endocrine and reproductive systems, genetic effects and chronic diseases such as cancer, cardiovascular disorders and asthma.

The existence of large amounts of waste is linked to inefficient use of resources as part of unsustainable consumption and production practices in modern societies. Some waste has hazardous properties and its sound handling is an

198 As called for in United Nations, *Transforming Extractive Industries for Sustainable Development* (May 2021).

199 UNEP, *Global Chemicals Outlook II: From Legacies to Innovative Solutions: Implementing the 2030 Agenda for Sustainable Development* (n.p., 2019).

200 European Commission, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Chemicals Strategy for Sustainability Towards a Toxic-Free Environment, COM(2020) 667.

essential element in reducing chemical pollution. Other waste streams cause losses of materials and energy and aggravate pressures on the environment, for example, the introduction of microplastics into food chains, affecting biodiversity and human health. At the same time, sound and value-oriented management of solid waste can substantially contribute to the mitigation of climate change by potentially displacing around 15 to 20 per cent of GHG emissions worldwide.[201]

The pan-European region faces the dual challenges of protecting the ecosystem services available to current and future human societies and decoupling environmental degradation from economic prosperity. To meet these challenges, the adoption of more sustainable consumption and production patterns, and the sound management of chemicals and waste, as parts of the transition to green economy, are required. Risks and opportunities must be well understood and responded to with effective measures.

3. State, main trends and recent developments

In 2017, the global chemical industry's production capacity amounted to 2.3 billion tons, making the chemical industry the second-largest manufacturing industry in the world in terms of economic relevance.[202] The volume of traded chemicals is expected to grow significantly in the future;[203] the number of new chemicals is also rising.[204] Of the 345 million tons of chemicals consumed in the European Union in 2016, 62 per cent belonged to categories classified as hazardous to human health and 35 per cent were hazardous to the environment.[205] The latest report on *The European Environment: State and Outlook* identified as a specific issue of concern the potential combined effects of different chemicals.[206] The full extent of exposure to hazardous chemicals and the impacts on environmental and human health are difficult to capture because of the complexity of this field and the high number of different chemicals in use, and because no concise set of impact-oriented indicators is regularly monitored across the region. Methodologies for such risk assessments are still rather fragmented.[207] The knowledge base is reasonably broad, although still fragmented for the European Union[208] but strongly deficient for other subregions.

A complex body of legislation addresses usage and handling of chemicals. The most stringent regulations exist in the European Union, with approximately 40 legislative instruments.[209] These include the European Regulation on Registration, Evaluation, Authorization and Restriction of Chemicals,[210] which identifies the key characteristics of the listed chemicals. In October 2020, the European Union Chemicals Strategy for Sustainability Towards a Toxic-free Environment was launched; it aims to phase out the most harmful substances from consumer products and to support financially the uptake of safe and sustainable chemicals.[211] For all countries, the Globally Harmonized System of Classification and Labelling of Chemicals has established standards for hazard classification, labelling and

201 UNEP and the International Solid Waste Association (ISWA), *Global Waste Management Outlook* (n.p., UNEP, 2015).

202 UNEP, *Global Chemicals Outlook II*.

203 Ibid.

204 Beate I. Escher, Heather M. Stapleton and Emma L. Schymanski, "Tracking complex mixtures of chemicals in our changing environment", *Science*, vol. 367, No. 6476 (January 2020), pp. 388–392.

205 EEA, "Consumption of hazardous chemicals", 26 November 2019.

206 EEA, *The European Environment: State and Outlook 2020*.

207 S. Rotter and others, "Overview on legislation and scientific approaches for risk assessment of combined exposure to multiple chemicals: the potential EuroMix contribution", *Critical Reviews in Toxicology*, vol. 48, No. 9 (October 2018), pp. 796–814.

208 Milieu Ltd and others, *Study for the strategy for a non-toxic environment of the 7th Environment Action Programme: Final Report* (Luxembourg, Publications Office of the European Union, 2017).

209 European Commission, Chemicals Strategy for Sustainability.

210 Regulation (EC) No. 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorization and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC, *Official Journal of the European Union*, L 396, vol. 49 (30 December 2006), pp. 1–849.

211 European Commission, "Green Deal: Commission adopts new Chemicals Strategy towards a toxic-free environment", 14 October 2020.

elaboration of material safety sheets since 2002. Its adoption was much slower than was foreseen,[212] but the region is now on the right path.[213] Furthermore, the Strategic Approach to International Chemicals Management, hosted by UNEP, has advanced policy responses to issues of particular concern, including lead in paint,[214] and, together with the chemical manufacturing industry's Responsible Care initiative,[215] has contributed to capacity-building. The mandate of the Strategic Approach to International Chemicals Management expired in 2020. Designing the process for the period beyond 2020 represents an opportunity to further strengthen multilateral cooperation and advance frameworks that ensure that stakeholders have adequate data and knowledge at their disposal during their decision-making processes, and adequate capacities when it comes to the implementation of measures.[216]

Several MEAs regulate the processing of substances that are of high concern for human and environmental health. These instruments establish a powerful framework, but full benefits can only be unlocked if universal ratification is achieved across the region, which is currently not the case. Eight of the 54 countries of the pan-European region are not party to the Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade. Only 37 countries of the region are party to the Protocol on Pollutant Release and Transfer Registers.

Regarding waste management, strong differences continue to exist between Western Europe and the other subregions. A common challenge is that total waste generation has continued to increase in most countries, even though waste prevention is the top priority in the waste management hierarchy. National waste prevention programmes exist for European Union and European Free Trade Agreement countries – promoting reuse and repair activities is a frequent focus – but only a few programmes explicitly support market-driven reuse activities such as refurbishment or remanufacturing.[217]

The European Union waste regulations establish a fairly robust framework for the collection, valorization or sound disposal of waste. Average European Union municipal solid waste recycling rates have been increasing continuously over the last 10 years and, since March 2020, the new Circular Economy Action Plan is in place as part of the European Green Deal. Countries joining the European Union show pronounced progress on waste management, which illustrates the effectiveness of the bloc's regulations. Across Eastern Europe, South-Eastern Europe and Central Asia, valorization of municipal solid waste has made some progress; however, overall, the recycling rates remain at relatively low levels and change is slow. This signals that circular economy schemes are not yet effectively in place across these subregions. Some countries, however, have initiated ambitious reforms of waste management frameworks, including the specification of target municipal solid waste recycling rates (i.e. the Russian Federation, Uzbekistan).

Rapidly rising volumes of e-waste across Central Asia, Eastern Europe and South-Eastern Europe are a specific challenge. In the European Union and Western Europe, e-waste quantities are stabilizing, but at a remarkably high level; e-waste generation per capita was more than twice the global average of 7.3 kg per capita in 2019. Of particular concern are the low shares of e-waste collection; collection is a prerequisite for valorization. Even in the European Union, where advanced schemes are in place, less than 45 per cent of the estimated generated e-waste volume was collected in 2017.[218]

Circularity-oriented initiatives have also emerged in the region as an effort of civil society or the private sector. Repair initiatives, sharing approaches and remanufacturing schemes are only a few examples of new business models,

212 UNEP and ECE, *GEO-6: Global Environment Outlook: Regional assessment for the Pan-European Region*.

213 ECE, "GHS implementation" (n.d.).

214 UNEP Strategic Approach to International Chemicals Management (SAICM), website, https://www.saicm.org/, accessed 2 September 2021.

215 International Council of Chemical Associations, "Responsible care" (n.d.).

216 The Strategic Approach is expected to be revised in 2022.

217 EEA, "Waste prevention in Europe: policies, status and trends in reuse in 2017", EEA Report, No. 4/2018 (Luxembourg, Publications Office of the European Union, 2018.

218 Eurostat, "Waste statistics – electrical and electronic equipment", data from August 2020. Available at https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Waste_statistics_-_electrical_and_electronic_equipment (accessed 29 May 2021).

community schemes and alternative production systems. They signal that all sectors of society have started to respond to the need for more sustainable resource usage and the prevention of waste.

Implementation of a circular economy represents a major opportunity to ensure future prosperity in the region. One promising element to support sustainable consumption is the introduction of a right to repair. Urgent measures must also be taken to end premature obsolescence of products. Two circular economy schemes to reach an industrial scale are remanufacturing and industrial symbiosis. Independent and transparent sustainability assessments are essential. International expert groups could help countries analyse their future needs for specific resources and how these can be met.

Greenwashing, by misleading consumers and exploiting their environmental concerns, can have severe detrimental impacts and is not acceptable. Those countries that manage their transition well today will be the ones with a competitive advantage in a few decades.

4. Indicators

Compliance with multilateral environmental agreements on hazardous waste and other chemicals (Sustainable Development Goal indicator 12.4.1)

This indicator identifies progress in managing chemicals and hazardous wastes in a sound way, as regulated by the Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade, the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, the Stockholm Convention on Persistent Organic Pollutants and the Montreal Protocol on Substances that Deplete the Ozone Layer. The Minamata Convention on Mercury has recently been added, with 102 of the 114 parties reporting by June 2021. Compliance in meeting reporting obligations as required by the MEAs is monitored in five-year cycles (annual monitoring is not possible because the MEAs foresee differing time schedules to submit reports). While the region performs well regarding the Montreal Protocol, insufficient performance is recorded regarding the Stockholm Convention, with all subregions, apart from South-Eastern Europe, performing worse than in the previous period and average compliance below 60 per cent (see figure 34). For the Basel and the Rotterdam Conventions, average compliance in the region ranges between 70 and 80 per cent; the European Union and South-Eastern Europe perform better than the other subregions. There has been an improvement across South-Eastern Europe and, for the Rotterdam Convention, also across Eastern Europe.

All countries have room for improvement. Participation in MEAs enables Governments to shape international negotiations and policymaking in the environmental field together and facilitates coordinated measures. Effective implementation of MEAs requires continued efforts and the allocation of sufficient financial resources to the responsible environmental institutions.

Other possible indicators include implementation of pollutant release and transfer registers (or being party to the ECE Protocol on Pollutant Release and Transfer Registers) and adherence to the Globally Harmonized System of Classification and Labelling of Chemicals.

Figure 34 Compliance with waste- and chemicals-related multilateral environmental agreements in the reporting cycles 2010–2014 and 2015–2019, by subregion, with trends (Percentage)

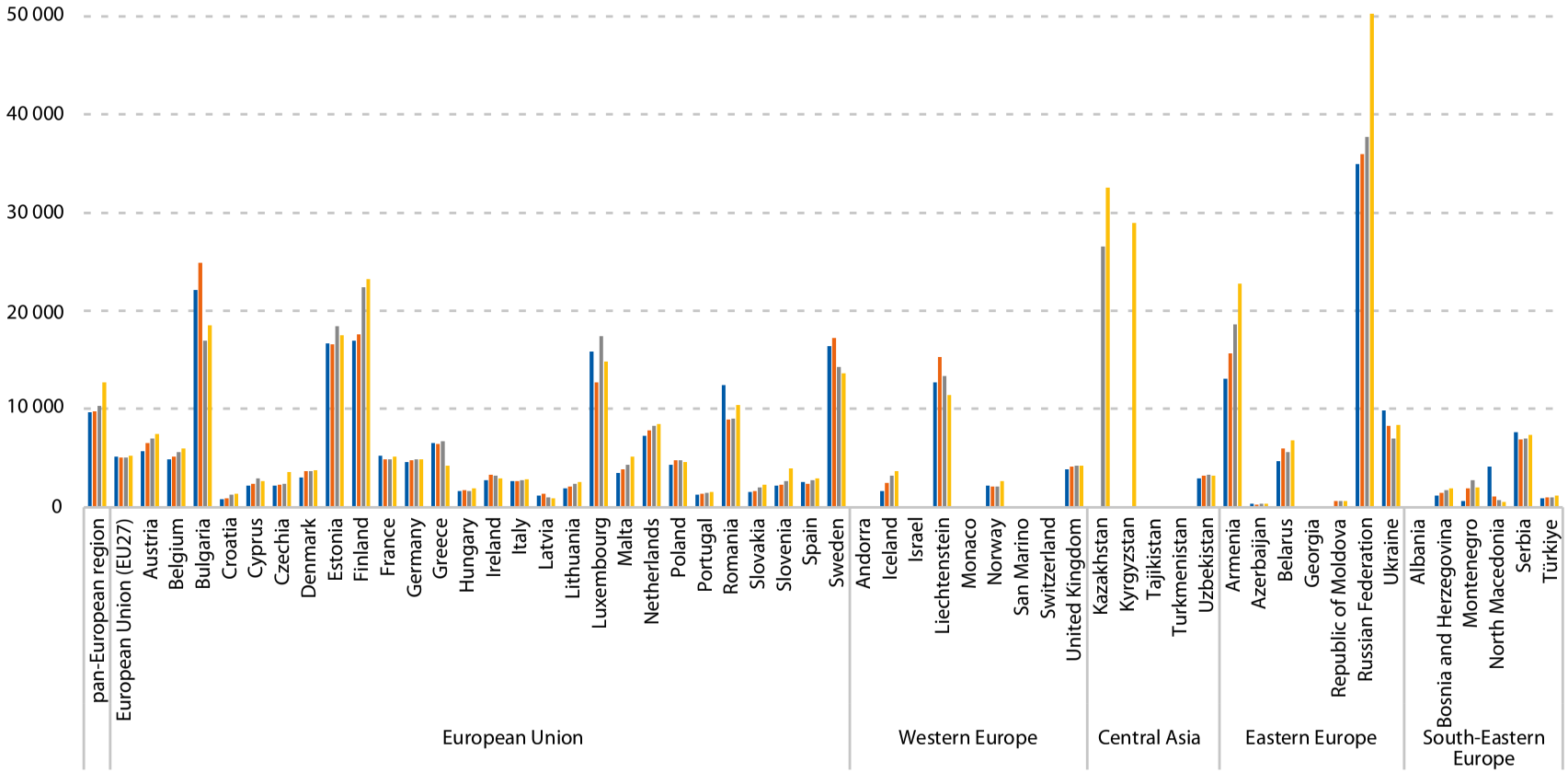
Source: United Nations, "Global SDG Indicators Data Platform" (accessed on 18 May 2021).

Notes: The trend is calculated as a percentage change between reporting periods 2010–2014 and 2015–2019, with an improvement shown as an upwards arrow and a worsening as a downwards arrow (horizontal arrow means no change). The arrow is shown in black unless the change is an improvement of at least 5 per cent (green) or a worsening of at least -5 per cent (red).

Total waste generation per capita

This indicator describes the quantity of total waste (hazardous and non-hazardous) produced in a country per year, by all sectors. Waste generation is an ECE environmental indicator; good progress was reported in the final review report on establishment of the SEIS (ECE/CEP/AC.10/2021/6) and thus it represents a robust indicator. Average waste generation per capita increased in the region by 31 per cent between 2012 and 2018 (see figure 35), and by 7 per cent when excluding major mineral wastes. Most countries have witnessed growth in waste volumes. Large variations exist between countries; some of this difference can be explained by specific economic sectors being dominant in certain countries. For example, in Estonia, much of the waste comes from the oil shale industry,

Figure 35 Total waste generation per capita, by subregion, 2012, 2014, 2016 and 2018, with trends (Kilograms per capita per year)



Trends: Increase in average waste generation; 21 of 27 countries with an increase in the period 2016–2018 | Mixed picture | Increase in nearly all countries in the period 2016–2018 | Mixed picture

Sources: National statistics; for the European Union, Iceland, Liechtenstein, Norway, the United Kingdom and South-Eastern Europe except Albania, Eurostat data (accessed 20 May 2021); for other countries: national data published by country statistical entities (accessed May–July 2021).

Notes: No data for Andorra, Georgia, Israel, Monaco, San Marino, Switzerland, Tajikistan and Turkmenistan. 2019 value instead of 2018 for Uzbekistan; 2017 value instead of 2016 for the Republic of Moldova. Limited data for the Republic of Moldova, Kazakhstan and Kyrgyzstan. Average value for pan-European region is calculated based on the available country data in each year (weighted average by considering population in each country and year).

a unique situation in the region. Mining waste largely explains the high quantities across Eastern Europe and Central Asia. Although progress has been made regarding the reporting of relevant data, it is not possible to derive waste quantities excluding major mineral wastes for all countries.

Despite the commitments of countries to foster waste prevention, overall, waste generation is growing across the pan-European region and all subregions. More efforts are required. Benchmarks are needed to assess the waste quantities that can be prevented in different sectors. To foster waste prevention, economic instruments, such as landfill taxes, deposit-refund systems, tax reductions or other fiscal incentives for innovative businesses and extended producer responsibility,[219] should be explored urgently.

E-waste generation per capita

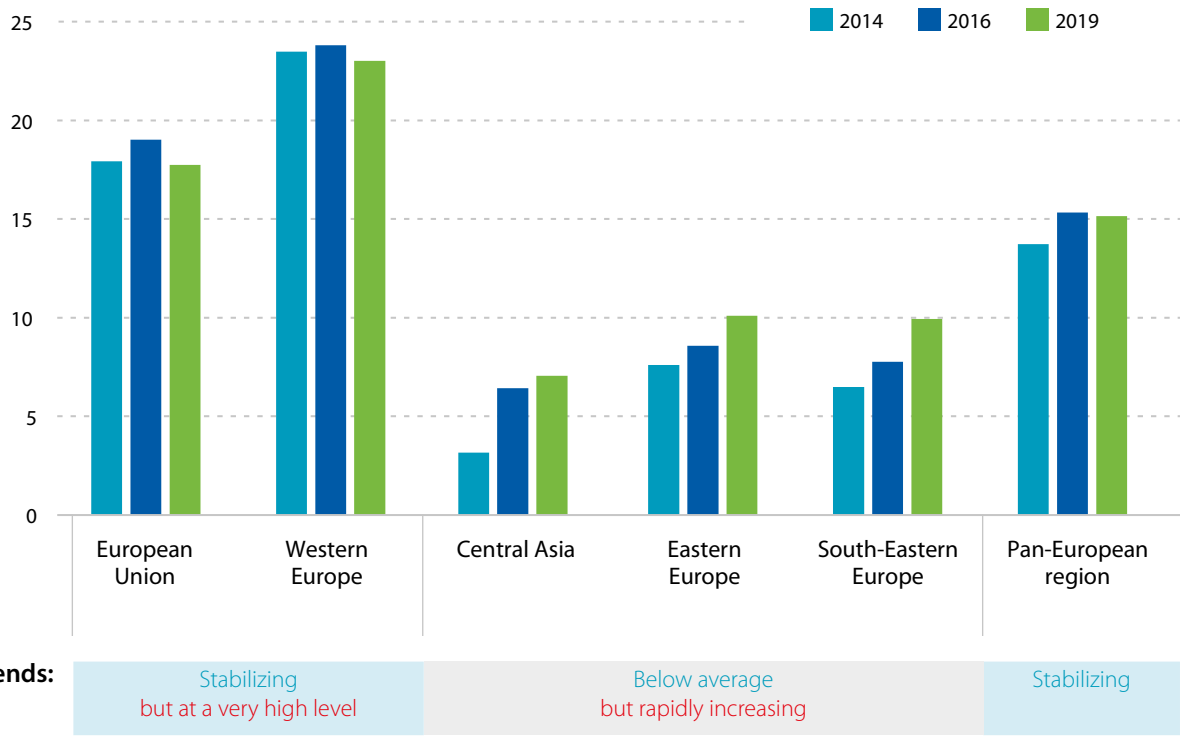
E-waste contains both hazardous components and precious resources such as critical raw materials. For the pan-European region, the average annual e-waste generation per capita is plateauing at around 15 kg, with differing trends in the subregions (see figure 36). This is mainly due to a stabilized or slightly declining quantity in the European Union and in Western Europe, while it continues to grow at a rapid pace across Central Asia, Eastern Europe and South-Eastern Europe. The level of e-waste generation in the region is much above the global average,[220] but countries in Western Europe, on average, generate more than three times the per capita volumes in Central Asia. Separate collection is a prerequisite for high-value valorization of this material stream. However, even across the European Union and Western Europe, where collection and recycling infrastructures are in place, significant quantities of e-waste do not enter the official collection and valorization schemes.[221]

219 Extended producer responsibility (EPR) extends the responsibility of the entity that brings a product to market to the collection, recovery and final disposal phases (end-of-life stage) of the product. EPR schemes integrate environmental costs into the market price of products and create a connection between the design and recycling/reuse phases, which stimulates design of more durable products and production of easily and cheaply recyclable goods.

220 At a global level, e-waste generation per capita increased from 5.8 kg in 2014 to 7.3 kg in 2019, according to Cornelis Peter Baldé and others, *The Global E-waste Monitor 2014: Quantities, Flows and Resources* (Bonn, United Nations University (UNU), 2015); Vanessa Forti and others, *The Global E-waste Monitor 2020: Quantities, Flows and the Circular Economy Potential* (Bonn, Geneva and Rotterdam, UNU, United Nations Institute for Training and Research, International Telecommunication Union (ITU) and ISWA, 2020).

221 Baldé and others, *The Global E-waste Monitor 2017;* Forti and others, *The Global E-waste Monitor 2020*.

Figure 36 Domestic e-waste generation per capita, 2014, 2016 and 2019, with trends (Kilograms per capita)



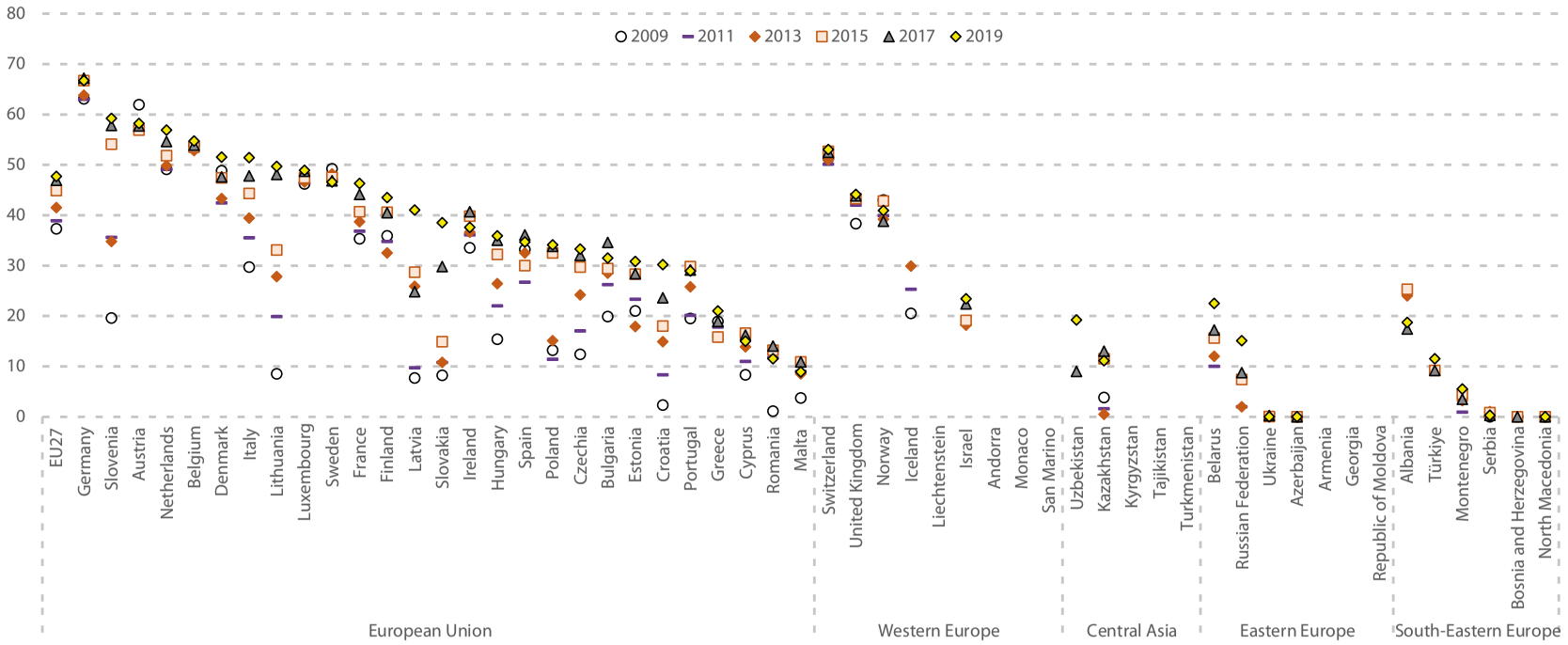
Sources: Global E-Waste Monitor, 2014, 2017 and 2020 editions.

Notes: 48–50 countries; no data for Andorra, Liechtenstein, Monaco and San Marino in all years; no data for Tajikistan and Uzbekistan in 2016 and 2019.

Municipal solid waste recycling rate

There are significant differences in municipal solid waste recycling among the subregions (see figure 37), but all subregions have made some progress. Some countries of the European Union, such as Austria, Germany, the Netherlands and Slovenia, have the highest recycling rates in the world. The average European Union recycling rate has increased from 37.3 per cent in 2009 to 47.7 per cent in 2019. Five European Union countries still have municipal solid waste recycling rates below 25 per cent. Croatia, Latvia, Lithuania, Slovakia and Slovenia, which joined the bloc around 15 years ago, present the most pronounced improvement. Across Eastern Europe, South-Eastern Europe and Central Asia, no country has a municipal solid waste recycling rate above 25 per cent and rates tend to be substantially lower than 25 per cent or even negligible. A few positive cases stand out, such as Uzbekistan, where the municipal solid waste recycling rate is currently around 20 per cent (see case study below). Overall, the region is advancing to more recycling and thus to a more circular economy, but progress is slow. To accelerate the transition, a strong commitment by policymakers is required, along with an adequate allocation of financial resources and the readiness to learn from successful schemes.

Figure 37 Recycling rate of municipal solid waste, including composting and anaerobic digestion, by subregion, biennially 2009–2019, with status and trends
(Percentage)



Status and trends	Average over 45 per cent, with 7 countries over 50 per cent and up to 67 per cent; increasing average, with good improvement in most countries and strong improvement in some countries; 5 countries still below 25 per cent	Mixed picture; only 1 country over 45 per cent	Mixed picture; some countries good progress; all below 25 per cent; for some, no data available	Slow change; all countries still below 25 per cent

Sources: National statistics; for the European Union, Iceland, Liechtenstein, Norway, Switzerland, the United Kingdom and South-Eastern Europe except Albania, Eurostat (accessed 27 May 2021); for other countries, data published by country statistical entities (accessed May–July 2021).

Notes: 2018 instead of 2019 data for Bulgaria, Montenegro, Serbia, the United Kingdom; for Ireland, 2012 used instead of 2013, 2014 instead of 2015, 2016 instead of 2017, 2018 instead of 2019 data; for Israel 2014 instead of 2013; for Belarus 2012 instead of 2011; for the Russian Federation and Türkiye 2016 instead of 2015; Albania: urban waste only.

5. Case studies

Reforming the waste management framework in Uzbekistan

Uzbekistan has initiated ambitious reforms of its environmental frameworks, including new institutional arrangements for waste management since 2017 and the launch of a strategy on municipal waste management for the period 2019–2028.[222] Coverage of the population by waste services increased from 22 per cent in 2016 to 53 per cent in 2018.[223] The national target is to reach 100 per cent of the population covered by waste collection services by 2025; furthermore, the strategy aims to achieve 45 per cent municipal solid waste recycling by 2025 and 60 per cent by 2028. The country is on the right path; the municipal solid waste recycling rate in 2019 was close to 20 per cent, up from 9 per cent in 2017.

Chemicals in plastics

Recent research identified more than 6,000 different additives in plastic products.[224] Only some are polymerized within the plastic matrix, while many can leach and potentially have an impact on the environment and humans.[225] When plastics are recycled, individual chemicals or cocktails of substances can unintentionally be transferred to the new products as contaminants, which creates new risks in the value chains. Such cross-contamination has been identified in, for example, children's toys and food-contact articles.[226]

222 UNEP, *Waste Management Outlook for Central Asia* (n.p., 2017).

223 *Environmental Performance Reviews: Uzbekistan – Third Review*.

224 Nicolò Aurisano, Roland Weber and Peter Fantke, "Enabling a circular economy for chemicals in plastics", *Current Opinion in Green and Sustainable Chemistry*, vol. 31, special issue (October 2021).

225 John N. Hahladakis and others, "An overview of chemical additives present in plastics: migration, release, fate and environmental impact during their use, disposal and recycling", *Journal of Hazardous Materials*, vol. 344 (15 February 2018), pp. 179–199; Lisa Zimmermann and others, "Benchmarking the in vitro toxicity and chemical composition of plastic consumer products", *Environmental Science and Technology*, vol. 53, No. 19 (2019), pp. 11467–11477.

226 Antonella Guzzonato, Franky Puype and S.J. Harrad, "Evidence of bad recycling practices: BFRs in children's toys and food-contact articles", *Environmental Science: Processes and Impacts*, vol. 19, No. 7 (19 July 2017), pp. 956–963; Alin C. Ionas and others, "Downsides of the recycling process: harmful organic chemicals in children's toys", *Environment International*, vol. 65 (April 2014), pp. 54–62.

H. Environmental financing and public spending on environmental protection

1. Key messages and recommendations

Key messages

Despite the negative impacts of fossil fuels on the environment, all countries continue to implement fossil fuel subsidies to varying degrees. International Monetary Fund (IMF) projections suggest that these subsidies will remain in place at least until 2025, with implicit subsidies increasing until that time.

Environmental tax revenues increased in all countries in the pan-European region between 2000 and 2019. In 2019, European Union environmental tax revenue amounted to €330.6 billion, an increase of 52 per cent in nominal terms since 2002.

In all countries across the pan-European region for which data are available, government expenditures on environmental protection have increased since 2000, closely following gross domestic product (GDP) growth.

Over the last five years, there has been an increase in the use of green bonds as a tool for financing environmentally friendly projects. These bonds have been used by both the private sector and sovereign Governments. Across the pan-European region, European Union countries are leaders in the use of green bonds – in particular, France, Germany and the Netherlands. However, since 2019, countries in other regions have also started using such instruments, for example, Georgia, Kazakhstan, the Russian Federation and Türkiye.

There is a severe lack of quantitative data for the countries of Central Asia and South-Eastern Europe. This hinders attempts to evaluate progress in environmental protection and environmental financing. The lack of reliable data also implies that investment and operational costs of meeting environmental objectives cannot be calculated in a robust way and used in policy development.

Recommendations

National environmental policies across the pan-European region should aim at abolishing harmful subsidies and transitioning towards greener energy sources quickly.

Environmental taxes are one of the most efficient tools for providing economic agents with incentives to decrease different kinds of pollution and protect the environment. Compared with green subsidies, which provide the same incentives, they have the added advantage of allowing Governments to raise revenues, which can be used to decrease distortionary taxes within economies and/or finance public environmental protection expenditures. It is recommended that countries strengthen the use of these instruments or of equivalent ones, for example, cap-and-trade schemes.

The future of government spending on environmental protection should be considered in the wider context of environmental and public finance. Subsidies always distort markets and increase public sector spending. Therefore, the need for environmental subsidized finance is to be periodically reconsidered in the light of the "polluter pays" principle. Furthermore, to help target subsidies better – so that the funds can bring a genuine value added where and when necessary – it is important that impact assessment analysis of such funding be performed regularly.

Governments in the pan-European region should favour the development of green finance, and green bonds markets in particular, through a series of policies, including demonstration issuance, dissemination of clear guidelines for green bonds issuance and implementation of favourable regulatory policies.

There is an urgent need to improve data-collection systems in Central Asia and South-Eastern Europe, in line with internationally recognized standards, such as those of OECD and Eurostat. For example, data on environmental expenditures must be collected according to internationally acknowledged methodologies and classifications. In particular, it is important to clarify and report which entities spend money on the environment, how much they spend and with what objectives, and who finances these expenditures.

2. Context

To meet the Paris Agreement goals and protect the environment – while ensuring an adequate quality of life for their citizens – countries need major environmental and energy transitions. At the global level, OECD estimates that $95 trillion in public and private investments will be necessary in energy, transport, water and telecommunications infrastructure between 2016 and 2030, so as to support growth and sustainable development,[227] i.e. around $6.3 trillion per year. According to the same source, an additional $0.6 trillion per year would also be necessary to make these investments climate compatible – a small additional cost given the expected benefits. The European Union Green Deal plans to invest a total of €1 trillion until 2030, or around €125 billion per year.[228]

Governments have a responsibility to lead the way for these necessary transitions, by implementing policies that align private interests with the common good. Public spending alone will not suffice. Well-designed environmental, fiscal and investment policies are therefore important, to maximize the impact of public spending and leverage private investment.

The pan-European region encompasses countries that vary considerably in terms of political, economic and social context. However, environmental protection and climate change mitigation need to be objectives shared by all countries. In particular, getting fundamental environmental protection policies right is essential to aligning incentives across the region. There is also an urgent need to accelerate reform of inefficient fossil fuel subsidies and broaden the carbon pricing base, while focusing on tracking the impact of implemented policies and sharing policy experiences.

3. State, main trends and recent developments

At the global level, environmental protection and climate change mitigation goals are far from having been met; a recent UNEP report, *Measuring Progress: Environment and the SDGs*,[229] shows that several indicators continue to reveal negative trends.[230] The pan-European region is no exception. For example, despite the European Union being a leader on environmental issues, the key objectives of its Seventh Environment Action Programme are, for the moment, out of reach.[231] At the national level, environmental goals are often not achieved: for instance, even in environmental front runner Sweden, 15 of the 16 national environmental quality objectives set by parliament to be achieved by 2030 have not yet been met.[232]

These observations highlight the need for countries in the pan-European region to further reinforce their environmental policies and step up investments for environmental protection and climate change mitigation. Environmental financing tools need to be used to their full extent.

In line with these objectives, public expenditures for environmental protection and environmental tax revenues have increased across the region since the early 2000s. Similarly, green finance and green bonds are picking up, led by the European Union zone. However, fossil fuel subsidies are still in place and projections are that they will remain so until at least 2025.[233]

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227 OECD, *Investing in Climate, Investing in Growth (*Paris, 2017).

228 For additional details, see InvestEU at https://europa.eu/investeu/contribution-green-deal-and-just-transition-scheme_en.

229 (Nairobi, 2021).

230 This concerns, among other things, increased water stress levels and a decrease in local water management (6.4.2 and 6.5.1), an increase in the consumption of domestic material products and increased material footprint (12.2.1 and 12.2.2), consumption and production patterns with an increase in hazardous waste generated per capita (8.4.1/8.4.2 and 12.4.2), oceans with a decrease in sustainable levels of fish stocks (14.4.1), and land and biodiversity, with a decrease in the proportion of total forest area and in the Red List Index (15.1.1 and 15.5.1).

231 EEA, "Achieving EU's key 2020 environmental objectives slipping away", 29 November 2018.

232 Sveriges Miljömål, "Många insatser behövs för miljömålen", 31 March 2021, available at https://sverigesmiljomal.se/sa-fungerar-arbetet-med-sveriges-miljomal/uppfoljning-av-miljomalen/arlig-uppfoljning-2021/ (Swedish only).

233 International Monetary Fund (IMF), "Government Policy Indicators", Climate Change Dashboard. Available at https://climatedata.imf.org/pages/go-indicators (accessed on 27 January 2022).

4. Indicators

Environmental tax revenue

The environmental tax revenue used in this assessment (from the IMF Climate Change Indicators Dashboard and the Eurostat database) is to be considered as a lower bound estimate, as it does not include environmental fees and charges; it does, however, include energy, transport and pollution taxes.

In the European Union, on average, environmental tax revenues have remained at around 2.2 to 2.5 per cent of GDP since 2000. Nevertheless, there are clear contrasts among individual countries within the bloc. For instance, since 2015, environmental tax revenues have represented over 3.4 per cent of GDP in Croatia, while amounts levied by Germany, Ireland and Luxembourg are below 2 per cent of GDP.

In Western Europe,[234] on average, environmental tax revenues represented 2.5 to 3 per cent of GDP during the 2000–2007 period, subsequently stabilizing at around 2 per cent of GDP. In terms of total revenues levied, Iceland, Norway and the United Kingdom all experienced a sharp decline in revenues in the period 2007–2008, most certainly due to the financial crisis. Data for Switzerland are only available from 2008 and show environmental tax revenues representing around 1.4 per cent of GDP since that year.

Serbia and Türkiye are the two other countries for which data on environmental tax revenues are available for most of the period 2000–2019. For Türkiye, environmental tax revenues increased sharply between 2000 and 2003, rising from 2.4 per cent to around 4 per cent of GDP. They then stabilized at around 3.5 per cent of GDP, before declining to around 2.3 per cent of GDP in 2018 and 2.2 per cent of GDP in 2019 (i.e. to around €15.5 million in both years). Serbia, on the other hand, has continuously increased the amount of environmental taxes levied. In the period 2005–2018, the amount rose from €631 million to €1,791 million, i.e. a 184 per cent increase (see figure 38). In these two countries, environmental tax revenues represent a higher share of GDP than in countries of both the European Union and Western Europe.

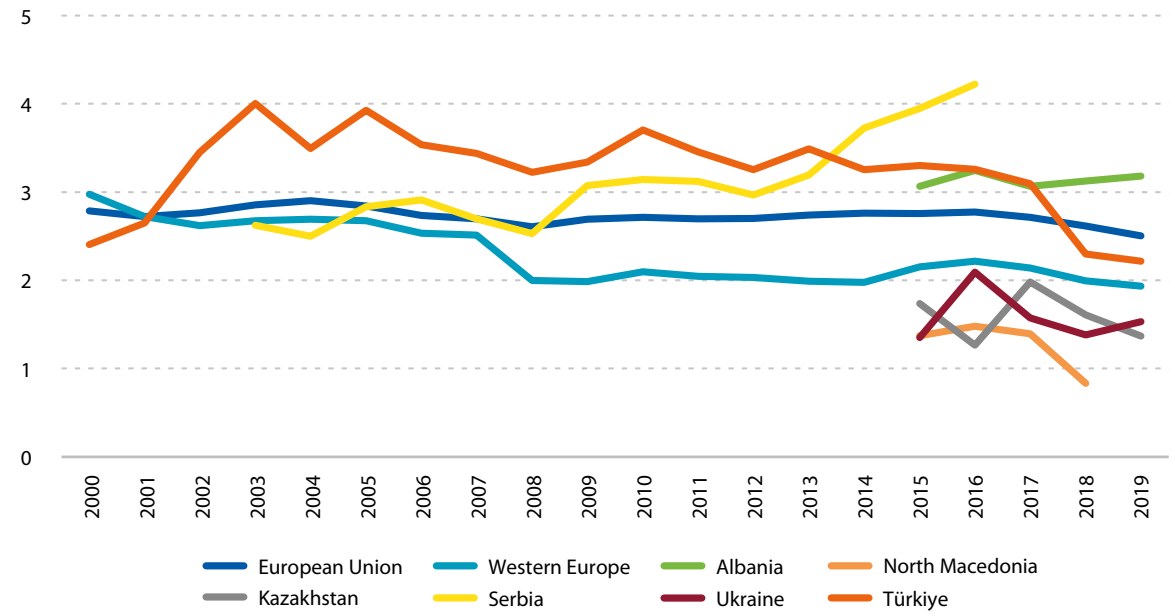
As noted above under Key Messages, there is a lack of data for most countries outside Western Europe.

When looking at environmental tax revenues per capita (see figure 39), the Netherlands collects the highest amount, almost $2,000 per capita, while Kazakhstan collects the smallest, a little less than $210 per capita. Environmental tax revenues tend to be correlated to GDP per capita, but not perfectly. For example, in 2019, Slovenia and Estonia levied quite a significant amount of environmental taxes per inhabitant ($1,311 and $1,285, respectively) compared with their GDP per capita ($27,421 and $20,835, respectively).[235]

234 Environmental tax revenue data are only available for Iceland, Israel (since 2015), Norway, Switzerland and the United Kingdom.

235 For comparison, in 2019, Greece had a GDP per capita of $23,503 and collected $454.27 of environmental taxes per inhabitant. Slovakia had a GDP per capita of $21,003 and environmental tax revenues per inhabitant of $669.91.

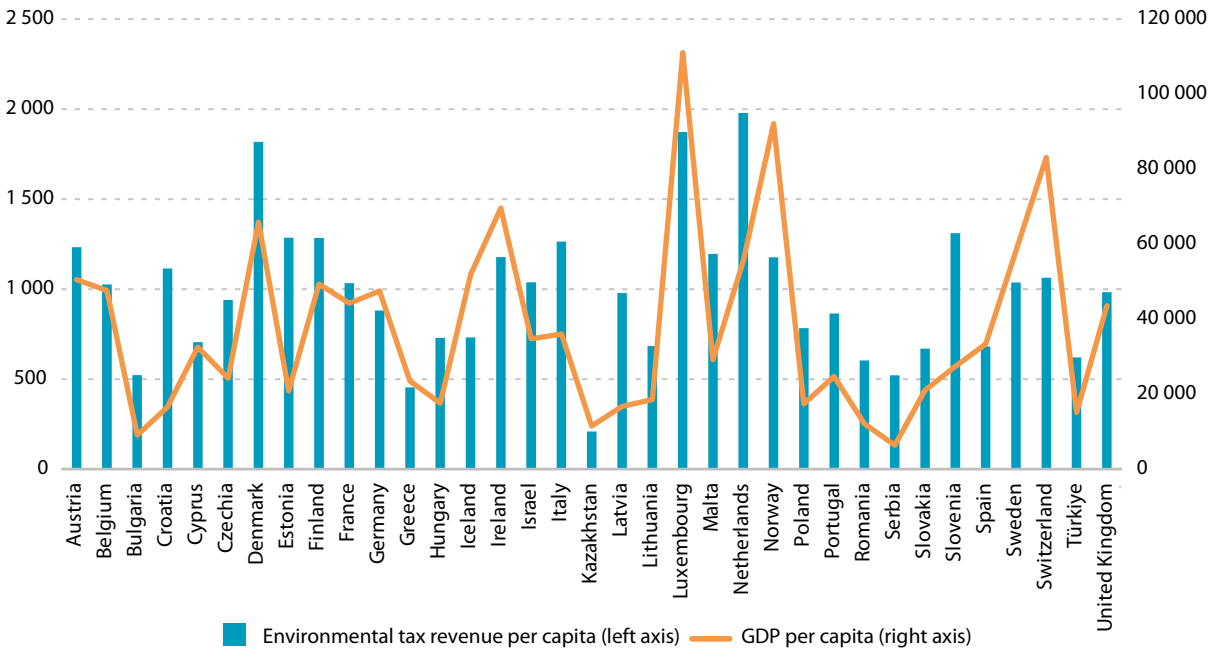
Figure 38 Environmental tax revenues as a proportion of gross domestic product, 2000–2019 (Percentage)



Source: IMF, "Government Policy Indicators", Climate Change Dashboard.

Note: Values for the European Union and Western Europe are simple unweighted averages across the countries.

Figure 39 Environmental tax revenue and gross domestic product per capita, 2019 (United States dollars)

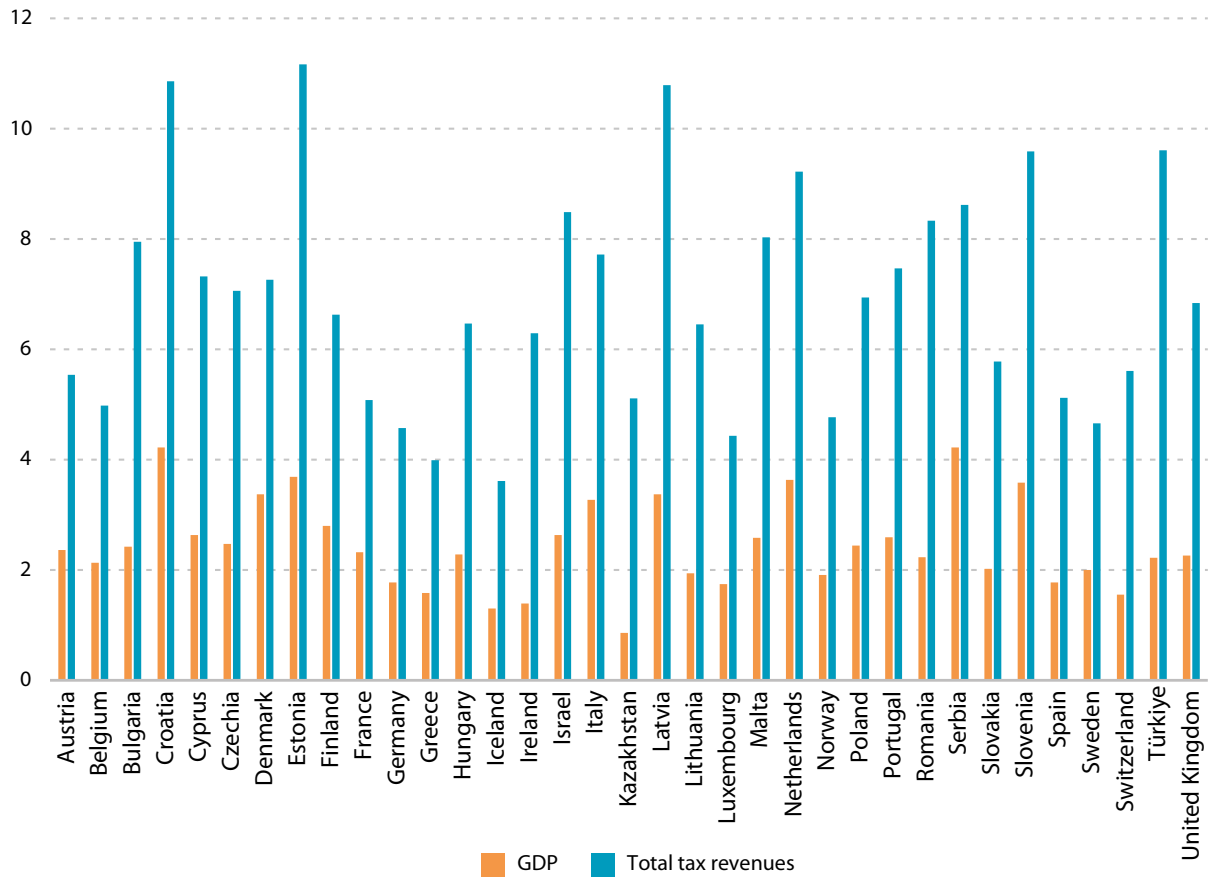


Sources: "Compare your country: Environmentally related tax revenue, Overview, Per capita, United States dollars, 2019" (accessed on 27 January 2022); and The World Bank, DataBank, available at https://databank.worldbank.org/source/sustainable-development-goals(sdgs)/Series/NY.GDP.PCAP.KD (accessed on 24 January 2022).

Note: 2019 GDP per capita in constant 2010 United States dollars. Tax revenue data for Israel and Kazakhstan are from 2018 and for Serbia from 2016.

Another relevant way of looking at environmental taxes is to compare how much their revenue represents in relation not only to a given country's GDP but also to the total tax revenue levied. Environmental tax revenues appear to represent a fairly high share of total tax revenues (i.e. around 11 per cent) in Croatia, Estonia and Latvia (see figure 40). Unfortunately, data are not available for many Central Asian and Eastern European countries.

Figure 40 Environmental tax revenue as proportion of gross domestic product and of total tax revenue, 2019
(Percentage)



Source: OECD, "Compare your country: Environmentally related tax revenue, Overview, Per capita, United States dollars, 2019". Available at www.compareyourcountry.org/environmental-taxes/en/0/182/default (accessed on 27 January 2022).

Notes: Tax revenue data for Israel and Kazakhstan are from 2018 and for Serbia from 2016.

Government expenditures on environmental protection

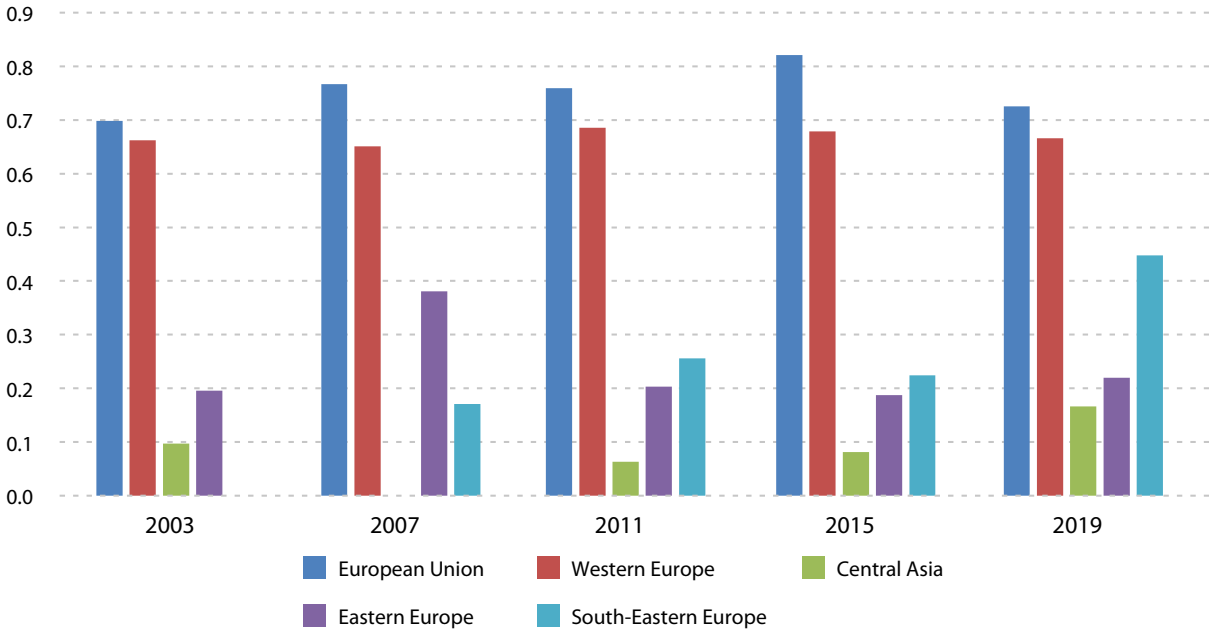
Environmental protection public expenditures include government spending on biodiversity and landscape protection, environmental protection research and development and pollution abatement, as well as waste and wastewater management.

This measure represents the minimum amount spent annually within countries in the pan-European region, as only public expenditures are accounted for. Hence, total environmental protection expenditures are likely to be larger, as the private sector also contributes to environmental protection. In the European Union, for example, in 2020, Governments spent €70 billion on environmental protection expenditures, while corporations spent almost

€157 billion (i.e. more than double the amount spent by Governments) and households spent around €60 billion.[236] However, data on total (i.e. public and private) environmental protection expenditures are, unfortunately, not available for most of the countries outside the European Union and Western Europe.

European Union countries spend, on average, an amount equivalent to 0.8 per cent of GDP on public environmental protection. This is the highest share within the pan-European region, followed by Western Europe countries. For all other countries, government environmental protection represents a lower share of GDP (see figure 41).[237]

Figure 41 Government environmental protection expenditures as proportion of GDP, by subregion, 2003–2019
(Percentage)



Source: IMF, "Government Policy Indicators", Climate Change Dashboard.

Notes: Values are simple unweighted averages across the countries. No data for Central Asia in 2007 or for South-Eastern Europe in 2003. No data for Andorra, Bosnia and Herzegovina, Liechtenstein, Monaco, Montenegro, San Marino, Tajikistan and Turkmenistan, nor for Albania (2003), Armenia and North Macedonia (2003, 2007, 2011, 2015), Azerbaijan and Türkiye (2003, 2007), Kyrgyzstan (2003, 2011), the Russian Federation (2007), Serbia (2003, 2015) and Uzbekistan (2003).

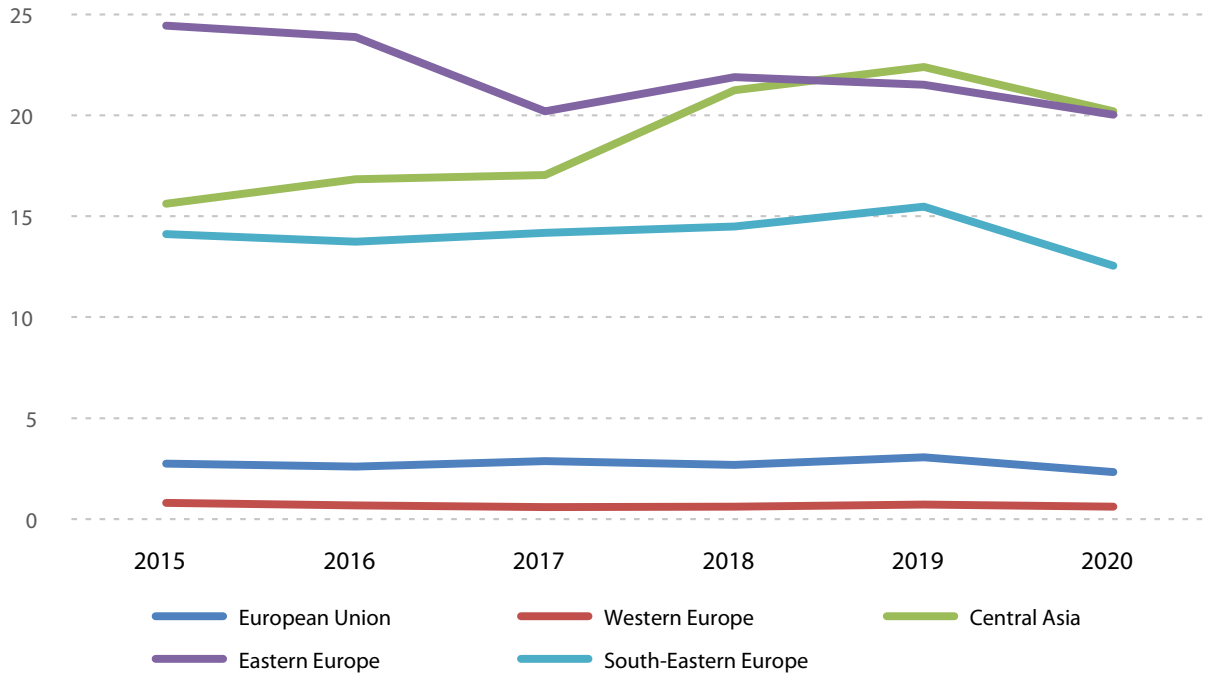
Fossil fuel (implicit and explicit) subsidies

All countries across the pan-European region subsidize fossil fuels (see figures 42 and 43), except for San Marino. Also, data are not available for Andorra, Liechtenstein and Monaco. This indicator is the estimated value of explicit and implicit government subsidies related to fossil fuels (i.e. coal, natural gas and oil). Explicit subsidies reflect underpricing, due to supply costs being greater than prices paid by users. Implicit subsidies reflect the difference between supply costs and socially efficient prices (incorporating the cost of negative externalities of fossil fuel use and foregone consumption tax revenues), exclusive of any explicit subsidy. Hence, together, these subsidies show the impact of government policy decisions on fossil fuel prices paid by consumers compared with an unsubsidized price that accounts for climate change and other externalities.

236 Eurostat, "National expenditure on environmental protection by institutional sector", Data Browser. Available at https://ec.europa.eu/eurostat/databrowser/view/ENV_AC_EPNEIS__custom_1428687/default/table?lang=en (accessed on 21 June 2022).

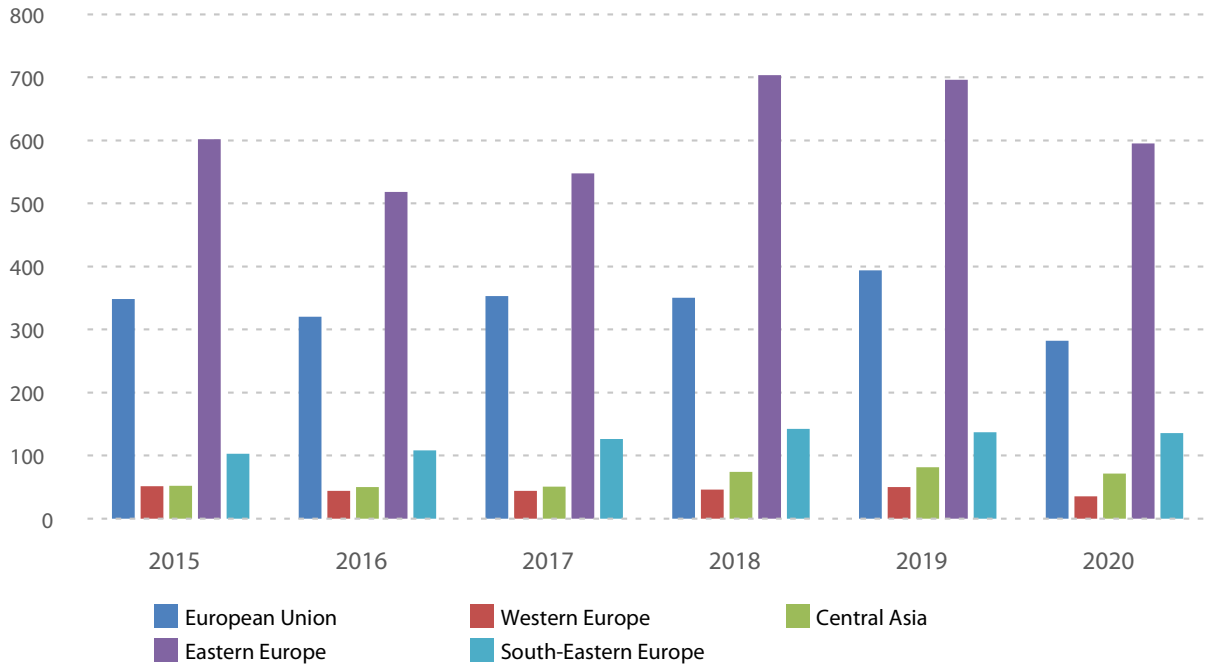
237 IMF, "Climate Change Indicators Dashboard".

Figure 42 Fossil fuel subsidies as proportion of gross domestic product, by subregion, 2015–2020 (Percentage)



Source: IMF, "Government Policy Indicators", Climate Change Dashboard (accessed on 24 January 2022).
Notes: Values are simple unweighted averages across countries. No data for Andorra, Liechtenstein and Monaco.

Figure 43 Total fossil fuel subsidies, by subregion, 2015–2020 (Billions of United States dollars)



Source: IMF, "Government Policy Indicators", Climate Change Dashboard (accessed on 24 January 2022).
Note: No data for Andorra, Liechtenstein and Monaco.

Countries of Eastern Europe subsidize fossil fuels at higher rates than countries of the other regions. This result is mainly driven by the important subsidies implemented by the Russian Federation, which represented more than €520 billion in 2019, i.e. around 35 per cent of the country's GDP.

High levels of fossil fuel subsidies can mainly be explained by two factors. First, countries whose economies partially depend on fossil fuel production have economic incentives to subsidize them. For example, the three countries with the highest shares of fossil fuel rents in 2019, according to the World Bank, namely, Azerbaijan (25 per cent of GDP), Kazakhstan (29 per cent of GDP) and the Russian Federation (35 per cent of GDP), are also among the countries subsidizing fossil fuels to a significant extent relative to their GDP – 33.4 per cent, 29.4 per cent and 35.2 per cent, respectively. Second, explicit fossil fuel subsidies tend to be implemented as poverty alleviation measures to decrease the burden of transport and energy costs for poorer households and are, therefore, more common in poorer economies. This mechanism also seems to be at play in the sample used in the present report. Table 32 shows the 10 countries with the lowest GDP per capita in 2019; they all implement fossil fuel subsidies that amount to more than 10 per cent of GDP (with the exception of Albania and the Republic of Moldova, where subsidies represent around 2 per cent and 9 per cent of GDP, respectively).

Table 32 Fossil fuel subsidies and gross domestic product per capita, 2019

Country	Total fossil fuel subsidies (implicit and explicit) (Percentage of GDP)	Explicit fossil fuel subsidies (Percentage of GDP)	GDP per capita (United States dollars)
Kyrgyzstan	22.0	6.5	1 117.5
Tajikistan	16.2	8.0	1 123.2
Uzbekistan	22.2	3.7	2 464.5
Ukraine	31.9	4.9	3 224.6
Republic of Moldova	9.0	4.4	3 712.4
Armenia	10.4	5.4	4 732.1
Georgia	12.6	4.1	4 977.5
Albania	1.9	0.0	5 207.3
North Macedonia	14.0	1.2	5 625.7
Azerbaijan	33.4	5.7	5 895.2

Sources: Data on GDP per capita provided by the World Bank. Data pertaining to estimated fossil fuel subsidies provided by IMF.

Capital levied through green bonds

Green bonds were created to fund projects that have environmental and/or climate benefits and can be issued by sovereign Governments, regional and local government entities and also private sector actors. Proceeds from these bonds are earmarked for green projects but are backed by the issuer's entire balance sheet. The green bond market has seen exponential growth since its creation around 2007 (see figure 44 for the value of green bonds in the period 2014–2021). In December 2020, the market reached the symbolic threshold of $1 trillion in cumulative issuance.

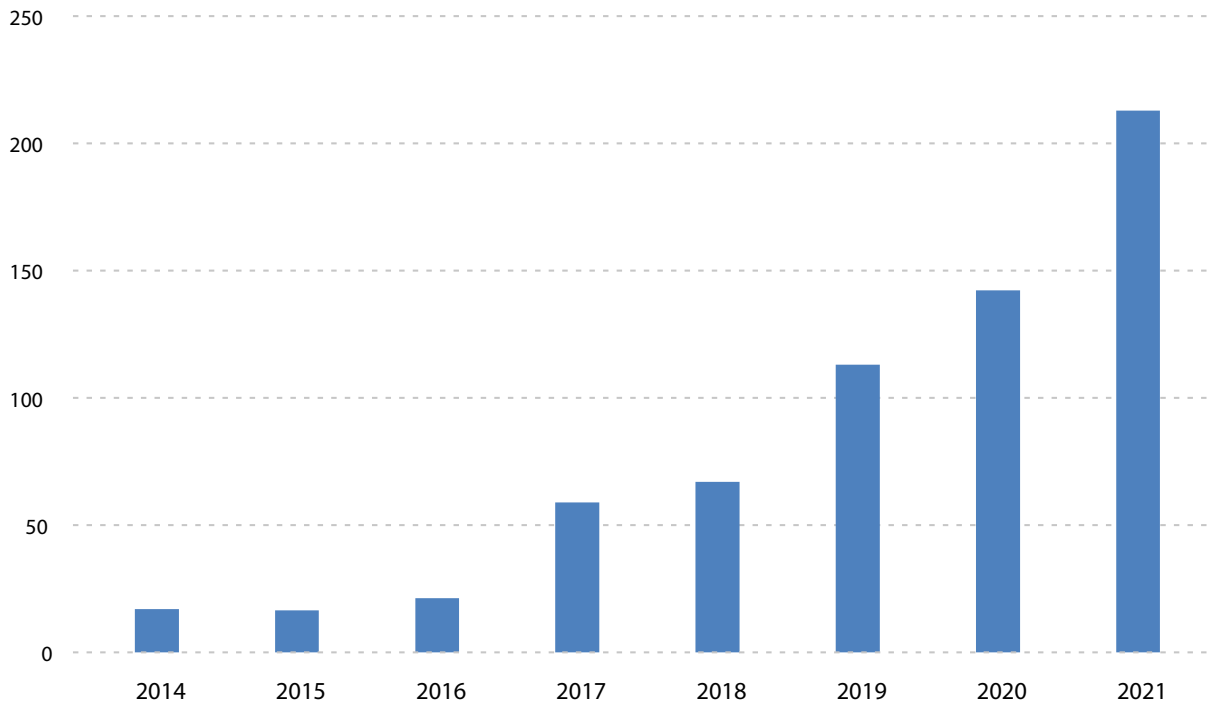
Certified green bonds have been shown to effectively contribute to GHG emissions reduction in the private sector.[238] While additional research is needed on how such bonds could be used by Governments, it is important to keep track of the development of green finance in general, and green bonds in particular should be tracked. Indeed,

238 Caroline Flammer, "Corporate green bonds", *Journal of Financial Economics*, vol. 142, No. 2 (November 2021), pp. 499–516.

the presence of green and climate finance might have an impact on the optimal level of more traditional policy instruments such as carbon taxes.

The European Union countries are leaders in the green bond market.

Figure 44 **Value of green euro bonds, 2014–2021** (Billions of United States dollars)



Source: Data extracted from Climate Bonds Initiative, available at www.climatebonds.net/market/data/ (accessed on 16 June 2022).

5. Case studies

Croatia

Croatia's environmental policy has been strongly shaped by European Union accession in 2013. While some indicators show the country has made significant efforts towards environmental protection and green growth, there is still room for improvement. In particular, Croatia can decrease the existing diesel differential (e.g., by increasing taxes on diesel to match those imposed on other fuels) and increase its fund absorption capacity.

One of the institutions that plays a key role in environmental financing is the Environmental Protection and Energy Efficiency Fund (EPEEF). It is the central point for collecting environmental fees and charges and managing programmes and projects promoting environmental protection, energy efficiency and the use of renewable energy sources. Funds for such projects come from foreign funds, international organizations, financial institutions and bodies, and national and foreign entities. In particular, as a part of the European Union, Croatia has been allocated a total of €10.7 billion from European Structural and Investment Funds for 2014–2020. The country also benefited from €8.6 billion (at current prices) in total cohesion policy funding for the period 2014–2020. Part of these funds are earmarked for environmental protection and energy efficiency.

Regarding the use of European Union funds, however, a recent report by the SGI Network[239] points to difficulties in funds absorption. Following the National Strategic Reference Framework, which guides the use of European Structural and Cohesion Fund money, Croatia is required to spend almost €10 billion on waste management, water management and air protection – the three most important environmental issues in the European Union accession negotiations – by 2023. Nevertheless, the SGI network highlights difficulties in policy implementation, largely due to an incoherent Public Procurement Law. The uncertainty caused by the law's interpretation is presented as the main issue affecting absorption of European Structural and Investment Funds in Croatia. According to European Commission data, Croatia remains among the five countries with the lowest absorption rates.[240]

Croatia's revenue from environmentally relevant taxes – in proportion to GDP – is among the highest in the European Union. In 2019, environmental taxes accounted for around 3.5 per cent of GDP, while the European Union average is around 2.35 per cent. According to the latest assessment made by the European Commission,[241] there are several examples of sound fiscal measures for the environment being implemented in Croatia. For example, the country levies a "forest public benefit function fee", which is an annual charge paid by companies and other business associations since 1983. Besides funding the management of forest restoration in karst regions, a proportion of the funds levied is spent on demining activities (10 per cent), firefighting (5 per cent) and scientific work (5 per cent).

However, as in all other countries of the pan-European region, fossil fuel subsidies are still in place. In 2019, these amounted to $1.3 billion. The country also has not completely eliminated the "diesel differential" – the difference in the price of diesel and petrol that amounts to an implicit subsidy on diesel.

Türkiye

Türkiye has been experiencing environmental pressures due to population growth, industrialization and rapid urbanization.[242] These pressures translate into a range of environmental challenges, such as desertification, deforestation, water scarcity, nature degradation and marine pollution.[243] To address these challenges, the country has adopted new legislation and institutional practices as part of an effort to comply with the European Union environmental regulations.[244]

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239 William Bartlett and others, *Croatia Report: Sustainable Governance Indicators 2020* (Bertelsmann Stiftung, Gütersloh, Germany, n.d.).

240 European Structural and Investment Funds, "2014–2020 ESIF Overview", Data. Available at https://cohesiondata.ec.europa.eu/overview.

241 European Commission, "The Environmental Implementation Review 2019: country report Croatia, Commission Staff Working Document, SWD(2019) 114 final (Brussels, 2019).

242 Türkiye's GDP per capita rose from $4,300 in 2000 to $9,100 in 2019, i.e. a 111 per cent increase.

243 EEA, "Turkey country briefing: the European environment: state and outlook 2015", 18 February 2015.

244 *OECD Environmental Performance Reviews: Turkey 2019* (Paris, 2019).

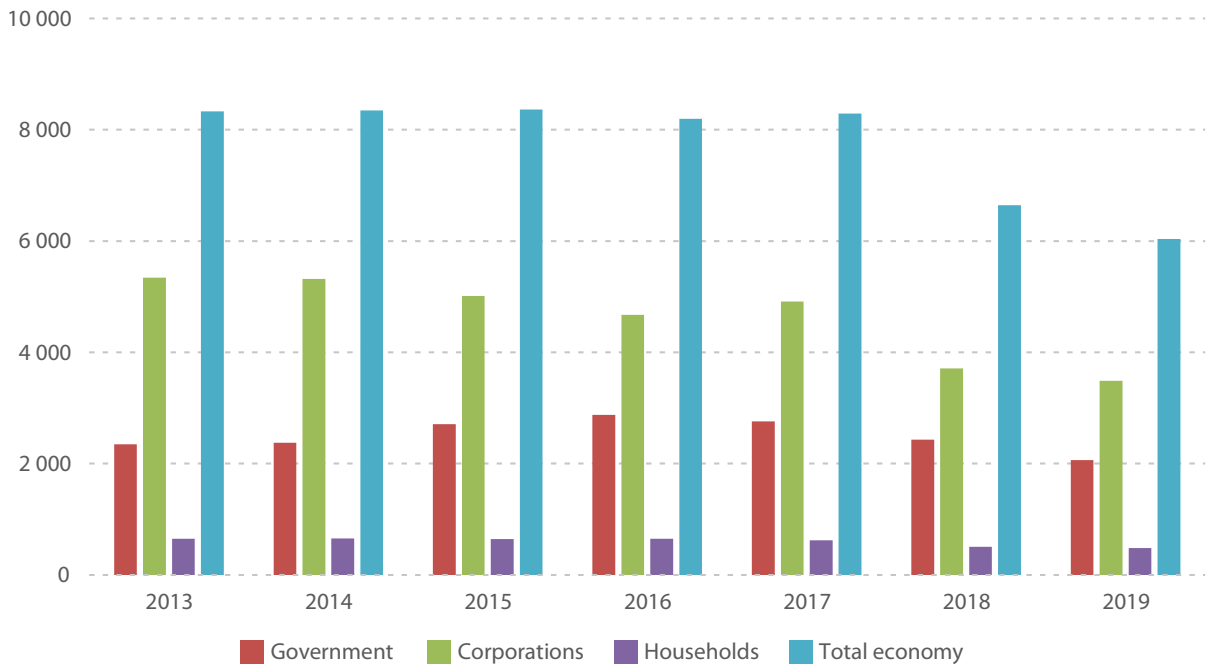
Türkiye has relatively high environmental taxes as a percentage of GDP (3.4 per cent on average for the period 2002–2017, a bit less since), largely due to high taxes on petrol and diesel. However, while transport taxes do provide some green incentives, they also tend to push poorer consumers towards older, more polluting, vehicles.[245] A revision of the transport tax schemes would therefore be beneficial.

While the country remains highly dependent on fossil fuels, the share of renewables in the country's energy mix has been increasing, mainly due to feed-in tariffs implemented by the Government. At the end of 2020, Türkiye finalized the draft legal and institutional framework for a pilot emissions trading scheme (ETS) for the power and industry sectors.[246]

Eurostat data allows a more detailed look at environmental protection expenditures by Türkiye for the period 2013–2019 (see figure 45). The data shows a private sector that is quite active and spending between 50 and 100 per cent more than the Government. Türkiye can expand the use of instruments that leverage private sector investment in environmental projects, including public–private partnerships, green banks and green bonds.

Regarding fossil fuel subsidies, tax exemptions for petroleum products and heating subsidies to poor families constitute the bulk of harmful subsidies.[247] These should be gradually eliminated and replaced with support for a transition towards cleaner alternatives.

Figure 45 Environmental protection expenditures in Türkiye, 2013–2019 (Millions of euros)



Source: Eurostat statistical database. Available at https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=env_ac_epneis&lang=en (accessed on 16 June 2022).

245 Ibid.

246 World Bank (2021), "State and Trends of Carbon Pricing 2021", available at: https://openknowledge.worldbank.org/handle/10986/35620.

247 OECD, *Environmental Performance Reviews: Turkey 2019*.

Case study: carbon pricing in the post-pandemic recovery

The COVID-19 pandemic has affected all countries and induced an economic crisis in many of them. However, despite the unequivocal negative impacts of the pandemic, this opens up an interesting opportunity to use policy instruments to support an economic recovery that is in line with environmental protection objectives. As the attention of Governments turns to stimulating and stabilizing their economies, the design of these recovery packages will play a decisive role in our climate and economic future. Alongside other measures, a carbon price can play a role to support a sustainable recovery, primarily through three mechanisms: supporting green industries, encouraging investments, and raising revenue.[248]

First, carbon pricing helps support sustainable industries and the competitiveness of low-carbon products, which can generate additional green jobs, in line with many Sustainable Development Goal targets. Second, a carbon price can encourage investments in and mobilize revenue towards low-carbon, net-zero and net-negative technologies. Third, carbon pricing can generate much-needed government revenue to support additional stimulus and investment programmes.

However, for the time being, a large share of stimulus expenditure is not directed towards a green recovery. Only a fraction of economic recovery expenditure is being spent on low-carbon or environmental projects. For example, the Greenness of Stimulus Index[249] reports that only 12 per cent of the almost $15 trillion stimulus spending of G20 countries as at end of June 2021 is directly channelled to low-carbon or environmental projects – or has environmental conditions. In some of the countries of the pan-European region, the stimulus as announced will likely have a negative impact on the environment, i.e. in Iceland, Italy, Norway, the Russian Federation and Türkiye. In Denmark, Finland, France, Germany, Spain, Sweden, Switzerland and the United Kingdom, the overall impact expected is positive.

There is, however, time to redesign the post-COVID-pandemic recovery policies to maximize their environmental benefits. Some measures that would allow that include:

- Corporate bailouts with green conditions
- Loans and grants for green investments
- Green research and development subsidies.

248 OECD (2021), "*Taxing Energy Use for Sustainable Development*", available at https://www.oecd.org/tax/tax-policy/taxing-energy-use-for-sustainable-development.pdf.

249 Finance for Biodiversity Initiative, *Greenness of Stimulus Index*, 6th ed. (2021). The Greenness of Stimulus Index examines 30 economies to assess the environmental orientation of their stimulus funding based on: the total stimulus funds flowing into environmentally intensive sectors; the existing green orientation of those sectors, such as the share of renewables in the energy sector; and the green orientation of new stimulus measures.

IV.

THEMES OF THE NINTH ENVIRONMENT FOR EUROPE MINISTERIAL CONFERENCE

This chapter provides an assessment of the two themes of the Ninth Environment for Europe Ministerial Conference, as selected by the ECE Committee on Environmental Policy. For each theme, key messages and policy recommendations are presented based on an assessment of the state, trends and outlook towards meeting policy objectives.

A. Greening the economy in the pan-European region: working towards sustainable infrastructure

1. Key messages and recommendations relevant to the theme

Key messages

Sustainability should be mainstreamed as early as possible in the strategic planning phase. Although sustainability should be present throughout the entire project life cycle, the earlier it is incorporated, the greater the benefits it can deliver. By considering sustainability as early as possible, policymakers can create a proper policy, regulatory and institutional environment that enables better integration of sustainability further "downstream". As the project timeline advances, the ability to make effective political, technical or economic changes decreases. However, decision-making processes are still siloed, reducing the capacity to identify synergies at the national and sectoral levels and interconnections between infrastructure sectors. Those silos must be dismantled in order to achieve more sustainable outcomes of infrastructure development.

Investment in sustainable infrastructure[250] has been recognized as one of the strategies with the most impact in terms of building back better in the post-COVID-19-pandemic recovery; this is due to its essential role in job creation, short-term economic growth and long-term development in alignment with global sustainability commitments such as the Sustainable Development Goals and the Paris Agreement. The lack of pipelines of bankable sustainable infrastructure projects, as well as of technical and institutional capacity to plan and prepare sustainable infrastructure projects, and the urgent need to boost economic development and job creation worldwide are pushing decision-makers towards business-as-usual projects instead.

Infrastructure needs are more variable and changing more rapidly than ever before. Thus, sustainable infrastructure should be flexible, interconnected and rely on real-time information to adapt to changing conditions. To have real time data, citizens in general and particularly users of the infrastructure systems should play an active role in the data gathering process (through mobile applications among other technologies) and periodic reporting of service satisfaction. This would help not just in improving the service but also in building modern information systems in the pan-European region.

Climate resilience, ecosystem services preservation, environmental restoration and biodiversity protection are key considerations in the planning of future infrastructure projects. Achieving these goals while providing much-needed infrastructure services will require the mainstreaming of nature-based solutions (NbS),[251] an approach already incorporated into the Pan-European Strategic Framework for Greening the Economy (ECE/BATUMI.CONF/2016/6).

250 Sustainable infrastructure (sometimes called "green infrastructure") systems are those that are planned, designed, constructed, operated and decommissioned in a manner that ensures economic and financial, social, environmental (including climate resilience) and institutional sustainability over the entire infrastructure life cycle. Sustainable infrastructure can include built infrastructure, natural infrastructure or hybrid infrastructure that contains elements of both. Note: This definition was published by UNEP in its report *International Good Practice Principles for Sustainable Infrastructure* (Nairobi, 2021), as an adaptation of the definition provided by the Inter-American Development Bank in its March 2018 Technical Note No. IDB-TN-1388 entitled *What is Sustainable Infrastructure? A Framework to Guide Sustainability Across the Project Cycle*.

251 The Resolution adopted by the United Nations Environment Assembly on 2 March 2022 on Nature-based solutions for supporting sustainable development (UNEP/EA.5/Res.5) decided on a definition of nature-based solution as "*actions to protect, conserve, restore, sustainably use and manage natural or modified terrestrial, freshwater, coastal and marine ecosystems, which address social, economic and environmental challenges effectively and adaptively, while simultaneously providing human well-being, ecosystem services and resilience and biodiversity benefits*".

Efficient use of materials and a circular economy are at the core of a sound sustainable consumption and production strategy. New technological advances in resource efficiency, recycling and reuse (including through increased modularity of infrastructure project components), should be considered as key elements in the planning, design, construction and operation of infrastructure projects.

Sustainable infrastructure must be environmentally responsible, socially inclusive and economically viable. It is important to guarantee that the needs of all stakeholders are identified and addressed. The multifaceted nature of sustainable infrastructure is addressed in the Resolution adopted by the United Nations Environment Assembly on Sustainable and resilient infrastructure (UNEP/EA.5/Res.9), in which several of the previously identified elements (including the importance of circular economy, infrastructure resilience, environmental protection and nature-based solutions) are also referenced.

Recommendations

A common definition of sustainable infrastructure should be developed in the pan-European region. This would allow reporting on and quantifying of progress across countries and subregions. Significant data gaps have been identified both in the social, environmental, institutional, economic and financial indicators proposed and when quantifying the contribution (positive or negative) of infrastructure development and the achievement of the indicators proposed in this assessment.

Governments should make use of existing tools to promote sustainable infrastructure development, including the ECE Protocol on Strategic Environmental Assessment, and ensure an integrated and full-life-cycle approach where decisions made today about infrastructure are aligned with other national and international sustainable development targets and commitments, such as GHG emissions reduction and social inclusion. A life-cycle approach should help to reconcile short- and long-term objectives; for instance, investing in traditional, carbon-intensive energy sources could meet short-term needs, but will lock in unsustainable development patterns and prevent countries from achieving the goals of the Paris Agreement and the Sustainable Development Goals, closing the already small window of opportunity for achieving a sustainable future.

There remains a significant capacity gap that is preventing sustainable infrastructure from being deployed at scale. Additional resources should be devoted to ensuring that the institutional and technical capacity necessary for the planning, design, execution, operation and decommissioning of sustainable infrastructure projects is achieved. Creating a common understanding of what "sustainable infrastructure" means and defining a common strategy to quantify progress across nations could contribute to closing these capacity gaps.

NbS can be used to complement, substitute or safeguard traditional grey infrastructure, thus contributing to closing the infrastructure access, quality and sustainability gap in a climate-resilient manner. Thus, NbS can play an important role in increasing climate-change resilience and ensuring delivery of sustainable infrastructure services.[252] There is abundant research and literature on the potential and capacity of NbS to increase the resilience of communities; however, the lack of demand and incentives does not make it viable in some cases. Economic and financial incentives should be deployed by Governments in the region in the short and medium term to support implementation of NbS. Special incentives and capacity-development will be required to strengthen and implement circular economy strategies at the regional and national levels. These incentives must find alignment with the work already conducted on the European Union Taxonomy and the Pan-European Strategic Framework for Greening the Economy in sustainable consumption and production patterns, as well as the agreed definition of Nature-based Solutions.

To ensure that the needs of all stakeholders are identified and addressed, it is crucial that environmental and social impact assessments be conducted. These assessments should include, among other topics, a gender analysis recognizing women's specific needs. This will help to mainstream gender in infrastructure planning, design, construction and operation.

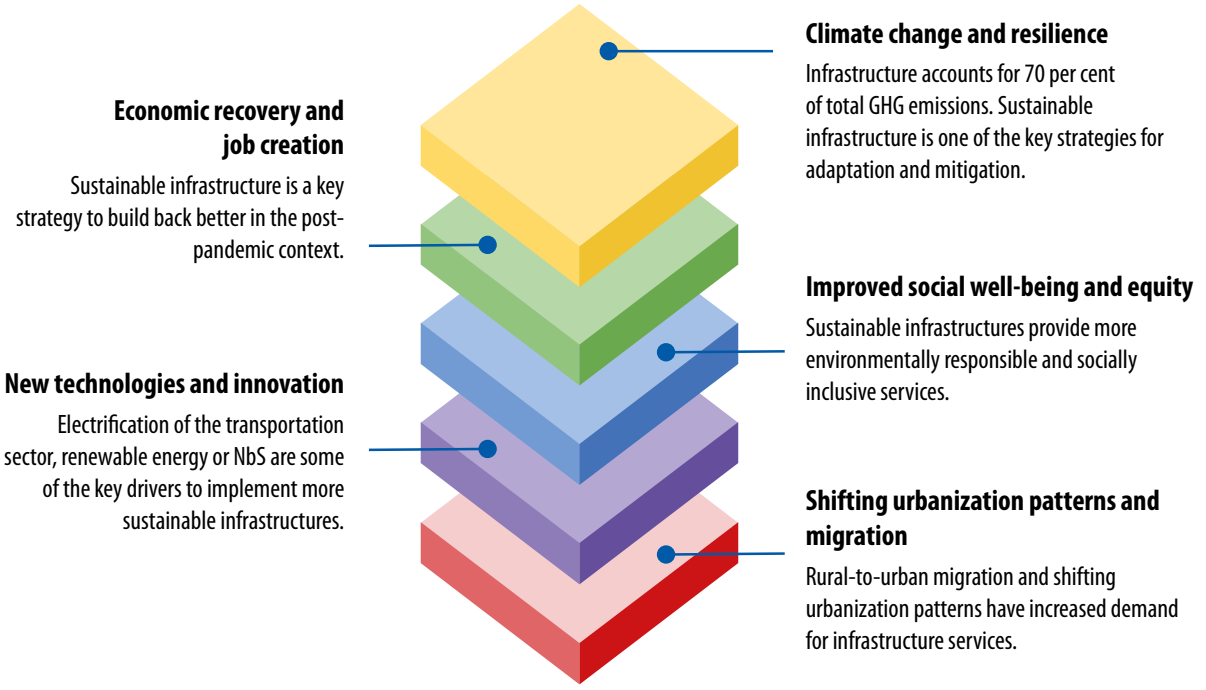
252 Mariana Silva and others, *Increasing Infrastructure Resilience with Nature-based Solutions (NbS): A 12-step Technical Guidance Document for Project Developers* (n.p., Inter-American Development Bank, 2020).

2. Context

For decades, infrastructure development has been seen as the backbone of economic growth and development. However, in recent years, the world has come to realize that the potential benefits of infrastructure delivery do not always materialize. Environmental degradation, loss of biodiversity, social displacement and increased GHG emissions are some of the unintended consequences of unsustainable infrastructure. To meet climate and development objectives while also "leaving no one behind," it will be vital to bridge the infrastructure gap, which will require an estimated investment of $6.9 trillion a year until 2030.[253] As indicated by Ban Ki-moon, former Secretary-General of the United Nations: "There is an urgent need to include sustainable and climate-resilient infrastructure as an integral part of green growth to deliver energy, water and transportation solutions that will facilitate opportunity, connection and sustainable growth."[254]

The countries of the Pan-European region face similar challenges, as energy demand continues to rise, climate-related hazards become more frequent and intense and demand for improved social well-being and equity increases. These drivers and many more will define the need to develop more sustainable infrastructure (see figure 46).[255]

Figure 46 Main drivers of infrastructure demand



Source: Developed by author.

Climate change and resilience

GHG emissions in the pan-European region continue on an upward trajectory. Paired with the fact that infrastructure construction and operations account for 70 per cent of total GHG emissions,[256] infrastructure development should be at the core of any sound climate strategy. Infrastructure development will play a dual role in achieving a more

253 OECD, the World Bank and UNEP, *Financing Climate Futures: Rethinking Infrastructure: Policy Highlights* (Paris, 2018).

254 UNEP, "Sustainable infrastructure can drive development and COVID-19 recovery: UNEP report", 4 March 2021.

255 See Glossary: Sustainable infrastructure.

256 Deblina Saha and Akhilesh Modi, *Low-Carbon Infrastructure: Private Participation in Infrastructure (PPI) – 2002 TO H1 2017* (n.p., World Bank Group, 2018).

climate-resilient future, first as mitigation and then as an adaptation strategy. Considering the significant contribution that infrastructure in different sectors makes to GHG emissions, it is vital that the current productive models be transformed into less carbon-intensive ones. Moreover, large areas in the pan-European region are already suffering on a regular basis from the effects of climate change, including in the form of heatwaves, extended droughts, sea-level rise or flooding, for example. Thus, infrastructure solutions are widely recognized as a key strategy for climate change adaptation.

For many decades, the value added of infrastructure was thought of as its capability to create strong, resilient barriers to protect the population from unwanted disturbances such as flooding. However, this approach has been reversed and complemented with NbS in what is sometimes known as "green infrastructure".[257] Now it is understood that traditional grey infrastructure[258] is often unable to withstand the intensifying effects of climate change. Thus, a combination of NbS and a comprehensive understanding of the ecosystem services that nature provides, together with the predictability flowing from traditional grey infrastructure options, offers a broader spectrum of synergies (green-grey) that will better serve the multitude of solutions required, based on the context.

Economic recovery and job creation

The COVID-19 pandemic has created an unprecedented global economic downturn. This crisis has exposed gender inequality, global gaps in accessibility to basic services and the lack of flexibility and resilience of infrastructure systems. According to the International Labour Organization (ILO), the crisis-induced job gap (i.e. shortfall in jobs required) will reach 75 million in 2021 before falling to 23 million in 2022.[259] Additionally, the employment growth lost will not be recovered until 2023. However, the pandemic also creates a once-in-a-century opportunity to build back better by building a foundation for a sustainable and green future through investments in sustainable infrastructure. Infrastructure investment is likely to be a key element of recovery measures in many countries, in part because of its job creation potential. Besides, ensuring that infrastructure investments are climate resilient and do not increase exposure and vulnerability will reduce direct economic damages from climate-related disasters, while minimizing the indirect costs created by the cascading impacts of the disruption of both critical services and economic activities.

New technologies and innovation

The pandemic has exposed the interconnectedness of the world and the reality that existing infrastructure systems are, in many cases, fragile, not fit for purpose and even obsolete. Thus, the health crisis, combined with an inequality crisis and lack of flexibility in infrastructure systems, has created a domino effect, amplifying the pandemic's devastating consequences. Even now, when digital communication technologies update their operating systems every couple of months, multimillion-dollar infrastructure projects are still planned, designed, built and operated that are rigid, inflexible and expected to operate unchallenged for decades to come. Thus, it is unsurprising that countries struggle to accommodate shifting needs for temporary health-care facilities, teleworking and the next generation of transportation systems, such as electric or driverless vehicles. To better accommodate future infrastructure needs, it is imperative to ensure that the infrastructure sector focuses broadly on provision of infrastructure services instead of narrowly on projects. A problem-solving approach promotes innovation, creates opportunities to explore new technologies and incentivizes more efficient solutions.

For example, it will be critical to frame the problem as in "the need to deliver more safe drinking water", instead of the solution as in "creating more water treatment facilities". The second and more conventional alternative limits the capacity to integrate non-traditional and more sustainable alternatives, such as NbS, to address the problem at hand.

257 "Green infrastructure" refers to natural systems, including forests, floodplains, wetlands and soils, that provide additional benefits for human well-being, such as flood protection and climate regulation. See Green-Gray Community of Practice, *Practical Guide to Implementing Green-Gray Infrastructure* (n.p., 2020).

258 "Grey infrastructure" refers to structures such as dams, seawalls, roads, pipes or water treatment plants. Ibid.

259 ILO, *World Employment and Social Outlook: Trends 2021* (Geneva, International Labour Office, 2021).

Data-driven decision-making, geospatial design and simulation will be crucial to ensure better understanding of the complexity of the world ahead, where human needs, environmental and social impacts and planetary boundaries should all be part of the design of the most optimal solution.

Shifting urbanization patterns and migration

Migration has been a pattern connected to the search for better opportunities all around the world. In recent years, the shifting urbanization pattern has been intensified as the result of climate change, violence and conflict. The International Organization for Migration estimates that there are 272 million international migrants – 3.5 per cent of the world's population[260] – surpassing projections for 2050. Europe has traditionally been a major destination for international migrants. In 2019, Europe received around 82 million international migrants and Asia around 84 million; together they accounted for 61 per cent of the total global international migrant stock that year.[261] Considering the complexity in predicting mitigation patterns, due to the close connection with economic crises, political instability and conflict, the lack of predictability puts significant pressure on existing infrastructure such as hospitals or drinking water, making it impossible to deliver the needed services for an increased number of users.[262] Consequently, it is of crucial importance to ensure that the upstream infrastructure planning process takes a long-term view, including demographic changes such as an ageing population and potential migration patterns that may result in shifting urbanization patterns and, therefore, higher infrastructure demand.

Improved social well-being and equity

Creating and maintaining healthy and safe environments is central to the delivery of sustainable infrastructure. Hence, the direct and indirect safety and health implications of an "unsustainable solution" should also be considered. Exposure to air, water or soil pollution, as well as to other poisonous hazards, can have a long-term impact on human health and well-being. To guarantee well-being and equity for all potential infrastructure users, the special needs of certain groups, such as women, should also be addressed. Stakeholder engagement processes, public consultations and gender mainstreaming strategies should be core considerations of every infrastructure project, helping to identify and minimize the risk of social exclusion.

3. State, main trends and recent developments

Climate change, population growth, growing inequality and biodiversity protection are just some of the challenges humanity will have to face in the years to come. In response to all of them, global initiatives supporting more inclusive, responsible and sustainable development models have emerged in recent decades. One example is the 2030 Agenda for Sustainable Development and its Sustainable Development Goals. Although such initiatives address different topics, they all agree on one thing; a paradigm shift towards a more sustainable development model is necessary to face the crucial challenges of the twenty-first century. The achievement of this new paradigm is only possible through coordinated actions in which Governments, public and private institutions, academia and civil society are actively engaged.

The ongoing pandemic has shone a spotlight on the great opportunity that sustainable infrastructure represents to build back better in the post-pandemic recovery era. In this regard, the role of sustainable infrastructure in both supporting inclusive growth and productivity and accelerating the transition toward low-carbon and climate-resilient economies is now widely recognized.[263] However, global efforts to foster the green economy and develop more sustainable and resilient infrastructure were a topic of conversation prior to the pandemic – how can States

260 Marie McAuliffe and Binod Khadria, eds., *World Migration Report 2020* (Geneva, International Organization for Migration, 2019.

261 Ibid.

262 International Federation of Red Cross and Red Crescent Societies, *New Walled Order: How Barriers to Basic Services Turn Migration into a Humanitarian Crisis* (Geneva, 2018).

263 Amar Bhattacharya and others, "Attributes and framework for sustainable infrastructure: consultation report", Technical Note, No. IDB-TN-01653 (n.p., Inter-American Development Bank, May 2019).

ensure that this critical period of awakening does not pass by with little result or action? The Pan-European Strategic Framework for Greening the Economy, developed in 2016 by the ECE Committee on Environmental Policy with the support and cooperation of the ECE secretariat, UNEP and many other key players, is a significant first step.

The main goal of the Pan-European Strategic Framework is to guide the pan-European region in its transition to an inclusive green economy by 2030, in alignment with the outcomes of the Rio+20 Conference and the 2030 Agenda. The Framework envisions the pan-European region pursuing a development pattern that ensures economic progress, social equity and the sustainable use of ecosystems and natural resources, thus ensuring that the needs of current generations will be met without compromising those of future generations. The implementation of the Framework is supported by the Batumi Initiative on Green Economy (BIG-E), which encompasses the period 2016–2030 and comprises voluntary commitments on the green economy by countries and both public and private organizations. To date, more than 30 countries and organizations have submitted more than 100 commitments to the BIG-E platform.[264]

Achieving all these ambitious goals requires cooperation among countries, as well as regulatory and policy instruments that support and embrace the transition to a more sustainable way of development. Equally important, all these efforts should take place at an early stage of the development process. A good example that illustrates the significance of these elements is the Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention, adopted 1991), according to which parties are obliged to assess the environmental impact of certain activities at an early stage of planning. The Espoo Convention builds on the idea that adverse environmental consequences and threats do not respect national borders. In doing so, it imposes an obligation of consultation between parties on all major projects that might cause a negative environmental impact across borders, thus contributing to reducing environmental threats and potential damage. The Espoo Convention laid the foundations for the introduction at the international level of strategic environmental assessment, a systematic decision-support process aimed at ensuring that environmental and other sustainability aspects are considered effectively in policymaking and plan- and programme-making.

The COVID-19 crisis has not just worsened countries' budgetary constraints but has also reinforced the need to invest in sustainable and more resilient projects. Financial mobilization towards sustainable investments can have a great impact on achieving sustainable development projects. Tools such as thematic bonds – mainly green, social and sustainable bonds – can greatly contribute to supporting the Sustainable Development Goals and sustainable recovery from the impacts of the pandemic. However, sustainable finance was part of the international conversation for years before the pandemic. In 2015, the Paris Agreement (art. 2 (1) (c)) included the commitment to "making finance flows consistent with a pathway towards low GHG emissions and climate-resilient development".

In addition to the already existing commitments, in the last couple of years, initiatives such as the European Union Taxonomy[265] have been put in place. Created in 2020, the Taxonomy is a classification system that establishes a list of environmentally sustainable economic activities. Besides its importance in the sustainable recovery from the pandemic, the Taxonomy also plays a role in meeting European Union climate and energy commitments and implementing the European Green Deal. Mobilization of finances and strengthening of policy frameworks will need to be accompanied by capacity-development initiatives. This will ensure that countries have the technical and institutional capacity to integrate these changes into their infrastructure pipelines. Most recently, in March 2022, the Resolution adopted by the United Nations Environment Assembly on Sustainable and resilient infrastructure encourages Members States to integrate the UNEP International Good Practice Principles for Sustainable Infrastructure[266] into national policy, implement existing tools and frameworks, cooperate internationally to strengthen different approaches (including financing) and consider the role of digital infrastructure.

264 "BIG-E commitments". Available at https://www.greengrowthknowledge.org/initiatives/batumi-initiative-green-economy-big-e?page=5.

265 European Union Technical Expert Group on Sustainable Finance, *Technical Report: Taxonomy: Final Report of the Technical Expert Group on Sustainable Finance* (n.p., 2020).

266 UNEP (Nairobi, 2021).

4. Indicators

Current landscape of sustainable infrastructure initiatives

Due to the broad spectrum of actors involved in the project life cycle of infrastructure projects, numerous initiatives have been developed to define indicators to quantify progress around sustainable infrastructure. The different approaches identified range in scope and intent from high-level aspirational principles, safeguards and good practices, infrastructure sustainability rating systems and schemes to reporting guidelines.

High-level principles

High-level principles aim to provide aspirational lines of action at a global scale; in most cases, they are published by international groups. Examples of high-level principles include the G20 Principles for Quality Infrastructure Investment, the UNEP International Good Practice Principles for Sustainable Infrastructure,[267] the *OECD Compendium of Policy Good Practices for Quality Infrastructure Investment*[268] and *OECD Implementation Handbook for Quality Infrastructure Investment: Supporting a Sustainable Recovery from the COVID-19 Crisis*.[269]

Safeguard policies

Multilateral development banks (MDBs) and other international financial institutions have traditionally incorporated safeguards and good practices aimed at providing a minimum baseline for due diligence processes to support decision-making. These environmental and social considerations provide the foundation for a better understanding of the potential unintended consequences and other risks associated with infrastructure development. Examples of well-known and widely applied safeguard and risk management frameworks include the International Financial Corporation Performance Standards and the Equator Principles. Most MDBs have their own safeguard policies as the baseline for due diligence processes.

Infrastructure sustainability rating systems and schemes

Numerous infrastructure sustainability rating systems have been developed in different geographic locations. These frameworks aim to provide comprehensive guidance and scoring criteria to rate projects across 50+ indicators. The application of these tools is, in many cases, linked to the achievement of a certification or sustainability award. Examples of some of the best infrastructure sustainability rating systems include Envision (the United States of America), CEEQUAL (the United Kingdom), SuRe (Switzerland) and IS Rating Scheme (Australia).

Reporting guidelines

To monitor and communicate the sustainability performance of a given project – not necessarily infrastructure – several reporting guidelines have been developed in the last few years, including the Global Reporting Initiative and the Dow Jones Sustainability World Index.

The complexity of infrastructure development, diversity of infrastructure sectors, phases within the infrastructure life cycle and stakeholders engaged have created a significant number of tools and frameworks to quantify progress for sustainable infrastructure. This has created the need to be able to access information and better understand the use of currently existing tools to find the one that best fits user needs. Consequently, the German Agency for International Cooperation created a platform called "The Sustainable Infrastructure Tool Navigator",[270] designed to help users identify the most relevant tools for their needs and goals. This new initiative provides access to a comprehensive database of sustainable infrastructure tools that users can navigate by keyword or filter by types of tools, sectors and infrastructure life cycle phases, among other things. This initiative has been recently supported by UNEP as a partner.

267 UNEP (Nairobi, 2021).

268 OECD (n.p., 2020).

269 OECD (n.p., 2021).

270 See https://sustainable-infrastructure-tools.org/.

5. List of indicators proposed

As previously identified, a significant number of frameworks and quantification criteria for sustainable infrastructure have been developed in recent years. However, different stakeholders have recognized the need for consolidation and harmonization of approaches[271] and the newly created "Finance to Accelerate the Sustainable Transition-Infrastructure.[272] These initiatives, together with other efforts by public and private groups, as well as international institutions, are presented in the comparative analysis below (see table 33).

The comparative analysis includes six relevant frameworks:

(a) Pan-European Strategic Framework for Greening the Economy

(b) MDB Common Set of Aligned Sustainable Infrastructure Indicators

(c) UNEP International Good Practice Principles for Sustainable Infrastructure

(d) G20 Principles for Quality Infrastructure Investment

(e) Finance to Accelerate the Sustainable Transition-Infrastructure (FAST-Infra)

(f) European Union Taxonomy for Sustainable Activities.

These frameworks are compared according to the following main categories: environmental sustainability and resilience; social sustainability; institutional sustainability; and economic and financial sustainability.

From the comparative analysis, several key matters were identified:

(a) In the category "Environmental sustainability and resilience", almost all the tools selected incorporate references to GHG emissions reduction, climate-change mitigation and adaptation, environmental preservation and circular economy or efficient use of resources. This category is the one that presents the most alignment across frameworks;

(b) Regarding "Social sustainability", all but one of the frameworks incorporate references to equity, inclusiveness and/or gender. Nevertheless, considerations of human and labour rights, health and well-being and resettlement are not always covered;

(c) In the "Institutional sustainability" category, references to transparent and anti-corruption practices are addressed in two thirds of the tools analysed. Other accountability procedures, such as sustainability certification, sustainability disclosure or sustainability and compliance policies, are other specific considerations addressed by some of the frameworks;

(d) Regarding "Economic and financial sustainability", less homogeneity was identified. Several frameworks refer to the need to guarantee positive economic returns and job creation. In contrast, others address the importance of mobilizing innovative financing sources and externality accounting.

The comparative analysis conducted has informed the proposal of indicators, subindicators and units of measurement in table 34.

271 The Infrastructure Cooperation Platform was formed in January 2018 in response to the growing consensus over the role of multilateral development banks in supporting the preparation and financing of infrastructure investments, as well as in mobilizing private finance to close the global infrastructure services gap. The Platform is supported by the G20 Infrastructure Working Group.

272 FAST-Infra was conceived in early 2020 by Climate Policy Initiative, the Hong Kong and Shanghai Banking Corporation (HSBC), the International Finance Corporation, OECD and the Global Infrastructure Facility under the auspices of the One Planet Lab of the President of the French Republic, Emmanuel Macron. The new FAST-Infra Sustainable Infrastructure Label (SI Label) is designed to enable project sponsors, developers and owners to signal the positive sustainability impact of infrastructure assets and attract investors seeking assets that positively contribute to sustainable outcomes.

Table 33 Comparative analysis of sustainability criteria

	Core elements			
Framework	Environmental sustainability and resilience	Social sustainability	Institutional sustainability	Economic and financial sustainability
Pan-European Strategic Framework for Greening the Economy	Natural capital Ecosystem services Sustainable production patterns (circular economy)	Healthy living and well-being Sustainable consumption Public participation and education	Externalities and natural capital Green and fair trade	Externalities and natural capital Green and decent jobs, and human capital
MDB Common Set of Aligned Sustainable Infrastructure Indicators	GHG reduction Climate risk, resilience Biodiversity Pollution control and monitoring Efficient use of materials Energy and water efficiency	Access and affordability Stakeholder engagement Human and labour rights Disability and special needs Gender integration Health and safety	Anti-corruption protocols and procedures Corporate sustainability disclosure	Positive economic and social return (expected rate of return) Job creation
UNEP International Good Practice Principles for Sustainable Infrastructure	Resilience Environmental impacts and nature Resource efficiency Circular economy	Equity, inclusiveness and empowerment	Life cycle assessment Strategic planning Transparent, inclusive and evidence-based decision-making	Fiscal sustainability and innovative finance Enhancing economic benefits
G20 Principles for Quality Infrastructure Investment	GHG reduction Climate risk, resilience Biodiversity Natural capital Pollution control and monitoring Resource efficiency Circular economy	Community development Stakeholder engagement Displacement Female jobs Data gathering	Participatory project identification Procurement standards Conflict of interest and ethics Sustainability certification	Rates of return and cost contingencies Cost overruns Domestic goods and services Training and education Permanent and construction jobs
FAST-Infra	GHG reduction Climate-change mitigation, resilience Biodiversity Natural environment Pollution prevention and control Waste reduction Circular economy	Stakeholder engagement Human and labour rights Land acquisition and resettlement mitigation Gender and inclusivity Health and safety	Sustainability and compliance policies Anti-corruption policies and procedures Transparency and accountability	Embedding government policies for project fiscal transparency and procedures
European Union Taxonomy for Sustainable Activities	Climate change mitigation Climate change adaptation Biodiversity and ecosystems Pollution and control Circular economy Water and marine resources	—	—	—

Source: Developed by author.

Table 34 Infrastructure sustainability indicators

		Indicator at the national level and unit of measurement	
Indicator	Definition	Indicator	Unit of measurement
1. Climate change adaptation and mitigation	Infrastructure projects should reduce/avoid GHG emissions, be climate-resilient and integrate adaptation and mitigation strategies through the full cycle	Subindicator 1.1: GHG emissions reduction	Total GHG emissions in the pan-European region (without land use, land-use change, and forestry) by subregion, million tons of CO_2 equivalent (2014–2018)
		Subindicator 1.2: Disaster risk reduction strategies	Score of adoption and implementation of national DRR strategies in line with the Sendai Framework in the pan-European region (2018)
2. Environmental conservation and biodiversity protection	Infrastructure projects should avoid negative impacts and/or restore biodiversity and the environment while preserving ecosystems and ecosystem services during the entire life cycle	Subindicator 2.1: Biodiversity protection	Number of countries in the pan-European region that established national targets in accordance with Aichi Biodiversity Target 2 of the Strategic Plan for Biodiversity 2011–2020 in their National Biodiversity Strategy and Action Plans
		Subindicator 2.2: Ecosystem services protection	Proportion of land that is degraded over total land area (2015)
3. Circular economy	Infrastructure projects should be planned, designed, constructed, operated and decommissioned considering the efficient use of resources as well as principles of circular economy (including repurpose, recycle, reduce, reuse, repair, refurbish and remanufacture)	Indicator 3: Circular economy	Recovery rate of construction and demolition waste in the European Union (2014–2018) Recovery rate of construction and demolition waste in other pan-European countries (non-European-Union) (2014–2018)
4. Gender equality and empowerment	Infrastructure projects should promote social inclusion, gender equality and human rights protection by fostering economic empowerment and social mobility, and equal opportunities for all	Indicator 4.: Gender equality and empowerment	Gender employment gap across the pan-European region (2020)
5. Life-cycle cost accounting	Infrastructure projects should consider the net economic and social returns as well as the real cost of economic activities and natural capital over the entire project life cycle (including during maintenance and decommissioning, where appropriate), taking into consideration both positive and negative externalities and life-cycle cost accounting	Indicator 5: Life-cycle cost accounting	Sectors in which countries usually perform cost–benefit analysis (2014)
6. Access to basic services	Infrastructure projects should improve physical and economic access to basic services (including drinking water, sanitation, electricity and digital technology) ensuring healthier living conditions and well-being	Indicator 6: Access to basic services	Percentage of population using basic drinking water services by location (2020) Percentage of population using basic sanitation services by location (2020) Percentage of population with access to electricity by location (2020) Proportion of population covered by at least 2G, 3G or 4G mobile network across the pan-European region (2018)

		Indicator at the national level and unit of measurement	
Indicator	Definition	Indicator	Unit of measurement
7. Transparency and anti-corruption	Infrastructure development should be planned and designed, constructed and operated in a transparent manner, so as to guarantee that relevant information is available and accessible to all stakeholders. Projects should have anti-corruption and anti-bribery management systems in place, for long-term monitoring	Indicator 7: Transparency and anti-corruption	Score and rank of the pan-European subregions on the Corruption Perceptions Index, 2020 Score and rank of the European Union on the Corruption Perceptions Index during the period 2016–2020
8. Financial sustainability and innovative finances	Infrastructure development should guarantee the financial sustainability of the assets through the full life cycle. This will include mobilization of innovative sources of capital at scale	Indicator 8. Sustainable investment	Contribution to the international $100 billion commitment on climate-related expenditure (2014–2019)

Source: A selection developed by author.

6. Quantification of indicators in the pan-European region: trends identified

An infrastructure project is sustainable when different environmental, social, institutional and economic considerations are met throughout the project's entire life cycle. However, due to the multidimensional nature of sustainability and the lack of an agreed baseline, limited or no information exists at the pan-European regional or subregional levels regarding infrastructure sustainability performance. Therefore, after defining the most commonly used sustainability indicators and the information available at the country and regional levels, the author conducted an indicator-by-indicator analysis.

Indicator 1 "Climate change adaptation and mitigation" aims to reduce GHG emissions while ensuring that infrastructure projects are resilient and integrate adaptation and mitigation strategies through the entire life cycle. Due to the broad scope of this indicator, it is divided into two subindicators: 1.1 "GHG emission reduction" and 1.2 "Disaster risk and reduction strategies". As reported in the United Nations SDG Indicators Database, regarding the quantification of progress on Sustainable Development Goal indicator 13.2.2 "Total greenhouse gas emissions per year", net GHG emissions have increased in the pan-European region, taking 2014 as the baseline year. From 2014 to 2018, two subregions in the pan-European region (European Union and Western Europe) showed positive progress in reducing GHG emissions. However, the Central Asia, Eastern Europe and South-Eastern Europe subregions presented an overall GHG increase, raising the level of emissions in the region overall. When considering the progress achieved on subindicator 1.2 "Disaster risk and reduction strategies" and based on United Nations Statistics Division (UNSD) data on the Sendai Framework Monitoring System, all the subregions, and, therefore, the pan-European region as a whole, increased the adoption and implementation of disaster risk reduction strategies from 2015 to 2018. Thus, indicator 1 shows mixed performance results overall, and additional effort should be devoted to climate-change adaptation and mitigation. See also section III.B on climate change. Additional efforts should be devoted to gather information regarding adaptation strategies to be used in countries and regions. Adaptation strategies include using nature-based solutions to reduce flooding, restoring hydrological connections, designing or planning infrastructure considering the potential effects of climate change, providing capacity to adapt to new risks and diversifying energy supplies. Due to the complexities of several of these topics, the indicators suggested are just the first steps towards the measurement of a more comprehensive strategy for resilient climate infrastructure. Additional data gathering should be conducted regarding regional adaptation strategies to incorporate additional indicators.

Indicator 2 "Environmental conservation and biodiversity protection" seeks to avoid negative impacts and/or restore biodiversity and the environment, while preserving ecosystems and ecosystem services during the entire life cycle of the infrastructure project. This indicator is quantified using two subindicators: 2.1 "Biodiversity protection" and 2.2 "Ecosystem services protection". Biodiversity protection is quantified in alignment with Sustainable Development Goal 15 and its indicator 15.9.1. (a) "Number of countries that have established national targets in accordance with

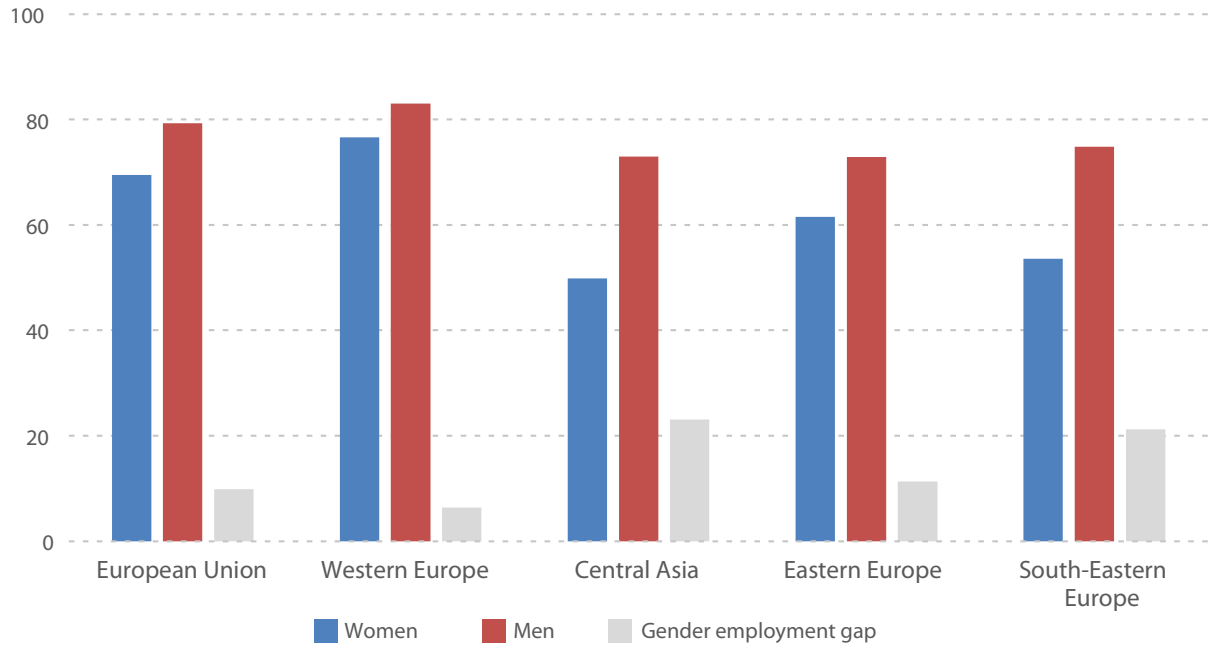
or similar to Aichi Biodiversity Target 2 of the Strategic Plan for Biodiversity 2011–2020 in their national biodiversity strategy and action plans and the progress reported towards these targets". According to information published by UNSD, every country in the pan-European region has established its respective strategic plans for biodiversity and action plans. The achievement of this target does not necessarily indicate that biodiversity objectives are achieved but that national strategies are in place. It is worth noting that there is limited or no information currently available at the national, subregional or regional levels regarding the effects of infrastructure development on biodiversity disruption. Subindicator 2.2 "Ecosystem services protection" has been quantified in alignment with Sustainable Development Goal indicator 15.3.1 "Proportion of land that is degraded over total land area". According to the ECE Dashboard for SDGs, there are significant differences in land degradation by country, ranging from 97 per cent in Tajikistan – because of erosion caused by overgrazing, poor irrigation services and salinization[273] – to a total of 1 per cent of degraded land in Belarus and Finland. Similar to the situation regarding biodiversity, limited or no information has been identified across countries regarding the percentage of land degraded associated with infrastructure development or other relevant information regarding quantification of services provided by natural ecosystems. See also the assessment of biodiversity and ecosystems in section III.E.

Indicator 3 "Circular economy" looks at the importance of making good use of resources over the full life cycle of the infrastructure project. Based on the information available and its alignment with infrastructure development, the most relevant unit of measurement identified is "Recovery rate of construction and demolition waste". Limited information was identified at the pan-European regional level. However, this indicator is part of the European Commission Circular Economy indicator set. Consequently, detailed information exists at the European Union level for the period 2014–2018. According to the most recent information published by Eurostat in 2018, the average recovery rate of construction and demolition waste has remained almost constant at 87 per cent in 2014 and 2016 and 88 per cent in 2018. The data gathering process followed in the European Union could be extrapolated at the pan-European region level to quantify this indicator. See also section III.G on chemicals and waste.

Indicator 4 "Gender equality and empowerment" aims to promote social inclusion, gender equality and human rights protection by fostering economic empowerment, social mobility and equal opportunities for all. Based on data availability, the unit of measurement proposed is "Gender employment gap across the pan-European region." According to the most recent information published by the International Labour Organization (ILO) in the ILOSTAT database in 2021, essential differences are appreciated by subregion (see figure 47). For example, the gender employment gap in the South-Eastern Europe subregion is currently 21.2 per cent, compared with the Western Europe subregion (6.4 per cent) and the European Union subregion (9.9 per cent). The gender employment gap has shown a positive trend, having decreased in most subregions. This is the case for the European Union, where the gender employment gap decreased dramatically from 20.8 per cent in 1990 (oldest data available) to 9.9 per cent in 2019, or the Western Europe subregion, where the gap was reduced from 18.2 per cent in 1990 to 6.4 per cent in 2019. The Central Asia and Eastern Europe subregions bucked this trend since their gender employment gaps increased by 1.5 per cent and 0.9 per cent, respectively, from 1990 to 2019. The gender employment gap across the pan-European region decreased from 19.2 per cent in 1990 to 14.4 per cent in 2019; however, significant opportunities for improvement still exist in this area.

273 UNDP-UNEP Poverty Environment Initiative, *Final Report: The Economics of Land Degradation for the Agriculture Sector in Tajikistan: A Scoping Study* (Dushanbe, Tajikistan, 2011).

Figure 47 Gender employment gap: simple average of national values by subregion, 2019 (Percentage)



Source: ILO, ILOSTAT database. Available at https://ilostat.ilo.org/topics/employment/.

Indicator 5 "Life cycle cost accounting" is at the core of the concept of sustainability. This indicator considers the net economic and social returns of infrastructure over the entire project life cycle (including positive and negative externalities). Specific references to externalities are found in the Pan-European Strategic Framework for Greening the Economy. One of its nine focus areas (FA.2) aims to promote the internalization of negative externalities and the sustainable use of natural capital. However, limited data exist regarding the quantification of externalities across the region. The existence of cost–benefit analysis represents the first step in that direction. Consequently, the quantification criteria for this indicator look at the number of countries that conduct cost–benefit analysis by infrastructure sector. According to a 2014 OECD questionnaire on the challenges and applications of cost–benefit analysis for the preliminary feasibility study of capital investments,[274] 15 countries from the pan-European region that participated in this study applied cost–benefit analysis in large infrastructure projects. However, just one third of the countries did so because of a legal requirement. Furthermore, the traditional cost–benefit analysis does not incorporate sustainability considerations (such as climate risk) and externality accounting (such as the cost of pollution, ecosystem services or biodiversity protection). Thus, the existence of cost–benefit analysis should not be the end goal but, rather, represent good progress towards a more comprehensive analysis of infrastructure development over the entire life cycle.

Indicator 6 "Access to basic services" seeks to improve physical and economic access to basic services, ensuring healthier living conditions and well-being. Given the scope of this work and data availability, the services considered for quantifying this indicator are access to drinking water, sanitation, electricity and a 2G, 3G or 4G mobile network. The quantification of access to drinking water is done in alignment with Sustainable Development Goal indicator 1.4.1 "Proportion of population living in households with access to basic services". According to data published by the WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene in 2021, access to basic drinking water services is consistent across the pan-European subregions and above 90 per cent in all cases. In this regard,

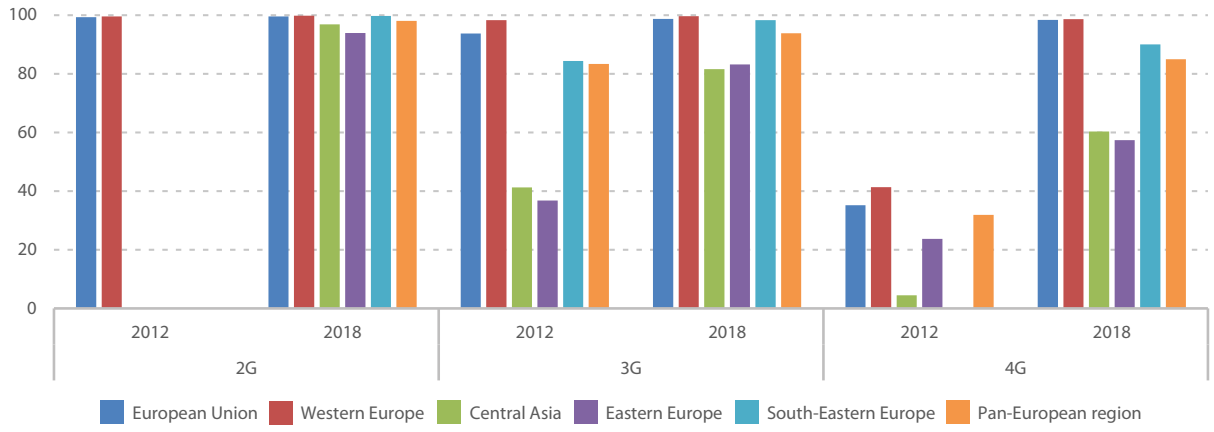
274 OECD, Cost Benefit Analysis (CBA). Available at https://qdd.oecd.org/subject.aspx?Subject=17375f7e-fc6c-4a5f-81bf-5b7e6a1da53c.

the Western Europe subregion is the only one with full access to such services, closely followed by the European Union (98.6 per cent). In almost all countries, access is above 75 per cent in a rural context.

When looking at the proportion of the population using basic sanitation services, the information gathered shows more heterogeneity in the results than the previous subindicator. The results range from 82.3 per cent access in rural Eastern Europe to 99.5 per cent in urban South-Eastern Europe and Western Europe. The overall proportion of the population using basic sanitation services in the pan-European region is 96.3 per cent. At the country level, the lowest percentage (72 per cent) of access to sanitation services is found in rural areas in two countries. Electricity access is equally relevant when looking at basic services. This subindicator is quantified in alignment with Sustainable Development Goal indicator 7.1.1 and refers to the proportion of the population that has access to electricity. According to UNSD, the pan-European region shows full access to electricity, with the exception of Central Asia (99.9 per cent). See also section III.C on fresh water.

The last subindicator considered as part of access to basic services is "proportion of population covered by a mobile network". Provision of mobile networks is covered by Sustainable Development Goal indicator 9.c.1 and refers to the percentage of inhabitants living within range of a mobile-cellular signal. While 2G offers limited voiced-based services, 3G and 4G provide high-speed, reliable, high-quality access. The ECE Statistical Database indicates that almost all populations across the different pan-European subregions were covered by a 2G mobile network in 2018. In the case of 3G, in 2018, the range varied from 83.8 to 99.3 per cent depending on the region. In comparison, 4G coverage presented broader differences, ranging from 63.1 to 98.3 per cent. Compared with previous years, the proportion of the population covered by 2G in the pan-European region does not vary. However, there was a significant increase 3G and 4G coverage from 2012 – the earliest records available – to 2018 – the latest year recorded. In 2012, the percentage of the population covered by 3G was 77.7 per cent, 17.6 per cent lower than in 2018. In the case of 4G, the difference is even greater: while the percentage of the population with access to 4G in 2012 was 22.6 per cent, in 2018 this figure was 83.6 per cent, an increase of 61 per cent (see figure 48).

Figure 48 **Proportion of population covered by a second-, third- or fourth-generation mobile telephone network, by subregion, 2012 and 2018** (Percentage)

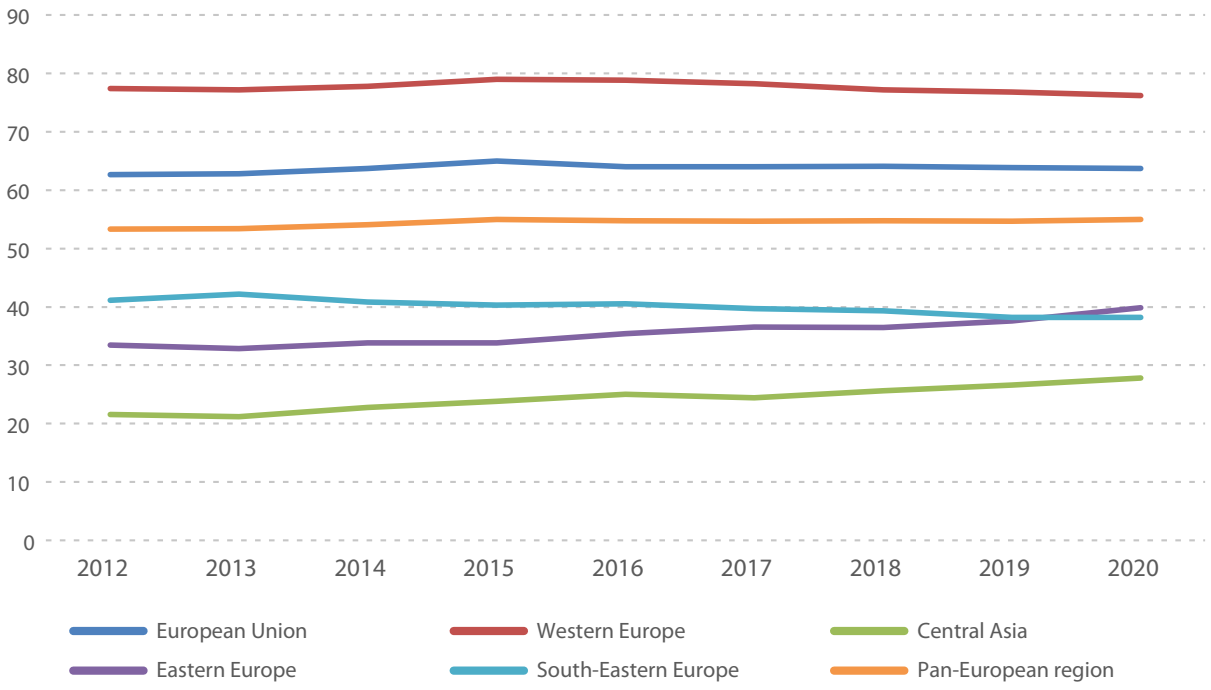


Source: ECE Statistical Database.

Notes: Insufficient 2G data for Central Asia, Eastern Europe, South-Eastern Europe (and the region as a whole) in 2012; no 3G data for the Russian Federation (among others) in 2012; insufficient 4G data for South-Eastern Europe in 2012. For population data, only 2016 figures for Monaco, latest figures for the Russian Federation 2013, latest figures for Turkmenistan 2009.

Indicator 7 "Transparency and anti-corruption" aims to guarantee that projects are planned, designed, constructed and operated transparently to ensure that relevant information is available and accessible to all stakeholders. This indicator is quantified in alignment with the Transparency International Corruption Perceptions Index, on which 0 represents the highest level of corruption and 100 the lowest. According to Eurostat, this indicator is part of the European Union Sustainable Development Goals indicator set and is used to monitor progress towards Sustainable Development Goal indicator 16.5.2. Based on the results published in the Corruption Perceptions Index 2020, Western Europe is the subregion with the lowest level of corruption (76.2), followed by the European Union (63.7). However, the score for each of the remaining subregions is below 40, meaning that the public sector there is perceived as more corrupt than those in the western subregions. In this regard, Central Asia is the subregion with the highest level of perceived corruption (27.8), followed by South-Eastern Europe (38.2) and Eastern Europe (39.9). Scores from previous years are available only for the European Union. When comparing 2019 and 2020 scores, most countries in the European Union slightly lowered their level of perceived corruption or remained at the same level. However, taking a much broader time frame (2012–2020), the situation looks very different, with 17 of the 27 countries experiencing an increase in perceived corruption (see figure 49).

Figure 49 Corruption Perceptions Index, simple average by subregion, 2012–2020
(0 = the highest and 100 = the lowest level of corruption)



Source: Transparency International, Corruption Perceptions Index.
Notes: No data for Andorra, Liechtenstein, Monaco and San Marino.

Indicator 8 "Fiscal sustainability and innovative finances" seeks to guarantee the financial sustainability of assets through the entire life cycle. This includes the mobilization of innovative sources of capital at scale. Significant work has been done in different subregions to mobilize finance for more sustainable and resilient projects. An example is the European Green Deal Investment Plan, which will mobilize European Union funding and create an enabling framework stimulating the public and private investments needed to transition to a climate-neutral, green, competitive and inclusive economy. The unit of measurement proposed for this indicator is aligned with Sustainable Development Goal indicator 13.a.1 and the aim is to mobilize funding for the $100 billion international commitment for climate-related expenditure. According to the European Environment Information and Observation Network (Eionet) and the European Commission Directorate-General for Climate Action, in 2019, the European Union contributed €16.206 billion, a 37 per cent increase compared with the 2014 base year. Limited information exists regarding some of the other pan-European subregions. This indicator does not cover the full scope of sustainability finances. However, it is a first step towards financing other key sustainability considerations such as biodiversity protection and social inclusion. See also section III.H on environmental financing.

Overall, these indicators reflect the current situation regarding sustainable infrastructure in the pan-European region, based on information that is available at present. Additional work will be required in the future to refine these indicators (e.g. quantify progress in the implementation of adaptation strategies in the different countries) and making the indicators more infrastructure specific. This should be considered a first step towards a sound agenda in sustainable infrastructure.

7. Case studies

Naples–Bari (Italy) railway line: the first sustainability-certified project in Europe by Envision rating system

Railway systems are at the core of the long-term transportation strategy defined by many countries around the world. However, these linear projects can often have potential consequences on environmental and social disruption and be affected by climate change, among other risks. Thus, applying a sustainable infrastructure framework can help to identify opportunities for improvement and existing gaps affecting the sustainability performance of infrastructure projects. This case study provides an overview of the application of the Envision rating system,[275] as one of the most widely applied methodologies for quantifying infrastructure sustainability and its application to the first Envision-certified project in Europe, the Naples–Bari (Italy) railway line.

The Naples–Bari route is part of the Scandinavia–Mediterranean railway corridor of the Trans-European Transport Network.[276] This project aims to improve the service by increasing travelling speed, accessibility, capacity and interconnection with other transportation modes, including ports and airports. This €6.2 billion effort will also integrate a multifunctional corridor where synergies with other infrastructure sectors such as energy and telecommunications are also considered.[277]

The application of Envision and the project verification cover a shorter, 21 km, section of the project in Italy (Frasso Telesino–Telese–San Lorenzo). The holistic sustainability approach provided by the application of Envision during the early phases of the project enabled the achievement of the highest sustainability performance – the platinum award. Some of the benefits of the incorporation of sustainability indicators into the project include the selection of the route so as to minimize environmental impact. The application of environmental indicators at an early stage of the project enabled the identification of high ecological value areas, floodplains and farmland used for wine production, so they could be avoided. Specific climate change and resilience considerations and the engagement

275 As defined by the Institute for Sustainable Infrastructure (ISI). This tool is divided into 64 sustainability and resilience criteria in five main categories: quality of life; leadership; resource allocation; natural world; and climate and resilience.

276 ISI, "Itinerario Ferroviario Napoli-Bari, Tratta Frasso Telesino-S. Lorenzo", 17 May 2019.

277 Stantec, "The Naples-Bari railway line is the first infrastructure in Europe certified by Envision for sustainability", 20 March 2019.

of local authorities were also identified as part of the Envision assessment of this project.[278] According to the project team, the application of sustainability tools and its indicators makes it possible to "favour an innovative approach to design. Those who design according to the environmental sustainability criteria of the protocol [Envision] are also driven to seek new and creative solutions to achieve a high-quality goal with less waste, more optimization of natural resources, use of innovative materials".[279]

Lower Danube Green Corridor: floodplain restoration for flood protection

More than two decades ago, the Governments of Bulgaria, the Republic of Moldova, Romania and Ukraine came together to define what is known as the Lower Danube Green Corridor (map 4). This 1,000 km corridor project aims to have a positive effect on flood management, water purification and climate change mitigation while restoring areas of high ecological value.[280] As defined in the Declaration of Cooperation for the Creation of a Lower Danube Green Corridor, signed in 2000 in Bucharest by the Ministers of Environment of the four countries, the scope of the project includes "a minimum commitment of 773,166 ha of existing protected areas, 160,626 ha of proposed new protected areas, and 223,608 ha of areas proposed to be restored to natural floodplain".[281]

Currently, 70 per cent of the floodplain along this section of the river has been lost or damaged. This project has the potential to restore 25 per cent of the total floodplain. The restoration of the former wetlands could store up to 1.6 billion m^3 of water, significantly minimizing the flooding risk in the area.[282] From the economic viability perspective, floodplain restoration along the Lower Danube Green Corridor has been estimated to cost €183 million, while the annual earning associated with ecosystem services[283] has been estimated at €111.8 million per year.

Beyond the previously mentioned project benefits (flood risk prevention, natural connectivity, etc.), the restoration of ecosystem services and the use of NbS provide significant positive additional externalities. Some of the main ones include the key role of wetlands as carbon sinks, the restoration of biodiversity in the area of influence, the development and protection of economic zones and the reduction of water pollution in floodplains and wetlands.

This project illustrates the importance of environmental restoration and the positive externalities associated with the protection of natural capital. Green infrastructure solutions help mitigate the imminent effects of climate change, environmental degradation and biodiversity loss.[284]

278 ISI, "Itinerario Ferroviario Napoli-Bari, Tratta Frasso Telesino-S. Lorenzo".

279 Stantec, ""The Naples-Bari railway line is the first infrastructure".

280 WWF, "Green infrastructure for Europe: the Lower Danube Green Corridor", WWF Factsheet (May 2015.

281 Declaration on the Cooperation for the Creation of a Lower Danube Green Corridor, signed 5 June 2000, Bucharest, Romania.

282 WWF, "Lower Danube Green Corridor: one of the world's most important ecoregions with outstanding and distinctive biological resources", WWF Factsheet (September 2010).

283 The main ecosystem services identified are flood control, water purification, groundwater replenishment, sediment and nutrient retention, reservoirs of biodiversity, recreation, tourism, etc.

284 Climate ADAPT, "Lower Danube green corridor: floodplain restoration for flood protection", 7 December 2021.

Map 4 Lower Danube Green Corridor (shown in dark green)

Source: WWF, "Green infrastructure for Europe: the Lower Danube Green Corridor", WWF Factsheet (May 2015).

B. Applying principles of circular economy to sustainable tourism

1. Key messages and recommendations

Key messages

A pan-European circular tourism economy will be more resilient to and better equipped to cope with future crises, be they economic, health related or derived from the environmental challenges that the region faces. Circular economy is essential for the sustainable development of tourism and can contribute to the achievement of the Sustainable Development Goals; in particular, it will accelerate a transition to a green travel and tourism economy. With the rapid growth of tourism, its impacts are growing despite efficiency improvements, increasingly contributing to environmental and social problems. Circularity should be the major strategy for the transformation and recovery of the tourism sector from the COVID-19 pandemic. Policymakers therefore need to ensure the transformation, through circularity, by providing the necessary means and guiding a path away from business as usual.

Circular economy mainly covers the physical environmental issues of energy and resource use and closing resource cycles, though it is dependent on social aspects, such as green jobs and well-being. Sustainable tourism development takes the broader perspective of economic development within social and environmental constraints. Therefore, circular economy is a necessary but incomplete element of sustainable tourism development.

Circular economy is an economic system that replaces the (linear) end-of-life concept with reducing, reusing, recycling and recovering materials in production, distribution and consumption processes.[285] The application of its principles in tourism is still in its infancy, apart from individual cases, given the complexity of the tourism value chain, which involves many subsectors. Due to the cross-sectoral nature of tourism, a circular approach in tourism is complex but also holds opportunities to become driven through other sectors. The extensive and transversal value chain of tourism offers numerous opportunities to make longer, better, more circular use of the materials and products utilized to deliver tourism services, creating value and partnerships, and reducing waste to as close to zero as possible.

285 Julian Kirchherr and others, "Conceptualizing the circular economy: an analysis of 114 definitions", *Resources, Conservation and Recycling*, vol. 127 (September 2017), pp. 221–232.

Key areas in tourism with a strong relation to both Sustainable Development Goals and circular economy are energy use and emissions in transport, accommodation and restaurants, waste management in tourism destinations, including of accommodation and restaurants (e.g. food waste and plastics), water consumption and generation of wastewater in general, and resource usage in building, for interiors and in amenities.

Opportunities may be most straightforward in the construction and operations, including (food) waste management, of accommodation facilities and restaurants. Opportunities in sustainable aviation fuels (e-fuels) are exploited on a very small scale. Many sharing economy initiatives currently have too many non-circular counter effects, such as additional construction or kilometres travelled.

While impacts of tourism have been measured for decades from an economic angle, monitoring and indicator development for sustainable tourism, let alone for monitoring circularity, is still evolving but is hampered by various issues. There are currently no indicators across the pan-European region that give explicit information on tourism's circular state and trends. It is therefore pressing to redefine how success is to be measured in the future. On several general circularity aspects, classification definitions differ between States. Finally, even mainstream tourism statistics tend to be incomplete and suffer from varying definitions, while detailed statistics needed for accurate circularity monitoring are absent. Digitization holds promise for better and more uniform measurement and monitoring but depends on the availability of uniform and relevant data on circular economy in tourism.

Recommendations

Governments should increase efforts to help reduce energy use and GHG emissions, in particular from tourism transport, as large gains can be achieved with relevance for climate policy and the 2030 Agenda for Sustainable Development. They should also invest in low-emission transport mode infrastructure. Widespread commitment to the 2021 Glasgow Declaration: A Commitment to a Decade of Tourism Climate Action can contribute to these efforts and align climate action across tourism stakeholders, including governments, civil society and others. Actions include, among others, the scaling up of international, long-distance rail infrastructure and travel, provision of electric charging infrastructure in tourism destinations, circular approaches related to water use, waste and materials use, as well as the scaling up of the integration of circularity aspects in policies and funding. Next to reductions of energy and emissions in transport, such reductions in tourism can also be achieved by facilitating the transition towards renewable energy use by accommodation facilities, restaurants and attractions. In general, the sharing of good circular practices and promotion of initiatives such as the Global Tourism Plastics Initiative, led by UNEP and UNWTO, in tourism is recommended.

The Governments of the pan-European region should take the opportunity, when elaborating COVID-19-pandemic recovery plans, to prioritize domestic tourism, as it is more resilient to crises,[286] has lower impacts on climate, and its product loops are tighter and easier to make circular than those of medium and long-distance international tourism products.

Decision-makers and entrepreneurs in the region should apply circular economy principles across the tourism value chain. A value chain approach could accelerate the transformation to more circularity in tourism and increase its long-term health and resilience. Tourism has the potential for long-lasting positive impacts beyond the sector itself, due to its interlinkages with other economic activities and the direct producer–consumer interaction. Financial support can aid tourism regions to set up adequate (recycling and other) infrastructures that can cope with the high seasonal variations of material streams.

ECE member States and governing bodies should select a limited number of specific key-impact tourism indicators, relevant for measuring circularity in tourism, to be included in ECE statistical databases. Indicators for circular economy in tourism should be aligned and used for the monitoring of sustainable development in tourism and be compatible

286 European Commission, "Scenarios towards co-creation of transition pathway for tourism for a more resilient, innovative and sustainable ecosystem", Commission Staff Working Document SWD(2021) 164 final (Brussels, 2021).

with Sustainable Development Goals. Circular economy indicator development could follow the approach led by the UNWTO initiative towards a Statistical Framework for Measuring the Sustainability of Tourism (SF-MST).[287] This framework is being developed with the United Nations Statistics Division (UNSD) with the aim to become the next United Nations measurement standard for tourism and to provide a guiding tool for countries to produce credible, comparable and integrated data to better guide decisions and policy with respect to sustainable tourism – including the Sustainable Development Goals. Other avenues include:

(a) Further integration of established measurement frameworks (Tourism Satellite Accounts, System of Environmental-Economic Accounting, European Tourism Indicator System and SF-MST) to provide a platform for the measurement of sustainable and/or circular tourism;

(b) Further engagement with the definition and measurement of Sustainable Development Goal indicators, including the development of a complementary set of circular tourism indicators;

(c) Advancing the development of subnational tourism statistics, recognizing the importance of location-specific information in decision-making on tourism.

2. Context

There is growing consensus that recovery of the tourism sector after the COVID-19 pandemic must be anchored in sustainability (people, planet and prosperity) to underpin resilience and that circular economy, as a strategy to achieve the green transformation of the sector, plays a crucial role.

Over the past half-century, the extraction of minerals has tripled, with the extraction and processing of natural resources accounting for over 90 per cent of biodiversity loss and water stress and about 50 per cent of climate change impacts.[288] Critical resources are already becoming scarce, while ecosystem services are increasingly degraded and anthropogenic pollution and waste have become increasingly difficult to absorb.[289]

Over the past decades, tourism has started to play a considerable role in this development, having become a major industry, with 1.5 billion international tourist arrivals in 2019.[290] According to UNWTO estimates made in 2021, in 2019, tourism constituted 4 per cent of global GDP. Tourism consists of various resource-consuming practices, including flights, accommodation, restaurants and attractions, but also contributes to social exchange and intercultural dialogue. Tourism practices before the pandemic followed the traditional linear economy paradigm that has an impact on climate and environment. There is a high risk that this linear paradigm will continue after the pandemic and that the opportunity for a green transformation in the tourism sector is missed. The environmental issues in which tourism plays a considerable role are energy use and emissions, biodiversity loss, water use, overconsumption (of food but also other environmental and social aspects) and waste generation.

Tourism's share of global emissions of CO_2 is estimated at 5 per cent for 2005, of which tourism transport was responsible for 75 per cent (air transport 40 per cent, car transport 32 per cent and other transport 3 per cent), accommodation for 21 per cent and activities for 4 per cent.[291] Air transport also has a considerable non-CO_2 impact on climate change, due to effects at high altitude. A more recent study, using a wider scope, points at tourism

287 United Nations World Tourism Organization (UNWTO), "On measuring the sustainability of tourism: MST", n.d. Available at https://www.unwto.org/standards/measuring-sustainability-tourism.

288 Bruno Oberle and others, *Global Resources Outlook 2019: Natural Resources for the Future We Want* (n.p., UNEP, 2019).

289 Will Steffen and others, "Planetary boundaries: guiding human development on a changing planet", *Science*, vol. 347, No. 6223 (13 February 2015).

290 UNWTO, "International tourism growth continues to outpace the global economy", 20 January 2020.

291 UNWTO and UNEP, *Climate Change and Tourism: Responding to Global Challenges* (Madrid and Paris, 2008).

representing around 8 per cent of global emissions in 2013.[292] In 2016, transport-related tourism emissions alone were estimated to represent 5 per cent of global emissions and forecast to grow by 25 per cent by 2030, under a current ambition scenario.[293] Under another (pre-COVID) business-as-usual scenario, worldwide tourism is on track to exceed the complete carbon budget for all sectors and households required to stay within the maximum temperature increase agreed upon in the Paris Agreement by 2060–2070.[294] This relates to the high energy use in tourism, notably in transport and accommodation, where it increases with luxury.

Travel distance and modal choice are the key determining factors in transport emissions from tourism. UNWTO and the International Transport Forum (ITF) forecast the number of domestic arrivals to reach 15.6 billion and international arrivals 1.8 billion by 2030. Tourism arrivals by surface modes of transport will grow by 70 per cent between 2016 and 2030 (almost 5 billion more trips), but emissions from these trips will grow by 12 per cent (691 million to 775 million tonnes of CO_2), representing 44 per cent of total emissions (compared with 50 per cent in 2016). In contrast, in 2030, tourism arrivals by air (both international and domestic) are expected to represent 33 per cent of the total arrivals but to produce 56 per cent of total emissions.[295] The type and volume of growth will depend on the post-COVID-19 development of tourism.

Water use in tourism is problematic in a range of destinations, due to travel taking place in warm countries during dry seasons, with high consumption for swimming pools, accommodation facilities and attractions, but also, for instance, in the production of artificial snow for winter tourism.[296] This leads to pressures on water availability, groundwater levels and frequently inadequate infrastructure.

Food consumption in tourism, with an estimated 75 billion meals a year, leads to a range of environmental issues.[297] For instance, the average food waste in hospitality is estimated at 40 per cent and in restaurants at 60 per cent.[298] UNEP estimated that international tourism would be responsible for around 200 Mt of waste in 2050, which appears a conservative estimate since international tourists in Europe already produce 1 kg of solid waste per day.[299] Tourism waste, including plastic waste, can stress the local waste management infrastructure, particularly during the high season and in destinations where facilities are still underdeveloped. There are various global initiatives to tackle the problem of waste, including in tourism, such as the Global Tourism Plastics Initiative.[300]

Tourism contributes to biodiversity loss through land conversion,[301] overexploitation of natural resources for food, materials, freshwater and recreation, the spread of invasive species, disturbance of wildlife, pollution from wastewater, sewage effluents, solid wastes, use of fertilizers and pesticides and, indirectly, its share in GHG emissions.[302] At the global level, the share of land use for tourism is still small. But locally, tourism can have strong impacts and cause

292 Lenzen and others, "The carbon footprint of global tourism.

293 UNWTO and International Transport Forum (ITF), *Transport-related CO_2 Emissions of the Tourism Sector: Modelling Results* (Madrid and Paris, 2019).

294 P.M. Peeters, "Tourism's impact on climate change and its mitigation challenges."

295 UNWTO and ITF, *Transport-related CO_2 Emissions of the Tourism Sector*.

296 Stefan Gössling, "New performance indicators for water management in tourism", *Tourism Management*, vol. 46 (February 2015), pp. 233–244.

297 Stefan Gössling and others, "Food management in tourism: reducing tourism's carbon 'foodprint'", *Tourism Management*, vol. 32, No. 3 (June 2011), pp. 534–543.

298 Sanaa I. Pirani and Hassan A. Arafat, "Solid waste management in the hospitality industry: a review", *Journal of Environmental Management*, vol. 146 (December 2014), pp. 320–336.

299 UNEP, *Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication* (Nairobi, 2011).

300 One Planet, "Sustainable Tourism Programme, Global Tourism Plastics Initiative", n.d.

301 Land conversion is the converting of an area to another use, such as converting forest area or wetlands into agricultural land or urban area.

302 UNWTO, *Tourism and Biodiversity: Achieving Common Goals Towards Sustainability* (Madrid, 2010).

many issues with land rights and land distribution, including competition with nature and agriculture and issues with landscape quality.[303] However, tourism can also contribute to biodiversity protection through nature conservation.

Next to these environmental issues is the relatively recent problem of overtourism, which describes situations "in which the impact of tourism, at certain times and in certain locations, exceeds physical, ecological, social, economic, psychological, and/or political capacity thresholds".[304] The underlying contributing factors to overtourism are often related to those causing some of the above-mentioned environmental problems, such as tourist density, air travel intensity and online rental platform (such as Airbnb[305]) bed capacity shares.

Modelling conducted prior to the COVID-19 pandemic showed that the resource use of energy and emissions, water, land and food by the tourism sector will double within 25 to 45 years.[306] This will contribute to already significant anthropogenic stress on several planetary boundaries,[307] and is in conflict with policy objectives such as those formulated in the Paris Agreement and the Sustainable Development Goals. Many of these stresses already have, or will have, impact on tourism itself, like climatic change that may lead to shifts in the attractiveness of destinations, causing tourist flows to change, increasing water and snow shortages impacting the tourism offer, or weather extremes damaging tourism infrastructure, ultimately also leading to reduced incomes and contributions to national and local economies.

While the transformation to more sustainable development of tourism has been pursued at all levels for at least two decades, attempts have not succeeded on a broad scale and cannot keep up with the impacts of the overall growth in volume. UNWTO acknowledges that approaches "such as the circular economy – promoting business models based on renewable resources, longer and diverse product life cycles, shared consumption and interconnected value chains – can play a significant role when designing and improving resource management systems, not only in the tourism sector but also for the sustainable development of destinations".[308]

In essence, the circular economy concept is seen as an alternative business model to the traditional linear economic development model, with a fundamental role for the environment. An overarching definition of the circular economy is "an economic system that replaces the 'end-of-life' concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes. It operates … with the aim to accomplish sustainable development, thus simultaneously creating environmental quality, economic prosperity and social equity, to the benefit of current and future generations" [309], and thus is a strategy to accelerate the green transformation and the sustainable development of tourism.[310] Its classic "3 Rs" principles (reduce, reuse and recycle) are frequently extended to "ladders" or R-frameworks, containing up to 10 principles or strategies (refuse, rethink, reduce, reuse, repair, refurbish, remanufacture, repurpose, recycle and recover).[311] The main benefits of circular economy lie in its potential to boost sustainable development and lower pressure on the environment, while also creating economic

303 Ward Anseeuw and others, *Land Rights and the Rush for Land: Findings of the Global Commercial Pressures on Land Research Project* (Rome, International Land Commission, 2012).

304 Paul Peeters and others, "Research for TRAN Committee - Overtourism: impact and possible policy responses" (Brussels, European Parliament, Policy Department for Structural and Cohesion Policies, 2018), p. 22.

305 Reference to commercial companies and products does not imply endorsement by the United Nations or its Member States.

306 Stefan Gössling and Paul Peeters, "Assessing tourism's global environmental impact 1900–2050". See also UNWTO and UNEP, *Tourism in the Green Economy – Background Report* (Madrid and Nairobi, 2012).

307 Steffen and others, "Planetary boundaries: guiding human development on a changing planet".

308 UNWTO and UNDP, *Tourism and the Sustainable Development Goals – Journey to 2030* (Madrid, 2017), p. 94.

309 Julian Kirchherr and others, "Conceptualizing the circular economy: An analysis of 114 definitions", p. 229.

310 Note the definition of sustainable tourism: "Tourism that takes full account of its current and future economic, social and environmental impacts, addressing the needs of visitors, the industry, the environment and host communities." UNEP and UNWTO, *Making Tourism More Sustainable: A Guide for Policymakers*, (Paris and Madrid, 2005), p. 12.

311 José Potting and Aldert Hanemaaijer, eds., "Circular economy: what we want to know and can measure. Framework and baseline assessment for monitoring the progress of the circular economy in the Netherlands" (The Hague, PBL Netherlands Environmental Assessment Agency, 2018), p. 27.

gain and jobs. Technological, but more so, cultural, barriers, are found to be the most pressing in slowing down the transition to circularity.[312]

The United Nations Development Programme (UNDP) and UNEP identify tourism as one of a few sectors that are key to the economic development of all countries, while also providing opportunities for climate change mitigation through resource efficiency and increasing circularity.[313] They recommend a circular or value chain approach to tourism, to allow for the identification and assessment of its interdependencies with other sectors, for example, those defined for climate action. Under a circular economy approach, responses could be developed that would drive (climate) action across all the various sectors on which tourism depends. Tourism's strong relation to food production, distribution and disposal is named as an example. UNDP sees a particular potential for a circular economy approach in tourism in countries where tourism is a large economic force.[314] The circular economy is regarded as very promising for contributing to the achievement of several Sustainable Development Goals, particularly Goal 7 on energy, Goal 8 on economic growth, Goal 11 on sustainable cities, Goal 12 on sustainable consumption and production, Goal 13 on climate action, Goal 14 on oceans and Goal 15 on life on land.

The main policy challenge related to circular economy is to ensure its effective definition and implementation in the tourism sector, specifically because of the number of different industries – from building to transport – forming part of the tourism value chain and its being mainly a service sector. Policy awareness is also an issue as, in a 2019 published review of 73 national tourism policies, UNWTO and UNEP found only one reference to circularity.[315] However, there are a few countries that make reference to tourism in their circular economy strategies or roadmaps, such as Slovenia and Spain.

3. State, main trends and recent developments

The *Circularity Gap Report 2021* estimated the global circularity rate at 8.6 per cent, down from 9.1 per cent in 2018, while 17 per cent is required to close the global emissions gap.[316] Progress in the development of circular economy in the pan-European region is varied.

ECE reports an increase in the efficiency of resource use in its region from 2000 to 2017. While domestic material consumption per unit of GDP decreased by about 10 per cent, aggregate output increased by 40 per cent. Again, there are large differences between ECE member States, with an average 3.1 per cent decrease of domestic material consumption by European members of OECD versus an increase in eastern ECE member States. In the same period, the material footprint continued to grow by 18 per cent in the ECE region, partly due to the import of raw materials, substituting domestic production. ECE also points to the major role of ECE member States in global material demand and a consequent responsibility (in a transition towards more sustainable consumption and production) beyond the ECE region.[317] This issue is also extremely present in international tourism, where resources are mainly consumed abroad and where many products consumed are imported. Material resource use in the ECE region is very much a mirror of the economic level of States: in less advanced economies, growth is accompanied by high resource use, whereas in more developed (service) economies, material use is less intensive. Material resource use and the complex interactions and feedback loops between human and natural systems in the ECE region are described in *Natural Resource Nexuses in the ECE Region*.[318]

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312 Julian Kirchherr and others, "Barriers to the circular economy: evidence From the European Union (EU)", *Ecological Economics*, vol. 150 (August 2018), pp. 264–272.

313 UNDP, *A 1.5°C World Requires a Circular and Low Carbon Economy* (New York, 2020).

314 Ibid.

315 UNWTO and UNEP, 2019, *Baseline Report on the Integration of Sustainable Consumption and Production Patterns into Tourism Policies* (Madrid and Paris, 2019).

316 Laxmi Haigh and others, *The Circularity Gap Report 2021*, (n.p., Circle Economy, 2021).

317 E/ECE/1495, paras. 2–3.

318 *Natural Resource Nexuses in the ECE Region* (United Nations publication, Sales No. E.20.II.E.42).

In the European Union, the circular material use rate (recovered materials as a percentage of overall materials used) increased from 8.2 per cent in 2004 to 11.2 per cent in 2017, though with little change since 2012.[319] The Netherlands (24.5 per cent) is regarded as a global circularity front runner, whereas Norway (2.4 per cent), for instance, lags far behind the global average.[320]

The European Commission, as part of its European Green Deal[321] and to align with new strategies, presented a new circular economy action plan in March 2020,[322] following an earlier version.[323] In its circular economy action plan, the European Commission notes that "Scaling up the circular economy from front-runners to the mainstream economic players will make a decisive contribution to achieving climate neutrality by 2050 and decoupling economic growth from resource use, while ensuring the long-term competitiveness of the [European Union] and leaving no one behind". To achieve this shift, the "[European Union] needs to accelerate the transition towards a regenerative growth model that gives back to the planet more than it takes, advance towards keeping its resource consumption within planetary boundaries, and therefore strive to reduce its consumption footprint and double its circular material use rate in the coming decade". The action plan includes proposals on product design, circular production processes, waste reduction and consumer empowerment. The European Parliament followed up with a resolution on the action plan, demanding additional measures and aiming for a fully circular economy by 2050.[324] The resolution underlines the major contribution that the circular economy may give to reaching the goals of the Paris Agreement and the Convention on Biological Diversity, as well as achieving the Sustainable Development Goals.

Circular approaches have yet to make it into direct European Union tourism policy, the Commission's current framework dating from 2010.[325] The Council of the European Union encourages European Union member States to consider a number of challenges and opportunities when developing tourism strategies and policies, of which "sustainability, including resource efficiency, circular economy, seasonality and the management and distribution of increasing tourism flows" is one. Policies are to contribute to European Union climate goals, the Paris Agreement and the Sustainable Development Goals.[326] It is likely that circular economy aspects will be included in the Tourism Transition Pathway process leading up to a new European Agenda for Tourism 2030/2050.[327]

The integration of circular economy in tourism, globally and in ECE member States, is still very limited. Tourism products are very diversified, often cross sectoral and usually consist of a whole range of components, such as accommodation, transport, activities and food and beverages. The tourism value chain is complex. A vast number of businesses and organizations are responsible for all these tourism components, with the tourist often combining them into a final product.[328] It may thus prove difficult to apply circular economy principles to overall tourism products on a large scale. To address single components will be more practicable, but a value chain approach will be more rewarding in the longer term. There are some longer established businesses in tourism that are linked to circularity,

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319 Marc de Wit, Jelmer Hoogzaad and Caspar von Daniels, *The Circularity Gap Report 2020* (n.p., Circle Economy, 2020).

320 Laxmi Adrianna Haigh, "Countries: the crucial piece to finish the circular economy puzzle", 2 November 2020.

321 European Commission, Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions, The European Green Deal, COM(2019) 640 final.

322 European Commission, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, A New Circular Economy Action Plan. For a cleaner and more competitive Europe, COM(2020) 98 final.

323 European Commission, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Closing the loop – An EU action plan for the Circular Economy, COM(2015) 614 final.

324 European Parliament, European Parliament resolution of 10 February 2021 on the New Circular Economy Action Plan (2020/2077(INI)).

325 European Commission, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Europe, the world's No 1 tourist destination – a new political framework for tourism in Europe, COM(2010) 352 final.

326 Council of the European Union, Outcome of Proceedings, The competitiveness of the tourism sector as a driver for sustainable growth, jobs and social cohesion in the EU for the next decade - Council conclusions (adopted on 27/05/2019), 9707/19 TOUR 10 IND 186 COMPET 434.

327 European Commission, "Scenarios towards co-creation of transition pathway for tourism".

328 Sorin and Einarsson, *Circular Economy in Travel and Tourism.*

based around replacing ownership by access, offering shared amenities and product–service systems.[329] Well-known examples are Airbnb and Uber. Currently, such initiatives present a range of adverse effects, including additional house building and vehicle-kilometres, beside a range of other environmental, social and leakage issues.[330] Examples of sharing without these externalities can be found in transport (bicycle and, to a lesser extent, scooter schemes). Examples are also found in traditional accommodation facilities (circular hotels). The UNEP and UNWTO Global Tourism Plastics Initiative includes commitments such as the engagement of the value chain in moving towards 100 per cent of plastic packaging being reusable, recyclable or compostable, investments to increase recycling rates and public reporting of targets.[331] Some measures can be simple and effective, such as making drinkable tap water accessible in public places, reducing tourist dependence on bottled water and preventing packaging waste.[332]

The COVID-19 pandemic has had a devastating effect on tourism, particularly international tourism. UNWTO reports that, in 2020, global international arrivals dropped by 74 per cent, due to travel restrictions and various socioeconomic challenges. For the first three quarters of 2021, international arrivals continued at 76 per cent below 2019 levels.[333] The collapse of international tourism in 2020 alone was estimated to represent a loss of $1.3 trillion in export revenues and around 120 million direct jobs put at risk. There is growing scientific and political consensus that a recovery of the sector must be anchored on sustainability to reduce impacts and underpin resilience.[334] UNWTO acknowledges that the COVID-19 crisis "has raised awareness of the importance of local supply chains and the need to rethink how goods and services are produced and consumed, both key elements of a circular economy. Integrating circularity and further advancing resource efficiency in the tourism value chain represent[s] an opportunity for the tourism sector to embrace a sustainable and resilient growth pathway".[335] Thus, for a circular economy transition in tourism, UNWTO recommends investing in transforming tourism value chains, integrating circular economy processes, prioritizing sustainable food approaches for circularity and shifting towards circularity of plastics in tourism. UNWTO concludes that there is growing consensus among tourism stakeholders that recovering from the pandemic must also involve tackling the underlying reasons and sustainability challenge. However, the time for a genuine transition is short, with many tourism-dependent countries and businesses desperate to reopen after various lockdowns, and consumers longing for holidays away from home. A return to business as usual is a risk, with implications for (additional) investments in sustainable or circular tourism development. In terms of energy use (and emissions), the faster recovery of domestic tourism that some countries have experienced is positive in terms of circular economy.

4. Indicators

Universally agreed circular economy indicators are still being developed. A simple and effective monitoring framework was called for in the first European Union circular economy action plan. In 2018, the European Commission presented a new set of measures, including a Monitoring Framework for the Circular Economy,[336] which was operationalized by

329 Jesper Manniche and others, *Destination: A Circular Tourism Economy. A Handbook for Transitioning Toward a Circular Economy within the Tourism and Hospitality Sectors in the South Baltic Region* (Nexoe, Denmark, Centre for Regional & Tourism Research, 2019).

330 Peeters and others, "Research for TRAN Committee - Overtourism".

331 Global Tourism Plastics Initiative, *Recommendations for the Tourism Sector to Continue Taking Action on Plastic Pollution During COVID-19 Recovery* (n.p., 2020).

332 European Commission, COM(2020) 98 final.

333 UNWTO, "2020: Worst Year in Tourism History with 1 Billion Fewer International Arrivals", 28 January 2021; UNWTO, *UNWTO World Tourism Barometer and Statistical Annex*, vol. 19, No. 6 November 2021.

334 Stefan Gössling, Daniel Scott and C. Michael Hall, "Pandemics, tourism and global change: a rapid assessment of COVID-19", *Journal of Sustainable Tourism*, vol. 29, No. 1, pp. 1–20; OECD, "Tourism policy responses to the coronavirus (COVID-19)", 2 June 2020; UNWTO, "From vision to action: One planet vision for a responsible recovery of the tourism sector", n.d.; A/RES/75/229; United Nations, *Policy Brief: COVID-19 and Transforming Tourism* (n.p. August 2020).

335 UNWTO, *Recommendations for the Transition to a Green Travel and Tourism Economy: Developed by UNWTO and the G20 Tourism Working Group on the Occasion of Italy's Presidency of the G20 in 2021* (Madrid, 2021).

336 European Commission, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on a Monitoring framework for the circular economy, COM(2018) 29 final.

Eurostat.[337] The framework consists of 10 indicators, some of which are broken down into subindicators, and aims to measure progress towards a circular economy in a way that encompasses its various dimensions at all stages of the life cycle of resources, products and services. Indicators cover four thematic areas: production and consumption; waste management; secondary raw materials; and competitiveness and innovation. The list is constructed to be short and focused. It uses available data while also earmarking areas where new indicators are in the process of being developed, particularly for green public procurement and food waste. The European Commission indicators are largely restricted to the circulation of materials and focused on waste, partly due to the availability and reliability of data and the lack of other options.[338] In its 2021 resolution, the European Parliament calls on the Commission to propose binding European Union targets for 2030, to be monitored with new indicators to be adopted by the end of 2021, as part of an updated Monitoring Framework for the Circular Economy. The European Commission relates these new indicators to the focus areas in its action plan, but it also desires interlinkages among circularity, climate neutrality and its zero-pollution ambition.

In previous decades, the impacts of tourism have been measured from an economic angle and it has become pressing to redefine how success is measured, which implies reinforcing the measurement of social and environmental dimensions – with circular economy indicators playing an important role for the latter. Therefore, in 2016, the UNWTO, with the support of the United Nations Statistics Division (UNSD), launched the initiative Towards a Statistical Framework for Measuring the Sustainability of Tourism (SF-MST). The aim of the SF-MST is to "develop an international statistical framework for measuring key aspects of tourism's role in sustainable development, including economic, environmental and social dimensions".[339] In the last reported development stage of the SF-MST, the four core main accounts identified were flows of water, energy, GHG emissions and solid waste.[340]

As the literature on circular economy in tourism is still in its infancy, there are very few direct references to indicators for measuring the circular economy in tourism other than the recommendation of UNWTO and UNEP, which asserts that "embracing circularity implies robust measurement and monitoring of the sustainable development impacts of economic activities".[341] Effective indicators need to be relevant to core issues and (statistical) data for evaluation need to be available and should be comparable over time and geographical, economic or political regions. Other sources recommend not making indicator (sets) too ambitious.[342] This may be politically and scientifically appealing but is not necessarily practicable. It is also recommended to avoid a "choice overload", suggesting that the focus be on a small set of meaningful key indicators to be prioritized through a participatory process to make them actionable and to allow follow-up. Indicators to monitor the circularity of tourism could be generated from policymaking related to the establishment of the pan-European Shared Environmental Information System (SEIS).[343] Digital platforms are widely seen as an opportunity to harmonize indicators, allowing for a comprehensive outlook that takes into account the economic, sociocultural and environmental aspects.

To propose relevant indicators for measuring and monitoring circular economy development in tourism in ECE member States, a starting point is to identify the key issues in the tourism value chain that are relevant in terms of their environmental impacts, contribution to the Sustainable Development Goals and potential for the application of circular principles. This is rather similar to the identification of "hotspots" as part of the Hotspot Analysis framework

337 Eurostat, "Monitoring Framework". Available at https://ec.europa.eu/eurostat/web/circular-economy/indicators/monitoring-framework.

338 Opinion of the European Economic and Social Committee on the 'Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on a monitoring framework for the circular economy', *Official Journal of the European Union*, C 367, vol. 61 (10 October 2018), pp. 97–102; Gustavo Moraga and others, "Circular economy indicators: what do they measure?", *Resources, Conservation and Recycling*, vol. 146 (July 2019), pp. 452–461.

339 UNWTO, Working Group of Experts on Measuring the Sustainability of Tourism. Terms of Reference (Madrid, 2016).

340 UNWTO, "Linking the TSA and the SEEA: A technical note" (Madrid, n.d.).

341 UNWTO and UNEP, *Baseline Report on the Integration of Sustainable Consumption and Production Patterns*, p. 66.

342 Elizabeth Agyeiwaah, Bob McKercher and Wantanee Suntikul, "Identifying core indicators of sustainable tourism: a path forward?" *Tourism Management Perspectives*, vol. 24 (October 2017), pp. 26–33.

343 ECE, *Sharing our Vision for the Pan-European Region: Setting Strategic Goals and Objectives for the Working Group on Environmental Monitoring and Assessment* (United Nations publication, ECE/CEP/187).

advocated in the UNEP Life Cycle Initiative.[344] UNEP considers an environmental impact to be a hotspot if it contributes to more than 50 per cent of total life cycle impact across all of the product or service life-cycle stages in any given impact category (e.g. GHG emissions, energy or water use, or waste), ensuring that most of the impact is considered.[345]

In the remainder of this section, a simplified approach is taken to arrive at provisional indicators at the national level, where the main elements of tourism are compared with the key environmental impact categories. Indicators could then follow from these hotspots, i.e. where the contribution of a certain element of the tourism value chain to an impact category is significantly larger or more relevant than that of other tourism elements. In "warm spots", this contribution is relevant but less pressing than in hot spots, and in "cold spots" it is not or hardly relevant. Through this analysis, based on the impact literature summarized in subsection 2 above on context, several hotspots are identified for accommodation operations, origin-to-destination transport, and events and activities (see table 35). Service providers do not make a direct impact but can serve as driving agents of impacts.

Several hot and warm spots in table 36 can be identified as priority areas in the tourism value chain with potential for integrating circular principles. These are the operations and building of accommodation facilities, as well as the operations of restaurants and bars, where circular potential can be found in all impact categories except for biodiversity. They range from renewable energy usage to water saving, circular building, using circular food chains, to upscaling reuse and recycling and, as a result of some of these steps, lowering emissions. Similar potential can be identified for various activities. In transport, the largest potential is in saving energy through lowering distances and energy efficiency, and switching to renewable energy sources, ultimately lowering emissions.

The final step is to define provisional indicators and measure their performance, to determine the current state of circularity in tourism. Where applicable, such indicators can overlap with indicators for the sustainable development of tourism. In the discussion on indicators in the following subsections, provisional indicators for monitoring circular economy in tourism are presented, including the origin of or a database for each indicator. Each indicator is discussed in terms of the state and trends in ECE member States, data comparability and data availability. Due to data limitations, sometimes only selected ECE member States from each subregion (European Union, Western Europe, Eastern Europe, South-Eastern Europe and Central Asia) are compared to show how circularity has developed over the past decade. A European Union bias could mostly be avoided, but not always, due to data unavailability.

Indicator development is hampered by various issues. There are currently no indicators across ECE member States that give explicit information on tourism's circular state and the establishment and agreement of a list of indicators for circularity of tourism should therefore be ensured. On several general circularity aspects, classification definitions differ between States. Despite recommended standards for tourism satellite accounting going back to 2008[346] and, for example, the International Recommendations for Tourism Statistics, data about tourism tend to be incomplete and difficult to compare. Data availability and quality also varies from country to country in the pan-European region. The most important data gaps are about transport modes, transport distances travelled and almost all domestic tourism flows in terms of trips, arrivals, nights, passenger-kilometres and transport modes used. Finally, detailed statistics needed for accurate circularity monitoring in tourism are largely absent. Digitization holds promise as an additional data source and for better and more uniform measurement and monitoring, but it depends on the availability of uniform, high-quality and relevant data on circular economy in tourism.

344 Mark Barthel and others, *Hotspots Analysis: An Overarching Methodological Framework and Guidance for Product and Sector Level Application* (UNEP, 2017).

345 Sandra Averos-Monnerey and Mark Barthel, presentation to UNEP, "How to map tourism value chains and identify key actions: Online training #1 – Sustainable Tourism Programme", 17 April 2019, available at https://www.oneplanetnetwork.org/sites/default/files/tourism_value_chain_mapping_methodology_-_april_2019__1.pdf.

346 UNWTO, "UN standards for measuring tourism" (n.d.).

Table 35 Validating and prioritizing tourism environmental impact hotspots

	Impact category					
Tourism element	Energy use	Water use	Material resource use and/or over-consumption	Waste	Climate change and/or GHG emissions	Biodiversity
Accommodation: Buildings	Warm	Warm	Warm	Warm	Warm	Warm
Accommodation: Operations	Hot	Hot	Hot	Hot	Hot	Cold
Restaurants and bars: Buildings	Warm	Warm	Cold	Warm	Cold	Cold
Restaurants and bars: Operations	Warm	Warm	Warm	Hot	Warm	Cold
Transport: Local	Warm	Cold	Cold	Cold	Warm	Warm
Transport: Origin to destination	Hot	Cold	Hot	Cold	Hot	Warm
Activities: Events, attractions and festivals	Warm	Warm	Hot	Hot	Cold	Warm
Services (tour operators, travel agencies, financial and booking services)	Driving agent					

Notes: Cold spot | Warm spot | Hotspot | Driving agent

Waste generation

Reducing waste is a focus in aiming for circularity, and tourism contributes significantly to local waste production. Tourism inflows significantly increase municipal solid waste generation (measured per resident) at first, up to a turning point where more arrivals contribute to lowering municipal waste per capita, due to a counterbalancing technological effect linked to changes in the characteristics of tourism firms that arise with an increase in tourism arrivals.[347] For achieving a circular tourism economy, special attention needs to be drawn to countries with high tourism activity and a high waste disposal rate. The examples of the Netherlands, Norway and Türkiye show that national municipal waste disposal (i.e. not composted, recycled or energy recovered) shares differ greatly from country to country. While the Netherlands disposes of 2.6 per cent of its total municipal waste, Norway disposes of 9.7 per cent and Türkiye 88.4 per cent. And whereas the Netherlands has cut its disposal rate in half since 2010, Norway has increased its disposal share, mainly due to an increasing amount of waste.

To determine the real impact of tourism on national waste production, more specific indicators must be measured by all countries. Multiplication of waste figures by tourism's share of national GDP[348] gives a rough indication of waste generated by tourism. It could be considered a coarse proxy for the ratio of tourists to residents and tourist expenditure, which have been identified as factors in municipal waste generation.[349] For more detailed statistics, UNWTO suggests the application of its Statistical Framework for Measuring the Sustainability of Tourism (SF-MST) and that the collection of information for tourism may require direct data supply from tourism industries, for example,

347 Italo Arbulú, Javier Lozano and Javier Rey-Maquieira, "Tourism and solid waste generation in Europe: A panel data assessment of the Environmental Kuznets Curve", *Waste Management*, vol. 46 (December 2015), pp. 628–636.

348 World Travel & Tourism Council (WTTC), "Economic impact reports", Country / Region Data 2020, available at wttc.org/Research/Economic-Impact/Data-Gateway.

349 Arbulú and others, "Tourism and solid waste generation in Europe".

estimating the volume of solid waste generated per visitor.[350] The European Tourism Indicator System (ETIS) suggests determining percentage waste recycled per tourist compared with total waste recycled per resident per year.[351]

Future policies may use tourism income to invest in recovery plants, including composting facilities where pilots already exist, or to introduce a maximum tourism capacity where necessary to manage the amount of waste. Furthermore, tourism businesses may be asked to actively reduce waste production by banning single-use and non-recyclable items and packaging and encouraging restaurants and hotels to donate food leftovers.

Water consumption

There is strong evidence that tourists use considerably more water at their destination than they do when at home and compared with local inhabitants.[352] Water consumption in tourism is closely linked to energy and food production, and best addressed in accommodation facilities, where much of the consumption in tourism takes place.[353]

To make water usage circular, the aim should be that all demand is covered by renewable water sources, including closed cycle usage. No fossil water sources (fossil groundwater or ice) should be used. As tourism concentrates in the warm and dry season, many (summer) tourism destinations suffer from water shortages. In destinations with concerns about the availability of water to support tourism activity, it will not be sufficient to record only the levels of water use by tourism activities.[354] Information on the stock of water and changes in this stock also need to be recorded.

The preliminary indicator proposed for water circularity in tourism is derived from the work of Gössling and others[355] and consists of two (national) subindicators: the share of water used for tourism; and the share of renewable water in overall supply (the stock). Figures in the pan-European region differ, with frequently high tourism water shares in Mediterranean countries, while shares of renewable water vary. The share of water extracted from renewable sources depends on water scarcity and therefore differs greatly among countries.

Using national figures can mask water scarcity at the regional and local scales.[356] Trends show an increasing demand for fresh water in destinations, which puts pressure on renewable resources, and water scarcity is becoming an increasing problem due to climate change. More comprehensive water management indicators are recommended for bridging the gap between current scientific opinion and industry practices, addressing the water situation in the specific area, the infrastructure planning process and operations.[357] These can be linked with circularity, such as renewable water resources per guest night (in peak season), area of solar thermal and photovoltaic panels installed per bed, and energy use per guest night.

Future policy responses may focus on demanding the use of water-saving technologies and a water management plan in dry regions that accounts for the allocation of water among tourism, agriculture and the local inhabitants. Furthermore, research has shown that informing tourists about their water consumption footprint and water shortage issues can have a positive impact on lowering water demand.[358] Examples already exist, for instance, the city of

350 UNWTO, "Measuring the sustainability of tourism: Statistical Framework for Measuring the Sustainability of Tourism" (n.d.).

351 European Union, *The European Tourism Indicator System: ETIS Toolkit for Sustainable Destination Management* (Luxembourg, Publications Office of the European Union, 2016).

352 Stefan Gössling and others, "Tourism and water use: supply, demand, and security – an international review", *Tourism Management*, vol. 33, No. 1 (2012), pp. 1–15.

353 Gössling, "New performance indicators for water management in tourism".

354 UNWTO, Statistical Framework for Measuring the Sustainability of Tourism. Consultation Draft. Draft prepared for discussion with the Working Group of Experts on Measuring the Sustainability of Tourism (October 2018).

355 Gössling and others, "Tourism and water use: supply, demand, and security".

356 Ibid.

357 Gössling, "New performance indicators for water management in tourism".

358 Lluís Garay, Xavier Font and August Corrons, "Sustainability-oriented innovation in tourism: an analysis based on the decomposed theory of planned behaviour", *Journal of Travel Research*, vol. 58, No. 4 (April 2018), pp. 622–636.

Valencia in Spain is measuring the water footprint from tourism. Advanced water generation methods may also become indispensable for tourism in the coming decades.

Energy use by accommodation and restaurants

Accommodation facilities and restaurants account for 21 per cent of tourism emissions and are tourism's main energy consumer at the destination, excluding transport.[359] Substantial differences in the energy consumption of tourists and residents can occur, notably depending on the level of luxury and accommodation facilities. On the other hand, the volume of emissions caused by energy use can be reduced by using renewable energy sources and energy-saving technologies.

The share of renewable energy in the total final energy consumption at the destination can function as an indicator for circularity in tourism's non-transport energy consumption. The ECE Dashboard for SDGs[360] includes data on renewable energy for each ECE member State. The ETIS suggests measuring the annual amount of energy consumed from renewable sources compared with overall energy consumption at the destination level per year to better define the energy consumption of tourism.[361]

One of the limitations of comparing destinations or countries is that the share of renewable energy in the energy mix differs greatly from one to another. For example, Iceland produces 81.1 per cent of its energy from renewable sources, while Turkmenistan uses 99.9 per cent non-renewable sources.[362] The ECE member State average is 21.5 per cent renewable energy in the energy mix. Historic development of energy supply determines the status quo. Between 2000 and 2017, both positive and negative trends, depending on the country, in the usage of renewable energy can be observed.

Future policies should focus on pushing the transition towards renewable energy, including in remote tourism destinations, and demand or incentivize the implementation of energy-saving technologies in new facilities and during renovation.

Energy use and contribution to climate change by tourism transport

Tourism transport depends almost completely on fossil fuels and is the main source of tourism's CO_2 emissions, with aeroplanes also having a considerable non-CO_2 impact and "radiative forcing", or heating effect caused by GHGs in the atmosphere, on climate change. Transport between a tourist's home and destination produces the bulk of the travel distance and thus of the energy use and emissions. To define circularity measures for this hotspot, it is important to know how tourists arrive at and depart from their destinations: by aircraft, car, cruise ship or a more sustainable mode of transport such as bicycle, bus or train. The more tourists use these more sustainable modes and travel shorter distances, the more energy can be saved and emissions prevented. The opportunities to decarbonize transport using renewable energy are also much greater for other modes than for aircraft. The choice of travel mode is related to the availability of transport modes and the psychological default of transport modes for citizens of a country.

As there are no suitable indicators for tourism transport's energy use regularly produced, it is proposed to look at the proportion of trips that are domestic and the proportion of international trips that are made by air. An increasing number of countries voluntarily participate in the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA).

With some reservations for large countries, domestic tourism trips are expected to create lower emissions than outbound travel, due to shorter distances and a transport mix that should contain less air travel. In 2019, 73.3 per

359 UNWTO and UNEP, *Climate Change and Tourism: Responding to Global Challenges*.

360 Available at https://w3.unece.org/SDG/en.

361 European Union, *The European Tourism Indicator System*.

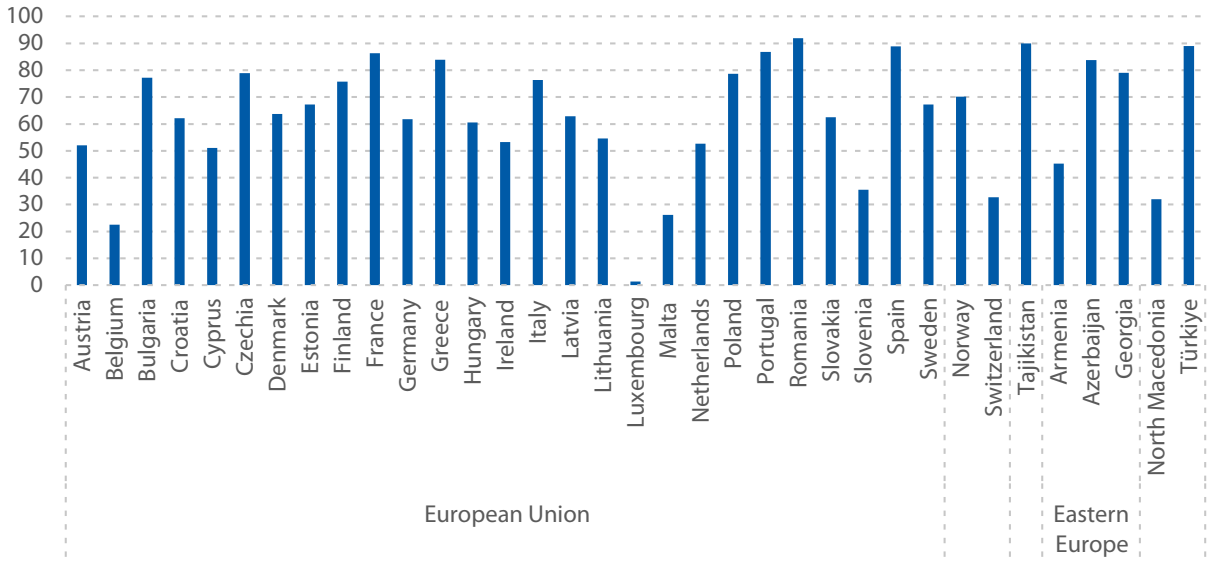
362 ECE, "Indicator 7.2.1: Renewable energy share in the total final energy consumption, %". Available at https://w3.unece.org/SDG/en/Indicator?id=23 (accessed on 17 June 2022).

cent of trips taken in the ECE member States shown in figure 50 were domestic,[363] with the proportion strongly correlated with country area.[364] Between 2012 and 2019, 0.4 per cent more domestic trips than outbound travel were taken in European Union countries.[365]

In 2019, 48.6 per cent of inbound tourism in the ECE member States shown in figure 51 involved arrival by air. In 2019, 49.3 per cent of outbound tourism trips from the European Union (minus Sweden but including Switzerland) were by air, up from 46.1 per cent in 2012. Between 2012 and 2019, outbound travel by air increased in these countries by 34.8 per cent (see figure 52), which represents 61.5 per cent of the total increase in outbound travel.

Future policies should invest in infrastructure for low-emission transport modes such as rail, instead of aviation, in most cases, and increase marketing for domestic tourism. Furthermore, the concept of climate-aware tourism should be promoted as it aims to redirect investments in international promotional efforts to lower carbon experiences (e.g. longer stays).

Figure 50 Proportion of overnight trips that are domestic, selected countries by subregion, 2019 (Percentage)



Source: UNWTO Tourism Statistics Database, available at https://www.unwto.org/tourism-statistics-database; and Eurostat statistical database, available at https://ec.europa.eu/eurostat/web/tourism/data/database.

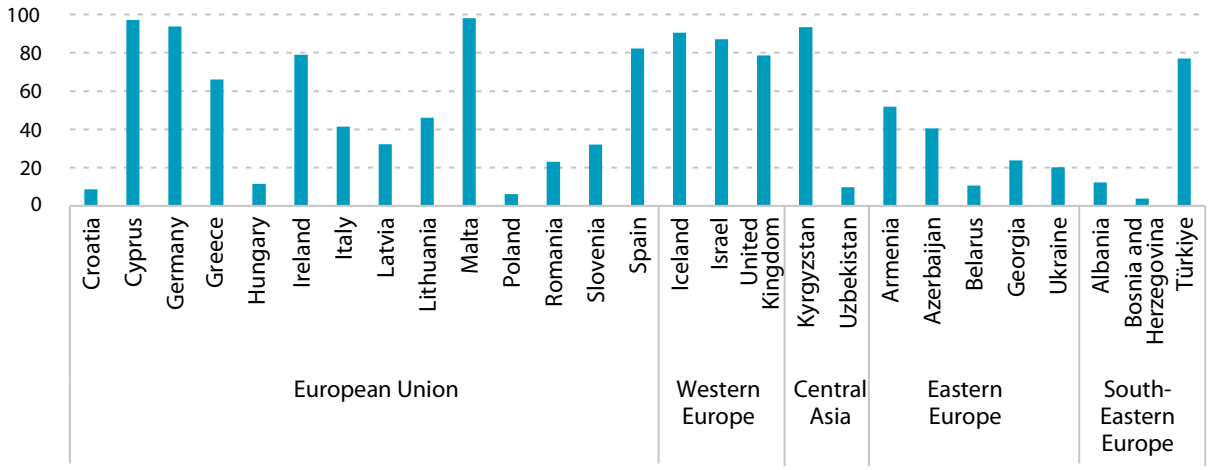
Notes: Norway and Tajikistan, data for 2018.

363 Eurostat, "Number of trips by mode of transport", 21 April 2021. Available at https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=tour_dem_tttr&lang=en (accessed on 28 August 2021); UNWTO, Compendium of Tourism Statistics data set [Electronic], Series 2.9: Domestic tourism - Total trips by mode of transport – Thousands, and Series 3.2: Outbound tourism - Departures of overnight visitors (tourists) - Thousands (2021) (accessed on 28 August 2021).

364 Area from ECE Statistical Database, 2020.

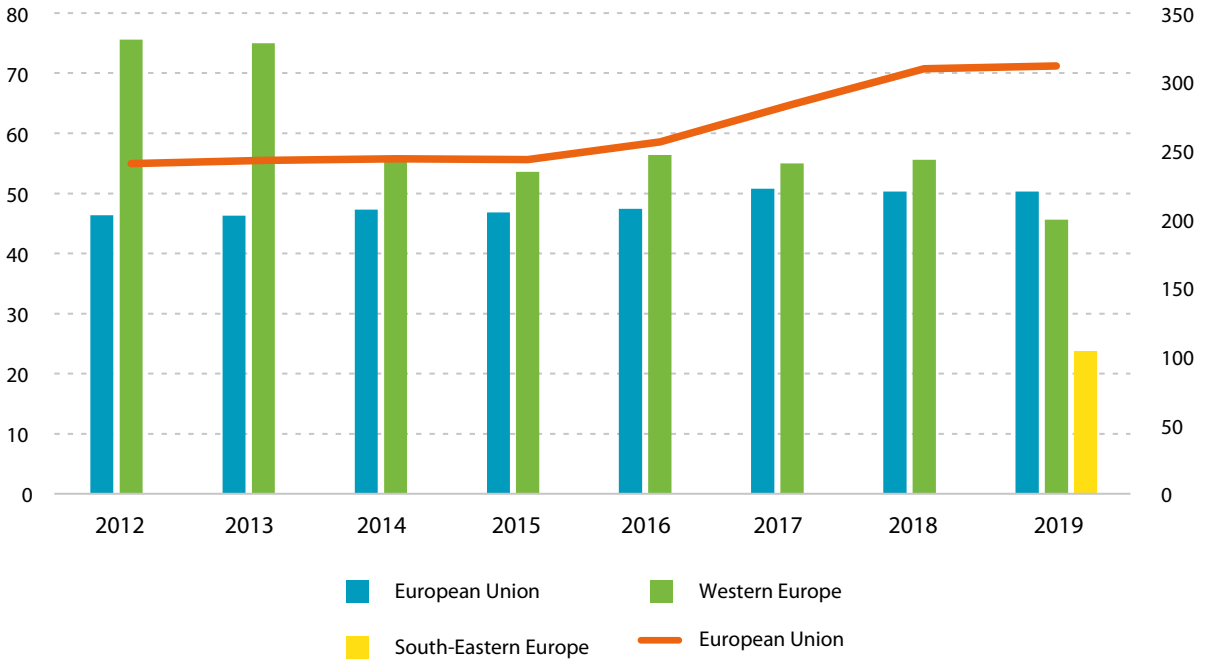
365 No data for Sweden.

Figure 51 Proportion of inbound arrivals by air, selected countries by subregion, 2019 (Percentage)



Source: UNWTO Tourism Statistics Database, available at https://www.unwto.org/tourism-statistics-database.

Figure 52 Proportion of overnight outbound trips by air and total number of flights, 2012–2019
(Percentage (left axis) and Millions of flights (right axis))



Source: Eurostat statistical database, available at https://ec.europa.eu/eurostat/web/tourism/data/database.

Notes: No data for Sweden in 2012–2013 (for number of flights, the value for 2014 is used); for Western Europe, data only for Norway (2013–2018), Switzerland (2012–2019) and the United Kingdom (2012–2013); for South-Eastern Europe, data only for North Macedonia (2019). The step change in the proportion of outbound trips by air from 2013 to 2014 in Western Europe is explained by the lack of data for the United Kingdom after 2013.

Material resources use for tourism facilities

Resource use in the construction and maintenance of tourism facilities (e.g. accommodation) is high and can well be addressed with a circular economy approach. These aspects are as yet unmeasured, so this section cannot report on their state.

To increase circularity within tourism facilities, suggestions include using the share of circular building material flows, remanufacturing furniture, leasing contracts for high-end appliances and using easy-to-repair materials and interiors,[366] but these will be a challenge to use as indicators. There are some cases where circularity in construction has been used for marketing purposes.

Future policies should support the use of recycled resources and circular building material flows and make it mandatory to offer repairs for appliances.

National tourism management policies and plans

Sustainable tourism development plans are crucial and can connect destination strategies to national sustainability goals and push tourism circularity beyond simply reducing impacts.[367] Also, some international processes – for instance, as defined by the ECE Protocol on Strategic Environmental Assessment[368] – will help to reduce impacts and thus to reduce the challenge to reach circularity. To measure tourism sustainability and circularity, the integration of sustainable development and circular economy policies in national tourism policy plans can be assessed. In their report on sustainable consumption and production patterns, UNWTO and UNEP review 73 national tourism policies and present the extent of reporting on sustainable consumption and production.[369] The report shows that biodiversity and sustainable land use have entered tourism sustainability reports in countries across the world. However, policies on water efficiency are lacking and circularity was only mentioned once. Other weaknesses identified in the study concern the integration of energy efficiency, emissions and waste management. A similar pattern has been observed regarding sustainability. Only about 55 per cent of national policies provide specifications on how sustainability is to be addressed in practice.[370]

To achieve circular practices at destinations, future policies should favour funding destination management organizations that base their tourism development plans not only on sustainable development principles but also on circular frameworks and opportunities to learn about circular tourism. In addition, policymakers should identify barriers to circular tourism development and provide the policy framework necessary to overcome those challenges and ensure interministerial collaboration, in particular between tourism and environmental authorities but also with others, including transport and energy authorities.

5. Case studies

E-fuels for aviation

International aviation has been identified as one of the sectors difficult to align with climate targets,[371] despite European Union aviation being part of the European Union Emissions Trading System. E-fuels are based on the well-developed power-to-liquids process: producing jet fuel (Jet A) from CO_2, water and a substantial amount of renewable energy.[372] The CO_2 source could be a large industry, but is ultimately also from direct air capture. In the

366 Manniche and others, *Destination: A Circular Tourism Economy*.

367 Ibid.

368 See https://unece.org/text-protocol.

369 UNWTO and UNEP, *Baseline Report on the Integration of Sustainable Consumption and Production Patterns*.

370 Manniche and others, *Destination: A Circular Tourism Economy*.

371 ETC, *Mission Possible: Reaching Net-zero Carbon Emissions from Harder-to-abate Sectors*.

372 Schmidt and others, "Power-to-liquids as renewable fuel option for aviation".

latter case, one would completely close the carbon cycle (hence the term "circular kerosene" is sometimes used). E-fuels need 80 per cent less land than other sustainable aviation fuels, and very little water, and do not compromise feedstocks, nature and agriculture. The development of e-fuels for (international) aviation is a perfect transnational case for circular development related to tourism, which also directly contributes to international targets for mitigating climate change, in line with Sustainable Development Goal 13 (Climate Action).

Various projects are under development. In the Netherlands, the start-up Synkero, in collaboration with the Port of Amsterdam, Schiphol Airport, KLM and SkyNRG,[373] aims to develop a commercial plant in the Port of Amsterdam, using waste CO_2 and green hydrogen.[374] SkyNRG is also building a factory for e-fuels in Delfzijl (Netherlands), with KLM, Schiphol Airport and SHV Energy.[375] The Zenid initiative, with Uniper, Rotterdam The Hague Airport, Climeworks, SkyNRG and Rotterdam The Hague Innovation Airport, aims to construct a demonstration factory for sustainable kerosene using captured CO_2 from the air as a raw material in Rotterdam.[376] The Norwegian consortium Norsk e-Fuel is planning a commercial plant for hydrogen-based renewable aviation fuel.[377] In February 2021, KLM announced having carried out a passenger flight partly on sustainably produced synthetic kerosene, based on CO_2, water and renewable energy from solar and wind energy.[378]

The production process does require a very high amount of energy, however, which could further increase the mismatch between the demand for and failing increase in renewable electricity supply, and these fuels will be two to six times more expensive than Jet A was in 2017. E-fuels cannot enter the market without a very substantial tax on fossil kerosene and/or subsidies, or through the application of a mixing mandate with an increasing share over time, up to 100 per cent in 2050.[379] A mandate would be the most direct and secure way to reach the goal of zero aviation emissions in 2050, with the costs falling on airlines and thus passengers ("polluter pays" principle). Mixing mandates are already included in national-level aviation policies in Germany, the Netherlands, Norway and Sweden. The European Union announced its "Fit for 55" package of regulatory proposals on 14 July 2021, a part of which is a blending mandate for sustainable aviation fuel.[380]

Circular hotels and restaurants

2018 saw the launch of The Circular Hotels Leaders Group in the Netherlands. A group of hotels, currently 12, located mainly in Amsterdam, have already taken many steps along the path to sustainability or are on the verge of doing so. The group explores opportunities for circular business operations and has shown that cooperation, beyond knowledge, can lead to new circular opportunities. These include, among others, joint purchasing and bundling of waste streams for useful applications. Hotel Jakarta is one of the better-known examples (see box 1).

In 2019, Circular Restaurants Leaders Groups started in the Netherlands cities of Haarlem and Rotterdam, as a follow-up to the Circular Hotels Leaders Group. Each of the groups in Haarlem and Rotterdam consists of around 20 restaurants, which also explore circular solutions. The prevention of food waste is an important objective, but it is not the only focus. The project also focuses on circular procurement (from sustainably produced, local ingredients to

373 The mention of commercial companies, services or products does not imply endorsement by the United Nations or its Member States.

374 Synkero, "Synkero: Futureproof aviation" (n.d.).

375 SkyNRG, "SkyNRG, KLM and SHV Energy announce project first European plant for sustainable aviation fuel", 27 May 2019.

376 SkyNRG, "Consortium launches Zenid – sustainable aviation fuel from air", 8 February 2021.

377 Norsk e-fuel, "Accelerating the transition to renewable aviation" (n.d.), see www.norsk-e-fuel.com/en/ (accessed 20 June 2022)

378 KLM, "World first in the Netherlands by KLM, Shell and Dutch Ministry for Infrastructure and Water Management: first passenger flight performed with sustainable synthetic kerosene", 8 February 2021.

379 Jörgen Larsson and others, "International and national climate policies for aviation: a review", *Climate Policy*, vol. 19, No. 6 (January 2019), pp. 787–799.

380 European Commission, Proposal for a Regulation of the European Parliament and of the Council on ensuring a level playing field for sustainable air transport, COM(2021) 561 final.

circular clothing and alternatives for plastic straws), packaging, the menu, kitchen management, waste management and communication with guests.[381]

In Spain, the Impulsa Balears Foundation, in line with the recommendations of One Planet Vision for a Responsible Recovery of the Tourism Sector,[382] has built its own strategic circularity framework for the hotel sector. It is aimed at enabling good practices to be established and monitored among those within the sector, encouraging the creation of circular connections along its value chain and, in this way, contributing to closing the gap in implementing the global principles relating to sustainability and tourism at a local level. The framework also proposes a metric that allows hotel companies to track their circular progress, using 81 key performance indicators that are directly linked to 125 lines of action to inspire the implementation of good circular practices.[383]

Box 1 Selected sustainability and circularity measures, Hotel Jakarta, Amsterdam

1. **Construction**
   - Building Research Establishment Environmental Assessment Method (BREEAM) "excellent" score. BREEAM is the certification method for a sustainable built environment.
2. **Energy Consumption**
   - 1700 m^2 of solar panels have been installed on the roof and on the sunny side of the building.
   - Interior garden to cool down the entire interior by 5°C, so air conditioning is rarely needed.
   - Water from the surrounding Ij River used to cool down the building through its floors.
   - Ground heat pump sources natural heat to warm the hotel's water.
3. **Water Usage**
   - Water irrigation system that uses rainwater and greywater to water the garden and plants.
   - Water-saving showerheads and taps to reduce guests' consumption.
   - All plastic water bottles (apart from in minibars) replaced with water filtration machines that purify tap water.
4. **Food Sourcing and Disposal**
   - The hotel's restaurant and bakery mainly use local ingredients. Food waste is recycled in a press, generating dense blocks that are used as compost.
5. **Single-use Plastics**
   - Strict attitude against single-use plastics, and no plastic bottles sold.
   - Refill bathroom toiletries instead of throwaway travel versions.

Source: Hotel Jakarta (2021); Pantaleoni (2019).[384]

Circular destination

Since 2008, the Danish island of Bornholm has sought to become sustainable and carbon neutral. Inspired by the Sustainable Development Goals, the municipality defined eight development goals (see box 2). Without specifically mentioning circular goals, the wide scope, systematic approach and carbon-neutrality goals of this destination development strategy come close to showing what a circular tourism destination could be. The strategy was developed by the municipality, the tourism marketing organization and various local actors, leading to a successful

381 CREM, "Circular Restaurants Leaders Group Haarlem and Rotterdam", 16 July 2020.

382 UNWTO, "From vision to action: One planet vision for a responsible recovery of the tourism sector".

383 UNWTO, "Circularity in the hotel industry and competitiveness: a manual for implementing good practices", 4 April 2020.

384 Hotel Jakarta, "Sustainably built", available at www.hoteljakarta.com/sustainably-built/; Maxime Pantaleoni, "Hotel Jakarta Amsterdam: Where circular economy meets hospitality", 6 August 2019.

transition over the past 13 years. The case study shows how long-term strategies co-developed by key stakeholders can have great impact and support transitioning to circular economy.

Box 2 Bornholm goals for sustainable and carbon-neutral development

1. **Business: Make sustainability good business.**
2. **Fact-based sustainability: Document and keep track of the green transition.**
3. **Carbon neutrality (2025 in energy production, 2032 all waste treated as resources, 2035 zero-emission society).**
4. **Mobility: Make land-based transportation green.**
5. **Housing: Make sustainable housing part of our cultural identity.**
6. **Food products: Be a pioneer within Danish sustainable food.**
7. **Nature: Make the protection of natural resources vital to everyone's bottom line.**
8. **Inclusion: Ensure that everyone on Bornholm is part of the Bright Green Island.**

Source: Christensen and others (2021).[385]

385 Christensen, D., Hjul-Nielsen, J., Moalem, R. M., and Johansen, B., "Circular economy in Denmark: Borholm's vision to achieve 100 per cent reuse and recycling", in *Circular Economy: Recent Trends in Global Perspective* (S. K. Ghosh and S. K. Ghosh, eds.), pp. 385–424 (Springer, 2021).

V.

STRENGTHENING ENVIRONMENTAL GOVERNANCE

A. Introduction

"Today's multilateral system is too limited in its instruments and capacities, in relation to what is needed for effective governance of managing global public goods." –

Secretary-General of the United Nations, address to the General Assembly, 21 September 2021.

Environmental governance relates to decision-making on the environment and natural resources and the interactions that take place among different actors, whether the State, private sector or civil society and at different levels, which, for the purposes of this assessment, are limited to regional, subregional and national levels. Fundamental principles of environmental governance include participation, the rule of law, transparency, responsiveness, consensus, equity and inclusiveness, effectiveness, efficiency and accountability. The main interest here is in decisions, often commonly agreed, that further environmentally sustainable development.

Given that the Ninth Environment for Europe Ministerial Conference is being held in conjunction with a meeting of Ministers of Environment and Education, and the importance of education for participative and informed decision-making, this chapter also addresses education for sustainable development (ESD).

Considering the importance also of adhering to human rights for good governance, this report also addresses human rights. Rights can be considered in terms of substantive rights, including the right to a clean, healthy and sustainable environment,[386] and procedural rights, such as those provided by the ECE Aarhus Convention and its Protocol on Pollutant Release and Transfer Registers (PRTRs), and the Espoo Convention and its Protocol on Strategic Environmental Assessment.

The 2030 Agenda for Sustainable Development can also be viewed as a good governance framework, as realization of the 17 Sustainable Development Goals is dependent on good governance. However, unravelling the 2030 Agenda to reveal indicators of good environmental governance is more difficult and incomplete. Not only do the indicators address environmental governance in a limited way but there is also a severe lack of data for those indicators that are relevant.

Commitments to advancing gender equality and women's empowerment are a key part of the 2030 Agenda and the Sustainable Development Goals, the universal adoption of which demonstrates the global recognition of the importance of gender equality and women's empowerment for the realization of sustainable development.[387] Therefore, effective environmental governance must also take into consideration and analyse the effects of environmental policies and programmes through a gender perspective.

B. Intergovernmental bodies

1. Regional and subregional bodies

The highest level regional meeting on environment is the Environment for Europe Ministerial Conference, prepared by the ECE Committee on Environmental Policy; the Conference outcomes provide substantive regional input to the United Nations Environment Assembly.

Numerous other international bodies support environmental governance at a subregional level, including:

(a) The GREEN Action Programme Task Force, established under the Environment for Europe ministerial process and serviced by OECD, with its focus supporting countries in Eastern Europe, the Caucasus and Central Asia to reconcile their environmental and economic goals;

386 Recognized by the Human Rights Council on 8 October 2021 through its resolution 48/13.

387 United Nations Sustainable Development Group, "UNCT Gender Equality Marker Guidance Note", June 2019.

(b) The Executive Committee of the International Fund for saving the Aral Sea, which promotes cooperation between the Central Asian Governments in the field of water resources and environmental management. Its subsidiary bodies include the Interstate Commission on Sustainable Development;

(c) Bodies of the European Union, including the European Environment Agency (EEA), whose task is to provide sound, independent information on the environment through its European Environment Information and Observation Network (Eionet), which brings together member countries (European Union members, plus Iceland, Liechtenstein, Norway, Switzerland and Türkiye) and cooperating (West Balkan) countries.

With the dissolution of the Regional Environmental Centre for Central and Eastern Europe, only two (sub-)regional centres remain: that for the Caucasus and that for Central Asia.

2. Treaty bodies

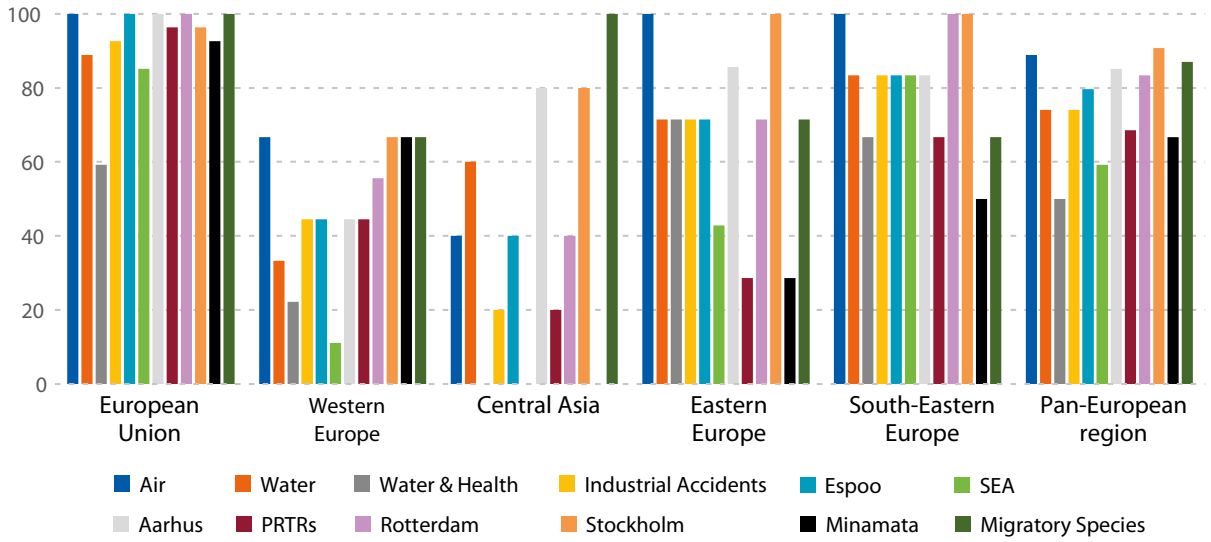
The region's multilateral environmental agreements (MEAs) also provide a forum for environmental governance through their treaty bodies, including governing bodies, working groups and implementation or compliance bodies. These agreements include the ECE environmental treaties, as well as, for example, the Barcelona Convention, the Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas, the Framework Convention on the Protection and Sustainable Development of the Carpathians and, aiming at the protection and sustainable development of the Alps, the Alpine Convention.

Though the number of parties exceeds the level of 50 per cent noted in the regional GEO-6 report, being a contracting party to these agreements (see figure 53) and attendance at meetings of their governing bodies is not sufficient to ensure improved environmental governance. However, the effectiveness of such agreements can be measured through their implementation and compliance mechanisms and by assessments of the achievement of their aims, and with the help of regular reporting under the agreements. For example, one of the obligations of the parties to the Water Convention is to enter into agreements on transboundary water cooperation. This obligation corresponds to Sustainable Development Goal indicator 6.5.2 "Proportion of transboundary basin area with an operational arrangement for water cooperation" (see figure 54, in which improvements reflect better reporting rather than new agreements).

For the Espoo Convention and its Protocol on Strategic Environmental Assessment, the number of occasions on which their environmental assessment procedures are applied to projects, plans and programmes provides a good measure of their effectiveness and of improved governance, but many parties to these agreements lack centralized databases and there is no legal obligation to report on their practical application. Another measure of effectiveness of the Espoo Convention can be determined based on the work of the Convention's Implementation Committee following a reporting exercise for the period 2015–2018. On the basis of the reports, 25 of the 45 parties to the Convention were asked to provide clarifications, all of which were deemed satisfactory, while two of the 33 parties to the Protocol were also contacted, with the Committee finding that the legislation of one party was not compliant with the treaty.

In the case of the Air Convention, one of the basic obligations is to report national emissions inventories. Emission inventories reported by parties to the Convention in 2019 demonstrate, in more than 90 per cent of cases, a reduction in air pollutant emissions in the region. Regular reporting by countries of their emissions inventories enables the assessment of emissions reduction trends and emission control strategies in support of informed policymaking and decision-making. In that regard, the 2016 Scientific Assessment Report of ECE detailed how reductions in particulate matter (PM) concentrations at European measurement sites and in the United States had declined by approximately one third between 2000 and 2012 and by 4 per cent in Canada, leading to an estimated 600,000 premature deaths prevented annually. The Protocol on Pollutant Release and Transfer Registers requires parties to establish and maintain a publicly accessible national PRTR.

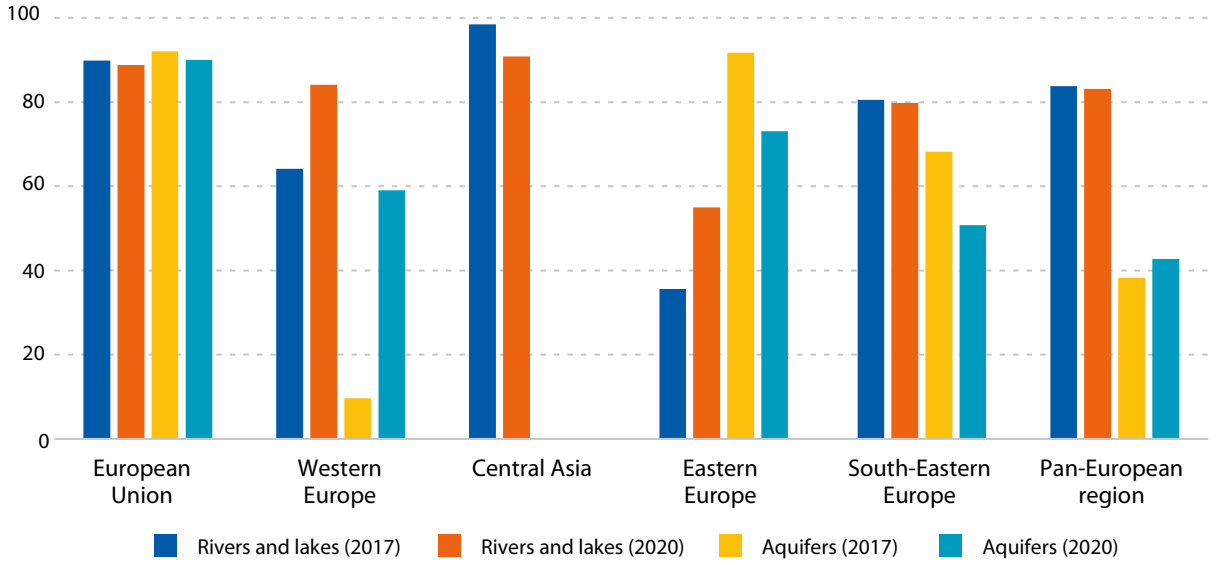
Figure 53 Membership of selected regional and global multilateral environmental agreements, countries in each subregion that are parties (Percentage)



Source: United Nations Treaty Collection and websites of treaties.

Notes: Air = Convention on Long-range Transboundary Air Pollution; Water = Water Convention; Water & Health = Protocol on Water and Health; Industrial Accidents = Convention on the Transboundary Effects of Industrial Accidents; Espoo = Convention on Environmental Impact Assessment in a Transboundary Context; SEA = Protocol on Strategic Environmental Assessment; Aarhus = Aarhus Convention; PRTRs = Protocol on PRTRs; Rotterdam = Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade; Stockholm = Stockholm Convention on Persistent Organic Pollutants; Minamata = Minamata Convention on Mercury; Migratory Species = Convention on the Conservation of Migratory Species of Wild Animals.

Figure 54 Proportion of transboundary basin area with an operational arrangement for water cooperation, for rivers and lakes and for aquifers, 2017 and 2020 (Percentage)

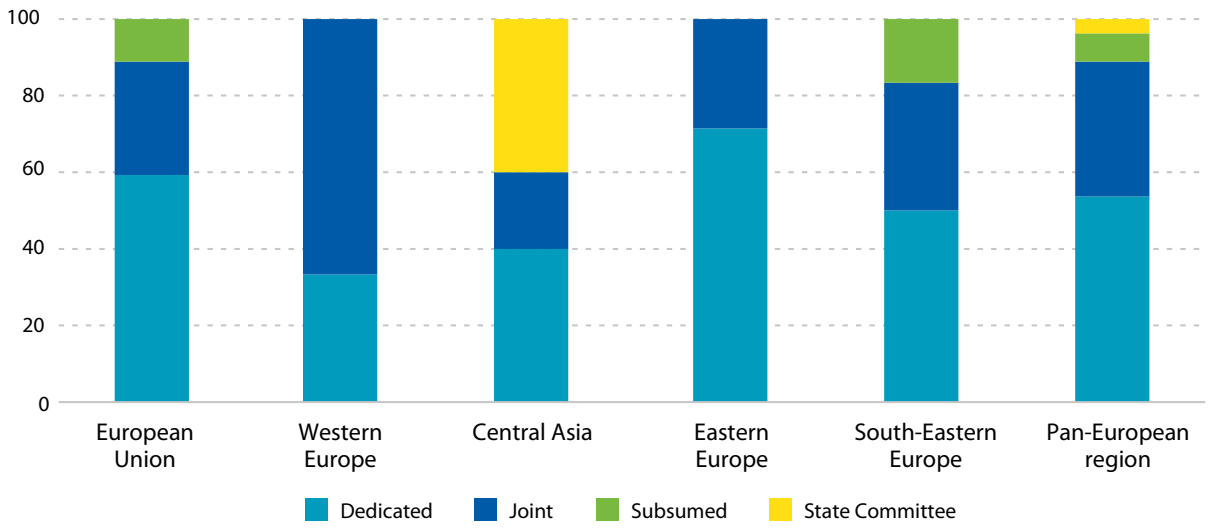


Source: United Nations, "Global SDG Indicators Data Platform". National values weighted by area in a transboundary basin, whether surface or groundwater, to generate subregional values. No data for Israel, the Russian Federation, Tajikistan and Türkiye; in the case of aquifers, no data for Finland, France, Portugal, Spain and Turkmenistan, among others. No reported arrangements for aquifers in Central Asia.

C. National institutions and legislation

At the national level, the weight given to the national environmental policy authority reflects the political priority given to environmental protection (the smaller States in Western Europe often have ministries leading on multiple portfolios, including the environment, because of the low number of ministers) – see figure 55. One measure of national legislation for environmental governance is the existence of national environmental impact assessment (EIA) and strategic environmental assessment (SEA) laws (see figure 56).

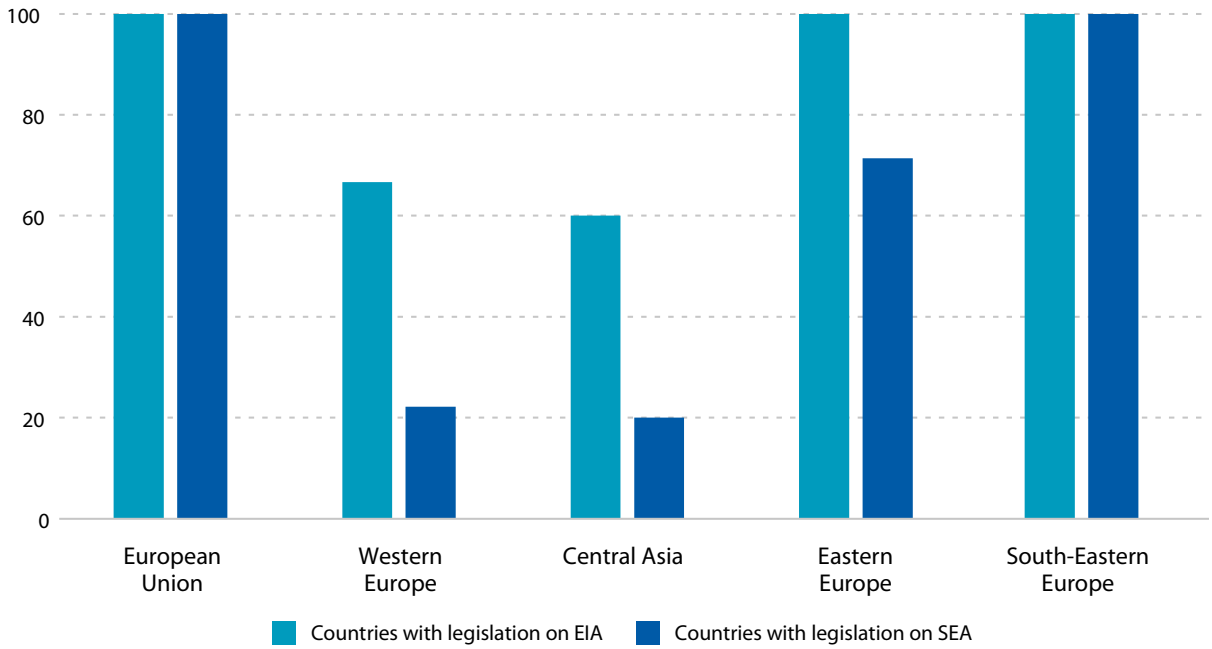
Figure 55 Status of the main national environmental policy authority in each country (Percentage)



Source: ECE and national websites (accessed on 1 June 2022).

Notes: "Dedicated" ministry, including if with climate change, water, forests, (spatial) planning, natural resources or sustainable development; "Joint" ministry if with at least one economic sector; "Subsumed" ministry if no mention of the environment in the ministry's name; a State Committee is a body subordinate to the Cabinet of Ministers.

Figure 56 Countries with national legislation on environmental impact assessment and strategic environmental assessment in place, by subregion (Percentage)



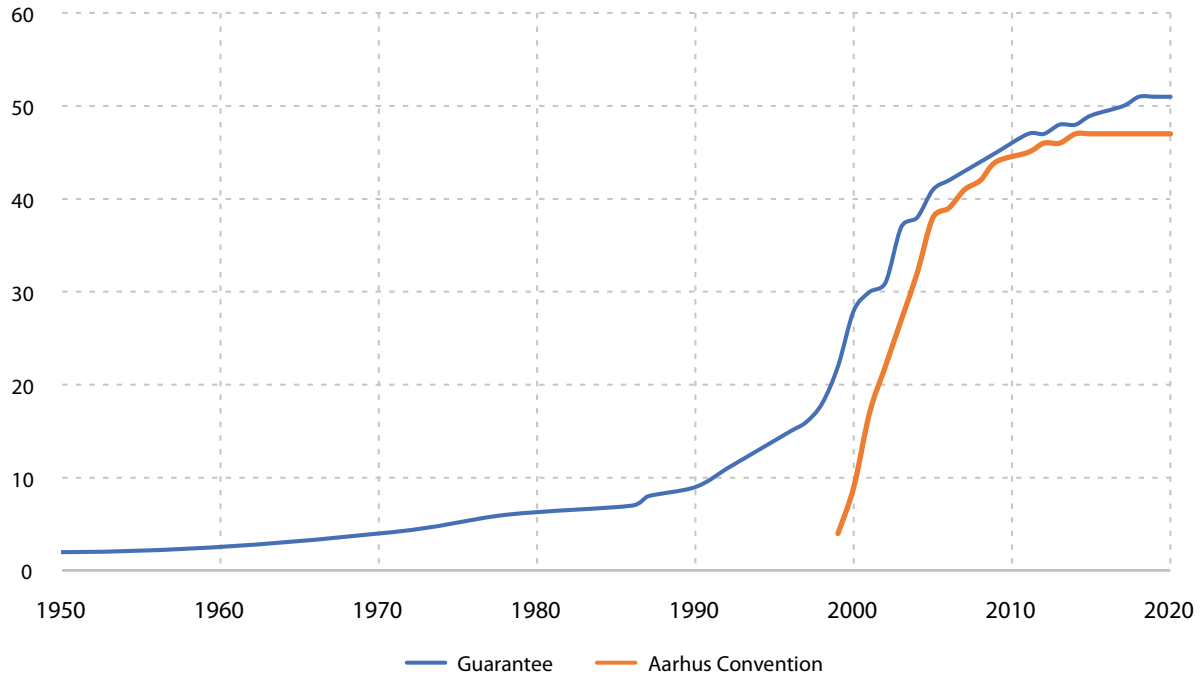
Note: This figure gives information on available legislation but does not reflect full compliance with the Espoo Convention and its Protocol on Strategic Environmental Assessment, nor its effective application. Data gaps for some countries.

D. Civil society

The role of civil society in environmental governance is generally framed by three topics: public participation in decision-making, access to information and access to justice in environmental matters.

These are the three pillars of the Aarhus Convention and the general Sustainable Development Goal indicator on access to information (16.10.2, Number of countries that adopt and implement constitutional, statutory and/or policy guarantees for public access to information) and is closely tracked by the number of parties to that Convention (see figure 57).

Figure 57 Cumulative number of countries in the pan-European region that adopt and implement constitutional, statutory and/or policy guarantees for public access to information (Sustainable Development Goal indicator 16.10.2) and number of parties to the Aarhus Convention (to date)



Note: Sweden adopted such a guarantee in 1766. The Aarhus Convention was adopted in 1999.

Sustainable Development Goal indicator 16.7.2 (Proportion of population who believe decision-making is inclusive and responsive, by sex, age, disability and population group) could provide a similar picture for the pillar on public participation in decision-making, but data are severely lacking at present.

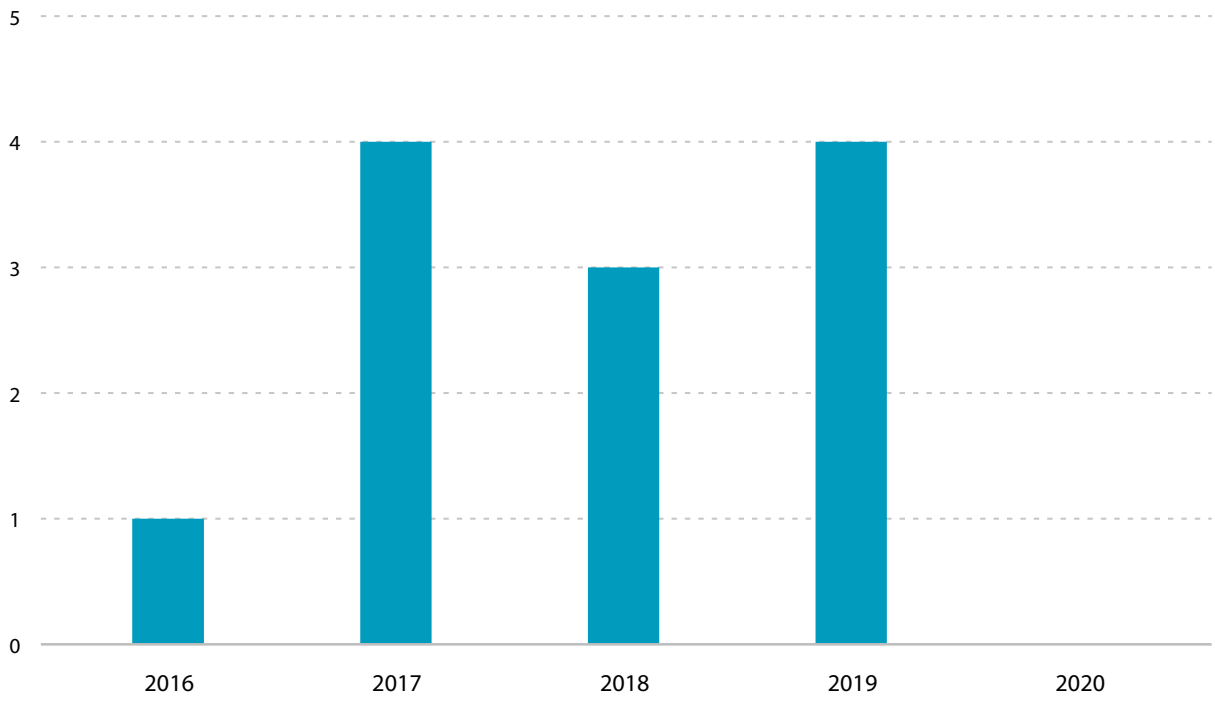
Access to justice is even more difficult to track. Countries should continue developing specific arrangements to collect, coordinate, aggregate and process information from various statistics providers, which is needed for monitoring access to justice in environmental matters by members of the public. Countries should also include in their national monitoring frameworks indicators for Sustainable Development Goal target 16.3 (Promote the rule of law at the national and international levels and ensure equal access to justice for all), with disaggregated data related to environmental cases. The number of environmental courts or courts with environmental units, or the number of environmental lawyers, per capita might provide useful measures of access to justice in environmental matters.

To track progress in the implementation of Sustainable Development target 16.10 (Ensure public access to information and protect fundamental freedoms, in accordance with national legislation and international agreements), the number of environmental defenders killed, harassed or persecuted (while defending human rights, their land and the environment) might be used, but the tally is mercifully low in the pan-European region (see figure 58).

The Espoo Convention and its Protocol on Strategic Environmental Assessment promote access to information through the mandatory notification of the public on projects, plans and programmes that are likely to significantly affect the environment and provide for public participation and due consideration of comments from members of the public in the related decision-making and planning processes.

The latest Synthesis report on the status of implementation of the Aarhus Convention (ECE/MP.PP/2021/6), prepared further to the sixth reporting cycle (2017–2020) under the Convention, demonstrated that, overall, most aspects of access to information and public participation have been regulated. At the same time, challenges remain in implementing certain provisions regarding access to justice and public participation. General obstacles hampering the full and effective implementation often include lack of awareness among the public authorities, financial constraints and lack of human resources and technical facilities, or the low quality of those resources, in conjunction with lack of coordination among different environmental bodies, government bodies, NGOs and the public. Some countries reported considerable legislative changes to transpose the provisions of the Convention into national legislation. Implementation, however, continues to vary across countries, depending on countries' legal traditions, governing structures and socioeconomic conditions, among other matters.

Figure 58 Number of environmental defenders killed each year in the pan-European region when defending human rights, their land and the environment, 2016–2020



Source: Global Witness, Annual reports, 2017–2021.

Note: No reported deaths in 2020.

With respect to access to information, only a few countries have updated and changed their national legislation, as most parties already adequately address the provisions of the Aarhus Convention in this area. However, some obstacles remain with respect to access to information, including difficulties in distinguishing between environmental and non-environmental information and applying the appropriate procedure for handling requests from the public. Ensuring the public's right to environmental information and, at the same time, considering rights related to commercial and industrial secrets, confidentiality of statistical information and personal data, intellectual property and copyright continue to present a challenge in many countries. Many parties to the Aarhus Convention noted delays and missed deadlines in the provision of requested information, including due to the COVID-19 pandemic. Some parties continue to note challenges related to review procedures of "fictitious decisions" on access to information requests. Some parties reported obstacles, such as a lack of interoperability of databases and incomplete and fragmented data, that lead to providing incomplete information. On a positive note, parties across the region reported significant progress in ensuring that environmental information is available in electronic databases that are easily accessible to the public through public telecommunication networks. This highlights the important contribution of the SEIS to environmental good governance. Numerous effective electronic tools are being further developed in this area, for example, electronic databases, publicly accessible governmental electronic services, websites and information portals, which are routinely updated and improved. Despite the progress reported in this area, additional steps are needed in this regard in countries in the Eastern Europe and Central Asia and South-Eastern Europe subregions, to enable them to establish and operate more efficient information systems and online environmental monitoring systems. This is particularly the case when it comes to pollution and emissions registers.

The parties and a few non-parties[388] to the Protocol on Strategic Environmental Assessment reported that, in the period 2016–2018, virtually all ensured the "timely public availability" of a draft plan or programme and the environmental report, and that they did so through both public notices and electronic media. Some indicated that other means were also employed, such as publication in the electronic journal of official announcements publication in newspapers and by letter.[389] The majority identified the "public concerned" based on the geographical location of the plan or programme and/or by making the information available to all members of the public and letting them determine whether they constituted the public concerned. Many also considered the nature of the environmental effects (significance, extent, accumulation, etc.) of the plan or programme in question. In order to communicate effectively and efficiently when it concerned a regional or local plan, the plan or programme was usually announced regionally and/or locally.

With respect to implementation of public participation provisions of the Aarhus Convention in Eastern Europe, Central Asia and South-Eastern Europe, countries reported recent legislative developments. For some parties, these focused on setting legal frameworks for public participation in EIA and SEA processes and environmental permitting, while others focused on improving existing provisions in this regard. Similar developments in Eastern Europe, Central Asia[390] and South-Eastern Europe were reported by parties to the Protocol on Strategic Environmental Assessment during the third review of implementation of the Protocol in the period 2016–2018.[391] Still, Aarhus Convention parties from these subregions mentioned many obstacles to ensuring public participation in practice. Parties from the European Union, Iceland, Norway, Switzerland and United Kingdom subregion continue to sharpen procedures for public participation in decision-making on specific activities, as well as to widen the scope of decisions and decision-making stages where public involvement is required.

388 Non-parties that reported on time and are included in the statistics above are Georgia, Italy and Kazakhstan.

389 ECE/MP.EIA/SEA/14, para. 34.

390 Kazakhstan and Kyrgyzstan reported on their preparations for joining the Protocol on Strategic Environmental Assessment.

391 See parties' reports at https://unece.org/environment-policy/environmental-assessment/review-implementation-national-reporting.

For EIA procedures, parties to the Aarhus Convention increasingly ensure participation in the screening procedure, at the scoping stage, and at the stage of draft EIA decision prior to its adoption. The parties to the Protocol on Strategic Environmental Assessment reported that they ensured that the public was able to provide comments and opinions on draft plans and programmes in a number of economic areas,[392] which set the framework for the development consent for projects requiring EIA and that the public increasingly participates in the screening, scoping and drafting stages of preparation of an environmental report.[393] The public concerned could do so primarily by sending comments to the relevant authority or focal point, or by taking part in a public hearing.

Other types of decisions affecting the environment, where parties to the Aarhus Convention made efforts to ensure public participation, include building and planning decisions, integrated environmental permits/authorizations, decisions on environmental protection measures, decisions on authorization of projects that may have a significant impact on Natura 2000 sites, decisions on nature and landscape protection, decisions on forest management, environmental licensing, decisions on lifetime extension, and decisions related to management of radioactive waste.

In accordance with the Protocol on Strategic Environmental Assessment, all parties are obliged to ensure that, when a plan or programme is adopted, due account is taken of comments received through public participation. The same holds true for parties to the Espoo Convention with respect to projects that are likely to cause significant adverse impacts. Other relevant tools include the 2021 United Nations Policy Brief, *Transforming the Extractive Industries for Sustainable Development* on ensuring sustainable natural resource management.

In general, implementation of the access-to-justice provisions of the Aarhus Convention remains the most difficult pillar for parties to the Convention. Two of the main issues mostly reported were: the regulation of the rights of environmental NGOs to seek judicial or administrative remedies in environmental cases (standing); and financial barriers. Parties were aware of these difficulties, and the efforts reported demonstrate how keen parties are to promote implementation of this pillar. Some parties amended their legislative provisions as a result of developments in case law or on the basis of recommendations by the Aarhus Convention Compliance Committee. During the current reporting cycle, four positive trends were identified, namely:

(a) Increasing admissibility of public interest litigation environmental cases;

(b) Increasing review by courts and other review bodies of the substantive legality of challenged decisions, acts and omissions;

(c) Measures introduced to remove or reduce financial barriers;

(d) Promotion of awareness-raising and specialization of judiciary and other legal professionals in environmental matters.

All reporting parties stated in their reports that their legislation ensured the principles of non-discrimination and equality before the law, as well as protection against penalization, prosecution or harassment of persons exercising their rights under the Convention. At the same time, practice on the issue of penalization, prosecution and harassment of environmental defenders varies significantly among the parties.

There is research to show that women are often excluded from environmental decision-making.[394] This occurs at all levels: personal; household; within private companies; and local and national government.

392 Including agriculture, forestry, fisheries, energy, industry including mining, transport, regional development, waste management, water management, telecommunications, tourism, town and country planning or land use

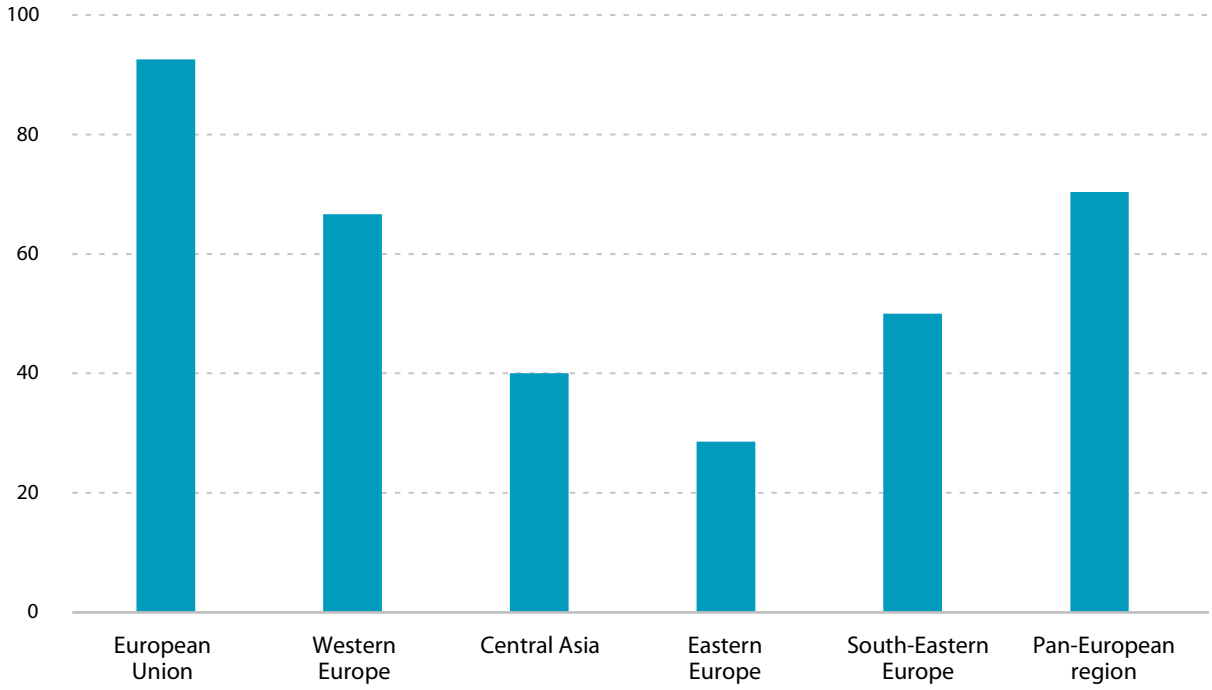
393 ECE/MP.EIA/SEA/14, paras. 27, 38.

394 Melissa Luna and others, *Women in Environmental Decision Making: Case Studies in Ecuador, Liberia, and the Philippines* (Washington, D.C., IUCN Global Gender Office, n.d.).

E. Private sector

One indicator of the engagement of the private sector is the number of companies publishing sustainability reports (Sustainable Development Goal indicator 12.6.1). A simple measure is whether any company in a country publishes a minimal report (see figure 59), but the sparsity of the reporting undermines any possible message. As reporting improves, more meaningful values may emerge. Another indicator related to governance in the private sector is the number of countries with legislation and regulation on mandatory corporate sustainability reporting in place (see table 36).

Figure 59 Proportion of countries in each subregion in which at least one company published a minimum-requirement sustainability report (Sustainable Development Goal indicator 12.6.1) (Percentage)



Source: United Nations, "Global SDG Indicators Data Platform" (accessed on 9 February 2022).

Table 36 Number of countries with legislation and regulations on mandatory corporate sustainability reporting

European Union	Western Europe	Central Asia	Eastern Europe	South-Eastern Europe	**Pan-European region**
27	5	1	2	3	**38**

Source: Carrots & Sticks, Database of mandatory and voluntary instruments that either require or encourage organizations to report sustainability-related information, 2020, https://www.carrotsandsticks.net/.

Note: No data for several countries in Centra Asia, Eastern Europe and South-Eastern Europe.

The exclusion of small and medium-sized enterprises (SMEs) from mandatory environmental, social and governance (ESG) reporting instruments in most of the countries in the pan-European region may be one of the reasons for rather limited ESG reporting so far, considering that SMEs account for the majority of companies.

The European Union Non-Financial Reporting Directive (NFRD) requires certain large companies and public-interest companies to disclose material on environmental, social and employee-related matters, such as anti-corruption, anti-bribery and human rights performance. The forthcoming Corporate Sustainability Reporting Directive, which will amend or replace the NFRD Directive, should alter the picture for European Union member States, requiring all large and listed companies in the European Union to introduce mandatory sustainability reporting standards. Under the Protocol on Pollutant Release and Transfer Registers, a lack of technical capacity in companies for emissions monitoring and data production is observed.

The report on the outcomes of a survey on the experiences in implementing the Protocol on Pollutant Release and Transfer Registers[395] conducted in 2020 noted that PRTRs have evolved significantly since the Protocol was adopted in 2003. The PRTRs play an important role in ensuring transparency and public participation in environmental decision-making.

F. Gender

Gender mainstreaming is important for both men and women. The importance of gender mainstreaming in policies and programmes stems from the fact that the needs, responsibilities and roles of men and women differ. There may be negative consequences, especially for women, if policies and programmes are developed without analysing the effects of such policies on men and women. Moreover, male perspectives are so ingrained in society that policies, programmes and infrastructure often cater to men even if a gender-neutral approach is taken. This so called "gender-blind" approach results in policies and programmes that only cater to men.

In environmental governance it is important to make the processes gender responsive so that the needs and interests of both women and men are taken into consideration equally and the negative consequences of discriminatory policies, strategies or programmes are mitigated. Such approaches also ensure that environmental policies are equitable and that the benefits are distributed fairly.

In a just transition to a sustainable society, policies must be designed to include women, with the need for participation in decision-making by women. This is especially pertinent in roles that will be subject to automation in the future and roles in the informal economy, of which women form a large part.

Approaches to gender mainstreaming in environmental governance should also take into consideration the differences in women's experiences. Discrimination based on, for example, racism, social class, age or disability lead to different lived experiences for women. Thus, a one-size-fits-all approach to gender mainstreaming should be avoided.

While there is no overarching framework for gender mainstreaming in environmental governance across the pan-European region, some ECE subprogrammes have developed guidance and are mainstreaming gender in their work. For instance, the guidelines of the Committee on Housing and Land Management were revised in 2017 to recommend the analysis of a gender dimension in housing and urban development policies. The ECE Gender Responsive Standards Initiative led to the development of a Declaration for Gender Responsive Standards and Standards Development, which invites all standards bodies to ensure that their processes are gender responsive, with the ultimate goal of contributing to gender equality. Moreover, at the nineteenth session of the Steering Committee of the Transport, Health and Environment Pan-European Programme in October 2021, it was decided that further work on gender mainstreaming should be undertaken and be incorporated into the programme's workplan for 2021–2025.

395 ECE/MP.PRTR/WG.1/2020/4.

A difficulty in analysing environmental governance that incorporates a gender perspective is the lack of a baseline and disaggregated data demonstrating how environmental policies affect women. However, even non-disaggregated data is lacking for gender-related indicators on governance. For instance, only 34 per cent of countries have data for Sustainable Development Goal indicator 5.c.1 which indicates the proportion of countries with systems to track and make public allocations for gender equality and women's empowerment, and less than 50 per cent of countries have data on Sustainable Development Goal indicator 5.1.1, which indicates whether legal frameworks are in place to promote, enforce and monitor equality and non-discrimination on the basis of sex.[396]

G. Reviewing progress made and guiding future steps

The peer-reviewed environmental performance reviews (EPRs) carried out by ECE and OECD provide a mechanism for the regular impartial review of progress in environmental governance. The reviews also provide recommendations on how environmental performance and governance may be improved; box 3 describes how implementation of recommendations made in a previous review is followed up. Figure 60 records EPRs carried out in the pan-European region since their instigation more than 25 years ago. The methodologies employed by ECE and OECD have evolved over the past 25 years. The latest, fourth cycle of ECE reviews introduces a nexus option (e.g. water–food–energy–ecosystems, air–transport–health, or water–soil–waste) to be offered to interested countries. The nexus approach will be guided by the principle of integration of governance and management across nexus components, with a view to making recommendations that increase policy coherence, improve synergies and mutual benefits and highlight trade-offs (or compromises) and reduce them over time. Such an approach is also expected to support the transition to green economy and increase resource efficiency. The implementation of recommendations made in a nexus approach chapter would require boosted joint actions and collective efforts from relevant institutions and stakeholders.

Box 3 Environmental performance review recommendations implemented by countries reviewed in 2018

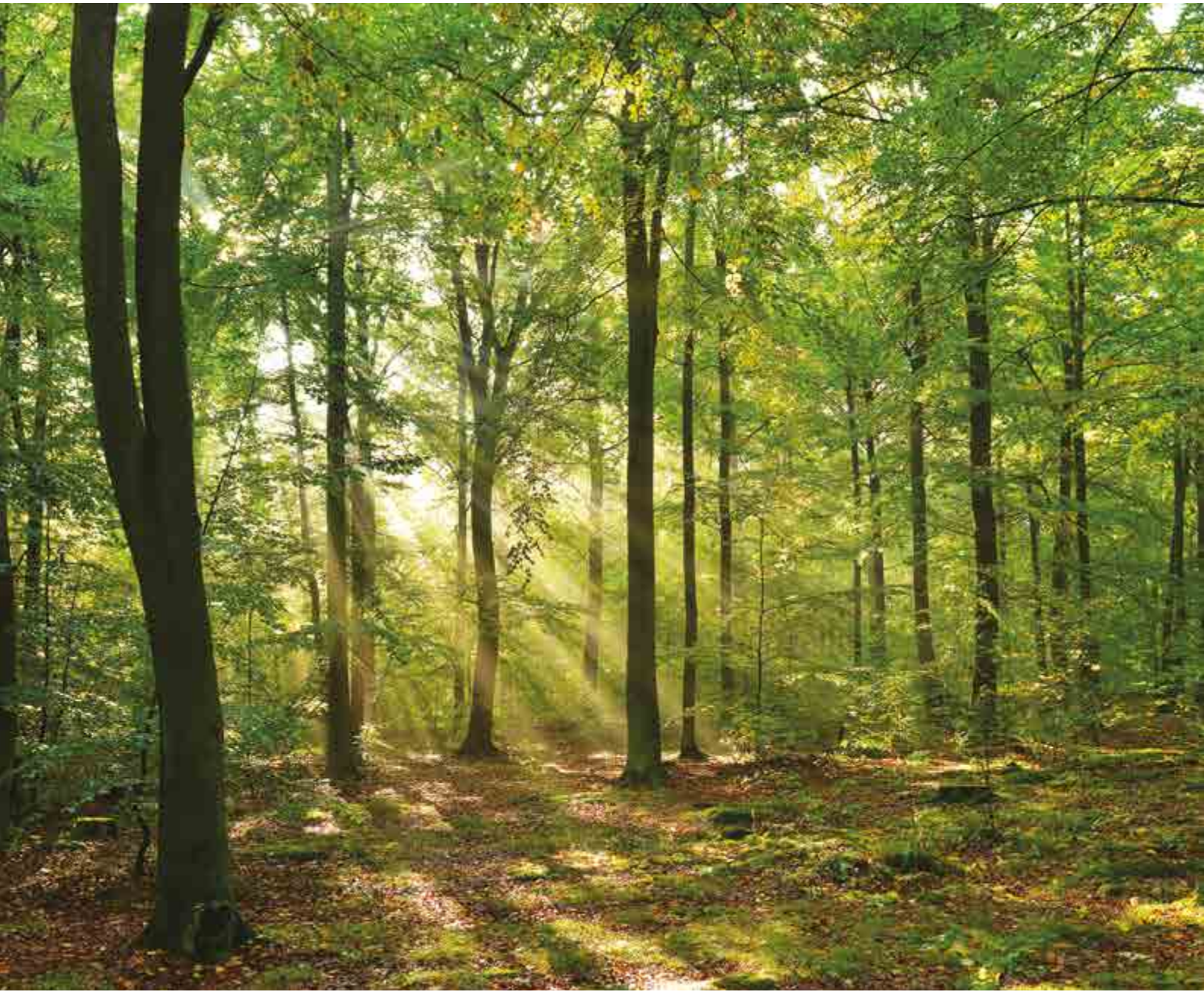
Many countries have now undergone three reviews, at intervals of five to 15 years. Part of each country review is the examination of the implementation of recommendations made in its previous review. For example, in 2018, the overall rate of implementation was calculated to be 70 per cent for the two countries undergoing their third review: Kazakhstan and North Macedonia.

Kazakhstan had 28 (80 per cent) of the 35 recommendations made in its previous review (2008) implemented, partially implemented or with implementation ongoing. North Macedonia had 29 (63 per cent) of the 46 recommendations made in its previous review (2011) implemented, partially implemented or with implementation ongoing.

In both countries, full implementation of the recommendations in their second review had yet to be achieved in 2018. Lack of capacity and resources, as well as gaps in legislation, institutional development and administrative organization, and frequent changes in the institutional framework and/or government policy were identified as major obstacles to the countries' efforts to implement the EPR recommendations.

The fourth cycle of ECE EPRs will cover similar topics to the third cycle reviews, addressing environmental governance and financing, the domestic–international interface, media and pollution management, and the integration of environmental issues into selected sectors. Reviewing progress made in attaining relevant Sustainable Development Goals targets and covering green economy remains important. If requested by the country under review, the content

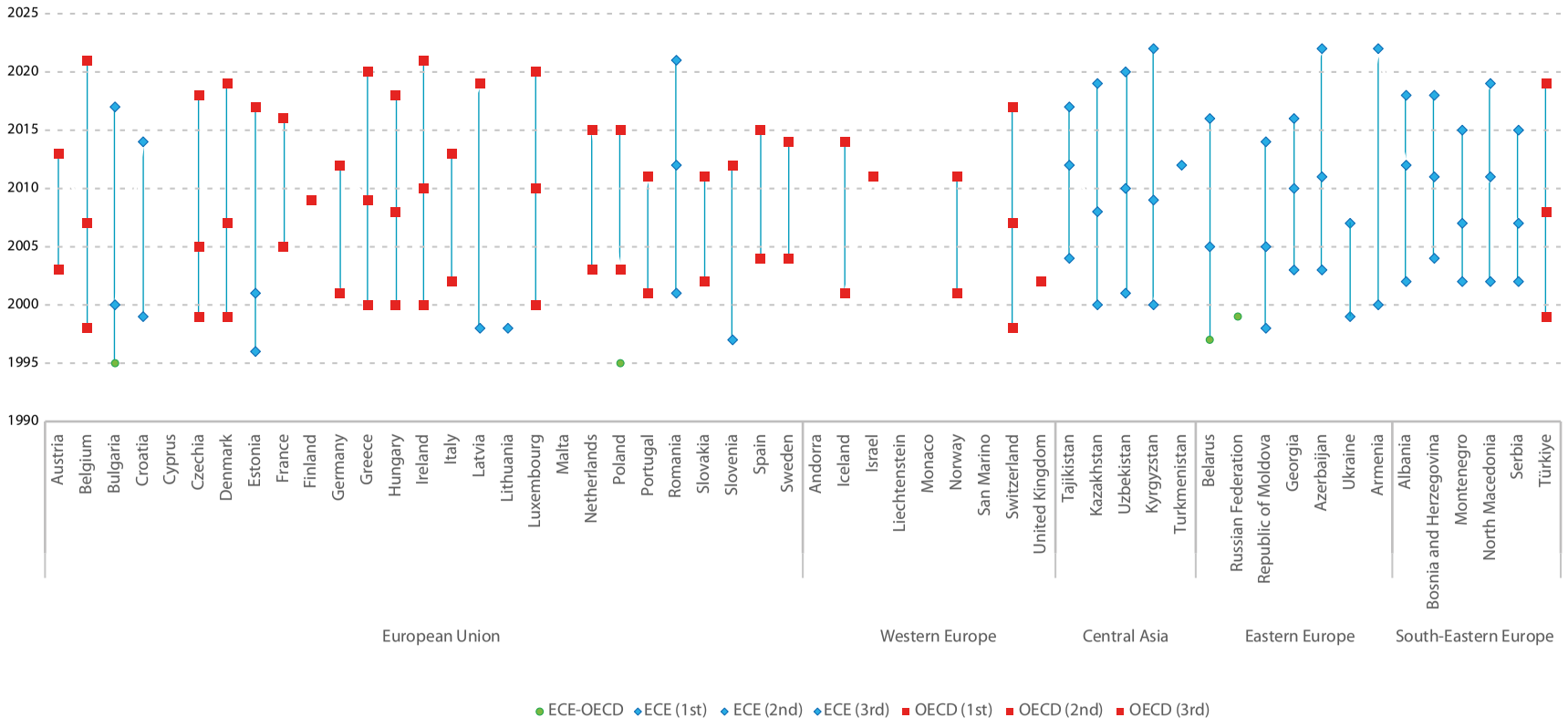
396 United Nations Statistics Division (UNSD), "Metadata repository", SDG Indicators. Goal 5. Achieve gender equality and empower women and girls. Available at https://unstats.un.org/sdgs/metadata/?Text=&Goal=5 (accessed 21 December 2021).



on green economy can be enhanced to address circular economy. The climate change chapter will be strengthened and continue to focus on the impact of climate change on priority sectors, mainstreaming climate adaptation into priority sectors, mitigation of GHGs and low-carbon development, among other issues. The fourth cycle EPRs will continue to address issues related to human rights and the environment, including considering the needs of vulnerable groups. The decision on the substantive content of fourth cycle EPRs will continue to be taken in a flexible manner, guided by the specific needs of each reviewed country. Assessment of the status of implementation of EPR recommendations made in previous reviews will continue to figure prominently.

Figure 60 shows some gaps in coverage by the EPR programmes and in opportunities for countries to benefit from further reviews employing the latest methodologies.

Figure 60 Environmental performance reviews, 1995–2022



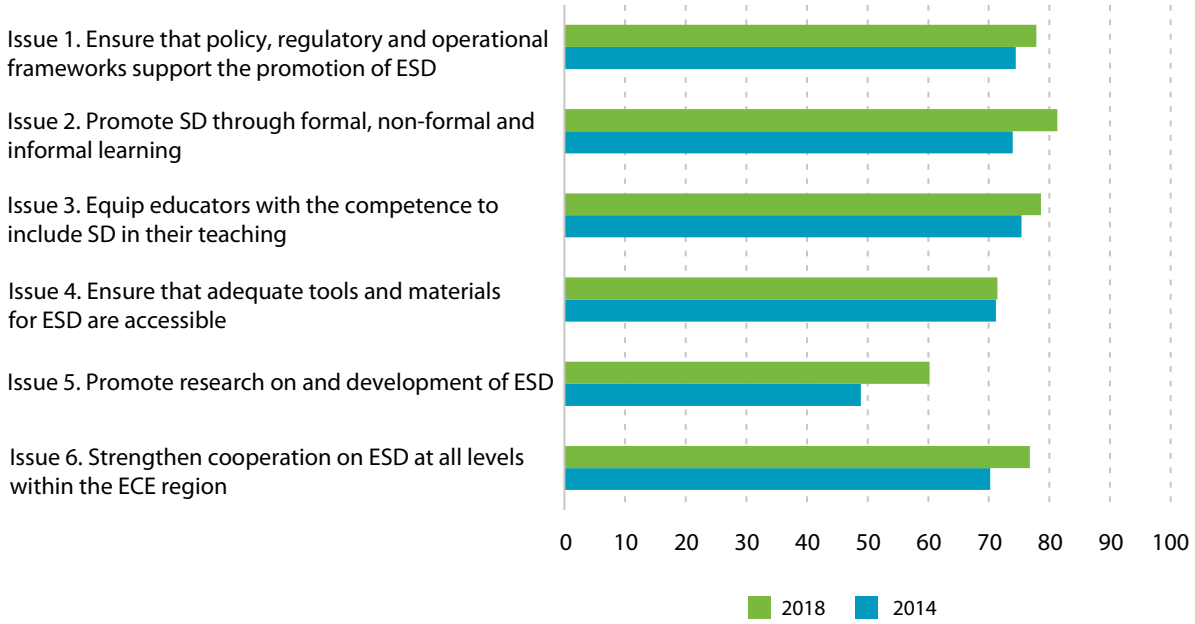
Note: ECE and OECD have each carried out up to three EPRs. The third reviews of Azerbaijan and Kyrgyzstan are underway in 2022; the second review of Armenia is also under way in 2022.

H. Education for sustainable development

Education for sustainable development (ESD) equips people with knowledge and skills to give them opportunities to lead healthy and productive lifestyles in harmony with nature and with concern for social values, gender equity and cultural diversity. It also endows people with capacities to play an active role in environmental governance. The ECE Strategy for Education for Sustainable Development provides a framework for ESD in the pan-European region.

Periodically, a questionnaire is issued to ECE member States to gather information on the state of ESD in each country. The two latest rounds of information-gathering were in 2014 and 2018. Six issues are monitored against a series of 51 criteria. Figure 61 shows progress made across all six issues. For five of the issues, the level of achievement has risen from above 70 per cent to close to 80 per cent; only for the issue of research and development is a lower level of achievement evident; figure 62 provides a subregional perspective.

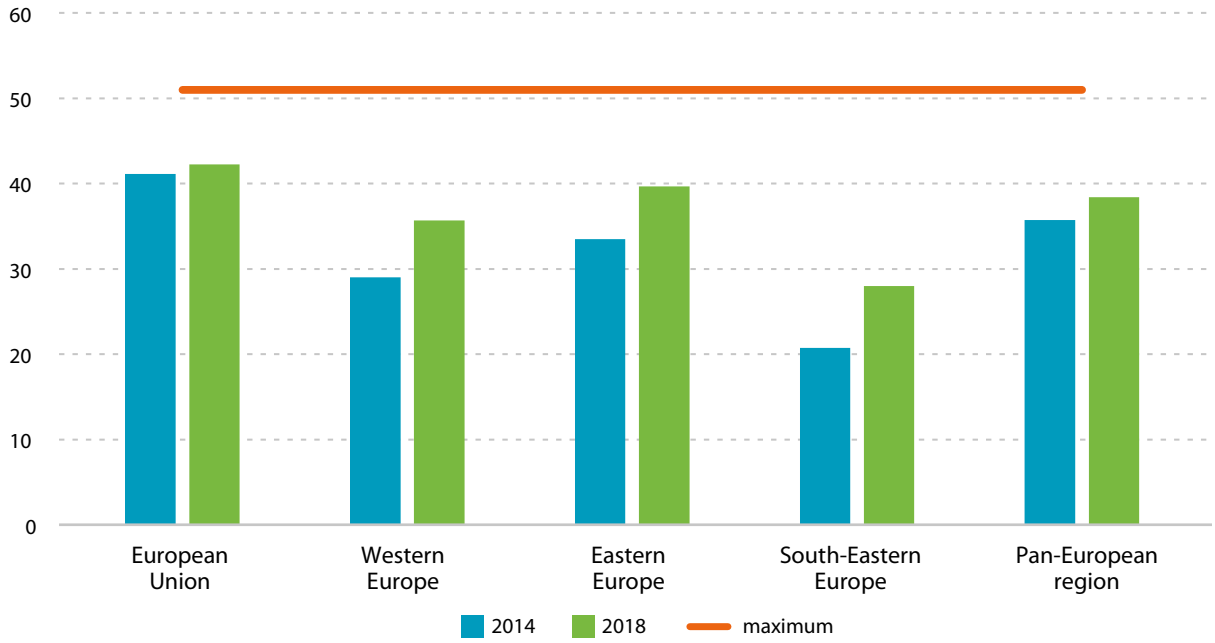
Figure 61 Proportion of maximum number of education for sustainable development criteria met in the pan-European region, by issue, 2014 and 2018 (Percentage)



Source: ECE, national ESD implementation reports, 2014 and 2018.

Note: SD = sustainable development.

Figure 62 Education for sustainable development criteria met by subregion, 2014 and 2018
(Number: maximum possible = 51)



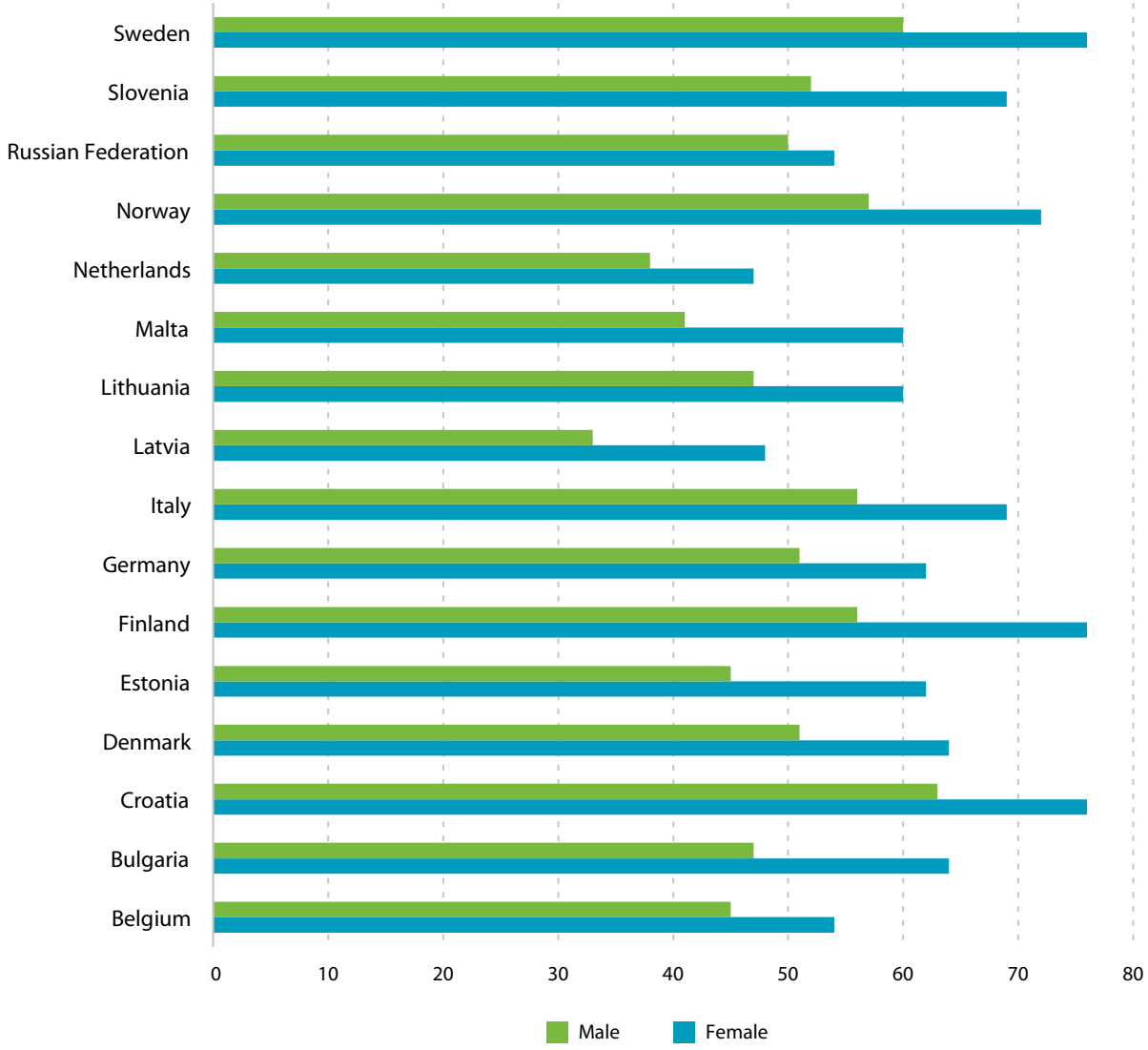
Source: ECE, national ESD implementation reports, 2014 and 2018.

ESD is also reflected in the 2030 Agenda for Sustainable Development and in initiatives of UNESCO. For example, UNESCO published an ESD roadmap in 2020[397] (having adopted it in 2019), and gathers detailed data in relation to the related Sustainable Development Goal indicator (4.7.1, 12.8.1 or 13.3.1), as shown in figure 63 for a few countries. For the countries for which data are available, it is apparent that more female students show an adequate understanding of issues relating to global citizenship and sustainability than their male counterparts. There is also a great disparity in levels of understanding among countries, even those that are members of the European Union.

Also in 2019, the General Assembly adopted a resolution (A/RES/74/223) on ESD in the framework of the 2030 Agenda. It called upon the international community to provide inclusive and equitable quality education at all levels so that all people may have access to lifelong learning opportunities that help them to acquire the knowledge and skills needed to exploit opportunities to participate fully in society and contribute to sustainable development.

397 UNESCO, *Education for Sustainable Development: A Roadmap* (Paris, 2020).

Figure 63 Proportion of students in lower secondary education showing adequate understanding of issues relating to global citizenship and sustainability, by sex (countries reporting), 2016 (Percentage)



Source: UNESCO, Institute of Statistics, Technical Cooperation Group. Available at https://tcgtest.uis.unesco.org/sdg-4-dashboard/sdg-4-country-dashboard/ (accessed on 16 June 2022).

I. Conclusions on governance

While existing policies and MEAs, institutions, the private sector and civil society have contributed to environmental protection and progress has been achieved in certain areas throughout the region, the assessment of state and trends and policy recommendations in the thematic chapters of this assessment indicate the need to further strengthen the environmental governance system and existing policies in the region and to make necessary adjustments to address substantive gaps and inequalities. The following chapter on the way forward provides an overview of findings and recommendations in support of improved environmental governance and the protection of the environment in the coming years.

VI.

THE WAY FORWARD

The environmental governance system and environmental legislation and policy landscape in the pan-European region have evolved and become more integrated and coherent since the Eighth Environment for Europe Ministerial Conference (Batumi, Georgia, 8–10 June 2016), in particular through developments under key mechanisms such as the 2030 Agenda for Sustainable Development, the Paris Agreement and other multilateral environmental agreements (MEAs) and efforts to establish a Shared Environmental Information System (SEIS), as well as many other policy instruments not directly focusing on environment. This landscape is based on an indispensable system of science–policy interaction with key elements of monitoring, assessment and knowledge creation, and enabled by partnerships and cooperation among stakeholders and countries in the pan-European region.

While progress has been achieved in environmental protection in certain areas, there are significant shortcomings that pose a threat to the health of both people and the environment in the pan-European region, as highlighted in this assessment. The Seventh Pan-European Environmental Assessment has identified knowledge gaps in various areas, including air quality, fresh water, marine ecosystems and land and soil. In addition, knowledge and data gaps exist in chemicals and waste, including e-waste, and common policy targets are missing in most countries for biodiversity, resource efficiency and waste prevention, the development of sustainable infrastructure and circular economy. Environmental monitoring and measurement continue to be weaker than in most other sectors, and there is little disaggregated information. There is also room for improvement in integrative environmental planning and in enhancing integrative policies, including with respect to environment and health, particularly in countries in the eastern part of the region, as identified in the assessment.

Furthermore, the environmental governance system in the pan-European region remains partly fragmented in terms of the application of policies, strengthening of institutions and harmonization of legislation, as illustrated by the incomplete participation of the countries in existing MEAs and their implementation and reporting exercises.

Tracking progress and evaluating the effectiveness of policies in the region also remains a challenge, because of a lack of: (a) data and information; and (b) established standard procedures to evaluate whether policies are fulfilling their goals. The selected indicators in the assessment provide only a narrow snapshot of where progress has been achieved and what developments are expected in the coming years. Nonetheless, they provide guidance on where urgent action is required.

Availability and accessibility of timely, relevant and robust data is essential for ensuring informed decisions, transparency and public participation. The sparsity of underlying data, particularly for the assessment of sustainable infrastructure and applying the principles of circular economy in sustainable tourism, highlights the need for better integration between the environmental dimension of the Sustainable Development Goals and the social and economic dimensions of sustainable development.

Besides strengthening participation in existing MEAs and international policy instruments, including the Batumi Initiative on Green Economy (BIG-E), there is a need to: (a) develop policy and set coherent and quantitative targets to better address emerging topics, including circular economy and sustainable infrastructure, to support the transition to sustainable development in the region; and (b) strengthen the implementation of policies on the ground, for example, through upscaling successful pilot schemes, mobilizing resources from State and non-State actors and improving regulatory frameworks.

Strengthening of the knowledge base in support of environmental policies is another crucial enabling condition for improved environmental governance. The enhanced use of geospatial data and new technologies, including Big Data, artificial intelligence and, specifically, machine learning, and increased digitization will increase efficiency and effectiveness in integrating policies, if used in a sound manner. Strong partnerships within countries, but also across borders, will be crucial and need to be further strengthened.

There is little time left to ensure the successful implementation of the 2030 Agenda. The recent ECE assessment, *Sustainable Development Goals: Is the UNECE Region on Track for 2030? Assessment, Stories and Insights*,[398] indicates that the ECE region will achieve only 23 of the 169 Sustainable Development Goal targets by 2030 and only seven of the targets related to environment and climate change. For 57 targets, progress needs to accelerate and, for nine targets, the current trend needs to be reversed. Data are insufficient for the assessment of 80 targets. Therefore, it is essential to make the best possible use of existing tools and initiatives in the coming years in support of the Sustainable Development Goals. Where needed, additional measures and more ambitious goals, such as for e-waste or resource efficiency, can accelerate the implementation of the policy agenda.

The following areas have been identified as enabling conditions for a successful transition to a green and circular economy and sustainable development in the region.

A. Strengthening of policies and their implementation and upscaling of actions

1. Promotion of participation in multilateral environmental agreements and harmonization of polices and legislation

Policy fragmentation should be reduced across the region to promote the existing MEAs and participation therein and support countries in ensuring coherency and harmonization of legislation.

2. Acceleration of the implementation of the Pan-European Strategic Framework for Greening the Economy

Participation in the Pan-European Strategic Framework for Greening the Economy and the Batumi Initiative for Green Economy needs to be enhanced. Governments and public and private organizations should scale up contributions through voluntary commitments in the form of green economy actions and envisage, in particular, commitments on circular economy and sustainable infrastructure development, including through promoting nature-based solutions. Successful pilot actions, including those illustrated in the case studies presented in this assessment, could be scaled up or replicated.

3. Development and adoption of common and coherent policies in the pan-European region for emerging topics, including circular economy and sustainable infrastructure

To address emerging challenges stemming from increased pressures on ecosystems and health, the development and adoption of systemic policy frameworks across the region in support of green economy and the transition to sustainable development will be crucial to keep pace with and address challenges in an increasingly complex world. Possible areas of engagement include adoption of common and systemic policies with common targets for circular economy, sustainable infrastructure and resource efficiency. Gender should be mainstreamed in policy development.

4. Strengthening of mechanisms for monitoring the effectiveness of policies and legislation, including at the international level

The tracking of progress and evaluation of the effectiveness of policies in the region remains a challenge and standard procedures to evaluate whether the policies are fulfilling their goals often need to be established or improved and data and information gaps need to be closed.

398 ECE, *Sustainable Development Goals: Is the UNECE Region on Track for 2030? Assessment, Stories and Insights* (Geneva, United Nations, 2021).

B. Investing in a just transition and redirecting finance, notably to sustainable infrastructure, a circular economy and nature-based solutions

The pandemic has created an unprecedented global economic downturn, with significant losses in human lives and employment in certain sectors. It has exposed gaps in knowledge, capacity, accessibility to basic services and gender equality. However, the pandemic has also created an opportunity to correct the path of resource exploitation, the rise of GHG emissions and other injustices, which came at the expense of healthy ecosystems and human well-being. Countries should take this opportunity to invest in a just and green transition.

1. Investing in and reorienting finance to support a just transition

Governments and private actors need to invest in and redirect finance towards sustainable infrastructure, circular economy and, especially, nature-based solutions (NbS). While the transition will require major investments, the pan-European region will gain immensely, both in terms of reduced pressure and impacts on ecosystems and nature and through gained health benefits and new economic opportunities. Investments in NbS should be given priority where possible to enhance resilience, while at the same time constructing and operating in a climate-friendly manner.

2. Strengthening of participation and access to information in environmental governance

Good environmental governance is built on broad participation, including from the public and pluralistic governance, which are key for a just transition. Furthermore, participative processes in planning, implementation and evaluating the effectiveness of actions for a just transition are needed to ensure optimal solutions and buy-in, paying particular attention to the participation of vulnerable groups and ensuring access to justice in conformity. Access to and availability of timely and reliable information are fundamental.

3. Investing in capacity development and education for sustainable development

In order to ensure the transition to sustainable development, there is a need to develop and invest in capacity and education in responsible authorities, the private sector and civil society.

C. Strengthening the science–policy interaction and the use of technology and innovation

The pan-European region is home to many outstanding scientific organizations, universities, research centres and individuals capable of innovation and of filling knowledge and data gaps. To support existing and upcoming environmental policy objectives, there is a need to strengthen the dialogue between science and policy and the monitoring of environmental conditions and progress in policy implementation. Innovation and technology, including Earth observation, Big Data supported by analysis through artificial intelligence, developments in digitization and citizen science, provide major opportunities for the pan-European region to enhance the creation of knowledge to complement existing monitoring.

1. Enhancing the use of technology and innovation in support of system thinking

Decision-making can benefit from strengthened science–policy interaction supported by data-driven innovation and technology. Digitization in all areas, while respecting personal rights, will be crucial to enhance the understanding of complex processes and interlinkages of human needs, environmental and social impacts and planetary boundaries.

2. Benefiting from existing knowledge and potential new sources

Making use of existing knowledge, tools and systems is beneficial not only from an economic perspective but also for sustainability reasons. The ECE and OECD environmental performance review programmes, the SEIS, the various UNEP assessments and the EEA *The European Environment: State and Outlook* reports are examples of existing knowledge products and tools in the pan-European region. Their continued development and alignment with emerging policy needs should be supported. The use of the ECE Revised Guidelines for the Application of Environmental Indicators and the ECE set of environmental indicators, in accordance with the principles of the SEIS and the updated Recommendations on the more effective use of electronic information tools (ECE/MP.PP/2021/2/Add.2)), adopted by the Meeting of the Parties to the Aarhus Convention in October 2021, will support sound policymaking. At the same time, better environmental monitoring and reporting will help facilitate reporting on Sustainable Development Goal indicators.

D. Development and strengthening of partnership initiatives and cooperation at regional and subregional levels

To achieve the Sustainable Development Goals and other global and regional policy targets, Governments, the private sector, academia and citizens must work together. In the pan-European region, various forms of cooperation, partnerships, institutional information exchanges and citizen engagement have advanced the protection of the environment in certain areas. Challenges remain, however, in many areas, including the creation of partnerships for emerging policy topics.

1. Strengthening of existing partnerships to address regional challenges

Governments should promote cooperation at all levels in order to address transboundary environmental challenges, including in integrated water resources management, the prevention of industrial and chemical accidents, environmental impact assessment and the establishment of environmental information systems in line with the principles and pillars of an SEIS.

2. Development of new partnerships for emerging policy themes

Governments and others need to consider creating new partnerships on emerging and urgent policy themes, including on circular economy, sustainable infrastructure, resource efficiency and waste management.

GLOSSARY

Blue economy is an economy that comprises a range of economic sectors and related policies that together determine whether the use of ocean resources is sustainable (Source: United Nations).

Climate neutrality refers to the idea of achieving net zero GHG emissions by balancing those emissions so they are equal to (or less than) the emissions that are removed through the planet's natural absorption.

Coastal resilience is the ability of a community to "bounce back" after hazardous events such as hurricanes, coastal storms and flooding, rather than simply reacting to impacts.

Conservation agriculture is a farming system that promotes minimum soil disturbance (i.e. no tillage), maintenance of a permanent soil cover and diversification of plant species. It enhances biodiversity and natural biological processes above and below the ground surface, which contribute to increased water and nutrient use efficiency and to improved and sustained crop production. (Source: FAO)

Critical raw materials (CRMs) are raw materials of high importance to the current and future economy and the availability of which is associated with a high risk, due to absolute scarcity or market characteristics or strong regional concentration. Based on the main two parameters, economic importance and supply risk, a list of, currently, 30 CRMs has been determined for the European Union.[399] It depends on the region and sector which materials display criticality and therefore are to be considered CRMs.

Decarbonization is the reduction of carbon dioxide emissions through the use of low-carbon power sources, achieving a lower output of GHGs into the atmosphere.

Energy mix refers to the breakdown of primary energy sources in the final energy consumption in a given geographical region.

Eutrophication is the process by which a body of water becomes enriched in dissolved nutrients (such as phosphates) that stimulate the growth of aquatic plant life, usually resulting in the depletion of dissolved oxygen.

E-waste, or waste electrical and electronic equipment (WEEE), refers to electrical and electronic equipment that the owner discards, intends to discard or must discard. This can be because the equipment no longer satisfies the owner or because it is no longer functional. E-waste comprises any appliance with an electric power supply when the appliance has reached its end of life. This includes large technical appliances such as washing machines, small household appliances such as toasters, IT and telecommunication equipment such as computers and telephones, and consumer equipment such as radios, lighting equipment and other technical devices.

Flame retardants are chemicals added to materials or applied as coating to products or components in order to increase fire resistance of flammable products.

Food safety is the assurance that food will not cause harm to the consumer and will provide the expected nutritional value when it is prepared and/or eaten according to its intended use.

Food security exists when all people have, at all times, physical, social and economic access to sufficient, safe and nutritious food that meets their dietary energy requirements and food preferences for an active and healthy life.

Fossil fuels are carbon-based fuels from fossil hydrocarbon deposits, including coal, peat, oil and natural gas.

Greenhouse gases (GHGs) covered by the United Nations Framework Convention on Climate Change are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6) and nitrogen triflouride (NF_3).

399 European Commission, *Study on the EU's list of Critical Raw Materials* (Luxembourg, Publications Office of the European Union, 2020).

Illegal, unreported and unregulated (IUU) fishing comprises all fishing activities that break fisheries laws or occur outside the reach of fisheries laws and regulations.

Industrial symbiosis describes synergistic networks between traditionally separated industrial entities. Participants engage in collaborative management of material or energetic resources and share infrastructures, capacities or know-how. High-value valorization of by-products and wastes by another company in the network is one widespread element. Industrial symbiosis goes beyond traditional waste management because it represents a coordinated effort of several entities to align their activities and needs, with the goal to find mutually beneficial solutions. Industrial symbiosis increases resource efficiency in an economically viable way, and thus accomplishes both higher business profit and reduced adverse environmental impacts.

Land abandonment refers to land that was previously used for crop or pasture/livestock grazing production but no longer has farming functions and has not been intentionally converted into forest or artificial areas either.

Malnutrition essentially means "bad nourishment". It encompasses overnutrition as well as undernutrition. It concerns not only the quantity and quality of food (not having enough food, or having too much food or the wrong types of food) but also the body's response to a wide range of infections that result in malabsorption of nutrients or the inability to use nutrients properly to maintain health.

Municipal solid waste (MSW) covers waste from households and waste generated by other sources which is similar in nature and composition to household waste. This includes waste from commerce and small businesses. It also includes waste from selected municipal services, such as park and garden maintenance, street cleaning and litter containers in public spaces.

Nationally determined contributions (NDCs) are expressed by parties to the Paris Agreement, describing national efforts by each country to reduce national emissions and adapt to the impacts of climate change.

Natural infrastructure refers to strategically planned and managed networks of natural lands, water and soil, such as forests and wetlands, working landscapes and other open spaces, that conserve or enhance ecosystem values and functions and provide associated benefits to humans.

Nature-based solutions (NbS) are actions to protect, sustainably manage and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits (Source: International Union for Conservation of Nature).

No tillage (or zero tillage) is the simple technique of drilling seed into the soil with little or no prior land preparation. No tillage is a technical component used in conservation agriculture, but not everyone carrying out zero tillage is practising conservation agriculture.

Overnutrition is a daily energy intake that consistently exceeds energy requirements, leading to people being overweight or obese. Obesity is associated with risk of chronic diseases, such as high blood pressure, diabetes, etc. Children and adults whose body weight significantly exceeds their normal weight for an extended period are thus overnourished.

Persistent organic pollutants (POPs) are a group of organic compounds that are resistant to environmental degradation, i.e. they show high stability against chemical, biological and photolytic processes occurring in the environment. Polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs) and brominated flame retardants are some examples. Most POPs are halogenated organic compounds with high lipid solubility and bioaccumulating characteristics, and thus a high risk for detrimental impacts on the environment and human health (e.g. cancer, endocrine disruption, impacts on the immune system). Most POPs are human made. They are or were used, for example, as pesticides, flame retardants in plastics and electrical goods or heat exchange fluids or in capacitors. Others, such as dioxins, are furans, unintentional by-products of high-temperature processes, including combustion.

Pollutant release and transfer register (PRTR) is a publicly accessible database that establishes an inventory of pollution by documenting chemicals or pollutants released from industrial sites and other sites to air, water and soil and transferred off site for treatment. A set of specified activities and pollutants is considered.

Polycyclic aromatic hydrocarbons (PAHs) are aromatic hydrocarbons composed of multiple aromatic rings from the group of PAHs. Human exposure to PAHs has been linked with cancer, cardiovascular disease and damage to foetus development. Bioaccumulation (gradual accumulation of substances in a living organism) is a specific concern.

Recycling refers to a material reprocessing operation by which secondary raw materials are recovered from waste materials, including the reprocessing of organic material through composting or anaerobic digestion.

Recycling rate is calculated by dividing the weight of a (recyclable) material that enters the recycling facilities by the total weight of the (separately) collected (recyclable) material. The amount of collected waste (or collected recyclables) is not equivalent to the amount of generated waste (or generated recyclables), since some generated waste does not enter the collection schemes. The recycling rate refers to the collected amount only.

Refurbishment denotes a process of bringing a product up to standards and upgrading it to a more satisfying working condition or more appealing appearance. Common measures are the replacement of outdated components, such as in computer hardware devices, and cosmetic changes to improve the appearance of an item (e.g. painting, changing surface coating). Refurbished products sold on the market often have a warranty that covers the whole product (unlike repaired products). Unlike a remanufactured product, a refurbished product usually has a performance level that is not equivalent to an original device.

Remanufacturing is a product lifetime extension scheme carried out at an industrial scale, by either the original manufacturer or a remanufacturing company.[400] It returns an already used product to the performance specification of the original equipment manufacturer, typically using a combination of reused, repaired and new parts. A prerequisite of remanufacturing is a scheme that ensures the specific product is returned to the manufacturer/remanufacturer. Products are dismantled and the components restored; the reassembled product is extensively tested. Remanufacturing supplies products in like-new conditions; they meet the same customer expectations as new products. Warranty is in general at least equal to that of the original product. Examples from different sectors have been compiled by the European Remanufacturing Network.[401]

Repair is an operation to fix a fault of a product. This can be done in a private setting or by making use of a business service. Repair measures will usually be performed with no guarantee on the product as a whole.

Reuse means any setting which achieves that a product which is not waste, or its components are used again for their original purpose, i.e. the same purpose for which they have already been used at least once.[402] Where products or components are used again but for a purpose other than the original one, this represents a further use. Reuse is part of waste prevention. In contrast, "preparing for reuse" is part of waste management and subject to the availability of waste management infrastructures and waste collection and handling procedures. Preparing for reuse means checking, cleaning or repairing operations, by which products or components of products that have become waste are prepared so that they can be reused without any other pre-processing.[403] Preparing for reuse is a waste valorization scheme. Reuse and preparing for reuse are both product lifetime extension schemes. Remanufacturing, refurbishment and repair are relevant operations in the context of reuse schemes.

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400 Nabil Nasr, Jennifer Russell, Stefan Bringezu, Stefanie Hellweg, Brian Hilton, Cory Kreiss, and Nadia von Gries, *Re-defining value – The manufacturing revolution. Remanufacturing, refurbishment, repair and direct reuse in the circular economy*. A Report of the International Resource Panel (United Nations Environment Programme, Nairobi, Kenya, 2018).

401 European Remanufacturing Network, Case Study Tool, available at https://www.remanufacturing.eu/case-study-tool.php

402 European Environment Agency, *Waste prevention in Europe — policies, status and trends in reuse in 2017* (Publications Office of the European Union, Luxembourg, 2018); Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives (annex).

403 European Environment Agency, *Waste prevention in Europe — policies, status and trends in reuse in 2017*.

Soil carbon sequestration is a biogeochemical process whereby soils take up and fix carbon. Soil carbon sequestration is one of the options for climate change mitigation with a wide range of synergies. By increasing carbon concentrations in the soil through better management practices, this option offers benefits for biodiversity, soil fertility and productivity, and soil water-storage capacity. Further, it stabilizes and increases food production, reversing land degradation and restoring the "health" of ecological processes

Soil erosion – geologically, erosion is defined as the process that slowly shapes hillsides, allowing the formation of soil cover from the weathering of rocks and from alluvial and colluvial deposits. Erosion caused by human activities, as an effect of careless exploitation of the environment, results in increasing runoffs and declined arable layers and crop productivity.

Soil organic carbon (SOC) refers to the carbon held within the soil and is expressed as a percentage by weight (gC/Kg soil). Climatic shifts in temperature and precipitation have a major influence on the decomposition and amount of SOC stored within an ecosystem and that is released into the atmosphere. The amount of SOC stored within an ecosystem is dependent on the quantity and quality of organic matter returned to the soil matrix, the soil's ability to retain organic carbon (a function of texture and cation exchange capacity) and biotic influences of both temperature and precipitation.

Sustainable infrastructure (sometimes called "green infrastructure") systems are those that are planned, designed, constructed, operated and decommissioned in a manner that ensures economic and financial, social, environmental (including climate resilience) and institutional sustainability over the entire infrastructure life cycle. Sustainable infrastructure can include built infrastructure, natural infrastructure or hybrid infrastructure that contains elements of both.[404]

Total final energy consumption refers to the consumption of primary and secondary energy by manufacturing, construction and non-fuel mining, by transport, and by others (agriculture, forestry and fishing, commerce and public services, households and other consumers).

Triple planetary crisis comprises the interlinked and cascading effects of climate change, biodiversity loss and pollution.

Waste management hierarchy, or waste hierarchy, ranks waste management options to prioritize the options that are best for the environment. The waste management hierarchy applied across the European Union consists of five levels: waste prevention; preparing for reuse; recycling; other recovery; and disposal. In other regions or contexts, alternative versions of the waste management hierarchy exist, including versions with a breakdown of priorities into more than five levels. In all cases, waste prevention is defined as the top priority, while disposal represents the least preferred option to manage waste.

Waste means any substance or object which the holder discards or intends or is required to discard.[405] This is not equivalent to residues. A production residue is a material that is not deliberately produced in a production process; it may or may not be a waste. A by-product is a production residue that is not a waste.

Waste prevention includes activities and measures which prevent products, substances or materials from becoming waste. Waste prevention can be achieved by reducing the quantity of materials used in goods, for example, through eco-design, or the amount of materials used for the delivery of services; by increasing the efficiency with which products are used, for example, sharing products instead of purchasing them; and by adopting product lifespan extension schemes such as reuse, repair and refurbishment.[406] Changes in lifestyles of citizens towards more non-material-oriented consumption habits and dematerialization of the economy, for example, due to a higher share of services, tourism and culture, also contribute to waste prevention.

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404 Note: This definition was published in the UNEP *International Good Practice Principles for Sustainable Infrastructure* (Nairobi, 2021), as an adaptation of the definition provided by the Inter-American Development Bank in "What is sustainable infrastructure?" A framework to guide sustainability across the project cycle" (Technical Note, No. IDB-TN-1388, March 2018).

405 Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives.

406 European Environment Agency, Waste prevention in Europe — policies, status and trends in reuse in 2017.

Europe's Environment
The Seventh Pan-European Environmental Assessment

Europe's Environment: The Seventh Pan-European Environmental Assessment reports that progress has been achieved in environmental protection in certain areas, but significant shortcomings remain and pose a threat to the health of both people and the environment in the pan-European region. The assessment, which is both indicator based and thematic, has been prepared to inform deliberations by ministers at the Ninth Environment for Europe Ministerial Conference (Nicosia, 5–7 October 2022) and focuses on the period since the previous assessment issued in 2016. It builds upon the Shared Environmental Information System in Europe and Central Asia.

The assessment addresses the two Conference themes – Greening the economy in the pan-European region: working towards sustainable infrastructure; and Applying principles of circular economy to sustainable tourism – as well as a series of straightforward environmental topics: atmospheric air; climate change; fresh water; coastal waters, marine ecosystems and seas; biodiversity and ecosystems; land and soil; chemicals and waste; and environmental financing. It also includes a discussion on environmental governance. It includes a summary for policymakers that sets out the key messages from and recommendations of the assessment.

The assessment is the result of a collaboration between the secretariat of the United Nations Economic Commission for Europe (ECE) and the United Nations Environment Programme (UNEP), in cooperation with numerous partner organizations and individual experts. The ECE Working Group on Environmental Monitoring and Assessment was tasked with leading the process of consultation on the regular pan-European environmental assessment.

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