1 The benefits and costs of the blue economy at the territorial level

The blue economy has been gaining traction as a means of achieving sustainable economic growth while preserving coastal, marine and freshwater ecosystems. Because the blue economy takes place, creates value and provides jobs in cities and regions, subnational governments play a key but untapped role in the blue economy. Unlocking their potential calls for a territorial approach to the blue economy, which implies leveraging place-based policies to tailor measures to local challenges and accelerate efforts towards sustainable blue economies. This chapter provides an overview of the latest international developments in the blue economy before zooming in on the socio-economic and environmental benefits as well as the costs and threats to the blue economy at the subnational level, drawing from the results of the OECD Global Survey on Localising the Blue Economy.

Defining the blue economy

There is no single definition of the blue or ocean economy, which are often used interchangeably by international organisations and government institutions. The OECD definition of the ocean economy accounts for the economic activities of ocean-based industries, as well as the assets, goods, and services provided by marine ecosystems (2016[1]), while the sustainable ocean economy recognises the need to integrate economic, social and environmental dimensions of sustainability in line with the United Nations Sustainable Development Goals (SDGs) (OECD, 2020[2]).

However, national and subnational government strategies employ various terminologies, including economy of the sea and coast (e.g. France), blue economy (e.g. Portugal), ocean economy (e.g. South Africa), sustainable ocean economy (e.g. Norway), marine economy (e.g. United Kingdom), maritime industry (e.g. state of Washington, United States) or maritime economy (e.g. region of Catalonia, Spain). International definitions consistently highlight the role of economic activities associated with oceans, seas and coasts in contributing to economic growth and job creation, as well as the sustainable use and management of coastal and marine resources (Table 1.1). The OECD considers that any definition of the ocean economy is incomplete unless it also encompasses non-quantifiable natural stocks and non-market goods and services (OECD, 2016[1]; Jolliffe and Jolly, 2024[3]). Although challenges remain, measuring the value of the natural capital of marine ecosystems, in particular, is progressing at the international level (Jolliffe and Jolly, 2024[3]).

Table 1.1. Definitions of the blue or ocean economy across international organisations

Organisation	Definition	Established sector(s)	Emerging sector(s)
European Commission	The **blue economy** refers to all economic activities related to oceans, seas and coasts. It aims to achieve the objectives of the European Green Deal and ensure a green and inclusive recovery from the COVID-19 pandemic.	• Marine living resources • Marine non-living resources • Marine renewable energy • Port activities • Shipbuilding and repair • Maritime transport • Coastal tourism	• Ocean energy • Blue bioeconomy and biotechnology • Desalination • Marine minerals • Maritime defence, security and surveillance • Research and education • Infrastructure
OECD	The **ocean economy** refers to the economic activities of ocean-based industries, as well as the assets, goods, and services provided by marine ecosystems. It aims to conserve and sustainably use the oceans, seas and marine resources for sustainable development. As defined by the Sustainable Ocean for All initiative, the **sustainable ocean economy** emphasises the sustainable use and conservation of natural resources in the world's oceans, seas and coastal areas, in line with the 2030 Agenda for Sustainable Development and ocean-related SDGs.	• Capture fisheries • Seafood processing • Shipping • Ports • Shipbuilding and repair • Offshore oil and gas (shallow water) • Marine manufacturing and construction • Maritime and coastal tourism • Marine business services • Marine research and development (R&D) and education • Dredging	• Industrial marine aquaculture • Deep- and ultra-deep-water oil and gas • Offshore wind energy • Ocean renewable energy • Marine and seabed mining • Maritime safety and surveillance • Marine biotechnology • High-technology marine products and services

Organisation	Definition	Established sector(s)	Emerging sector(s)
United Nations	The **blue economy** comprises a range of economic sectors and related policies that determine whether the use of ocean resources is sustainable. It aims to improve human well-being and social equity while reducing environmental risks and ecological scarcity. UN-Habitat suggests expanding the **blue economy** concept to all waterbodies, including lakes, rivers and wetlands, arguing that inland cities are as affected by water-related risks as coastal or island cities. The UNDP defines the **blue economy** as the sustainable use of ocean resources for economic growth, jobs and social and financial inclusion. UNEP refers to the **blue economy** as a way to facilitate sustainable ocean-based economic, social and environmental benefits within the planetary boundaries of oceans and coasts. The UNCTAD refers to the **sustainable ocean economy** as economic sectors that sustainably use and contribute to the conservation of oceans, seas and coastal resources for the benefit of humanity in a way that sustains ocean resources.	• Fisheries • Secondary fisheries and related services • Trade of sea products • Tourism and recreation • Coastal development • Shipping and shipbuilding • Oil and gas • Maritime transport • Ports and related activities	• Renewables (e.g. offshore renewable energy) • Aquaculture • Seabed extractive activities • Marine biotechnology and bioprospecting • Desalination. Indirect supporting activities: • Carbon sequestration (blue carbon) • Coastal protection • Waste disposal • Biodiversity and habitat protection
World Bank	The **blue economy** refers to the sustainable use of ocean resources for economic growth, improved livelihoods and jobs, and ocean ecosystem and health. It aims to move beyond business as usual and make economic development and ocean health compatible.	Following the same co-elaborated framework as the United Nations.	Following the same co-elaborated framework as the United Nations.

Note: UN-Habitat: United Nations Human Settlements Programme; UNDP: United Nations Development Programme; UNEP: United Nations Environment Programme; UNCTAD: United Nations Conference on Trade and Development.

Source: Based on EC (2018[4]), *The 2018 Annual Economic Report on EU Blue Economy*, https://data.europa.eu/doi/10.2771/305342; EC (2021[5]), *The EU Blue Economy Report 2021*, https://op.europa.eu/en/publication-detail/-/publication/0b0c5bfd-c737-11eb-a925-01aa75ed71a1; OECD (2016[1]), *The Ocean Economy in 2030*, https://doi.org/10.1787/9789264251724-en; World Bank/UN (2017[6]), *The Potential of the Blue Economy: Increasing Long-term Benefits of the Sustainable Use of Marine Resources for Small Island Developing States and Coastal Least Developed Countries*, https://sustainabledevelopment.un.org/content/documents/15434Blue_EconomyJun1.pdf; UNEP (2018[7]), *Enabling Sustainable, Resilient and Inclusive Blue Economies*, https://www.unep.org/explore-topics/oceans-seas/what-we-do/enabling-sustainable-resilient-and-inclusive-blue-economies; UN-Habitat (2018[8]), "UN-Habitat background paper on Blue Economy and Cities", https://unhabitat.org/un-habitat-background-paper-on-blue-economy-and-cities; UNDP (2023[9]), *Action Brief: An Ocea of Opportunities - How the Blue Economy can Transform Sustainable Development in Small Island Developing States*, https://www.undp.org/sites/g/files/zskgke326/files/2023-02/UNDP-RBAP-Blue-Economy-Action-Brief-2023.pdf; World Bank (2017[10]), *What is the Blue Economy?*, https://www.worldbank.org/en/news/infographic/2017/06/06/blue-economy; OECD (2020[2]), *Sustainable Ocean for All: Harnessing the Benefits of Sustainable Ocean Economies for Developing Countries*, https://doi.org/10.1787/bede6513-en; UNCTAD (2020[11]), *Towards a Harmonized International Trade Classification for the Development of Sustainable Ocean-based Economies*, https://unctad.org/system/files/official-document/ditcted2020d4_en.pdf.

Ocean-based industries are often divided into "established" and "emerging" sectors (Table 1.1). The former refer to traditional sectors with a consolidated market presence, such as marine fisheries, shipping and port activities, while the latter refer to sectors in earlier stages of development characterised by innovation, rapid growth and the introduction of new technologies or business models, such as blue biotechnology. Sectors are often disaggregated differently across organisations: for instance, the trade of seafood is considered as a sector by the United Nations and as a sub-sector by the European Commission. Taxonomies also change over time to reflect evolving trends, as evidenced by changes in the European Commission's "established" sectors from 2018 to 2021, which now include marine renewable energy, previously considered an "emerging" sector.

Going beyond "established" and "emerging" sectors, the OECD (Jolliffe, Jolly and Stevens, 2021[12]) proposes a new list of 14 sectors (Table 1.2) to ensure the international comparability of ocean economy data. These sectors result from a precise scoping of ocean economic activities, defined as those that: take place on or in the ocean; produce goods and services primarily for use on or in the ocean; extract non-living resources from the marine environment; harvest living resources from the marine environment; use living resources harvested from the marine environment as intermediate inputs; or would likely not take place were they not located in proximity to the ocean.

Some definitions of the blue or ocean economy expand to cover freshwater, coasts and the ocean. For example, freshwater sources are considered integral parts of the ocean economy in Canada and the United States. Likewise, UN-Habitat suggests expanding the concept of blue economy to all waterbodies, including lakes, rivers and wetlands, arguing that urban centres on coasts and waterfronts play a pivotal role in the blue economy and that inland cities are affected by water-related risks as much as coastal or island ones (UN-Habitat, 2018[8]).

Table 1.2. OECD list of ocean economic activities for internationally comparable statistics

	Ocean-specific description
1	Marine fishing
2	Marine aquaculture
3	Maritime passenger transport
4	Maritime freight transport
5	Offshore extraction of crude petroleum and natural gas
6	Marine and seabed mining
7	Offshore industry support activities
8	Processing and preserving of marine fish, crustaceans and molluscs
9	Maritime ship, boat and floating structure building
10	Maritime manufacturing, repair and installation
11	Offshore wind and marine renewable energy
12	Maritime ports and support activities for maritime transport
13	Ocean scientific research and development
14	Marine and coastal tourism

Source: Jolliffe, J., C. Jolly and B. Stevens (2021[12]), "Blueprint for improved measurement of the international ocean economy: An exploration of satellite accounting for ocean economic activity", https://doi.org/10.1787/aff5375b-en.

This report considers three additional factors. First, beyond ocean-based industries and marine ecosystems, it refers to freshwater-based industries and ecosystems, moving from "ocean" to "blue" economy at large. Second, because freshwater and seawater are intrinsically linked through the global water cycle, the report asserts that water security should be considered as a critical element for resilient blue economy sectors. Third, it emphasises the importance of a territorial approach to the blue or ocean economy, which implies tailoring policies to local challenges including through effective multi-level governance. To shed light on the state of play, challenges and opportunities for the blue economy at the subnational level, the OECD has developed and disseminated a Global Survey on Localising the Blue Economy (Box 1.1), hereafter referred to as "the OECD survey".

Box 1.1. OECD Global Survey on Localising the Blue Economy

The OECD survey was developed as part of the OECD Cities and Regions for a Blue Economy programme, aiming to:

- Build knowledge on the scope and the state of play of the blue economy in cities and regions, including the main drivers, challenges, threats and impacts of the blue economy at the local level and formal blue economy initiatives across levels of government.
- Identify the governance landscape of the blue economy across levels of government.
- Inventory future priorities for the blue economy in cities and regions.

Launched in July 2022, the OECD survey was developed and disseminated in collaboration with the International Association of Cities and Ports (AIVP), Atlantic Cities, the International Network of Basin Organizations (INBO), ICLEI – Local Governments for Sustainability Southeast Asia Secretariat, the Ocean & Climate Platform, the Resilient Cities Network and United Cities and Local Governments Africa (UCLG-Africa).

By September 2023, the survey had collected 81 responses from subnational governments and river basin organisations from 41 countries (Figure 1.1). A total of 50 cities, 17 regions, 11 basins and 3 small island developing states (SIDS) (Comoros, Mauritius and Seychelles) completed the survey. Of these 81 responses, 27 came from Europe, 20 from Africa, 17 from Latin America and the Caribbean, 11 from Asia-Pacific and 6 from North America. More than half (51%) of the responses came from OECD countries. The survey participants comprised 51 coastal[1] and 30 inland cities, regions, basins and SIDS.

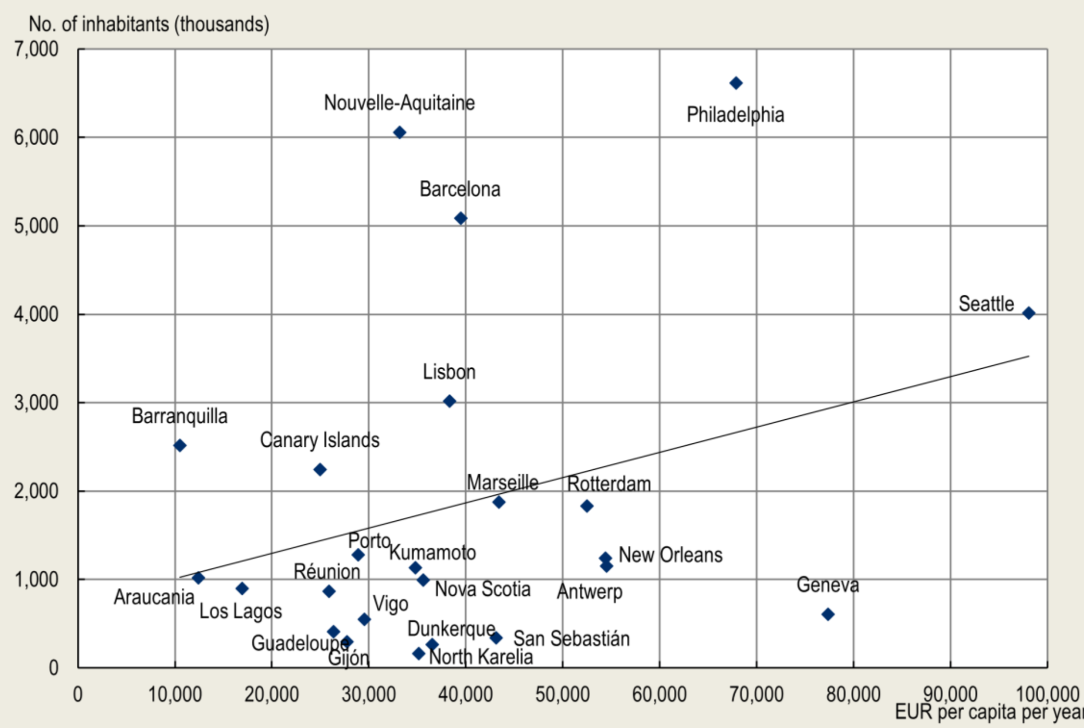
Figure 1.1. Geographical coverage of the OECD Global Survey on Localising the Blue Economy

Note: Based on the 81 cities, regions, basins and SIDS that completed the OECD survey.

Targeted respondents were primarily officials from local and regional governments in charge of the blue economy, water or economic development. In addition, the OECD survey collected responses from river basin organisations, which are set up by political authorities or in response to stakeholder demands, to deal with water resource management issues in river basins, lake basins or aquifers, and by national government officials from SIDS where the blue economy plays a crucial role in national economic development and the competencies of subnational governments are not as significant as in other countries. Respondents were invited to participate in the survey irrespective of their current stage of development in terms of blue economy strategies and initiatives. They had the opportunity to respond in English, French, Portuguese or Spanish.

Survey respondents from subnational governments in OECD countries represent cities and regions of all sizes (Figure 1.2): one-third (29%) have more than 2 million inhabitants, half (50%) have between 500 000 and 2 million, and 21% have fewer than 500 000 inhabitants. Figure 1.2 also illustrates the gross domestic product (GDP) per capita of OECD cities and regions that responded to the survey, showcasing a diverse sample with GDP per capita ranging from EUR 10 510 (Barranquilla) to EUR 98 051 (Seattle), with 68% of cities and regions below the average.

Figure 1.2. Population size by GDP per capita of a selection of surveyed OECD cities and regions



Note: Data provided for 24 OECD cities and regions (data not available for 12 OECD cities and regions in the survey sample; Los Angeles considered as an outlier). They refer to the corresponding administrative level of the city or region responding to the survey. Average population: 1 851 837 inhabitants; Average GDP: EUR 39 483/capita/year. Data for population size refer to most recent available year, which ranges from 2019 to 2022: 2019 [Dunkerque (France), Marseille (France)], 2020 [Porto (Portugal), Lisbon (Portugal)], 2021 [San Sebastián (Spain), Guadeloupe (France), Vigo (Spain), Geneva (Switzerland), La Réunion (France), Los Lagos (Chile), Nova Scotia (Canada), Araucanía (Chile), Kumamoto (Japan), North Karelia (Finland), New Orleans (United States), Rotterdam (The Netherlands), Canary Islands (Spain), Seattle (United States), Barcelona (Spain), Nouvelle-Aquitaine (France), Philadelphia (United States), and 2022 [Barranquilla (Colombia)]. Data for GDP per capita refer to most recent available year, which ranges from 2019 to 2020: 2019 [Kumamoto (Japan), Dunkerque (France), Marseille (France)] and 2020 [Barranquilla (Colombia), Araucanía (Chile), Los Lagos (Chile), Canary Islands (Spain), La Réunion (France), Guadeloupe (France), Gijon (Spain), Porto (Portugal), Vigo (Spain), Nouvelle-Aquitaine (France), North Karelia (Finland), Nova Scotia (Canada), Lisbon (Portugal), Barcelona (Spain), San Sebastián (Spain), Rotterdam (The Netherlands), New Orleans (United States), Antwerp (Belgium), Philadelphia (United States), Geneva (Switzerland), Seattle (United States)].
Source: OECD (2023[13]), *OECD Regions and Cities Statistical Atlas*, https://www.oecd.org/cfe/regionaldevelopment/oecdexplorer.htm.

Socio-economic benefits of the blue economy

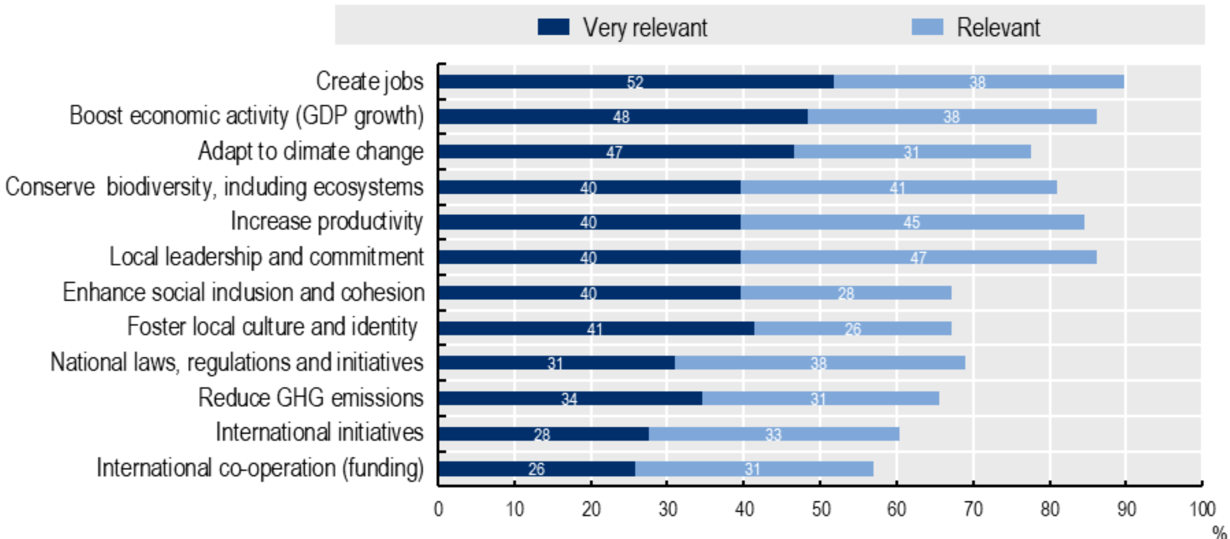
Considering only ten sectors as proxies, the OECD conservatively valued the ocean economy at USD 1.5 trillion annually in 2010 in global value added, accounting for around 2.5% of global GDP and 30 million direct jobs (OECD, 2016[1]). Offshore oil and gas accounted for one-third of total value added, followed by maritime and coastal tourism, maritime equipment and ports. In a business-as-usual scenario, in 2030, it was anticipated that these sectors would employ over 40 million people and grow to more than USD 3 trillion, maintaining the ocean economy's share of 2.5% of total global gross value added (GVA). Across almost all sectors, employment was expected to grow faster than the average for the world economy. For example, in the European Union (EU) alone, GVA and employment in offshore wind energy grew by 1 762% and 1 000% respectively between 2010 and 2020. EU port activities, which grew 25% over the same period, generate around 2.5 million direct and indirect jobs in related industries such as logistics, shipping and maritime services (Scholaert, 2020[14]). Since the first OECD estimates, much progress has been made in terms of measurement and new OECD preliminary indicators on the ocean economy show that ocean industries could represent more than 6% of global value added in 2020 (OECD, forthcoming[15]).

Some blue economy sectors can play a key role in unlocking the green transition. For example, water-based renewable energy (e.g. offshore wind power, floating solar panels or tidal energy) can power the clean energy transition; aquaculture solutions (e.g. oyster reefs) can mitigate coastal flood risks; and blue bioeconomy and biotechnology (e.g. seaweed farming) can capture carbon and nutrient pollution. The number of global ocean renewable energy inventions grew by 7% annually between 2000 and 2019 (OECD, 2023[16]). Offshore wind provided just 0.3% of global electricity supply in 2018 but has the potential to generate more than 420 000 terawatt-hours per year worldwide, representing 18 times the current global electricity demand (OECD, 2022[17]).

The blue economy can be a powerful driver of local and regional development. According to the OECD survey, job creation and economic growth are considered the most significant drivers for the blue economy at the subnational level, with respectively 90% and 88% of respondents deeming them "very relevant" and "relevant" drivers (Figure 1.3). For example, the blue economy represents 4.3% of the GDP of Barcelona, Spain, and 1.4% of the city's workforce (Ajuntament de Barcelona/Barcelona Activa, 2021[18]). In the state of California, United States, 1 in 9 jobs connects to port-related activity (Port of Los Angeles, 2022[19]) and, in the state of Louisiana, United States, the inland Port of South Louisiana is the first in the country in terms of dry bulk cargo and second in terms of tonnage handled (U.S. Department of Transportation, 2022[20]). Despite the COVID-19 pandemic, the blue economy in the region of Flanders, Belgium, grew from 4.5% of GDP in 2018 to 5.2% in 2021, and port activities in the region have a multiplier effect of 2, with 103 000 direct jobs in the ports of Flanders and 230 000 related ones (Blue Cluster, forthcoming[21]). In the city of Seattle, United States, cruise passenger spending benefits local businesses with nearly USD 900 million per year in local economic activity, supporting around 5 500 local jobs (Port of Seattle, 2022[22]). In SIDS, fisheries represent an important share of GDP, such as in Comoros (8% in 2017) (World Bank, 2019[23]) and the Seychelles (16% in 2019) (Seychelles Trade Portal, 2019[24]).

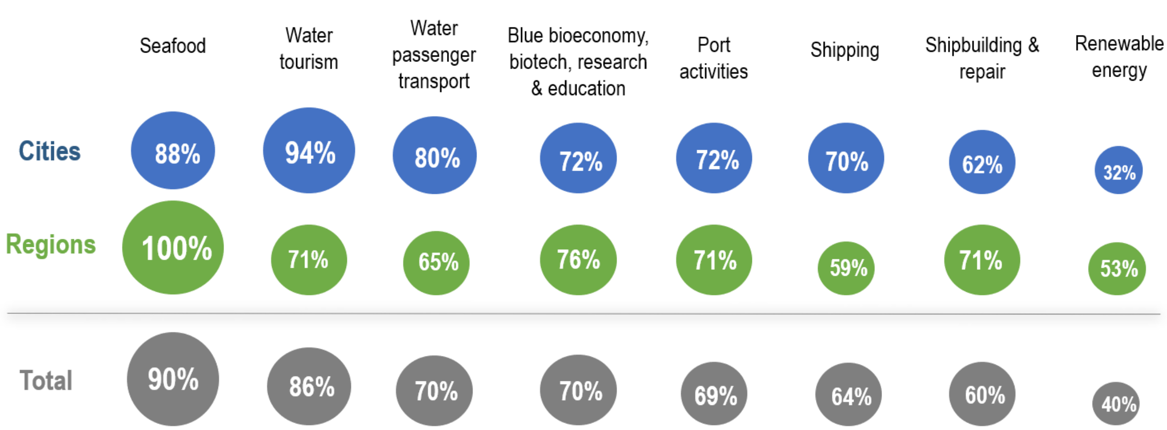
The OECD survey highlights that blue economy sectors have different levels of relevance across scales. Seafood (90%), water-related tourism (86%) and water passenger transport (70%) are the most common sectors of the blue economy cities and regions (Figure 1.4). On average, cities and regions report a similar number of blue economy sectors (5.7 out of the 8 considered), albeit with sectoral differences (Figure 1.4). Compared to other regions, cities recognise more prominently the presence of tourism (23 percentage points higher) and water passenger transport (+15 percentage points). Compared to cities, regions consider more prominently emerging sectors such as renewable energy (+21 percentage points) and blue bioeconomy, biotechnology, research and education (+4 percentage points). The divergence in sectors reported by cities and regions may be explained by the fact that local governments generally have the competency for local public transport and tourism, and that regional governments tend to be responsible for higher education and research (OECD, 2022[25]).

Figure 1.3. Drivers for the blue economy across survey respondents



Note: Based on 81 responses to the question: "1.2.1. What are the main drivers behind blue economy activities in your city/region?". Survey respondents were invited to select one of the following options: "very relevant", "relevant", "somewhat relevant", "little relevant" or "not relevant".
Source: OECD (2023[26]), "OECD Global Survey on Localising the Blue Economy (July 2022- September 2023)", Unpublished, OECD, Paris.

Figure 1.4. Blue economy sectors creating value and providing jobs in cities and regions



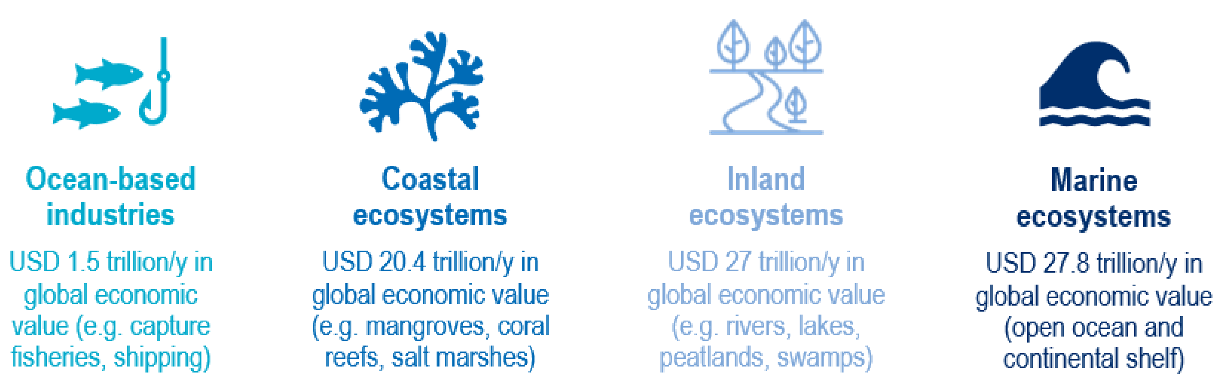
Note: The OECD survey focused on eight sectors (seafood; water-related tourism; water passenger transport and related services; blue bioeconomy, biotechnology, research and education; shipping; shipbuilding and repair; renewable energy), based on OECD and EU classifications of ocean economy and blue economy sectors respectively. Shares based on 67 responses from cities and regions only (basins and SIDS excluded, given they represent only 18% of the sample) to the question: "1.1.1 What blue economy sectors take place in your city/region?". Survey respondents were invited to select any of the eight sectors.
Source: OECD (2023[26]), "OECD Global Survey on Localising the Blue Economy (July 2022- September 2023)", Unpublished, OECD, Paris.

Non-market benefits of the blue economy

Conserving biodiversity and ecosystems is considered a major or important driver for a sustainable blue economy for 81% of respondents (Figure 1.3). The blue economy also includes non-market benefits provided by freshwater, coastal and marine ecosystems (e.g. natural river systems, lakes, wetlands, mangroves and coral reefs), such as provisioning services (e.g. seafood), regulating services (e.g. coral reefs and mangroves acting as flood protection barriers or carbon sinks), cultural services (e.g. recreational use of freshwater ecosystems) and supporting services (e.g. mangroves supporting fish nurseries) (Millenium Ecosystem Assessment, 2004[27]). In the European Union, an EUR 400 billion worth of ecosystem services are generated on average on a 10 km coastal zone (EC, 2021[5]). The ecosystem services provided by freshwater[2] (rivers, streams, lakes, inland wetlands and aquifers) have been valued at USD 58 trillion per year globally (WWF, 2023[28]). Other studies indicate that coastal and inland ecosystems (wetlands) and marine ecosystems (open ocean and continental shelf) have been estimated to provide ecosystem services worth over USD 47 trillion and USD 27 trillion per year respectively (Davidson et al., 2019[29]) (Figure 1.5).

Ecosystem services provided by freshwater, coastal and marine ecosystems include the provision of food and raw materials, water purification, carbon capture, biodiversity and recreation. For example, the global annual value of coral reefs, mangroves and peatlands has been estimated at USD 172 billion (OECD, 2022[30]), USD 2.7 trillion and USD 17.5 trillion respectively (Davidson et al., 2019[29]) (Table 1.4). Within the blue economy, investing in natural assets such as mangroves and coral reefs can pay a double dividend, benefitting economic activities (e.g. tourism) and ecosystem services (e.g. flood protection, carbon capture and biodiversity) alike. For example, in the framework of its Climate Action Plan, the city of Salvador, Brazil, considers natural assets such as mangroves and coral reefs beneficial for tourism and climate resilience. It aims to implement a coastal management system to protect these assets from environmental damage. More broadly, it has been estimated that investing USD 1 in mangrove conservation and restoration can generate a financial, environmental and health benefit of USD 3-17 over a 30-year period (Ocean Panel, 2020[31]).

Figure 1.5. The value of the ocean economy and related ecosystems

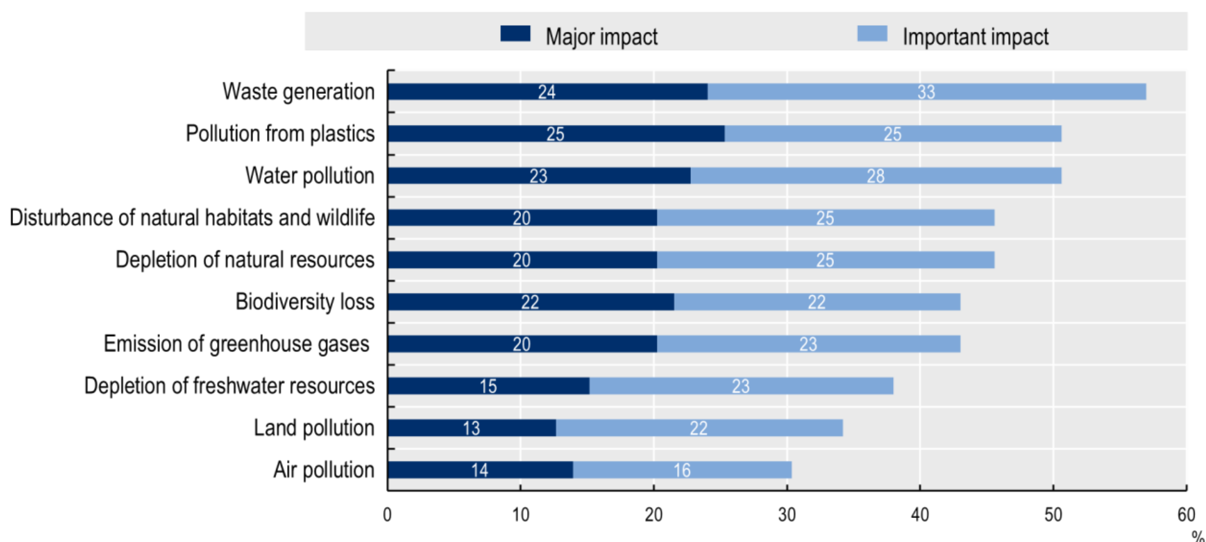


Note: The OECD estimated conservatively ten ocean-based industries' net direct contribution to the overall economy, using value added to avoid double counting. The global economic values of marine, inland and coastal ecosystems are measured by Davidson et al. (2019[29]) as the sum of ecosystem service values provided by inland and coastal wetlands (2011 base year) using the value transfer approach.
Source: OECD (2016[1]), *The Ocean Economy in 2030*, https://doi.org/10.1787/9789264251724-en; Davidson, N. et al. (2019[29]), "Worth of wetlands: Revised global monetary values of coastal and inland wetland ecosystem services", https://doi.org/10.1071/mf18391.

Costs of unsustainable blue economies

Despite the numerous socio-economic benefits of blue economy sectors and the non-market benefits of blue ecosystems, the blue economy is almost never sustainable. In fact, it can be a major source of carbon emissions and pollution in cities, regions and basins. According to the OECD survey, 57% of respondents see waste generation as a "major" or "important" environmental impact of the blue economy, and 51% perceive the same for pollution from plastics and water pollution (Figure 1.6). For instance, resource-intensive activities such as tourism and coastal development can drive waste generation, ghost fishing gear contributes to around 10% of plastic pollution in the ocean (OECD, 2021[32]; Greenpeace, 2019[33]) and aquaculture can introduce excess nutrients that overstimulate toxic algal growth (Jeanson et al., 2022[34]). In the absence of adequate wastewater treatment, all blue economy sectors contribute to water pollution, which can trigger toxic algal blooms and cause "dead zones" (oxygen depletion) in the ocean and coastal waters, which in turn can affect fisheries and marine tourism (OECD, 2022[30]). These environmental stressors affect the waterways, coastal and ocean's capacity to provide economic benefits such as seafood and ecosystem services that strengthen resilience[3] to the impacts of climate change and environmental degradation (OECD, 2022[30]).

Figure 1.6. Main environmental impacts generated by blue economy activities at the local level



Note: Based on 79 responses to the question: "1.2.4. What environmental impacts do blue economy activities generate in your city/region?". Survey respondents were invited to select one of the following options: "major impact", "important impact", "moderate impact", "small impact" or "no impact".
Source: OECD (2023[26]), "OECD Global Survey on Localising the Blue Economy (July 2022- September 2023)", Unpublished, OECD, Paris.

Survey respondents also flag the disruption of natural habitats and wildlife and the depletion of natural resources as major or important environmental impacts of the blue economy (both 46%). For instance, the discharge of ballast water[4] from ships can disrupt the balance of marine ecosystems by introducing non-native species or spreading diseases among local aquatic and marine organisms (Braathen, 2011[35]); deep-water fisheries (bottom trawling) can destroy natural habitats and facilitate the extinction of sensitive species (Falsone et al., 2022[36]); and offshore renewable energy infrastructure can affect marine fish behaviour and migration (Galparsoro et al., 2022[37]). Some ocean-based sectors, such as offshore oil and gas extraction and production, and sand extraction from the seabed and beaches, can significantly disrupt the functioning of the ecosystems in which they take place. For example, the state of Louisiana, United States, has lost nearly one-quarter of its coastal land in the past century due to several factors, including the creation of canals for shipping and levees to stop the natural flooding cycles that originally built and maintained the land around the Mississippi River Delta. Other examples of the impacts of the blue economy on freshwater, coastal and marine ecosystems are presented in Table 1.3.

Table 1.3. Examples of impacts of blue economy sectors on blue ecosystems

Sector	Examples of impacts	C&M	F
Seafood	Overfishing can deplete fish stocks, disrupt marine food webs, and harm non-target species	✓	✓
	Use of aquafeed, fertiliser, and hormone use in aquaculture can stimulate algae growth	✓	✓
	The introduction of non-native species in open-water aquaculture can create ecological disruptions	✓	✓
	Bycatch poses challenges to fishermen, recovering fish populations and entire food webs	✓	✓
	Waste and ghost fishing gear damage the environment and disrupt habitats	✓	✓
	Destructive fishing practices (e.g. trawling, cyanide and dynamite fishing) damage ecosystems and habitats	✓	✓
	Seafood processing effluent discharges contaminate water bodies and disrupt ecosystems	✓	✓
Water-related tourism	Waterside tourist infrastructure can alter coastal landscapes, create soil erosion and loss of biodiversity	✓	✓
	Plastic waste influx affects marine and aquatic life (increased risk of death)	✓	✓
	Overtourism can lead to coral bleaching and disturb the balance of marine and aquatic life	✓	
	Water abstraction induces water stress in freshwater ecosystems		✓
Renewable energy	Infrastructure can disrupt ecosystems through noise pollution and collision risks	✓	✓
	Hydropower infrastructure can alter river flow and affect fish migration		✓
Blue bioeconomy, biotechnology, research and education	Release of pollutants and chemicals that contaminate water bodies and impact ecosystems	✓	✓
	Release of genetically modified organisms or invasive species into the marine/aquatic environment	✓	✓
Water passenger transport and shipping	Discharge of pollutants from vessels, such as oil spills, ballast water or sewage, can harm ecosystems	✓	✓
	Vessels can disrupt ecosystems through noise pollution and collision risks with wildlife	✓	✓
	Water abstraction for canals induces water stress in freshwater ecosystems		✓
Port activities	The release of sediments, chemicals and debris affects water quality and ecosystem health	✓	✓
	Infrastructure and dredging operations can alter river flow patterns	✓	✓
	Noise pollution and light pollution from port activities can disrupt coastal habitats	✓	✓
	The release of invasive species into the marine/aquatic environment can disrupt ecosystems	✓	✓
Shipbuilding and repai	The improper disposal of hazardous materials and waste can harm marine and aquatic life	✓	✓
	Run-off containing pollutants affects water quality and ecosystem health	✓	✓
	Dredging and construction lead to sediment discharge into freshwater, impacting habitats	✓	✓

Note: F = Freshwater ecosystems; C&M = Coastal and marine ecosystems.

Source: Based on Balint, P. et al. (1998[38]), "Risks and benefits of marine biotechnology: Conclusions and recommendations", https://doi.org/10.1007/978-1-4615-5431-8_7; Earth.org (2023[39]), "Coral reef degradation in Hawaii: Is overtourism to blame?", https://earth.org/coral-reef-degredation/; Galparsoro, I. et al. (2022[37]), "Reviewing the ecological impacts of offshore wind farms", https://doi.org/10.1038/s44183-022-00003-5; Guzmán-Luna, P., P. Gerbens-Leenes and S. Vaca-Jiménez (2021[40]), "The water, energy, and land footprint of tilapia aquaculture in Mexico: A comparison of the footprints of fish and meat", https://doi.org/10.1016/j.resconrec.2020.105224; Haraldstad, T. et al. (2019[41]), "Migratory passage structures at hydropower plants as potential physiological and behavioural selective agents", https://doi.org/10.1098/rsos.190989; Jeanson, A. et al. (2022[34]), "Inland fisheries management - Case studies of inland fish", https://doi.org/10.1016/b978-0-12-819166-8.00170-5; Kong, W. et al. (2023[42]), "Sediment and residual feed from aquaculture water bodies threaten aquatic environmental ecosystem: Interactions among algae, heavy metals, and nutrients", https://doi.org/10.1016/j.jenvman.2022.116735; Phillips, M. and A. Jones (2006[43]), "Erosion and tourism infrastructure in the coastal zone: Problems, consequences and management", https://doi.org/10.1016/j.tourman.2005.10.019; WWF (2019[44]), *Plastic Pollution in Greece - A Guide for Policy-makers*, https://wwfeu.awsassets.panda.org/downloads/05062019_wwf_greece_guidebook.pdf.

Beyond these direct impacts on ecosystems and biodiversity, blue economy sectors also contribute to greenhouse gas (GHG) emissions and air pollution, which drive climate change and harm health. Maritime transport alone accounted for almost 3% of global carbon dioxide (CO_2) emissions in 2018 and transport-related emissions from tourism represented approximately 5% of global GHG emissions in 2016 (UNWTO/ITF, 2019[45]). Ships generate around 5-10% of global emissions of sulphur, a GHG and air pollutant with important negative health impacts, and these shipping emissions can represent a large share of total emissions in port cities (ITF, 2016[46]). For example, the 75 cruise ships that docked in the Port of Marseille, France, in 2022 emitted twice as much sulphur oxide as the entire fleet of registered cars in the city (Transport & Environment, 2023[47]).

These impacts generate significant economic losses. For example, marine plastic pollution is estimated to cause global annual losses of 1-5% in the value of ecosystem services, resulting in an annual economic impact ranging from around USD 500 billion to USD 2.5 trillion (Beaumont et al., 2019[48]). In the Gulf of Thailand, plastic pollution has been estimated to cost fisheries around USD 23 million per year (IUCN, 2019[49]). The estimated economic losses due to overfishing amount to USD 83 billion annually at the global level (World Bank, 2016[50]). About 76% of fish species in the Lake Victoria Basin, Kenya, could go extinct (Sayer, Máiz-Tomé and Darwall, 2018[51]), putting at risk not only an industry valued at USD 840 million annually and contributing to more than 800 000 jobs but also a rich freshwater ecosystem (LVFO, 2016[52]).

Ecosystems and the services they provide are declining, with strong consequences of inaction, whereas ecosystem restoration can have a significant return on investment (Table 1.4). Overall, the degradation of six ecosystem services[5] (protection of coasts from flooding and erosion, supply of water, marine fisheries, carbon storage, pollination of crops and timber production) would cost the economy an estimated USD 9.87 trillion by 2050 (WWF, 2020[53]). Inaction has already led to the loss of one-third of the world's freshwater biodiversity (OECD, 2012[54]), 87% of wetland area (UNEP, 2021[55]) and the degradation of 60% of the world's major marine ecosystems (OECD, 2017[56]). At the local level, for example, the Mississippi River Delta in the United States provides ecosystem services worth up to USD 47 billion per year (Batker et al., 2014[57]) and the cost of inaction on land loss induced by erosion, land subsidence and sea level rise could damage ecosystem services, amounting to USD 190 billion over a 100-year period (Batker, Costanza and Day, 2010[58]). However, the literature shows a clear business case for investing in ecosystem restoration: for example, it has been estimated that every dollar invested in ecosystem restoration, including blue ecosystems, could create up to USD 110 in economic benefits including financial returns (e.g. ecotourism or carbon market revenues), savings (e.g. avoided costs of natural disasters) and non-market benefits (e.g. increased food security, recreation services, human health) for public, private and philanthropic investors (World Bank, 2022[59]).

Table 1.4. Estimated value and consequences of inaction on blue ecosystems

Ecosystems	Estimated value of ecosystem services	Status and projections	Examples of consequences of action or inaction
Rivers, streams, lakes, aquifers, inland wetlands (freshwater)	USD 58 trillion per annum or 60% of GDP (WWF, 2023[28])	One-third of global freshwater biodiversity has already been lost and further loss is projected by 2050 (OECD, 2012[54])	19% of global GDP comes from watersheds with high to very high physical water risk (WWF, 2018[60])
Peatlands (freshwater)	USD 17.5 trillion for 2011 (Davidson et al., 2019[29])	15% of the world's peatlands are currently drained and degraded (FAO, 2022[61])	Degradation at current rates will consume 41% of the remaining CO_2 emissions budget to keep global warming within +1.5 degrees Celsius (°C) (UNEP, 2022[62])
Mangroves (coastal)	USD 2.7 trillion for 2011 (Davidson et al., 2019[29])	7.6% of mangrove cover has been lost or degraded between 1996 and 2016 (Worthington and Spalding, 2018[63])	Without mangroves, flood damages globally would cost an additional USD 65 billion and 15 million more people would be at risk of floods each year (Menéndez et al., 2020[64])

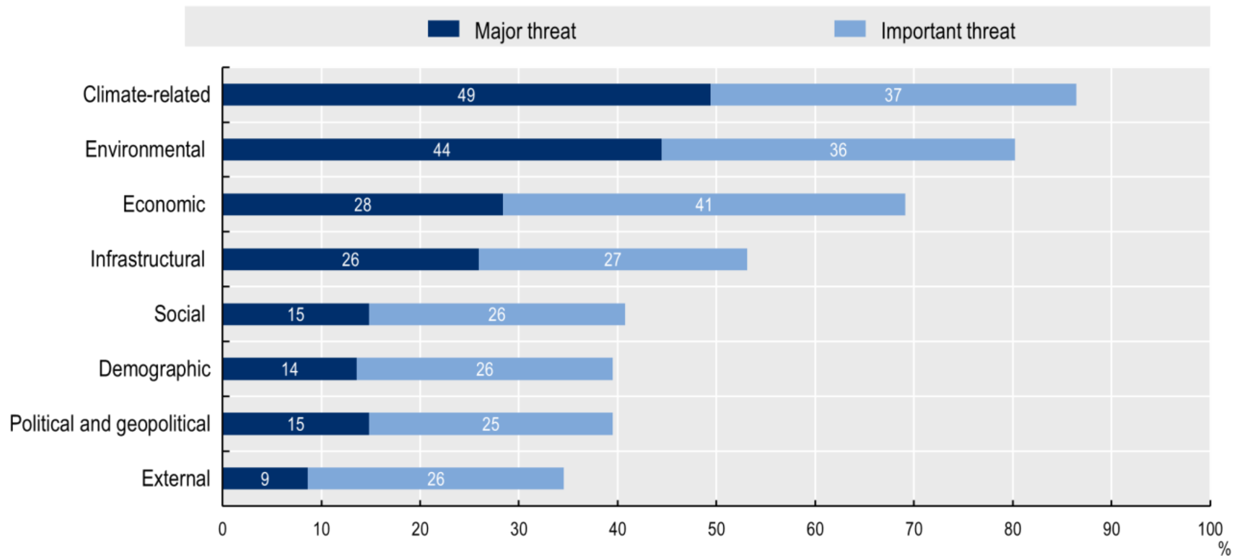
Ecosystems	Estimated value of ecosystem services	Status and projections	Examples of consequences of action or inaction
Salt marshes (coastal)	USD 1.1 trillion for 2011 (Davidson et al., 2019[29])	25-50% of historic global coverage has been lost (Mcowen et al., 2017[65])	The average overall restoration cost of salt marshes was estimated at USD 1 million (2010) per hectare (Bayraktarov et al., 2016[66])
Estuaries (coastal)	USD 1.9 trillion for 2011 (Davidson et al., 2019[29])	No data	Every USD 1 invested in mitigation saves USD 6 in recovery on estuaries (Rouleau et al., 2021[67])
Seagrass (marine)	USD 1.9 trillion per year (Waycott et al., 2009[68])	Loss rate of 7% per year (Waycott et al., 2009[68])	Global seagrass degradation emits 0.65 gigatonnes of CO_2 per year, equivalent to global shipping industry annual emissions (UNEP, 2020[69])
Coral reefs (marine)	USD 172 billion per year (OECD, 2022[30])	Likely to decline by 70-90% if the global temperature increases by 1.5°C compared to pre-industrial levels (IPCC, 2019[70])	Climate-related loss of coral reef ecosystem services is expected to cost at least USD 500 billion annually by 2100 (WWF, 2015[71])
Oyster reefs (marine)	USD 5 500-99 000 per hectare per year (Grabowski et al., 2012[72])	Around 85% of oyster reefs have been lost globally (Beck et al., 2011[73])	Ocean acidification costs around 6 billion USD annually (Narita, Rehdanz and Tol, 2012[74])
Kelp forests (marine)	USD 500 billion annually in global economic value (Eger et al., 2023[75])	Degradation of 40-60% of kelp forests over the last 50 years (Eger et al., 2023[76])	Restoring 1 million hectares of kelp forest will cost USD 40 billion between 2023 and 2040 (Kelp Forest Alliance, 2023[77])

Note: To assess the global value of ecosystem services, different classifications have attempted to categorise these freshwater and marine ecosystems either through biomes or wetland classes (de Groot et al., 2012[78]; Costanza et al., 2014[79]). Recent work defined 22 classes of marine or coastal and inland wetlands, where inland wetlands (representing 77% of total wetland surface) are dominated by peatlands, marshes, swamps, rivers and lakes, while marine or coastal wetlands are dominated by salt marshes, seagrass beds, coral reefs, estuaries and mangroves (Davidson and Finlayson, 2018[80]). The table presents a selection of ecosystems (two freshwater, three coastal, four marine) with available data.
Source: Citations in table.

Costs of environmental and socio-economic risks for blue economies

Climate change is considered a "major" or "important" threat to the blue economy at the local level by 86% of survey respondents (Figure 1.7). Disaggregated survey results indicate that cities and basins consider climate change threats the highest (90% and 82% respectively), while regions consider environmental threats the highest (82%). These threats include chronic and acute hazards related to water, wind, temperature and solid mass, such as droughts, heatwaves, floods and sea level rise (Table 1.5). In addition to generating 50% of the Earth's oxygen, the ocean plays a critical role in regulating the global climate by absorbing 25% of all CO_2 emissions and 93% of the heat generated by these emissions (UN, 2022[81]). Resulting ocean warming and acidification cause damage to coastal and marine ecosystems, such as coral reef bleaching, which increases coastal flood risk and hinders reef-related tourism. In the state of Queensland, Australia, for example, the bleaching of the Great Barrier Reef could cause the loss of 1 million visitors to the region each year, equivalent to at least AUD 1 billion in tourism spending and 10 000 jobs (Australian Climate Council, 2017[82]). In Florida, United States, coral reef degradation could increase the coastal flood risk for more than 7 300 residents, costing USD 823 million every year (Storlazzi et al., 2021[83]). The frequency of marine heatwaves has doubled since the 1980s, causing potentially long-lasting or irreversible damage to many marine species, leading to mass mortality events and ultimately threatening food security (Ocean & Climate Platform, 2023[84]). Environmental threats cover different forms of pollution, including sewage, chemicals and plastics. In 2019, about 30 and 119 megatonnes of plastics had accumulated in oceans and rivers respectively (OECD, 2022[85]). Around 80% of wastewater flows back into the ecosystem without being treated or reused (UNESCO, 2017[86]). Global damage from marine litter was estimated at USD 21 billion in 2020 (McIlgorm et al., 2022[87]).

Figure 1.7. Main threats to the blue economy across survey respondents



Note: Based on 81 responses to the question: "1.2.2. What are the main threats to blue economy activities in your city/region?". Survey respondents were invited to select one of the following options: "major threat", "important threat", "moderate threat", "small threat" or "not a threat".
Source: OECD (2023[26]), "OECD Global Survey on Localising the Blue Economy (July 2022- September 2023)", Unpublished, OECD, Paris.

Table 1.5. Tentative EU classification of climate-related hazards

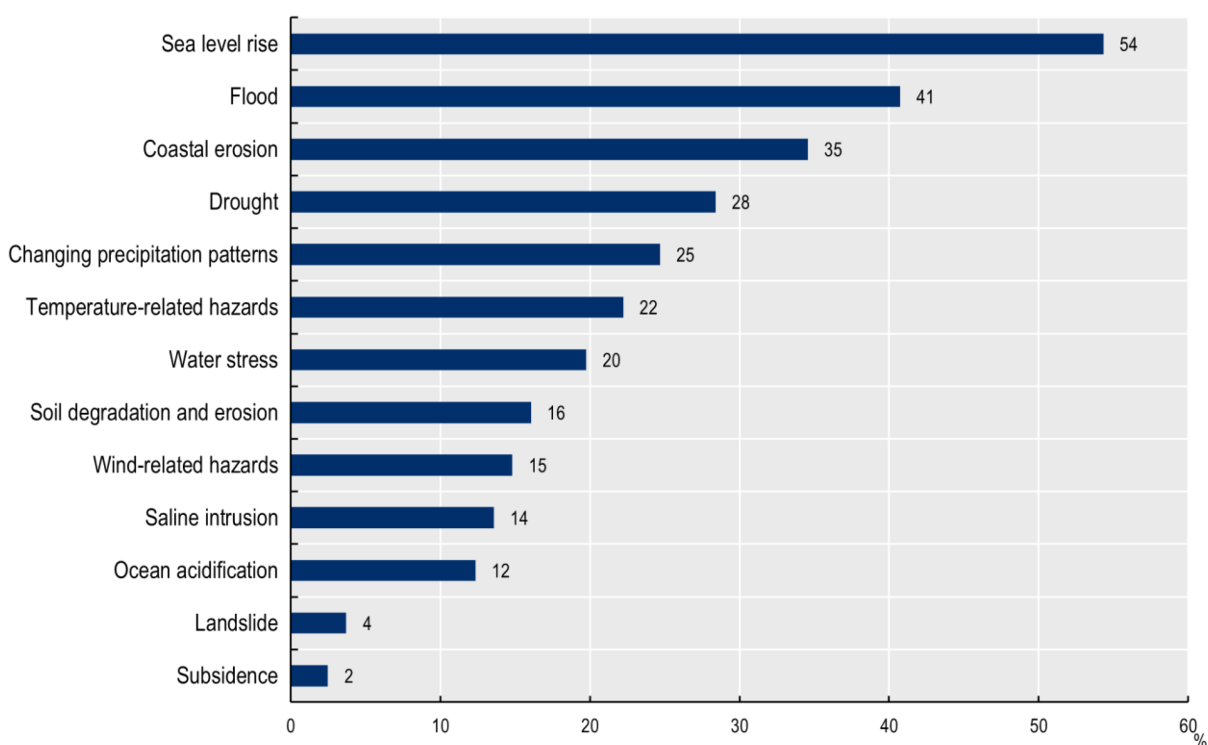
	Temperature-related	Wind-related	Water-related	Solid mass-related
Chronic	• Changing temperature (air, freshwater, marine water) • Heat stress • Temperature variability • Permafrost thawing	• Changing wind patterns	• Changing precipitation patterns and types • Precipitation and/or hydrological variability • Ocean acidification • Saline intrusion • Sea level rise • Water stress	• Coastal erosion • Soil degradation • Soil erosion • Solifluction
Acute	• Heatwave • Cold wave/frost • Wildfire	• Cyclone, hurricane, typhoon • Storm (including blizzards, dust and sandstorms) • Tornado	• Drought • Heavy precipitation (rain, hail, snow/ice) • Flood (coastal, fluvial, pluvial, ground water) • Glacial lake outburst	• Avalanche • Landslide • Subsidence

Source: EC (2023[88]), *Commission Delegated Regulation (EU) 2023/2486 of 27 June 2023 Supplementing Regulation (EU) 2020/852 of the European Parliament and of the Council by Establishing the Technical Screening Criteria*, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32023R2486.

In addition to prominent climate and environment-related issues, the blue economy is also vulnerable to a number of other challenges. These include: economic threats that affect the broader economy (e.g. inflation, cost-of-living crisis, supply chain disruptions), as well as ageing, lacking or insufficiently resilient infrastructure; social issues (e.g. territorial and rights issues between local fishers and larger international fishing companies, workers' strikes, conflicts with civil society organisations, etc.); ageing, booming or shrinking populations; and political and geopolitical threats. Regarding the latter in particular, systemic and smaller-scale corruption can threaten the integrity and inclusiveness of blue economy sectors (e.g. fisheries, port activities and tourism) as well as through corruption in cross-cutting policies at the subnational level (e.g. land use planning and permitting, water supply and sanitation services, waste management, etc.). For example, countries with weak governance frameworks and insufficient capacity to police their waters – often developing ones – are particularly vulnerable to illegal, unreported and unprotected fishing (Hutniczak, Delpeuch and Leroy, 2019[89]). However, the issue is not limited to emerging economies: recognising the potential socio-economic impacts of such practices in the blue economy, in 2020, the European Union made a commitment to address "the negative impact of malpractices and corruption on the sustainable management of marine resources" (CFFA, 2020[90]).

Survey respondents report sea level rise (54%), floods (41%) and coastal erosion (35%) as the main climate threats to the blue economy, with droughts coming in at a close fourth place (28%) (Figure 1.8). About 90% of natural disasters and climate change impacts are water-related (UNISDR, 2015[91]). Sea level rise is projected to affect 800 million people living in the 570 cities exposed to sea level rise of at least 0.5 metres (C40 Cities, 2018[92]). Floods cause damage to urban property worth around USD 120 billion per year (Browder et al., 2019[93]). Sea level rise and floods can disrupt marine and freshwater ecosystems while damaging waterfront infrastructure and assets such as ports, shipyards and accommodation. Coastal erosion, which damages coastal ecosystems and impacts ecosystem services as well as coastal sectors (e.g. tourism, shipping), could be responsible for the loss of 5% of coastal ecosystem services in Europe by 2100 (Paprotny et al., 2021[94]). Droughts and water scarcity can make rivers too shallow for shipping, port activities and energy generation, with ripple effects beyond the blue economy. Droughts can cost the global economy up to 6% of GDP per year by 2050 (World Bank, 2016[95]) and can cost cities up to 12 percentage points in GDP growth (Zaveri et al., 2021[96]). The economic impacts and costs of inaction imposed by climate-related hazards have both global and local implications (Table 1.6).

Figure 1.8. Main climate-related threats to the blue economy at the territorial level



Note: Based on 81 responses to the mandatory question: "1.2.3. What are the three most significant climate-related threats to blue economy activities in your city/region?". Survey respondents were invited to select one of the following options: "yes" or "no".
Source: OECD (2023[26]), "OECD Global Survey on Localising the Blue Economy (July 2022- September 2023)", Unpublished, OECD, Paris.

Table 1.6. Economic impacts and cost of inaction of climate-related hazards

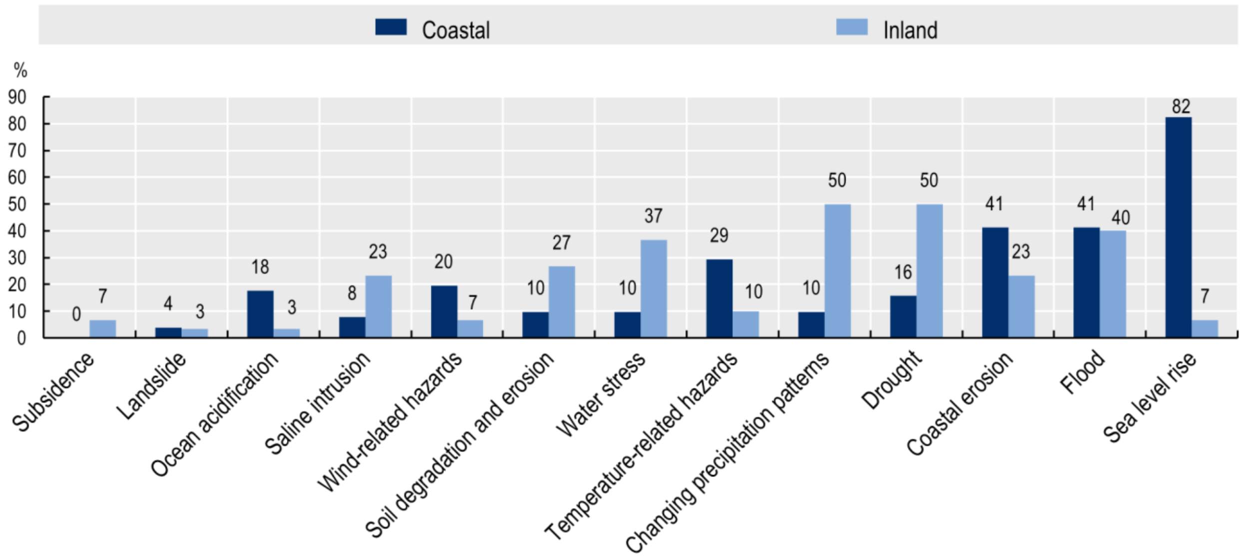
Climate-related hazard	Global economic impacts and projections	Example of local impacts on the blue economy
Sea level rise	Global annual adaptation costs due to sea level rise could reach up to USD 14 trillion by 2100 (NOC, 2018[97])	The cost of elevating the Port of Los Angeles, United States, above the projected sea level rise for 2100 is estimated to be around USD 100 million per year between 2021 and 2100 (RTI, 2022[98])
Coastal flooding	Coastal flooding annual adaptation costs could reach 2.9% of global GDP by 2100 (Kirezci et al., 2022[99])	6% of touristic beaches in Galicia, Spain, are at risk of coastal flooding (Toubes et al., 2017[100])
River flooding	River flooding has caused USD 1 trillion in losses globally since 1980 (WRI, 2020[101])	Floods cost USD 60-70 million on average in the Lower Mekong River Basin (MRC, 2019[102])
Storms	Storm adaptation costs could rise up to USD 2.7 trillion in GDP across 8 countries between 2022 and 2050 (Aquanomics, 2022[103])	Hurricanes Irma and Maria in 2017 caused USD 741 million in tourism revenue losses in the Caribbean region (WTTC, 2018[104])
Drought	The most extreme water deficit events can cost cities up to 12 percentage points in GDP growth (Zaveri et al., 2021[96])	Shipping on the Rhine River was down 27% in 2018 due to low water levels, leading German industrial production to fall by 1.5% and the production of chemicals and pharmaceuticals to drop by 10% for three months (OECD, 2023[105])
Ocean acidification	Ocean acidification could cost the global economy USD 1 trillion annually by 2100 (CBD, 2020[106])	Ocean acidification could cost the shellfish aquaculture industry in the state of Washington, United States, around USD 270 million and 3 200 jobs per year (Cooley et al., 2016[107])
Coastal erosion	Coastal erosion could incur an annual cost of USD 8 billion to global GDP (Sartori et al., 2019[108])	Coastal erosion causes losses of USD 500 million per year to coastal property in US coastal states (U.S. Climate Resilience Toolkit, 2021[109])

Note: i) Sea level rise is an increase in the level of the world's oceans because of global warming. ii) Coastal flooding refers to the inundation of low-lying coastal areas because of extreme weather events. iii) River flooding refers to an overflow of water onto normally dry land. iv) Storms refer to an extreme weather condition with very strong wind, heavy rain, often thunder and lightning. v) Drought refers to a long period with little or no rain. vi) Ocean acidification refers to an alteration of the chemical composition of seawater. vii) Coastal erosion refers to the gradual wearing away of the land or shoreline due to the action of natural forces such as waves, tides, currents and wind.

The disaggregated survey results reveal that cities identify sea level rise (79%) as the main threat; regions identify coastal erosion (35%) and basins drought (73%). Inland respondents primarily mentioned droughts and changing precipitation patterns (both 50%), while coastal respondents emphasised sea level rise (82%) (Figure 1.9).

Climate threats have different impacts across and between territories. For example, in 61 OECD regions spanning 38 countries, more than 30% of the population is at risk of river flooding. In some OECD regions, about 60% of the population is exposed to 100-year river flooding (e.g. Yukon [Canada]; Vaupés, [Colombia]; Tabasco [Mexico]) (Figure 1.10). The city of Rotterdam in the Netherlands is the most exposed OECD metropolitan area of more than 1.5 million inhabitants to river flooding, with more than 60% of its population at risk. Among the OECD survey respondents from OECD countries, Rotterdam and 4 other cities out of 28 (Quillota [Chile]; The Hague [Netherlands]; Geneva [Switzerland]; New Orleans [United States]) as well as the region of North Karelia, Finland, have more than 20% of their population exposed to river flooding. In terms of coastal flood hazard, the Netherlands is the country most at risk, with 55% of its population exposed to 100-year coastal floods. Population exposure is even higher than 90% in 4 out of 12 Dutch regions (Flevoland, Friesland, Groningen, Zeeland). Among the OECD survey respondents, the most exposed cities are all major European port cities: Antwerp [Belgium], Dunkerque [France], Rotterdam and the Hague, [Netherlands], with more than 30% of their population exposed to coastal flooding. By 2030, in the absence of effective adaptation policies, coastal flood risk is projected to increase by a factor of four, while fluvial flood risk could more than double.

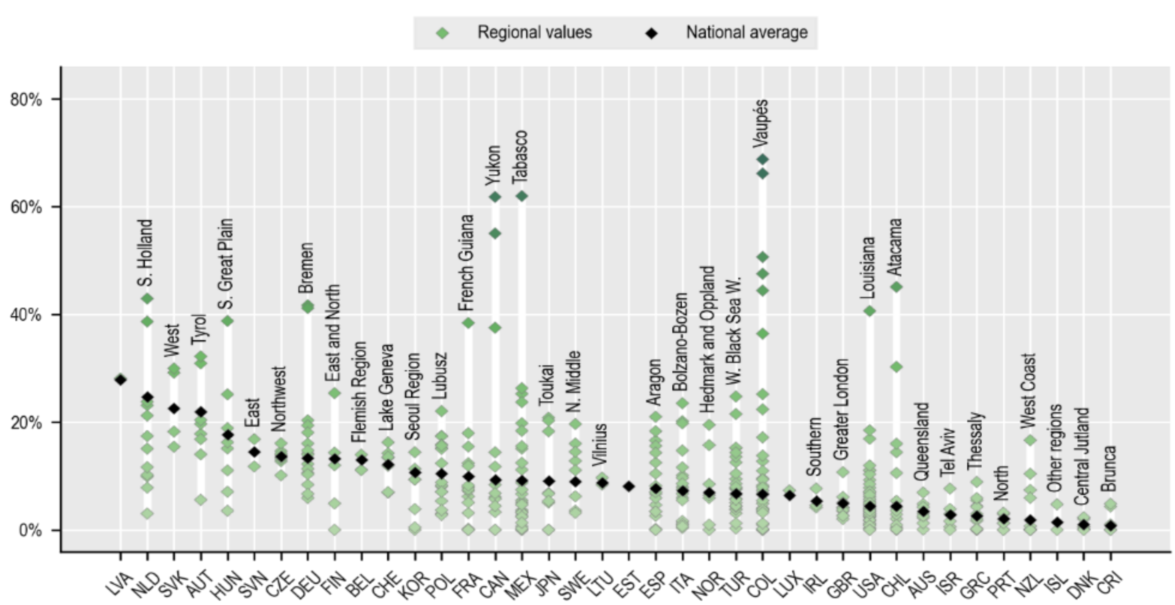
Figure 1.9. Main climate-related threats to the blue economy at the inland and coastal levels



Note: Based on 81 responses to the mandatory question: "1.2.3. What are the three most significant climate-related threats to blue economy activities in your city/region?". Survey respondents were invited to select one of the following options: "yes" or "no".
Source: OECD (2023[26]), "OECD Global Survey on Localising the Blue Economy (July 2022- September 2023)", Unpublished, OECD, Paris.

Figure 1.10. Large subnational disparities in exposure to river flooding

Population exposure to 100-year river flooding in OECD large regions (TL2), 2015



Note: The dataset is derived from river flood hazard maps with a 100-year return period, representing the average or estimated time within which a specific hazard is likely to recur.

Source: OECD (2022[17]), *OECD Regions and Cities at a Glance 2022*, https://doi.org/10.1787/14108660-en; Maes, M. et al. (2022[110]), "Monitoring exposure to climate-related hazards: Indicator methodology and key results", https://doi.org/10.1787/da074cb6-en based on Dottori, F. et al. (2021[111]), *River Flood Hazard Maps for Europe and the Mediterranean Basin Region (dataset)*, https://data.jrc.ec.europa.eu/dataset/1d128b6c-a4ee-4858-9e34-6210707f3c81; Florczyk et al. (2019[112]), *GHS Urban Centre Database 2015, Multitemporal and Multidimensional Attributes, R2019A (dataset)*, https://data.jrc.ec.europa.eu/dataset/53473144-b88c-44bc-b4a3-4583ed1f547e.

Within cities and regions, structural inequalities in exposure to climate risks mean that economically vulnerable groups (e.g. low-income groups, those living in sub-standard housing, women, children, the elderly, the disabled, Indigenous peoples and ethnic minorities) are likely to be hit the hardest by climate change impacts and have a lower capacity to recover from such shocks (OECD, 2023[113]). Informal settlements, home to approximately 29% of the global urban population, face significantly higher risks from floods and other water-related disasters, as many informal settlements sit on floodplains and riverbanks, and consist of very closely built structures that can disturb natural land drainage patterns and watercourses. Developed countries are not exempt: in the United States, 1.4% of the population and 11% of adults in the state of Louisiana were forced to evacuate their homes in 2022 due to hurricanes, floods and other extreme events, and evacuation rates were the highest for the lowest-income households. Women, who account for more than 75% of displaced persons from climate hazards, are often disproportionately affected and take longer to recover from climate shocks due to their comparatively vulnerable social and economic status.

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Notes

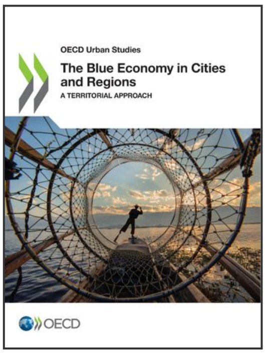
[1] Coastal areas are defined as the interface or transition areas between land and sea, including large inland lakes (FAO, 1998[116]), an area within a distance of 10 km from the coastline (OECD, 2023[114]). Coastal cities are a densely inhabited place within a coastal area with a population of 50 000 or more (Urban Ocean Lab, 2022[115]).

[2] The global economic value of freshwater ecosystems is measured by the World Wildlife Fund (WWF) in terms of direct freshwater use (including consumptive and non-consumptive industries as well as supportive water-related infrastructure and services) and indirect use (including biodiversity, extreme event protection and environmental regulation) benefits (2021 base year) using the total economic value framework.

[3] According to the OECD, resilience is about addressing the root causes of crises while strengthening the capacities and resources of a system to cope with risks, stresses and shocks (OECD, n.d[118]).

[4] Ballast water is seawater carried in ships' ballast tanks to improve vessel trim, manoeuvrability and stability (Braathen, 2011[35]).

[5] The six ecosystem services were selected based on their economic significance and availability of supporting evidence, with perspectives to add more services in future iterations of the estimation model.



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