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Climate change adaptation for seaports in support of the 2030 Agenda for Sustainable Development

Note by the UNCTAD secretariat

Summary

Ports are critical infrastructure assets that serve as catalysts of economic growth and development and are key nodes in the network of closely interconnected global supply chains. In addition to being gateways to international trade, they create employment, generate wealth, contribute to national gross domestic product (GDP) and promote nearby urban and industrial agglomerations. However, ports and other coastal transport infrastructure are exposed to the risk of climate change-related impacts, particularly in view of their location in coastal zones, low-lying areas and deltas, with broader implications for international trade and for the development prospects of the most vulnerable nations, particularly the least developed countries and small island developing States. Given the strategic role of ports as part of the global trading system and the potential for climate-related damage, disruption and delay across global supply chains, with significant associated costs and economic and trade-related losses, enhancing the climate resilience of ports is a matter of strategic economic importance and key in achieving progress on many of the Goals and targets under the 2030 Agenda for Sustainable Development.

Against this background, and drawing on the related work of UNCTAD, some key issues are presented in this note, to facilitate deliberations on a way forward. A brief overview is provided of the main climate change-related impacts in the light of observed trends and projections and of the key considerations with regard to adaptation and resilience-building. In addition, special considerations for small island developing States are presented, as well as recent related international developments and some cross-cutting issues.

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I. Introduction and context

1. With over 80 per cent of the volume of world trade carried by sea from port to port, international shipping and seaports provide crucial linkages in the network of global supply chains and are essential for all countries, including landlocked countries, to be able to access global markets. Seaports in developing countries account for more than 60 per cent of goods loaded and unloaded, at the global level, illustrating the interconnectedness and interdependence of economies and of key transport nodes and networks.[1] Ports are critical infrastructure assets that serve as catalysts of economic growth and development. In addition to being gateways to international trade, they create employment, generate wealth, contribute to national GDP and promote nearby urban and industrial agglomerations.

2. While ports are at the heart of international trade and globalization, they are also exposed to various hazards induced by climate change. Due to their locations along open coasts or low-lying estuaries and deltas, ports are particularly affected by rising sea levels and storm surges, waves and winds, as well as riverine and pluvial flooding. Given the concentration of populations and services and the size and value of infrastructure in port areas, as well as the vital role of ports in international supply chains, climate change-related impacts on ports and their hinterland transportation links can have broad ramifications for a range of economic sectors. Port infrastructure damages and/or operational disruptions and delays may adversely affect trade, energy and food supply, as well as tourism, with broader implications for international supply chains and for the development prospects of the most vulnerable nations, particularly the least developed countries and small island developing States.

3. Given the strategic role of ports as part of the global trading system and the potential for climate-related damage, disruption and delay across global supply chains, with significant associated costs and economic and trade-related losses, enhancing the climate resilience of ports is a matter of strategic economic importance. At the same time, effective adaptation and resilience-building for ports and other important transport infrastructure assets will also be key in achieving progress on many of the Goals and targets that collectively make up the international community's 2030 Agenda for Sustainable Development. This includes Goal 9 on building resilient infrastructure, promoting inclusive and sustainable industrialization and fostering innovation; Goal 13 on taking urgent action to combat climate change and its impacts; Goal 14 on conserving and sustainably using the oceans, seas and marine resources for sustainable development; and target 1.5 on building the resilience of the poor and those in vulnerable situations and reducing their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters.

4. Without well-functioning and climate-resilient ports, it will be difficult to achieve progress in advancing towards many of the sustainable development objectives of the 2030 Agenda, as well as those of other international agreements such as the New Urban Agenda, the Paris Agreement under the United Nations Framework Convention on Climate Change, the Programme of Action for the Least Developed Countries for the Decade 2011–2020, the Sendai Framework for Disaster Risk Reduction 2015–2030 and the Small Island Developing States Accelerated Modalities of Action (SAMOA) Pathway. This is also implicitly recognized in the Addis Ababa Action Agenda of the Third International Conference on Financing for Development, the Ashgabat Statement on Commitments and Policy Recommendations of the Global Sustainable Transport Conference and the Nairobi Maafikiano.[2]

5. UNCTAD has been working on the implications of climate change for transportation since 2008, with a particular focus on impacts on and the adaptation needs of ports and

[1] UNCTAD, 2019, *Review of Maritime Transport 2019* (United Nations publication, Geneva).

[2] See https://sustainabledevelopment.un.org/Global-Sustainable-Transport-Conference-2016; TD/519/Add.2, paragraph 55 (f), (k) and (l).

Note: All websites referred to in this note were accessed in January 2020.

other coastal transport infrastructure, including in small island developing States.[3] Relevant research and analytical work, including peer-reviewed publications, as well as the outcomes of a series of expert meetings and technical cooperation activities with a focus on small island developing States, has significantly helped to raise awareness and advance the international debate and benefits from strong support by member States.[4] Most recently, UNCTAD has published a compilation of policies and practices of relevance to climate change-related impacts and adaptation for coastal transport infrastructure.[5]

6. Lessons learned as part of UNCTAD work in the past 10 years indicate that multifaceted approaches to adaptation and resilience-building for coastal infrastructure assets are required to effectively address the challenges. These include mainstreaming climate change-related considerations into coastal transport infrastructure planning and operations and pursuing policy coherence in transport, trade and overall sustainable development decision-making. Innovative and mixed adaptation responses in terms of regulation, management and technical measures are needed, including soft and hard adaptation measures.

7. Against this background, and drawing on the related work of UNCTAD, some key issues are presented in this note to facilitate deliberations at the eighth session of the Multi-Year Expert Meeting on Transport, Trade Logistics and Trade Facilitation on a way forward. To this end, the note provides an overview of the main climate change-related impacts in the light of observed trends and recent projections, as well as of the key considerations with regard to adaptation and resilience-building. In addition, special considerations for small island developing States are presented, as well as recent related international developments and some cross-cutting issues.

II. Climate change-related impacts and adaptation for seaports

A. Climate change impacts

8. Seaports are critical coastal transportation assets. They are points of convergence between maritime and inland transportation, providing access to global markets for all countries. Ports and other coastal transport infrastructure that provides multimodal linkages to hinterland connections (that is, coastal roads, railways and inland waterways) consist of complex systems, which will be particularly affected by the impacts of climate variability and change.[6] Rising mean sea levels, the increased frequency and intensity of extreme storm surges and waves, precipitation and droughts and/or river floods, as well as increased mean temperatures and extreme temperature variability are some of the climatic changes that pose serious threats to ports and other coastal transport infrastructure and operations. In the case of large ports, which are mostly integrated within large coastal urban agglomerates, related impacts may affect large populations and a broad range of socioeconomic activities.

[3] See https://unctad.org/ttl/legal.

[4] See https://SIDSport-ClimateAdapt.unctad.org and https://unctad.org/en/pages/MeetingDetails.aspx?meetingid=2354. UNCTAD work has informed, among others, reports of the Intergovernmental Panel on Climate Change in 2014, 2018 and 2019; the Climate Change Policy Framework for Jamaica, 2015; the Brazil National Adaptation Plan to Climate Change, 2016; United Nations climate action pathways for transport and resilience, 2019; port guidance developed by the World Association for Waterborne Transport Infrastructure; and work by the Economic Commission for Europe Group of Experts on Climate Change Impacts and Adaptation for Transport Networks and Nodes.

[5] UNCTAD, 2020, *Climate Change Impacts and Adaptation for Coastal Transport Infrastructure: A Compilation of Policies and Practices* (United Nations publication, Geneva).

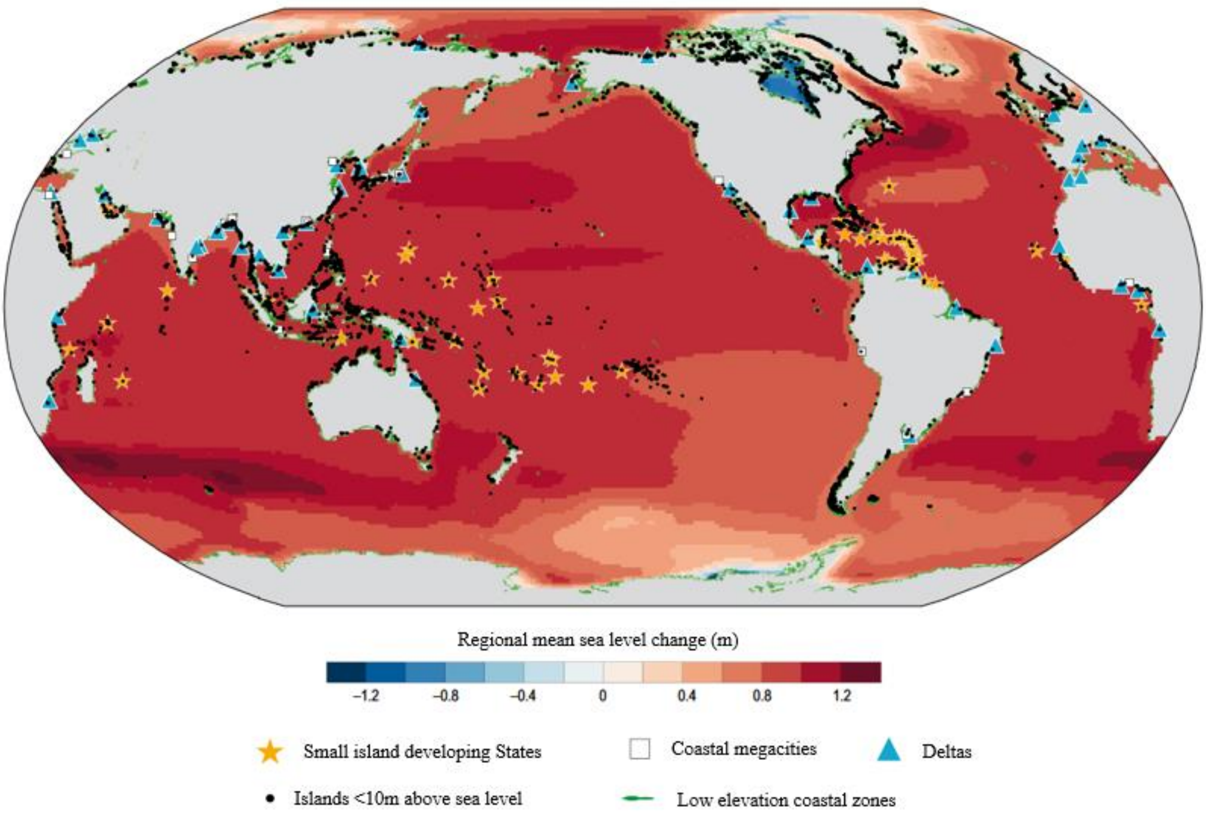
[6] Economic Commission for Europe, 2019, Report of the Group of Experts on Climate Change Impacts and Adaptation for Transport Networks and Nodes, ECE/TRANS/WP.5/GE.3/36, Geneva, 27 June; Economic Commission for Europe, 2013, *Climate Change Impacts and Adaptation for International Transport Networks: Expert Group Report* (New York and Geneva).

9. In addition to causing damage to infrastructure and equipment, climate change-related impacts may also result in significant operational disruptions and delays and lead to extensive economic and trade-related losses. Indirect impacts of climate change on ports include those arising from climate-driven changes to demand for transportation through, for example, changes in population concentration or distribution and changes in production, trade and consumption patterns. Associated risks, vulnerabilities and costs may be considerable, in particular for ports and other coastal transport infrastructure in developing regions with low adaptive capacity and in small island developing States.

10. More detailed information on the types of impacts affecting seaports and other coastal transport infrastructure and on related trends and projections is available, including in a report relating the findings of an UNCTAD port industry survey on climate change impacts and adaptation and, most recently, in the UNCTAD compilation of policies and practices of relevance to climate change-related impacts and adaptation for coastal transport infrastructure.[7] An overview is provided in this section of some of the major impacts of changing climatic factors and hazards on seaport infrastructure and operations in the light of observed trends and recent projections.

11. Projected increases in mean and extreme sea levels are expected to cause permanent and/or recurring marine inundations of ports and other coastal transport infrastructure in many regions, with those in small island developing States particularly affected (figures 1 and 2).

Figure 1
Global distribution of low-lying islands and coasts particularly at risk from sea level rise

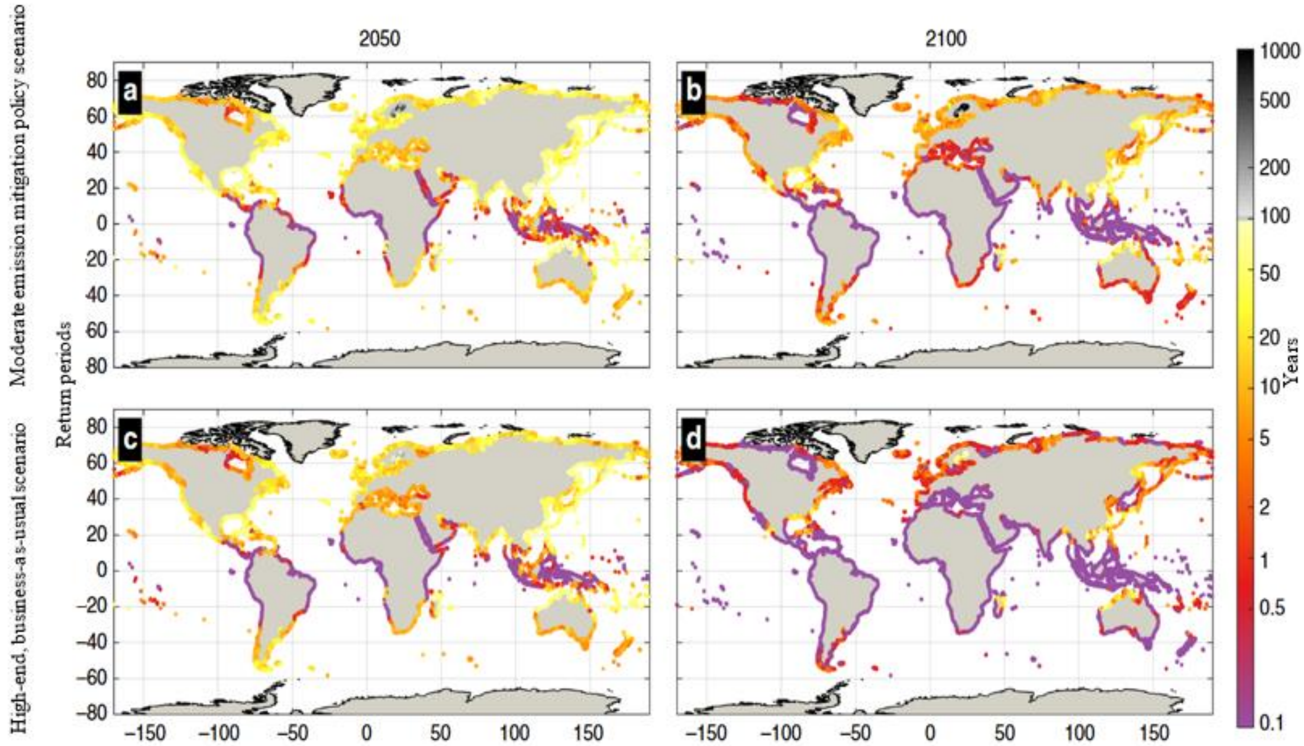


Source: Intergovernmental Panel on Climate Change, 2019, *Intergovernmental Panel on Climate Change Special Report on the Ocean and Cryosphere in a Changing Climate: Cross-Chapter Box 9 – Integrative Cross-Chapter Box on Low-lying Islands and Coasts*.

[7] UNCTAD, 2020, and Asariotis R, Benamara H and Mohos-Naray V, 2018, Port industry survey on climate change impacts and adaptation, Research Paper No. 18, UNCTAD. Both of these documents may be consulted for additional information and extensive further references.

Note: The designations employed and the presentation of material on any map in this work do not imply the expression of any opinion whatsoever on the part of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

Figure 2
Future frequency of the present day 100-year extreme sea level



Source: Vousdoukas MI, Mentaschi L, Voukouvalas E, Verlaan M, Jevrejeva S, Jackson LP and Feyen L, 2018, Global probabilistic projections of extreme sea levels show intensification of coastal flood hazard, *Nature Communications*, 9(2360).

Note: Colours show projected return period of present day 100-year extreme sea level under each scenario in 2050 and 2100 based on the median values; colour scale is not linear.

Coastal inundation

12. Coastal inundation from extreme events can render ports and related transportation systems unusable for the duration of an event and damage terminals, freight villages, storage areas and cargo and disrupt supply chains for longer periods. Impacts could include disruptions to operations and damages to port infrastructure and vessels, as well as hinterland connections.

13. Extreme sea levels are set to occur more frequently almost everywhere. Extreme sea level events of a certain magnitude that currently have a low recurrence frequency or return period[8] will become more frequent in the future (figure 2). As the recurrence frequency of extreme sea levels and associated waves forms a part of the fundamental parameters of the design of defences for coastal transport infrastructure, both the assessment of impacts and the choice and design of effective adaptation options need to be considered on the basis of future projections of the return periods of extreme sea level events.

[8] The return period of an extreme event is a probabilistic measure that shows how many times an event of a certain magnitude will appear in a given period. Infrastructure is commonly designed to be relatively resilient to events with a magnitude seen once in 100 years (a 100-year event).

Heavy rainfall (downpours) and fluvial and pluvial flooding

14. Downpours and flooding can damage coastal transport infrastructure and affect port operations, due to poor visibility and the decreased manoeuvrability of locks and vessels caused by suddenly increased water levels and speeds. Extreme precipitation can cause flash floods that can damage the structural integrity and affect the operations of connecting inland roads, railroads and terminals, as well as inland waterway connections. Regions in which the risk of flooding is already high will face severe problems more frequently in future.

Increases in mean temperatures and the frequency and duration of heat waves

15. Such increases will pose substantial challenges to seaport infrastructure and operations, such as damage to port paved areas, navigational equipment and bridges, as well as road asphalt rutting, rail track buckling and speed restrictions, and higher levels of energy consumption for cooling and health and safety issues with regard to personnel and passengers. At the same time, although global warming can create new opportunities for international maritime networks and trade due to the opening up of new Arctic shipping routes, there will be significant engineering challenges due to the projected increases in extreme sea levels and coastal erosion along Arctic coastlines and thawing permafrost.

16. In addition, extreme winds and waves can cause coastal erosion, port and coastal defence overtopping and flooding, infrastructure failures and operational disruptions.

Costs and economic losses

17. Costs and economic losses arising from damage to infrastructure, as well as from operational disruptions and delays across closely interconnected global supply chains, may be extensive, as illustrated in studies that have provided cost estimates. One study that included tipping points in climatic forcing estimated that by 2050, the value of assets exposed to flooding in 136 port megacities would be close to $28 trillion.[9] Another study estimated, for ports in the Tokyo Bay area, the potential costs and inundation levels under mean sea level rise and typhoon storm surges combined and found that costs could be up to $690 billion.[10] Another study indicated that by 2100, global flood damage due to sea level rise and related extreme events alone might amount to up to $27 trillion per year, or about 2.8 per cent of global GDP in 2100.[11]

18. In areas affected by tropical cyclones and related storm surges and waves, damage to ports and other coastal transport infrastructure and associated losses can be particularly significant. In 2017, in the Caribbean, total damages following the hurricane season were estimated at $320 billion, with damages and losses in Dominica at over 200 per cent of GDP.[12] In the British Virgin Islands, the most affected infrastructure sectors were roads, ports and coastal airports, with related damages and losses estimated at $252 million.[13] In 2019, in the Bahamas, the total cost of the impact of Hurricane Dorian was estimated at $3.4 billion, with hundreds of people missing or dead and effects on the economy that will last for years.[14]

[9] World Wide Fund for Nature and Allianz, 2009, *Major Tipping Points in the Earth's Climate System and Consequences for the Insurance Sector* (Gland, Switzerland, and Munich, Germany).

[10] Hoshino S, Esteban M, Mikami T, Takagi H and Shibayama T, 2016, Estimation of increase in storm surge damage due to climate change and sea level rise in the Greater Tokyo area, *Journal of the International Society for the Prevention and Mitigation of Natural Hazards*, 80(1):539–565.

[11] Jevrejeva S, Jackson LP, Grinsted A, Lincke D and Marzeion B, 2018, Flood damage costs under the sea level rise with warming of 1.5°C and 2°C, *Environmental Research Letters*, 13(7).

[12] World Meteorological Organization, 2018, *World Meteorological Organization Statement on the State of the Global Climate in 2017* (Geneva).

[13] Economic Commission for Latin America and the Caribbean Subregional Headquarters for the Caribbean, 2018, Irma and Maria by the numbers, *Focus: Magazine of the Caribbean Development and Cooperation Committee*, 1.

[14] Inter-American Development Bank, 2019, Damages and other impacts on Bahamas by Hurricane Dorian estimated at $3.4 billion: Report, 15 November.

B. Climate change adaptation

19. In the light of recent projections and given the potential for a broad range of impacts, all stakeholders involved in planning, development and operations for ports and other coastal transport infrastructure need to take into account the effects of climate variability and change as part of their decision-making processes. Collaboration and the participation of a broad range of actors will be of particular importance, with regard to both the assessment of impacts and the planning, development and implementation of effective adaptation measures.

20. More systemic approaches are needed to better respond to and reduce the likelihood and impacts of climate change. To this end, coordinated action that cuts across policy domains is required. Many ports and other coastal transport assets are owned and/or operated by private actors, yet public authorities play a pivotal role in providing the appropriate regulatory and policy frameworks to facilitate an enabling environment that promotes climate change adaptation for coastal transport networks and assets. Other institutions, such as financial institutions and the insurance industry, also have an important role to play.

21. Approaches to the adaptation of coastal transport infrastructure will differ depending on the type of hazard, namely, episodic hazards due to extreme events; and slow-onset hazards such as permanent facility flooding due to sea level rise or the effects of thawing permafrost. These different types of hazards require different responses and technological considerations. The former type requires risk-reduction solutions, including coastal protection works, whereas the latter type requires long-term risk retention and resilience-building. In turn, this necessitates effective regulatory response measures that integrate or adapt existing regulatory and policy frameworks that include national adaptation plans, disaster risk reduction instruments and coastal zone planning policies.

22. Efficient adaptation and resilience-building for coastal transport infrastructure and operations depends on the assessment of the risks posed by climate variability and change. Assessments are determined by the spatiotemporal scale and resolution and the available information. Global and/or continental-scale assessments can inform the development of global and/or multinational adaptation policies and regulations, and those at the regional and/or national scales can assist in the planning of regional and national adaptation policies and improve the efficiency of the allocation of available human and economic resources. Assessments at the local facility level are necessary to support on-the-ground decision-making and the design of the required adaptation measures.

23. Risk assessments of coastal transport infrastructure consist of different, constituent assessments. First, assessments of the climatic hazards induced by changing climatic factors. Second, assessments of the exposure of transport infrastructure and operations present in hazard zones. Finally, assessments of the vulnerabilities that make transportation assets and systems susceptible to damage and loss from coastal hazards. These are, in turn, affected by the availability of technologies and materials for the required coastal protection and/or asset elevation, the available human and financial resources and the effectiveness of governance, regulation and management. Various approaches to risk assessment have evolved in recent years, based on significant developments in relevant observation technologies and tools. On the basis of such risk assessments, the probability of a damaging climatic event and the severity of its impacts can be determined. The urgency of the adaptation responses can be defined as the ratio of the time needed to plan and implement an effective response to the time available.[15]

24. Climate change adaptation of ports and other coastal transport infrastructure may involve the construction of new resilient infrastructure, in addition to measures to enhance the resilience of existing infrastructure, involving both soft and hard adaptation measures. This requires a shift in planning paradigms to address various challenges, including, among

[15] A climate emergency can be defined as a function of the probability of a damaging event, the severity of impacts and the urgency to respond, that is, the ratio of the time needed to respond effectively to the time available (see https://www.nature.com/articles/d41586-019-03595-0).

others, lack of awareness of climate change-related impacts and localized climate information, particularly with regard to small transportation assets; a mismatch between the time frames for facility planning, infrastructure lifetimes and climatic factor projections characterized by inherent uncertainties; funding; regulations that may reflect competing priorities and are not necessarily fit-for-purpose; constraints related to research and technology; and lack of human capacity and technical expertise. There is no single approach to climate change adaptation planning, due to the diverse, complex and context-dependent nature of adaptation. A variety of tools and approaches are already being employed, including the widespread use of engineering and technological options. In addition, there is increasing recognition of the need for social, institutional and ecosystem-based adaptation mechanisms for the purposes of climate change adaptation in general.

25. In view of the long service life of transport infrastructure, effective adaptation requires rethinking established approaches and practices early on. Moreover, a good understanding of risks and vulnerabilities is needed for the development of well-designed adaptation measures that minimize the adverse effects of climatic factors. However, this presents a major challenge. The potential adverse impacts of climate variability and change may be wide-ranging, but they vary considerably in accordance with physical setting, climate forcing and other factors. For example, ports in river deltas face different challenges than open-sea ports and extreme events and flooding may affect coastal transport infrastructure in some areas, while melting permafrost could become a major problem in others. However, significant knowledge gaps remain with regard to vulnerabilities and the specific nature and extent of exposure that individual coastal transport facilities may face, as seen in the results of the UNCTAD port industry survey on climate change impacts and adaptation.[16]

26. For the purposes of risk-assessment and with a view to developing effective adaptation measures, the generation and dissemination of more tailored data and information is important, as are targeted case studies and effective multi-disciplinary and multi-stakeholder collaboration. Infrastructure inventories, higher resolution data (including better digital elevation models[17]) and a better understanding of coastal processes under climate change are required for effective risk assessment and adaptation planning and detailed technical studies at the facility level are needed to avoid maladaptation. In addition, technical adaptation measures are widely needed and should involve innovative and efficient designs to avoid over-engineering. Ecosystem enhancement can play a significant role in reducing risks. Finally, increased investment in human resources and skills, in particular skilled coastal scientists and engineers, at regional and local levels will be critical for successful adaptation and resilience-building in the future, as also the mainstreaming of climate change-related considerations into ordinary transport planning, operations and management.

27. Guidance, best practices, checklists, methodologies and other tools in support of adaptation are urgently required, such as the guidelines for ports of the World Association for Waterborne Transport Infrastructure and the climate risk and vulnerability assessment framework for Caribbean coastal transport infrastructure developed by UNCTAD.[18] Targeted capacity-building, for example as part of the UNCTAD Train for Trade Port Management Programme (box), is critical, in particular for the most vulnerable countries, including small island developing States, which depend on ports and airports for food and energy needs, external trade and – crucially – tourism, which typically accounts for a major share of GDP. In this context, it is important to explore ways to raise and allocate the necessary financial resources, particularly in developing countries, and to consider how best to highlight and integrate the above considerations as part of nationally determined contributions under the Paris Agreement and in national adaptation plans.

[16] Asariotis et al., 2018.

[17] See Bove G, Becker A, Sweeney B, Vousdoukas M and Kulp S, 2020, A method for regional estimation of climate change exposure of coastal infrastructure: Case of USVI[United States Virgin Islands] and the influence of digital elevation models on assessments, *Science of the Total Environment*, 710.

[18] See UNCTAD, 2020, and https://sidsport-climateadapt.unctad.org/.

Train for Trade Port Management Programme

This programme supports port communities in developing countries in delivering more efficient and competitive port management. To increase trade flows and foster economic development, the programme creates port networks that bring together public, private and international entities. The aim is to share knowledge and expertise among port operators and strengthen talent management and human resources development in port communities. In November 2019, UNCTAD organized the twelfth meeting of the Advisory Group on the Strengthening of Training Capacity and Human Resources Development, on future challenges for port managers. Port representatives discussed the development of a new training package to cover issues such as climate change adaptation, mitigation and resilience, decarbonization, the circular economy, the blue economy, sustainable ports and linkages with the Sustainable Development Goals. The new module, titled "Challenges of sustainable ports", will be available to the English, French and Spanish-speaking port networks in 2020, aimed at more than 60 countries in Africa, Asia, Europe and Latin America and the Caribbean. Through the networks, new generations of port managers and port community leaders are trained and provided assistance in addressing challenges by designing new strategies and policies for climate change-resilient transport infrastructure.

Source: UNCTAD, 2019, Port management, available at https://tft.unctad.org/.

28. Successful adaptation strategies need to be underpinned by strong legal and regulatory frameworks that can help to reduce the exposure and/or vulnerability of coastal transport infrastructure to climate-related risks. Given that ports form complex systems and large ports are usually linked to coastal urban agglomerates, coastal planning regulation can play a particularly important role as a facilitator of climate change adaptation through the mainstreaming of climate change-related considerations. Legal and regulatory tools may further provide economic incentives to fund adaptation efforts, promote the transfer of adaptation technologies and contribute to the availability of accurate climate-related data and tools. At the same time, it is critical that legal and regulatory approaches do not, even inadvertently, foster maladaptation that may limit or lock in adaptation options. Appropriate policies and standards also have an important role to play, particularly in the context of infrastructure planning and coastal zone management. Examples of relevant approaches include European Union directive 2014/52 on the assessment of the effects of certain public and private projects on the environment, in force since 2017, which requires climate change-related impacts to be taken into account as part of environmental impact assessments of large infrastructure projects; the Climate Change Policy Framework for Jamaica (2015), which provides for the cross-sectoral mainstreaming of climate change-related considerations; and the recently adopted International Organization for Standardization standard 14090, "Adaptation to climate change – principles, requirements and guidelines", which provides a framework to enable organizations to prioritize and develop effective, efficient and deliverable adaptation tailored to the specific climate change-related challenges they face, using a consistent, structured and pragmatic approach.[19]

III. The special situation of small island developing States

29. Due to their small size and geographic remoteness, small island developing States are exposed to both economic and environmental shocks. They also have limited connectivity to major international transport networks, disproportionately high transport costs and a relatively narrow resource and export base. Many small island developing States are highly reliant on trade, with tourism often a key export sector and an important source of income and employment. Access to international markets is exclusively facilitated by seaports and by airports that, due to terrain-related constraints, are mostly

[19] For further information on these and other relevant regulatory and policy approaches, as well as practices, see UNCTAD, 2020.

located along the coasts. Many small island developing States face particular threats from climate change, such as increasing mean and extreme sea levels, changing wave patterns and rising temperatures, which increase the exposure of critical transport infrastructure to damage, disruption and delay. Climate change can also induce or exacerbate coastal erosion and coral bleaching, with direct and indirect impacts on trade and tourism. Small island developing States are vulnerable to extreme weather events such as tropical cyclones, as seen for example in the impacts of the hurricane season in 2017 and of Hurricane Dorian in 2019.[20]

30. Climate change is expected to lead to the increased frequency and severity of such natural hazards, thereby increasing the exposure of key transport infrastructure in small island developing States to hydrometeorological hazards, particularly those associated with sea level rise, storm surges and tropical cyclones.[21] A recent assessment by UNCTAD of climate change-induced impacts on eight seaports and coastal airports in two small island developing States in the Caribbean, namely Jamaica and Saint Lucia, which focused on the risk of coastal flooding and of potential operational disruptions under different climate scenarios, highlighted the importance of climate change adaptation for critical international transportation assets.[22] The study projected severe impacts on coastal transport infrastructure and operations that could cause major disruptions to the connectivity of small island developing States to international markets and to related economic sectors, such as tourism. In the absence of adaptation, most of the examined assets were projected to experience severe flooding in response to a 100-year extreme sea level event as early as in the 2030s. Another study with a focus on the United States Virgin Islands found, inter alia, that by 2050, a 100-year flood event could threaten 64 per cent of coastal transport buildings.[23]

31. Due to the significant reliance of small island developing States on maritime and air transport infrastructure, climate-related disruptions affecting facilitating transportation assets may lead to significant economic impacts, exacerbating existing challenges and causing substantial damage, disruption and delay to supply chains, international trade flows and tourism.[24] Many small island developing States are popular tourist destinations, with tourism accounting for over one quarter of GDP in at least seven small island developing States and representing 9 per cent, or $61 billion, of overall exports.[25] The Caribbean Development Bank has estimated that a reduction in tourist arrivals of 1 per cent could cost the Caribbean region $137 million in lost revenue.[26] Beaches are a primary natural resource supporting the dominant sea-sand-sun tourism model of small island developing States. However, beaches and relevant backshore infrastructure and assets will be increasingly exposed to coastal erosion and flooding under projected mean sea level rise and extreme storm events, as shown in a recent assessment of beach erosion under climate change in Saint Lucia that revealed that about 47 per cent of the beaches will lose at least 50 per cent

[20] Economic Commission for Latin America and the Caribbean Subregional Headquarters for the Caribbean, 2018; Inter-American Development Bank, 2019; World Meteorological Organization, 2018.

[21] See Intergovernmental Panel on Climate Change, 2014, *Climate Change 2014: Synthesis Report*; Intergovernmental Panel on Climate Change, 2019, *Global Warming of 1.5°C*; and Intergovernmental Panel on Climate Change, 2019.

[22] Monioudi IN, Asariotis R, Becker A, Bhat C, Gooden DD, Esteban M, Feyen L, Mentaschi L, Nikolaou A, Nurse L, Phillips W, Smith DAY, Satoh M, Trotz UO, Velegrakis AF, Voukouvalas E, Vousdoukas MI and Witkop R, 2018, Climate change impacts on critical international transportation assets of Caribbean small island developing States: The case of Jamaica and Saint Lucia, *Regional Environmental Change*, 18:2211–2225.

[23] Bove et al., 2020.

[24] World Travel and Tourism Council, 2018, *Caribbean Resilience and Recovery: Minimizing the Impact of the 2017 Hurricane Season on the Caribbean’s Tourism Sector* (London).

[25] World Tourism Organization, 2014, *Tourism in Small Island Developing States: Building a More Sustainable Future for the People of Islands* (Madrid).

[26] Barrow J, 2017, Addressing the challenge of climate change adaptation and resilience building for key international transportation assets: Perspectives, presented at the UNCTAD regional workshop on climate change impacts and adaptation for coastal transport infrastructure in the Caribbean, Bridgetown, 5–7 December.

of their current carrying capacity and 25 per cent will be completely overwhelmed by 2050.[27] In the light of such findings, in small island developing States, beach nourishment schemes and inventories of beach replenishment deposits and their sustainability should be ensured as a matter of priority.

IV. Recent related international developments

32. While climate change adaptation and resilience-building for seaports and related coastal transport infrastructure, services and operations is a matter of strategic economic importance and increasing urgency, much more needs to be done. However, there were a number of developments in 2019 of relevance to such adaptation and resilience-building that are worth noting.

33. The importance of climate-resilient transport infrastructure was highlighted in a resolution adopted by the United Nations Environment Assembly on sustainable infrastructure and in a report of the Global Commission on Adaptation providing specific insights and recommendations with regard to resilient infrastructure and disaster risk management.[28] In addition, the European Parliament voted to declare a climate and environment emergency.[29]

34. In September, the Climate Action Summit convened by the Secretary-General of the United Nations aimed to galvanize action in nine key areas, including resilience and adaptation, nature-based solutions and cities infrastructure and local action.[30] Summit results with regard to adaptation and resilience included the following: climate finance pledges from Governments and the private sector; new initiatives for unlocking the potential of nature in climate action that offered scalable solutions, to increase adaptation and resilience; increased ambition in adaptation and resilience, with more than 110 countries and 85 international organizations and private sector entities, including maritime industry associations such as the International Chamber of Shipping and the World Association for Waterborne Transport Infrastructure, committing to enhanced action on adaptation and resilience; new measures to support small island developing States and the least developed countries; new initiatives with a view to preventing disasters; and collaborative plans to develop sustainable transport systems and scale up access to finance for sustainable urban infrastructure projects.[31]

35. At the Summit, over 80 stakeholders from across shipping value chains launched an initiative to decarbonize the shipping sector, committing to commercially viable zero-emission vessels operating along deep-sea trade routes by 2030.[32]

36. Building on the outcomes of the Summit, thematic and cross-sectoral climate action pathway documents were prepared by the Marrakech Partnership for Global Climate Action and launched at the twenty-fifth Conference of the Parties to the United Nations Framework Convention on Climate Change.[33] In the context of climate change adaptation and resilience-building for ports, it is worth noting that the transport pathway action table includes two distinct action areas with a focus on adaptation for transport systems and

[27] UNCTAD, 2019, Climate change impacts and adaptation for coastal transport infrastructure in the Caribbean, poster presented as part of the optimizing climate ambition in the ocean exhibit at the twenty-fifth Conference of the Parties to the United Nations Framework Convention on Climate Change, 2–13 December, available at https://seors.unfccc.int/applications/seors/reports/archive.html#exhibits.

[28] See UNEP/EA.4/Res.5 and https://gca.org/global-commission-on-adaptation/report.

[29] See https://oeil.secure.europarl.europa.eu/oeil/popups/ficheprocedure.do?lang=en&reference=2019/2930(RSP).

[30] See https://www.un.org/en/climatechange/un-climate-summit-2019.shtml.

[31] United Nations, 2019, *Report of the Secretary- General on the 2019 Climate Action Summit and the Way Forward in 2020*, available at https://www.un.org/en/climatechange/reports.shtml.

[32] See https://www.globalmaritimeforum.org/getting-to-zero-coalition/members.

[33] United Nations Climate Change Secretariat, 2019, *Yearbook of Global Climate Action: Marrakech Partnership for Global Climate Action* (Bonn, Germany).

transport infrastructure and related milestones for 2020, 2030 and 2050. Relevant key actions and milestones for transport are also integrated into the cross-sectoral resilience pathway action table, which focuses on climate resilience-building. Key milestones include, among others, the following: by 2030, “all critical transport infrastructure assets, networks/systems components are climate resilient to (at least) 2050”; and by 2050, “all critical transport infrastructure assets, networks/systems components are climate resilient to (at least) 2100”.[34] This represents an important and timely ambition, yet a major acceleration of efforts is required to implement the relevant measures.

37. UNCTAD actively contributed to the preparation of the transport and resilience pathway documents, drawing in particular on some of the key recommendations of technical experts, key industry stakeholders and a number of international organizations that participated at an UNCTAD ad hoc expert meeting titled “Climate change adaptation for international transport: Preparing for the future”.[35] At the twenty-fifth Conference of the Parties, the World Association for Waterborne Transport Infrastructure issued a declaration on climate change that highlighted a number of priority action areas to strengthen adaptation and resilience-building, including inspection and maintenance; monitoring systems and effective data management; risk assessments, contingency plans and warning systems; and a focus on flexible and adaptive infrastructure, systems and operations and engineered redundancy to improve resilience.[36]

V. Cross-cutting issues

A. Energy efficiency in seaports and clean energy use

38. Energy efficiency is a cross-cutting enabling factor that underpins maritime transport sustainability, as well as climate change adaption and mitigation action. Seaports are crucial nodes that link global supply chains and at which much of globalized world merchandise trade is handled. Therefore, energy efficiency and the use of clean energy sources is critical to achieving the Sustainable Development Goals and global climate-related targets. Emphasizing the role of port energy efficiency and the use of clean energy for greening port operations and promoting sustainable freight transportation systems has been one of the main areas of focus of recent UNCTAD work in the field of transport and trade logistics. Relevant insights derived from such work are disseminated through various channels, including recurrent publications such as the annual *Review of Maritime Transport*, dedicated expert meetings and technical assistance advisory instruments and tools, such as the sustainable freight transport toolkit. This work underscores the role of clean energy, energy efficiency and demand management as strategic policy and planning instruments for ports and terminals aiming to reduce energy consumption, curb air emissions and enhance environmental sustainability. Relevant measures in this regard include operational strategies, technologies and energy management systems such as energy demand and supply planning.[37]

39. Port energy efficiency and demand management measures, as well as clean energy use in ports, are generally associated with emissions reduction, including air pollutants and greenhouse gases, and also contribute to building climate resilience in ports and serve as

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[34] See https://unfccc.int/climate-action/marrakech-partnership/reporting-and-tracking/climate_action_pathways, including https://unfccc.int/sites/default/files/2019-11/Resilience-Infographic.jpg (resilience infographic), https://unfccc.int/documents/201829 (resilience and adaptation executive summary), https://unfccc.int/documents/201840 (resilience and adaptation narrative), https://unfccc.int/documents/201839 (resilience and adaptation action table) and https://unfccc.int/documents/201827 (transport action table).

[35] See https://unctad.org/en/pages/MeetingDetails.aspx?meetingid=2092.

[36] See https://www.pianc.org/uploads/files/COP/PIANC-Declaration-on-Climate-Change.pdf.

[37] See Çağatay I and Lam JSL, 2019, A review of energy efficiency in ports: Operational strategies, technologies and energy management systems, *Renewable and Sustainable Energy Reviews,* 112:170–182.

key adaptation tools.[38] Climate change-related factors such as increased and more volatile temperatures and extreme weather events can drive up demand for energy, including for air conditioning, heating and maintaining operations in stressful weather conditions. Ports handling reefer or temperature-controlled containers are particularly affected as they depend heavily on access to energy to safeguard the integrity of perishable goods such as fruits, meat, fish, vegetables and dairy products. In addition to their direct impacts on energy consumption at ports, climatic factors indirectly affect energy requirements because energy supply production networks and infrastructure such as power plants and refineries, among others, are also vulnerable to climatic factors and related damage and disruption. Together, these considerations emphasize the importance of port energy efficiency and require management and a shift towards cleaner energy sources as key strategies for climate change adaptation in ports.

B. Seaports, fisheries and seafood supply chains

40. The value of fish harvests from marine fisheries and aquaculture is estimated at over $150 billion. Fish and seafood are among the most traded food commodities in a variety of products and used in diverse processes. Some 35–38 per cent of world production enters international trade, with a value of $143 billion in 2016 and about $152 billion in 2017. Almost 60 million people were engaged in the primary sector of capture fisheries and aquaculture in 2016 and, of the 171 million tonnes of total fish production, over 151 million tonnes, or about 88 per cent, were used for direct human consumption.[39]

41. In value chains, supply is usually focused on efficient logistics and supporting services using upstream and downstream businesses aimed mostly at offering quality products rapidly and efficiently to consumers. With regard to fisheries, there is a need to differentiate between fresh, live and chilled products, which account for some 45 per cent of fish consumed, and processed seafood products, which account for about 55 per cent. For the former, harvesting is conducted by fishing fleets and harvests are usually sold at ports or pre-elaborated by cutting and cleaning, chilled or frozen in factory vessels for industrial fishing and later unloaded at ports for immediate commercialization or further processing. In the fisheries value chain, fresh products have a higher value and level of consumer acceptance in the market than processed products, and transport, cooling and custody chain services are essential for the safe and timely delivery of fresh produce to consumers. Transport and logistical services for seafood products secure the safety, uninterrupted refrigeration and quality of fish products for both manufacturers and consumers. Fishing ports may represent nodes for creating seafood clusters that promote sustainable fisheries and aquaculture, provide improved logistics and services and generate value for communities. Such clusters have been launched in several developed countries, for example in Norway, Spain and the United States of America, and in emerging economies and developing States, for example in Argentina, China, Ecuador, Mauritania, Mauritius and Papua New Guinea. Creating a seafood cluster requires building the capacity of stakeholders to design, organize and promote systems that integrate the sustainable management of fisheries, climate resilient port infrastructure and diverse post-harvest support services. Improving the handling, port landing and processing of harvests is also required, along with promoting value addition for exports at the seafood cluster and building the capacities of local suppliers and vulnerable groups, to capture greater benefits from productive and inclusive seafood value chains.[40]

[38] See https://www.sft-framework.org/.

[39] Food and Agriculture Organization of the United Nations, 2018, *The State of World Fisheries and Aquaculture: Meeting the Sustainable Development Goals* (Rome).

[40] UNCTAD, 2019, *Advancing Sustainable Development Goal 14: Sustainable Fish, Seafood Value Chains, Trade and Climate* (United Nations publication, Geneva).

C. Climate finance

42. The Addis Ababa Action Agenda states that investing in sustainable and resilient infrastructure, including transport, energy, water and sanitation for all, is a prerequisite for achieving many goals, and expresses a commitment to facilitating the development of sustainable, accessible and resilient quality infrastructure in developing countries through enhanced financial and technical support. However, accessing adequate climate finance to enhance adaptive capacity, including with regard to ports and other coastal transport infrastructure, remains a major challenge in developing countries. Costs of adaptation in developing countries have been estimated at $70 million–$100 million per year by 2050, but more recent forecasts project costs that are at a minimum two to three times higher.[41] In addition, as adaptation costs and finance needs are emissions-dependent, costs may further increase, with the latest projections indicating 3–4°C of global warming by 2100.[42]

43. In 2009, developed country Parties to the United Nations Framework Convention on Climate Change pledged $100 billion annually until 2020 for the climate mitigation and adaptation needs of developing countries. The Paris Agreement reiterated this commitment and stated that the provision of financial resources should be scaled up. Nevertheless, a major adaptation financing gap persists, with global public finance flows for adaptation reaching $23 billion in 2016, an amount that falls short of both the estimated adaptation costs and indicative financial needs as communicated by a group of non-annex I countries in their nationally determined contributions (approximately $500 billion in 2020–2030).[43] In 2016, global public adaptation finance from developed to developing countries was channelled mainly (64 per cent) via multilateral climate funds ($0.4 billion), multilateral development banks ($5.9 billion) and bilateral climate finance instruments ($8.5 billion).[44] Other sources include financial flows from other development finance institutions and domestic public and private sources (table).

Examples of relevant sources of climate change adaptation finance

Type	*Institution, fund or entity*	*Contribution*
Multilateral climate fund	Adaptation fund	Allocated $720 million to adaptation
	Global environment facility	Delivered more than $1.7 billion in adaptation finance in more than 130 countries
	Green climate fund	As at December 2019, committed projects reached $5.6 billion, with 24 per cent for adaptation finance
	Least developed countries fund	Approved adaptation projects and programmes reached $148.3 million in latest reporting period (1 July 2018–30 June 2019)
	Special climate change fund	As at June 2019, provided $282.7 million (climate change adaptation window) and $60.7 million (technology transfer window) to adaptation projects

41 Chambwera M and Heal G, 2014: Economics of adaptation, in: *Climate Change 2014: Impacts, Adaptation and Vulnerability, Part A: Global and Sectoral Aspects, Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (Cambridge University Press, Cambridge, United Kingdom):945–977; see also United Nations Environment Programme, 2014, *Adaptation Gap Report 2014* (Nairobi), and United Nations Environment Programme, 2016, *Adaptation Finance Gap Report 2016* (Nairobi).

42 United Nations Environment Programme, 2019, *Emissions Gap Report 2019* (Nairobi).

43 United Nations Environment Programme, 2018, *Adaptation Gap Report 2018* (Nairobi).

44 Ibid.

Type	*Institution, fund or entity*	*Contribution*
	African Development Bank	Total climate finance amounted to $1.2 billion in 2013; for adaptation finance in Africa, contributes more than $6 for every $1 of external financing mobilized
Multilateral development bank	Asian Development Bank	In 2011–2018, approved over $29 billion in climate financing; in 2018, mobilized $4.01 billion in total climate finance, with $1.29 billion (32 per cent) for adaptation
	Caribbean Development Bank	In 2015, climate financing represented 13 per cent of total project financing; in 2016, $50 million approved for projects with explicit climate resilience and sustainable energy actions; as immediate response to impacts of Hurricane Dorian, almost $1 million allocated for the Government of the Bahamas
	European Investment Bank	In 2018, provided €16.2 billion to fight climate change, with €1.1 billion for adaptation
	Inter-American Development Bank	In 2018, invested approximately $5 billion in climate finance
	International Finance Corporation	In 2019, provided $5.8 billion in climate-smart financing
	Islamic Development Bank	In 2018, delivered climate finance totalling $351 million, with adaptation finance of $77 million (22 per cent)
	World Bank	In 2018, delivered $20.5 billion in climate finance; 49 per cent of all climate finance dedicated to adaptation
Other development finance institution	Asian Infrastructure Investment Bank	Total investment of up to $12.04 billion in sustainable infrastructure and other productive sectors
	New Development Bank	In 2016–2017, approved loans involving financial assistance of over $3.4 billion
Regional or bilateral climate finance provider	National development agencies (e.g. Austrian Development Agency and Swedish International Development Cooperation Agency	
	Germany: International climate initiative	
	United Kingdom of Great Britain and Northern Ireland: International climate finance	
	European Union: Global climate change alliance plus	
Domestic public climate finance provider	Bangladesh: Climate change trust Indonesia: Climate change trust fund	

Type	*Institution, fund or entity*	*Contribution*
Private climate finance provider	Foundations Finance institutions Insurance sectors	

Sources: Caribbean Development Bank, 2017, $10 million of new support for climate change mitigation, adaptation and resilience projects across the Caribbean as EIB[European Investment Bank] and CDB[Caribbean Development Bank] sign new financing agreement, 24 May; Caribbean Development Bank, 2019, CDB[Caribbean Development Bank] allocates almost $1 million for immediate Bahamas relief, 5 September, available at https://www.caribank.org/newsroom/news-and-events/cdb-allocates-almost-usd-1-million-immediate-bahamas-relief; Heinrich Böll Stiftung, 2018, Climate finance thematic briefing: Adaptation finance; United Nations Environment Programme, 2014; United Nations Environment Programme, 2016; United Nations Environment Programme, 2018; United Nations Framework Convention on Climate Change, 2020, Bilateral and multilateral funding, available at https://unfccc.int/topics/climate-finance/resources/multilateral-and-bilateral-funding-sources.

44. Significant challenges remain with regard to mobilizing adequate climate change adaptation finance, in particular from the private sector, in addition to major information gaps concerning adaptation finance flows, in particular from domestic public and private sources, and methodological inconsistencies.[45] However, there are encouraging recent developments, including, among others, increased disclosure efforts, for example through a task force on climate-related financial disclosure; new climate finance pledges by Governments and private sector actors made at the Climate Action Summit; increased efforts by banks to align practices with climate change-related purposes, such as a collective commitment by 33 banks on climate action; and efforts to provide climate finance, for example a pledge by multilateral development banks to raise $175 billion in climate finance annually by 2025.[46] In the shipping sector, recent climate finance efforts include the development of a framework for assessing and disclosing the climate alignment of ship finance portfolios, such as the Poseidon principles of 2019, as well as shipping industry proposals for the establishment of a $5 billion greenhouse gas reduction research and development programme at the International Maritime Organization to accelerate the introduction of low-carbon and zero-carbon technologies and fuels.[47]

VI. Way forward

45. As this overview of key issues shows, there are considerable challenges ahead, yet there is also significant momentum, with a number of recent international initiatives recognizing the need for the acceleration of action on adaptation and resilience-building and a wide range of public and private sector actors and stakeholders declaring commitments to take action.

46. At the same time, there are a number of important intergovernmental meetings to be held in 2020 that may provide further impetus for enhancing the climate resilience of seaports, namely, the second United Nations Global Conference on Sustainable Transport (May); the United Nations Ocean Conference (June); the fifteenth session of the United Nations Conference on Trade and Development (October); and the twenty-sixth Conference of the Parties to the United Nations Framework Convention on Climate Change, sixteenth session of the Conference of the Parties serving as the Meeting of the Parties to the Kyoto Protocol and the third session of the Conference of the Parties serving as the Meeting of the Parties to the Paris Agreement (November).

[45] United Nations Environment Programme, 2018.

[46] See https://www.fsb-tcfd.org/, https://www.un.org/en/climatechange/reports.shtml, https://www.iadb.org/en/news/mdbs-pledge-raise-climate-finance-us175-billion-annually-2025 and https://www.unepfi.org/banking/bankingprinciples/collective-commitment/.

[47] International Maritime Organization Marine Environment Protection Committee, 2019, Reduction of greenhouse gas emissions from ships: Proposal to establish an international maritime research and development board, MEPC 75/7/4, London, 18 December.

47. In the light of the above, the eighth session of the Multi-Year Expert Meeting on Transport, Trade Logistics and Trade Facilitation provides an important and timely opportunity to build on the current momentum by considering how best to translate ambitious targets into action and develop concrete policy recommendations that both help to advance the important issue of climate change adaptation for seaports in support of the 2030 Agenda and that can serve to inform the intergovernmental meetings and processes that will take place in 2020.