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Multi-Year Expert Meeting on Transport and Trade Facilitation:

Maritime Transport and the Climate Change Challenge

16–18 February 2009, Geneva

Summary of Proceedings

UNITED NATIONS

Acknowledgments

The present publication was prepared on the basis of the report of the first session of the Multi-year Expert Meeting on Transport and Trade Facilitation, and on the related background documentation prepared to facilitate deliberations at the meeting.

UNCTAD acknowledges with appreciation the contributions of the panellists who participated at the meeting as well as other experts who have participated in the meeting, made written submissions, or both.

All relevant documentation related to the meeting, as well as speakers' presentations and audiofiles of the sessions, are available on UNCTAD's website at www.unctad.org/ttl/legal.

Preface

December 2009 is a crucial time for global climate action. With the first commitment period of the Kyoto Protocol set to expire in 2012, the international community will congregate in Copenhagen to adopt, under the auspices of the United Nations Framework Convention on Climate Change (UNFCCC), a new global regime to combat climate change. While reaching agreement remains a challenge, the citizens of the world cannot afford a failure by decision-makers. Climate change poses a serious threat to human development and prosperity, with implications for water and food security, coastal infrastructure, human health, biodiversity, migration, global trade and security. The latest scientific findings indicate that matters may be worse than previously thought, with forecasts about global warming and sea-level rise exceeding earlier predictions and adding weight to the worst-case scenarios outlined in 2007 by the Intergovernmental Panel on Climate Change (IPCC) in its Fourth Assessment Report. As the impacts of climate change are increasingly being felt on a global scale, particularly in the most vulnerable countries, the window of opportunity for global action to stabilize emissions at "manageable" levels is getting progressively smaller.

International maritime transport carries over 80 per cent of the volume of world trade and is vital to globalized trade. Like other economic sectors, it is facing a dual challenge in relation to climate change: the need to reduce its contribution to global warming – international shipping generates around 3 per cent of global CO_2 emissions from fuel combustion – and the need to adapt to the impacts of climatic changes. If left unchecked, these emissions, which are not currently covered by the UNFCCC framework, are expected to increase by a factor of 2.2 to 3.1 over the next four decades. At the same time, maritime and related transport systems are also likely to be directly and indirectly affected by various climatic changes, such as rising sea levels, extreme weather events and rising temperatures, with broader implications for international trade and development.

Against this background, from 16 to 18 February 2009, an UNCTAD expert meeting on "Maritime Transport and the Climate Change Challenge" debated how best to address the multiple challenges, especially those of concern to developing countries, the least developed countries (LDCs) and small island developing States (SIDS). Some 180 experts from 60 countries and 20 intergovernmental and non-governmental organizations, as well as representatives of the global shipping and port industries, met in Geneva to discuss a wide range of issues over the course of three days. The discussions, chaired by Professor Costas Grammenos of City University, London, focused on greenhouse gas emissions and climate change mitigation options; the potential impacts of climate change on maritime transport systems and supply chains; and the broader economic, social and developmental implications, which have yet to be adequately understood and addressed.

Experts at the meeting stressed the urgent need for agreement in ongoing negotiations on a regulatory regime for greenhouse gas emissions from international shipping. They also urged that greater attention be paid to the potential impacts and implications of climate change for transportation systems, and in particular for ports – key nodes in the supply chain, and vital for global trade. In this context, the central role of technology, energy efficiency and finance was highlighted, as was the need for international cooperation among scientists and engineers, industry, international organizations and policymakers, especially on the preparation and design of adequate adaptation measures.

This publication has been prepared to present the key issues discussed by the experts and to make their insights available to a broader audience, as part of UNCTAD's contribution to the important debate about appropriate action to address the formidable challenge of climate change.

Supachai Panitchpakdi
Secretary-General of UNCTAD
1 December 2009

CONTENTS

PART ONE

UNCTAD Multi-Year Expert Meeting on Transport and Trade Facilitation: Maritime Transport and the Climate Change Challenge

16-18 February 2009, Geneva

Outcome of the Meeting and Conclusions of the Chair[1]

As many of the experts emphasized, the three-day meeting provided the background for extremely useful and fruitful substantive discussions. It provided an opportunity to address, in an informal setting, the implications of climate change for maritime transport from a broader economic and commercial perspective, thus supporting and complementing the current work carried out under the auspices of IMO and UNFCCC. The considered and thoughtful discussions helped to significantly raise awareness among experts from different backgrounds about the complex implications climate change may have for maritime transport systems – and more generally international trade – and the urgency of developing appropriate climate policy action, as well as practical responses and solutions. To this end, the meeting should be considered a starting point for further consideration of the important issues raised and discussed.

Key points that emerged from the three-day discussions could be summarized as follows:

- The available scientific evidence suggested that growing concentrations of GHG in the atmosphere had already resulted in significant climatic changes, which were predicted to increase in the future. The scale of the global challenge was enormous and, as climate change accelerated, there was an increasingly urgent need for action;
- Although predictions based on current trends already suggested an enormous challenge, it must be stressed that there was an inherent degree of uncertainty associated with those predictions. Natural systems were complex and non-linear, and there was a very real risk that growing GHG concentrations could trigger various feedback mechanisms that would drive climatic changes and their consequences to levels that were extremely difficult to manage. From a risk-management perspective, it would be unwise to wait for perfect scientific predictions concerning the response of the non-linear natural system before taking action. In view of the potential very substantial monetary and non-monetary costs of climatic change, particularly the very worrisome consequences of "tipping points"/abrupt climatic changes, inaction and business-as-usual approaches were not viable options. Dealing with the climate change challenge was a priority, which should not be undermined by other concerns, including the current global economic and financial constraints;
- Time-frame was a real concern. Current trends in terms of energy consumption and carbon path suggested that if no action were taken within the following two years,

[1] Part A reflects the conclusions of the Chair as set out in the Report of the Multi-year Expert Meeting on Transport and Trade Facilitation on its first session, TD/B/C.I/MEM.1/3 at Section C, paragraphs 26 and 27. All relevant documentation related to the meeting, as well as speakers' presentations and audiofiles of the sessions are available on UNCTAD's website at www.unctad.org/ttl/legal.

including relevant investment decisions which would determine the type of technologies that would be locked in, the world would forever miss the opportunity to stabilize emissions at "manageable" levels along either the 450 ppm or the 550 ppm CO_2 equivalent scenarios. It was crucial that the world be informed very soon of which scenario would be realistically achievable. This information was of the essence for adaptation planning;

- Despite the current unfavourable economic conditions, projected growth in international trade suggested that GHG emissions from shipping would continue to increase, unless effective regulatory, technical and operational measures were agreed and implemented without delay. Thus, there remained an urgent need to address GHG emissions from the maritime transport sector and to step up mitigation efforts. In view of the global dimension of international maritime transport and the climate change challenge, a global and concerted solution was urgently required. To this end, negotiations towards regulation of CO_2 emissions from international shipping should be pursued with all due speed;
- Various technical, operational and market-based mitigation measures were currently under consideration under the auspices of MEPC at IMO. While the reduction potential and the effectiveness of each measure were yet to be fully established, there remained a need to improve the understanding of the respective merits of different options and to assess the potential implications of the proposed mitigation measures for global trade and market distortions. UNCTAD was encouraged to make use of its expertise and conduct relevant work in this area, especially regarding the trade and development of developing countries. There was also a need to ascertain the added value of these proposals in terms of energy efficiency to be achieved by the world fleet and their impacts on international shipping;
- The meeting was an eye-opener in that it helped raise awareness about the importance of climate change impacts and adaptation in relation to maritime transport systems. While international maritime transport was responsible for around 3 per cent of global CO_2 emissions from fuel combustion, it was important to note that more than 80 per cent of global trade (by volume) was carried by sea, from port to port. Given the potential impacts and implications of climate change for transportation systems, and in particular for ports – key nodes in the supply-chain, and vital for global trade – maritime transport should be seen much less as a culprit than as a victim. Thus, increased focus on responding to the challenge was important for the long-term prospects of the maritime transport sector and, more generally, global trade. Planning for the already-predicted impacts should be pursued without delay;
- Further studies were required to improve the understanding of potential climate change impacts for the maritime transport sector and the hinterland. For ports and transport infrastructure in coastal zones, especially in developing countries, appropriately funded, well-targeted vulnerability studies based on adequate data – as well as better data and dissemination of existing information – were required to assess potential climate change impacts and to develop appropriate adaptation responses;
- Studies on the vulnerability of the maritime industry to the impacts of climate change would strongly benefit from the availability of information on climate variability and change both at the global and regional scales. Efforts to develop a system to provide such information should be encouraged and supported;
- Scientific research based upon accurate and relevant data was essential for better predictions of climatic impacts on maritime transport and coastal infrastructure,

especially in more vulnerable regions such as SIDS and low-lying areas. In this respect, there was an important need for cooperation among scientists and engineers, industry, international organizations and policymakers to ensure that up-to-date relevant information on climate change impacts and adaptation measures was available, widely disseminated and taken into account by policymakers, transportation planners and development strategists;

- Further awareness-raising, knowledge sharing, education and information dissemination was needed. The intention to pursue the possibility of including a compulsory subject on climate change in the undergraduate curriculum at the Cass Business School of City University, London – as well as a series of lectures for postgraduate students – was a step in this direction. As noted by experts, other approaches in this respect could include capacity-building and technical assistance initiatives, especially with a view to helping developing countries and the most vulnerable gain an improved understanding of the climate change challenge from a maritime transport perspective to ensure that they were better prepared to cope with its various effects;
- Assessing the costs of climate change impacts on ports and, more generally, supply chains, was seen as important. Understanding the implications for trade and development especially for developing countries needed to be enhanced and relevant studies should be carried out;
- Climate change mitigation in maritime transport and the need to adapt to climate change impacts posed a particular challenge for geographically disadvantaged landlocked countries with significant population, especially for their already-volatile trade and development prospects. In that context, further attention should be focused on the impact of potential mitigation measures and adaptation requirements for the trade and development prospects of landlocked developing countries, as well as LDCs. In that context, financial and technical assistance, as well as capacity-building, were important;
- Adequate funding was paramount for successful climate action in maritime transport and the wider supply chain, in particular for adaptation purposes. In that context, it was important to explore ways in which financial resources could be generated as part of mitigation efforts in relation to maritime transport and ensure that any proceeds were reinvested within the industry for climate change action, in particular for the purposes of effective adaptation, especially in developing countries;
- Taking advantage of existing technology and development of new technologies would go a long way in helping address the climate change challenge in maritime transport. For developing countries, being able to access and benefit from such technologies and advances would be crucial;
- The international shipping and port industries were already active in addressing the climate change challenge and were committed to stepping up their efforts to ensure that broader climate change implications for maritime transport were taken into account. In that respect, indications by representatives of the global port industry of their willingness to explore the possibility of including considerations on impacts and adaptation in work under the World Ports Climate Initiative constituted an important step in the right direction;
- It was felt that it would be useful to preserve some continuity to these deliberations and plan for a follow-up meeting in a year's time to assess progress with respect to the key issues raised and take stock of achievements made, as well as reflect on potential next steps.

PART TWO

Background note by the UNCTAD secretariat on "Maritime Transport and the Climate Change Challenge"[2]

Executive summary

Climate change is a global challenge and a defining issue of our era. Compelling scientific evidence and a better understanding of the economics of climate change have moved the issue to the forefront of the international agenda. Greenhouse gas (GHG) emissions from international shipping are increasingly drawing attention and possible mitigation measures are being considered, both at the regulatory and industrial levels. At the same time, the effects of climate change and their implications for maritime transport – as well as for access to cost-efficient and sustainable international transport services – need to be properly understood to ensure that appropriate adaptation measures are taken. This is crucial given the special needs of the most vulnerable countries, namely the least developed countries (LDCs), the landlocked developing countries (LLDCs) and the small island developing States (SIDS). Against this background, the present note raises some relevant issues for the consideration of experts. It (a) argues the importance of a climate policy for international maritime transport that takes into account sustainable development objectives as well as the need for transport efficiency and improved trade competitiveness of developing countries; (b) highlights the underlying issues at the interface of international shipping and climate change; (c) identifies, from the perspective of maritime transport, some of the potential impacts and opportunities arising in connection with climate change; (d) describes the current state of play in terms of the regulatory and institutional framework of relevance to climate change and shipping; (e) outlines some mitigation and adaptation options applicable to ships and ports; and (f) explores cross-cutting elements with a bearing on climate action, such as financing and investment, technology and energy security. Finally, experts are invited to consider a number of issues that may enable effective climate action in maritime transport as well as support efficient maritime transport services in support of sustainable development and enhanced trade competitiveness of developing countries.

[2] The UNCTAD secretariat prepared a background note (TD/B/C.I/MEM.1/2) to facilitate discussions and to assist participants in their deliberations. The content of the background note is presented here with minor amendments to table 1 and figure 2 intended to reflect the results of the Second IMO GHG Study, 2009 (MEPC/59/INF.10). The Note has also been amended to reflect the new designation of the IMO's Energy Efficiency Design Index (EEDI) and to include some additional references.

Introduction

The Secretary-General of the United Nations has called climate change a defining issue of our era.[3] It has in recent years emerged as an important global challenge. The compelling scientific evidence presented in the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2007)[4] and an improved understanding of the economics of climate change, including the potential costs associated with action and inaction, have placed the issue high on the international agenda.[5] The climate change challenge remains a serious threat to humanity, with developing countries, in particular LDCs and SIDS, being the hardest hit.[6] As the Kyoto Protocol is due to expire in 2012, a conference by the United Nations Framework Convention on Climate Change (UNFCCC) was held in Bali in December 2007 to launch negotiations on a post-Kyoto agreement. Set to conclude in December 2009, these negotiations provide a renewed opportunity for the international community to undertake meaningful commitments to combat climate change.

GHG emissions from international shipping – which carries over 80 per cent of world trade by volume – are increasingly drawing public attention. These emissions are not covered under UNFCCC, the international regulatory framework dealing with climate change. Rather, parties to UNFCCC asked the International Maritime Organization (IMO) to take initiatives that would address emissions from ships. While IMO leads international efforts on technical aspects and mitigation with a view to developing a binding instrument, there remains the need to address the potential policy, economic and trade ramifications of a new regulatory regime on GHG emissions from maritime transport, in particular for LDCs and SIDS. Moreover, greater attention needs to be drawn to adaptation requirements which have to date enjoyed limited attention.

As maritime transport grows in tandem with trade and economic activity, the challenge – especially from a sustainable development perspective, as well as a transport and trade facilitation perspective – is to cut GHG emissions from international shipping without undermining development objectives, including the Millennium Development Goals, and without jeopardizing transport efficiency and trade facilitation gains. In this context, not only is mitigation important, but also adaptation, which will be required as a result of observed and projected climate change effects.

I. The climate change challenge

A. Scientific evidence and observed effects[7]

The Kyoto Protocol covers six major GHG: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorcarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6). Between 1970 and 2004, and weighted by their global warming potential, global

[3] The Secretary-General of the United Nations, Ban Ki-Moon, G-8 Summit, June 2007.
[4] Stern N (2006). *Stern Review: The Economics of Climate Change*.
[5] See also United Nations Environment Program (2007). *Global Environment Outlook 4* (GEO-4).
[6] See, for example, Huq S and Ayers J (2007). *Critical List: the 100 Nations Most Vulnerable to Climate Change*. International Institute for Environment and Development (IIED).
[7] Unless otherwise stated, information in this section is based on IPCC, 2007.

emissions of theses gases have increased by 70 per cent, with growth in the transport emissions being the second largest.

Box 1. Global warming and some associated effects

The atmospheric concentration of CO_2, the most significant GHG, has increased from 280 parts per million (ppm) in the pre-industrial period to 379 ppm in 2005. Increased concentration of GHGs in the atmosphere and the associated warming effect are considered to cause climate change. Over the last century, the global average surface temperature has increased by around 0.74°C. Under "business as usual" scenarios, IPCC climate models indicate a further temperature rise of 1.1–6.4°C during the twenty-first century. To ensure that the global average temperature increase does not exceed 2°C above pre-industrial levels – the threshold above which dangerous climate change effects are likely to be triggered (tipping point) – the atmospheric concentration levels of CO_2 should be stabilized at 350–400 ppm, while emissions should peak by 2015 and decline thereafter.

Observations from all regions and oceans show that many natural systems are being affected. The observed effects include a decline in mountain glaciers and snow cover, a change in the arctic ice coverage and a rise in the global average sea level. The sea level rise is thought to be caused by increased volumes of water in the ocean basins (due to melting ice) and thermal expansion of seawater. The average global sea level increased by 0.17 m over the last century. Relative sea level rise is particularly relevant and varies according to local conditions, including land subsidence. More frequent extreme weather conditions – such as storms, heatwaves, drought and increased intensity of tropical cyclones – are also being observed.

Scientists are also concerned about abrupt climate change effects.[8] These so-called "surprise effects" relate, inter alia, to the instability of ice sheets and the planet's feedback mechanisms (self-reinforcing loop).[9] The uncertainty of these effects is due to the limited information on the nature of climate–carbon cycle feedbacks. For example, reaching climatic tipping points could lead to a potentially "abrupt" effect known as the shutdown of the thermohaline ocean circulation[10] or to an acceleration of global warming due to released methane from thawing permafrost.[11]

Climatic changes entail impacts which vary regionally, with potentially positive impacts for some sectors and regions, and potentially negative impacts for others. Aggregated, however, the various impacts are likely to impose costs which increase with rising global temperatures. Potential implications relate to a broad range of areas including water resources, food security, biodiversity, infrastructure, trade, human settlement, health, living conditions, and international peace and security.[12]

Maritime transport is not insulated from climate changes; the type, range and magnitude of impacts vary according to local conditions, transportation systems, designs and policies, as well as the capacity to adapt and minimize the costs. Direct impacts are likely in relation to

[8] See IPCC, 2007. See also the Recommendations of the International Climate Change Task Force, Meeting the Climate Change Challenge, January 2005; and Lenton TM (2007). *Tipping Points in the Earth System*. School of Environmental Sciences, University of East Anglia.

[9] Environment News Service (2008). U.S. National Labs Probe Abrupt Climate Change. 22 September.

[10] See IPCC (2007). Summary for Policy Makers, WG II. See also Recommendations of the International Climate Change Task Force, Meeting the Climate Change Challenge, January 2005; and Lenton TM (2007). *Tipping Points in the Earth System*. School of Environmental Sciences, University of East Anglia.

[11] Environment News Service (2008). *U.S. National Labs Probe Abrupt Climate Change*. 22 September.

[12] UNEP (2007). *Global Environment Outlook 4* (GEO-4). 2007. See also UNDP (2008). Human Development Report 2007/2008.

maritime transport infrastructure, operations and maintenance. Maritime transport services may also be affected indirectly, as a result of changes in demand, induced by climate change effects on trade, investment decisions, demographics, agricultural production, forests, energy exploration, energy demand and fishing activity.

To better understand the extent of the challenge for the maritime transport sector, the following section describes the fuel consumption and emissions profile of the sector, together with some trends.

B. International shipping emissions

Estimates of fuel consumption and GHG emissions from shipping vary in timescale, underlying assumptions and modelling techniques. As shown in table 1, emissions from international shipping are estimated to account for 1.6 per cent to 4.1 per cent of world CO_2 emissions from fuel combustion. IMO expects emissions from international shipping to increase by a factor of 2.2 to 3.1 between 2007 and 2050.[13] Within the transport sector, maritime transport accounted for 10 per cent of emissions in 2005.[14] Road transport accounted for 73 per cent, followed by aviation (12 per cent), pipeline (3 per cent) and rail (2 per cent). Unchecked, emissions from the transportation sector are expected to double by 2050.[15]

Table 1. Some estimates of fuel consumption, CO_2 emissions and projected growth

	Base year	**CO_2 million tons**	**Fuel million tons**	**% of world fuel combustion***	**Projected growth**
Second IMO GHG Study 2009	2007	870	277	3.1	By a factor of 1.1-1.2 by 2020 & 2.2-3.1 by 2050***
IMO/Group of Experts (2007)	2007	1120	369	4.1	+ 30% by 2020
IMO GHG Study (2000)	1996	419.3	138	1.6	--
IEA (2005)	2005	543	214	2.0	--
TRT Transporti e Territorio	2006	1003	NA	3.7	--
Endressen et al, 2007**	2002	634	200	2.3	+ 100-200% by 2050
Eide et al, 2007**	2004	704	220	2.6	+ 100-200% by 2050
Eide et al, 2007**	2006	800	350	2.9	+ 100-200% by 2050
Corbett et al, 2003**	2001	912	289	3.1	--

** Based on IEA 2005 data for world CO_2 emissions from fuel combustion. ** Obtained from secondary sources including the IMO Upated Study on GHG, 2008 and the Second IMO GHG Study 2009. ***Base values and according to six main scenarios under the IPCC Special Report on Emission Scenarios (SRES): A1F1, A1B, A1T, A2, B1 and B2.*

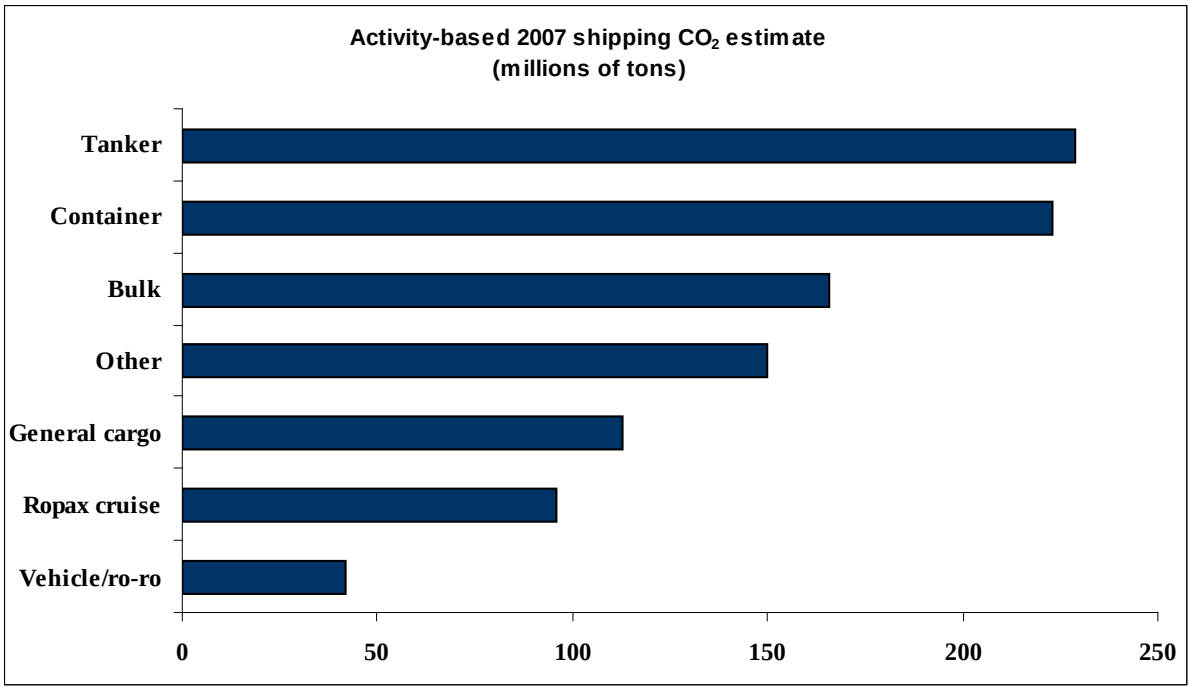
[13] See the Second IMO GHG Study 2009, Update of the 2000 IMO GHG Study, Final report covering Phase 1 and Phase 2, MEPC 59/INF.10, 9 April 2009.

[14] Transport share expressed as a percentage of the 2005 International Energy Agency (IEA) total world CO_2 emissions from fuel combustion.

[15] Based on data from the World Business Council for Sustainable Development, 2004.

Figure 1 shows the carbon footprint of international shipping, broken down by ship type. The heavy reliance on oil, in particular heavy oil, for combustion underscores the relevance of greater energy efficiency and energy source diversification for mitigation action in shipping.

Figure 1. Shipping sector CO_2 emissions

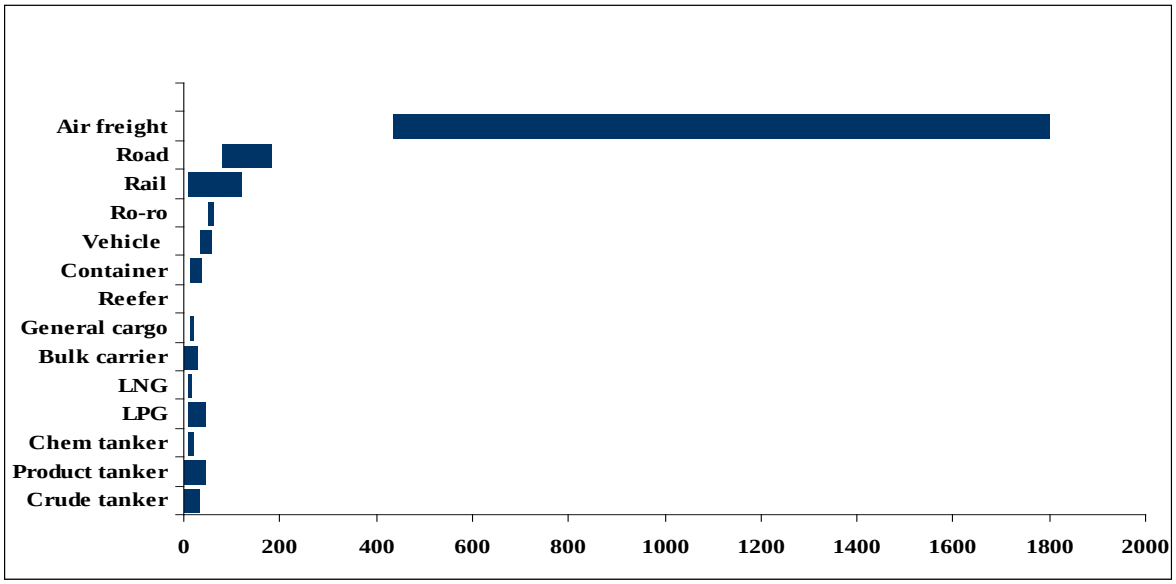


Source: UNCTAD, based on IMO 2000 Updated Study on Greenhouse Gas Emissions from Ships, 2008. Includes international and domestic shipping and excludes fishing and military vessels.

While in absolute terms GHG emissions from international shipping are significant, in relative terms maritime transport – in particular where larger ships are used – surpasses other modes of transport in terms of fuel efficiency and climate friendliness. On a per ton kilometre (km) basis and depending on ship sizes, CO_2 emissions from shipping are lower than emissions from other modes. For example, emissions from rail could be 3 to 4 times higher than emissions from tankers, while emissions from road and air transport could, respectively, be 5 to 150 times and 54 to 150 times higher. Equally, in terms of fuel consumption (kilowatt (kW)/ton/km), a container ship (3,700 twenty-foot equivalent units (TEUs)), for instance, is estimated to consume on average 77 times less energy than a freight aircraft (Boeing 747-400), about 7 times less than a heavy truck and about 3 times less than rail.[16]

[16] The Network for Transport and the Environment (NTM) data published in Environment, Container Shipping Information Service, 10 January 2008. See also World Shipping Council (2008). *Record Fuel Prices Places Stress on Ocean Shipping*. 2 May.

Figure 2. CO_2 efficiencies by cargo carrier (g CO_2/ton-km)



Source: UNCTAD, based on the Second IMO GHG Study 2009.

This suggests that increased use of shipping, including in multimodal transport and through modal shift, can achieve some CO_2 and energy efficiency gains. However, international shipping is unlikely to always offer a workable alternative to other more polluting modes, as it does not in general overlap with other freight modes. As different modes are used to carry different types of goods over varying distances, a modal shift may be an option, but only for specific market segments (e.g. short-sea shipping in Europe). It is also argued that improving the environmental performance of each freight mode is likely to be more effective than a modal shift.[17] However, where a modal shift to shipping is technically feasible and economically viable, creating a government policy atmosphere supportive of a targeted and considered modal shift would be important.

II. Addressing the climate change challenge: a maritime transport perspective

A. The regulatory and institutional framework: mitigation and adaptation

1. 1992 UNFCCC[18]

With 192 member States, UNFCCC sets an overall framework for international efforts to tackle climate change. The convention places a heavier burden on developed countries to reduce GHG emissions under the principle of "common but differentiated responsibilities". While developing countries are not bound by any specified emission reduction targets, by 2000 developed countries had to reduce their GHG emissions to 1990 levels. They are also required to promote and facilitate the transfer of climate-friendly technologies to developing countries and to countries with economies in transition.

[17] Annema J, Francke J (2008) *Reducing CO_2 Emissions in Goods Transport*. Discussion Paper, Research, Industry and Stakeholders' Day, Workshop 3. International Transport Forum. 28 May. See also Chapman L (2007) Transport and climate change: a review. *Journal of Transport Geography*. Volume 15, Issue 5. September.

[18] See http://unfccc.int/essential_background/convention/items/2627.php.

2. 1997 Kyoto Protocol[19]

The 1997 Kyoto Protocol enhances many of the commitments under UNFCCC. While UNFCCC encourages developed countries to stabilize GHG emissions, the Kyoto Protocol sets specific commitments, binding 37 developed countries over 2008–2012. These countries need to cut their GHG emissions by about 5 per cent from 1990 levels, including through cost-effective emission reduction mechanisms available under the protocol: the Clean Development Mechanism (CDM), the Joint Implementation (JI) and emission trading via a cap and trade system. Negotiations are also currently being held under the Kyoto Protocol to set further emission reduction targets for developed countries by 2009, analyse the effectiveness of means to achieve these targets, and further operationalize the protocol's Adaptation Fund.

3. Post-Kyoto 2012[20]

In December 2007, a conference was held in Bali to launch negotiations on a new international climate change agreement. UNFCCC adopted the "Bali Roadmap", which includes the "Bali Action Plan". The plan covers mitigation, adaptation, technology and financing, and provides for a new negotiating process on climate change to be completed by 2009. A new Ad Hoc Working Group on Long-Term Cooperative Action (AWG-LCA) – which was established at the conference to carry out the "Bali Action Plan" – has held four meetings in the course of 2008 (Bangkok, Bonn, Accra and Poznan).

According to discussions at the AWG-LCA meetings, there seems to be no opposition to including international shipping in a second commitment period, but views differ with respect to the appropriate forum (i.e. UNFCCC or IMO). Some, especially the most vulnerable developing countries, have questioned how the principle of "common but differentiated responsibilities" could be applied in the context of international shipping.

4. A shipping perspective: IMO[21]

Although no mandatory instrument has been adopted as yet, IMO has recently intensified its work on GHG emissions from ships. The aim is the adoption in 2009 of a binding, coherent and comprehensive IMO regulatory framework on GHG emissions from ships. IMO's Marine Environment Protection Committee (MEPC) agreed that, among other things, the framework should be (a) effective, binding all flag States; (b) cost effective; (c) practical; (d) transparent; (e) fraud-free; and (f) easy to administer. It should have limited competitive distortion, support technical innovation, promote sustainable development and not penalize trade. It should also adopt a goal-based approach and promote energy efficiency. Views differed somewhat about the scope of a future IMO regime, with some countries arguing that the principle of "common but differentiated responsibilities" under UNFCCC was not compatible with a global regime on GHG emissions applying equally to both developed and developing countries.

[19] See http://unfccc.int/kyoto_protocol/items/2830.php.
[20] See http://unfccc.int/meetings/items/2654.php.
[21] For additional information see www.imo.org.

The MEPC has already considered a report by the intersessional Correspondence Group on Greenhouse Gas-related Issues outlining a range of possible short-term and long term measures for curbing emissions from international shipping. A Working Group on Greenhouse Gas Emissions has also been established and has commenced its work.

Possible short-term measures under discussion include a proposal to establish a global levy scheme applicable to all ships engaged in international voyages. Other potential short-term measures under consideration include wind power, speed reductions and onshore power. Possible long-term measures include technical measures for ship design, use of alternative fuels, a mandatory limit on the Energy Efficiency Design Index (EEDI) for new ships, a mandatory CO_2 element in port infrastructure charging and an emissions trading scheme.

5. National and regional initiatives

In addition to international efforts, action has been taken at the national and regional levels. While some national and subnational initiatives deal specifically with transportation (e.g. the 2004 California regulations on GHG emissions from motor vehicles and the Japan green taxation plan for automobiles), others are not sector-specific. Examples include (a) a climate change levy in the United Kingdom; (b) a 2005 climate change plan for Canada; (c) Australia's GHG abatement programme; (d) a carbon tax and negotiated GHG agreement in New Zealand; (e) a 2005 law on renewable energy in China; (f) a national biodiesel programme in Brazil; (g) GHG action plans in 30 states in the United States; (h) California laws on a State-wide cap on GHG emissions; and (i) coal-generated electricity.

At the regional level too, initiatives are not necessarily transport-specific. An important regional climate change action is underway at the European Union (EU) level, where steps to address GHG emissions have been taken since the early 1990s. In March 2000, the European Commission launched the European Climate Change Programme which has led, inter alia, to the launch of the 2005 EU emission trading scheme (ETS). In 2007, a directive was adopted setting an overall binding target for the EU of 20 per cent renewable energy and a 10 per cent minimum target for the market share of biofuels, by 2020.[22] More recently, in North America, the Western Climate Initiative – a cap and trade programme binding seven American States and four Canadian provinces – has been announced.

B. Potential approaches to mitigation in maritime transport

An important consideration in relation to mitigation options for international shipping is the complexity inherent in this sector, since CO_2 emissions are largely generated outside national boundaries and ships may be linked to different nations through registration, beneficial ownership and operation. Table 2 below highlights some possible mitigation measures potentially applicable to maritime transport.

Each option entails opportunities and challenges, with a key challenge relating to potentially extensive costs as well as the fact that many potential win–win solutions (e.g. alternative cleaner fuels) are at preliminary stages of development. In respect of these, time and significant investments are required to ensure commercial viability and wide diffusion. In particular, from developing countries' perspectives, there may be concerns about the cost

[22] Commission of the European Communities (2007). *Renewable Energy Road Map Renewable Energies in the 21st Century: Building a More Sustainable Future*. COM(2006) 848 final.

implications of the various mitigation measures and, where applicable, the capacity to adopt and implement a number of technology-based measures. Increased costs are likely to exert additional pressure on the maritime industry and, by extension, on transport costs, which are already disproportionately higher in developing countries and entail implications for trade competitiveness. As may be recalled, the industry is already facing increased expenditures associated with supply chain security requirements, trade facilitation measures, other environmental regulations (e.g. of air pollutants) as well as highly volatile fuel prices.

1. Technology and energy use improvements

Technology and energy use improvements can reduce emissions by replacing older, less energy-efficient or higher-polluting equipment and engines. The potential of technical measures (e.g. technologies affecting hull, propeller and machinery) to reduce fuel consumption and CO_2 emissions is estimated at 5–30 per cent in new ships and 4–20 per cent in old ships.[23]

A significant shift to *alternative fuels and energy sources* could be difficult in the short term, as most promising alternative techniques cannot yet fully compete with diesel engines. In some cases, a switch from diesel to natural gas is possible (e.g. inland ferries in Norway and offshore supply vessels operating on the Norwegian Continental Shelf).[24] As to biofuels, concerns over their production processes and related implications for food security, climate change and sustainability make their future uncertain. Their uptake will depend on progress made in the field of less controversial biofuels which are not yet widely available (e.g. waste-based). Solar panels and sails – as well as hydrogen-propelled ships and fuel cell power for auxiliary engines – constitute long-term options. Carbon capture and storage technology could also be further developed and applied to the transport sector.

Ports, as key nodes in the transport chain and given their ability to leverage other partners, can reduce their own emissions as well as emissions that occur along the supply chains. This can be achieved by, inter alia, collaborating with other transportation and logistics players, and co-investing in land equipment and vehicles such as feeders, barges and rail solutions. Recently, ports' commitment to a lighter carbon footprint culminated in the adoption of the World Ports Climate Declaration in July 2008.[25]

Along the supply chain, *optimizing vehicle utilization* could help mitigate emissions through (a) telematics; (b) intelligent transport; (c) new vehicle and engine design; and (d) information and communications technology-enabled scheduling, planning and routing. Equally, trade facilitation solutions, such as computerized customs data (e.g. Automated System for Customs Data (ASYCUDA)) could have a role to play. Experiences with customs automation and Single Window projects have shown that the volume of energy consumed during waiting times at border crossings and in ports can be significantly reduced.

[23] IMO (2000). *Study of Greenhouse Gas Emissions from Ships.* March.
[24] InterAcademy Council (2008). *Lighting the Way Toward a Sustainable Energy Future*. October.
[25] See 2008 C40 World Ports Climate Conference at www.wpccrotterdam.com.

Box 2. ASYCUDA programme

The ASYCUDA programme is UNCTAD's flagship technical assistance programme. It is the leading media of customs modernization worldwide and is operating in nearly 90 countries in all regions of the world. ASYCUDA makes it possible to electronically process declarations and clear goods, facilitate risk management operations, support transit operations, apply risk management and selectivity to all steps of the clearance process, and produce timely and accurate statistical data for fiscal and trade policy objectives. It facilitates the exchange of electronic documents and data between the national customs administrations and other governmental agencies and traders, as well as between different customs administrations via the Internet. For over 20 years, ASYCUDA, by using electronic processing of transactions and thus saving on paper, has been adding to the conservation of the environment.

2. Operational measures

Operational measures are also important for mitigation since they are estimated to have a short-term CO_2 reduction potential of up to 40 per cent through, for example, rerouting and speed reduction.[26] Vessel speed reduction to save fuel consumption and, by extension, reduce GHG emissions, is a key cost-cutting strategy for shipping. Slowing down by 10 per cent can lead to a 25 per cent reduction in fuel consumption.[27] A number of shipping companies have relied on this approach to cut their operating costs during the 2008 record rise in oil and bunker prices. Operators have reduced sailing speed, reviewed route scheduling and entered into partnerships and alliances to take advantage of economies of scale by consolidating existing loops and deploying more fuel-efficient larger vessels.[28] As a side effect, these cost-cutting strategies have helped somewhat in containing the rise in freight rates which might otherwise have negatively impacted trade, including that of developing countries.

In ports, improving operations may entail, for instance, reconfiguring terminals to improve barge access, enhance on-dock rail capabilities, speed up loading and unloading, reduce congestion, and provide shore-side electricity.

3. Market-based programmes

Market-based programmes may include measures such as taxation, differentiated port fees and emissions trading programmes (cap and trade and emissions credits). One analysis estimates that a creative market-based instrument covering all ships could deliver significant and differentiated benefits and could raise between $10 billion and $45 billion annually.[29] If such revenues were channeled towards a mixture of adaptation, technology transfer and emission mitigation projects, benefits of such policies for developing countries could equal two to five times their costs. That being said, many issues need to be addressed before any definite conclusions are drawn on the full implications of these types of measures. Many developing countries have called for further analysis and thorough assessment of the various

[26] See IMO (2000). *Study of Greenhouse Gas Emissions from Ships*. March.
[27] See for example, The Slow Route to Fuel Savings. *Lloyd's Ship Manager (LSM)*. May 2008.
[28] See for example, Nightingale B (2008). Life in the Slow Lane. *Lloyd's Shipping Economist (LSE)*, March 2008 and Kirschbaum E. Harnessing Kite Power to a Ship. *International Herald Tribune*. 20 January.
[29] IMO (2008). *Benefits and possible adverse impacts of market-based instruments*. MEPC 58/4/39. 15 August.

proposals under consideration at IMO. Concerns relate in particular to trade competitiveness, as well as technical assistance and capacity-building requirements.

Box 3. Selected market-based mitigation measures

Cap and trade programmes include the JI and CDM under the Kyoto Protocol, the EU ETS and an International Maritime Emission Reduction Scheme (IMERS) proposed by Norway at IMO's MEPC 56. Current discussions at IMO highlight the challenges associated with a cap and trade approach for shipping. These include the geographic and substantive scope of coverage (i.e. which pollutants and how much of the shipping fleet would be subject to the scheme), whether emission reduction credits from-land based sources would be allowed, the baseline and allowance allocation.

A fuel tax, or a levy such as the current proposal discussed at IMO, poses a challenge, given the risk of evasion: ships may avoid the tax by taking fuel on board outside the taxed area. Offshore bunker supply is already common practice to avoid paying port fees or being constrained by loading limits in ports. Hence, a global fuel tax may be difficult to implement given the international dimension. Issues to be addressed include, for example, (a) the point of application of the charge; (b) responsibility for collecting the proceeds; and (c) the question of how such proceeds would be distributed among countries and for which purpose (e.g. mitigation, adaptation and technology). A fuel tax for international shipping without an equivalent levy for other modes could also undermine the relative cost advantage of shipping and may impact different trades. This may have implications for transport costs and trade competitiveness, including for developing countries that are major bulk commodity exporters and non-bulk commodity importers.[30]

Measures that involve port infrastructure charging include port dues and other charges which can be differentiated to take into account the environmental performance of users (e.g. environmentally differentiated fairway dues in Sweden, the Green Award scheme in a number of world ports, the Green Shipping bonus in Hamburg, and environmental differentiation of tonnage tax in Norway). Support measures such as grants, low-interest loans and favourable tax treatment can also help mitigate GHG emissions from shipping (e.g. California Air Quality Investment Programme). Shipbuilding subsidies could also be increased if new ships incorporate GHG control technologies or are built to meet emission performance targets.

Industry-led voluntary initiatives include, for example, committing to an average emissions rate, known as the benchmark, as well as promoting specific emission control technologies (e.g. West Coast Diesel Collaborative Marine Vessels) and preferential contracting of cleanest carriers whereby shippers (e.g. IKEA) require shipowners and ports to compete in terms of environmental performance, as well as in terms of costs.

[30] See IMO Study of Greenhouse Gas Emissions from Ships. March 2000.

Table 2. Potential mitigation options

Scope of intervention	Measure	Example
Technology & Energy	• Efficient and lower-emitting propulsion systems • Clean fuels and alternative energy sources • Ship design (structure, hull and machinery) • Emission control technologies (e.g. after exhaust treatment, carbon captures and storage)	• EU and IMO sulfur emission control areas • Solar Sailor 2006 and Skysails 2006 • Switch from diesel to natural gas
Operational	• Speed Reduction • Route selection • Monitoring of weather and sailing conditions • Collaboration among ports, carriers, other modes and other players in the supply chain • Cold ironing or onshore power	• NYK announcement in early 2008 to reduce the speed of all vessels in the fleet by 10% to cut fuel consumption by up to 25% • Vessel sharing agreement between Maersk MSC and CMA-CGM on Transpacific trade
Market-based	• Environmentally differentiated rates/dues • Cap and trade • Taxation • Subsidies • Industry-led voluntary schemes	• Fairway dues in Sweden, Green Award Scheme, Green Shipping Bonus, differentiated tonnage tax in Norway • Kyoto CDM and JI • EU ETS and proposed IMERS • Potential global fuel tax • California Air Investment Programme • Preferential contracting

Source: UNCTAD based on literature review.

C. Potential climate change impacts and approaches to adaptation in maritime transport

Mitigation alone is not sufficient to effectively address the climate change challenge. Adaptation remains a necessity to minimize the effects of irreversible climatic changes. Adequate adaptation measures for maritime transport require information on likely vulnerabilities and a good understanding of relevant climatic impacts, including their type, range and distribution across different regions and parts of the industry. Given the high vulnerability and low adaptive capacity of many developing countries, adaptation costs are likely to impose a significant burden for these countries' economies and trade. The following section highlights some climate change impacts, their potential implications for adaptation needs in maritime transport, and some potentially relevant adaptation measures (see also table 3).

1. Impact on maritime infrastructure and equipment

Higher temperatures are likely to affect maritime transport infrastructure, vehicles and equipment. Extreme temperatures and large variations, together with more frequent freeze and thaw cycles, could, for example, result in a deterioration of ports' paved areas. Heat could also cause damage to equipment (e.g. cranes), especially when made from metal with limited heat resistance. Ports may also experience increased energy consumption and CO_2 emissions due to refrigeration needs for perishable goods and air conditioning.

Rising sea levels, floods and inundations entail heavy consequences for transport infrastructure and may involve damage to terminals, intermodal facilities, freight villages, storage and warehousing areas, containers and cargo. Extreme weather events (e.g. extreme storm surges) may also disrupt the intermodal supply chain and undermine transport connectivity through damage to port hinterland connections. This would be of particular concern to LLDCs, whose trade depends on well-functioning transportation networks in transit and coastal countries.

Box 4. High exposure and vulnerability of coastal and low-lying areas

Coastal areas, especially low-lying parts with high-exposure possibilities (e.g. people, port assets and cargo) and significant vulnerability (e.g. low adaptive capacity) are at greater risk. While covering only 2 per cent of the world's land area, low elevation coastal zones contain 10 per cent of the world's population and 13 per cent of the world's urban population (e.g. small island countries, which are often also LDCs, and countries with heavily populated deltas).[31] An Organization for Economic Cooperation and Development (OECD) study assessed the exposure of the world's largest port cities to coastal flooding and found that in 2005 the top 10 cities in terms of exposed population were Mumbai, India; Guangzhou, China; Shanghai, China; Miami, United States; Ho Chi Minh City, Viet Nam; Kolkata, India; New York, United States; Osaka-Kobe, Japan; Alexandria, Egypt; and New Orleans, United States. The most vulnerable port cities in terms of exposed assets were Miami; New York; New Orleans; Osaka-Kobe; Tokyo, Japan; Amsterdam, the Netherlands; Rotterdam, the Netherlands; Nagoya, Japan; Tampa–St. Petersburg, United States; and Virginia Beach, United States. The total value of assets exposed across all 136 port cities examined was estimated at $3 trillion.[32]

Increased sediment mobility and *changes in erosion/sedimentation patterns* around harbours and access channels could also complicate operations and raise costs through the need for dredging. Beyond direct costs, damages caused by sea level rise, floods and inundations could lead to port shutdowns, disruption of service, delays and further economic losses.

2. Impact on maritime transport services

Extreme weather events, such as intense storms, could disrupt services, including in ports, as well as challenge sailing conditions and potentially pose hazards to navigation, ship, cargo, crew and the environment. Difficult sailing conditions could also lead to a modal shift – when technically feasible and economically viable – if other modes are deemed less vulnerable to weather. This may entail further implications for infrastructure investments, fuel consumption and GHG emissions, as well as transport efficiency and trade facilitation.

[31] McGranahan G, Balk D, Anderson B (2007). *The Rising Tide: Assessing the Risks of Climate Change and Human Settlements in Low Elevation Coastal Zones*. International Institute for Environment and Development.
[32] Nicholls RJ et al. *Ranking Port Cities With High Exposure to Vulnerability to Climate Extremes – Exposure Estimates.* OECD, ENV/WKP/(2007)1.

A potentially positive impact of climate change relates to shipping routes, since rising temperature in the Arctic could open some new opportunities for shipping. Although existing trade lanes are likely to continue serving the bulk of international trade, new trade may emerge with some existing trade being diverted towards northern routes. By 2080, the ice-free season of the Northern Sea Route (NSR) could increase by up to 80 days per year.[33] A fully operating NSR would reduce the sailing distance between Rotterdam and Yokohama via the Suez Canal by more than 40 per cent.[34] This would impact on seagoing trade, fuel consumption and GHG emissions, fuel costs and freight rates. It would also entail some implications for ship order books (i.e. ice-class ships), icebreaking services and associated fees.

In the summer of 2007, according to the European Space Agency (ESA), satellite images showed that sea ice in the North-west Passage (NWP) had shrunk to its lowest level since satellite measurements began in 1978. Many experts expect the Arctic to be ice free before the date projected by the IPCC (i.e. mid-2070). While one recent study concluded that the Arctic would be ice free in the summer as early as 2013, recent satellite images show that "Open water now stretches all the way round the Arctic, making it possible for the first time in human history to circumnavigate the North Pole".[35]

Currently, ships sail on the main shipping routes using the Panama Canal, South-east Asian straits or the Suez Canal. If the potential Arctic sea lanes were fully open for traffic, savings on distance, time and costs could be achieved. A navigable NWP offers a route between Tokyo and New York that is 7,000 km shorter than the route through the Panama Canal, thus saving on time, fuel and transit fees. Taking into account canal fees, fuel costs and other relevant factors that determine freight rates, the new trade lanes could cut the cost of a single voyage by a large container ship by as much as 20 per cent, from approximately $17.5 million to $14 million.[36] The savings would be even greater for the megaships unable to fit through the Panama and Suez Canals and currently sailing around the Cape of Good Hope and Cape Horn. One shipping company (Beluga Group) announced that it would send the first ship through the Arctic in 2009.[37]

These potential shortcuts could foster greater competition with existing routes, including through a cut in transport costs, thereby promoting trade and international economic integration.[38] Changing transport and trade patterns are likely to affect infrastructure investments. Ports and terminals in the Arctic need to be able to berth iceclass ships, equipment needs to be sturdy and adequate, and labour needs to be skilled and specialized.

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[33] Pinnegar JK et al. (2006). *Alternative Future Scenarios for Marine Ecosystems*. United Kingdom Department for Environment, Food and Rural Affairs (Defra).

[34] Borgerson SJ (2008) Arctic Meltdown: The Economic and Security Implications of Global Warming. Foreign *Affairs*. April.

[35] See for example, Hansen K (2008). *NASA Data Show Arctic Saw Fastest August Sea Ice Retreat on Record.* The National Aeronautics and Space Administration (NASA). 26 September. See also projections by scientists from the United States National Snow and Ice Data Center (NSIDC) and Naval Postgraduate School, Monterey, California.

[36] Bergerson SG (2008). Arctic Meltdown, The Economic and Security Implications of Global Warming. *Foreign Affairs*. March/April.

[37] Lean G (2008). For the First Time in Human History, the North Pole Can be Circumnavigated. *The Independent*. 31 August.

[38] See for example, Wilson KJ, et al. (2004). *Shipping in the Canadian Arctic: Other Possible Climate Change Scenarios*. Institute of Electrical and Electronics Engineers International.

A navigable North is also likely to promote resource exploration activities in the region. World shipbuilders, including in developing countries, may therefore be expected to receive more orders for ice-capable ships. In 2006, a total of 262 ice-class ships were being built, with an additional 234 ice-strengthened ships expected for delivery by 2012.[39] However, opening the NWP for navigation may also give rise to conflicting territorial claims by countries in the region as well as involve some governance and regulatory considerations.

To sum up, an Arctic open for navigation holds many opportunities and challenges. These, however, need to be fully assessed to ascertain their potential implications for trade and competition among routes, shipbuilding, labour, port development, offshore activity and human settlement. Implications for the Arctic's ecosystem, local communities, possible territorial disputes and governance also need to be assessed.

[39] Patrik Wheater (2006). *Improved Ice Efficiency*. Twentyfour7. February.

Table 3. Potential implications adaptation in maritime transport

Climate change factor	Potential implications	Adaptation measures
Rising temperatures • High temperatures • Melting ice • Large variations (spatial and temporal) • Frequent freeze and thaw cycles	• Longer shipping season (NSR), new sea route (NWP) • Shorter distance for Asia–Europe trade and less fuel consumption • Additional support services and navigation aids such as ice-breaking search and rescue • Competition, lower passage tolls and reduced transport costs • New trade, diversion of existing trade, structure and direction of trade (indirectly through impact on agriculture, fishing and energy) • Damage to infrastructure, equipment and cargo • Increased construction and maintenance costs; new ship design and strengthened hulls; environmental, social, ecosystem related and political considerations • Higher energy consumption in ports • Variation in demand for and supply of shipping and port services • Challenge to service reliability	• Heat-resistant construction and materials • Continuous inspection, repair and maintenance • Monitoring of infrastructure temperatures • Reduced cargo loads, speed and frequency of service • Refrigeration, cooling and ventilation systems • Insulation and refrigeration • Modal shift • Transit management scheme and regulation of navigation in northern regions • Ship design, skilled labour and training requirements
Rising sea levels • Flooding and inundation • Erosion of coastal areas	• Damage to infrastructure, equipment and cargo (coastal infrastructure, port-related structures, hinterland connections) • Increased construction and maintenance costs, erosion and sedimentation • Relocation and migration of people and business, labour shortage and shipyard closure • Variation in demand for and supply of shipping and port services (e.g. relocating), modal shift • Structure and direction of trade (indirectly through impact on agriculture, fishing, energy) • Challenge to service reliability and reduced dredging, reduced safety and sailing condition	• Relocation, redesign and construction of coastal protection schemes (e.g. levees, seawalls, dikes, infrastructure elevation) • Migration • Insurance
Extreme weather conditions • Hurricanes • Storms • Floods • Increased precipitation • Wind	• Damage to infrastructure, equipment and cargo (coastal infrastructure, port-related structures, hinterland connections) • Erosion and sedimentation, subsidence and landslide • Damage to infrastructure, equipment, cargo • Relocation and migration of people and business • Labour shortage and shipyard closure • Reduced safety and sailing conditions, challenge to service reliability • Modal shift, variation in demand for and supply of shipping and port services • Change in trade structure and direction	• Integrate emergency evacuation procedures into operations • Set up barriers and protection structures • Relocate infrastructure, ensure the functioning of alternatives routes • Increase monitoring of infrastructure conditions • Restrict development and settlement in low-lying areas • Construct slope-retention structures • Prepare for service delays or cancellations • Strengthen foundations, raising dock and wharf levels • Smart technologies for abnormal events detection • New design for sturdier ship

Source: UNCTAD based on literature review.

3. Some adaptation options for maritime transport

Adaptation involves enhancing the resilience of infrastructure and operations through, inter alia, changes in operations, management practices, planning activities and design specifications and standards. The extended timescale of climate change impacts and the long service life of maritime infrastructure, together with sustainable development objectives, imply that effective adaptation is likely to require re-thinking freight transport networks and facilities. This may involve integrating climate change considerations into investment and planning decisions, as well as into broader transport design and development plans.

To better deal with *extreme weather events*, emergency evacuation procedures need to be integrated into operations. Preparing for service delays or cancellations may contribute to minimizing impacts, while smart technologies could be used to detect abnormal events and therefore allow for appropriate actions to be taken in time. Investing in infrastructure and equipment able to withstand extreme weather events such as storm activity, flooding, corrosion and heat will also be crucial (e.g. new, more heat-resistant construction and paving materials and construction techniques). Managing these events may involve continuous inspection, better monitoring of infrastructure temperatures, increased maintenance, reduced cargo loads, reduced speed and frequency of service, and changes to ship design. Ships, ports, terminals, warehouses and storage areas may require increased refrigeration, cooling systems and ventilation, resulting in higher energy consumption and CO_2 emissions. Finally, stronger ships able to better withstand extreme weather events will probably be required.

The potential full operation of the NWP and NSR would require a transit management regime, regulation (e.g. navigation, environmental, safety and security) and a clear legal framework to address potential territorial claims that may arise, with a number of countries having a direct interest in the Arctic.

Adaptation in the context of *rising sea levels* may involve relocating facilities (e.g. warehouses, storage areas and other services offered on the port side could be relocated further inland), rerouting traffic, redesigning structures or retrofitting with appropriate protection, including through elevation, defences, levees, seawalls and dikes. Using flood defences is estimated to reduce losses for high-risk properties by 70 per cent.[40] Land planning polices need to ensure that risks associated with further settlement and port infrastructure investment in vulnerable areas are better assessed and taken into account.

D. Cross-cutting issues

An international regime on GHG emissions from shipping cannot succeed if some underlying cross-cutting issues are not sufficiently considered. These include addressing costs through adequate financing and technology transfer to help, in particular, developing countries build, as a matter of priority, their adaptive capacities. There is also a need to further explore and capitalize upon the potential win–win solutions that could be achieved by linking climate policy imperatives with other objectives, such as in relation to energy security, transport efficiency and trade facilitation, within a broader sustainable development framework.

[40] Lloyd's (2008). *Coastal Communities and Climate Change: Maintaining Future Insurability*. September.

1. Costs and financing[41]

Addressing climate change requires significant global investment and financial flows, including those that are private sector-driven; yet the cost of inaction is estimated to be much higher (5 per cent to 20 per cent as compared to 1 per cent of gross domestic product annually).[42] Although the current global financial crisis and economic downturn might change the perceived relative cost of climate change policy and sideline the fight against climate change, postponing action is not a viable option. Necessary funding, including in maritime transport, needs to be mobilized with an urgency equivalent to that of the global credit crisis. While a "bailout package" for climate change remains crucial, there is, nevertheless, a concern about climate change objectives being put "on the back burner", with potential implications for the outcome of the Bali negotiating process.

Current financial flows for both mitigation and adaptation from the UNFCCC and Kyoto Protocol financial mechanisms remain, however, inadequate in comparison with the challenge. As of March 2008, funds pledged to UNFCCC's Special Climate Change Fund totalled $90 million while those pledged to the Least Developed Countries Fund totaled $173 million. The Adaptation Fund under the Kyoto Protocol could have $80 million– $300 million per year for adaptation projects and programmes in developing countries during 2008–2012. Given the projected mitigation and adaptation requirements, scaling up financial assistance is key.

Additional funds needed for mitigation are estimated at $81 billion to $249 billion in 2030, equivalent to only 1.1 per cent to 1.7 per cent of projected global investment in 2030. About 50 per cent of these amounts will be required by developing countries, where mitigation options are considered less costly but where adaptation needs are greater. Costs of mitigation in maritime transport are also likely to be significant. Climate-related expenditures affecting maritime transport operations, equipment and infrastructure can be expected to pose an additional financial burden for the maritime industry, and could affect transport and trade costs. That being said, a thorough assessment of cost implications for the maritime transport sector is as yet to be completed and will depend on the type of measures adopted as well as their scope of application.

Additional financing required globally for adaptation in five sectors, including infrastructure and coastal protection, are estimated at $49 billion–$171 billion in 2030, with $28 billion–$67 billion of this total being needed in developing countries. Other estimates of adaptation costs for developing countries include those by the World Bank ($9 billion–$41 billion), Oxford Institute for Energy Studies ($2 billion–$17 billion), Oxfam (greater than $50 billion), and the United Nations Development Programme ($86 billion). Irrespective of the divergence of these estimates, the bottom line is that current funding levels are dwarfed by the billions of dollars that will be needed, especially by developing countries, to adapt to climate change.

Adaptation in maritime transport is likely to require important financial resources, especially in the most vulnerable developing countries where, very often, existing transport infrastructure and equipment lack the resilience necessary to withstand the various projected

[41] Lloyd's (2008). *Coastal Communities and Climate Change: Maintaining Future Insurability*. September.
[42] Stern N (2006). *Stern Review: The Economics of Climate Change,*. 2006. See also Valentina B et al. (2006) *How Can China Help Reduce Climate Policy Costs?*.VoxEU.org. 1 October.

climatic impacts. Adaptation costs in maritime transport are not yet fully understood given the important knowledge gap in terms of adaptation needs, geographic distribution and required response measures. Ensuring adequate financing for adaptation in maritime transport is likely to also achieve some collateral benefits (e.g. transport efficiency and trade facilitation), which could help partly offset the adaptation costs.

2. Technology

Promoting large-scale development and deployment of technology in support of climate change action is challenging yet crucial for developing countries, especially since the "Bali Action Plan" provides that – within a context of sustainable development –mitigation action is also required from developing countries. Achieving reduction targets necessary to prevent dangerous climate change effects requires massive mobilization of technology across different sectors, including maritime transport.

The "Bali Action Plan" emphasizes the need to remove barriers to financing and technology transfer, and for developing countries to have access to such technologies. Specific actions include faster deployment and diffusion of green technologies, and cooperation on research and development. Economic opportunities offered by a "green revolution" and a revision of the global financial system may provide a new departure for climate policy investments.[43] Coordinated international action on climate change has the potential to raise global incomes and provide additional rural employment, especially in areas with limited alternative opportunities in developing countries.[44]

Other mechanisms outside UNFCCC that could mobilize a global technology revolution include the World Bank Group's Clean Energy for Development Investment Framework, the IEA Programme and bilateral agreements to promote technology (e.g. EU–China, the United States–Russian Federation). Technologies used in trade facilitation and supply chain security could also be leveraged to achieve climate policy gains in transport. The challenge, however, is for many of these initiatives to translate into a real technology transfer to developing countries. Indeed, much remains to be done to ensure measurable, reportable and verifiable diffusion of these technologies.

3. Energy

While climate-led policies and those related to energy security may have different objectives, they are nevertheless interconnected and entail important synergies. Relieving global dependency on fossil fuel sources and reducing GHG emissions from fossil fuel combustion are two faces of the same coin. World primary energy needs are projected to grow by 55 per cent over 2005–2020 (IEA World Energy Outlook (WEO) 2007). IEA estimated the cumulative required investment in energy infrastructure at $22 trillion over the period 2005–2030.

However, whether and how future energy demand will be met remains unclear, given concerns about fossil fuel supply levels and increasingly converging views about the prospect of a peak in global production levels with production declining thereafter (Peak

[43] See for example, UNEP/ILO/IOE/ITUC (2008). *Green Jobs: Towards Decent Work in a Sustainable, Low-Carbon World*. See also UNEP Global Green New Deal - Green Economy Initiative. *Green New Deal Group.*
[44] Barker T (2008). *The Macroeconomic Effects of the Transition to a Low-Carbon Economy*. University of Cambridge and Cambridge Econometrics.

Oil).[45] Unavailable or unaffordable oil and gas make more polluting coal and unconventional fossil fuel sources more attractive and competitive. While biofuels hold important potential, their implications for sustainability need to be addressed to ensure that their attractiveness is not undermined and that a balance is struck between energy security objectives, climate policy and achieving the Millennium Development Goals.

As maritime transport relies predominantly on oil for fuel, energy security and oil price volatility are of particular relevance for this sector. Typically, fuel costs account for 20–25 per cent of total ship operating costs, although this share increased to over 50 per cent when oil prices reached record highs in mid-2008. Energy prices – through their impact on shipowners' operating costs and thus freight rates – could provide incentives for effective de-carbonization through significant investment, including from the private sector, in technologies to save energy and increase energy efficiency. These could lead to other benefits such as transport cost reduction and trade promotion, especially for the shipping-dependent trade of developing countries.

III. Conclusion and expected outcome

Climate change is happening and its impacts are already being felt, in particular in the more vulnerable countries. Unchecked, climatic changes can reach tipping points resulting in disastrous and irreversible consequences for humanity. The wide-ranging impacts of climate change and their potential implications for development underscore the need for integrating climate considerations into development and transport planning and strategies. Thus, urgent, concerted and considered action is required at all levels to ensure effective control of GHG emissions and establish the requisite adaptive capacity, especially in developing countries.

Like other economic sectors, maritime transport, which is vital to globalized trade, has a role to play in addressing this challenge. At the same time, access to cost-efficient and sustainable international transport services must be safeguarded and enhanced –especially for LDCs, LLDCs and SIDS.

Against this background, and to contribute to the debate, deliberations at the meeting may help identify relevant policy actions that serve the purpose of climate change mitigation and adaptation in maritime transport without undermining transport efficiency and trade facilitation gains. One objective of the meeting is to gain a clearer vision of the format, scope and content of a potential new regime on GHG emissions from international shipping and help ascertain the economic and policy implications of various mitigation measures, including on trade competitiveness of developing countries. To this end, and with a view to providing substantive policy guidance in the context of UNFCCC conference in December 2009, discussions are expected to help, inter alia:

(a) Assess impacts on/implications for transportation systems, in particular ports and ships;

[45] For an overview, see Aleklett K (2007). *Reserve Driven Forecasts for Oil, Gas and Coal and Limits in Carbon Dioxide Emissions*. December.

(b) Improve the understanding of required adaptation measures;
(c) Explore the potential for synergies between transport and trade facilitation measures and climate policy, including in relation to technology;
(d) Outline best practices in terms of mechanisms used to integrate climate change considerations into transportation policy, land use planning, as well as infrastructure investment decisions, and development strategies; and
(e) Identify current climate change-driven cooperation mechanisms between maritime industry stakeholders and explore their potential expansion in developing countries.

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PART THREE

Programme of the meeting

Multi-Year Expert Meeting on Transport and Trade Facilitation: Maritime Transport and the Climate Change Challenge

Palais des Nations, Geneva, 16-18 February 2009

DAY 1 February 16th 2009	
10.00 - 10.45	Opening statement by Ms. Puri, Acting Deputy Secretary-General of UNCTAD Item 1: Election of officers Item 2: Adoption of the agenda and organization of work Item 3: Maritime Transport and the Climate Change Challenge Keynote Address by Dr. Martin Lees, Secretary-General, Club of Rome
10.45 - 13.00	**Understanding the challenge** *Panellists* Prof. Martin Beniston, Head of Research Group on Climatic Change and Climate Impacts, University of Geneva, Contributing author, IPCC 2007 Mr. Florin Vladu, Manager, Adaptation, Technology and Science Programme, UNFCCC Secretariat *Interactive debate*
15.00 - 18.00	**GHG emissions from international shipping and the potential for control and reduction** *Panellists* Mr. Eivind Vagslid, Head, Chemical Air Pollution Prevention Section, Marine Environment Division, IMO Mr. Philippe Crist, Administrator, ITF Research Centre, ITF/OECD, Mr. Paul Gunton, Managing Editor, Lloyd's Register/Fairplay Ltd. *Interactive* debate
DAY 2 February 17th 2009	
10.00 - 13.00	**Potential approaches to mitigation in maritime transport** *Panellists* Mr. Andreas Chrysostomou, Chair, IMO Marine Environment Protection Committee Dr. Andre Stochniol, International Maritime Emissions Reduction Scheme (IMERS) Dr. Jasper Faber, Co-ordinator, Aviation and Shipping, CE Delft Mr. Peter Hinchliffe, Marine Director, International Chamber of Shipping (ICS) Dr. Satoshi Inoue, Secretary-General, International Association of Ports and Harbours (IAPH) *Interactive debate*

15.00 - 17.45	**Potential climate change impacts and approaches to adaptation in maritime transport** *Panellists* Mr. Michael Savonis, Senior Policy Adviser, U.S. Dept. of Transportation Mr. Andre Theron and Mr. Marius Rossouw, Council for Scientific and Industrial Research (CSIR), South Africa Mr. Peter W. Mollema, Director of Port Planning and Development, Port of Rotterdam Mr. Richard Newfarmer, Special Representative to UN and WTO, World Bank *Interactive debate*
DAY 3 February 18th 2009	
10.00 - 13.00	**Cross-cutting issues: costs and financing, technology and energy** *Panellists* Ms. Raffaella Centurelli, Energy Analyst, Office of the Chief Economist, IEA Mr. Paul Clements-Hunt, Head of Unit, UNEP Finance Initiative Mr. Mark C. Lewis, Global Head of Carbon Research, Deutsche Bank Climate Change Investment Research Dr. Awni Behnam, President, International Ocean Institute (IOI) *Interactive debate*
15.00 - 17.45	**The way forward** Chairman's summary of discussions and open interactive debate Closing and adoption of outcome

PART FOUR

Sessions and Summary of Proceedings[46]

1. The Opening

At the opening session, the Acting Deputy Secretary-General of UNCTAD stressed that, unless action were taken urgently, climate change would pose an enormous threat and challenge for humankind, particularly for the poorest populations, with Africa and small island developing States (SIDS) being probably the hardest hit. In the light of compelling scientific evidence and potential economic, social and environmental losses that might be caused by climate change, the potential costs of inaction in relation to climate change were difficult to contemplate. International maritime transport, a backbone of the world's globalized economy, was playing a part in contributing to climate change but, importantly, was also itself likely to be directly and indirectly impacted by the various climate change factors such as rising sea levels, extreme weather events and rising temperatures.

The Acting Deputy Secretary-General further noted that adaptation in maritime transport was crucial and in this context, a better understanding of the potential climate change impacts and of the associated costs and funding mechanisms was necessary. Measures to address the global economic slowdown and financial crisis could be framed to meet the twin objectives of helping the world economy recover as well as spur a "green new deal" in support of climate change policy action, including in maritime transport. Experts were called upon to consider the various challenges arising from the global economic, financial, environmental, and development context, as well as from a maritime transport perspective. Given the time-frame for the adoption of a comprehensive deal on climate change at the Fifteenth Conference of the Parties of the United Nations Framework Convention on Climate Change (UNFCCC) in Copenhagen and in support of the current work on a maritime transport regime under the International Maritime Organization (IMO), experts were invited to give thoughtful consideration to the various perspectives that may be presented at the meeting, so as to gain a clearer understanding of relevant actions required.

In his keynote address, the Secretary-General of the Club of Rome presented an overview of the difficult international context in which the current debate on climate change, including from the maritime transport perspective, was taking place. He noted that the world was faced with a number of interconnected challenges spanning three main areas, namely (a) climate, environment and resources; (b) poverty and world development; and (c) problems in the global economic and financial systems. However successful climate change mitigation action may be, developing countries would be forced to adapt to the irreversible climate change which was already taking place and was affecting the chances of achieving the Millennium Development Goals (MDGs). To accelerate mitigation and adaptation efforts, predictable sources of financing and technology transfer to developing countries were required. The various interconnected issues could not be resolved separately, and called for a coherent and systemic approach, with economies being restructured onto a low carbon path, and a fairer

[46] Part D is based on the Report of the Multi-year Expert Meeting on Transport and Trade Facilitation on its first session., 23 March 2009, at Section A, pargraphs 1, 2 and 3.

and more inclusive process of world development being established. Despite the challenge, there remained an opportunity to reform institutions and policies and spur a new economic revolution. The connections between maritime transport, global trade, climate change, global economic and financial systems – as well as development and sustainability imperatives – highlighted the importance for the maritime transport industry to play a central and leading role in addressing the climate change challenge, in terms of both mitigation and adaptation.

2. Understanding the challenge

The panellists were Professor Martin Beniston, Head of Research Group on Climatic Change and Climate Impacts, University of Geneva (Intergovernmental Panel on Climate Change (IPCC) 2007 contributing author); and Mr. Florin Vladu, Manager, Adaptation, Technology and Science Programme, UNFCCC secretariat.

Bearing in mind the particular concerns of SIDS and LDCs, the session helped set the scene by presenting the overwhelming scientific evidence that climate change was a fact and that delaying action was not an option. Some key implications of climate change for our economies and societies – in particular for development prospects of developing regions as well the attainment of the MDGs – were highlighted. Experts at this session were also briefed on the existing international regulatory framework set up to deal with climate change, namely the UNFCCC and the subsequent Protocol adopted in Kyoto in 1997.

Relevant issues highlighted could be summarized as follows:

- Climate change posed a serious threat to our economies and societies and needed to be addressed urgently. It would impact countries in different ways and magnitude with the most vulnerable countries likely to be the hardest hit;
- There was a need for a balanced approach where countries responsible for the largest share of emissions were made subject to a strict regulatory and control regime. In this respect, the "polluter pays" principle should be upheld to the benefit of the most vulnerable, in particular in Africa and in LDCs. Studies – including within the regional chapters of IPCC assessment reports – highlighted the vulnerability of Africa to climatic effects. That vulnerability was caused by, inter alia, the fragility of its ecosystems and its economies;
- In view of the potential significant monetary and non-monetary costs of climate change – in particular the consequences of "tipping points" and abrupt climate change – inaction was not an option. Dealing with the climate change challenge was a priority which should not be undermined by other concerns, including the current global economic and financial constraints;
- Global action was needed to address the causes of climate change, with national and regional actions being useful complements. Localized and sector-specific approaches (e.g. in maritime transport) – together with regional cooperation – were also needed to deal with the impacts and consequences of climate change;
- Increasingly improved scientific understanding of the causes and potential implications of climate change had been and remained crucial for increasing awareness and helping formulate sound and effective policies and response measures. There was also a need to bridge the gap between science and policymaking, and to reflect on how best to link the current and the evolving scientific knowledge with policy and decision-making processes;
- There was an inherent uncertainty associated with current climate predictions. Natural systems were complex and non-linear, and involved climate variability (cooling–warming effect). From a risk management perspective, it was important to note that a perfect scientific answer to a complex system was not possible. It was sufficient to note that the warming effect was accelerating, driven mainly by human activity, and that natural systems would not be able to counteract those effects;

- Addressing the climate change challenge did not necessarily require in all cases new technologies, but rather, in many instances, a full deployment of existing technologies. Predictable energy technology transfer and financial assistance to developing countries were required for effective mitigation and adaptation;
- Maritime transport, a key economic sector and a trade enabler, had a role to play in climate change mitigation and adaptation. While international shipping contributed a relatively small share of global greenhouse gas (GHG) emissions, emissions from this sector were forecast to grow significantly over the coming decades and at a fast rate. In that context, urgent efforts were needed to agree on a global regulatory mechanism to address emissions from international shipping;
- Shipping needed to factor in new and variable problems such as coastal flooding and restricted access to ports, shifting zones of storminess and potentially more frequent and stronger hurricanes;
- The impact of climate change on the maritime transport sector – including through rising sea levels, and changes in ocean circulation and weather patterns – was likely to be particularly detrimental for low-lying coastal areas and SIDS. The potential for new shorter maritime routes and resource exploration through the melting of ice in the Arctic could provide opportunities as well as challenges. The net effect, however, was expected to be very large and negative;
- Climate action in the transport sector was challenged by the up-front high capital costs that were mainly borne directly by investors, while benefits to society were usually accrued in the long term;
- In view of the principle of "common but differentiated responsibilities" (CBDR) under UNFCCC, it was thought to be useful to examine the disadvantages/costs and benefits for different countries resulting from the application of potential uniform measures discussed at the IMO that could be applied globally;
- Improving understanding of how climate change could affect maritime transport was important, including through studies assessing the climate change challenge from a maritime transport perspective.

3. GHG emissions from international shipping and the potential for control and reduction

The panellists were Mr. Eivind Vagslid, Head, Chemical Air Pollution Prevention Section, Marine Environment Division, IMO; Mr. Philippe Crist, Administrator, International Transport Forum Research Centre, Organization for Economic Cooperation and Development (OECD); and Mr. Paul Gunton, Managing Editor, Lloyd's Register/Fairplay Ltd.

The session helped highlight the extent of the challenge, initially by describing in quantitative terms the contribution of international shipping emissions to global CO_2 emissions and climatic changes. Various estimates of GHG emissions from international shipping, in particular the most recent estimates by the IMO, were presented. While the relative efficiency and environmental-friendliness of maritime transport were noted, emissions from international shipping called, however, for urgent mitigation action. The potential for reducing emissions from international shipping and the role of technology as a main source for such reduction were underscored.

Relevant issues raised could be summarized as follows:

- Despite the current unfavourable economic conditions, projected growth in international trade suggested that GHG emissions from international shipping would also continue to increase, unless radical regulatory, technical and operational measures were implemented;
- Under a business-as-usual approach, CO_2 emissions from international shipping would increase between 125 per cent and 220 per cent from 2007 to 2050. The potential emission reductions of fuel intensive and high speed shipping services such as container shipping was likely to be significantly influenced by developments in fuel prices;
- It was noted that a study on maritime transport and greenhouse gases other than CO_2 and other relevant substances in accordance with the methodology adopted by UNFCCC was currently underway at IMO and was expected to be finalized in the summer of 2009;
- Any future initiatives in the field of pollutant reduction from shipping, including reduction of GHG emissions, should fall within the auspices of IMO;
- Some experts believed that future solutions must be based on a flag-neutral approach. However, other experts were of the view that UNFCCC and the Kyoto Protocol had set the principles and the legal framework on climate change, which should also form the legal basis for IMO's work on GHG emissions from international shipping. In their view, the principle of CBDR should guide all international negotiations and cooperation on climate change;
- The view was expressed that developed countries had to accept clear targets while developing countries had to reduce emissions, taking into account their respective capacities and the assistance available from developed countries. In that context, it was important to consider how the financial system reform could assist in climate change improvements as issues such as externalities necessarily must be included in the climate change equilibrium;
- For some developing countries, technology transfer in relation to future introduction of more stringent international regulations on GHG emissions was an important consideration;

- Knowledge sharing, possibly from other industries, with regard to the use of regulatory and market-based instruments, was important to stimulate behavioural change in respect of emissions reduction in the maritime industry;
- Data availability and reliability regarding the maritime industry's contribution to CO_2 and GHG emissions were crucial to ensuring better impact assessments for appropriate policy response and action;
- More detailed market-based data (experts, in general, agreed that the most reliable data could only be collected directly from individual ships) was needed, although existing data provided enough information about the overall trend, which was compelling enough to trigger requisite mitigation action;
- Hull and vessel design, engines, propulsion systems, other energy-using systems and operational changes were likely to be the main tools for potential emission reductions in shipping. The range of potential emission reductions, were dependent on the specific measure and varied, in general, between 5 to 40 per cent. In that respect, it was noted that reduction potentials depended on the specific deployment of vessels and that those varied largely between vessel types. With regard to technical and operational measures, the work of IMO had already advanced significantly;
- Regarding vessel speed reduction as a means of cutting emissions, the more accurate indicator was optimal operating speed, as speed reduction could actually lead to an increase in CO_2 emissions;
- A major obstacle to realizing global emissions reduction was that the global fleet turnover over recent years had increased from 27 to 32 years, meaning that technological improvements might not happen quickly in the market.

4. Potential approaches to mitigation in maritime transport

The panellists were Mr. Andreas Chrysostomou, Chair, IMO Marine Environment Protection Committee (MEPC); Dr. Andre Stochniol, Founder, International Maritime Emissions Reduction Scheme (IMERS); Dr. Jasper Faber, Coordinator, Aviation and Shipping, CE Delft; Mr. Peter Hinchliffe, Marine Director, International Chamber of Shipping; and Dr. Satoshi Inoue, Secretary-General, International Association of Ports and Harbour.

This session covered potential approaches to mitigation in maritime transport and the currently evolving regulatory and institutional framework dealing with GHG emissions from the sector. An update on the current work at IMO – including on the various technical, operational and market-based measures currently under consideration – was provided. The meeting was also informed, as an example, of a particular market-based scheme, IMERS. Focusing in particular on issues of relevance to developing countries, a policy assessment of various climate policy instruments for shipping, including their potential impacts on trade, and of ways to mitigate any undesired impacts, was presented. An industry perspective on climate change mitigation action by shipping and port industries highlighted actions taken at the industry level, with a view to reducing GHG emissions.

Relevant issues raised could be summarized as follows:

- Global regulation of maritime transport was necessary because of the inherently international nature of shipping. A regulatory scheme for maritime transport needed to be simple and acceptable to both developed and developing countries;
- The complexity of regulating CO_2 emissions from international shipping stemmed from the global nature of the industry. The main issue to be addressed was where carbon emissions from international shipping should be accounted for and at which level (e.g. flag State/port State, importing country/exporting country, ship level/fleet level). An added element of complexity related to the practice in container trade where ships loaded and unloaded containers at different ports of call on their journey;
- From the perspective of the maritime industry, a global solution which took into account the efficiency of international shipping as compared to other modes of transport and its role as the prime mover of international trade was important. While the maritime industry was not ready yet to make a choice between a levy and carbon trading scheme, it was assessing the merit of all measures under consideration to ensure that any option potentially selected effectively delivered on carbon emission reductions and did not hinder trade;
- A key point of divergence of views about a global regime to regulate GHG emissions from shipping related to the principle of CBDR under UNFCCC and the uniform global application approach under IMO;
- IMO work on an international regulatory scheme on GHG emissions from shipping was undertaken taking into account nine criteria set out under MEPC at its fifty-seventh session (e.g. no distortion of competition);
- The shipping industry had supplemented the MEPC criteria with three additional requirements that it regarded as important, namely credibility to stakeholders, giving credit for actions already taken to reduce GHG emissions and providing a high degree of certainty for investment purposes;

- A wide range of policies was conceivable to limit or reduce GHG emissions from maritime transport. They differed in environmental effectiveness and cost-effectiveness. A suggestion was made that, in general, market-based instruments addressing GHG emissions directly, such as emissions trading or an emissions levy, appeared to be the most environmentally effective as well as the most cost-effective instruments;
- Experts discussed whether regulation should be market-based or standard-based, whether emissions trading schemes or levies were superior and whether they should apply to all ships uniformly (be "flag-neutral"), be differentiated by route of the vessel or country of destination of the cargo, or a combination of both;
- The concept of IMERS provided for a levy on fuel sold for international shipping and offered to reconcile the principle of CBDR under UNFCCC with that of global uniform application under IMO. That scheme provided that a centrally-collected levy could be applied to all ships while differentiating by destination in line with CBDR. It suggested that at least $6 billion could be raised annually for climate change action, including adaptation in developing countries. Questions remained, however, as to how that concept compared to other market-based proposals under consideration;
- With a view to later enforcement, a balance of responsibilities was needed between flag and port States, respectively, and that of the entire transport chain;
- The impacts on developing countries of various policy instruments under consideration related mainly to potentially higher import and export costs and consequences for the demand for tourism by cruise ships, along with potentially higher demand for new fuel efficient ships and ship maintenance. Undesirable impacts of various policy instruments could be mitigated through differentiated treatment, either by responsibilities, targeted use of revenues from regulation, or a combination of both;
- Further work and analysis was needed to assess market-based proposals, including their added value in terms of energy efficiency, to be achieved by the world fleet and their impact on international shipping;
- Assistance, including financial and technical, and capacity-building were necessary for many developing countries, especially if uniform standards were to be adopted, which would imply a corresponding need for enforcement capabilities by those countries;
- The port industry was actively involved in addressing GHG emissions, as was illustrated by the adoption of the World Ports Climate Declaration in July 2008 and the launching of the World Ports Climate Initiative in November 2008. The declaration promoted an integrated, sustainable and innovative approach to CO_2 reduction and improvement in air quality by ports;
- Ports also had to address wider transport chain issues related not only to ship transport but also ground transport;
- On the issue of adaptation measures by ports, there was considerable scope for increased information sharing of the experiences of countries, in particular Japan and some advanced countries, which had already witnessed substantial port activity for natural disaster preparedness.

5. Potential climate change impacts and approaches to adaptation in maritime transport

The panellists were Mr. Michael Savonis, Senior Policy Adviser, United States Department of Transportation; Mr. Marius Rossouw and Mr. Andre Theron, Council for Scientific and Industrial Research, South Africa; Mr. Peter W. Mollema, Director of Port Planning and Development, Port of Rotterdam; and Mr. Richard Newfarmer, Special Representative of the World Bank to the United Nations and the World Trade Organization

The results of a compelling case study on climate change impacts on transportation systems, carried out in the United States in the Gulf Coast region, were presented and highly commended. Another presentation focused on the preliminary study of effects of weather variability, intensity and climate change on southern African coasts. The presentation by the Port of Rotterdam, with its long-standing experience as a low-lying area port, provided an opportunity to learn about potential adaptation solutions that could be adopted at the port level and highlighted the important capital investment required to implement similar measures. While providing some estimates of the potential adaptation costs, including for infrastructure purposes, the World Bank argued the importance of stepping up efforts on the adaptation front, and highlighted the large gap between the adaptation needs and existing funding levels.

Discussions highlighted the potential implications of various aspects of climate change for maritime transport, the backbone of international trade. As that issue had so far received inadequate consideration in existing literature and at international forums, the session was very informative and instrumental in raising awareness about the potential impacts of various climate factors on transport infrastructure and coastal zones, as well as their broad ramifications for human settlement, trade and development. It further underscored the need for adaptation, including through adequate planning and integration of climate change considerations into transportation design, as well as into broader economic and development policies.

Relevant issues raised could be summarized as follows:

- A key message that emerged from this session was “prepare for known impacts”. Raising awareness was instrumental. Investments and decisions made on one day could prove wise or otherwise in the future, but planning for what was already known to us made good sense. It was important that approaches to climate change from a transportation perspective be based on continuous risk management, so that adequate response measures be adopted, which enhanced the resilience of transport systems;
- Adaptation fell within the purview of UNFCCC, which contained various relevant mechanisms. Those included the Adaptation Fund under the Kyoto Protocol, national plans at the country level, the Nairobi Work Plan and the Bali Action Plan. Inclusion of different sectors should be pursued;
- Climate change would have adverse effects, especially for countries that were already experiencing higher precipitation variability and more frequent storms, as well as water scarcity. As a result, adaptation costs were expected to be significant, especially for these countries;

- Climate change posed a serious threat to maritime transport, especially ports, even when catastrophic scenarios were not taken into consideration. While the global mean sea level rise could certainly pose serious problems to ports, there were other major concerns about the increased intensity of the extreme events (e.g. storm surges) and the compounded effect of local environmental conditions, such as the subsidence of port cities built on low-lying and subsiding coasts;
- It was noted that climate change would affect weather patterns, which would change ocean storm patterns. For example, an increase in storm intensity could lead to an increase in long-period waves and subsequently an increase in ship motions, thereby adversely affecting mooring or berthing of large vessels. Thus, the issue of down-time would be of concern. Changes in waves could also lead to increased dredging of ports and waterways which in turn could increase costs;
- In addition to direct impacts of climate change, there could be indirect effects, including potential changes in trade flows as a result of climate change and subsequent changes to transportation infrastructure;
- Scientific research based upon accurate and relevant data was essential for better predictions of climatic impacts on maritime transport and coastal infrastructure, especially in more vulnerable regions, such as SIDS and low-lying areas. In that respect, cooperation and concerted efforts among the relevant parties – including the scientific community, Governments and industry – were required. More importantly, the evolving scientific information needed to be effectively conveyed to policymakers for better integration into policymaking processes and decisions;
- Studies on the vulnerability of the maritime industry to the impacts of climate change would strongly benefit from the availability of information on climate variability and change, both at the global and regional scales. Efforts to develop a system to provide such information should be encouraged and supported;
- With respect to ports, vulnerability studies would be required, with specific focus on developing countries, especially since insight gained from localized case studies could not be easily extrapolated to other regions. Funding of relevant vulnerability studies in particular in developing regions was urgently required;
- Further exchange of information on vulnerability and impacts were important to raising awareness, including in the context of planning disaster preparedness. In that respect, the United States study, the work undertaken by the Environmental Working Group of the World Association for Waterborne Transport Infrastructure and the insight gained through the study on climate change risks of the six pilot countries currently underway at the World Bank should be further expanded and their results widely disseminated;
- To better prepare for climate change, robust transportation systems, including maritime transport systems, were required. For that, climate change considerations needed to be taken into account in transportation planning, while a risk assessment-based approach should be used as an integrated tool for adaptation to obtain greater resilience in transport infrastructure. Authorities at all levels and the private sector should be involved in the planning work to ensure long-term planning, e.g. in relation to land use. It was also important to ensure that timeframes for investment planning decisions including in transport infrastructure take into account climate change considerations;
- Port planning and emergency planning were key, especially for port cities;
- In addition to the World Ports Climate Initiative, the port industry has also launched the Environmental Ship Index, which aimed to encourage emission reduction by the shipping

industry through incentive-based port policies (e.g. through tariff incentive schemes). The Port of Rotterdam suggested that there could be a possibility for the World Port Climate Initiative to be expanded to include not only mitigation efforts by the port industry, but could also focus on impacts and adaptation aspects;

- Financing gaps for mitigation and adaptation in relation to climate change were significant. More resources were required for adaptation from both the private and public sectors. Existing funding mechanisms under the World Bank – including loans and grants as well as dedicated climate change assistance facility and the disaster relief mechanism – had the potential to support countries in relation to climate change impacts, and should be further leveraged;
- Trade was an engine for development and could therefore generate the requisite funding to support climate change action. Accordingly, it was felt that efforts should be made to promote further trade and to ensure that trade facilitation gains were capitalized upon, including in view of climate policy objectives. It was also noted that there was an opportunity to reduce costs with green development and trade;
- The question of generating adequate funding for climate change action was currently being addressed as part of the ongoing UNFCCC negotiating process;
- Technology and knowledge transfer were crucial. In that respect, specific education and learning packages and modules could prove useful. Also, cooperation between national innovation centres, such as existing centres in the Netherlands, could help promote much-needed knowledge transfer;
- The International Organization for Standardization (ISO) suggested that it could contribute to devising environmental standards in maritime transport as a tool for risk management. The view was that a holistic approach was needed and could draw from the experience acquired in the context of maritime transport security;
- The role of the insurance industry should further be defined and its contribution further leveraged;
- It was important to adopt a supply chain perspective, since landlocked countries would also be affected by climate change effects on ports and coastal zones, as well as port access networks;
- The meeting on maritime transport was considered as a good beginning, but there remained a need to improve understanding of impacts, compile more data, conduct relevant studies and promote information exchange.

6. Cross-cutting issues: costs and financing, technology and energy

The panellists were Ms. Raffaella Centurelli, Energy Analyst, International Energy Agency (IEA); Mr. Paul Clements-Hunt, Head of Unit, United Nations Environment Programme (UNEP) Finance Initiative; Mr. Mark C. Lewis, Global Head of Carbon Research, Deutsche Bank Climate Change Investment Research; and Dr. Awni Behnam, President, International Ocean Institute.

Panellists at this session addressed some of the cross-cutting issues which involved all countries, developed and developing alike. They reiterated the need for urgent action to ensure that climate policy, including in relation to maritime transport, was enabled by adequate financing and investment, technology development as well as through grater energy efficiency and security. The panellist from the IEA presented the results of the 2008 World Energy Outlook highlighting the two climate scenarios necessary to stabilize the concentration of carbon emissions at "manageable" levels, as well as underscoring the unsustainable path associated with the reference scenario. An urgent call was made for climate action that would help achieve carbon concentration levels of 450 parts per million (ppm) CO_2-equivalent or lower. On the whole, the cost of inaction outweighed the cost of the two emission reduction scenarios considered in the IEA report. The UNEP Finance Initiative (partnership with the financial sector) was presented and the need to seize the current momentum – including of the opportunities offered by various stimulus packages to mobilize funds for climate change action – was emphasized. The panellist from Deutsche Bank Climate Change Investment Research highlighted some lessons to be drawn from the European Union Emission Trading Scheme (EU ETS) as a way of controlling emissions and raising necessary funds to support climate change action; he also addressed the particular case of carbon capture and storage technologies. The International Ocean Institute drew attention to the difficulties associated with managing global public goods such as oceans and dealing with a global challenge such as climate change in the context of an inherently globalized maritime industry.

Relevant issues raised could be summarized as follows:

- IEA's reference scenario under continued current trends for energy consumption and GHG emissions remained unsustainable and would create large temperature rises beyond levels considered sustainable by IPCC;
- Forecasts of energy consumption revealed that oil, coal and gas would, in 2030, continue to account for 80 per cent of global energy consumption;
- The reference scenario considered in the IEA's World Energy Outlook became even more unsustainable each year, because policy action had remained inadequate to date and the situation continued to deteriorate;
- Time-frame was a real concern. Current trends in terms of energy consumption and carbon path suggested that, if no action were taken within the next two years – including relevant investment decisions which would determine the type of technologies that would be locked in – the world would forever miss the opportunity to stabilize emissions at "manageable" levels along either the 450 ppm or the 550 ppm CO_2 equivalent scenario;
- It was crucial that information was expeditiously available as to which scenario would be realistically achievable. This information was of the essence for adaptation planning;

- There was an urgent need for targeted energy policy action within OECD countries as well as in other major non-OECD economies whose share in emissions was increasing;
- It was critical that both OECD and non-OECD countries collaborate to achieve deep emission reductions. It was pointed out that while OECD countries accounted for the bulk of energy consumption and emissions, 87 per cent of the forecasted future incremental energy demand would stem from non-OECD countries. The potential for emissions reductions by these countries was growing;
- It was felt that the Copenhagen conference on climate change, in December 2009, must establish clear international agreement on reduced future GHG emissions and policies to promote energy efficiency and low carbon energies (including renewable and potentially nuclear). Missing this opportunity could nullify the possibility of reaching either of the two IEA target scenarios (550 ppm or 450 ppm CO_2 equivalent);
- The current economic crisis should be seen as an opportunity to retool economies onto sustainable lower carbon production paths, through their various economic stimulus packages. Clear decisions were urgently needed in order to promote investments in those areas in time to allow deep reductions (enabled by current investments) in the future;
- While, in general, the accuracy of modelling exercises depended upon the accuracy of both assumptions and oil price projections, the fundamental assumptions remained reasonable. IEA and UNFCCC collaborated closely and regularly, including in relation to modelling exercises;
- According to UNEP, in 2002, climate change losses amounted to about $150 billion per year, with that sum possibly rising to about $1 trillion per year by 2040. Indeed, climate change impacts dwarfed those of the present global financial crisis. To mitigate these risks, policy action was needed to promote private investment, since the investments needed could not be covered by the public sector alone;
- Investors were mainly attracted by the potential profitability of sustainable energy technologies (such as clean and green energy) and interested in investing, if Governments provided clear signals that they were committed to establishing effective frameworks for GHG emissions reduction and establishing a real global market for carbon that would grow in size;
- The momentum in clean energy investment should be seized, including through national stimulus packages;
- The commercial feasibility of sustainable technologies depended upon the specific technology and company in question. The problem of split incentives among those investing and those benefiting from reduced energy costs was probably a major problem in exploiting potential gains in energy efficiency;
- Creating a well-functioning carbon market was important for climate policy. The key issue was whether the price signal was working properly. The EU ETS had some strong features, but a number of its structural deficiencies had been brought to light by the recent economic meltdown. The experience acquired since its establishment provided some lessons to be drawn. Policymakers should ensure that such weaknesses were better understood and effectively addressed to send the right market signals and create a functional global carbon market;
- It was suggested that the current institutional structure for ocean governance was not adequate to effectively address new and emerging challenges such as climate change. In

that context, reference was made to initiatives that had been agreed internationally and provided concrete approaches for an effective international maritime regime;

- A brief description of the International Oil Pollution Compensation (IOPC) funds was provided. Established under an IMO convention and operational for over three decades, the Funds could provide an example to draw from with respect to a potential global fund related to GHG emissions from international shipping.

ANNEX[47]

List of participants

Experts

Afghanistan

Mr. Hafezullah Walirahimi, President of the Private Sector Development, Ministry of Commerce and Industry, Kabul

Mr. Mostainbillah Balagh, Third Secretary, Permanent Mission, Geneva

Algeria

M. Athmane Mehadji, Attaché, Mission permanente, Genève

Angola

Mr. Arcanjo do Nascimento, Ambassador, Permanent Representative, Geneva

Mr. Makiesse Kinkela, Third Secretary, Permanent Mission, Geneva

Mr. Rui Pedro Livramento, Economic Expert, Permanent Mission, Geneva

Mr. Lukonde Luansi, Minister Counsellor, Permanent Mission to the World Trade Organization (WTO), Geneva

Ms. Filomena Pereira De Sousa, Assessor, National Direction of Trade Policy, Ministry of Trade, Luanda

Mr. Mbungua Francisco Xavier de Agua Rosada, Chief, National Department of Bilateral Trade Cooperation, Luanda

Mr. Oluimo da Silva, National Direction of Customs, Luanda

Ms. Edna Silva, Directrice de l'Institut maritime et portuaire, Ministère des transports, Luanda

Argentina

Mr. Rodrigo Bardoneschi, Permanent Mission, Geneva

Australia

Ms. Linda Rasmussen, Policy Adviser, Department of Infrastructure, Transport, Regional Development and Local Government, Maritime Branch, Canberra

Azerbaijan

Mr. Rasul Hasanov, State Maritime Administration, Baku

Mr. Emin Teymurov, Attaché, Permanent Mission, Geneva

Bangladesh

Mr. Md. Shafiqul Islam, Principal Officer, Mercantile Marine Department, Ministry of Shipping, Chittagong

Mr. Hussain Motaher, Permanent Mission, Geneva

Belarus

Mr. Zakhar Naumov, First Secretary, Permanent Mission, Geneva

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Ms. Leticia Alexandre

Mr. Frank Almeida de Sousa, First Secretary, Permanent Mission to the WTO, Geneva

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Mme. Anna Natova, Directeur de la Direction, Union européenne, relations et projets internationaux, Sophia

Mr. Nikolay Apostolov, Executive Director, Executive Maritime Agency, Sophia

Mr. Volodya Bojkov, Counsellor, Permanent Mission, Geneva

Ms. Angelina Ermakov, Transport Canada, Policy Group, Ottawa

Chile

Mr. Andrés Lamoliatte, Counselor, Permanent Mission of Chile to the WTO

China

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[47] Based on document TD/B/C.I/MEM.1/Inf.1.

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Abbreviations

ASYCUDA	Automated System for Customs Data
AWG-LCA	Ad Hoc Working Group on Long-term Cooperative Action under the Convention
CBDR	Common but differentiated responsibilities
CDM	Clean Development Mechanism
CH_4	Methane
CITMA	Ministerio de Ciencia, Tecnología y Medio Ambiente
CO_2	Carbon dioxide
CSIR	Council for Scientific and Industrial Research
EEDI	Energy Efficiency Design Index
ESA	European Space Agency
ETS	Emission Trading Scheme
EU	European Union
GHG	Greenhouse Gas
GEO	Global Environment Outlook
HFCs	Hydrofluorocarbons
Km	Kilometer
Kw	Kilowatt
IAPH	International Association of Ports and Harbours
ICS	International Chamber of Shipping
IEA	International Energy Agency
IEEE	Institute of Electrical and Electronics Engineers
IIED	International Institute for Environment and Development
IMERS	International Maritime Emission Reduction Scheme
IMO	International Maritime Organization
IOI	International Ocean Institute
IOPC	International Oil Pollution Compensation
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
JI	Joint Implementation
LDCs	least developed countries
LLDCs	landlocked developing countries
MDGs	Millennium Development Goals
MEPC	Marine Environment Protection Committee
NASA	National Aeronautics and Space Administration
NSR	Northern Sea Route
NSIDC	National Snow and Ice Data Center
NTM	Network for Transport and Environment
NWP	North-west Passage
N_2O	Nitrous Oxide
OECD	Organization for Economic Cooperation and Development
PPM	Parts per million
PFCs	Perfluorocarbons
SF_6	Sulphur Hexafluoride
SIDS	Small Islands Developing States
SRES	Special Report on Emission Scenarios
TEU	Twenty-foot equivalent unit
UNDP	United Nations Development Programe
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change
WEO	World Energy Outlook
WTO	World Trade Organization