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International Maritime Transport and Climate Policy

The contribution of international maritime transport to anthropogenic climate change has so far attracted little attention. This may be expected to change in the near future due to both ongoing research and the political processs. The present article looks at the relevant trends in international maritime transport and discusses both the greenhouse gas emissions from shipping and the possible repercussions of climate change on shipping. It concludes with an overview of policies and measures that should be implemented to reduce the greenhouse gas emissions from shipping in a cost-efficient way.

In the last decade, international climate policy has developed strongly and is nowadays one of the most important elements of national and international environmental policies. It started with the adoption of the Framework Convention on Climate Change (FCCC) at the UN Conference on Environment and Development in 1992 and culminated in the negotiation of the Kyoto Protocol in 1997. While the FCCC remained relatively vague concerning concrete measures, the Kyoto Protocol defines legally binding emission targets for industrialised countries and countries in transition. These targets apply to the so-called "commitment period" from 2008 to 2012 and could be seen as an initial step towards an international climate regime. In the long run, the effective mitigation of anthropogenic climate change will require further efforts to reduce the emission of greenhouse gases (GHG) in all sectors of the world economy, including international transport.

While there has been considerable discussion on emissions reduction options for industrial sectors and carbon sequestration in forestry, one important sector so far has been neglected: maritime transport.[1] This is quite astonishing, especially as air transport has been strongly targeted by environmental non-governmental organisations. Although maritime transport is the most ecological mode of transport, this sector is of great significance when it comes to international climate protection.

We shall look at development trends in international maritime transport, discuss possible impacts of climate change on shipping and greenhouse gas emissions from shipping. After looking at the interdependence of environmentally sound and quality shipping, we will conclude with an overview of policies and measures that should be applied to allow cost-efficient greenhouse gas reduction.

Trends in International Shipping

95% of world trade is transported by ship.[2] Transport is a service which is not demanded for its own sake and its demand can be viewed as deriving from the changing nature of international trade relations. With the growth in world trade, international shipping is expanding.[3] Before the oil shock of the seventies, oil shipments from the Middle East and low energy prices were the driving force for the prosperity of the shipping industry. After a high in the early 1970s, shipping contracted sharply in the 1980s mainly due to the halving of oil shipments from the Middle East between 1979 and 1985 following the second oil price rise. Since then, the 1970s figure has been reached again. Today, the ubiquitous globalisation of economic activity promotes international shipping, in particular trade relations between the industrialised countries and with the emerging markets in Asia. The focus on export-oriented growth leads to an over-

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[1] Of 150 sources cited in the transport chapter of IPCC's Second Assessment Report (Laurie Michaelis: Mitigation options in the transportation sector, in: Robert Watson, Marufu Zinyowera, Richard Moss (eds.): Climate change 1995: impacts, adaptations and mitigation of climate change: scientific-technical analyses, Cambridge 1996, pp. 681-712), only three mention shipping and none of them concentrates on greenhouse gas emissions.

[2] Venugopalan Ittekot: Oceans, in: Robert Watson, Marufu Zinyowera, Richard Moss (eds.), op. cit., pp. 269-288, here p. 274.

[3] This paper does not look into military operations. Fuel used in this context is not included in international bunkers in the IPCC inventory guidelines.

Table 1
World Shipping Fleet[1] (million GT) and Shares of different Ship Types (%)

	1976	1981	1986	1990	1991	1992	1993	1994	1995	1996	1997	1998
Total	372	421	405	424	436	444	458	476	491	508	522	531
Oil tankers	45	41	32	32	32	32	31	30	29	29	28	28
Dry bulk	25	27	32	31	31	31	31	30	31	31	31	30
Others	30	32	35	37	37	37	38	39	40	40	41	42

[1] Ships of 100 gross registered tons and over.

Source: OECD: Maritime transport statistics, Paris 1999; URL: http://www.oecd.org/dsti/sti/transpor/sea/index.htm, accessed Dec. 12, 1999, Table 11.

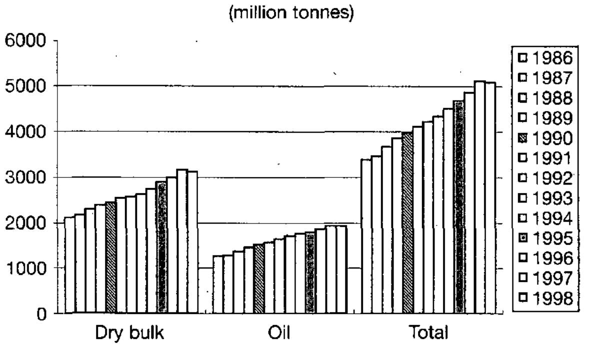
proportional expansion of the international transport of goods, mostly by seaborne vessels.

The fastest growth since 1990 has been in gross tonnage of "Ro-Ro" cargo vessels and container vessels (see Table 1). The introduction of standardised containers enabled the fast and efficient handling of goods in intermodal transport chains, which in turn enabled the more efficient use of ship tonnage and rationalised cargo handling in ports.

Freight rates have shown a steady downward trend since the beginning of the 1980s. They are so low that the export of recyclable wastes from Europe to Asia is a prospering business. In some cases, freight rates have not covered operational costs. Shipowners have developed different strategies to cut costs wherever possible. In 1994, only 16% of the tonnes shipped in bulk carriers began and ended their journey in non-Annex I countries.[4] While the majority of all transports involve trade between industrialised countries, an increasing share of merchant tonnage is registered outside of the main trading countries, in open registers. OECD registered tonnage declined from 51% of world tonnage at the beginning of the 1980s to 28.4% at the end of 1995.[5] A large share of this decline is the result of the introduction of open registers and OECD flagging-out. Flagging-out is an operational decision by shipowners aimed at bringing operational costs and regulatory requirements into line with those prevailing in competing countries.[6] Given the uneven enforcement of international standards and inspections in some countries, flagging-out often implies an easy exit option from national regulations, e.g. in the field of safety and environmental standards. While this helps shipowners from OECD countries to compete on the global market, at the same time it jeopardizes quality shipping and promotes a rat race towards substandard.

In addition to flagging-out, shipowners have passed their responsibility for asset marketing and day-to-day operation to ship management organisations. In many cases the focus of such a management company is on commercial aspects, neglecting those related to the safe operation of the ship.[7] Cost-cutting has induced reckless loading practices in ports and operation at a higher speed, sometimes beyond permissible design limits. The hiring of seamen from low-wage countries reduces operating costs, but it often implies less qualified crews. The market pressure on ships causes the accelerated physical

Figure 1
World Maritime Freight, 1986-1998
(million tonnes)



Source: OECD: Maritime transport statistics, Paris 1999; URL http://www.oecd.org/dsti/sti/transpor/sea/index.htm, accessed Dec. 12, 1999, Table 1.

[4] Laurie Michaelis: Special issues in carbon/energy taxation: marine bunker fuel charges, Annex I, Expert Group to the UNFCCC Working Paper No. 11, Paris 1997.

[5] OECD: Competitive advantages obtained by some shipowners as a result of non-observance of applicable international rules and standards, Paris 1996.

[6] H. E. Haralambides: Introduction: A Synthesis, in: H. E. Haralambides (ed.): Quality Shipping, Market Mechanisms for Safer Shipping and Cleaner Oceans, Rotterdam 1998, pp. XVII-XXXVIII.

[7] G. Nieuwpoort, E. L. M. Meijnders: The integration of economic and safety policy for shipping: The need for self-organisation, in: H. E. Haralambides (ed.), op. cit., pp. 191-216.

deterioration of shipping assets due to the postponement of maintenance and the increasing average age of the world merchant fleet.

Impacts of Shipping on the Global Climate

In the competitive environment of international maritime transport, environmental friendliness is often considered to be a pure cost factor. Any activity by a market actor would, consequently, mean a disadvantage for him as long as there is no "green" bonus or premium available on the market. The fact that shipping is the most environmentally sound mode of transport is another major argument for neglecting pollution from ships. However, a switch from other modes of transport to seaborne transport could bring substantial emission reductions of GHG and other air pollutants. For instance, if air cargo were transported by ships, this would reduce CO_2 emission per ton-kilometre by over 90% (see Table 2).

Maritime transport in 1990 accounted for 7% of world transport CO_2 emissions, i.e. around 2% of total global emissions. In addition, approximately 600,000 tonnes of oil enter the oceans annually as a result of normal shipping operations, accidents and discharges.[8] In addition to the consequences of oil pollution for the marine and coastal environment, the energy input involved in the extracting, refining and transporting of the oil products which enter the ocean are lost.

Bunker fuel contains large amounts of sulphur (commonly in the range 3-4%). Ships thus account for more than half of northern hemisphere SO_2 emissions. This may have a strong cooling effect as emissions spread to wide areas with no other anthropogenic aerosol load.[9] Ships also emit about 9.3 million tonnes per year of NOx (11-12% of the world total from fossil fuel sources). Since there has been no agreement which would create an incentive to reduce emissions from international shipping, their share of total emissions will increase. In 1990, international shipping was responsible for 4% of Europe's emissions of sulphur and 9% of the total emissions of nitrogen oxides.[10] In a business as usual scenario, these shares will grow to 11 and 15 per cent respectively in 2010.

In 1990, the base year of the Kyoto Protocol, CO2 emissions from international shipping amounted to 376.0 million tonnes, 1.8% of worldwide emissions. By 1997, they had risen by 11.6%. 55% of these emissions were due to sales in industrialised countries. For the development of emissions over time see Table 3.

In some countries/territories, especially small states with large ports, the share of marine bunker fuel in total emissions can be extremely high (see Table 4). However, data quality sometimes seems to be suspect as some countries with ports and access to the sea report zero bunker fuel emissions.

Residual fuel oil (carbon emission factor 21.1 t C/TJ, 5.5% above crude oil and 11.6% above gasoline,[11] see IEA 1999) accounts for 80% of marine bunker consumption. Over 98% of the world's fleet is now diesel-powered, although the 2% of steam-powered ships account for about 17% of gross tonnage as they are typically tankers, bulk carriers and container ships. Bulk carriers (mainly carrying oil, iron ore, bauxite, coal and grain) account for about three quarters of maritime freight traffic, but only a quarter of maritime transport energy use. "Ro-Ro" and container ships operate at high speeds, resulting in high energy intensity, and are intensively used. Their share of energy consumption is therefore much higher

Table 2
Energy Use for Different Modes of Freight Transport

Mode of transport	Energy use/tkm (MJ)	CO_2 emissions/tkm (g)
Air	7- 15	501-1073
Road	1.8–4.5	133-333
Rail	0.4-1	30-74
Sea	0.1-0.4	7.7-31
- oil products	0.1	7.7
- dry bulk goods	0.05	3.9
- crude oil	0.045	3.5

Sources: Laurie Michaelis: Mitigation options in the transportation sector, in: Robert Watson, Marufu Zinyowera, Richard Moss (eds.): Climate change 1995: impacts, adaptations and mitigation of climate change: scientific-technical analyses, Cambridge 1996, pp. 681-712, here p. 693; Laurie Michaelis: Special issues in carbon/energy taxation: marine bunker fuel charges, Annex I, Expert Group to the UNFCCC Working Paper No. 11, Paris 1997, p. 18; own calculations.

[8] TUMPA – Turkish Marine Pilots Association: Calculations, based on reports of the UN Conference on Environment and Development, 2000, URL http://www.turkishpilots.org/marinecare/marinecare.html, accessed Jan. 13, 2000.

[9] Barry Huebert: Sulphur emissions from ships, in: Nature, 400, 1999, pp. 713-714.

[10] Per Kågeson: Economic instruments for reducing emissions from sea transports, Air Pollution and Climate Series No 11 / T & E Report 99/7, Solana 1999.

[11] IEA: CO_2 emissions from fuel combustion 1972-1995, Paris 1997, p. I.14.

Table 3
Emissions from International Marine Bunker Fuels
(million tons CO_2)

Year	1975	1980	1985	1987	1989	1991	1993	1995	1997
Emission	352.9	351.5	304.1	333.6	332.0	394.8	396.4	405.7	419.6

Source: IEA: CO_2 emissions from fuel combustion 1971-1997, Paris 1999; IEA: CO2 emissions from fuel combustion 1972-1995, Paris 1997.

than their share of gross tonnage. The huge differences in emission intensity between different ship types are shown in Table 5.

Emissions from bunker fuels have also an influence on port cities' emission registers. In Hamburg, for instance, 11,600 ships call into the port annually. In addition to these 23,200 ship movements to and from the port, 8,500 ship movements inside the port area are registered.[12] However, the largest source of emission in ports is the engines of non-moving ships. In 1995 over 85% of the air pollutants, such as SO_2, CO or NOx, were emitted by non-moving vessels. In Hamburg maritime transport is responsible for the emission of approx. 200,000 tonnes of CO_2 in total annually.[13] This represents 10% of the emissions by the transport sector in Hamburg, or 1.5% of Hamburg's total emissions, in 1995.

Table 4
Shares of Marine Bunker Fuel in Total Emissions above 5% (1995 values)

Country	Share of bunker fuel (%)	Total emissions (million t CO_2)
Gibraltar	86.5	3.05
Netherlands Antilles	52.5	10.1
Angola	45.8	4.50
Panama	40.6	8.05
Singapore	37.5	94.0
United Arab Emirates	30.5	109
Uruguay	20.0	5.89
Netherlands[1]	16.7	215
Sri Lanka	14.5	7.31
Senegal	14.0	3.00
Hong Kong	13.8	51.0
Greece[1]	12.8	87.9
Ivory Coast	12.3	4.4
Belgium[1]	9.6	130
Egypt	7.9	98.3
Denmark[1]	7.7	65.6
Ecuador	6.2	18.5
Norway[1]	6.1	36.4
Guatemala	5.9	6.4
Iceland[1]	5.6	2.48
Kenya	5.6	7.53
Sweden[1]	5.6	59.4

[1] Annex B countries.

Raw data source: IEA: CO_2 emissions from fuel combustion 1971-1997, Paris 1999; IEA: CO_2 emissions from fuel combustion 1972-1995, Paris 1997.

Potential Impacts of Climate Change on International Shipping

Climate change is likely to have substantial impacts on the oceans and thus on international shipping.[14] These impacts are not necessarily negative. Both impacts on infrastructure (port facilities) and ships have to be considered:

☐ The rise in sea-levels will have enormous impacts on ports. If the current infrastructure is to be protected, extremely high costs are to be expected. One study calculates costs of $ 63 billion to protect Japanese ports.[15]

☐ Increased run-off and precipitation will lead to a higher sediment load in rivers. The need for dredging operations will increase, leading to an increase in costs in ports.[16] If the frequency and intensity of tropical storms and cyclones increases, tropical routes will become more dangerous and higher losses can be expected.

☐ Global warming will lead to a reduction of sea ice. Costs for icebreakers, which can amount to annual double-digit million dollar figures for Canada and Russia, could be saved. Both the Northwest passage and the Northern sea route around Russia are likely to be opened up for routine shipping in the next decades. This would reduce freight costs from East Asia to Europe considerably.[17]

[12] Umweltbehörde Hamburg: Luftreinhaltung in Hamburg 1982-2000, Hamburg 1997.

[13] Umweltbehörde Hamburg, op.cit.

[14] Venugopalan Ittekot, op. cit.

[15] Cited in Michael Scott: Human settlements in a changing climate: impacts and adaptation, in: Robert Watson, Marufu Zinyowera, Richard Moss (eds.), op. cit., pp. 401-426, here p. 418.

[16] Venugopalan Ittekot, op. cit., p. 275.

[17] Venugopalan Ittekot, op. cit., p. 282.

☐ The rising public awareness of the greenhouse effect and the implementation of the Kyoto commitments in Annex I countries have a positive side-effect on seaborne transport: as the most environmentally sound mode of transport, any internalisation of external costs into freight rates will favour ships, in particular as long as there are no GHG emission reduction targets for bunker fuels (see below). For the promotion of sustainable transport systems, short sea shipping is often an alternative option to road-based or railway transportation.

Despite regulatory measures at both national and international levels, for some individuals or organisations the prevention of GHG emissions is an integral element of their environmental management. In addition to freight rates, relatively low CO_2 emissions per transport kilometre are an argument for choosing seaborne transport. The availability of information on emission intensities is an important factor for transport consumers.[18]

Policies and Measures in the Shipping Sector

Reducing greenhouse gas emission by seagoing vessels: Energy intensity in shipping has been affected by oil prices, along with other factors including the rate of new building and the level of overcapacity in the industry. Fuel costs amount to around 10% of overall costs for new bulk carriers, but over 30 % for a fully-depreciated 15-year-old, steam turbine-powered tanker. The energy efficiency of ship engines is around 50% and further improvements are limited (technical potential 5-10%). Improvements in hull and propeller design have a technical savings potential of 10-30% while using sails would have a potential of 10-20%.[19] Due to huge overcapacities in the shipping sector and the high lifetimes of existing ships, replacement is only limited. The large number of orders placed in the 1960s, as well as high oil prices in the 1970s and 1980s, accelerated efficiency improvements in engines. Since the late 1980s, improvements have been limited. Energy intensity has also been improved by operational changes such as the general introduction of GPS (global positioning by satellite), and the use of computers to optimise routing and scheduling. Michaelis[20] estimates a low price elasticity for energy intensity. The doubling of fuel prices relative to 1990 levels might achieve energy intensity reductions in general cargo shipping in the region of up to 1%, relative to underlying trends, as a result of accelerated technological development. Operational changes resulting from a doubling in fuel prices might reduce energy consumption by an additional 0.5-1% per annum. Past movements of oil prices show responses to increases in fuel costs. Bulk freight traffic, apart from crude oil and coal, has not been affected by oil price changes except in the short term following sudden, large price rises. Non-bulk freight traffic has been reduced by oil price increases and this may reflect more flexibility in markets for manufactured and agricultural goods, although it may be an effect of changes in international terms of trade rather than a response to bunker prices. Crude oil traffic is strongly affected by the oil price: high oil prices in the 1970s and 1980s both reduced the demand for oil and resulted in its being produced closer to the main markets, resulting in a halving of traffic in ton-miles.

Table 5
Emission Intensities of Different Ship Types

Type	Speed (knots)	CO² Emission per (kg / tkm)
Ro-Ro 4500 DWT	23	0.02
RoRo 1300 DWT	16	0.06
Tanker 18370 DWT	15	0.003
Tanker 845 DWT	8	0.04
Bulk Carrier 14000 DWT	11	0.007
Bulk Carrier 1720 DWT	11	0.014

Source: Lloyds Register: Lloyds Register Marine Exhaust Emissions Research Programme, London 1990.

Exemption of bunker fuel emissions from Kyoto targets: IPCC guidelines for emissions inventories state that bunker fuel emissions shall not be reported under the national emissions, but separately. In 1996 a discussion on the allocation of bunker fuels was started in the international climate negotiations but did not lead to any results. It centred on air traffic. Greenhouse gas emissions from international bunker fuels are not subject to the Kyoto Protocol's emission targets for Annex B countries. Art. 2,2 of the Protocol states that emissions reduction "shall be pursued" in the shipping sector by the International Maritime Organisation (IMO).

Coverage of national emissions: Greenhouse gas emissions from domestic shipping are covered by the emissions targets. Unfortunately, most national

[18] A leading example in the transport sector is Green Cargo, developed by the SJ Cargo Group, a subsidiary of SJ (Swedish Railways). One element in the concept to promote environmentally sound transport, is an overview of the specific emissions of the consumer (http://www.greencargo.com).

[19] Laurie Michaelis: Mitigation options in the transportation sector, op. cit., p. 693.

[20] Laurie Michaelis: Special issues in carbon/energy taxation: marine bunker fuel charges, op. cit., p. 25 f.

communications do not give detailed information on the share of different modes of transport. In Germany, for instance, national shipping was responsible for 2 million tonnes of CO_2 emissions, or 0.2% of total national emissions.[21]

Activities of IMO: The International Maritime Organisation (IMO), a specialised UN organisation, is the highest supervisory body for international shipping. It has over 150 member states, covering 98 per cent of world shipping tonnage. The IMO occupies the central role in the standard-setting for international maritime transport and was established to develop and adopt safety and pollution prevention and control standards for international applications. The OECD[22] refers to the IMO as the relevant authority in a position to set standards for the environmental performance of ships. Over recent decades, the IMO has adopted several rules and regulations to improve the environmental and safety situation of maritime transportation. Although the IMO was successful in producing standards, it was less successful in ensuring their application and enforcement.[23] Its lack of the necessary executive power hampers the economic development of the shipping industry: non-compliance reduces annual operating costs by 13-15%.[24]

The IMO's activities concerning environmental issues have so far centred on marine pollution, where a convention (MARPOL) was signed in 1973. Air pollution has only lately come in and has been under consideration by the Marine Environment Protection Committee (MEPC) since 1990. IMO member states have signed Annex VI of the MARPOL convention, providing a regulatory framework for the prevention of air pollution from ships. Annex VI, which has not yet entered into force, would address a variety of pollutants including ozone-depleting substances, VOCs, NOx and SOx. In 1999, the IMO published draft guidelines on SO_2 content monitoring of fuels.[25]

After a long period of inactivity, in 1999 the MEPC commissioned a study on greenhouse gas emissions by ships.[26] This study is currently being prepared by a consortium consisting of the Norwegian Marine Technology Institute (MATINTEC), the classification company Det Norske Veritas (DNV), the ECON Centre for Economic Analysis, and the Carnegie Mellon University. The study on "greenhouse gas emissions from ships" will make short-term recommendations on what GHG reductions are most feasible by means of current technologies or market-based approaches. Additionally, long-term considerations shall identify the feasible reductions through technical and operational alternatives and define the cost benefit ratios for such efforts. The report is to be released in 2000.

Allocation of bunker fuel emissions: There are a number of possibilities for allocating bunker fuel emissions. UNFCCC lists the following options:[27]

1. *No allocation;*

2. Allocation of bunker emissions to Parties in proportion to national emissions;

3. *Allocation to Parties according to the country where the bunker fuel is sold;*

4. *Allocation to Parties according to the nationality of the transporting company, the country where the ship is registered, or the country of the operator;*

5. *Allocation to Parties according to the country of departure or destination. Alternatively the emissions related to the journey could be shared between the country of departure and the country of arrival;*

6. *Allocation to Parties according to the country of departure or destination of passengers or cargo. Alternatively, the emissions related to the journey of a passenger or cargo could be shared by the country of departure and the country of arrival;*

7. *Allocation to Parties according to the country of origin of the passenger or owner of the cargo;*

8. Allocation to the Party of emissions generated in its national space.

Options set in italics were stated to be the basis of further discussions and will be discussed below in more detail.

Allocating bunker fuels according to fuel sales (Option 3) is certain to lead to distortions as fuel sales do not correspond to the transport shares of the

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[21] Germany: Second national communication to the UNFCCC, Bonn 1997.

[22] OECD: Understanding between DNMEs and OECD member countries on principles to be adhered to in international maritime transport, Paris 1999.

[23] G. Nieuwpoort, E. L. M. Meinders, op. cit.

[24] OECD: Competitive advantages obtained by some shipowners as a result of non-observance of applicable international rules and standards, op. cit.

[25] IMO: Draft resolution on sulphur content monitoring, MEPC 43/10/1, New York 1999.

[26] IMO: Prevention of air pollution from ships, Progress report on follow-up activities, MEPC 43/10/2, New York 1999.

[27] U.N. Framework Convention on Climate Change: National Communications: Communications from parties included in Annex I to the Convention: Guidelines, Schedule and Process for Consideration: Addendum; Detailed Information on Electricity Trade and International Bunker Fuels, UNFCCC/SBSTA/1996/Add.2, Bonn 1996.

country. The seemingly easiest equitable way to allocate bunker fuels to national inventories is to split them 1:1 between the country where the ship started its trip and the country where the ship arrived (Option 5). However, this is more complicated than it seems. Often ships first stop in a major port after a long overseas trip and then go on to smaller ports in the area (see Figure 2).

To avoid this problem of unequal allocation, emissions could be shared 1:1 between exporting and importing country (Option 6). This would assume that each shipping company would have to keep records for each ship on:

- ☐ exporting country, importing country, amount of freight and transport distance for each shipment of goods; and
- ☐ total emissions.

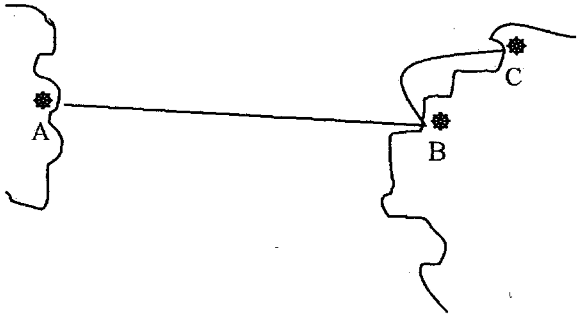
The reporting has to be on a per-ship basis to account for different degrees of efficiencies of ships. The data would be reported annually to the UNFCCC Secretariat. It is likely that shipping companies would object to this approach due to the high data needs.

Allocation could also be done on the basis of the shipping registries (see Table 6), i.e. the registering country would have to bear the emissions of its fleet. This allocation mode would of course lead to a huge transfer of emissions from Annex B countries to non-Annex B countries such as Panama and Liberia.

Allocation according to the country of origin of passengers or owners of the cargo (Option 7) would help to integrate potentials for GHG emission offsets over the transport chain. Despite relatively high transaction costs, this option promotes the polluter-pays principle and supports cost efficient measures to reduce emissions.

One way to prevent national allocation (Option 1) would be to agree to a *worldwide target* for marine bunker fuels and make the IMO responsible for reaching the target.

Figure 2
Trip Planning and Emissions Allocation



A ship travels from port A to port B and then on to port C. 25% of its cargo is unloaded at port B and 75% at port C. In the 1:1 allocation, port B's country would be disadvantaged as it would have to bear 50% of the emissions of both the long trip A-B and the short trip B-C but only get 25% of the cargo. Port C's country would be advantaged as it would only bear 50% of the emissions of the short trip B-C but get 75% of the cargo. Emissions per ton of freight would thus be allocated very unevenly.

Institutional Considerations

The global dimension of the shipping industry and, in particular, the existence of substandard shipping are obstacles to the introduction of policies to reduce GHG emissions. Nevertheless political actors at the local (port), national, regional or international level should use their authority to introduce climate policy as an addition to other fields of environmental policy and as a device for accelerating the promotion of sustainable development.

The IMO is criticised as being too slow to agree on, and implement, stricter requirements. Moreover, new and stricter requirements only apply to new ships ("grandfather clause"); existing ships are continuously permitted to release high levels of pollution. As the IMO has no executive power to secure the homogeneous implementation of the new rules, there are currently no real economic incentives for shipowners to invest in low-polluting ships or in additional environment-friendly equipment for existing ships. Therefore, it is obvious that Annex VI to the MARPOL will not have any major effect towards reducing

Table 6
Shares of Flag States in the World Fleet above 2%, end 1998

Country	Share
Panama	18.5
Liberia	11.4
Bahamas	5.2
Greece[1]	4.7
Malta	4.5
Cyprus	4.4
Norway[1]	4.3
Singapore	3.8
Japan[1]	3.3
China	3.1
USA[1]	2.2
Russia[1]	2.1
Total Annex I	28.2

[1]Annex I country.

Raw data source: OECD: Maritime transport statistics, Paris 1999; URL: http://www.oecd.org/dsti/sti/transpor/sea/index.htm, accessed Dec. 12, 1999, Table 12.

emissions of sulphur and nitrogen oxides in the foreseeable future.[28] Despite this relative disillusionment on the opportunities to implement an effective climate regime in the near future, the IMO's experience in developing international environmental standards could be beneficial. The established cooperation of Annex I and non-Annex I countries in a highly competitive market makes the IMO the first address for the introduction of GHG reduction commitments, at least in the long run.

For the governments of both industrialised and developing countries international shipping is an important industry for the promotion of national economic activity and employment. With a favourable shipping policy, countries intend to maintain or improve the situation of their national ports, their shipbuilding industry and/or national fleet. However, government interference often leads to market distortions, as it facilitates price-dumping and over-capacity, and puts more pressure on freight rates, thus fuelling the need for more cost-reductions by shipowners.[29] Countries have an incentive to register old, inefficient ships in countries with lax registration requirements. For any IMO or national regulation to target GHG emissions, the existence of numerous exit options and the competitive advantage of non-compliance will reduce their effect. Free-riding reduces the economic incentive for safe and environmentally sound shipping. Nevertheless, countries like the Netherlands try to promote quality shipping in conformity with international market trends. Sweden uses the inflexibility of the demand for port calls to introduce environmental charges linked to the emission of sulphur and nitrogen oxides (see below).

Ports have an important position for the implementation of environmental policies. The differentiation of port dues is an important instrument for every port to promote traffic, in particular ships with a high profit margin or strategic importance for the port and its hinterland. Port fees could be related to ship energy efficiency and the length of the voyage. Within their individual competitive environment, ports are in the best position to differentiate dues without affecting their business (Ramsey pricing). However, ports could also promote adverse selection, as they may try to attract traffic by offering incentives to low-efficiency ships if other ports in the vicinity have introduced differentiated fees.

As the Swedish example shows, reduced dues in a single port or within one country are not sufficient as an incentive to introduce environmentally sound or climate-oriented technologies.[30] Nevertheless they are an important signal. Only an international network of similar systems could provide the necessary momentum. However, several European ports have shown that co-operation in environmental protection is possible, despite fierce competition. The Eco-Information project initiated a network between the environmental management systems in ports. Participation in the network helps ports to benchmark individual activities and to exchange information on best practice in the field of environmental management and on port-city relations.

The European Commission is of increasing importance for international shipping and environmental policies in Europe. On the one hand, at its supranational level, the EU promotes clean and safe shipping in all member states. On the other hand, the intermodal competition in the EU has led to a high elasticity of port calls, which is an obstacle to national or port-based climate policies. The European Com-

[28] Per Kågeson, op. cit.

[29] G. Nieuwpoort, E. L. M. Meinders, op. cit.

[30] M. Zachcial, B. Volk, A. Hader: Incentive-based instruments for environmentally acceptable sea transportation, Bremen/Hamburg 1999.

mission has developed a Maritime Industry Charter on Quality, which seeks to lay down basic principles of quality shipping and some indications of the actions which would follow from those principles.

An additional opportunity is the promotion of the self-regulation of market actors. Chemical tankers could commit themselves to GHG offsets, insurance companies or pilots could provide a bonus for cleaner ships etc. Furthermore, the maritime industry and the relevant public authorities should improve their cooperation.

Instruments for Greenhouse Gas Reduction

Minimum efficiency standards are the most established form of environmental policy. They could be implemented either by the IMO, or by regional, national or local authorities. Within the individual competencies, these institutions could develop regulations on how much and in which way GHG could be emitted or would have to be reduced. Based on knowledge of the technological state of the art, regulatory instruments could prescribe emission reduction objectives precisely.

Over the last decade, however, the inflexibility of regulatory instruments and the high costs per emission reduction unit have led to criticism of regulatory instruments. Voluntary agreements with shipbuilders and operators are of course another option to reduce greenhouse gas emissions. However, given the patchy performance of voluntary agreements in a national context, they are unlikely to go beyond business-as-usual in the context of an international sector with strong competition as is the case with international shipping.

The most efficient way to reduce greenhouse gas emissions from ships is to apply economic instruments. There are two principal types: emissions trading or taxes.

The introduction of international emissions trading mechanisms is an important element of the Kyoto Protocol. On the basis of project-based emission reductions or the trading of emissions reductions between governments, these flexible instruments will promote international cooperation. Currently, the mechanisms are under development. Their introduction depends on the outcome of the negotiations on the next UNFCCC sixth conference of parties in The Hague in 2000. Due to the exclusion of bunker fuels from any reduction commitment, emissions trading has not yet been discussed in the shipping industry.

Emissions trading systems can be administered at different levels. The level depends on the allocation mode (see above). A state can allocate emissions permits to port authorities or to shipping companies according to historical load (grandfathering) or by auctioning the permits.

If the IMO were allocated an emissions target, it could allocate emissions permits to shipping companies at a worldwide level. Of course, emissions trading should be combined with the other flexible instruments under the Kyoto Protocol. Depending on the price of a carbon credit, i.e. of one ton of GHG emission reduction, international shipping could either host or delegate emissions reduction measures.

Michaelis[31] has analysed the effects of an emissions tax on bunkers in detail. He asked industry representatives for their reactions to tax levels of $5, $25 and $125 per ton of carbon. These would represent about 5 per cent, 25 per cent and 125 per cent of the price for residual fuel oil (at $90/ton), and 3 per cent, 15 per cent and 75 per cent of marine diesel fuel prices (at $150/ton). Shipowners and charterers generally did not think that they would be able to pass the charge on by increasing their shipping rates and showed high preferences for avoiding payments by charging fuel offshore.[32]

Various methods of tax collection are possible (e.g. based on sales of fuel from bunkers to ships, sales from oil companies to bunker dealers, fuel out of the refinery gate) which might influence the ease of implementation, potential for avoidance, and hence greenhouse gas impacts of the measure. Michaelis[33] shows a preference for tax collection from ship operators based on ship accounts, which would be possible if detailed fuel accounting were implemented by the IMO as part of the introduction of sulphur controls. The charge might be raised by flag states — in which this option would have relatively little effect if the charge were agreed only among Annex I countries, as two-thirds of vessels (on a gross-ton basis) are registered in non-Annex I countries. Alternatively, the charge might be collected at the

[31] Laurie Michaelis: Special issues in carbon/energy taxation: marine bunker fuel charges, op. cit.

[32] The only maritime fuel tax that ever existed – California introduced a 8.5% sales tax in 1991 – led to a reduction of fuels sales in Los Angeles/Long Beach from around 4.5 million barrels per month to 1 million per month. The shipowners evaded the tax by fuelling in Panama. The tax was rescinded in late 1992 (Laurie Michaelis: Special issues in carbon/energy taxation: marine bunker fuel charges, op. cit., p. 40).

[33] Laurie Michaelis: Special issues in carbon/energy taxation: marine bunker fuel charges, op. cit., p. 31.

ports visited by the ship, by port or customs authorities. In this case, an Annex I agreement could be effective. However, a bunker charge could be evaded easily by bunker suppliers and ship operators unless it were globally implemented as part of a general carbon tax. Offshore refuelling is already normal practice, making it a simple matter to bring fuel from any untaxed source in the world at costs of $10-15/ton. Thus, any charge in excess of this level would provide an incentive for suppliers to transport untaxed fuel to supply points immediately outside the national waters of Annex I countries. So any tax would have to be capped at around 10$/t C.

Any future taxation of GHG emissions could learn from the international experience with differentiated environmental dues. In 1998 Sweden introduced measures to reduce ships' nitrogen oxide emissions by the installation of catalytic converters, and to promote the use of low-sulphur bunker fuel. Environmentally differentiated fairway and harbour dues are intended to provide an economic incentive to stimulate the ferry traffic and other frequent vessel traffic to and from Swedish ports.

Another example is the Green Award Foundation from Rotterdam. The Green Award is a certificate, based on high environmental and safety standards. Qualified ships get discounts on port dues, pilot fees etc. However, currently the system is only applicable to oil tankers and it has not been introduced by major European ports outside of the Netherlands.

Verification of GHG Emission Reductions

The classification societies already play an important role in the promotion of environmental standards in the shipping industry. They control the quality of ship design and the construction and operation period. Their network of surveyors enables the classification societies to take over the certification and regular control of "green ships" during their annual surveys.

In addition to its involvement in the IMO-commissioned study, Det Norske Veritas has also been active in climate issues in non-maritime sectors. For example, it has verified the emission reduction achieved by the ILUMEX project in Mexico, a project to enhance energy efficiency by subsidising sales of compact fluorescent lamps.[34] Moreover, the experience of classification societies with ship engines enables them to verify emissions from power plants onshore. Their mobile measuring instruments enable them, in particular, to verify GHG emission offsets in decentralised power systems.

In addition to this experience, the classification society Germanischer Lloyd (GL) has played an important role in the Swedish system of differentiated port and fairway dues. GL certifies the intensity of sulphur and nitrogen oxide emissions from shipping on which the differentiation of the dues is based.

Conclusions

The contribution of international maritime transport to anthropogenic climate change is not yet perceived as a major issue. Due to ongoing research and the political process, it will be one in the near future. The early recognition of the potential implications of climate change to the shipping industry could help to reduce the adaptation costs – as an industry with a vulnerability towards changing climate conditions and as a polluting industry without any reduction commitments. The shipping industry has to apply experience from other industries that have already implemented efficient environmental standards.

SO_2 and NO_X emissions are currently the most important environmental problem in the shipping industry. Even without any direct technical reduction option for CO_2, instruments could easily be applied to address the different forms of pollution together. GHG reductions could easily be integrated into the criteria for green/clean chips under the Green Award or as applied in Sweden. Comprehensive calculations of numerous measures for reducing sulphur and nitrogen oxides show their cost-effectiveness for reducing emissions from ships.[35]

Shipping might be the most complex area for climate policy due to several factors. First, extreme competition has lead to flagging-out and thus widespread substandard shipping. This makes the implementation of climate policy instruments very difficult. Free-riding is easy due to the global dimension of shipping, which manifests itself in the possibility of avoiding fuel taxes easily. However, the growing share of shipping in global GHG emissions and the total absence of any action makes the introduction of measures necessary. If the IMO is unable to agree on a global emissions target, JI and CDM projects can be implemented in any case and governments should pressure the industry to enter into voluntary agreements. Countries with major, competitive ports can try to differentiate port fees according to the emissions intensity of ships.

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[34] Det Norske Veritas: Technical report World Bank – ILUMEX lessons learned, Report 99-3287, revision No. 01, Oslo 1999.

[35] Per Kågeson, op. cit.