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GREENHOUSE GAS EMISSIONS FROM INTERNATIONAL MARITIME TRANSPORT: THE SCIENCE IN A NEW ZEALAND AND AUSTRALIAN CONTEXT

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Introduction

Greenhouse gas emissions from international maritime transport contribute to anthropogenic global warming, as do those from international air transport. However, no liability was apportioned for these international emissions under the Kyoto Protocol when it was adopted in 1997. Instead, Article 2.2 of the Kyoto Protocol (United Nations, 1998) stated that:

> *“2. The Parties included in Annex 1 shall pursue limitation or reduction of emissions of greenhouse gases not controlled by the Montreal Protocol from aviation and marine bunker fuels, working through the International Civil Aviation Organization and the International Maritime Organization, respectively.”*

In recent years, there has been increasing international attention given to quantifying such emissions, with a view to possible inclusion of liabilities under future international climate agreements, particularly leading up to the United Nations Climate Change Conference (Conference of Parties (COP) 15) in Copenhagen, 7-18 December 2009.

This paper will review the science of greenhouse gas emissions from international maritime transport in the context of international maritime vessels passing through New Zealand and Australian ports. New Zealand and Australia are both countries with entirely maritime international borders and are geographically remote from many of their trading partners. Both nations are therefore heavily reliant on international maritime transport for the trade of goods with other countries. The implications of recent legal and policy developments in the Australasian geographic context will be briefly discussed.

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Background: the science of greenhouse gas emissions and maritime transport

Light from the Sun, known to scientists as "solar radiation", interacts with the components of the Earth's atmosphere (gases, particles, clouds), land, and oceans. When it is absorbed at the surface, solar radiation is subsequently re-emitted as "longer wavelength" (i.e., stretched) radiation. Gases such as carbon dioxide, methane, and nitrous oxide allow most of the incoming radiation to pass through them, but the longer wavelength outgoing radiation does not pass as easily through these gases. The heat associated with this radiation is therefore trapped within the Earth's atmosphere. This warming effect is known as "the greenhouse effect".

A certain level of the natural greenhouse effect is necessary for life as we know it to exist on Earth. Without it, the mean temperature of the Earth would be approximately -17°C. However, human activities, particularly the burning of fossil fuels since the 18th century, have increased the levels of greenhouse gases in the atmosphere, with CO_2 concentrations being approximately 35% higher now when compared to pre-industrial times (Intergovernmental Panel on Climate Change, 2007). This additional “anthropogenic greenhouse effect” is what climate scientists are concerned about.

Coal, oil, and natural gas are collectively known as fossil fuels. This term is used because they are the fossil remnants of plants and animals that were geologically buried, predominantly during the Carboniferous Era, around 360 to 290 million years ago (although New Zealand coal, oil, and gas formation was more recent: Ministry of Commerce, 1993; Thomas, 2002). These remnants were then geologically “cooked” under intense pressure and heat, eventually forming the substances that we observe today.

Almost all vessels in the modern maritime fleet burn fossil fuels, specifically heavy fuel oil (or residual oil) and marine diesel oil, to power their main and auxiliary engines. The combustion of these fuels generates greenhouse gas emissions, primarily carbon dioxide (CO_2), oxides of sulphur (SOx), oxides of nitrogen (NOx), hydrocarbons, and also particulate matter (Corbett & Koehler, 2003).

Not all greenhouse gases are covered by the Kyoto Protocol. The six gases covered are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6) (United Nations, 1998). These gases are commonly referred to as the “Kyoto gases”. To compare the different climate impacts of each of the Kyoto gases, CO_2 is used as a baseline over 100 year time frames for multipliers called global warming potentials (GWPs). The multipliers used are 1 for CO_2, 21 for CH_4, 310 for N_2O, and values of between 6500 and 23900 for the other gases

(Ministry of Economic Development, 2008). The summation of the masses of Kyoto gases multiplied by their GWP is termed the “carbon dioxide equivalent” value, or CO_2-e.

Methodologies for accounting for greenhouse gas emissions from international maritime transport

Greenhouse gas emissions from maritime transport are subject to Kyoto Protocol liabilities for domestic shipping in the territorial waters of countries listed in Annex 1 to the Protocol (commonly referred to as “developed” countries), but emissions from international shipping are not liable under the Kyoto Protocol. Although these emissions are not liable under the Kyoto Protocol, the Intergovernmental Panel on Climate Change (IPCC) requires “bunker fuels” to be accounted for in national greenhouse gas inventories as a “memo item” (Eggleston et al., 2006).

To determine future potential liabilities for greenhouse gas emissions from international transport, the emissions need to be quantified, through measurement, calculation and/or modelling.

Direct measurement of greenhouse gas emissions from maritime transport would be challenging. Instead, calculation and modelling is the internationally preferred approach. Generally, the methodologies rely on quantifying the fuel use by vessels, and then converting these figures into emissions values. There are several possible ways to calculate the emissions in principle, for example:

1. Bunker fuels method: recording how much fuel is used to refuel ships in each country, and therefore the emissions generated.
2. Passenger focussed method: calculating emissions based on passenger numbers and distance sailed.
3. Ship focussed method: calculating emissions based on particular ship types and distances sailed.
4. Freight and passenger focussed method: calculating emissions based on both freight carried and passenger numbers.

There are problems with each of these methodologies.

The bunker fuels method (1 in the above list) is often referred to as a “top-down” approach to the calculation. The other three methods listed above are activity-based methods, which are referred to as “bottom-up” methods for quantifying fuel consumption and the subsequent emissions.

As stated previously, the IPCC requires the use of a top-down, bunker fuels methodology for the memo item entry in national greenhouse gas inventories on international marine bunker fuels use. Researchers such as Olivier and Peters (1999) have also attempted to quantify the total fuel usage, and subsequently CO_2 emissions, from maritime transport. However, recent studies have identified problems with such an approach. Although on a global scale one would expect this method to be relatively accurate, it has been acknowledged that at regional and national scales, fuel statistics can give values that do not accurately represent the actual quantities of fuel consumed in the region or country. This is because not all fuel consumed in a given region or country is bunkered in that region or country, leading to either overestimates or underestimates, depending on whether or not there is a hub refuelling port in the area examined. There are also issues surrounding misreporting of fuel statistics as well as problems trying to separate the statistics for fuel used for domestic purposes from that used for international transport (e.g. Smith and Rodger, 2009).

Recent studies have favoured the use of an activity based (bottom-up) method for quantifying fuel consumption and the subsequent emissions (Buhaug et al., 2008; Buhaug et al., 2009). This involves establishing the movements of individual vessels and then calculating the total amount of energy required to conduct the observed activity. The energy consumption can then be converted into a quantity of fuel, and therefore emissions, depending on the fuel used by individual vessels.

The global context

The International Maritime Organization (IMO) commissioned a two stage report on international maritime transport greenhouse gas emissions from an international consortium of scientists who specialise in research on this topic. Phase one of this report (Buhaug et al., 2008) reported a value of 843 Mt (one Mt (megatonne) denotes one million tonnes) of CO_2 emissions for all international maritime transportation during 2007, with lower and upper bounds of 685 Mt and 1039 Mt of CO_2, respectively. This represents approximately 2.7% of total global CO_2 emissions in 2007 (Buhaug et al., 2008). Phase two of this report, entitled "Second IMO GHG Study 2009" (Buhaug et al., 2009) also quantifies emissions of other air pollutants including 20 Mt of NOx, 12 Mt of SOx, and 1.5 Mt of particulate matter from international shipping. Both activity based (bottom-up) models and fuel statistics (top-down) models were used to compare results and attempt to standardise the methods when calculating fuel usage and emissions from maritime transportation, and the authors concluded that "the activity-based estimate is a more correct representation of the total emissions from the world fleet" (Buhaug et al., 2009).

The New Zealand context

The New Zealand Ministry of Economic Development calculated the CO_2-e emissions attributable to international marine bunker fuels to be 0.99 Mt for New Zealand in 2007 (Ministry of Economic Development, 2008). CO_2-e emissions attributable to international aviation bunker fuels were calculated to be 2.64 Mt of CO_2-e for the same period. In comparison, 14.9 Mt of CO_2-e was the figure calculated to be New Zealand's 2007 greenhouse emissions from all domestic transport (Ministry of Economic Development, 2008).

Following the finding of Buhaug et at. (2008) that an activity-based model gives more accurate results when calculating fuel usage and emissions for global maritime transport, our research group at the University of Otago have attempted to quantify greenhouse gas emissions from international maritime transport to and from New Zealand during 2007. However, the data that we used in our preliminary study only included the previous/next overseas port that the vessel visited. There was also no way of tracking the cargo carried on these vessels with the data that we had access to, although we are currently engaged in research to look at this for refrigerated cargo.

The method that we used was ship focussed, with emissions calculated based on categories of ship types and distances sailed.

From data provided by the New Zealand Customs Service, we found that ship types visiting New Zealand fall into 10 categories: container ships, bulk carriers, tankers, general cargo vessels, roros (roll-on, roll-off vehicle transport ships), cruise liners, specialised craft (such as scientific research vessels), fishing vessels, tugs, and oil rig supply vessels. There were 4472 unique international journeys by 745 ships passing through New Zealand ports in 2007. Some of these ships also travelled on domestic legs within New Zealand. The main types of vessels passing through New Zealand ports that year were container ships (51.1% of the journeys), bulk carriers (16.9%), and tankers (11.9%). Of all journeys, 42.2% were to and/or from Australia, with the next most common destination and/or origin countries being Japan (9.1%), Fiji (5.0%), and Singapore (4.9%).

Using a model for engine sizes based on the work of Buhaug et al. (2008), our preliminary calculations indicate that approximately 6 Mt CO_2 emissions from international ships travelling to and from New Zealand were emitted for travel between their previous and next international port of call. Minor contributions were also found for SO_2, NOx, and hydrocarbons (including methane).

The CO_2 figure above is roughly six times as large as the CO_2-e bunker fuels value reported in the official New Zealand Energy Greenhouse Gas Emissions document (Ministry of Economic Development, 2008). This indicates how few international maritime vessels refuel in New Zealand.

The Australian Context

Australia's National Greenhouse Gas Inventory for 2007 states that international bunker fuel CO_2-e emissions were calculated to be 2.6 Mt for emissions attributable to international marine bunker fuels and 9.3 Mt for emissions from international aviation bunker fuels (Australian Government - Department of Climate Change, 2009a, p. 24). In comparison, Australia's domestic transport emissions are given as 78.8 Mt in the National Greenhouse Gas Inventory for

2007. The National Inventory Report 2007 (Australian Government - Department of Climate Change, 2009b) gives the breakdown of this figure into road transportation (68.5 Mt of CO_2-e emissions), domestic aviation (5.3 Mt), “domestic navigation” (the term used for domestic shipping: 2.9 Mt), and railways (1.9 Mt). Of the road transport component, passenger cars generated 41.9 Mt of the total, and trucks and buses 15.4 Mt. (Australian Government - Department of Climate Change, 2009b, Vol. 1, p. 27)

It is likely that the Australian figures for international maritime transport emissions given above are also lower than the figures that would be obtained by using a bottom-up, activity-based approach.

International legal/policy context

Since 1997, the International Maritime Organization (IMO) has been vested with the responsibility for resolving the issue of how to limit or reduce greenhouse gas emissions from the burning of marine bunker fuels. However, to date limited progress has been made at the IMO on this issue (Oberthür, 2003). One particular sticking point has been that the Kyoto Protocol only called for countries listed in Annex I to the Protocol to pursue these measures through the IMO, consistent with the concept of “common but differentiated responsibility”, but the IMO operates on the principle of "no more favourable treatment of ships", in other words, all ships being treated the same, regardless of their country of registration. The IMO has recently made some progress on measures that may reduce greenhouse gas emissions from ships, with the commissioning of the Second IMO GHG Study 2009 (Buhaug et al., 2009), and the dissemination of a “package of interim and voluntary technical and operational measures”, including an Energy Efficiency Design Index for new ships, and a Ship Energy Efficiency Management Plan and Ship Energy Efficiency Operational Indicator for new and existing ships (International Maritime Organization, 2009a).

It is likely that some parties at COP 15 in Copenhagen in December 2009 will advocate that IMO’s role change, for example perhaps becoming merely a provider of technical advice due to a perceived lack of progress.

Future legal and policy implications for New Zealand and Australia

New Zealand and Australia currently support the IMO continuing to have the primary responsibility for dealing with the issue of greenhouse gas emissions from maritime transport. Whether the issue is left with IMO, or moved to another body, in the future discussions will invariably involve the issue of liabilities for greenhouse gas emissions, whether at a country or a sector level. The IMO has recently produced a discussion/information paper that calculated global maritime greenhouse emissions using the methodology of Buhaug et al. (2009), but then attempted to split into emissions scenarios per country, based on “flags” (the country where ships are registered: International Maritime Organization, 2009b).

New Zealand and Australia need to have the capability to be able to assess the accuracy of such calculations, in order to be able to make informed policy decisions.

Conclusion

Leading up to and following the United Nations COP 15 meeting in Copenhagen in December 2009, greenhouse gas emissions from international maritime transport will be a topic that researchers in the area of international maritime law, policy, and science actively engage with policy makers in order to determine a regime for limiting the climate impacts of these emissions. The economies of New Zealand and Australia are particularly dependent on international maritime transport, and therefore have a great need to contribute to these discussions. Looming issues include the scientific accuracy of bunker fuels as a methodology for calculating greenhouse gas emissions from shipping on a regional and national basis, and the policy issues surrounding the allocation of liabilities for these emissions once they are quantified.

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