Early Discussion Paper: What is the likely future demand for shipping?

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To evaluate policy strategies designed to deliver low carbon shipping requires realistic forecasts of future movements of different types of ships. In this project, WP1 is modelling global flows and drilling into the detail of particular flows and commodities as required; WP4 is studying UK wet and dry bulk flows and links between bunker prices and spot freight rates; and WP3 is concentrating on box trades, links with inland and port logistics and the detail of UK flows. Initially WP1 collated global transport demand for different ship types (dry and wet bulk, general cargo, and containers) and examined historical relationships with GDP (Gross Domestic Product), using GDP forecasts to project out to 2050, but this approach did not define the trade flows required for more disaggregated model analysis. Later, NEA (The UK National Ecosystem Assessment) data was aggregated to quantify the tonnes traded by sea and tonne-km of maritime transport demand for a range of commodities (disaggregated using NSTR [EUROSTAT Standard Goods Classification for Transport] codes) for all country pairs. This data was then aggregated into regional and commodity group transport demands to generate a 2005 base year database of historical data. Using NEA's agent-based model, forecasts were generated to 2050, along with data describing UK imports and exports for a range of commodities. Testing of NEA data and corroboration of their forecasts with other sources is ongoing. When the model has been tested UK-centric flows will be extracted.

To supplement these forecasts of global and UK transport demand, CCC (The Committee on Climate Change) have presented an aggregate transport demand forecast for the UK for scenarios which include high mitigation, consistent with 80% UK emission reduction by 2050. WP1 is preparing NEA data for the UK which may offer a comparison. These forecasts will be combined with work which has estimated the impact of bunker prices on freight rates, tests for consistency between an exogenous transport demand forecast and a forecast generated by endogenising transport demand, and testing of how demand forecasts react to different fuel/carbon price scenarios for selected commodities and flows. This will require an estimate of demand/freight rate elasticity, to be combined with work on bunker price/freight rate elasticity. It may be possible to link these higher level analyses with detailed work in WP3.

Research in WP4 has concentrated on the most polluting types of ship, namely wet and dry bulk (Ref: IMO 2nd GHG Study, 2009 for more information). The availability and comparability of secondary maritime statistics is problematic, with global and national data emanating from both official and private sources (e.g. UNECE, UN, BP, EIA, DfT, Dukes, MDS Transmodal Ltd). Changing trade classifications may frustrate serial commodity comparisons, where for example official UK oil products flow data incorporated liquefied gas until 2000. Varying aggregated spatial units are a perennial problem complicated by volatile commodity sourcing policies and political changes which redefine trading boundaries including perhaps China and/or Hong Kong, and individual EU accessionary states. Northern Ireland is the principal exclusion when comparing data collations for Great Britain with the UK. Further, port commodity arrivals data which does not identify transhipment flows or an ultimate source or destination, hampers maritime flow reporting and denies end-to-end supply chain mapping.

Indicative longer term forecast techniques span statistical time series and growth models, scenarios, and Delphi methods. Twenty-year quantitative meta-models typically highlight baseline, high growth and low growth scenarios, perhaps with a range of oil price assumptions, focused on interdependencies between exogenous input and resulting output, expressed primarily as elasticities. To construct alternative plausible futures, scenarios may draw on objective, quantitative forecasts or qualitative behavioural foresight amongst experts. Table 1 shows selected drivers which may underpin future demand for shipping wet bulk. To assist long term planning Delphi techniques facilitate remote communication between expert panellists recruited to represent key viewpoints. Panellists express agreement or otherwise with initial statements typically underpinned by detailed literature review and the reasons offered for disagreement are iteratively fed back for comment until consensus emerges.

Socio-economic effects	
SE1	How responsive is worldwide demand for maritime transportation to shipping cost changes?
SE2	How significant are transport costs per unit weight for imports into different regions?
SE3	Spatially differential rates of population growth will proportionately redistribute oil demand.
SE4	Spatially differential rates of industrial output growth will proportionately redistribute oil demand.
SE5	Reducing oil or energy intensities (oil or energy used per unit output) in industrial nations will persist
Ships and shipping markets	
S1	Will tankers be re-deployed as water carriers as drought risks increase with global warming?
S2	Will world oil tanker tonnage continue to remain constant whilst dry bulk tonnage trebles?
S3	Will large tankers be used for carbon storage and smaller ones transport liquid CO_2 to storage sites?
S4	Will regionalisation of oil supplies shorten supply chains and reduce demand for shipping? Will pipelines from Russia oilfields supply NE Asia and Canadian tar sands/ Brazilian oilfields the US?
S5	Will technical optimisation of ships reduce CO_2 emissions by 20% with scope for retrofitting?
Political and institutional changes	
P1	Will damage to BP's reputation and exposure to unlimited liability post *Deepwater Horizon* oil spills deter offshore exploitation in the US and stimulate re-sourcing of supplies?
P2	Will new trading relationships in the Russian Arctic reconfigure oil supply chains?
P3	Will droughts induced by global warming create more failed states causing piracy to proliferate; sub-optimal ship routing to avoid trouble spots; longer maritime hauls, and tie up more tonnage?
P4	Will scope to cut EU GHG emissions by up to 90% by 2050 create pressure to reduce emissions?

Table 1 Selected drivers which may underpin future demand for shipping wet bulk

Some of the uncertainties in predicting flows of coal, the current main UK dry bulk flow (and second globally) include assessing the likelihood and possible effects of changes in:

1. Regulation – EEDI, EEO1 and market based measures. What is the impact of e.g. a bunker fuel levy on spot freight rates? Elasticities are being estimated for oil, oil products, coal and iron.
2. Supply chain resourcing such as increased imports of coal and oil from Russia?
3. Piracy including costs of sub-optimal re-routing and re-sourcing supplies using less vulnerable routes?
4. Shipping networks such as opening of a NE passage due to climate change?
5. Technological efficiency such as reduced transport intensity?
6. Technical relationships in advanced economies such as dematerialisation or Kuznets curves?
7. Industrial structure including new ones (carbon capture and transfers, biofuels) or decline of e.g. coal?

With so many unknowns, a key challenge is to establish what constitutes 'foreseeable' future transport demand scenarios ranging from 'Business As Usual', through varying degrees of mitigation, which can then be modelled to assess the implications on the emissions of the shipping industry. A survey, to canvass expert opinion to estimate how foreseeable various scenarios and growth rates might be, may well be required.

We expect a likely spatial momentum of future CO_2 emissions arising from bulk movements involving the UK which reflects geographically inert configurations of deep-water ports but volatile domestic production and use of oil, coal, steel and other materials. As more sustainable products such as biomass are imported ahead of local production for energy consumption, cargoes may change radically, but tonnages handled will only reduce as energy or transport intensities reduce significantly. Forty-year projections are necessarily speculative and market volatility implies unknown but potentially substantial variations in the magnitude of both movements and emissions. Other movements are spread nationwide, engaging many small ports and often small ships with high CO_2 emissions per unit handled. Because of this complexity, maritime flow forecasts are interlinked with macro-economic decisions, developments in marine technology, logistical and supply chain sourcing, mode choice and routing decisions, micro and macroeconomic developments, regulatory changes and operational strategies which all affect the reduction of shipping's CO_2 emissions. Each theme defines a specialist work package which draws together five universities and twenty industrial collaborators to assist the process of accessing operating data and ensuring realistic market assessments, within a unique holistic systems framework. Because long term maritime flow forecasts for one sector are inevitably interdependent on complex operating and regulatory decisions taken across and beyond the shipping sector, complex scenario dependent testing of various combinations of technologies and operational strategies is needed to guide future work.