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Impacts of climate change on ports and shipping

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EXECUTIVE SUMMARY

Ships and ports operate in two distinct but interrelated sectors. The regimes which are present to control emissions in each sector are different.

As ships are regularly required to move across national boundaries it is recognised that the control of ship's emissions need to be considered at an international level. The work of the International Maritime Organisation (IMO) in this respect is being carried forward to provide an international framework of control. Member countries of the IMO, an agency of the United Nations, implement and enforce Conventions.

In 2011, the International Maritime Organisation added Chapter 4 "Energy Efficiency for Ships" to Annex 6 of Marine Pollution Prevention Convention (MARPOL 73/78) which came into force on January 1st 2013. The United Kingdom has powers as a Flag State and Port State to enforce the regulations established in the new Chapter of MARPOL Annex 6.

Observations in 2012 suggest that the Arctic ice is melting more quickly than previously considered leading to new opportunities for use of the Arctic Ocean.

Ship designs and primary power plant continue to be developed to reduce carbon emissions. A fossil fuel free cargo ship design and model was tested in 2012 and found economically viable for specific routes.

The United Kingdom's 2008 Climate Change Act provides the legal framework to ensure that the UK Government meets its commitments to tackle climate change. For example the Act requires that Green House gas emissions are reduced by at least 80% by 2050 when compared to 1990 levels. Ports in the United Kingdom are bound by the requirement of the Act.

In 2011 nine port authorities belonging to the UK Major Ports Group were required by DEFRA, under the Climate Change Act 2008, to provide Climate Change Adaptation Plans.

For some UK port authorities the development of Climate Change Adaptation Plans was the first time they had formally considered the impact of Climate Change upon their operations and infrastructure.

UK ports recognise the issues concerned with climate change including the impact of storm surges, sea-level rise, temperature change, precipitation and high winds, but have to balance risk against the cost of undertaking immediate adaptation plans. Several ports used data from the UK Climate Projections 2009 (UKCP09) to help in their evaluation of the impact of climate change in the Climate Change Adaptation Plans.

INTRODUCTION

Ships and ports operate in two distinct but interrelated sectors.

International shipping comprises assets (ships) which are not fixed and undertake sea and ocean passages linking nation states. Whilst ships are registered in a nation state, the ship may be involved in cross trades meaning that the state of registry may not be visited.

To provide a level playing field for all engaged in the international shipping business, shipping regulation has to be accepted internationally. As has been said 'a global industry requires global regulations' (Hinchliffe, 2012). The regulator is the International Maritime Organisation (IMO) , an agency of the United Nations which was formally established in 1948. Port States and Flag States are responsible for enforcement of the regulations agreed at the IMO. The government of the United Kingdom enforces agreed regulations through the Maritime and Coastguard Agency (MCA).

World seaborne trade grew 7% from 7,858 million tonnes to 8,409 million tonnes in 2010 after negative world growth in 2009 and is anticipated to grow, albeit at a slower rate into

the future. To cope with the increase, a greater shipping capacity will be required. This will be achieved by increasing the utilisation of the present fleet, an increase in ship size and a further growth in the number of ships used (UNCTAD, 2012a). At the beginning of January 2011, the number of ships greater than 100 gross tons in the world fleet was 10,339 (UNCTAD, 2012b). This was an increase of 1,198 ships on the previous year and represented an additional 119 million deadweight tonnes capacity. By January 2011 the world's merchant fleet had reached almost 1.4 billion deadweight tons. According to UNCTAD (2012b) 'since 2005, the dry bulk fleet has almost doubled, and the containership fleet has nearly tripled'. This has created a situation of capacity oversupply which is reflected in reduced freight rates, which in some cases do little more than cover the ship's operating costs (Leake, 2013).

Ships are predominantly powered by fossil fuels. In the future, the foreseeable increase in demand for ships will create an increase in green-house gas (GHG) emissions.

It has been estimated that the world's fleet presently generates no less than 3% of global carbon emissions (UNCTAD, 2012a). The IMO anticipate that this will treble in quantity unless emissions are controlled. The present market position, particularly the high cost of fossil, encourages the development of operational efficiency which in turn has a positive impact on the reduction of GHG emissions.

The United Kingdom shipping industry, with more than 1,200 cargo carrying ships on its register is an important sector of the UK economy. It has a turnover of £13 Billion and contributes £4 billion to the UK Balance of Payments (DoT, 2012). The UK industry has interest in playing its part to reduce GHG emissions through international agreements.

Ports provide a strategic role within the global trading system. Ports which are set within the national transport framework are expected to conform to national demands for GHG emission reduction, which were agreed at the Kyoto Climate Change Summit in 1997. There are 52 major ports in the United Kingdom handling 97% of the country's imports and exports (DoT, 2011). The UK Major Ports Group (UKMPG) has a membership of nine organisations who own and operate 41 ports and 2 terminals accounting for 70% of the tonnage handled in the UK.

1. WHAT IS ALREADY HAPPENING?

1.1 Shipping

Impact of climate change on the regulatory regime for ships.

Concerns about climate change were expressed as long ago as 1979 when the first World Climate Conference was held. By 1990 an Intergovernmental Panel on Climate Change was set up, followed in 1994 by the development of the United Nations Framework Convention on Climate Change (UNFCCC). The adoption of the Kyoto Protocol 1997 resulted in an international agreement that there was the need to reduce anthropogenic greenhouse gases (GHG) in a manner that reflected underlying national differences in wealth and their capacity to reduce the amount of GHG emitted; 1990 was taken as the bench mark year of GHG emissions from which targets would be set.

Public interest in the issue of climate change had preceded the adoption of the Kyoto Protocol, having been raised by the publication of a book and film 'An Inconvenient Truth' written by former United States Vice President, Al Gore.

In 2008, the scale of GHG emissions from ships was made public in an article by the Guardian newspaper. The article leaked a UN study suggesting that the annual emissions from the world's merchant fleet had reached 1.12bn tonnes of CO_2, or nearly 4.5% of all global emissions of the main greenhouse gas. It was stated that the quantity of GHG emitted was similar to that produced by an industrial nation, the size of Germany (Vidal, 2008).

At the international level, there has been controversy about the mechanism to control ships' GHG emissions. The question was whether regulation should be undertaken by the Flag State of the ship alone, or through the use of the international regulatory body, the IMO.

At Durban, in 2011, it was thought that the IMO would be formally established as the body to set international standards, with its membership providing enforcement through Port State and Flag State control. Whilst formal agreement did not occur, the IMO was widely acknowledged by the United Nations to be the body to undertake the reduction of GHG emissions by ships. The IMO (2011a) has wide experience in establishing international regulatory activities, having developed and kept under continuous review important conventions for the shipping community including, the Safety of Life at Sea Convention (SOLAS), the Standards of Training Certification and Watchkeeping Convention (STCW) and the Prevention of Marine Pollution Convention (MARPOL 73/78).

A major impact of the climate change challenge on ship operations is the development and agreement of an acceptable international regulatory framework to reduce the amount of green-house gases emitted by ships. In 2011 IMO adopted mandatory technical and operational energy efficiency measures which will significantly reduce the amount of GHG emissions from ships. The measures add Chapter 4 to Annex 6 of MARPOL 73/78. Entitled "Energy Efficiency for Ships", the Chapter makes mandatory an Energy Efficiency Design Index (EEDI), for new ships, and a Ship Energy Efficiency Management Plan (SEEMP) for all ships. Chapter 4 entered into Force on 1 January 2013 (IMO, 2011b).

It is estimated that the Energy Efficiency Design Index (EEDI) will lead to more efficient ship design, which, when used worldwide is estimated to contribute to a 25% - 30% reduction in GHG emissions by ships by 2030 when compared to the GHG emissions which would occur if the Index was not used (International Chamber of Shipping, 2011).

The Ships Energy Efficiency Management Plan (SEEMP) applies to all ships. It requires companies and ship operators to monitor and improve a ship's performance concerning

features that contribute to GHG emissions, including hull efficiency, voyage planning and use of fuel.

Together it is estimated that the adoption of both the EEDI and SEEMP will reduce the total of ship carbon emissions by 180 million tonnes per annum by 2020 and by more than 390 million tonnes by 2030. At present ship created GHG emissions are estimated to be in excess of 1,000 million tonnes per year.

The IMO efficiency measures, EEDI and SEEMP have been criticised by the European Commission as being insufficient, They suggest that 'intermediary' steps are taken to deliver GHG emission reduction more quickly. One intermediary step includes the development of market-based measures (MBM). MBMs will complement the technical and operational measures adopted by EEDI and SEEMP. In 2012 the European Commission stated that MBMs for existing ships should be established and introduced throughout Europe by early 2013. The EC proposals consist of a simple robust monitoring, reporting and verification of emissions created based on fuel consumption (Climate Action, 2012). Whilst recognising the concerns of the EC there is a feeling that international shipping does not lend itself well to inclusion in national or regional emission targets. If different rules are applied to ships at the different ends of a voyage 'there would be chaos, inefficiency and market disruption' (International Chamber of Shipping, 2012). In 2012, the European Commission stated that MBMs for existing ships should be established and introduced throughout Europe by early 2013. The use of MBMs has been considered at the IMO but detailed discussion is not expected until 2014.

Impact of Emission Control Areas on ships

For several years a Sulphur Emission Control Area (SECA) has been established about the European coast. It was set up to reduce damage done to the environment by sulphur contained in the emitted gas. In 2010, the amount of sulphur content in ships' fuel used within a SECA was reduced from 1.5% to 1.0% (EU, 2010). The ship owner can choose whether to use either a higher quality fuel (low sulphur Marine Gas Oil) or cheaper Heavy Fuel Oil with on board capability to clean the exhaust gases before emission using 'scrubber' technology. The use of higher quality fuels or the scrubbing of gases before emission will reduce the amount of GHGs emitted.

Arctic ice melt and new opportunities for international shipping

There is increasing evidence that the Arctic ice is melting at a rate greater than initially anticipated. On the 30th May 2012 under the title 'Arctic Climate Change Offers Opportunities for Shipping' Graig Eason of Lloyds List stated that 'by 2050, reliably ice-free waters in the Artic will allow shipping to directly transit the North Pole' (Eason, 2012). This was followed in September by a report from John Vidal of the Guardian (2012), who on a recent cruise to the Arctic stated 'the vast polar ice cap which regulates the Earth's temperature and has been a permanent fixture in our understanding of how the world works has this year [2012] retreated further and faster than anyone expected. Satellite images show that in 2007 the summer Arctic ice covered 4.11 million square kilometres, a reduction of 50% compared to 40 years ago. In late August 2012, the ice cap covered just 3.49 million square miles. Kumi Naidoo, Director of Greenpeace International, has suggested that the Artic will free of summer ice by 2030.

Ice cover in the Baltic and impact on ice-class ships

Further evidence of temperature rise in the Northern hemisphere was given by Eric Van Berg (2012) who writing in Lloyds List stated that 'The impact of less harsh winters where the ice cover in the Baltic Sea has not exceeded average levels in the last 15 years is leaving ice classed vessel owners with few places to put their pricey ships to good use'.

The Jet Stream and changing weather patterns

The loss of Arctic ice is affecting the path and speed of the jet streams which impacts on the movement of weather systems across the United Kingdom. Since 2007, the jet stream has been at an abnormally low latitude across the UK, lying closer to the English Channel, around 50°N, rather than at its more normal position north of Scotland. This explains in part the changed weather pattern experienced, including the spring drought and heavy summer rainfalls of 2012. Ed O'Toole (2013) of Netweather.tv stated in an article "The Jetstream and The Weather in the UK" that "...if the polar front jet stream is situated over the UK, wetter and windier weather conditions than average will be experienced.'" Changing weather patterns impact on shipping in several ways, including storminess which can effect ship's routing, delays on passage and for smaller ships the need to seek shelter. There is an economic 'knock on' effect of these impacts including increased costs and reduced utilization of the ship.

Poor harvests, drought and flood

In October 2012, the BBC quoted a farmer from East Anglia who stated "...2012 was the worst harvest in my life time" (www.bbc.co.uk/news/uk-19895911). The article went on to inform readers that 'record-breaking wet weather has damaged food production and led to poor crop yields across the UK'. Experts are warning of soaring food prices and worsening global conditions. The international distribution of agricultural products, particularly grain, is undertaken by sea transport. It is anticipated that food imports into the UK by ship will increase next year, a direct impact of climate change.

Slow steaming and potential reduction of greenhouse gas emissions

Slow steaming is the deliberate reduction of speed, from a ship's stated cruising speed, undertaken to reduce costs due to reduced fuel consumption.

Slow steaming by the world's merchant fleet could reduce shipping's GHG emissions by as much as 30%. In a report 'Regulated Slow Steaming in Maritime Transport', the authors outline the basic link between speed, fuel consumption and emissions (Faber *et al.*, 2012). They states that 'as a rule of thumb, engine power output is a third power function of

speed'. Reducing speed by 10% will reduce the engine power required by 27%' Recognising it takes longer to steam a given distance at a lower speed, calculations show that energy needs for a specific voyage are reduced by 19%. This is a significant saving both in terms of fuel costs and emissions. The report states that if the European Community enforced a regulated slow steaming regime of 85% of the 2007 average speed of ships entering European ports an annual saving in fuel costs in the region of $74 Billion could be made and a reduction of 20%, of GHG emissions achieved.

The present high cost of fuel and the present over-supply of shipping is encouraging slow steaming. Some shipping companies have also introduced slow steaming to optimise the use of their fleet. Slow steaming has a positive impact on the financial demands of ship operation and a positive impact on the reduction of GHGs.

1.2 Ports

Ports are important infrastructures that serve as a catalyst for economic growth and development. They have strategic importance to a nation, acting as gateways to trade. They also constitute a key node in the global supply chain. Unlike ships, ports are regulated by the laws of the nation in which they are sited. The impact of climate change on ports will be viewed within the national structure.

Under the United Kingdom's Climate Change Act 2008, key infrastructure providers in the UK are required to undertake Climate Change Adaptation Plans (Anon., 2008). In 2011 Climate Change Adaptation Plans were requested from 91 key infrastructure providers including water companies, electricity generators, aviation organisations, road and rail, public bodies and port providers by the Department for Environment, Food and Rural Affairs (Defra, 2011).

The request went to the nine port authorities belonging to the UK Major Port Group (UKMPG), each of which have an annual throughput of more than 10 million tonnes of commercial cargo. In March 2011, DEFRA received Adaptation Plans from ABP Ports, Dover Harbour Board, Felixstowe Dock and Railway Company, Harwich Haven, Mersey Docks and Harbour Company, Milford Haven, PD Teesport, Port of London and the Port of Sheerness. The Reports covered current and future predicted impacts of climate change on the individual organisations and their proposals for adaptation.

Some of the UK port authorities stated that they had not previously undertaken any assessment regarding the Impact of Climate Change on their activities, but it was stated that preparedness for 'extreme weather is part of the daily operations'. Some port authorities made use of the UK Climate Projections 2009 (UKCP09) to gain an understanding of the likely increase in sea level, change in temperature, rainfall and wind speed which might occur in the future.

In their plans the individual UK Port Authorities sought to identify the impact of climate change on their statutory responsibilities and business functions. Some plans rated the impact of climate change on the port's functions. The impression on reading the 'Climate Change Adaptation Plans' is that UK ports recognise the issues concerned, but feel that the relatively slow change of potential impacts can be coped with as 'extensions to existing ones'. In the absence of detailed research, the 'Climate Change Adaptation Plans' of the nine UK major port authorities provide a reasonable guide as to what is happening in ports at present and what is likely to happen in the future. As the Mersey Docks and Harbour Board plan states 'Business / investment decisions will be based upon the potential scale of the impact as it is realised over time and a balanced business case will consider the cost of disruption against the cost of any necessary investment' (Mersey Docks and Harbour Board, 2011).

The above comments are supported by The 'UK Climate Change Risk Assessment – Evidence Report' (Defra, 2012) which states that 'climate change risks are not considered by the ports industry to be substantial in the near to medium term. Sea-level rise may be more critical in the long term because quays have fixed elevation and as waters rise there is a greater risk of flooding and for some ports lifting equipment may need to be modified'. The Report states that where issues such as flooding are a problem 'they are already being addressed.'

Many UK ports are ideally located to use renewable energy e.g. wind turbines, to supply electrical power for port and port user needs. Three wind turbines at Bristol provide 75% of the power requirements for the port and port users. They contribute to a reduction of electricity generated from fossil fuelled power stations.

Studies have been undertaken to understand the impact of Climate Change on wave climate and the operation of ferry services (Defra, 2012). There is some interest associated with the socio-economic impact of disruption caused by potential increase in wave height to Roll-On Roll-Off (RO RO) services in the remoter ports of the United Kingdom.

2. WHAT COULD HAPPEN?

2.1 Shipping

The threat of global warming through climate change has its impact on ship and engine designers. Many conceptual designs and ideas are being developed which could be used to reduce or eliminate the need to use fossil fuels as a primary power source for ships. Some of the more recent design ideas include:

Supplementary wind power

Fossil-fuel free cargo ship: In June 2012, Southampton Solent University reported on the testing of a fossil fuel free cargo ship which it claims is "set to transform the shipping industry" (Ship-Technology.com, 2012a). The model of a 3,000 dwt three masted combination wind and biogas propelled ship designed by the B9 Energy group was tested. The test proved the economic case for using the design on certain routes. The next step is to seek finance for the building of a $45M full size ship to demonstrate the technology.

The 'UT Wind Challenger': The 'UT Wind Challenger' designed by the University of Tokyo, if built would incorporate 164 foot retractable sails. The use of the sails are calculated to

reduce fossil fuel demand by 30%. There are plans to build a half size prototype by 2016 (Hornyak, 2012a).

The 'Energy Sail': Produced by Japan's Eco Marine Power, the 'Energy Sail' design incorporates a rigid sail inset with solar panels. The sail could be deployed on any type of vessel from large bulk carriers to ferries and could provide annual fuel savings of between 10% and 20%. The 'Energy Sail' with its built in solar panels can operate in port eliminating the need to use auxiliary diesel generators and reducing the carbon footprint of the port (Hornyak, 2012b).

Fletner Marine Propulsion: In 2010, the use of the Fletner rotor, first demonstrated in 1922 was incorporated into the design of the 'E-Ship 1', a specialised vessel built for the world wide carriage of wind turbines. The four 27 foot high Fletner rotors used by the ship which results in a reduction of fossil fuel consumption by between 30% and 40% (Spilman, 2010).

New fuels

Use of Liquified Natural gas (LNG): The use of LNG as a fuel for ships is already being used for coastal ships in Norway. LNG is a more efficient, cleaner and less corrosive fuel than the traditional marine fuels. Germanischer Lloyd (GL) a major classification society worked with MAN, an engine manufacturer, to demonstrate that the use of LNG can reduce GHG emissions by between 20% and 25% when compared to a ship using Medium Gas Oil (MGO)

In October 2011, a ship "The Bit Viking" was converted to use LNG as fuel for the main propulsion system. At 25,000 deadweight she is presently the largest commercial vessel, not an LNG tanker, to use LNG as fuel. She is engaged on Norwegian coastal voyages (Marinelog.com, 2011). The conversion to LNG fuel has reduced the GHG emissions as planned. The issues concerning the use of LNG as a marine fuel are the handling and storing of liquefied gas on board and the limited opportunities for refuelling.

Economies of Scale

The growth of ship size, is claimed to reduce the greenhouse gas emitted per unit carried. In 2011, Maersk Line announced the building of ten container ships which will be the world's largest (Maersk, 2011). The economies of scale provided by the 18,000 TEU (Twenty-foot Equivalent Unit), "Triple E Class" container ships, and improved fuel efficiency of the engines will reduce the amount of GHGs emitted per container carried between Europe and the Far East by 50% when compared to the industry average. The ships will consume 35% less fuel compared to the 13,100 TEU ships presently being delivered to other container shipping lines.

New routes

The development and exploitation of the Arctic will be dependent on shipping. It is expected that Arctic voyages will be either "in and out" or "transit" One area of concern is the deposition of black carbon on the ice and snow which will lead to an acceleration of ice melting. A Polar Code is being developed by the IMO which will look towards minimising black carbon deposits (IMO, 2013).

The Northern Routes: As the Arctic ice melt continues, the Bering Strait may rival the Malacca Strait and Suez Canal as a major international waterway (Ship-Technology.com, 2012b). The passage length between Europe and Asia is reduced by approximately 4,500 miles, saving time, fuel and GHG emissions

In 2009, the first two commercial ships used the Northern Sea route between Asia and Europe. Two years, later 34 commercial ships transited the route. Predictions from researchers at the University of Delaware consider that the amount of shipping using the North West and Northern Sea could account for 2% per cent of global traffic by 2030, and 5% percent by 2050.

Shift from Road to Rail and Water: Four marine corridors have been identified by the European Union and are known as 'Motorways of the Sea'. The use of Motorways of the Sea could encourage the movement of cargo by coastal ship instead of by road or rail reducing the overall amount of GHG emitted within the transport sector.

Panama Canal: In 2014, the widened Panama Canal with new locks measuring 1,400 ft (426.72 m) long, 180 ft (54.86 m) wide, and 60 ft (18.29 m) deep will be opened to international traffic. Whilst not a new route, opportunities for revised schedules, for all but the very largest of the world's ships will be possible. This should lead to efficiencies in route capacity and a reduction of GHG emissions. It has been estimated that the expansion of the Panama Canal will reduce annual GHG emissions on the US East Coast – Asia trade by 1.4 billion kilogrammes in 2025, or a per-ton reduction of 2.69 percent (Bittner *et al.*, 2011).

2.2 Ports

The severity of climate change impact on a port will depend to upon the location and topographical nature of the area in which the port is sited. Ports that are located in low lying geographic areas are vulnerable to risks, in particular a rise of sea level, storm surges and increased storminess.

The impact of sea-level rise, storm surges and increased storminess could effect the port's supporting infrastructure. For example The Climate Change Risk Assessment (Defra, 2012) Summary for Marine and Fisheries suggests disruption to ferry services operating off North-West Scotland could increase from 5% at present to 12% by 2020. There is also increasing risk of damage to port infrastructure, stored cargo and transport systems due to flooding.

Key areas that could be impacted by climate change and have been identified by port authorities and discussed in their Climate Change Adaptation Plans include the maintenance of harbour facilities, the resilience of navigational safety functions, the increased need to maintain channels due to changes in sedimentation and tidal patterns, the movement of ships under challenging weather constraints and port operations including cargo handling activities. Many plans consider what could be the impact of storm surges, sea-level rise, temperature change, rainfall and snow and high winds.

Storm surges could cause water levels to rise above the sea defences and create flooding of the port and local area . Ports

in the UK which are particularly susceptible to storm surges are found in the southern North Sea and Bristol Channel, where the funnel shape coastal configuration can exaggerate the height of the surge. Combined with strong winds, storm surges could cause significant increase in sea level and increased flood risk.

Sea-level rise could increase the risk of flooding and overtopping. Ingress of water into sensitive Vessel Traffic System (VTS) equipment systems with consequent power loss has been identified as an event that could reduce navigation safety. Loss of navigation support could lead to port closure, which would have a consequent effect on a port's reputation. The reliance of the supply chain could be questioned with possible loss of future business.

Ports and terminals can adapt to temperature change. Higher temperatures could create difficulties for plant and equipment designed for more temperate regions, e.g. the melting of tarmac surfaces on the port terminal, the use of none air-conditioned vehicles. Fewer cold days would reduce the number of frost and ice days leading to safer operational conditions.

Increases in the amount of rainfall and snow could result in flooding, causing disruption to 'on site' port logistics. Heavy snowfall can cause particular problems for container terminals operating straddle carriers in the shore side operation. It is possible that container terminals could be closed due to unsafe working conditions. Heavy snowfall could also interrupt road and rail networks leading to the port.

High winds are a particular concern to ports involved in bulk gantry and container crane operations. The need to develop robust designs of quay gantry cranes able to withstand increased wind speed has been identified. High wind speeds could cause delays to arrivals and departures of ships and impact on pilot transfers, pilotage and ship handling. High winds could also cause additional disruption to crane activity, container yard stacking and the mooring of ships.

The Climate Change Adaptation Reports give a positive insight into how members of the UK Major Ports Group consider what could be the possible impact of climate change on their activities. They are aware of the impacts, but have to balance potential impact against the costs of immediate adaptation actions.

Overall as stated in the UK Climate Change Risk Assessment – Evidence Report' (Defra, 2012) climate change risks are not considered by the UK ports industry to be substantial in the near to medium term.

In the longer term, climate change could cause change in climatic regions, which would impact on trading patterns and the demand for port services.

3. KNOWLEDGE GAPS

a. The economics of potential new trade routes and trading patterns associated with new routes

b. The impact of a) on port development and shipping activities about the UK.

c. The potential opportunities for 'fossil fuel free' cargo ships and the use of ships using 'supplementary wind power' about the UK coast.

4. SOCIO-ECONOMIC IMPACTS

a. Development of new Arctic Routes will provide reduced distance between Europe and Asia. It is unlikely to have a major impact in the UK, although the UK's northern ports might benefit.

b. Decrease in Arctic ice will provide new opportunities to develop polar gas and oil fields. The use of the present North Sea service infrastructure could gain some benefit, but owing to distance from the expected areas of exploration and exploitation it would not be considered great.

c. Decrease in the Arctic ice will open up limited opportunities for settlements on the North coast of the Eurasian landmass.

d. Development of new technologies applied to ships for operation in hostile conditions will encourage advances in shipbuilding and support industries. A Polar Code is being developed by the IMO covering the full range of design, construction, equipment, operational, training, search and rescue and environmental protection matters relevant to ships operating in the inhospitable waters surrounding the two poles.

e. There will be a need for a maritime infrastructure to support shipping operations in hostile waters, such as Search and Rescue and Oil Pollution Protection. The expertise and present infrastructure provided by organisations such as the Maritime and Coastguard Agency and Oil Spill Responses Ltd could contribute to the need for extended services

f. Further opportunities for cruise ship operation and fishing to operate in polar regions may be encouraged.

g. In the UK, port and terminal authorities will adapt to sea-level rise by building appropriate resilience into new infrastructure and providing defences to present infrastructure.

h. In the future, UK ports and terminals will develop business models to include expected increases in the suspension of port activities due to storminess.

i. UK ports and terminals are not expected to meet increased storminess caused by climate change by building disproportionately expensive equipment such as container gantry cranes. Rather ports will suspend operations at times of increased storminess.

5. CONFIDENCE ASSESSMENTS

What is already happening?

Confidence score is low with respect to level of agreement / consensus. There is no model appropriate to the 'Impact of Climate Change on Shipping and Ports.'

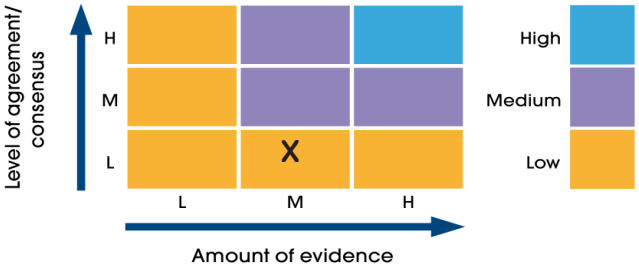
There is increasing evidence through observation that climate change is beginning to impact on international shipping through the reduction of Arctic sea ice.

New opportunities associated with the development of renewable energy power units are being considered.

There is no known single study which is specifically targeted at the impact of climate change on UK registered ships, ships within UK waters.

Ports are aware of the issues of Climate Change and if financially justifiable and operationally expedient are implementing adaptive and / or mitigating strategies.

UK ports and terminals are required to meet the legislative demands of the Climate Change Act 2008



What could happen?

Confidence scores are low on the agreement / consensus axis.

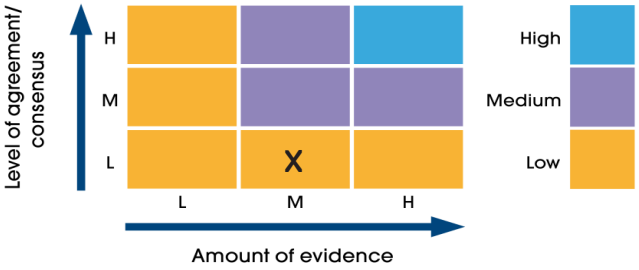
Climate change models associated with world average temperatures suggest an increase beyond that set by the Kyoto Protocol in 2007. The International Energy Agency (2012) is forecasting a 3.6oC 'long term average increase' in temperature.

Observations tend to be supportive of the climate change models, as evidenced by the changing seasonal patterns on UK ports and coastal shipping.

The IMO will continue to develop a legal framework for GHG reduction by international shipping, adopting technical and operations measures and implementing Market Based Measures to further encourage reduction of emissions.

The IMO will become the responsible authority for the reduction of GHG emissions, in the same way it is for other international shipping conventions, with implementation and enforcement being the responsibility of member states.

In the UK, Parliament will maintain the Climate Change Act 2008 amending as appropriate. The Act will continue to influence the operation of ports and terminals. Port authorities will recognise the impact of climate change and in new long term infrastructure will build in appropriate resilience.



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