PORT TECHNOLOGY

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OF PORTS AND TERMINALS

EDITION HIGHLIGHTS

- Increasing terminal capacity
- Pathways to zero emissions
- Dealing with the effects of climate change

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FROM THE

EDITOR

One topic that will define the 2020s is climate change. Already this year we have seen the wealthiest people on the planet descend on Davos, Switzerland, to discuss climate change and the risks it poses for the global economy.

The World Economic Forum has, for the first time, included climate change in the 'top five risks by likelihood' in its Global Risk Report.

But what does that mean for the maritime industry, in particular ports? Global shipping is often cited as one of the worst industries for pollution, alongside aviation, however a concerted effort is being made by regulatory bodies to reduce harmful emissions produced by ships.

The much anticipated International Maritime Organisation's (IMO) regulations to reduce sulphur emissions came into effect on 1 January 2020.

Papers in this journal examine the new regulations and what may happen next, including asking if the IMO's initiative is enough.

Throughout 2020 it is likely we will continue to see a strong focus on the IMO's sulphur regulations as the industry looks to comply and cut emissions across the maritime supply chain.

Ports themselves also have many challenges around the issue of climate change and sustainability. The Port of Oakland outlines its path to becoming a net zero-emissions port and how it plans to achieve this.

Meanwhile, the Fundación Valenciaport, an initiative of the Port Authority of Valencia considers how climate change affects ports, with extreme weather events having impact on operations, and how to deal with these changes.

Finally, ABB Ports presents a special case study on how to increase the capacity of the terminal yard. This study investigates the way Tianjin Five Continents International Container Terminal Co. Ltd. (FICT) in China resolved the 'mega-age' yard challenge. This includes a high level of automation being adopted by the port.

Beth Maundrill
Editor

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THE PORT OF OAKLAND'S PATHWAY TO ZERO EMISSIONS

Diane Heinze, Environmental Supervisor, Port of Oakland

The Port of Oakland strives for the cleanest operations to support the right to clean air for its workers and neighboring community. In June 2019, the Board of Port Commissioners approved the "Seaport Air Quality 2020 and Beyond Plan: The Pathway to Zero Emissions" (Plan) to minimize diesel particulate matter and greenhouse gas emissions. The Port is a landlord port and does not own or operate equipment including trucks, cargo handling equipment, ships or locomotives.

As the property owner and a public agency, the Port functions as a liaison with Port tenants (and associated equipment owners and operators), the West Oakland community and air quality regulators. To implement the Plan, Port staff evaluate the feasibility of zero and near zero-emissions equipment and encourage equipment owners to operate the cleanest equipment. The feasibility criteria in the Plan include commercial availability, operational feasibility, cost, community exposure reduction, cost-effectiveness, acceptability and need.

This article summarizes efforts to minimize four major mobile source categories: cargo handling equipment, drayage trucks, tugs and ships.

CARGO HANDLING EQUIPMENT (CHE) AND DRAYAGE TRUCKS

Zero emissions CHE and drayage trucks have been a focus in California especially since the Ports of Los Angeles and Long Beach announced their joint goals of all zero-emissions CHE by 2030, and all zero emissions drayage trucks by 2035. While applauding the San Pedro Bay ports for establishing these goals at the nation's largest seaport, the approach in Oakland is to establish goals based on the feasibility criteria in the Plan. The Port recently conducted two feasibility studies focused on CHE and drayage trucks as discussed below.

CHE: The feasibility study concludes that zero-emissions yard tractors operating in ancillary support areas (outside marine terminals or off-dock) meet the Port's feasibility criteria. Battery electric yard tractors are commercially available (vendors include OrangeEV, BYD and Kalmar); they are operationally feasible, and they are affordable with State of California incentive funding. The best source of incentive funding is the California Air Resources Board's (CARB) voucher program which can fund up to $150,000 for the tractor, $30,000 for electric infrastructure, plus another 10% because the seaport is adjacent to a disadvantaged community. To date, six OrangeEV yard tractors are operating off dock at the seaport.

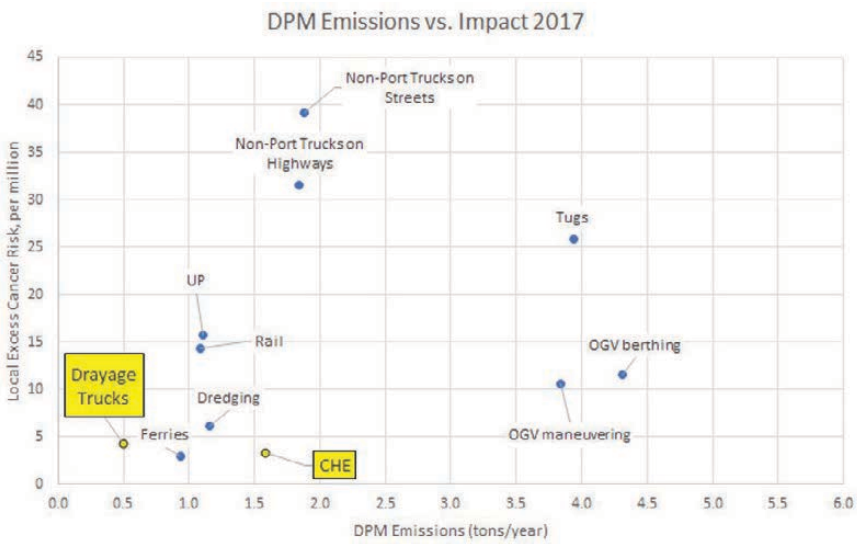
However, zero-emissions yard tractors are not yet operationally feasible at marine terminals. Terminal operators need tractors that can pull two loaded 20-foot containers on a chassis (or "bomb cart" - a chassis where import containers from vessels are dropped) for one or more shifts. Another issue at marine terminals is the desire for inductive versus manual charging of battery electric equipment.

Another type of CHE determined to be feasible is hybrid rubber tired gantry (RTG) cranes. RTG cranes are used to stack and load import containers onto drayage trucks. Currently, all 13 RTG cranes at Oakland's largest marine terminal, Oakland International Container Terminal (OICT), are being retrofitted using Mi-Jack Products hybrid electric technology. In Oakland, RTG cranes are used to stack imports in the yard and then load them onto drayage trucks. The terminal operator reports that diesel consumption has reduced from 10-12 gallons/hour to 1.2 gallons/hour.

Drayage Trucks: Over 5,000 drayage trucks transport containers to and from Oakland's four marine terminals. Currently, two off dock tenants operate a total of seven battery electric BYD drayage trucks which have all been funded by CARB. Currently, the retail cost of a new battery-electric drayage truck is unknown, but it is likely several $100,000's more than a used diesel drayage truck (which is what independent owner-operators typically buy). Another consideration is that currently, battery-electric drayage trucks are only commercially available for sale by one manufacturer.

The Port, in collaboration with the Port of Long Beach and others received a Zero and Near Zero Freight Facilities (ZANZEFF) grant from CARB to install electric infrastructure and operate ten zero-emissions Peterbilt/Transpower drayage trucks at a tenant facility. The estimated cost for these trucks is about $500,000 each, plus $200,000 each for Transpower's proprietary charging units. Construction of the infrastructure costs approximately $1 million with construction commencing in spring 2020.

Community Exposure from CHE and Drayage Trucks: As part of the West Oakland Community Action Plan recently approved by CARB, the local air district prepared a health risk assessment from the seaport and other sources of emissions. The risk assessment indicates that excess cancer risk from CHE and drayage trucks is lower than non-Port sources such as non-Port trucks on local streets and highways, and water based sources such as tugs and ocean going vessels.



The West Oakland Community Action Plan is a local plan funded by CARB's Community Air Protection Program.

TUGS AND OCEAN-GOING VESSELS

The following summarizes emission reduction measures for tugs and ocean-going vessels (OGV).

Tugs: Large ships may require up to four tugs to assist San Francisco bar pilots maneuver ships to berths. Many of these tugs have been or will be retrofitted with Tier 3 engines using incentive funding. As part of the ZANZEFF grant mentioned above, a tug operator plans to construct a new Tier 4 tug with a power management system to operate its main and auxiliary engines based on demand.

OGV: California is the only place in the world that requires container ships to plug into shorepower, and to use 0.1% sulfur marine distillate oil (MDO). In 2019, Oakland had 1,419 vessel calls from approximately 300 unique container ships of which approximately 80% plugged into shore power. It costs approximately $1,000,000 to retrofit a ship to be shore power capable. The biggest reason for not plugging in is unequipped vessels; about 15% of vessel calls in 2019. Significant incentive funding was provided by CARB to install shorepower in Oakland. The Port of Oakland has a robust shorepower program including vessel commissioning by Port staff, investigating and recording why a ship did not plug in, and monthly and annual reporting.

Another major emissions reduction measure is the use of lower sulfur fuel. While the IMO recently required that all ships transition from 3.5% to 0.5% sulfur fuel, CARB has required the use of 0.1% MDO for several years. Based on Port research, actual fuel sulfur content may be less than 0.1% sulfur (0.05% or less). The associated emission factors are unknown but will be quantified in a 2019 emissions inventory.

PORT OF OAKLAND NEWS

ABOUT THE AUTHOR

Diane Heinze oversees the seaport's environmental work. Together with four staff they obtain entitlements for projects and ensure compliance with environmental laws and regulations. Diane also manages the Port's archives.

ABOUT THE ORGANIZATION

Oakland's seaport originated in 1852 when Horace Carpentier, a lawyer and Oakland's first mayor, was granted exclusive control of the waterfront. In 1911, the State of California determined that the waterfront belonged to the public and Oakland's Harbor Commission was created. In 1927, the citizens of Oakland voted to establish a separate department to manage the port and created the Port of Oakland. The Port of Oakland's seaport is the ninth largest container port in the U.S. and handled 2.5 million TEUs in 2019. The Port of Oakland also includes the Oakland International Airport and commercial real estate property between the seaport and the airport.

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INCREASING TERMINAL CAPACITY BY 10%

A CASE STUDY IN YARD TRANSFORMATION

Björn Henriksson, ABB Ports, Sweden and Lin Hong-Wei and Wang Hong-Liang, Tianjin Port Container Terminal Co., Ltd

HOW TO DO SUCCESSFUL CONTAINER TERMINAL TRANSFORMATION?

This paper examines the way Tianjin Five Continents International Container Terminal Co. Ltd. (FICT) in China resolved the 'mega-age' yard challenge by modernizing and automating its existing manual RMGs. The case study explains the solution and improvements in KPIs achieved by improving the efficiency of yard operations.

As discussed in earlier papers written by ABB, we inhabit the 'mega-age' of megaships and consolidated shipping lines. It is an era which has forced the need to re-equip existing terminals and improve efficiency and productivity into the spotlight. To avoid becoming a bottleneck, the yard of today needs to be equipped with solutions that can support the required increase in capacity and productivity while retaining cost-efficient service to both waterside and landside operations.

ABOUT FICT

FICT, which is part of Tianjin Port Container Terminal Co., Ltd., is located in the Port of Tianjin. With 500 international port calls per month and total yearly volumes of 16 million TEU, Tianjin is the tenth busiest container port in the world and the largest in Northern China. The port is also the main maritime gateway to Beijing and serves as a link between the Northeast Asia, Central Asia and the Middle East.

The terminal was built in 2003 and was originally designed for annual throughput of 1.5 million TEU, which has become insufficient in the mega-age. In 2018 the terminal's actual volume clearly exceeded the design capacity and reached 2.57MTEU.

The terminal's perpendicular yard is equipped with 31 RMGs which were originally manually operated. It has capacity to store containers corresponding 32,000 TEU. The RMGs at FICT are not typical cantilever type cranes. They are specifically designed for this terminal and have two vehicle lanes within the crane portal on one side. This means that both internal and external chassis are served in the same lane whereas the second lane is used to allow the chassis to pass the vehicles in the service lane. In addition, some of the cranes have a rope tower, while some have reeving that resembles a ship-to-shore (STS) crane.

THE BOTTLENECK

FICT identified the need to increase the efficiency of the yard early on, with congestion resulting in long truck turnaround times and the yard filled up with containers stacked 5-6 high. Work during the night showed low efficiency and there was a huge imbalance in the workload between the cranes and therefore between crane drivers. The difficulty of recruiting crane drivers and increasing labor costs added to the problem, further restraining the growth in terminal volumes.

The arrival of mega ships, with a requirement to handle 7,000 containers in 30 hours, created frequent peaks in production and placed new demands on equipment performance requirements. In effect, the yard had become a bottleneck hampering the future development of the entire terminal; therefore, the yard equipment and processes needed a total make over to support larger container throughput in the terminal.

RE-EQUIPPING AND AUTOMATING THE YARD

In parallel with the capacity limit, after 15 years in operation the electrical systems installed in the cranes had reached the stage where refurbishment was needed. These circumstances created an opportunity for the terminal to raise the performance of its yard operations to a new level at the same time as it upgraded its crane control systems. Thus, a decision was taken to automate the yard operations, with the target of increasing the yard's production capacity while also improving cost-efficiency.

In the modernization project that was executed by ABB, the old crane electrical and control systems were fully retrofitted. The new systems were fitted in new innovative, containerized e-houses that were delivered pre-assembled to the terminal to enable faster project execution on site.

Major part of the process on the yard was automated. Pick-up and set-down of containers on internal terminal chassis are now fully automatic, since there is no twistlock handling and the automation system is equipped with a truck supervision function that ensures that the vehicle is in the right position and does not move during the set-down of the container.

As noted, both external and internal chassis are served in the same lane in a single-side two-lane operation at FICT. Therefore, ABB's 3D sensor based anti-lift system is used to scan the vehicle as part of the vehicle guidance process and verifies the vehicle type to eliminate safety risks caused by interference in RFID signals caused by vehicles passing by in the adjacent lane. As the cranes were automated, the operators also moved to a new control room from where each operator supervises six cranes. The interface between TOS and cranes was also upgraded to support the automated process and work order handling

Re-equipping 31 RMGs in the yard while keeping the terminal fully operational during the project was a key requirement and careful planning was necessary. A 40-stage reconstruction plan was created in collaboration between nine departments affected at FICT. A close collaboration was also established between ABB as crane control and automation system supplier and TOS supplier Navis. The planning resulted in a rolling weekly construction progress program that made sure that enough equipment remained in operation while a part of the crane fleet was under refurbishment and modernization.

CREATING A FLOW

The introduction of an automated process requires the creation of a flow – a pre-defined sequence of events with triggers

that initiate the next step in the flow. In the operation of a perpendicular yard the relevant triggers are the vehicle positions.

At FICT vehicles are monitored in real time using a RFID within the terminal's premises, with RFID antennas installed at the terminal gate, by the terminal's internal roads and on the yard cranes. The instructions and list of work orders issued by the TOS are processed through an equipment control system (ECS) that takes decisions on the sequence based on defined criteria such as time, priority or energy consumption.

The vehicles get instructions and drive to a specified block and bay close to the crane that will perform the pick-up or set down of the container. When a vehicle approaches the block, the ECS dispatches the work order to the crane based on information about the vehicle location. In the case of external trucks, the TOS schedules a work order based on the truck 'checking-in' at the terminal gate and on the location of the target block in the yard. Ideally, the crane is in the right position ready to perform the pick-up/landing when the vehicle arrives to minimize the waiting time.

The truck driver can verify that he has arrived at the right position from a screen attached to the crane which displays the registration plate. The crane also verifies that the vehicle to be handled matches with the work order with help of RFID. In case the vehicle does not arrive at the crane within the estimated time frame, the crane requests remote operator assistance.

RESULTS

The transformation project reached all of the targets set. Thanks to careful planning and collaboration, the terminal remained fully operational throughout the project's execution, and the whole project of modernizing 31 RMGs was completed in 13 months.

The KPIs show that automating the RMGs resolved the yard challenge. Yard congestion has disappeared as the entire crane fleet is now used more efficiently, with cranes consistently achieving 30 container moves per hour day and night. The equipment utilization ratio has increased by 35%. The higher and consistent production has also increased the speed of yard turnover, which in turn has resulted in fewer containers stored in the yard significantly reducing the need to stack 5-6 high.

The container handling capacity at the yard has already increased by over 20% and is expected to increase even further. The turnaround time for road chassis has gone down from 51 minutes to 18 minutes. On the quay side the ship berthing time has reduced by nearly 20% and the STS cranes can now perform five more moves per hour than before. Measured at the terminal level, the yard transformation has increased the terminal's overall production capacity by 10%, which allows FICT to serve more vessels than before and provide more efficient and reliable service to its customers both on the water and landside.

It was also remarkable to see that the terminal's capacity increased already during the project execution itself. We can conclude that the transformation project was successful and delivered to the requirements and expectations of FICT. The FICT case also verifies that transforming an existing terminal and eliminating the bottleneck allows an existing terminal to increase its capacity and thus remain relevant in the 'mega-age'.

THE YARD TRANSFORMATION IN NUMBERS

10% increase in the terminal's production capacity
35% increase in equipment utilization
20% increase in container handling capacity at the yard
Monthly average moves/hour at the yard: 30
Number of moves/hour at the quay up by 5 moves
Truck turnaround time down from 51 minutes to 18 minutes
The yard was fully operational throughout the project
The entire project was completed in 13 months.

TECHNICAL PAPER: TRANSFORMING TERMINALS IN THE MEGA-AGE

ABOUT THE AUTHORS

Björn Henriksson is the head ABB Ports Sweden. Prior to his current role, Björn was the Global Technology Manager at ABB Ports. He has extensive experience on container terminal automation and electrical systems through the various positions he has held over the years within R&D, engineering and commissioning, including several management positions. Henriksson joined ABB in 2001 via ABB's Executive Trainee program and has a Master of Science degree in Electrical Engineering from Royal Institute of

Lin Hong-Wei is the Vice General Manager of TCT (Tianjin Port Container Terminal). With over 15 years of experience on optimizing the production process in bulk and container cargo handling, including yard planning and management, he is one of the most experienced professionals in the field in China. He was also one of the key persons in the modernization and automation of FICT's RMGs.

Wang Hong-Liang is the Technical Director & Technology Engineering Branch Manager of TCT and possesses extensive experience in the maintenance of container handling equipment. He started his career at TCT for 20 years ago as a crane engineer and has since then held several positions in the company, including leading the company's technological innovations and equipment automation initiatives.

ABOUT THE ORGANIZATIONS

Tianjin Port Container Terminal CO,. LTD (TPCT) manages and operates the three container terminals located in the port of Tianjin. Tianjin Port was built in 1980 and was the first port in China specialized in container handling. Over the past 10 years the container throughput of Tianjin Port has grown rapidly and today TPCT handles annually 7 million TEU. TPCT's total quay length is 3,540m and the container yard area totals in 1,160,000m^2. The container terminals operate altogether 13 deep-water berths and the terminals are equipped with 37 quay cranes, 68 RTGs and 31 ARMGs.

ABB Ports develops and delivers intelligent terminal automation solutions and services to make container terminals safer, greener and more productive. The solutions include automation and remote operation for all types of container handling cranes, and complete OCR and electrical systems. With the track-record of the largest installed base, ABB's systems help to optimise container handling from ship to gate in greenfield installations and in existing terminals.

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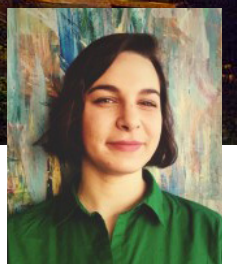

THE EARTH INSTITUTE
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DEVELOPING A PORT SUSTAINABILITY INDEX

HOW TO ACHIEVE PORT SUSTAINABILITY THROUGH OPEN SOURCE DATA

Isabela Brown, The Earth Institute, Columbia University

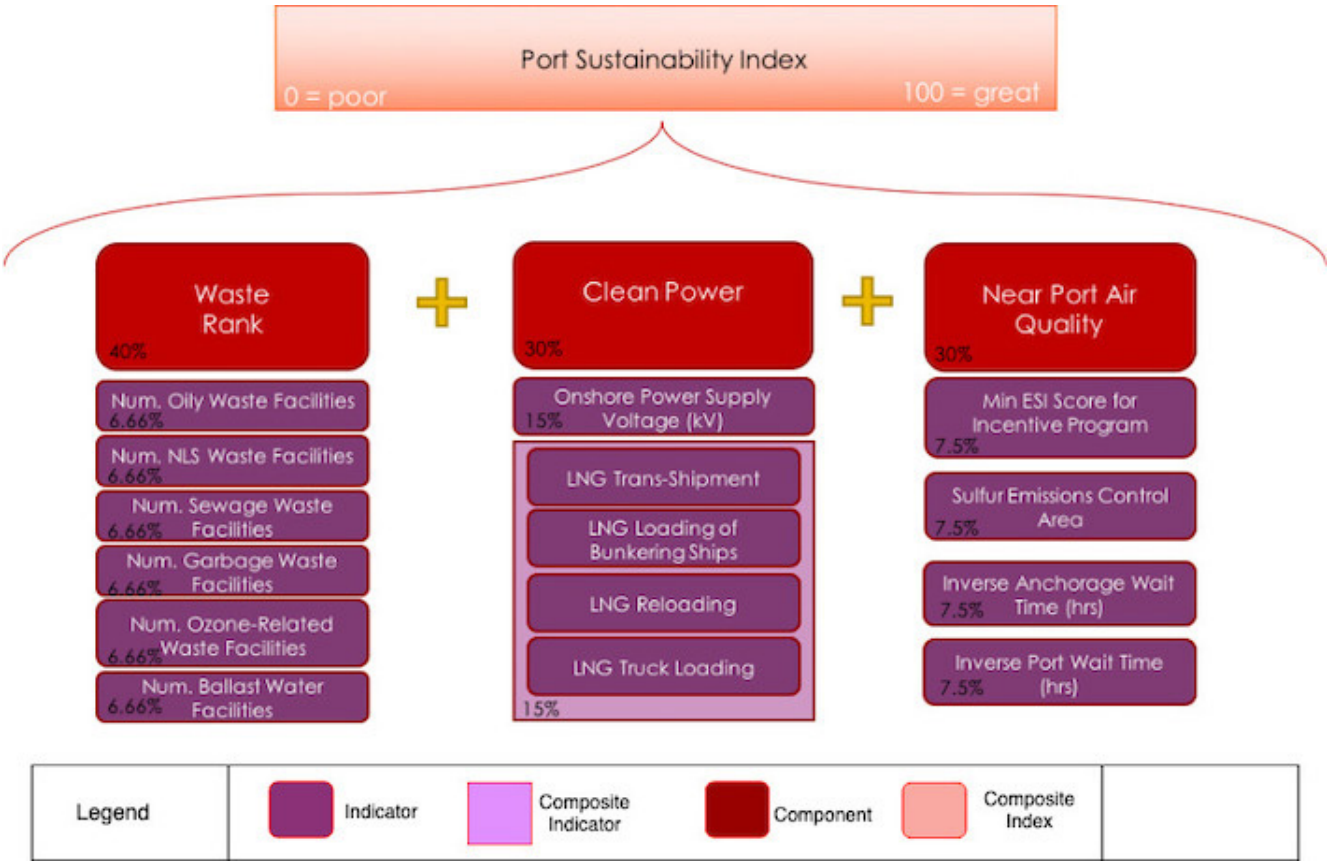
The success of today's global economy means we rely on ships, and therefore ports, more than ever to get goods from point A to point B. This growing reliance on international goods has helped make transportation the fastest growing cause of greenhouse gas emissions. Ship emissions are projected to increase as much as 250% by 2050.

Prior to 2020, shipping fuel sulfur concentrations were 3,500 times greater than those that triggered the Volkswagen emissions testing scandal. In response to this, International Maritime Organization regulations (IMO 2020) mandate that international shipping fuel sulfur drop from 3.5% to 0.5% as of January 2020. The success of IMO's 2020 sulfur regulation could solidify shipping's position as the most environmentally efficient transport for cargo worldwide. However, reaching this goal requires going further than fitting scrubbers on vessels or producing low-sulfur fuel. Ports serve as crucial points of connection between the smaller components at play, such as ships, fuel, waste facilities, cargo, and on-land freight; the combined sustainability of these components is critical to IMO 2020's success.

OPPORTUNITY FOR IMPROVEMENT

Data, statistics, and indexes play a necessary role in establishing a quantitative consensus around what sustainability means for ports. As such, an index was developed to compare the sustainability of 26 ports in light of the recent sulfur regulations. This index uncovered several opportunities for port improvements that would facilitate greater sustainability across the global supply chain to achieve IMO 2020.

No publicly available port sustainability index exists, which makes comparing port sustainability, and assessing readiness for IMO 2020, difficult. Privately available port sustainability indexes lack the transparency needed to support outside involvement, such as the allocation of federal funds towards port-sustainability projects. Transparency is necessary to assure communities that near-by ports are stewards of a sustainable economy, rather than close-doored polluters.



WASTING IMO 2020

Ships contribute a significant amount of waste to the ocean. The shipping industry is responsible for 20%of all marine litter, while some 34% of ship garbage ends up being discharged at sea. Ships discharge sewage, oily waste and chemicals, which can harm ecosystems, and release ballast water, which can spread invasive species. When port waste reception services are inadequate or missing, ship crews are more likely to dump waste overboard to reduce weight, thereby harming marine ecosystems.

The range of waste facilities offered by ports serve as valuable indicators of their sustainability and provide insight into port preparedness for IMO 2020. Their inclusion into this index allows for the establishment of sustainable port waste handling goals and the monitoring of progress towards those goals through metric-based assessments.

IMO waste reception facility categories were used as the basis of the port waste indicators established in this index. Port reception facility data was converted to binary data based on the existence of at least one facility per category, in order to reduce bias for large ports. The binary data was summed and normalized per category and each port was ranked on its ability to provide ships with a wide range of port waste reception facilities.

As IMO 2020 comes into effect, many ships will switch over to using scrubbers as a means to remove particulate matter, sulfur oxides and nitrogen oxides from their tail-pipe emissions. Because of this, ports should expect to handle much more scrubber waste, which has high concentrations of salts and sometimes metals. Yet of the 26 ports analyzed in this index, only 11 contained facilities to handle scrubber sludge and only two offered facilities to handle ballast water. Without the necessary waste facilities, ports will continue to hamper IMO 2020 goals.

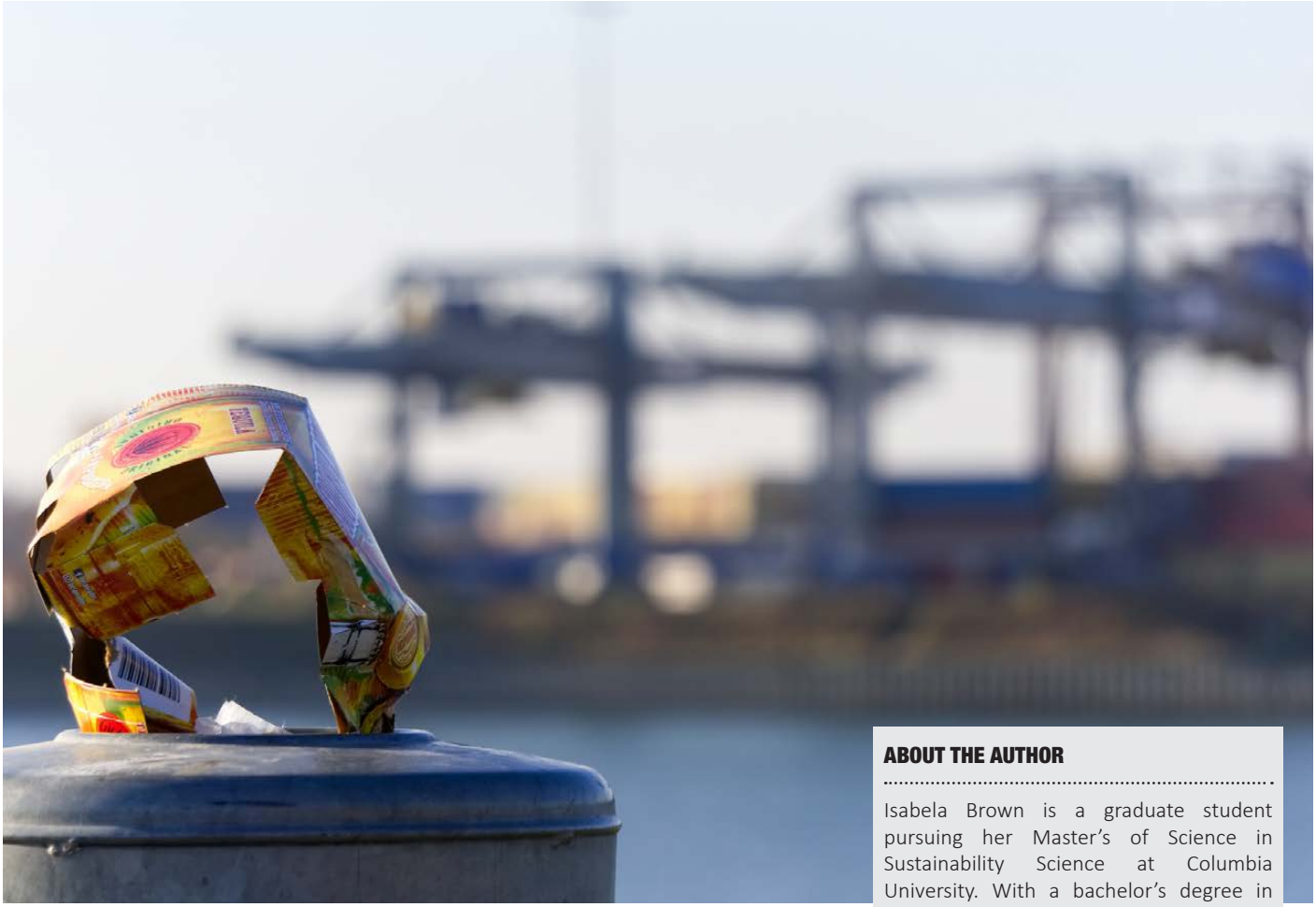
RANKING CLEAN ENERGY ALTERNATIVES

There are multiple ways that ports can offer clean energy alternatives to reduce the carbon footprint and emissions of ships. Compliance with IMO 2020 will require vessels to either switch to low-sulfur fuel, install scrubbers to filter pollutants from high-sulfur fuel, or use liquid natural gas (LNG). Sulfur Emission Control Areas (SECAs) have previously instated similar or stricter regulations and serve as good case-studies for the success of IMO 2020.

Even in SECA regulated areas, ships idle in ports over long periods of time, producing harmful emissions. The typical cruise ship remains the most egregious portside polluter, combusting nearly 20 tons of fuel while at berth- comparable to 35,000 trucks idling for 10 hours. Dockside activity of this magnitude has been shown to cause approximately 400,000 premature deaths from lung cancer and heart disease and 14 million childhood asthma cases each year.

On-shore power supply (OPS), offers a solution to this, as it can reduce the NOx and PM2.5 emissions of the ships that use it by 62% to 90% per port visit. Accordingly, an OPS accessibility indicator was developed from port-specific OPS voltage information, by summing the maximum OPS voltage with the range of voltage values per port. This indicator highlights ports that both service ocean-going vessels as well as smaller ships.

Beyond OPS, ports can be sustainability stewards by supplying ships with LNG fuel, which can reduce greenhouse gas emissions of marine vessels by up to 21%. However, of the 26 analyzed ports, only 13 had LNG accessibility. Furthermore, although LNG is a low sulfur, IMO 2020 compliant fuel, its accessibility did not seem to be contingent on a port SECA status. Only 25% of SECA ports offered LNG, as compared to 69% of non-SECA ports. Given that pre-IMO 2020 regulations have not influenced LNG accessibility, its speculative whether we will see greater LNG expansion because of IMO 2020.



Interestingly, a cluster analysis illuminated a clear division in clean-power investment by ports. Only two of the ports within this study reported both LNG and OPS capabilities; all others chose to invest exclusively in one or the other. However, OPS and LNG are not comparable substitutes for each other: the former effects near-port auxiliary engines while the latter changes over-ocean propulsive emissions. Ports pursuing sustainability should invest in both options to pave the way towards a holistic decarbonization of shipping.

WHY EFFICIENCY MATTERS

While both LNG and OPS offer opportunities to cut emissions, neither are full-proof pathways to decarbonized shipping. Methane leaks associated with LNG and fossil-fuel powered OPS both have climate impacts. Today, reducing fuel usage remains both an economic and climate-based necessity – nearly as critical as accessibility to low-carbon fuel alternatives. An assessment of port wait-times, collected from Marine Traffic, serves as good indicator of port efficiency which results in reduced ship fuel usage. This indicator emphasizes ports engaging in efficiency programs, such as Virtual Arrival which drastically reduces overseas emissions, sometimes by up to half. In the coming years, a wait-time indicator may highlight how efficiently ports take on their new fuel testing responsibilities with the onset of IMO 2020, and where greater assistance or equipment is needed.

TRANSPARENCY AND DATA IN PORT SUSTAINABILITY

Improvements in the waste facilities, clean energy offerings, and efficiency of ports are critical for shipping sustainability and the success of IMO 2020. Public port sustainability indexes are crucial for monitoring progress in these areas. Still, while ports are likely to monitor other important indicators, like energy and water consumption, noise, and sediment and soil quality, none of this information is available to the public.

The story of port sustainability is a common one. We cannot accurately define, defend, and evaluate sustainability goals without the help of data, and we cannot progress toward goals without making that data public. With a balance between data, metrics, and stakeholders in mind, the path toward sustainability for ports and for other areas becomes a lot clearer.

ABOUT THE AUTHOR

Isabela Brown is a graduate student pursuing her Master's of Science in Sustainability Science at Columbia University. With a bachelor's degree in mathematics, Isabela has spent the last three years working as an emissions modeler for the US Environmental Protection Agency, previously as a research fellow and currently as a consultant with Eastern Research Group. Her primary work has been the development of two high-resolution, AIS-based national ship emissions models for the purpose of EPA air quality modeling, regulatory analysis, and national emissions inventory work.

ABOUT THE ORGANIZATION

Columbia's Earth Institute is the largest university-wide research organization in the world dedicated to sustainability research, practice, and education. It blends research in the physical and social sciences, education and practical solutions to help guide the world onto a path toward sustainability. The Sustainability Science graduate program is designed for those who wish to pursue a career in technical aspects of sustainability, helping organizations better understand, predict, and address environmental impacts.

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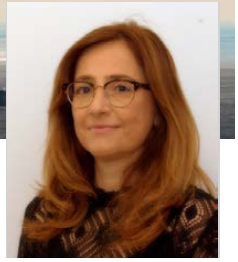


HOW TO DEAL WITH THE EFFECTS OF CLIMATE CHANGE IN PORTS?

Noemí Monterde, Project Manager, Fundación Valenciaport

From the end of the 19th century until 2011-2016 the average temperature of the Earth's surface has increased by only 1.1ºC and the average sea level by 0.2m, with wide geographical variability. These seemingly small variations have caused changes in the climate of the entire planet as well as an increase in the frequency, intensity and duration of extreme weather events. We are not moving from a stable ecosystem to another one that is also stable - but worse. The climate will continue to deteriorate, even in the fictitious scenario of the complete cessation of GHG emissions tomorrow.

CURRENT STATE OF PLAY

There are two sources of uncertainty: what and when humans will do about that GHG emissions and how the climate will respond both directly and, above all, through interconnected feedback processes. But despite this, the Intergovernmental Panel on Climate Change (IPCC), a non-alarmist body, expects a warming of between 3 and 4 degrees at the end of the 21st century, although every time it reviews the scenarios it corrects them towards more pessimistic forecasts.

In addition to eliminating or at least reducing CO2 emissions, there are two fields of technology that seek to reverse the effects of climate change: geoengineering and CO2 capture technology. Although both come with undesirable side effects. Meanwhile, the natural approach, revitalizing forests and with new plantations expressly designed for that purpose, does not seem to work on the necessary scale.

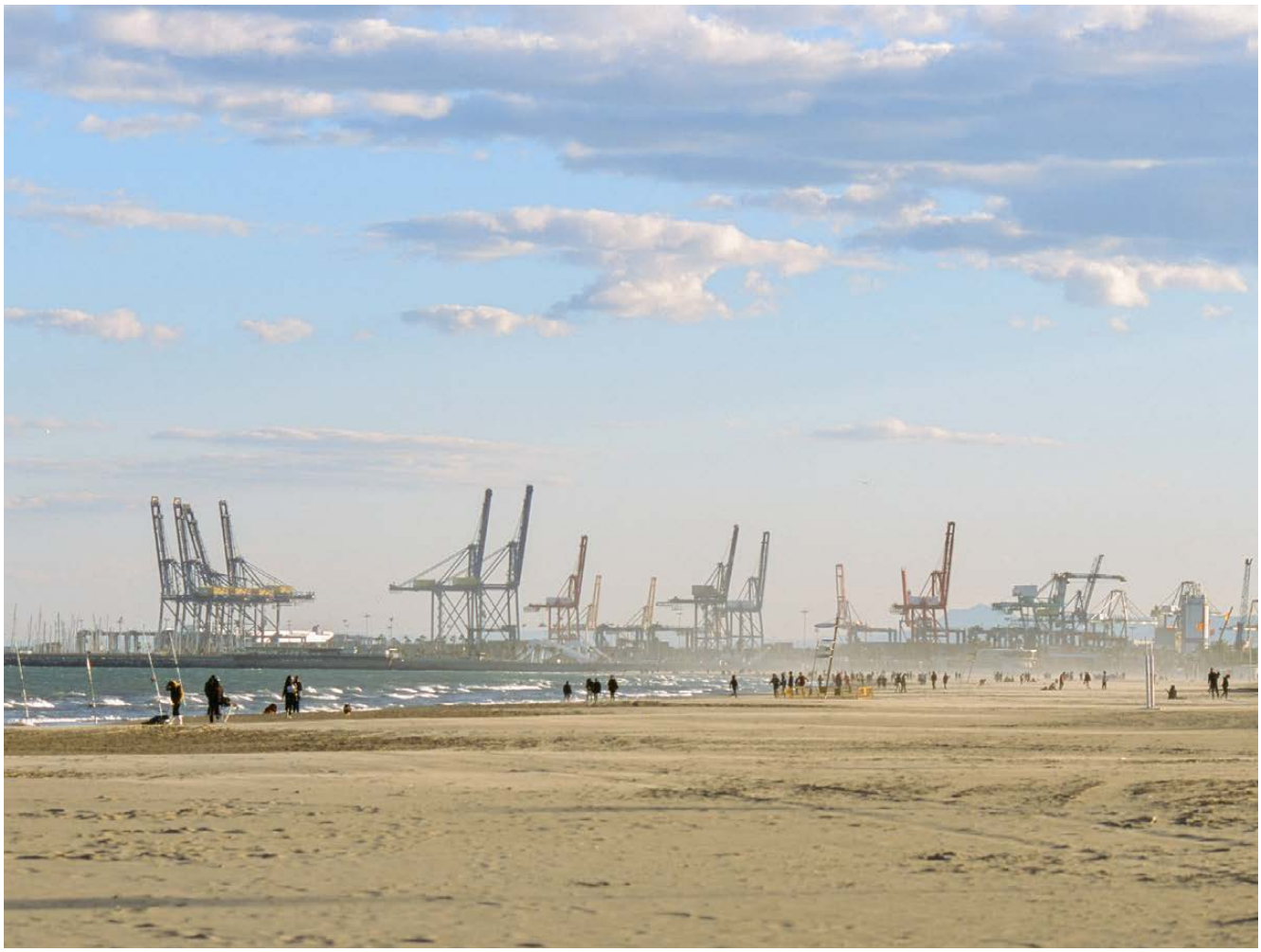
We will have to coordinate all kinds of measures to reduce emissions, mitigate impacts, adapt and capture CO2, acting as soon as possible to move away from the most catastrophic scenarios.

PORT PROBLEMS

What's going to happen to the ports? Because of the location, ports are likely to be affected differently by climate change and associated extreme weather conditions.

Ports are complex environments where multiple factors interact, which, according to UNCTAD, can be classified into four groups: environmental, market, infrastructure and operational. Port and terminal authorities can only act directly on some elements of these last two groups and improve knowledge about the influence of the other factors to optimize the actions to be taken.

Environmental factors refer to climate variables, their variability, and the incidence of extreme events. The first step to be taken is to raise awareness among ports and their stakeholders of the importance of the effects of climate change and thus create the necessary



environment to take further action. In this regard, it should be noted that the time scales of port planning and climate change have reversed their roles. The effects of climate change are already evident and the response of ports to them is not being sufficiently agile.

Thus, for example, weather phenomena that could be expected every 100 years are now more frequent and we can expect them every 25 or even every 10 years, and both port infrastructure and superstructure are affected by more intense actions than foreseen when they were designed. On the other hand, they suffer an acceleration of wear and tear with a consequent reduction in their useful life. This results in the need to improve information on climate variables, associated risks and the vulnerability of each of the elements of the ports and their environment.

PERCEIVED UNCERTAINTY

Ports must change their perception of uncertainty by using prediction models based on the most probable emissions scenarios. Long-term downscaling models must be applied in order to know the forecasts of the climate variables that affect each port and the effects that they may produce. Weather variable thresholds must be identified at each facility. With these models it can be calculated, for example, the interval of stop hours for operations due to wind gusts above a certain threshold. And the operator can decide if it is convenient to improve the equipment to raise the threshold or assume the losses for not operating. It allows decisions to be taken on the dimensioning and therefore necessary investments in infrastructure and equipment to maintain the operating conditions of the installations, as well as insurance policies that minimize the economic risks of the activity.

EXTREME WEATHER

A shift towards more extreme environmental conditions is already taking place: the increased intensity and frequency of rainfall can cause flooding because of capacity overload of the drainage systems, damage to warehouses, buildings and or cargo, the failure of inland links to other modes of transport, affecting supply and distribution of goods to and from the ports. Additionally extreme precipitations events will affect operations leading to lost work time or even port closures.

High-speed winds can damage buildings, warehouses, cranes and other port equipment as well navigation and communication equipment, can cause delays and stoppages in cargo handling, can make berthing difficult, requiring more tug assistance, or even impossible, and can increase the wave action at waterfront structures and consequently an increase in overtopping rates, hence flooding of berth facilities, and more agitation of the port waters.

High temperatures and heat waves can affect infrastructures and building materials as pavements, steel, asphalt, and others. The structure of equipment can be affected, engine cooling and cause power failures. Extreme temperatures can greatly worsen working conditions in berths and on board, and increases the energy demand for buildings, equipment cabins and warehouses cooling, and for reefers. Periods of high temperatures and low rainfall will produce droughts that will cause water shortages, increased fire risk and poor agricultural commodity production. In some locations, dust storms are also a risk to evaluate.

Other possible effects are those related to wave regimes and storm surges. Changes in the prevailing wave directions can increase internal agitation. Breakwaters could be vulnerable to overtopping in storms combined with sea level rise that could cause flooding of facilities, damages in cargo, infrastructures and equipment.

It can be mentioned effects such as loss of draft in inland ports and navigation channels due to drought, declining water quality due to the presence of invasive organisms caused to changes in water temperature, or variations in water acidity and salinity that can increase corrosion, biodeterioration resulting in higher maintenance costs, among others that is needed to analyzed in each particular case.

ECONOMY DECARBONIZATION

In the market and logistic context, the degree of uncertainty in the medium term is very high. Measures taken with regard to the decarbonization of the economy can change production and consumption patterns. The risk of disruptions in transportation and storage due to extreme climate events and the more than possible internalization of the costs of transport emissions will bring the centres of production closer to those of consumption, in a combination process of deglobalization and greening of the economy.

Global warming will drive the relocation of agricultural production to moderate climate latitudes to maintain productivity, that would require new ports, and will reduce of productivity in existing areas, consequently reduction of traffic in linked ports. Oil and coal shipping can be reduced to historic lows. Ports must install LNG and other alternative fuels bunkering infrastructures, must move to cold ironing and renewable energy sources, being as independent of general grids as possible in order to guarantee supply. It is also expected an increased pressure on the coastline due to rising average sea levels, changing the need for space for retreating populations, and for ports and logistics facilities. Finally, in each location there are local effects to be studied.

FAST ACTION

Ports must begin to consider the effects of climate change as soon as possible and start taking mitigation and adaptation measures in multiple areas of action: technological and engineering, design and maintenance, planning, insurance, management systems and stakeholders governance. Valenciaport Authority, with the support of Valenciaport Foundation, has begun to reinforce this line of work and participates in the ECCLIPSE and CRISI ADAPT-II European projects.

PORT OF VALENCIA VIDEO INTERVIEW

ABOUT THE AUTHOR

Noemí Monterde is civil engineer, Project Manager in the Fundación Valenciaport, developing her activity in port planning and development, port governance, terminals and services, energy efficiency and R+D in ports. Now is in charge of two European projects in the field of adaptation and mitigation of climate change effects.

ABOUT THE ORGANIZATION

Fundación Valenciaport is an Applied Research, Innovation & Training centre providing services to the port and logistics cluster. This initiative of the Port Authority of Valencia has enjoyed the collaboration of notable businesses, universities and institutions from the port community. Since its establishment, it has developed projects in more than 60 countries, primarily Mediterranean nations, as well as from the rest of Europe, Asia and Latin America.

WHY WILL IMO 2020 SAVE FEWER LIVES THAN EXPECTED?

Pablo Rodas-Martini, Author of the Book "IMO 2020: A Regulatory Tsunami"

One of the aims of the International Maritime Organisation's (IMO) 2020 regulation was to reduce morbidity and premature deaths due to sulphur oxides (SOx). The Finnish Meteorological Institute commissioned the study: "Health Impacts Associated with Delay of MARPOL Global Sulphur Standards." The authors created two scenarios: "an 'on-time' implementation case, which assumed that the fuel oil standard goes into effect in 2020; and a 'delay' implementation case, which assumed that the standard is delayed until [January 1] 2025." The results can be seen in Maps 1 and 2.

Map 3 shows the total additional premature mortality in 2020 in case the regulation was not entering into force on January 1.

DELAY SCENARIO

Using data from the World Health Organization (WHO) that estimated that about 3.7 million deaths in 2012 were due to air pollution globally, the authors concluded that the delay scenario would imply that the shipping industry was going to be responsible for about 4-7% of all deaths due to air pollution in 2020. Contrary, in the case of the on-time scenario, deaths attributed to the shipping industry could be reduced by about two-thirds, adding to only about 1.3% of all deaths caused by air pollution. Regarding the geographical distribution, more than 90% of the additional deaths would have taken place in the Asia-Pacific Region (58%), Africa (22%), and Latin America (10%). The impact would be much lower for North America and Europe: only about 5%. The main reason for that asymmetry, despite that North America and Europe have some of the busiest shipping routes in the world, is the prevalence of sulphur emission control areas (SECAs) in those zones.

In the end, the three main conclusions of the study were: a) by implementing the cap on SOx, emissions for 2020 through 2024 were going to be reduced by about 8.5 to 8.9 million metric tons annually, b) the benefit would be felt mainly in coastal communities due to the reduction of ambient sulphate concentrations and, most important of all, c) the delay in implementing the cap reduction could cause about 570,000 premature deaths worldwide. Let's never forget that such a reduction of premature mortality is the primary goal of the entire decision to proceed with IMO 2020.

IMPROVED PRECISION

In a later paper published in 2018 in the academic journal Nature Communications, the authors improved the precision of the figures. According to the new estimations, the entry into

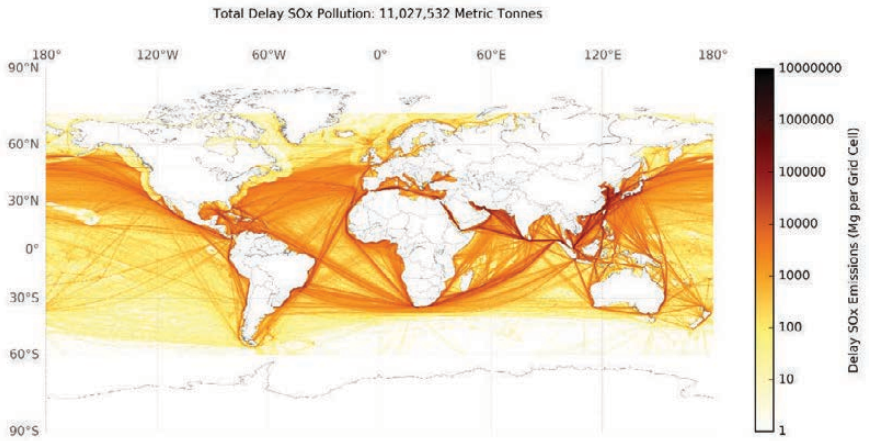
force of IMO 2020 (assuming the same levels for each year) would represent 685,000 fewer premature deaths rather than the 570,000 estimated originally for the period 2020-24. The number is 20% higher.

And the story's plot has an additional twist. Let's look at Map 4, which shows in gray the countries that have not ratified MARPOL Annex VI (the map is updated regularly by North P&I). The first impression is that most of the world will enforce the sulphur regulation: the yellow color is much more dominant than the gray. However, if we focus on the emerging and developing regions of the world, the result is dramatic because we realize that many of those countries have not ratified Annex VI, and consequently are not going to implement IMO 2020.

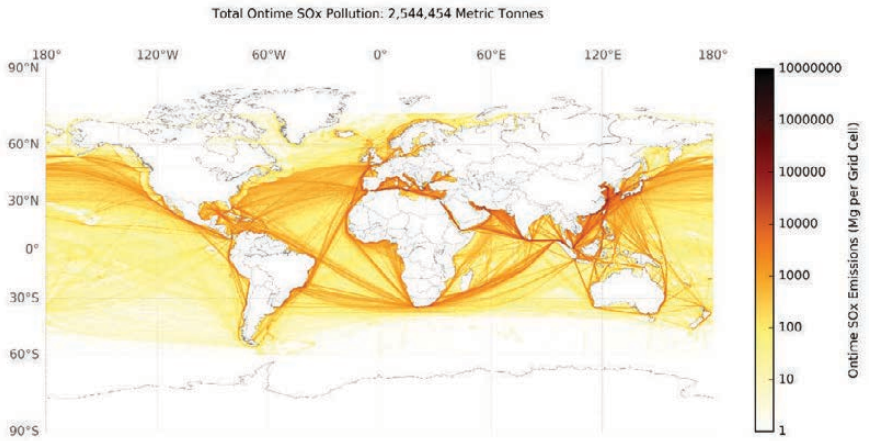
The countries in gray cover almost half of Latin American and Caribbean countries, most of Africa, nearly half of the Middle East, most of Indo-China, almost half of the countries of Oceania, Greenland, and a few additional pockets in the Balkans, the Caucasus, and Central Asia. We can certainly say that for many landlocked countries, the sulphur regulation is of little relevance but even if we focus only on those countries with coastlines, the list of "gray" countries is enormous. And some of those countries have extensive coastlines, which means that some of their inhabitants living in those areas could have benefited significantly if their governments had ratified the Annex. Indeed, the main shipping traffic does not involve most of those countries, but one had expected that these countries would have grasped the opportunity presented by IMO 2020—fewer premature deaths and less morbidity. That will regrettably not be the case. It is almost as if the regulation loses a significant part of its power because those emerging and developing countries (and New Zealand, an advanced country) have not ratified Annex VI.

NON-COMPLIANCE ISSUES

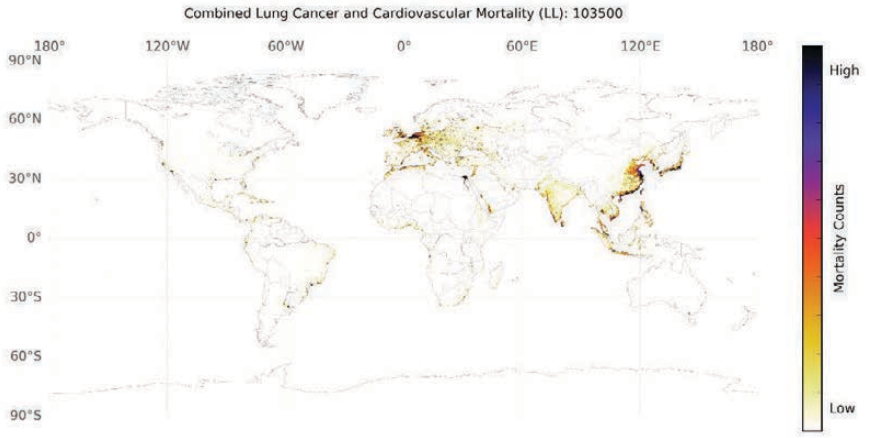
There is the additional issue of the countries that at some point during 2019 threatened not enforcing IMO 2020 for cabotage or river transportation (Russia, India, Indonesia, and the Philippines). IMO 2020 will be certainly be enforced on the main shipping routes. How can I say that IMO 2020 will be enforced while the high seas have always been considered a wild territory, in which anything may happen, from disposing of oily water through magic pipes to overfishing and piracy? First, I am referring to the main shipping routes, not to waters across all the oceans. Most of the traffic takes place



Map 1. Annual shipping inventories for SOX under the delay scenario for 2020



Map 2. Annual shipping inventories for SOX under the on-time scenario for 2020. (Source: Finnish Meteorological Institute)



Map 3. 2020 map of increased mortality from delaying MARPOL VI. (Source: Finnish Meteorological Institute)

along major and very well-identified shipping routes. Those routes connect industrialized countries or industrialized countries with emerging ones. A very impressive map by Marine Traffic shows those main traffic routes in detail (see Map 5).

DIVISION OF LABOR

Trade through the main traffic routes encompasses easily more than 90% of the cargo transported by sea, and that is the traffic I am referring to when I say that IMO 2020 will be enforced. The IMO may seem to be a bureaucratic and weak institution, but the truth is different. There is a perfect division of labor between the IMO and the countries: the IMO approves resolutions, and the maritime or port authorities of the member countries carry out the enforcement.

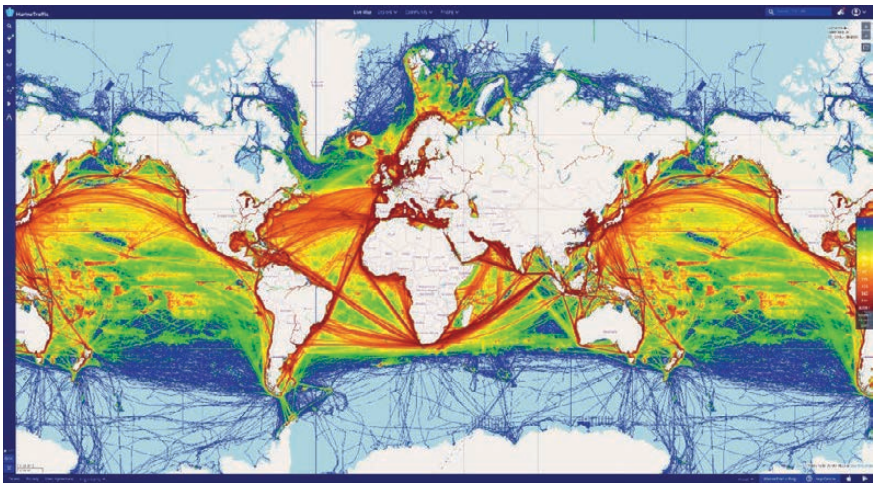
Will there be enforcement also in secondary shipping routes? Or will there be enforcement on cabotage along either coastlines or rivers? In the case of industrialized countries, with strict land regulations against air pollution and with competent enforcement agencies, I certainly can see a high degree of enforcement.

UNCERTAINTY AHEAD

In the case of many emerging and developing countries, however, the answer is more uncertain. Shipping companies will expect, in those cases, that the maritime authorities easily accept the fuel oil non-availability report (FONAR), in which captains will argue that they could not find the compliant fuel, or that the maritime authorities turn a blind eye. The reasons alleged for the possible non-enforcement range from mundane (national refineries have ample supplies of HSFO and it would be difficult to find an alternative market for the fuel), to technological (many refineries do not have cokers or the required equipment to crack the hydrocarbons of residual oils into VLSFO), to environmental (one mentioned exhaustively before the entry into force of SECA in the Baltic Sea was that shippers would replace maritime or river transportation by land transportation, therefore increasing air pollution rather than decreasing it) and ending with the most obvious—the economic (VLSFO would increase transportation prices).

The great paradox is that if we have a look again at Map 3, most of the expected reduction of premature deaths due to IMO 2020 is supposed to take place in countries like Indonesia and India. Will IMO later claim that IMO 2020 is avoiding more than 685,000 premature deaths across the world between 2020-24 while possibly one-fourth or one-third of that number were not saved because, in the end, some countries decided not to enforce the regulation in their internal waters and rivers?

Map 4. Countries and territories that have ratified MARPOL Annex VI (Source: North P&I)



Map 5. Shipping traffic density map of the world. (Source: MarineTraffic)

CONCLUSION

In summary, the main conclusion of this paper is that IMO 2020 will save much fewer lives than expected due to two main reasons: a) many emerging and developing countries have not signed MARPOL Annex VI and consequently will not enforce the new regulation despite they were included in the health study of countries that could benefit with the regulation, and b) some emerging countries such as India or Indonesia that were supposed to benefit greatly from the health benefits of IMO 2020 threatened at some point with not enforcing the regulation in their territorial waters (cabotage along the coastlines, cabotage between islands, and river transportation).

IMO 2020: A REGULATORY TSUNAMI

ABOUT THE AUTHOR

Pablo Rodas-Martini is Senior Associate of SQ Consult, a Dutch company specializing in carbon markets and climate change. He is the expert in charge of shipping emissions, shipping decarbonization, and, in general, environmental issues for the maritime industry. Pablo has a Ph.D. and MSc from Queen Mary and Westfield College, University of London.

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