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CLIMATE CHANGE

IMPACT OF DROUGHTS AND FLOODING ON SHIPPING RISKS

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CLIMATE CHANGE: DROUGHTS AND FLOODING

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OUR PARTNER FOR THE ISSUE

TRIGLAV Maritime

Triglav Maritime provides bespoke, comprehensive consultancy services focusing on risk management, loss prevention, as well as marine vetting and assurance matters.

The founder, Capt. Ostrowicki has 34 years of combined command and shore-based experience. He has sailed on bulk carriers, general cargo and container ships. His shore-based experience includes ship operations and marine vetting of dry cargo ships, tankers and gas carriers, as an operations manager, marine vetting director and loss prevention manager.

Capt. Ostrowicki provides expert advice on risk management and safety management processes. In addition to marine incident and claim investigations, he performs management reviews, ISM and TMSA audits and in-depth risk assessments through data analysis. He has also authored several publications.

SHIPPING IS AN INDUSTRY SENSITIVE TO DISRUPTION RESULTING FROM CLIMATE CHANGE, BOTH DIRECTLY AND INDIRECTLY.

Ports, terminals, canals, and other maritime infrastructure may be vulnerable to some of the consequences of climate change, such as the increase in the frequency and intensity of storms, winds and floods. Drought can also have a severe impact on shipping, as noted during recent high-profile challenges in the Panama Canal.

Although it may be counterintuitive, scientific research shows that climate change is supercharging both floods and droughts. Distortion of the water cycle, particularly of its extremes (droughts and pluvials), is among the most conspicuous consequences of climate change[1].

IMPACT OF **CLIMATE CHANGE ON SHIPPING**

THE UNDERSTANDING OF THE IMPACT OF CLIMATE CHANGE ON SHIPPING IS EVOLVING, AS MANY OF THE RESULTING EVENTS HAVE NO RECORDED PRECEDENT ON A GLOBAL SCALE.

There are several climate-related hazards which can pose considerable risks to the shipping and port industries (both direct and indirect) including:

- Change in patterns and intensity of severe weather events, e.g. tropical storms
- Inland flooding
- Drought
- Extreme heat events
- Rising sea level.

Shipping and related industries are dependent on weather and hydrological phenomena patterns, developed over decades, or even centuries. These patterns include typical tracks of low pressure systems and tropical storms, seasonal winds and rainfall, high/low river seasons and the associated current conditions, coastal erosion and inundation, etc.

A disruption of these patterns, such as unusually intensive storm systems around Newfoundland resulting in suspensions of ferry services, unavoidably affected the local population through supply chain delays and goods shortages[2]. Although very significant in local scale, the disruption globally is likely to be far more extensive.

The report "Act Now or Pay Later: The Costs of Climate Inaction for Ports and Shipping" published by Environmental Defense Fund (EDF)[3] provides a comprehensive review of the impact of climate change on the shipping and port industries, as well as an estimate of its economic effects if no actions are taken to reduce emissions.

FLOODING AND DROUGHT

Weather data indicates that precipitation is becoming more intense, which is partly attributed to the increasing amount of water evaporating from warmer oceans. This does not necessarily mean that the total rainfall is increasing everywhere equally, rather, a larger proportion is now occurring from heavy precipitation events[4].

As a result, the occurrence of inland flooding and droughts is also becoming more common and intense. Historically wet areas are likely to experience increased rainfall, whilst historically dry areas are likely to experience less precipitation.

The shift in weather patterns can be further exacerbated by the combination of climate change with recurring climate events, such as El Niño (a natural periodic climate phenomenon affecting the tropical eastern Pacific Ocean). Recent water deficits in Panama Canal have been attributed to this combined effect.

Parts of the world where dry periods are expected to increase in scale and frequency include central North America, Central America, southern and central Europe, the Mediterranean region, and southern Africa[3]. The effect of inland drought may also be intensified by extreme heat events and, in general, by higher temperatures resulting in increased evaporation. The resulting water flow changes affect inland maritime shipping routes dependent on the water level fluctuation cycle (such as the Great Lakes – St. Lawrence Seaway System).

There are a few examples of disruption events, which may serve as a reference level to what may be expected:

- In 2008, extreme rainfall in Brazil caused flooding and landslides, which led to the closure of the port of Paranagua. The resulting losses were estimated at about USD 420 million.
- In 2010/11, a series of floods hit Queensland, Australia, which resulted in the flooding of inland coal mines and reduced exports through Port Gladstone by about 40 million tons.
- In 2013, additional evaporation pushed the Great Lakes water levels in some areas to record lows. The EDF report[3] states that periods with low lake levels could in the long-term perspective increase Great Lakes vessel operating costs by 5-22%.
- In 2015 the second largest Indian container port (Chennai) was severely damaged by flooding from inland areas. The port was only partially operational at that time.
- In 2019, record high water levels on the Mississippi River caused supply chain interruptions with severe cascading consequences to the U.S. transport network for exporting agricultural and other goods through the river and its tributaries. That year, more than six million tons of grains with a total value of almost USD 1 billion could not be shipped due to barge traffic interruptions.
- Also in 2019, severe drought in the Panama Canal watershed required limits on through traffic that were estimated to cost global shipping between USD 230 million and USD 370 million.
- In 2023/24 we again saw a water crisis in the Panama Canal watershed. Initially, draft restrictions were introduced. As the situation worsened, restrictions in through traffic were imposed. The number of daily reservation slots decreased from around 35 transits a day to about 22 a day in December 2023. In addition, certain ship types (passenger and container ships) were prioritised. There was also a substantial increase in transit waiting times for ships without reservations[5].

Each of these cases and their contexts were very different. However, they had one thing in common: **they had a substantial impact on the global supply chain and caused enormous economic losses.**

FLOODING AND DROUGHT (continued)

KEY POINTS

- The patterns of weather and hydrological phenomena are changing
- As a result, both flooding and droughts are becoming more common and intense
- In cases where shipping and related industries are precisely tuned to these patterns, the change is likely to result in disruption
- Other effects of climate change, like extreme heat events, may further exacerbate the disruption
- The combined effect of the climate change and some of the recurring climate events (such as El Niño) has led to unprecedented water crises.

PREDICTING THE FUTURE IMPACT ON SHIPPING AND FORMULATING RESPONSES

OUR ABILITY OF PREDICTING THE FUTURE IMPACT OF CLIMATE CHANGE ON SHIPPING IS AFFECTED BY ITS SHEER EXTENT AND THE POTENTIAL FOR CASCADING DISRUPTION. IN ADDITION, IT IS EXTREMELY DIFFICULT TO ESTIMATE THE COMBINED EFFECTS OF THE MANY OVERLAPPING FACTORS.

From the loss prevention perspective, it is important to be able to try and foresee the severity and likelihood of the hazard and identify measures to mitigate or avoid it. This process needs to be robust enough to produce actionable, effective objectives.

The term coined to describe an impactful, large scale event: "gray rhino" may help to understand the risk management objectives in such cases.

Gray rhino is a metaphor for the obvious threats that we know about, yet we do nothing or little about them[6]. These can be highly probable, high-impact events that are predictable and can often be prevented or mitigated but usually are not.

Consequently, from the loss prevention point of view it is most effective to focus on the predictable gray rhinos associated with the climate change – identify the hazards, assess the risks and formulate mitigation or avoidance measures.

As this article is aimed at ship operators, we will focus on risk mitigation objectives they are likely to experience at shipboard or shore management level.

OPERATIONAL IMPACT ON **INLAND WATERWAYS, CANALS AND CONNECTED SEAPORTS** 6

THE IMPACT OF CLIMATE CHANGE ON INLAND WATERWAYS WORLDWIDE IS VARIABLE.

Whilst in some waterways, such as the Mississippi River, extreme river level events are already more severe and frequent, in others, such as the Rhine and the Danube, the change is only expected to occur in the long term.

There are several effects of flood/drought that may influence ships in inland waterways or in the connected seaports and terminals:

WATER LEVELS AND CURRENTS

DROUGHT

The local water level fluctuation cycle may become disrupted to the extent where **draft** and/or **traffic restrictions** are imposed for prolonged periods of time.

This in turn may result in congestions, delays and unusual operational challenges.

Unexpected draft limits may also result in the need to lighter a ship before it can proceed further up or downstream.

FLOODING

Strong currents in waterways, resulting from flooding or high river conditions, may cause damage to waterway banks and result in shoaling. This in turn may prompt restrictions in navigation and increase the risk of unexpected grounding.

Extensive flooding may limit the ability to use **visual references in waterway navigation** or even put navigational aids out of service.

CHALLENGES TO NAVIGATION

DROUGHT

Waterways availability: In drought conditions, waterways may become narrower or even impassable, forcing ships to take longer and unfamiliar routes.

Navigational aids may require extensive updates to remain effective, for example where they indicate the safe passage between sand bars which may migrate due to the variation in current flow.

FLOODING

Floods or extremely high river conditions can wash **debris, sediment** and **pollutants** into waterways, resulting in the risk of damage to hull, propellers, steering gear, or blocking sea chests / cooling system.

The timing of the seasonal river **ice breakup** may be disrupted by climate change and result in an increased ice jam flooding risk (as the ice jam breaks apart, it may result in a rapid surge of water).

Unusual visibility restrictions: As an example, the widespread "spring fog" blankets in the Mississippi River, up to 30 feet thick, occurring when the cold spring runoff carried by the river meets warm and humid air in lower river. The fog may disrupt navigation as navigational aids and visual reference points are not visible.

These events are seasonal, but their intensity may increase with the amount of snowfall being disrupted by climate change.

UNUSUAL HYDROLOGICAL PHENOMENA

DROUGHT

Flocculation, naturally occurring in rivers such as Mississippi: the colloidal suspension of clay and muddy sediment material behaves like a jelly and may extend 10-15 feet above the river bottom. It is accumulated during low stages of the river and flushed out during high stages.

Ships making their way through flocculation are exposed to engine overheating and propulsion problems, as well as sea chest blockages.

OPERATIONAL IMPACT ON **INLAND WATERWAYS, CANALS AND CONNECTED SEAPORTS** (continued)

'Challenging Water Quality' (CWQ) conditions may result in ballast water management system (BWMS) to be temporarily inoperable due to filter clogging or system limitations.

Increased solid particle content in water may also lead to sediment build-up in water ballast tanks.

FLOODING

Sand waves consisting of sandy material brought down during flooding and high stages. If not removed, it may build up bars and reduce the available draft.

Mud lumps or mud eruptions, typical for flood or high river stages, are small oval shaped mounds or islands, 8-20 feet high above the river bottom, caused by the pressure of sediment deposits.

EXCEEDING OPERATIONAL LIMITS OF SHIPS

DROUGHT

Limited Under Keel Clearance (UKC): Droughts cause water levels to drop in rivers, lakes and inland waterways.

This means less clearance for ships, increasing the risk of hitting unexpected underwater obstacles or grounding, as well as limiting cargo intake.

FLOODING

Mooring and anchoring in flood or high river conditions may lead to a situation where the operational limits of the mooring equipment or the anchor system are exceeded. It may result in dragging anchor, damage to windlasses or loss of anchors. The Club has published advice on anchor dragging prevention which reiterates the operational limits of equipment.
Where mooring arrangements are inadequate and moorings fail, breakaway incidents may occur, resulting in collisions and property damage.

Other, operational consequences of flooding/drought may include:

- Delays and closures
- Cascading supply chain issues affecting cargo availability
- Insufficient availability of labour to handle the cargo
- Exposure to additional costs (such as tug assistance, lightering etc.)
- Limitation of cargo intake
- Additional cargo handling/lightering operation

It is also worth noting that continuing climate change with various extreme events (drought, flooding, inundation) is likely to significantly increase maintenance costs of both inland waterways and seaports.

KEY POINTS

- Both drought and flooding have the potential to disrupt ship operations
- The above list of effects of flood/drought is not exhaustive – they will depend on local circumstances
- Local knowledge is important in understanding the situation and its impact on the ship. In addition to nautical publications, it may be necessary to seek information from local resources
- Adhere to the operational limits of mooring and anchoring equipment and have a contingency plan in case they are exceeded
- Be aware of local phenomena, like flocculation and be ready for action if they impact the ship adversely.

CLIMATE CHANGE IS ALSO LIKELY TO INFLUENCE THE RISK LANDSCAPE FOR CARGO CLAIMS.

The implications stem from both direct and indirect effects on cargo quality, quantity and logistics. These challenges are not new but are likely to occur on increased scale and frequency.

KEY IMPACTS INCLUDE:

CARGO QUALITY ISSUES IN EXTREME WEATHER

The increasing severity of drought or rainfall/flooding may lead to cargo quality issues, for example due to excessive moisture content. In such conditions, ensuring the cargo is presented in quality suitable for carriage will become increasingly challenging. For example when bulk cargoes, which can liquefy or undergo dynamic separation, are exposed to extreme rainfall.

INCREASED RISK OF CORROSION

Severe rainfall and excessive humidity increases the likelihood of corrosion occurring in steel products prior to carriage.

INCREASED CONTAMINATION OR DETERIORATION OF PERISHABLE CARGO

The risk of contamination or microbiological degradation for certain types of cargo may also increase, for example due to the increased presence of mould spores. The 'shelf life' of sensitive cargoes, such as soya beans in bulk, may also be affected. In consequence, the risk of cargo spoilage or degradation will also increase.

CHANGES IN AGRICULTURAL YIELDS

Climate-related impacts on agriculture (such as droughts, floods, altered growing seasons) affect the crop volume and availability of cargoes; in consequence, this variability may lead to claims related to shortfalls in expected volumes.

DISRUPTION TO SUPPLY CHAINS

Due to closures, congestion, route diversions etc., shipment delays may occur, leading to missed delivery deadlines or loss of market value. Whilst these issues are not likely to be a primary concern to a ship operator, they may cascade to other disputes or claims.

LEGAL AND CONTRACTUAL COMPLEXITIES

Disruptions induced by climate change may complicate contractual obligations, leading to disputes over liability for delays or damages – for example, to more frequent claims under "force majeure" clauses or other contractual terms.

ALTHOUGH IT IS NOT POSSIBLE TO OUTLINE A UNIVERSAL SOLUTION FOR ALL ABOVE IMPACTS, MANAGING THESE EMERGING RISKS MAY INVOLVE:

- Increased precautionary surveys at load and discharge ports
- The need for ship crew to be more aware at load port to highlight the quality issues and clause bills of lading as necessary
- Ensuring that shippers adopt best practices for cargo storage and handling through increased co-operation, 'know your customer' (KYC) approach etc.
- Refining underwriting models to account for climate variability and its impact on cargo-specific risks.

THE SUMMARY ABOVE INDICATES THAT THE CHANGES TO RISK EXPOSURE WILL CONTINUE OCCURRING ACROSS THE BOARD.

As the shipping industry adapts to the disruption, the evolving risk exposure may have indirect connection with climate change.

As an example, the periods of Panama Canal water crisis has forced some container carriers to move their cargo overland using a "land bridge" – either by lightering their ships, or by effectively breaking their service into two separate legs. Consequently, the cargo claim exposure increases due to the need to handle and move the containers, potential damage to perishable cargo, or exposure to theft.

In general, the climate change is likely to result in claims becoming more complex and of higher severity. In addition to known risk factors, there are several emerging risks. The key factors influencing risk exposure may be broadly divided into the following groups. It should be noted that the effects of flooding and drought may contribute to each of them:

INCREASED FREQUENCY AND SEVERITY OF EXTREME WEATHER EVENTS (INCLUDING FLOODING AND DROUGHT)

These events can cause significant damage to vessels, ports, and coastal infrastructure, resulting in higher volumes of incidents resulting from cargo losses, casualties, port facility liabilities and people risks.

ALTERED NAVIGATIONAL CONDITIONS

Rising sea levels and changing weather patterns are altering navigational conditions, including water depths, currents, and ice coverage. These changes increase the risk of groundings, collisions, and navigational incidents.

ENVIRONMENTAL IMPACTS

Due to the increasing risk of incidents such as grounding, climate change is exacerbating the associated environmental risks in the maritime sector, such as oil spills, chemical leaks, and pollution incidents, resulting in the potential uptick in claims for environmental cleanup costs, compensation for ecological damage, and regulatory fines and penalties.

PORT OPERATION DISRUPTIONS

May result in laytime disputes, cargo damage, and additional expenses incurred due to port closures or restrictions.

EMERGING RISKS

Climate change may give rise to new and emerging risks in the maritime sector, from biodiversity to regulatory compliance with the evolving environmental and sustainability regulation.

FROM A SHIP OPERATOR'S PERSPECTIVE, THE RISKS ASSOCIATED WITH FLOODING AND DROUGHT EVENTS SHOULD ALREADY BE COVERED IN GUIDANCE AND PROCEDURES PROVIDED BY THE SHIP'S SAFETY MANAGEMENT SYSTEM (SMS).

The challenges are not new in general – however, their severity and complexity are constantly evolving so should be reviewed frequently. Knowledge obtained from trading in a certain area may not be sufficient anymore to identify and manage all risks.

Each company is advised to maintain adequate risk perception in their trading area by using all available resources, including expert knowledge. It is highly recommended to apply a structured approach, as it will need to be a continual process.

As required by the International Safety Management (ISM) Code, companies should carry out a systematic review of their operations and activities, assess the risk for all identified hazards and develop adequate controls – such as procedures and instructions included in the SMS. This review should be kept up to date. Climate change disruptions should prompt such an update.

On the most basic level, preparedness for climate change disruption means that all policies and procedures should be effective and workable (rather than be treated as a bureaucratic burden). As an example, the UKC policy may be subject to repeated challenges in predominant drought conditions. The company should have a robust process regarding the precautions to be taken if the required UKC cannot be achieved. Furthermore, if this process is found to be ineffective (for example, due to the ongoing water level deficit in the trading area), then it should be reviewed and revised as necessary. There may be commercial implications, which should also be addressed as part of the business risk management.

The above is just an example of one isolated aspect. A severe disruption resulting from climate change (not limited to flooding and drought of course) may push safety management to the limit. In this regard, climate disruptions and crises may be game-changing for safety management as we know it today.

Therefore, to be able to meet these challenges it is essential to build resilience in advance. Again, it is highly recommended to apply a structured approach, based for example on a robust gap analysis.

KEY ACTIONS MARINERS AND COMPANIES SHOULD TAKE TO BE READY FOR CLIMATE CHANGE-RELATED RISKS

STAY INFORMED

Keep abreast of weather forecasts, climate projections, and environmental trends relevant to the trading area(s). Stay informed about emerging risks associated with climate change, such as sea level rise, extreme weather events, and changing ocean conditions.

ENHANCE TRAINING AND EDUCATION

Equip the crew with the skills, knowledge, and resources needed to respond effectively to climate-related risks and emergencies at sea.

ADOPT BEST PRACTICES

Along with regulatory compliance, monitor and continually implement best practices for safe navigation, seamanship, and environmental protection. Apply management self-assessment techniques to keep informed of industry best practices.

UTILISE TECHNOLOGY

Leverage technology and innovation to enhance navigation, monitoring, decision-making and risk management capabilities onboard.

CONDUCT RISK ASSESSMENTS

Conduct comprehensive risk assessments to identify and prioritise climate-related risks specific to the ship, route, and operational context. Assess vulnerabilities, develop contingency plans, and implement mitigation measures to minimise the likelihood and impact of adverse events. These assessments may include safety risks and business risks. The Club has published a white paper on effective risk assessment.

MAINTAIN CAUTION

Ensure that the ship's crew are aware of the changing environmental conditions and are able to react to unexpected challenges – as summarised in the phrase "there is no new normal when it comes to climate change".

COMMUNICATE EFFECTIVELY

Ensure clear communication protocols within the shipboard team and between the ship and shore-based management. Foster open communication channels and knowledge sharing to exchange vital information, coordinate responses, and make informed decisions in response to climate-related risks and emergencies

PRACTICE RESILIENCE BUILDING

Develop resilience-building strategies to adapt to changing environmental conditions and mitigate the impacts of climate-related risks. Foster a culture of safety, teamwork, and continuous improvement to enhance the ships' ability to withstand and recover from adverse events

INFRASTRUCTURE AND ASSET MANAGEMENT

Assess the resilience of the critical infrastructure and assets (shipboard and ashore) to climate-related hazards. Strengthen supply chain resilience by diversifying suppliers, optimising logistics, and enhancing inventory management practices, including critical spare parts. Collaborate with supply chain partners to identify climate-related risks and develop contingency plans to mitigate disruptions. Enhance communication and coordination to facilitate rapid response in case of supply chain disruptions.

KEY POINTS

- Most of the risks resulting from flooding and drought should already be covered in the SMS
- The challenge is in using the risk assessments and SMS procedures effectively, while the complexity and severity of the hazards is increasing
- It is necessary to stay updated using training and actively adopting best industry practices
- Effective communication and knowledge sharing is critical to building climate change resilience.

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