Marsh

High seas: Enabling a climate resilient Suez Canal

Physical climate change-related risk impacts of global shipping, and methods to build resilience at a local level

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Executive summary

The blocking of the Suez Canal in May 2021, caused by the Ever Given, demonstrated the vulnerability of global supply chains to disruptions to the world's canals and waterways. The "just-in-time" nature of shipping means that there is limited redundancy, and these routes become pressure points for cascading risk. With increasing incidence of disruptive weather events driven by climate change, greater focus should be given to understanding these potential critical points of failure.

As part of this paper, we have assessed how the Suez Canal may be affected over time by physical climate risks. The modeling results, provided by the Cross Dependency Initiative, a leading physical climate risk modeling organization (XDI), have demonstrated that the Suez Canal and its associated infrastructure is presented with vulnerabilities due to natural hazards that will be exacerbated by climate change, such as:

Increasing coastal inundation risk, particularly across the northern port infrastructure of the Suez Canal.

Increasing risk of extreme heat events occurring along the length of the Suez Canal itself.

Measures that could be considered in order to help mitigate these risks include the following:

1. **Physical resilience:** Resilience to physical climate risks, including coastal inundation, should be considered further and invested in to enable the long-term reliability of the Suez Canal, including adapting port infrastructure and lock considerations along the canal within the Canal's adaption window.

2. **Financial enablers:** Finance mechanisms, such as (re)insurance-backed public-private schemes, enable de-risking of resilience adaptation. Mechanisms could be developed further to enable resilience adaptation development offsetting for those that rely on and operate the canal.

3. **Resilience strategies:** Physical resilience and financial mechanisms must be underpinned by a consistent and structured approach. The UN Principles for Disaster Resilient Infrastructure can facilitate consistency in developing a resilience strategy.

The findings identified here should be considered for similar critical infrastructure assets globally.

Background

Global supply chains have been stressed to their limits over the last two years.

An estimated 80%-90% of the world's traded goods are traded by sea.[1] While demand for goods has increased only slightly from pre-COVID levels — increasing by approximately 3% against 2019 — a variety of factors have constrained supply.[2]

Global lockdowns reduced shipping capacity. Congestion of ships and containers resulting from social distancing measures, the inability to move shipping personnel around the globe, increased sicknesses, and cross-border friction during COVID-19 resulted in containers being held up at ports and at sea, constraining fleet capacity. Rapid reversal of lockdowns released pent-up demand from consumers, overwhelming the capacity of supply chains. This coincided with the exponential increase in e-commerce — heavily influenced by COVID-19 — that, according to the UN, accounted for roughly 30% of global GDP in 2019 and saw sustained growth through to 2021. The resulting impact has been twofold: delays in, and the surging costs of, getting goods to consumers.

There are a handful of key waterways across the world (a Marsh insights blog identifies five: the Suez and Panama Canals, the Straits of Hormuz, the Bab-el-Mandeb, and the Straits of Malacca (Figure 1).[3] If any are blocked — whether through accidents or deliberate political events — the impact is felt across global supply chains and beyond.

With unexpected and, at times, overnight changes in supply and demand from consumers and industry, the previously successful "just-in-time" delivery model is now less appropriate, and this highlights a lack of resilience in supply chains.

01| Global shipping routes, with the most common routes (>5000 journeys in 2010) highlighted in green

Source| Graphic derived from Kaluza P, et al. (2010) The complex network of global cargo ship movements.[4]

The Suez Canal

The Suez Canal, owing to its geographical location, is one of the most well-known shipping passages, and is critical for global trade. Sitting between Port Said and Port Tawfiq in Egypt, it provides entry to the Mediterranean Sea in the north and the Red Sea in the south, making it the quickest sea route between Asia and Europe.

Around 10%-12% of global trade is thought to pass through the Suez Canal, with around 30% of cargo containers using the route.[5]

This means that the resilience of the Suez Canal is fundamental for ensuring smooth operation of supply chains.

In the 2022 Global Maritime Issues Monitor,[6] the importance of enabling resilience across the marine industry was further highlighted, with “failure to adapt climate change” continuing to sit in the top 10 impacts to the marine industry over the next 10 years.[7]

THE EVER GIVEN AND INSURANCE IMPLICATIONS

In May 2021, the Ever Given ran aground in strong winds that exceeded 40 kn (74 km/h; 46 mph). During strong winds, a laden ship acts as a sail. Combined with the varying depth of the Suez Canal — especially along the banks — running aground can become a significant risk. With the canal facilitating almost US$10 billion of goods daily, the six-day blockage caused by the Ever Given is estimated to have resulted in US$60 billion of disrupted trade, and the subsequent trapping of an estimated US$700 million of cargo.[8]

While the impacts of the event were varied, the insurance considerations are important as firms try to cover associated losses. Claims could include physical damage (to the Ever Given), loss of revenue (on the part of the Suez Canal Authority), the cost of the salvage operations and business interruption (for owners and charterers of the blocked vessels), loss of perishables and cargo delays, as well as damage to the canal itself.

Increasing demand for cargo insurance lines have been part of a long-term trend in this sector. While the Ever Given event is unlikely to be the direct driver of long-term trends in the marine insurance industry, Marsh’s Marine & Cargo experts have seen a noticeable increase in demand since 2021 for insurance related to cargo delays, and specifically, trade disruption insurance (TDI).

The Ever Given event has demonstrated that while a blockage of any global maritime chokepoint for any reason can have a significant influence on supply, the second and third order affects can be significant.

Using the example of the Ever Given, we can begin to analyze the impacts of the canal being unavailable, including those on insurance which were identified above.

While it is difficult to overstate the canal's importance to international shipping, its value to the Egyptian economy is also high.

The canal is operated by the state-owned Suez Canal Authority (SCA) and represents a significant source of national income for Egypt, contributing 2%-3% of the country's GDP.[9] It is one of the government's main sources of foreign currency, with 60% of the country's foreign trade transferring through the waterway.[10]

To take advantage of the Suez's Canal's strategic importance, the Egyptian Government has been directing billions of dollars to the upgrading of port infrastructure, which also acts to attract new industries such as manufacturing and infrastructure. With the goal of creating an international commercial hub, their hope is the "Suez Canal Economic Zone" will bring 1 million to 1.5 million jobs by 2035.[11]

Also, in recent years, the Suez Canal has undergone adaptation and enhancement, including the addition of a waterway and four ports. The SCA is in the process of widening and deepening 18 miles of the 101 mile canal, to improve navigation and crossing times.[12]

Impacts of climate change on Egypt and the Suez Canal

On the ND-GAIN Country Index, which ranks countries based on their vulnerability to climate change, as well as their readiness to improve resilience[13], Egypt is ranked 107 of 181 countries.

Climate change impacts on Egypt are expected to manifest in a variety of ways. The country's 2,200 mile costal shoreline, and the Nile Delta, are particularly vulnerable to rising sea levels due to their low elevation. In turn, the country's agricultural sector is threatened due to the risk of saltwater intrusions: The Delta alone is expected to lose more than 30% of its food production by 2030[9]. This trend is likely to be found globally, as flood risk levels are expected to increase under every climate change scenario.[14]

Egypt's current climate is generally dry and hot, with very low annual precipitation. Due to climate change, temperatures in most parts of the country are now 1°C hotter than they were 100 years ago while annual total precipitation has reduced by approximately 22% over the past 30 years.[15]

The effects of climate change are being felt across what is already a highly arid country. Hot windstorms known as "Khamsin", have already played a role in the grounding of Ever Given, and with increased desertification and drought, an increase in the intensity and frequency of sandstorms and dust storms is likely.

The Ever Given event has demonstrated how weather events can threaten critical trade routes, disrupting canal operations and global supply chains. And, if climate change is not tackled sufficiently, the possibility of increased frequency or severity of similar events may need to be considered.

Given the canals importance to global supply chains and the Egyptian economy, exploring these evolving climate risks now is paramount. Conducting this analysis will provide transferable findings which can be utilized to mitigate risks to other similar critical infrastructures as well as to the broader global supply chain.

Climate change impact on the Suez Canal

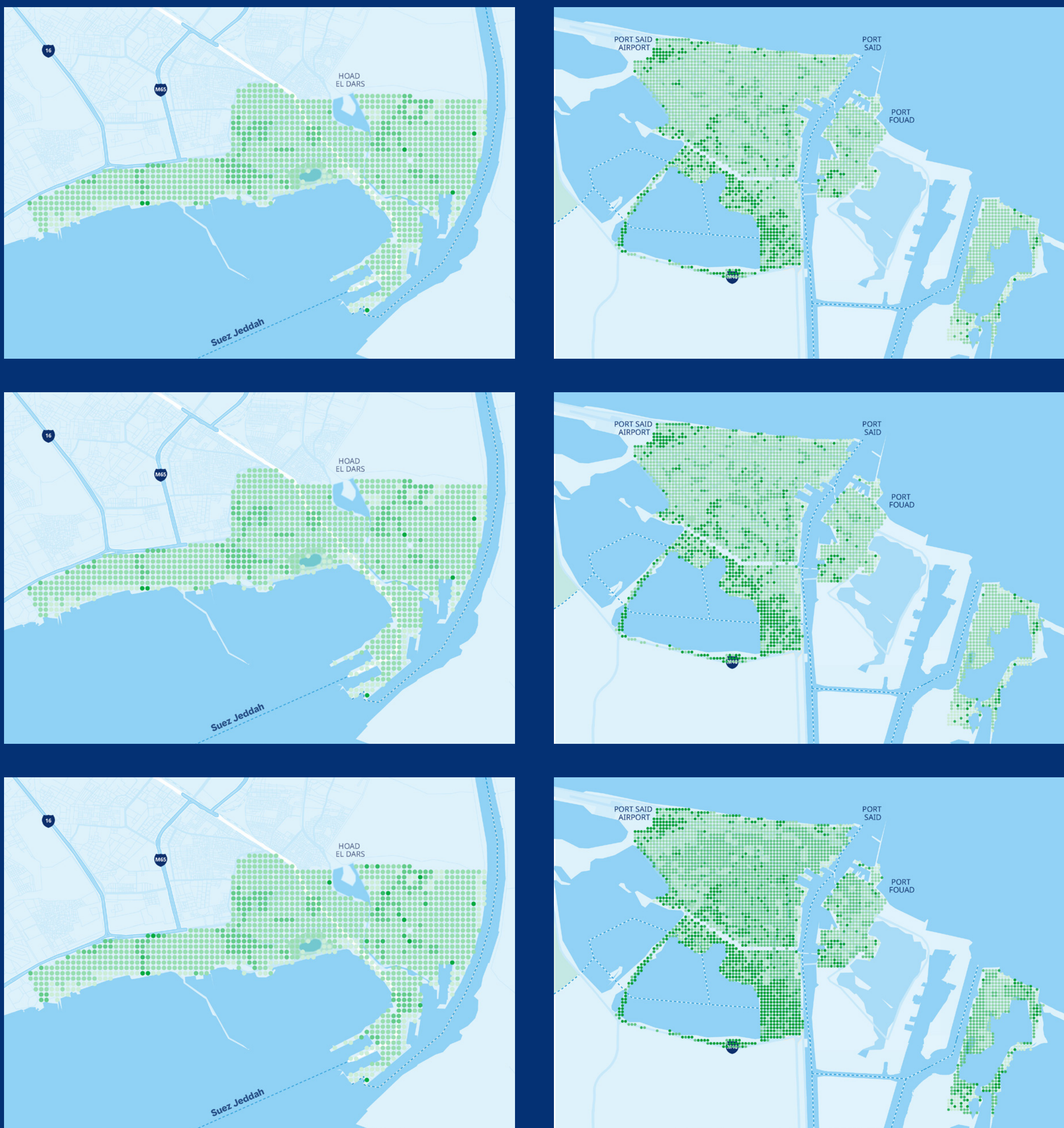
Our modeling shows that under a "high warming" climate scenario the physical climate risk will increase over the course of the century, which could directly affect the operation of the the Suez Canal.

02| **Physical climate risk modeling results, showing aggregate climate risk for each of the four ports.**

2020

2050

2100



Key | Very low · Low · Medium · High · Very high

Due to the difference in the nature of the assets, we have assessed the Suez Canal port infrastructure vulnerabilities and the canal waterway vulnerabilities separately.

Suez Canal port infrastructure vulnerabilities

Analysis shows that increase in physical climate risk exposure could cause considerable change to the surrounding environment.

The Suez Canal Container Port in the north has the highest physical climate-related peril exposure across the four locations (Figure 2). Between 2020 and 2100, the Container Port's risk to climate perils doubles — mostly driven by coastal inundation. This trend is also seen at Port Said, with a comparatively lower risk profile over the century modeled at Port Faud. A similar, but muted trend occurs for Port Tawfiq, with the greatest acceleration of risk occurring between 2050 and 2100. This is unsurprising because the primary driver of coastal inundation is sea-level rise which is projected to rise up to 1m by 2100.

The strategic importance of these sites as the entrance to the Suez Canal means that the impact from coastal inundation is material.

Increasing exposure to coastal inundation will challenge the integrity of infrastructure and port operations, due to potential disruption to the loading, unloading, and movement of cargo. Placement of infrastructure, including transportation and communication networks, industrial sites, housing, and sanitation systems are also likely to be affected. If central communication hubs and channels are impacted, additional investment will be required in resilience adaptation, as well as ensuring that canal operations are not disrupted. This is because logistical coordination of the Suez Canal is operated from the Port Said location.

The high likelihood of coastal inundation risk to Port Said and the Suez Canal Container Port is reflective of a wider issue. Global projections of inundation on seaports by the IPCC, estimated a 80% rise in the number of ports exposed to inundation of greater than 1 meter between 2030 and 2080.[16] If similar levels of exposure to coastal inundation are experienced at other global ports without considerable resilience adaptation investment, shipping pinch points could become hazard multipliers, causing considerable disruption, financial losses, and higher container costs across the global supply chain.

Suez Canal waterway climate vulnerabilities

Both extreme wind and heat events were modeled along the canal, as both can have impacts on shipping.

Extreme wind events were modeled to increase marginally over the course of the century. Separately, extreme heat events were also modeled to increase over the course of the century. Compared with today, extreme heat events reaching 45°C double by 2050 and are likely to increase seven-fold by 2100.

Extreme heat events affect soil moisture, leading to increased sandstorm events in semi-arid countries.[17] This is because extreme heat dries soil, making it easier for winds to mobilize it, creating dust storms.[18] If there is an increasing incidence of extreme heat and sandstorm events, visibility levels for navigating through the Suez Canal will be affected, which may result in, for example,restricted port operations or increased need for dredging due to higher rates of sand deposition.[19]

With the Suez Canal susceptible to a number of climate change impacts, the risk of confluence events — where multiple events occur simultaneously — is heightened.

While a number of conditions contributed to the Ever Given running aground, there is evidence that a similar confluence event may have occurred — temperatures of 43.6°C were recorded in Luxor, and a sandstorm preceded the incident.[20] With a projected rise in heat, and high wind events continuing to occur, the incident serves as a cautionary tale: with shipping trade typically running on tight time schedules, the propensity for these incidents to cause significant disruption to port services and the logistics chains is high.

In addition to potential navigational issues, the impact of extreme heat events can vary from productivity loss, to changes in sea salinity and density. The latter may also impact engine cooling ability and efficiency. These broader risks arising from extreme heat present second and third order risks that could result in increased costs and delays.

Implications for building resilience

Increasing the resilience of the Suez Canal and adjacent infrastructure can take the form of a patchwork of measures — financial enablers, physical adaptation, and operational adjustments.

For the SCA, the most critical priority is to mitigate operational risk and downtime for the canal. Over the short term, downtime will reduce revenue. Longer term, operational impacts will erode business models, requiring fleets to look at alternative routings if Suez cannot be depended upon. In future years, as the Suez Canal potentially achieves greater draft capacity through sea-level rise, practical resilience measures, such as reviewing operating procedures, may be necessary to build resilience.

As with any major infrastructure project, material proactive upgrades to the Suez Canal and its supporting ports and facilities may be decadal undertakings. This will require access to stable, long-term capital, which may come in the form of either government (co-)sponsorship, direct-to-market bonds issues by the SCA, or lending by pension funds (which, given the long-dated nature of their liabilities, often support multi-decade infrastructure projects). By using these alternative and proactive methods of financing, resilience can be embedded into the planning and development stage of infrastructure projects.

A combination of reliability and cost for fleets may begin to make longer routes financially appealing — as long as risk of disruption can be reduced. The knock-on effects would result in undesirable environmental implications: If transport is rerouted around Africa, rather than through the Suez Canal, there is a resulting increase in carbon emissions due to the additional distance travelled.[21]

While sea-level rise defences may improve the canal's risk profile through proactive investment in resilience, there will always be risks associated with its operation and maintenance, which may require a more holistic approach that considers associated infrastructure as well as the canal itself. Frameworks such as the UN's Principles for Disaster Resilient Infrastructure can support countries and communities to mitigate risk. At an enterprise level, a resilience strategy, underpinned by prudent risk management helps to minimize risks associated with operation and maintenance, with residual risks transferred to the insurance sector.

The UN's Principles for Disaster Resilient Infrastructure is a robust framework to underpin strategies such as these. When loss events do arise, restoring an asset to its previous specification — a historic norm for the insurance industry — may prove insufficient due to the evolving pressures of climate change. The insurance industry is increasingly recognizing the value of "resilient rebuilding". Initiatives such as FloodRe's Build Back Better — a public-private scheme that tops up pay-outs for flood risk for UK residential properties to focus on improving flood resilience — demonstrates how (re)insurance can focus adaptation funding where they are needed most, while reducing the likelihood of future claims.

"Frameworks such as the UN's Principles for Disaster Resilient Infrastructure can support countries and communities to mitigate risk."

UN PRINCIPLES FOR DISASTER RESILIENT INFRASTRUCTURE

Infrastructure underpins our quality of life and social well-being through the provision of essential services in a wide range of sectors from health and social care to education, transport, energy, telecommunications, public safety, security, and emergency services. Infrastructure at a local, regional, and national scale has begun to demonstrate vulnerabilities over the last few decades, exposed by systemic risks, increasingly driven by climate change.

The United Nations Office for Disaster Risk Reduction (UNDRR) recognizes the importance of infrastructure and the potential for climate change to make critical infrastructure vulnerability. As part of the UNDRR's remit, the UN Principles for Disaster Resilient Infrastructure have been developed, with Marsh collaboration. These principles were borne out of consultations engaging business leaders, academics, and civil society from over 100 countries.

The principles are designed to contribute to the UN's Sustainable Development Goal no. 9: "Innovation and Infrastructure", and offer a holistic approach to ensure that resilience is embedded into the planning and implementation of infrastructure projects. The aim is to achieve a "net resilience gain".

The Six Principles take the form of the Sendai Framework including: continuously learning, proactively protected, environmentally integrated, socially engaged, shared responsibility, and adaptively transforming.

The principles are intended for use by any level of government, institutions, donors, investors, owners, designers, contractors, service providers, and international organizations.

In enabling action, Marsh and UNDRR are now developing a handbook to assist different sectors in implementing the principles.

Looking ahead, significant infrastructure change may be required to enable the resilience of the Suez Canal. With coastal innundation increasing over the course of the century, ensuring the resilience of ports will soon be critical. For the canal this may include the raising or hardening of banks to adapt to sea-level rise.

A further physical infrastructural change to reduce vulnerability is the canal widening. While in theory this could considerably improve channel safety by promoting better and easier navigability, this change could also result in increased use. The existing one-way system may become two-way in some places, allowing more vessels to pass through. Unless actively managed, this could reverse the benefits of these resilience efforts.

All of the above adaptations should be considered in the context of the time horizon they occur over. There is an adaptation window to assess how quickly key infrastructure needs to react and the level of change required; this could coincide with planned upgrades and may inform lifecycle planning.

While physical infrastructure change has a place in building resilience, it is in ship and cargo owners' interest to seek independent risk mitigation measures. By building strong communication networks with suppliers, increasing visibility of supply chains, and taking time to understand any single points of failure, hazard multiplication can be limited through pro-active preparation.

Finally, purchasing Trade Disruption insurance (TDI) and other forms of bespoke insurance, are becoming increasingly popular and valuable methods of risk transfer. Insurance and reinsurance mechanisms play a critical role in reducing the financial risks associated with climate change.

Using the Ever Given event as a "wake-up call" that highlighted the importance of approaching risk mitigation from multiple angles will provide an improvement on the current level of resilience.

Conclusions

Shipping and global trade rely heavily on critical routes and infrastructure, and the insurance industry has mechanisms to enable the de-risking of their pinch points. Building resilience, can be achieved using multiple methods, including physical resilience, financial enablers, and definition of a resilience strategy (based on UN Principles for Disaster Resilient Infrastructure, for example). Given the global strategic importance of the Suez Canal, a patchwork of resilience measures in addition to a comprehensive understanding of the risk landscape will be required to galvanize asset owners, operators, governments, and investors on the long-term viability of the canal.

More broadly, similar lessons can be applied to other globally critical infrastructure assets. We have identified three primary takeaways for infrastructure asset owners as part of this paper:

1. Asset owners should seek to identify the physical resilience measures required and define their adaptation window to ensure the long-term viability of their assets.
2. Financial mechanisms such as (re) insurance-backed schemes can enable the development of physical resilience measures, and ultimately de-risk the investment required.
3. Finally, while an asset's resilience can be viewed in silo, a resilience strategy that takes a more holistic approach may prove beneficial in ensuring that the asset, as well as associated infrastructure, continues to remain viable.

Physical climate change risk modeling

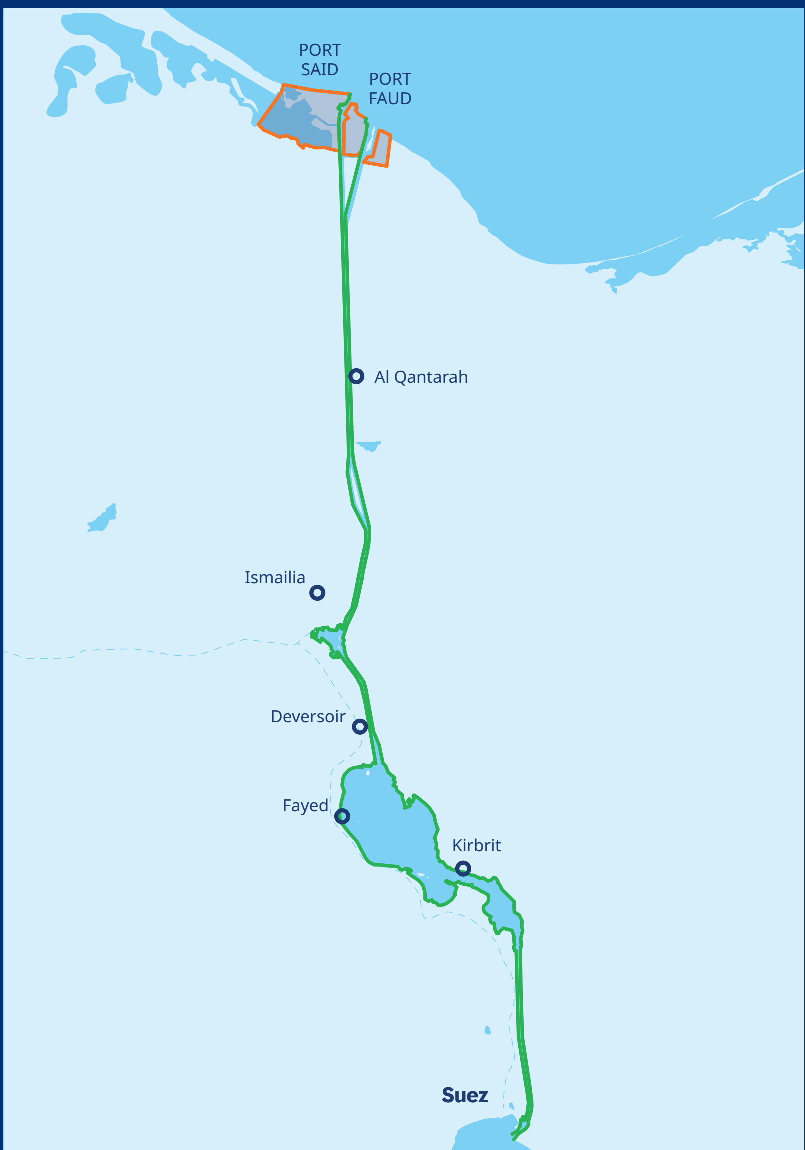
The assessment of physical climate risk is the first step in identifying the resilience measures required to reduce the impacts of climate change.

As part of this research, Marsh has collaborated with leading physical climate risk modeling organization XDI to assess how the Suez Canal will be impacted over time by physical climate risks.

Overview of modeling methodology

Our analysis focused on four infrastructure sites (Figure 3) — Port Tawfiq (Red Sea entrance to the Suez Canal), and Port Said, Port Fuad, and the Suez Canal Container Port (Mediterranean Sea entrance). At these sites, the risk from multiple perils was assessed across the years 2020, 2050, and 2100, under a climate scenario of 3.7°C global average temperature increases on a baseline of pre-industrial levels (RCP 8.5).

03| **Overview of research areas, including four ports and the length of the Suez Canal.**



Suez Canal:

- The eastern and western most banks of the canal were assessed as 2x linear assets.
- Regular points 1km apart, creating c.200 points per linear asset.

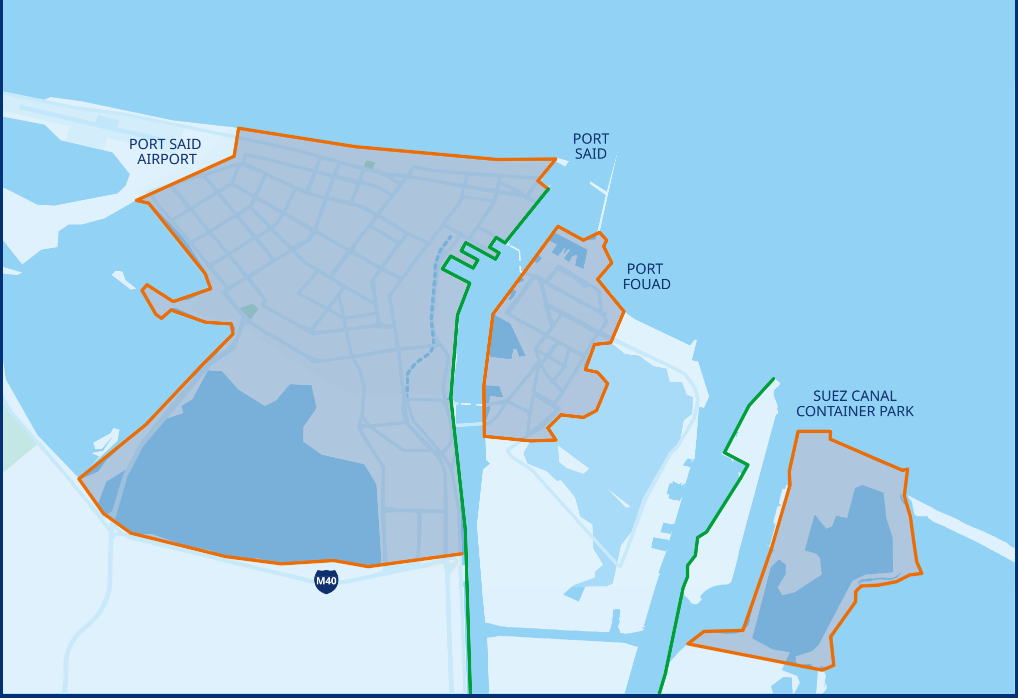
Key

Analysis of port areas

Analysis of Canal length

Suez Canal: Mediterranean ports

- 3x sites assessed.
- These locations represent areas of critical infrastructure along the Suez Canal's entrance to the Mediterranean Sea.



Suez Canal: Red Sea ports

- 1x sites assessed.
- This location represents an area of critical infrastructure along the Suez Canal's entrance to the Red Sea.

Key

- Analysis of port areas
- Analysis of Canal length

Our analysis covered eight natural hazards, including coastal, riverine and surface water flooding, forest fire, extreme wind, and soil subsidence.

In addition, we modeled the climate impact along the length of the canal, including the entrance to, banks, and length of the eastern and western canal. For the length of the canal (Figure 3), extreme heat and extreme wind risk over the same time periods were assessed. This modeling was used to inform both physical risk impacts and potential asset-level disruption, for current and future climate-related events in the region.

For our research for the north and southern ports, we used a site's Maximum-to-date Value-at-Risk (MVAR) as well as change in annual exceedance probability throughout the course of the century for the length of the canal. XDI derives MVAR using probabilistic models that calculate average annual loss due to the damage from eight climate hazards to component elements of an asset and the cost of their replacement.

Value-at-risk is calculated by expressing that loss as a percentage of the asset's replacement value. MVAR is the highest VAR up to the given year, indicating the peak physically damaging stress placed on the asset from extreme weather and climate change observed in the modeling results up to that year.

The change in annual exceedance probability for key hazards is performed by calculating the trend in either severity or frequency of that hazard at the given location from a 1990 baseline. In this case, we sought to understand the likely increased frequency of a given severity of extreme wind and heat events.

We acknowledge that all models have limitations and that there is further work to be done to understand the risks in the region, and we aim for the results of this research to provide directional risk indicators for the purpose of building resilience.

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About XDI

The Cross Dependency Initiative (XDI) is a global leader in physical climate risk analysis, providing data for company and investor TFCD reporting, due diligence and risk management. XDI's physical risk data is designed to empower business, government and financial markets to manage revenue impacts and identify opportunities for adaptation.

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