G20 INSIGHTS

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Impact of sea-level rise and extreme events on infrastructure development in global trade and logistics supply chain

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The rise in global sea levels and extreme events directly challenge the international freight infrastructure. This is particularly important considering the significance of sea-borne trade in international commerce and that key logistics and trade centers are located near coastal areas. Three strategies to adapt to the changes and disruptions are imperative. These include enabling a global framework to assess climate change and extreme event risks in maritime activities, design adaptive enforcement mechanisms that set a minimal standard to reduce pollutants and develop sustainable infrastructure for seaborne activities, and ensure that future infrastructure investments contribute to mitigating climate change and extreme events (such as pandemics).

Challenge

Rising sea levels and extreme events will severely impact key coastal areas that serve as entry points of trade for many countries. This is especially true for Global Twenty (G20) countries, which make up more than 80 percent of the world's economic output in terms of GDP and 75 percent of international trade (OECD-UNDP Progress Report 2019). These impacts include damage to or loss of infrastructure, operational delays, and disruptions to regional and global supply chains. Coastal cities and their ports, with their key logistics hubs, will need to re-evaluate their current infrastructure investments (OECD Trade and Environment Working Paper 2017). Several major ports adopted measures to build defenses against inundation and storm surges while limiting greenhouse gas (GHG) and pollutants emitted from freight transportation via global logistics supply chains. In 2016, the G20 Hangzhou Summit discussed the need for quality infrastructure, "which aims to ensure economic efficiency in view of life-cycle cost, safety, resilience against natural disaster, job creation…while addressing social and environmental impacts and aligning with economic and development strategies" (G20 2016).

Considering the overall potential costs of climate change, preemptively planning for resilient infrastructure development is key. To this end, the G20 developed guidelines for quality infrastructure based on six principles that can provide a strong foundation for transformation into a modern, resilient, inclusive, and sustainable society (OECD-UNDP Progress Report 2019).

Depending on future global warming scenarios, one or several simultaneous changes in the climate conditions—including hotter summers, extreme precipitation events, increased storminess, and sea level rise—could affect the infrastructure for seaborne activities. If future infrastructure design and maintenance do not account for such impacts, then changing weather conditions could, in some regions, accelerate deterioration, increase severe damage risks, interrupt traffic, and lead to accidents, which could ultimately affect economic activities.

Additionally, unexpected events as a result of climate change or other extreme events such as a pandemic can disrupt or even halt the global economy. This challenge requires resilient and adaptive trade, logistics, and supply chain infrastructure.

This policy brief focuses on actionable recommendations and specific policy actions to establish resilient physical and digital international freight infrastructure. The aim is to reduce and alleviate disruptions to the movement of goods along the value chain—primarily because of climate change, but also in the face of extreme events— and the management of sudden disruptions. The G20 can propose specific measures to the international community to adapt to or mitigate disruptions in trade. Additionally, the G20 can work with some of the aforementioned institutions to adopt some of the policy recommendations.

Proposal

Given the challenges described above, two policy recommendations are proposed.

Policy I

Enable a global framework based on a structural assessment of climate change risk in maritime activities to create a sustainability roadmap for the future.

Extreme weather events have had significant impacts on trade and global supply chains, such as flooding and extreme temperature phenomena, threatening transport systems in general (OECD 2017). Higher global surface temperatures and changing weather patterns are projected to accelerate glacier melting, leading to rising sea levels and more frequent temperature extremes, among other effects. This would have significant economic consequences worldwide, leading to large changes in sectoral and regional production and consumption, and ultimately, in international trade (OECD 2015).

Some manifestations of climate change represent "a long-term change in the average weather patterns that have come to define Earth's local, regional and global climate," according to NASA (2020). Since the establishment of the UNFCCC (1992), efforts are focused on limiting climate change through various measures and technologies with the aim of minimizing GHG emissions and increasing the efficiency of resource usage. However, the rise in atmospheric and ocean temperatures leads to more frequent extreme climate events (heat waves, heavy precipitation, tropical storms, and hurricanes/cyclones), which also result in flooding and a rise in the sea level (NASA 2020). As the frequency of climate change incidents increases, the need to protect against such phenomena also increases, especially as some events can cause short- and long-term disruptions to business and economic operations. This leads to the need to invest in adaptation.

Among the adverse effects of global warming, sea level rise is expected to range between 75–190 cm, according to the Intergovernmental Panel on Climate Change (IPCC 2019). In this context, by 2100, many ports will face regular inundation in the absence of future infrastructure developments. Rising sea levels can also threaten global trade and supply chain infrastructure such as ports, their surroundings, and their connections (Christodoulou, Christidis, and Demirel 2019), as well as inland waterway ports. An important concern is the uncertainty about the acceleration in the rise of sea levels after 2050, and how this may render existing infrastructure obsolete.

Several ports are protected against a once-in-a-millennium event (Nicholls and Cazenave 2010). The Rotterdam protection measures are of the highest level globally, consisting of different storm surge barriers, two of which are the largest in the world. In addition, London's flood barrier is among the biggest worldwide. Venice has barriers known as the "Mose" system. Hamburg, too, has a storm surge protection plan (Climate ADAPT 2014), and Belgium has its Sigma plan.

Many efforts aim to update climate change projection models, which examine the change in climatological factors such as temperature and precipitation, in order to include mitigation measures. However, there is little effort toward assessing the economic impact of climate change on transportation and supply chains (Koliokosta 2017). The Joint Research Centre (JRC) of the European Commission conducted several Projection of Economic impacts of climate change in Sectors of the European Union based on bottom-up Analysis (PESETA) projects. The impacts of climate change on the transport sector are covered in PESETA-II and PESETA-III. Specifically, PESETA-III assesses the effects on airports, seaports, and inland waterways; it aims to reduce interruptions by adopting adaptation strategies (Christodoulou and

Demirel 2018). This knowledge is important to scale adaptation measures/investments appropriately and assess their efficiency and impact, including the best timing for adaptation investments or even disinvestments, and to assess the resilience of existing infrastructure and planning to Build Back Better. Given the interdependence between business and society, business has a strong interest and critical role to play in these efforts (DNV-GL 2014).

Risk could be permanent or temporary; however, even temporary closures could have severe impacts on the economy. Inundated ports face the risk of temporary closure. The total amount of damage when closing the port of Rotterdam for 24 hours could exceed €3 million, while the sea shipping cost for other ports could reach €0.75 million (Doll et al. 2011).

Resilience plans for vulnerable coastal areas could include adaptation measures such as traditional engineering approaches, ecosystem-based approaches, and hybrid approaches. Traditional approaches include the construction of dikes, sea walls, and storm defenses, and the elevation of seaports to compensate for projected sea levels, among other measures. Ecosystem-based approaches such as nature-based solutions and landscape planning are also attracting attention. Adaptation measures are zone-specific and dynamic. On a case-by-case basis, two main adaptation strategies are possible, namely adaptive management implemented successively and a one-off adaptation in which an adaptation is undertaken once to deal with the long term. The long-life span of transportation infrastructure and uncertainties involved in future climate estimates make adaptation strategies complex.

Six specific policy actions are proposed to establish a global framework based on structural assessments of sea level rise risk and impacts on infrastructure and supply chains, including:

1.1 Development of methodologies to identify at-risk infrastructure and assess the resilience of infrastructure and operations in a standardized and comparable way

Resilience is a measure of how fast and at what level a system can bounce back to its initial level of operation (Christopher and Peck 2004; Linkov et al. 2014). It is imperative to distinguish between risk as a system disturbance and risk that requires adaptation measures, such as significant sea level rise when identifying a common measure.

1.2 Integrating the financial risk associated with climate change into infrastructure investment assessments

Infrastructure project rating tools should incorporate climate change, including the division of impacts on and risks to the various stakeholders.

1.3 Integrating best-available knowledge on climate-related infrastructure risk assessment of supply chains

It is advised to work with scenarios (related to expected sea level rise) and apply a cost–benefit analysis of specific measures, as the goal is to determine the expense of the new infrastructure. This requires some choices; for example, infrastructure development takes about 20 years. Equally, the assessment must determine the actor best placed to undertake specific measures, whether investments are left to individual operators or it is socially better if public authorities make the investments, given free-rider behavior, or others. Figure 1 in the Appendix sheds some light on the port network actors with involvement in the short and long run. Cost–benefit analyses addressing climate-change and sea level rise should also account for the social benefit (welfare), especially of vulnerable populations and settlements next to infrastructure, in line with the Sustainable Development Goals (SDGs).

1.4 Development of a framework to compare results under the varying conditions in each location, as each region will experience differing levels of sea level rise

Assessing the impact and efficiency of adaptation measures and tasks, as well as their underlying investments, is a challenging undertaking. However, it is important to know how well the different measures work. Such a framework would also provide guidance about the level of investment required and contribute to sustainable Building Back Better or planning disinvestment.

1.5 Improving high-risk assessment design standards for infrastructure developments

This proposal implies design standards for soft measures (e.g., beach nourishment with less impact on coastal ecosystems) and hard measures (e.g., constructing architectural storm walls on the seawall with sustainable concrete, wave-damping extensions, or storm surge barriers in coastal ports to avoid excessive water levels in the port). Adaptations to these will require a combination of policy, planning, and engineering approaches and standards, be it hard (formal) or soft (informal); see Figure 1 in the Appendix. The options for port activities are to build coastal armoring such as seawalls and dikes to elevate the entire port area, or to relocate to a nearby area with sufficient elevation to accommodate future commerce. Larger ports may need to consider a combination of these strategies; that is, it may be possible to raise or accommodate future commerce. Larger ports may need to consider a combination of these strategies, that is, it may be possible to raise or armor some operations at their current location, while others may need to relocate to higher ground. The elevation of an entire port will require large volumes of fill and does not address the possible need to protect the infrastructure to link the port to the transportation network. Relocating a port would be disruptive to local economies and could result in new and significant environmental impacts, such as erosion of land soil (IPCC 2017).

1.6 Implementing risk assessment standards for design policies for financial institutions

Standards for economic investment decisions on future infrastructure must consider sea level rise scenarios and climatic variables such as storminess, waves, future changes in intensity, frequency, duration for a proper analysis, and guidance for current and future investment decisions at the port. This should be combined with project rating (see 1.2).

Policy II

Adopt enforcement mechanisms that set a minimal standard for pollutant and GHG reduction in seaborne activities and enhance public and private engagement in developing resilient infrastructure through institutional collaboration.

Global trade and supply chains have many working parts, which implies energy consumption, and thus, anthropogenic emissions. In particular, the transportation component of trade, which produces much of the emissions in the sector, has been regulated in different ways globally. Many countries set similar emissions mitigation goals for road freight transport, to be reached by 2050. However, the air and maritime sectors are largely left out of these mitigation targets. The International Maritime Organization (IMO) is a UN agency responsible for setting standards and regulations that allow for the safety, security, and environmental performance of international shipping. G20 nations can adopt and enforce IMO regulations as the standard for the global community, ultimately meeting several SDG goals that the IMO supports.

One such regulation is the IMO 2020, which bans high-sulfur marine fuel in international waters. This regulation creates an opportunity to include maritime activities in international treaties calling for increased energy efficiency in supply chains and the mitigation of GHG emissions. This clearly reinforces the potential role of ports in environmental controls on shipping activities in supply chains along with the surrounding transport activities. Indeed, through the Tokyo and Paris Memoranda of Understanding (MoU) on Port State Control, port controls took on an entirely new role in the energy and environment efficiency of shipping activities in global supply chains. This is a key pillar in the potential reach of global reduction and mitigation efforts reflected in the IMO's Marine Environment Protection Committee and their resolutions calling for greater energy efficiency in maritime activities globally by 2050. Currently, the control for the sulfur content of fuels is an example of the expense and prolonged control process of shipping activities. Traditional compliance checks occur with a physical paper trail on bunker delivery or oil records when sampling a vessel's fuel. However, extending this to a world-scale mitigation control on other emissions and motor technologies is impractical. As such, scaling these mitigation targets requires massive investments in digital infrastructure and adoption by G20 countries to establish an international benchmark.

Ports in particular play a key role in the added value and economic growth of countries. The existing planning and communication processes of a port's stakeholders require reinforced resilience given the worldwide disruption of the global economy, and subsequent supply chain, due to the pandemic in 2020. To date, port efficiency and competitiveness, as well as accessibility and world-class infrastructure, are key factors in the attractiveness and success of port activities. In future, ports will require more pronounced and immediate responses to the market, environment, and economic shocks.

This brief proposes three policy actions for adopting enforcement mechanisms to comply with pollutant and emission targets and to develop standards and protocols to handle sudden disruptions (environmental, biological, security, etc.) to the physical and digital infrastructure of global supply chains.

2.1 Investing in digital infrastructure to enforce targets set on seaborne activities

Maritime supply chains have varying applications of digital solutions to improve port efficiency and shipping records, provide real-time status of cargo, reduce customs clearance times, and increase transparency (Yang 2019). Crucially, the digital innovations among some actors in the maritime supply chain created a "lock-in" situation that stifles progress owing to certain barriers. However, "co-innovation" among the stakeholders involved in the supply chain can be a mechanism for the development of digital innovations (Valentin et al. 2017).

First, in case of global target enforcement, digital solutions to check for noncompliance with G20-backed IMO regulations can create a standard, transparent process that applies to all seaborne activities. Specifically, adding markers to physical assets such as ships, lorries, and their fuel in the supply chain, and recording each transaction in a blockchain-based system, would enable a Hyperledger approach in which every transaction in the supply chain is linked to an open source, electronically traceable history. Here, the journey of fuel and cargo as it changes hands along the chain is tracked. Ultimately, digital solutions, such as blockchain, allow for secure and frictionless transactions globally (Bavassano, Ferrari, and Tei 2020) that can also include information on the energy content of freight transactions (from cradle to grave). They also include their inherent anthropogenic emissions for compliance checks with agreed upon international targets.

Second, several stakeholders in the transportation industry began independently implementing mitigation mechanisms that put a price on carbon. By doing so, they create a value for carbon that incentivizes the internalization of the cost of its atmospheric release. One of the drawbacks of these pricing mechanisms— particularly emissions trading schemes—is that, to achieve efficiency at a large scale, they must be connected. Schwartz, Gustafsson, and Spohr (2020) mention the numerous players in the shipping industry (consignor, shipowner, ship operator) and how their respective motives for carbon pricing are not aligned and must be considered.

As such, Hyperledger proposals set the scene for a globalized trading scheme that can be achieved efficiently and cost effectively, while accounting for the need for cooperative approaches, as evidenced in the Paris Agreement. The EU is considering adding shipping to the European Trading Scheme, which the G20 countries could use as a benchmark and potentially follow suit.

Lastly, the creation of a value chain for carbon would also drive other infrastructure investments, where the value of CO2 that is mitigated, captured, or stored would play a defining role in the financial assessment of future projects.

2.2 Enhancing security

Securing the digital infrastructure of seaborne activities is key and IT systems that lead to higher efficiency and growth are integral. Having all custom clearance activities at a terminal level will allow for more efficient and service-oriented processes. For example, it would enable 24-hour service (24/7). The service quality of customs clearance processes will continue to be an important factor in port development. However, this requires the consideration of separate tracks and paths.

Another key form of security that will enable preparedness and reduce future disruptions in the global economy and supply chain is the enhancement of the security and safety of employees in seaborne activities by designating them as essential workers. The IMO released a joint statement with the International Labor Organization and International Civil Aviation Organization on the importance of allowing the secure movement of personnel during a pandemic as well as the government facilitation to do so (IMO-ICAO-ILO 2020).

2.3 Enhancing resilience and preparedness

Climate change and sea level rise are already happening; hence, all stakeholders in the logistics ecosystem can take steps toward resiliency. Having a port development plan that aims to prevent natural and other hazardous events is key to preparedness.

Furthermore, other extreme events that occur as a direct result of climate change, or that are unrelated to climate change, such as the COVID-19 pandemic, require a new approach to preparedness. The COVID-19 pandemic has caused significant disruptions in short-term global trade, affecting supply chains, especially in the consumer goods sector. Such an event can also have medium- to long-term impacts on the conduct of trade, and, therefore, on the development of future supply chains. Although seaborne activities have continued during the COVID-19 pandemic, the types of goods involved have changed. Policymakers must develop contingency plans (a guide to how to act) for the response to these events in order to cope with and adjust quickly to sudden events that can disrupt the entire value chain of trade, and hence, affect the associated infrastructure. The public and private sectors must come together under a common framework to continue the development of resilient digital and physical infrastructure.

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Disclaimer

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Existing Initiatives & Analysis