



# PORT RESILIENCE

FRAMEWORK FOR ACTION

ARUP

 RESILIENCE  
RISING

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- The International Coalition for Sustainable Infrastructure (ICSI)
- Resilience First

## ABOUT ARUP

Arup is a global independent firm of more than 15,000 designers, planners, engineers, architects, consultants and technical specialists, working across every aspect of today's built environment. The company was founded on the belief that the built environment has a central role in creating a safer, more sustainable planet. Together we help our clients solve their most complex challenges – turning exciting ideas into tangible reality as we strive to find a better way and shape a better world.

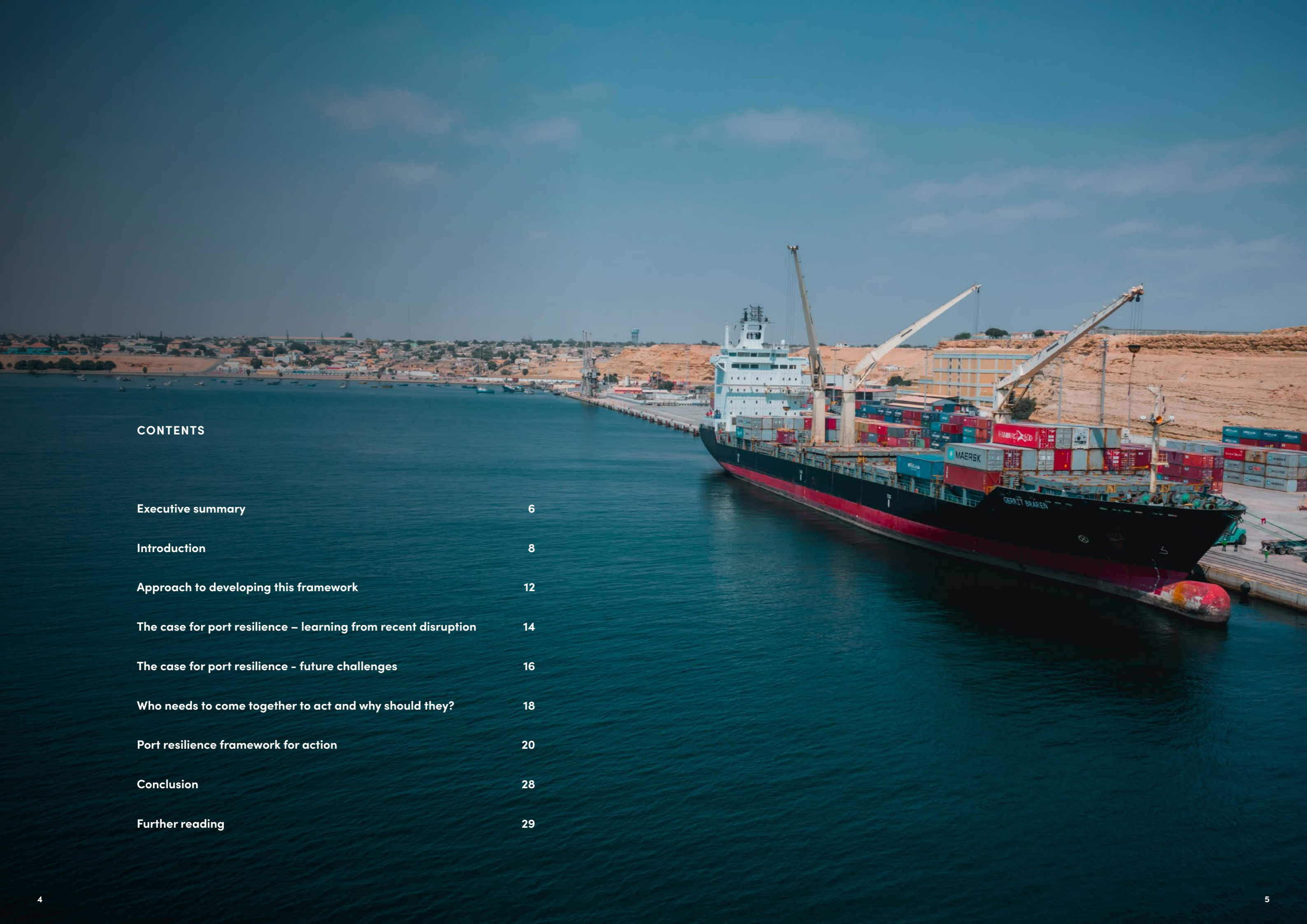
## ABOUT THE RESILIENCE RISING

Resilience Rising is a global non-profit consortium, working together to accelerate a safe, resilient, and sustainable future for all. The world is dealing with increasingly complex and interconnected challenges that no one can solve on their own. Bringing together multiple communities of practice under a shared purpose will reorient how we think about and influence change. By empowering leaders, providing expertise, and accelerating innovation, we are driving systemic change with a proven solution – resilience.



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## CONTENTS

Executive summary	6
Introduction	8
Approach to developing this framework	12
The case for port resilience – learning from recent disruption	14
The case for port resilience - future challenges	16
Who needs to come together to act and why should they?	18
Port resilience framework for action	20
Conclusion	28
Further reading	29

# Executive summary

## INTRODUCTION

Society needs resilient, low carbon gateways to prosper. In an increasingly disruptive world, resilient ports will connect people and supply chains, protect and enhance the environment, and provide opportunities for people to thrive – despite the shocks and stresses they may face.

This framework for action describes ten goals – across three dimensions: economy and society; leadership and strategy; and infrastructure and ecosystems – that together can transform port performance. It provides a line of sight for resilience from a policy level through to implementation at a port asset level.

The framework has been developed through research on global supply chain challenges, through investigation of wider port case studies, and by building on proven resilience frameworks developed for other sectors. The framework recognises resilience alongside traditional and contemporary port indicators, fostering an integrated approach.

## THE CASE FOR PORT RESILIENCE, WHY ACT?

Global supply chains are experiencing severe disruption as a result of multiple challenges; including issues at ports. The effects of the Covid-19 pandemic – from spikes in trade of goods, to reduced worker availability and uncoordinated action across supply chains – highlighted that port resilience is reliant upon people as much as infrastructure. It also highlighted the critical role for integration between activities by ports and their customers.

Additionally, recent case studies have shown the diversity of shocks and stresses posed to ports – from extreme weather and cyber-attacks to aging infrastructure and the need to decarbonise. They demonstrated that an enabling political economy is essential to reducing shocks and stresses and illustrated that unless a port is environmentally

sustainable and delivering social value to its communities, it will struggle to become resilient.

The disruptive forces that ports are exposed to and must respond to will increase in frequency, severity and complexity over time. Although we can draw lessons from recent events, the past is no longer a good predictor of the future. The nature of and response to these interrelated disruptors means that ports must be prepared for the threats we can anticipate and be able to respond to those we cannot predict or avoid – a shift to resilience.

The effects of climate change are a key driver for port resilience, posing a range of physical hazards as well as political and economic disruption. A range of best practice resources on climate adaptation are available across a number of the framework goals. An adaptive pathway approach to managing physical climate risks that recognises the level of uncertainty and risk of maladaptation is key. Climate adaptation can also serve as a key entry point for a more holistic approach to resilience. The framework for action is appropriate for adapting to climate change and a broader set of disruptors in an integrated way.

## A FRAMEWORK FOR HOLISTIC ACTION

Realising a shift in port resilience requires collective action across the value chain of ports, by their users, customers and civil society. By bringing these actors together, giving them sight of the essential and connected roles that other stakeholders in the value chain are playing, and articulating what they are set to gain both individually and collectively, we can catalyse the necessary action at the necessary scale to meet the challenges we face.

The four goals within economy and society reflect that port resilience will require action not just by the port sector, but by governments, investors, civil society and ports users/customers. These goals create an enabling platform for port resilience, reaching beyond the port boundary.

Three goals relate to leadership and strategy. This area looks to align adaptation and resilience planning at a sector and port level, and between the range of actors involved in governing and operating a port. Port resilience requires a line of sight and consistency across government regulation, maritime sector strategies, port masterplans and port operators.

Finally, there are three goals related to infrastructure and ecosystems. Port infrastructure includes physical assets, but also people, energy

and digital elements and the processes that link them all together. Ports are also embedded within and rely upon natural systems. These goals recognise resilience through action at an asset-level.

The report describes the background and context to each goal. The goals are purposefully broad to allow them to be developed according to a country or port's local context. Example actions are shown for each goal to inspire development of pilot projects for implementation.



# Introduction

In an increasingly complex and uncertain world, port resilience is essential to business continuity, but also to the communities and sectors that ports connect. Port cities need resilient, low carbon gateways to prosper.

There is no single 'silver bullet' to achieve resilient ports. Actions are required across a range of dimensions, from an enabling political economy to operation of port assets; and by a broad group of stakeholders, from governments to port designers.

Contemporary approaches to port resilience are often lacking or restricted to a narrow approach to adaptation of physical infrastructure. Resilience is often not a critical driver in planning of new ports or upgrades to existing ports. Furthermore, beneficiaries of port resilience are broad, often making a narrow business-case for port owners challenging. Action on port resilience requires an overarching view, working across silos and

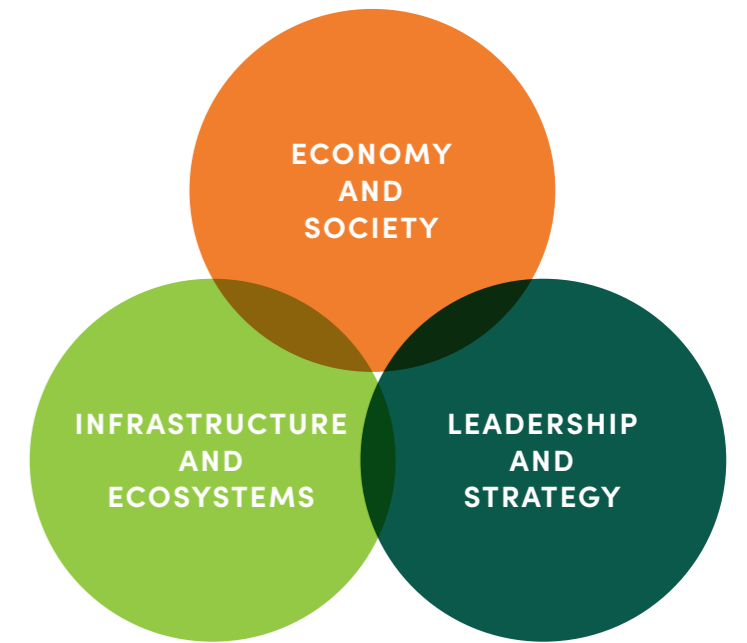
boundaries of an often complex and fragmented series of systems.

This fully integrated framework for action aligns efforts across dimensions and between actors, acknowledging ports' roles within maritime and land-based transport systems. The action areas have been shaped so that they can be refined into specific actions according to local context, to form the basis of port resilience agendas for action.

This framework has drawn inspiration from the cross-sector resilience experiences of Resilience Rising, its predecessor The Resilience Shift and Arup - including The City Resilience Index, The City Water Resilience Approach and The Energy Resilience Framework. The port resilience framework recognises the common features of ports, the diversity of ports' form and functions, and the need for actions catered to ports' local context.

## ACTION AND GOALS

We have developed a framework of goals under three dimensions, linking action by different stakeholders towards a common aim.



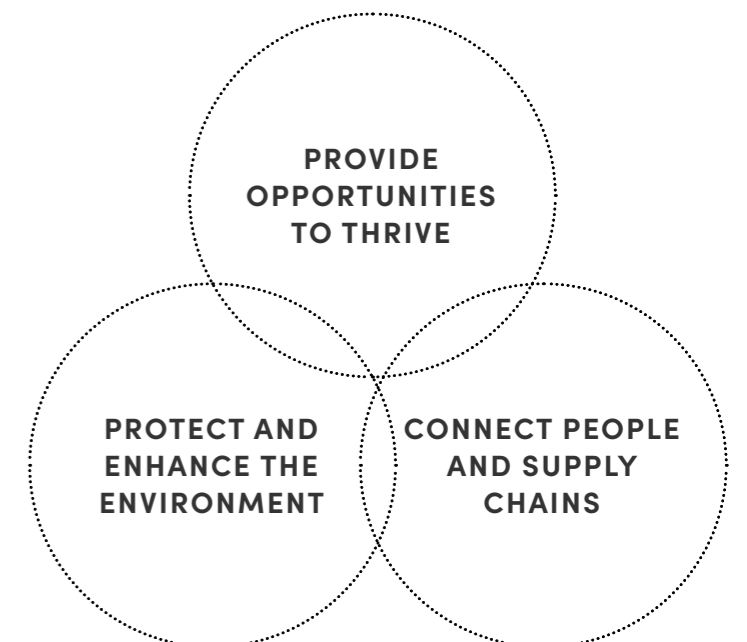
## DIRECT OUTCOME

New and existing ports can deliver essential services regardless of the shocks and stresses they face now and into the future.



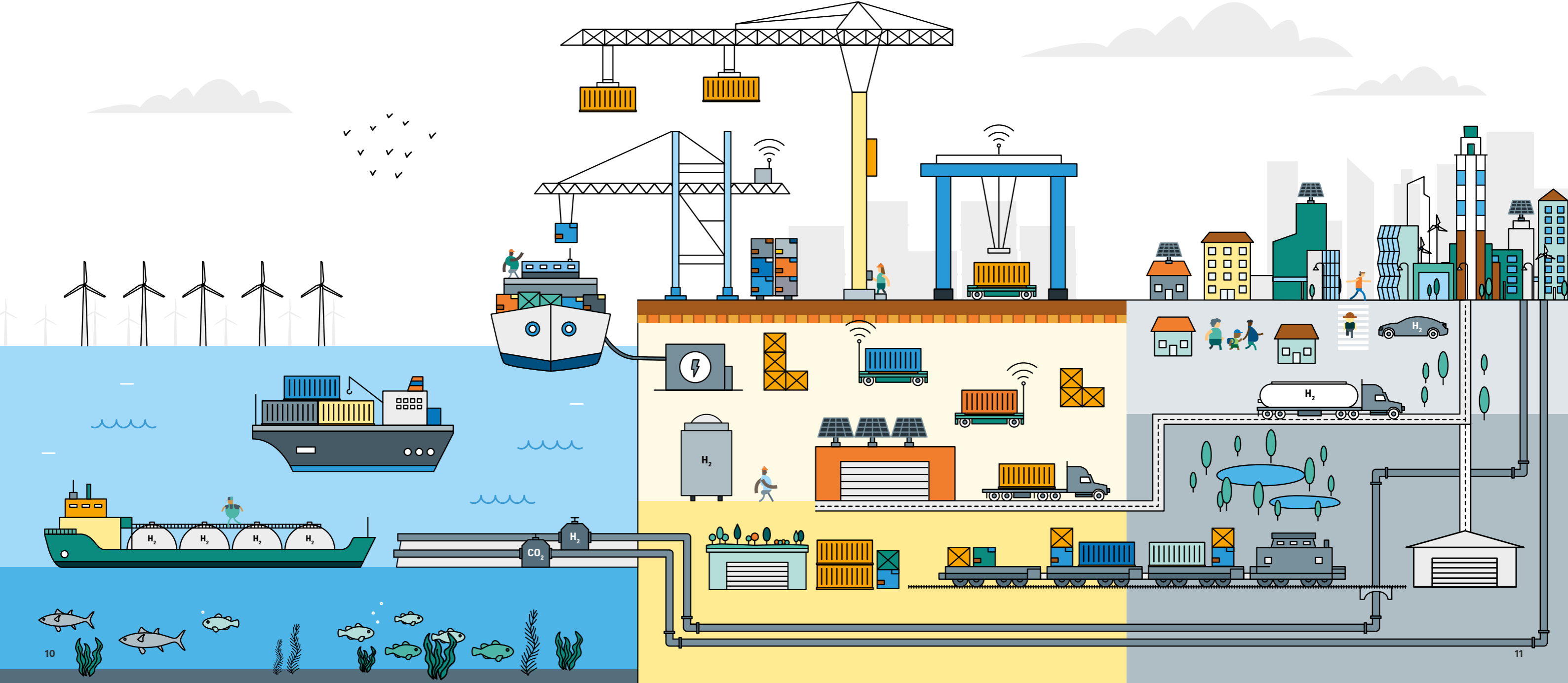
## IMPACT

This will result in ports supporting the global economy and local communities through turbulent times, through the essential services ports provide.



The Port Resilience Framework for Action builds on our work outlined in Resilience4Ports, *Gateways to a resilient future*:

- Port resilience is defined as the ability of ports, and the systems that they are part of, to withstand and adapt to changing conditions, and recover positively from shocks and stresses.
- Resilience needs a value chain approach. The port value chain includes stakeholders responsible for planning, financing, designing, delivering, operating and maintaining port systems. Each involved stakeholder can add resilience value to benefit the resilience of the whole system – benefitting them in turn.
- Ports can become a leading global example of the transition to a carbon-neutral world by the mid-Century. This approach requires planning and delivering transformation in a holistic manner – one which enhances the resilience of the broad elements of the port system, recognising future as well as current pressures and conditions.
- Port resilience also must recognise ports as a hub of systems, connecting land-based transport and energy systems with maritime transport systems, delivering value to a broad hinterland of communities. The interactions between ports, their users and communities are essential to resilience.
- There is a need for ports to manage deep uncertainty as well as to mitigate known risks associated with global climate change, recognising and implementing actions beyond adaptation of physical infrastructure.



# Approach to developing this framework

This framework has been developed through:

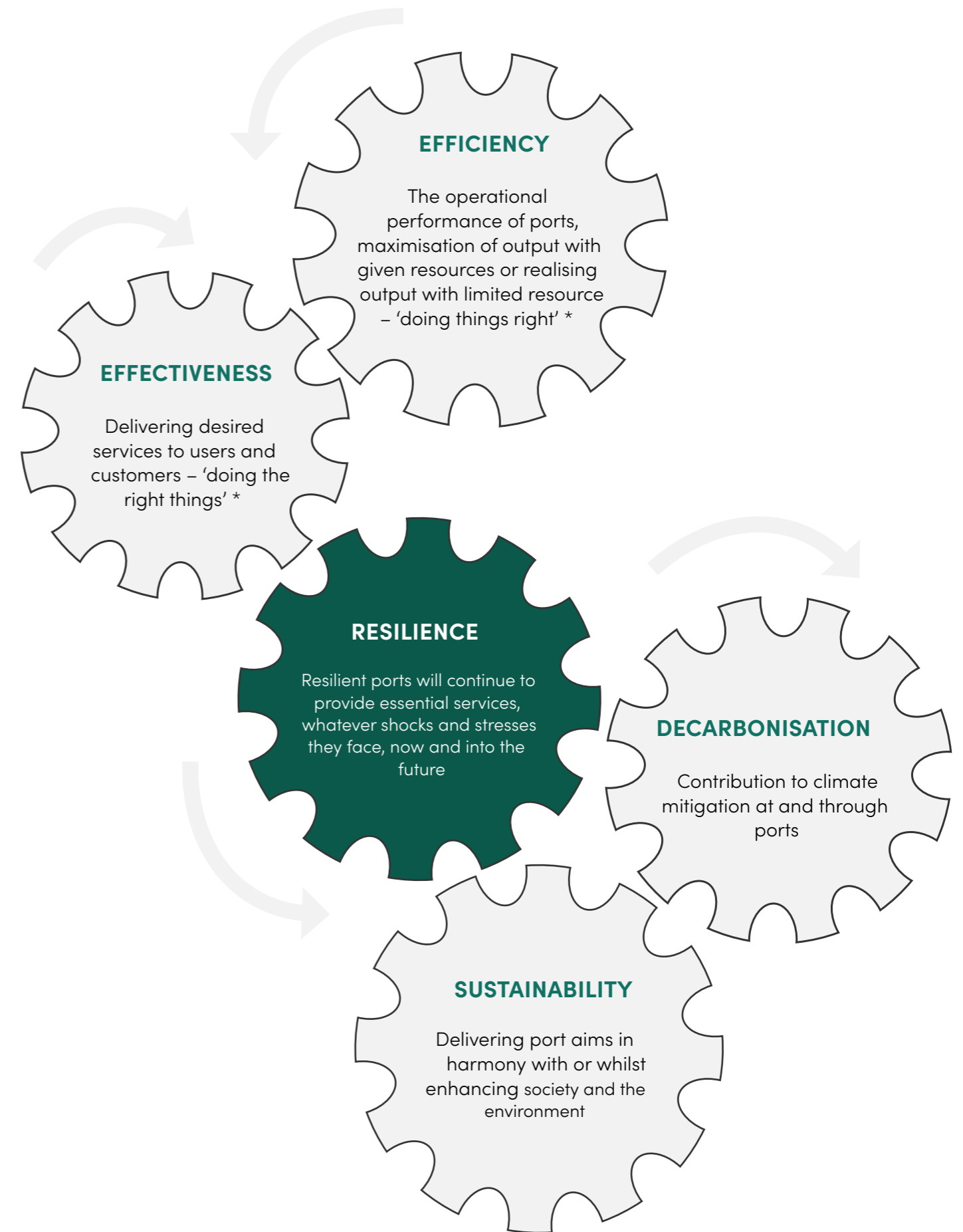
- Research that has explored the role and response of ports in recent global supply chain challenges, linked to the impacts of Covid-19 (see the next chapter for a summary).
- Investigation into recent case studies of port resilience challenges, drawing upon a diversity of disruptors, for a range of port types, around the world. This work explored what shock or stress affected the port system, the outcome for the ports and communities, and the recovery or long-term response.
- Building upon multifactor resilience frameworks developed by Arup and Resilience Rising for application in a number of other sectors (see the further reading chapter at the end of this report).
- The framework for action has been shaped in a way that allows specific actions to be developed according to a local context.

This framework acknowledges the traditional performance indicators – port effectiveness and port efficiency – that drive port development and operation. It also recognises the increasing onus for ports to be sustainable and contribute to rapid decarbonisation. There are many synergies between these indicators and resilience, and also occasionally some tensions.

By integrating resilience interventions across the existing processes by which ports are shaped, developed, operated and maintained, the framework can bring together these agendas, unlocking complementary action and acknowledging trade-offs.

Resilience can benefit other port indicators, it can:

- Strengthen relationships between ports, their customers and communities, enhancing port effectiveness, allowing agility and responsiveness to users' needs.
- Highlight the co-benefits that sustainability and decarbonisation realise for ports, including reducing the regulatory shocks and stresses ports are exposed to.
- Highlight where efficiency improvements strengthen long-term performance and service reliability, and where they can create fragility.



\*Theo Notteboom, Athanasios Pallis and Jean-Paul Rodrigue (2022) Port Economics, Management and Policy

# The case for port resilience – learning from recent disruption

## WHAT CAN WE LEARN FROM THE COVID-19 PANDEMIC?

Global supply chains have recently experienced severe disruption as a result of multiple challenges, many of which are likely to worsen in the future. Issues at ports are major contributors to these challenges. This disruption has severely impacted the global economy and the communities that rely on these supply chains.

As an example, the challenges that have affected ports and supply chains throughout the Covid-19 pandemic and the ongoing recovery are complex and varied, but key trends include:

- Unexpected upward swings in demand for traded goods (linked to Covid-19 recovery and economic stimulus) coupled with pandemic-induced challenges resulted in long-lasting congestion at ports, with knock-on effects for shipping and on-land logistics (e.g. delays), which in turn has sometimes further increased pressure on ports.

- The congestion at ports was linked to insufficient infrastructure capacity, as well as worker/family illnesses, skills shortages, and reduced productivity from social distancing, regulatory burdens, etc. The economic challenges linked to supply chain issues has in turn influenced worker wage demands, resulting in strikes and further stress on port productivity.
- The action of port users, in particular carriers (e.g., cut-and-run response to port congestion), has also at times exacerbated challenges, making forward planning and dealing with port backlogs difficult. The shipping sector has faced its own resilience and capacity challenges, but has also benefited from extremely high freight rates.

This example highlights that port resilience must consider actions by customers of ports and must focus on workers as much as infrastructure. It also suggests a key role for technology to enable coordinated action on resilience across supply chains. Port capacity and productivity must be considered alongside resilience, in a holistic way.



## WHAT OTHER CHALLENGES HAVE PORTS FACED RECENTLY?

There is a diversity of other risks posed to ports and their associated supply chains. The interconnected port system means that shocks and stresses can result in cascading impacts across system components and on surrounding communities. Shocks and stresses felt at one port can transfer between multiple ports.

Acute shocks include extreme weather events (e.g., typhoons and flooding, the frequency and severity of which are linked to climate change) which directly damage port infrastructure and connecting infrastructure such as rail and road networks. Digitalisation of port operations has also increased vulnerability to cyber-attacks and other technology failures. Biosecurity incidents, such as transfer of non-native, invasive species, have also put pressure on port operations with long-lasting reputational damage. Mitigating invasive species transfer can require significant resources.

Chronic stresses are also numerous. Ports are undergoing significant transformation to decarbonise and unlock the wider energy transition. This transition presents opportunities to enhance resilience but, if not undertaken

holistically, can create new vulnerabilities as decarbonisation planning is often undertaken independently from holistic resilience planning.

Ports often have a mix of modern and aging assets, situated in private and public realms, which are under pressure to deliver short-term productivity improvements. This issue can result in barriers to long term planning and adaptation, and place added stress on managing the health and safety of port operations.

Political changes and volatile trade relationships have led to additional shocks and stresses at ports. These include congestion at border controls, unclear drivers for forward planning, and increased regulatory burdens.

These challenges highlight that holistic port resilience needs to be integrated with wider port planning, and that a stable political economy that fosters long-term planning is key to enabling change. The issues noted also illustrate that unless a port is environmentally sustainable and delivering social value to its communities, it will struggle to become resilient.

Dozens of container ships waiting at sea to unload at the Port of Los Angeles during the Covid-19 pandemic (Image credit: Shutterstock)





# The case for port resilience – future challenges

Recent examples of port disruptions paint a picture of the diverse and complex nature of the shocks and stresses ports are facing across the globe. The world is full of disruptive forces, making it more volatile, uncertain, complex and ambiguous. This will increase the frequency, severity and complexity of the shocks and stresses that ports and their supply chains face in the future. Changes are happening at the fastest rates ever, and they are only likely to accelerate. Although we can draw lessons from recent events, the past is no longer a good predictor of the future.

The nature of and response to these interrelated disruptors means that ports must be prepared for the threats we can anticipate and be able to respond to those we cannot predict or avoid. This presents a need for ports to develop 'dynamic, holistic, resilience-based approaches' that will result in effective responses to deep uncertainties. This underpins the move from traditional risk management – where hazards and their impacts can be understood and mitigated – to resilience.

The effects of climate change are a key driver for port resilience. Knowledge and guidance on port climate adaptation have been developed by many parties (including [PIANC PTGCC](#) and [EnviCom](#), [UNCTAD](#), and [ESPO](#)) with [Navigating a Changing Climate](#) acting as a hub for best practice on climate change adaptation across the waterborne transport infrastructure sector, including ports. Our framework aims to sight these key resources within the big picture of action required.

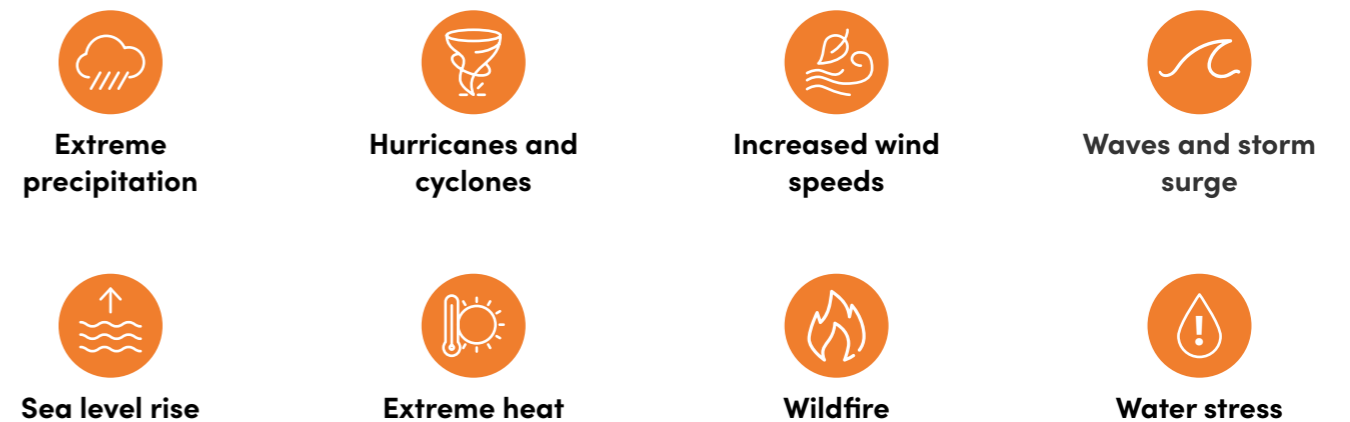
The past publication [Resilience Primer: Ports, An Industry Guide to Enhancing Resilience](#) report provides examples of hazards and impacts resulting from climate change. These impact across the port system affect physical and non-physical elements of ports as well as port interdependencies, including the connections with transport and energy systems. It is vital to recognise

the uncertainty in models of future climate scenarios and how they can result in cascading impacts to hazards and risks at a port level. Robust planning must embrace this uncertainty and plan for a wide range of futures using an adaptive pathway approach.

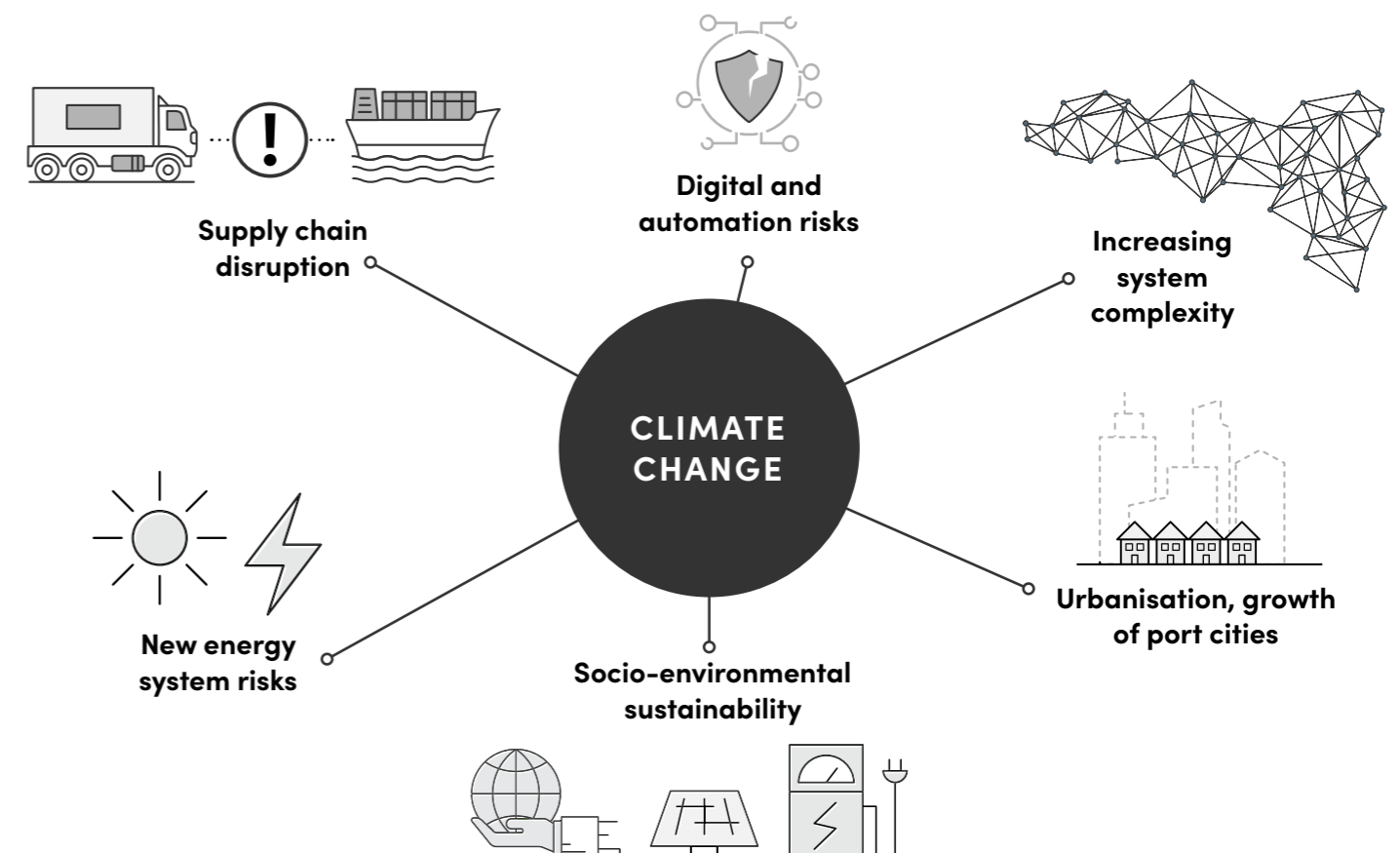
Ports must be resilient to climate change, but that is not enough. Undertaking climate adaptation can be a key entry point for a more holistic approach to enhancing resilience. This framework for action is appropriate for adapting to climate change and broader disruptors in an integrated way. Rapid urbanisation is increasing demands for ports, whilst escalating competition for space, on land and water. Decarbonisation – of and through ports – is changing patterns of traded goods and requiring an overhaul of port energy systems. The digital and automation agenda associated with port operations and logistics presents huge opportunities for enhancing resilience but can create new vulnerabilities and risks.

These issues can appear complex and overwhelming, but by integrating resilience with port planning and asset management processes, and by distributing actions across stakeholders, this framework provides a actionable approach that can be tailored to ports' local context.

## Climate change exposes ports to increasingly frequent and severe shocks and unpredictable stresses










## Climate change is a central disruptor for ports, amongst a range of others



# Who needs to come together to act and why should they?

Realising a shift in port resilience requires collective action across the value chain of ports, by their users, customers and civil society.

By bringing these actors together, giving them sight of the essential and connected roles that other stakeholders in the value chain are playing, and articulating what they are set to gain both individually and collectively, we can catalyse action at the scale to meet the challenges we face.

Actor	Descriptions	Key benefits
<b>GOVERNMENTS</b> 	National, sub-national and municipal levels of government including elected officials, public servants, and government agencies/authorities including regulators. Also includes intergovernmental organisations (IGO's) working across governments.	Supply chain challenges have highlighted the essential role of ports in the global economy and for local communities around the world. Action on port resilience can support the sustainable growth of economies and deliver tangible benefits to local people.
<b>PORT OWNER AND OPERATORS</b> 	Public-sector and private-sector companies that own and/or operate ports and terminals.	Action on port resilience can unlock investment, improve competitive advantage and help deliver wider port transformation. Further integrating ports internally and externally can deliver key efficiency and effectiveness gains.
<b>INVESTORS</b> 	Those involved in funding or financing ports including public finance institutions (national and sub-national as well as international financial institutions (IFI's)) and private finance institutions such as banks, infrastructure funds, and private developers.	As disruptive forces and uncertainty continue to grow around the world, action on infrastructure resilience is key to both short and long term financial performance. The investment required to decarbonise ports and their users is a key opportunity to embed resilience.
<b>DESIGNERS AND ADVISORS</b> 	Planners, architects, engineers, and other consultants involved in the design and operations of ports.	The integrated and holistic approach that resilience requires – taking a whole system view – is a key opportunity to innovate and realise positive outcomes for people and planet. Mastering this area is increasingly becoming a critical selling point of professional services firms.
<b>CONTRACTORS</b> 	National and international construction firms as well as small-scale, local contractors. Construction material supply companies and associated lobbyist groups.	Ensuring the delivery of resilience enhancements at an asset level and bringing innovative ideas for example in terms of materials, to implementation, can be a differentiator for contractors in a highly competitive maritime market.
<b>CIVIC SOCIETY</b> 	Non-governmental organisations (NGO's), community-based organisations, public and private universities and research institutions.	Closer integration between ports and their communities can deliver social value in a range of ways: human capital development supporting a 'just transition' to a low carbon and equitable economy; improved public realm and access to the waterfront fostering well-being and social cohesion; and integrated disaster preparedness and resilience planning.
<b>PORT USERS</b> 	These are direct users and customer of ports, on the land and water side.	Shipping lines, cargo interests and hinterland supply chain partners all stand to benefit greatly from resilient ports. Reduced incidence of delays, faster recovery from shocks and improved collaboration can improve supply chain performance and profitability.

# Port resilience framework for action

Enhancing port resilience requires action towards ten goals, across the three following dimensions:

## ECONOMY AND SOCIETY

Achieving port resilience will require action not just by the port sector, but by governments, investors, civil society and ports users/customers. These goals create an enabling platform for port resilience, reaching beyond the port boundary.

## LEADERSHIP AND STRATEGY

This area looks to align adaptation and resilience planning at a sector and port level, and between the range of actors involved in governing and operating a port. Port resilience requires a line of sight and consistency across government regulation, maritime sector strategies, port masterplans and port operators.







## INFRASTRUCTURE AND ECOSYSTEMS

Port infrastructure includes physical assets, but also people, energy and digital elements and the processes that link them all together. Ports are also embedded within and rely upon natural systems. These goals recognise resilience through action at an asset-level.



There are many actions being undertaken by a range of actors globally to enhance port resilience across the value chain of parts. The framework will help to link these actions together and identify key gaps. It will allow different actors to understand where their efforts contribute to a wider effort, helping to motivate action.

A background is described for each goal and an example priority action given to help illustrate the type of efforts envisaged for each of the three dimensions.

Goal	Key communities of practice
<p><b>1 Empowered and engaged port communities</b></p>	<ul style="list-style-type: none"> <li> Governments</li> <li> Port owner and operators</li> <li> Civic society</li> </ul>
<p><b>2 Port users working with ports to create resilient supply chains</b></p>	<ul style="list-style-type: none"> <li> Governments</li> <li> Port owner and operators</li> <li> Port Users</li> </ul>
<p><b>3 An enabling political and economic environment</b></p>	<ul style="list-style-type: none"> <li> Governments</li> <li> Investors</li> <li> Civic society</li> </ul>
<p><b>4 Effective disaster response and recovery</b></p>	<ul style="list-style-type: none"> <li> Governments</li> <li> Port owner and operators</li> <li> Investors</li> </ul>

Goal background
<p>Ports provide essential services to communities: connecting them via transport, providing goods and services, as well as jobs and training; and, improving the resilience of communities to coastal hazards.</p> <p>By engaging and empowering communities in all their forms - ports can build social capital, support sustainable economies, and reduce communities' exposure to shocks and stresses therefore helping to manage risks they cannot avoid or predict.</p>
<p>The action of port users/customers - including shipping lines, cargo interests and supply chain partners - affect ports ability to function amidst disruption (and vice versa). For ports to become resilient and foster resilience beyond their boundaries, they must work together with customer/users to reduce disruption and manage shocks and stresses by taking a holistic view.</p>
<p>The models of port ownership and the political-economic environment in which ports operate varies significantly around the globe. These factors have a strong influence on ports' opportunity and approach to enhancing resilience. A political-economy and finance sector that fosters long-term thinking, collaboration and innovation is critical to port resilience. There is a role for the private sector, third sector and civil society to influence this change.</p>
<p>Even stable and resilient ports may fail due to exceptional and unavoidable shocks and stresses. Having predefined, tested plans for response and recovery makes a significant difference to how severely an event affects a system. This applies to networks of ports within a country or region as well as to individual ports. A resilient port or port network has proactive, flexible and integrated approaches to identifying threats, responding to the failure and recovering the system. This guarantees the system is safe to fail. Recovery can also be an opportunity to rebound to a more resilient state than before the disaster.</p>

Example
<p><i>This might involve governments and port owners acting on port development that can unlock a 'just transition' for local communities.</i></p>
<p><i>This might involve governments creating incentives for collaborative action between shipping, ports and hinterland transport to reduce disruption at a transport system level.</i></p>
<p><i>This might involve governments and financial institutions fostering port ownership and governance structures that rewards long-term resilience decision making.</i></p>
<p><i>This could involve government co-ordination and finance sector funding of response and recovery plans across supply chain actors.</i></p>

5

**Regulations and national strategies that enable resilience**




Goal

Key communities of practice

-  Governments
-  Designers and advisors
-  Civic society


6

**Resilience at the centre of port masterplans**

-  Port owner and operators
-  Designers and advisors
-  Port users

7

**Integrated governance across the port system**

-  Port owner and operators
-  Port users
-  Civic society

Goal background

Ports and their users, as a result of their location at the boundary between land and sea and from their diverse activities, are affected by numerous regulations. These range in topics from health and safety and environmental protection to stakeholder engagement and port governance - and beyond.

Furthermore, Governments at all levels influence ports through maritime and adjacent sector strategies and programmes that set out short, medium and long term aims and actions for their implementation. Regulation and government strategies offer a key opportunity to embed resilience within and through ports, acknowledging the opportunities wider port transformation offer to enhance resilience, from digitalisation to decarbonisation and sustainability. There is a role for the private sector, third sector and civil society to influence this change.

Port masterplans, often led by port authorities, clarify the port's strategic plan for the medium to long term; assist regional and local planning bodies, and transport network providers in preparing and revising their own development strategies; and inform port users, employees and communities as to how they can expect to see the port develop in the coming years.

Embedding resilience within port master planning will help maintain a port's capacity to efficiently and sustainably provide the right services in the future whilst ensuring continuity of service. Centring resilience in decision making and communication at this stage can serve as a North Star for actions relating to infrastructure and ecosystems, as well as actors external to the port.

Ports are subject to varying systems of governance, but a common approach involves a range of different actors responsible for decision making in different spatial areas or at different levels (strategic, tactical and operational). These varying requirements are often there for a good reason, enabling specialisation and competition, for example, but can create silos that act as a barrier to enhancing resilience.

By integrating governance across the port system (e.g., between port owner, authority and operators) and with key external interdependencies (e.g., utility providers and local community leaders), a truly whole-system approach to port resilience can be unlocked.

Example

*This might involve governments shaping industrial strategies that centre resilience alongside productivity.*

*This might involve designers and advisors developing port ecosystem maps that take a systems view of ports, looking beyond infrastructure.*

*This might involve port owners and operators and users using digital platforms to collaborate on port operations and logistics.*

8

**Resilience embedded in asset planning and strategy**

Goal

Key communities of practice

-  Port owner and operators
-  Designers and advisors
-  Investors

Goal background

Port assets are diverse - they include anthropogenic physical assets such as quays, breakwaters and port equipment; natural assets such as sediments, harbours and reefs; and of course people. Increasingly, complex digital systems are also fundamental to port functionality. This section describes resilience goals for infrastructure and ecosystems, relevant at a port and terminal level. The goals aim to link with conceptual asset management models, such as that describes by the Institute of Asset Management (IAM).

Asset strategy and planning provides a line of sight between the port masterplan and wider asset management subject groups; to embed resilience, it must a) be adaptive and integrated and b) recognise asset vulnerability and criticality. This can apply to development of new ports and terminals, as well as management of existing port and terminals.

Example

*This might involve designers and advisors working with port owner and operators to develop climate adaptation plans, considering vulnerability and criticality of assets and the hazards they could be subject to.*

9

**Resilience integrated in wider asset management**

-  Port owner and operators
-  Designers and advisors
-  Contractors

There is a need for resilience to also be integrated into the wider asset management subject groups: organisation and people, asset management decision making, asset information, lifecycle delivery and risk and review – through a best-practice approach. This can apply to development of new ports and terminal assets (lifecycle delivery), as well as management of existing port and terminal assets. This includes a focus on people, new technologies and data, adaptive processes for managing assets and a robust and modern security strategy.

*This might involve designers and advisors embedding resilience during asset creation phase, with contractors ensuring the delivery of resilience enhancements during implementation.*

10

**Protection and enhancement of natural ecosystems**

-  Port owner and operators
-  Designers and advisors
-  Contractors

Nature delivers eco-system services to ports and their users: including storm protection, sources of energy and management of erosion. Nature linked to ports also delivers benefits to people and planet more broadly, providing habitats for diverse ecosystems, food and space for recreation. By protecting and enhancing natural assets, ports can reduce their exposure to shocks and stresses, align with regulation and build social capital with communities.

*This might involve port owners and operators working with designers and advisors as well as contractors to restore mangroves or oyster reefs around the port navigation areas.*

# Conclusion

This framework provides a line of sight for resilience from a policy level through to implementation at a port asset level. The actions are shaped to fit in and around the existing process by which new ports are realised and existing ports adapted and operated.

The framework is of course just the start. This provides an opportunity to bring together existing best practice across the sector, identify key gaps, and shape pilot projects for each goal. Ports, as gateways between ocean and terrestrial systems, are at the forefront of climate impacts – port actors understand the need to work with and not against nature. This makes the sector well placed to lead on the shift from risk management to holistic resilience.

This challenge can seem huge and at times complex, but, at its heart, resilience is about community: forging deep partnerships, working across silos and delivering value for people – all topics the port sector can excel at.

# Further reading

**For further reading on ports** from our portfolio of work please refer to:

*Resilience Primer: Ports, an industry guide to enhancing resilience*

<https://www.resilienceshift.org/publication/primer-ports>

*Resilience Shift Round Table: Ports and logistics*

<https://www.resilienceshift.org/publication/resilience-shift-round-table-ports-and-logistics/>

*Port energy supply for green shipping corridors*

<https://www.arup.com/perspectives/publications/research/section/port-energy-supply-for-green-shipping-corridors>

*Resilience4Ports: Gateways to a resilient future*

<https://www.resilienceshift.org/publication/resilience4ports-gateways-to-a-resilient-future/>

**For further reading on resilience frameworks** from our portfolio of work please refer to:

*The City Water Resilience Approach*

<https://www.arup.com/perspectives/publications/research/section/the-city-water-resilience-approach>

*Infrastructure Pathways*

<https://www.resilienceshift.org/infrastructure-pathways/>

*Energy Resilience Framework*

<https://www.arup.com/energy-resilience-framework>

*City Resilience Index*

<https://www.cityresilienceindex.org/>



