PRACTICAL CLIMATE CHANGE ADAPTATION SOLUTIONS FOR PORTS
Agenda

Keynote presentation: Robin Mortimer, Chief Executive Officer, Port of London Authority, UK

Climate change challenges and adaptation experience from Europe and the Middle East

- Joaquim Cortés, Head of Air Quality, Port of Barcelona, Spain
- Marc Eisma, Environmental Management Advisor, Port of Rotterdam
- Piotr Konopka, Senior Manager, Energy & Decarbonisation Programmes, DP World, Dubai

Panel discussion

Short break

Adaptation in practice

-Captain Karuppliah Subramaniam, General Manager of Port Klang Authority, Malaysia; President, International Association of Ports and Harbors
- Marika Gallas, Chief Executive Officer, NSW Ports, Australia
- Regina Asariotis, Chief, Policy and Legislation Section, UNCTAD
- Jan Brooke, Marine Environment Advisor, Peel Ports Group; Chair PIANC Permanent Task Group on Climate Change

Panel discussion

Closing remarks
Practical Climate Change Adaptation
London Experience

Robin Mortimer
Key elements of Port of London Approach

- **Top Down Commitment**
  - Board level support
  - Organisation Wide Process
  - Adequate Resources and Analytical capability
  - Integrated into risk management systems, ISO standards, BAU

- **External Partnerships and Communication**
  - Environment Agency (Thames Estuary 2100)
  - Thames Resilience Forum
  - Integrated into wider stakeholder communications
Step 1: Climate Analysis

What CLIMATE CHANGE means for the tidal Thames

Impacts of the mid-range change predicted for 2050, compared to a 1981–2000 baseline under the medium greenhouse gas emissions scenario (RCP4.5).

- Summer max air temperature of 36.3°C and more frequent heatwaves
- Increased peak river flow
- Increased wind speed in winter
- Increased number of fog days in winter
- 10% more rainfall in winter
- Sea level rise by 0.25m
- Increased annual mean temperature by 1.4°C
- Increased water temperature
- Increased wave height
- Increased frequency of flooding
- 12% less but more intense rainfall in summer

THAMES ESTUARY 2100 (TE2100)

Key facts from the Environment Agency’s ten-year Thames estuary plan review:
- Sea level rising at a rate of 1.4 mm per year between 1911 and 2018 and 3.66 mm per year between 1990 and 2018
- Thames Barrier is expected to be closed more frequently
- The majority of river flows have increased in the last 30 years

The fully reviewed flood defence plan for the Thames Estuary will be published by TE2100 in 2022.
Step 2: Impact and Risk Analysis

Impacts of Climate Change to the Port of London

Climate change could affect the operation of the Port of London in various ways.

**Economic**
- Remote sites less accessible for maintenance
- Increased risk of international supply chain interruption
- Shift in cargo type linked to consumer behaviour
- Increased electricity use for vehicles, vessels and machinery
- Increased dependence on energy providers
- Increased risk when developing new energy infrastructure

**Environment**
- Increased chance of non-native species colonisation
- Poor water quality due to increasing run off, temperature, water abstraction and discharge, changes in river flow and sediment movement
- Increased risk of heat exhaustion and UV exposure for all river users
- Coastal squeeze of saltmarshes due to rising sea levels and flood defence development
- Increased chance of bank erosion
- Increased chance of trees falling

**Safety**
- Poor summer air quality, due to higher temperatures, sunnier and less windy conditions
- Overhead bridge clearance (air draught) reduced due to increased sea/river levels
- Less favourable conditions for leisure activities afloat, due to extreme weather and increased river flows
- Disruption to the pilotage service, due to extreme weather and poor visibility
- Navigation channel depth affected due to change in sediment movement
- Potentially reduced operational window for hydrographic surveying
- Disruption in river traffic due to closure of flood defence barriers or closure of locks to retain water in the channel upstream

**Other**
- Climate change on the rail, road and water transport networks
- Increased chance of non-native species colonisation
- Poor water quality due to increasing run off, temperature, water abstraction and discharge, changes in river flow and sediment movement
- Increased risk of heat exhaustion and UV exposure for all river users
- Coastal squeeze of saltmarshes due to rising sea levels and flood defence development
- Increased chance of bank erosion
- Increased chance of trees falling
Step 3: Adaptation Plan - Actions Now & Adaptive Pathways

Adapting to Climate Change on the Thames

Safety
- Ebb tide flag warning system introduced to inform recreational users of river flow conditions.
- Check the weather, tide and Ebb flag before going on the river.
- Operating the Marine Safety Management System, including incident investigation.
- Information online, including tide tables, live tides, depths on tides, bridge heights and critical depths.
- Maintaining locks to ensure safe and reliable operations.
- Follow rules, guidelines and best practice for navigation on the tidal Thames.
- Monitoring the changes in riverbed.
- Upgrade tide gauges coverage.
- New surveying technologies to improve data collection efficiency.
- Support operators access to berths in line with safety requirements.
- Regular maintenance dredging to maintain water depth at berth.

Environment
- Developed the Thames Litter Strategy to combat the source of litter entering the Thames.
- Driftwood and debris recovery from the river by our passive debris collectors and driftwood vessels.
- Regular review of oil spill emergency plan.
- Reduce marine litter as much as possible.
- Report any incidents, i.e. oil spill, litter.
- Organise or join litter pick events.
- Use reusable water bottles and travel mugs.
- Maintaining team set up to maintain the riverbank between Kew and Putney.
- Working closely with the Environment Agency on flood defence, foreshore management and water quality.
- Working closely with water companies on their water management plans.
- Consume water sensibly.

Economy
- Continued investment in pilots recruitment and training, upgraded ship's bridge simulator.
- Avoid carrying pilots outside of the PLA's jurisdiction.

Awareness
- Publicising the impacts of climate change through different channels.
- Voluntarily submitted Climate Change Adaptation reports to DEFRA.
- Help us to spread our words through social media, news letters and public meetings.
- Participating at various resilience forums, partnership and working groups.
Climate Resilience – Low Winter Flows Over Teddington Weir
Climate Resilience – Usual Winter Flows Over Teddington Weir
Climate Resilience – Flag Warnings at Richmond Lock
Ports & National Adaptation Response

- Ports need to be active in engaging with wider national resilience planning

- Thames Estuary 2100
  - Future Location of Thames barrier
  - Development of Wider Estuary Flood Defences

- Potential Port Impacts
  - Impact on shipping – size and number of vessels passing through barrier
  - Impact on Berth Designs and cargo handling
  - Economic costs and benefits

- Work closely with Environment Agency…
Towards an emissions neutral port

Joaquim Cortes
Air Quality Manager
Environment Department

COP 26
Climate change challenges
and adaptation experience
Overview

Port de Barcelona actions in relation to Climate Change:

Global: Reduction of causes of CC

- Actions to reduce Green House Gas emissions of the logistic chain
- Ports are key actors: opportunity to influence in all sectors of transport of goods and persons: maritime, road, rail

Local: Actions to minimize local effects of CC

- Measures for Adaptation and Mitigation in the Port
Index

1. Decarbonization targets
2. Energy transition
3. OPS
4. Promotion of new clean fuels
5. Adaptation / mitigation
1. Decarbonization

Port of Barcelona Fourth Strategic Plan 2021-2025
Port Vision 2040

MISSION
TO GENERATE PROSPERITY IN OUR COMMUNITY, INCREASING THE COMPETITIVENESS OF OUR COSTUMERS BY PROVIDING EFFICIENT AND SUSTAINABLE LOGISTICS AND TRANSPORT SERVICES

VISION
SMART LOGISTICS HUB
The SMARTest logistics hub in the MED

S M A R T
Sustainable Multimodal Agile Resilient Transparent

THE GENERAL STRATEGIC OBJECTIVE FOR 2025 CAN BE SUMMARISED IN THE FIGURES 70/50/40

<table>
<thead>
<tr>
<th>Economic sustainability</th>
<th>Environmental sustainability</th>
<th>Social sustainability</th>
</tr>
</thead>
<tbody>
<tr>
<td>€70 billion in foreign trade value</td>
<td>50% electrified container and ro-ro wharves</td>
<td>40,000 people working at the Port</td>
</tr>
</tbody>
</table>
1. Decarbonization

GHG emissions from all the Port (in tons of CO2 eq)

- Vessels: 215,000
- Electrical consumption: 78,000
- Road traffic and activities: 20,000

GHG emissions of Port Authority (in tons of CO2 eq)

<table>
<thead>
<tr>
<th>Year</th>
<th>Electricidad</th>
<th>Movilidad y grupos auxiliares</th>
<th>Climatización</th>
<th>Emisiones GEI/trabajador</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>226</td>
<td>177</td>
<td>220</td>
<td>-</td>
</tr>
<tr>
<td>2015</td>
<td>255</td>
<td>183</td>
<td>252</td>
<td>0.7</td>
</tr>
<tr>
<td>2016</td>
<td>220</td>
<td>131</td>
<td>244</td>
<td>0.6</td>
</tr>
<tr>
<td>2017</td>
<td>224</td>
<td>123</td>
<td>167</td>
<td>0.4</td>
</tr>
<tr>
<td>2018</td>
<td>224</td>
<td>94</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2019</td>
<td>215,000</td>
<td>78,000</td>
<td>20,000</td>
<td>5.0</td>
</tr>
</tbody>
</table>

T CO2eq
T CO2eq/trabajador
1. Decarbonization

LOGISTICS:
10-11% Global GHG emissions

MARITIME TRANSPORT:
3% Global GHG emissions

Port of Barcelona GHG emissions
Objective 2030: 50% reduction
Before 2050: Carbon-neutral port

Source: McKinnon (2019) 'Decarbonizing Logistics'
Index

1. Decarbonization targets
2. **Energy transition**
3. OPS
4. Promotion of new clean fuels
5. Adaptation / mitigation
2. Energy transition

- Strengthening of energy saving and efficiency
- Promotion of renewable energies
- Electricity consumption sharing and storage
- Smart grid
Potential of photovoltaic power generation on surfaces and roofs in the port area: 92 MWp installed and 120 GWh of annual electricity production.

Currently: 4.6 MWp on warehouse roofs.
2. Energy transition

Encourage shared consumption and storage: Energy Community Project at the Fisherman's Wharf (CREATORS Project. Funding by Program H2020)

- 6 transformation stations
- Annual consumption of 682 MWh

- 4 photovoltaic installations 967 kWp
- Batteries storage: 530 kWh
- 92% electricity saving
- Total investment: 1.22 M€
Future new demands and new energy sources require future management of the electricity grid. Technology must be smart to always optimize use to reduce the cost of kWh and ensure the most sustainable combination.
Index

1. Decarbonization targets
2. Energy transition
3. **OPS**
4. Promotion of new clean fuels
5. Adaptation / mitigation
3. OPS

On-shore Power Supply (OPS) infrastructure requires 80 MW capacity for maximum peak demand. Electricity must be provided from High Voltage general grid 220kV.

GEG emissions reduction: 60 Tons CO2eq
By 2030 there will be OPS infrastructure available at the main docks.
Index

1. Decarbonization targets
2. Energy transition
3. OPS
4. Promotion of new clean fuels
5. Adaptation / mitigation
4. Promotion of new clean fuels

- From natural gas to H2
- From biodiesel to 2nd and 3rd generation biofuel
- Of synthetic hydrocarbons

Vessel redesign due to lower energy per volume: Increased storage
Electric or diesel-electric drives
4. Promotion of new clean fuels

Ports are key on the path to new fuels because they are a crossing point for transport chains and modal shift.

In the future, various fuels for ships will coexist:

- OPS
- AMMONIUM, BIOMETHANOL AND H2
- BIOFUELS
- SYNTHETICS, BIOMETHANE

- Supply infrastructure for various fuels
- Generation of renewable energy to produce renewable fuels
- Incentives program for ships and other transport modes
- Regulation and control of supply operations
4. Promotion of new clean fuels

Project to accelerate the change towards a clean fuels economy

- Create demand. Demonstrations and pilots
- Securing the value chain: stable framework
Index

1. Decarbonization targets
2. Energy transition
3. OPS
4. Promotion of new clean fuels
5. Adaptation / mitigation
5. Adaptation / mitigation

Expected main effects of Climate Change at the Port of Barcelona

Severe Weather Events: More frequent and stronger

❖ Winds: strong winds, storms

• Safety of navigation during maneuvering and mooring operations: risk of collision ship-dock or ship-ship

• Stay at berth: Risk of damage of bollards and defenses

• Safety for loading-unloading operations in port terminals
5. Adaptation / mitigation

Expected main effects of Climate Change at the Port of Barcelona

Severe Weather Events: More frequent and stronger

❖ Waves: Seawall overtopping. Sea Level Rise makes it worst.

• Reduction of the availability of the infrastructure

• Risk of damage of buildings and equipment existing on dock

• Risk of damage of moored boats: yacht marina
5. Adaptation / mitigation

Port response:

Information:

More accurate Weather Forecasts and communication to port managers, terminal operators, vessels

- 72h forecasts, run every 12 hours
- Meteo HARMONIE model
- Waves WAM model
- Overtopping SAPO model: Verification of forecast with VI-IR cameras

- Early warning system, referenced to operational thresholds
- Planning of activities and operations
5. Adaptation / mitigation

**Port response:**

- Regulations on operative limits: for land and sea activities
  - Revision of safety protocols:
    - Revision of decision taking criteria depending on activity: WiS, WiD, Hs, WaD
    - Update warning thresholds
    - Revision of operative conditions: p.ex. Number of tugs

- Strengthen the infrastructure:
  - Increase height of seawalls
  - Strengthen bollards
Thanks for your attention!
FLOOD RISK MANAGEMENT IN PARTNERSHIP
Port of Rotterdam at present climate proof
Port located outside the flood defence system, but RAISED

Sea level rise Delta Scenarios 2014:
2050: +0,15m to +0,35m
2100: + 0,35m to +0,85m
Flood risk adaptation strategies

- Botlek Vondelingenplaat 2015-2017
- Waal-Eemhaven 2017-2018
- Merwe-Vierhavens 2018
- Europoort 2019-2020
- Maasvlakte 2020-2021
- Dordrecht 2021
Flood risk adaptation strategies

- Botlek Vondelingenplaat 2015-2017
- Waal-Eemhaven 2017-2018
- Merwe-Vierhavens 2018
- Europoort 2019-2020
- Maasvlakte 2020-2021
- Dordrecht 2021
Approach and steps
- in partnership with companies and public organisations -

Approach:
- Creating awareness
- Information sharing + visualisation
- Joint Fact Finding
- Create common language and commitment!

Steps:
- Flood risk analysis
- Impact assessment (*workshop 1 with stakeholders*) + applying flood risk assessment framework
- Jointly building a flood risk adaptation strategy (*workshop 2 with stakeholders*)

Sea level rise Delta Scenarios 2014:
- 2050: +0,15m to +0,35m
- 2100: +0,35m to +0,85m
Stakeholder involvement right from the start

- **Companies**
  - Chemical industry
  - Refineries
  - Tank terminals
  - Distribution centres
  - Dry bulk terminals
  - Break bulk terminals
  - Power plants
  - etc.

- **Public organisations:**
  - Municipality of Rotterdam
  - Rotterdam-Rijnmond Safety Region
  - Environmental Protection Agency
  - Ministry of Water Management
  - Rail and road authorities

- **Utility owners**
  - Electricity
  - Gas
  - Water
ELEVATION MAP

Average height: +5,5m
Rough indication of the chance at present for flooding somewhere in the area: 1/10,000 year

Course of a flood:
- North West Storm wind force Beaufort 11-12
- Response time 1-2 days max
- Flood when water level > height of terrain (average +5.5m in Europoort)
- Salt water on terrain for max 1 - 2 days
Flood risk analysis

- Water depth 2015 (1/1,000 year storm) *

* Dutch Flood event 1953: 1/300 year storm
Flood risk analysis

Inundation [m]

2015: 1/100 year
2015: 1/1,000 year
2015: 1/10,000 year

2050 (W+): 1/100 year
2050 (W+): 1/1,000 year
2050 (W+): 1/10,000 year
Impact assessment
(workshop 1)

• Assessment of impact on:
  • (Deadly) casualties
  • Economy (direct and indirect)
  • Environment (air, water, soil)

• Quantitative approach (modelling of direct and indirect economical impact)

• Qualitative approach (workshops and interviews with stakeholders)
Impact assessment

2015: 1/100 year
2015: 1/1,000 year
2015: 1/10,000 year

2050 (W+): 1/100 year
2050 (W+): 1/1,000 year
2050 (W+): 1/10,000 year

Impact [€/m²]
Flood risk assessment framework

1. Definition of Limit State for a specific object
   - Difference between 2 Limit States: Functionality (Service Limit State - SLS):
   - Failure (Ultimate Limit State - ULS):

2a. Determine SLS / ULS
   - What is the chance that a SLS or ULS takes place in the present time and how does it change in time as a result of climate change?

3. Assessment if the object meets the SLS / ULS during its life span

Based on public assessment frameworks
(inside the flood defence system, “behind the dykes”)

Example ULS: Oil tank is damaged and causes environmental contamination of the surrounding area due to leakage of oil out of a tank. Repair will cost allot of money and months of work.

Result: insight if an object meets the acceptable SLS / ULS and if not, when does it become unacceptable in time (e.g. in 2060 in example above).
# APPLICATION OF THE ASSESSMENT FRAMEWORK
- COMPARISON OF THE IMPACT WITH THE ACCEPTABLE LEVEL OF RISK -

<table>
<thead>
<tr>
<th>Deelgebieden</th>
<th>Nu</th>
<th>2050</th>
<th>2100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Europoort</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deelgebied 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deelgebied 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deelgebied 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deelgebied 4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deelgebied 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deelgebied 6</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Legend:**
- Green = impact = still acceptable
- Yellow = impact = close to unacceptable
- Red = impact = unacceptable
“Risk dialogue”

- Combining preventive measures with spatial adaptation and emergency response.
- Cost-benefit analysis
- Gives insight in necessity of collaborative approach.
- Commitment and first steps to jointly follow up on the strategy.
Europoort flood risk adaptation strategy

Korte termijn
From 2050
To 2100
After 2100

Gebied
Area

1
2
3
4
5
6

Kade/ glooiing ophogen
Elevate quays/slopes
Ophogen / dry proofing
Wet / dry proofen assets, emergency & recovery plans
Gebiedsnood- en herstelplan
European emergency and recovery plan

short term
< 2050
< 2100
> 2100
Measures in progress

Korte termijn
Tot 2050

Na 2100

Gebied 6
Gebied 5
Gebied 3
Gebied 2
Gebied 1
Gebied 4

Kade/ glooiing ophogen
Ophogen / dry proofing
Wet /dry proofen
assets, noodplannen en
noodvoorzieningen
Gebiedsnood- en
herstelplan

• new embankment

• elevated quay
A safe port, now and in the future!
PRACTICAL CLIMATE CHANGE ADAPTATION CHALLENGES AND GOOD PRACTICE SOLUTIONS FOR PORTS

International Maritime Hub, COP 26

3rd November 2021
Our approach to achieve net zero carbon operations, is to primarily implement deep decarbonization measures where feasible and compensate for carbon emissions to reach the target.
CLIMATE CHANGE MITIGATION ASSESSMENT

We have created a tool to assess the resiliency of our ports & terminals across 3 criteria:

#1: Rising sea levels and flooding

#2: Increased adverse weather events

#3: Rising temperatures
CLIMATE CHANGE MITIGATION ASSESSMENT

Key findings

15 sites assessed

Future Sea Level
in many locations is not monitored by local agencies to inform the assessment

Adverse weather events
are not expected to severely impact equipment operation

Rising temperatures
and the impact on workforce was not a widely considered criterion

Motivation for assessment
longevity of investments

Capacity building
is required, particularly in developing countries where impacts may be worst

Operational excellence
As the low-hanging fruit in climate change resiliency

Way forward?
Setting up a cross-departmental working group
Thank you

Piotr Konopka
Senior Manager, Energy & Decarbonization Programmes
DP World
Piotr.Konopka@dpworld.com
PANEL DISCUSSION
PRACTICAL CLIMATE CHANGE ADAPTATION AND GOOD PRACTICE SOLUTION FOR PORTS

CAPT K. SUBRAMANIAM
General Manager, Port Klang Authority (PKA)
President, International Association of Ports and Harbors (IAPH)
CONTAINER THROUGHPUT 2020

90% WORLD TRADE IS MARITIME BASED
70% MARITIME TRADE CONVEYED BY CONTAINER SHIPS
50% NATIONAL THROUGHPUT VIA PORT KLANG
80,000 VESSELS PASSING THROUGH STRAIT OF MALACCA ANNUALLY

PORT KLANG PERFORMANCE

<table>
<thead>
<tr>
<th>Country</th>
<th>TEUs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. China</td>
<td>249.5 m</td>
</tr>
<tr>
<td>2. United States</td>
<td>43.5 m</td>
</tr>
<tr>
<td>3. Singapore</td>
<td>36.9 m</td>
</tr>
<tr>
<td>4. South Korea</td>
<td>27.3 m</td>
</tr>
<tr>
<td>5. Malaysia</td>
<td>26.7 m</td>
</tr>
</tbody>
</table>

TEUs Handling by Country

MALAYSIA PORTS

PORT KLANG

Penang Port 5.2%
Port of Tanjung Pelepas 37%
Johor Port 4%

90% WORLD TRADE IS MARITIME BASED
70% MARITIME TRADE CONVEYED BY CONTAINER SHIPS
50% NATIONAL THROUGHPUT VIA PORT KLANG
80,000 VESSELS PASSING THROUGH STRAIT OF MALACCA ANNUALLY

FEDERAL PORTS Under Marine Department
STATE PORTS

MALAYSIA PORTS

PORT KLANG PERFORMANCE

<table>
<thead>
<tr>
<th>TEUs</th>
<th>2019</th>
<th>2020</th>
<th>2021 (Jan - Sept)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Export</td>
<td>2,485,728</td>
<td>2,564,794</td>
<td>2,007,332</td>
</tr>
<tr>
<td>Import</td>
<td>2,548,714</td>
<td>2,556,427</td>
<td>2,007,793</td>
</tr>
<tr>
<td>Transhipment</td>
<td>8,546,397</td>
<td>8,123,202</td>
<td>6,419,304</td>
</tr>
<tr>
<td>Total</td>
<td>13,580,839</td>
<td>13,244,423</td>
<td>10,434,429</td>
</tr>
</tbody>
</table>
CLIMATE CHANGE IMPACT

ENVIRONMENT
- Higher Temperature
- Widespread Changes in rainfall patterns
- Increased risk of drought
- Ricing ocean levels
- Increased frequency of bad weather
- Erosion of shorelines
- Coral reef bleaching
- Tidal inundation of coastal areas

PORT
- Damage to infrastructure, equipment, road and cargo
- Air and water pollution
- Higher energy consumption for cooling
- Increases health risk for port workers
- Changes to port construction design
MALAYSIA’S GHG TARGET

MALAYSIA’S COMMITMENT

- Reduce GHG emission by 45% by 2030
- Towards net-zero GHG emissions as early as 2050

SUSTAINABLE PORT DEVELOPMENT

- Digitalisation
- Reduce carbon footprint
- Use of sustainable resource & operational practices

INITIATIVES
(Headed By Ministry Of Environment And Water)

1. Domestic Emissions Trading Scheme (DETS)
   - A scheme that involves the development
   - of a single platform for carbon credit
   - transaction at the domestic level
2. Increase new energy generation, 100% procurement of non-internal combustion engine (ICE) for government vehicles by 2030
3. Retaining at least 50% national forest coverage
4. Encourage zero – waste and recycling
5. Development of low carbon cities through Low Carbon Cities Master Plan
6. To improve on the engineering design for water related infrastructures, to ensure sustainable water management.
MALAYSIA MARITIME TRANSPORT INITIATIVES

Transport sector
- Utilises 40% of the energy
- Contributes approximately 30% of GHG

Waste Management
- Ballast water management
- Prevention & efficient response to oil and chemical spills
- Reduce / Reuse / Recycle
- Cleaner shipping and logistic industry throughout supply chain
- Water & Affluent Management
- Environmental Compliance

IMO Green Voyage 2050
- Global Partnership
- Commitment towards relevant climate change & energy efficiency goals
- 50% reduction in GHG emission from International Shipping by 2050

Malaysia Blue Economy
- To focus on port, shipping, marine transport and logistics
- To drive the maritime transport, ports & logistics industry using technological solutions for better stewardship of the environment and natural resources.

Port Safety, Health and Environmental Management System

Energy Management
Energy, electricity & fuel saving, clean shipping

Environmental Initiatives

Green Port Promotion
PORT KLANG’S INITIATIVE

RENEWABLE ENERGY & LOW CARBON FUEL
- Solar panel on warehouse rooftops
- LNG bunkering

ENVIRONMENT PROTECTION
- Dedicated waste management centre
- Ambient air and water quality monitoring
- Ship waste water treatment plant

ENVIRONMENTALLY FRIENDLY EQUIPMENT & FACILITIES
- Replacement of Diesel RTG with E-RTG
- Replacement of conventional light with LED light

GREEN PORT INITIATIVES

FUTURE PROJECTS
- LNG powered trucks and tug boats
- Electric forklifts
- Onshore power supply at new berths
- Waste to energy plant
- Port call optimisation Green Voyage 2050

GREENING THE ENVIRONMENT
- Garden port
- Mangrove rehabilitation
SHAPING A SUSTAINABLE FUTURE THROUGH ASSOCIATIONS

1. Work to resolve common issues and committed to a cleaner, safer and more environmentally-sustainable industry.

2. APSN is to promote economically and environmentally sustainable ports by strengthening cooperation, developing best practices and guidelines, enhancing supply chain effectiveness, building capacity and stimulating information and personnel exchange.

3. Facilitate the exchange of ideas and learn best practices.

4. Provide a venue for port officials concerned to meet and share experiences that may lead to finding solutions to identified problem areas and emerging issues affecting the port sector.
IAPH Technical Committee on Climate and Energy

1. IAPH – a non government / non profit International Association (port authorities / port terminals / logistics company / government authorities & academia)

2. 230 members from 90 countries

3. Primary objective of promoting port industry and facilitates global trade through sustainable development and harmonised practices

4. IMO MEPC – GHG emission reduction (submissions / interventions / workshops)

5. Coordination of the various initiatives on decarbonizing ports and shipping
Decarbonisation of shipping – Resolution MEPC.323(74)

Voluntary cooperation between ports and shipping on GHG emission reduction from ships

- Onshore Power Supply
- Safe and efficient bunkering of low/zero carbon fuels
- Port incentives
- Port call optimization and JIT
WPSP Port projects database

- Port of San Diego – ECOncrete Coastalock Blue Economy Pilot Project
- Port of Valencia – Increasing resilience to climate change
- Maryland Port Administration – Climate Change Adaptation & Stormwater Treatment

➤ Limited examples of Climate Adaptation projects - Call for additional contributions

https://sustainableworldports.org/portfolio/type/port-projects/
Joint initiative - Navigating a Changing Climate

PIANC led initiative on climate change mitigation and adaptation

2019 Survey on the impact of extreme weather events on port operations

https://sustainableworldports.org/pianc-navigating-a-changing-climate/
Climate adaptation in the ports’ context

Adapting Port Infrastructure

➢ Factoring in climate adaptation in new development projects

➢ Business case may be of challenge as recent report demonstrates

Impact on Port Operations

➢ Work closely with Pilots, Harbour masters, terminal operators to define challenges and adjust as needed
CONCLUSION

1. Fast action needed to tackle environment issues
2. Strategies to face future climate challenges & disruption using digital technology in every aspect of the industry
3. Commitment to reduce emission & GHG to protect the environment towards developing a sustainable industry for the future
4. Climate Adaptation/Resilience is being addressed as part of the work programme of the IAPH Technical Committee on Risk and Resilience
5. IAPH is an active partner at the NaCC Initiative that is expected to have an increased focus on adaptation in the years to come.
6. More work is needed and IAPH is willing to work with relevant stakeholders on further initiatives targeting both infrastructure and operations
Thank you for your attention!
Adaptation in Practice
Practical climate change adaptation challenges and good practice solutions for ports

Presentation at COP26 International Maritime Hub
Marika Calfas
3 November 2021
Who is NSW Ports?
Key trades handled for NSW:

**Port Botany**
- Containers (2.7m TEU)
- Refined petroleum (Fuel - 5B L)
- Bitumen
- LPG
- Bulk chemicals

**Port Kembla**
- Motor Vehicles (338k)
- Agricultural products
  - Fertiliser, grain
- Bulk liquids
  - Diesel, lubricants, chemicals
- Project cargo
  - Large machinery
- Construction Materials
  - Cement clinker, gypsum, steel
- Minerals
  - Copper, Zinc, Coal, Iron ore

- $4.4 billion to NSW GSP p.a.
- 29,400 jobs
- Supported by port operations

29,400 jobs
$4.4 billion to NSW GSP p.a.
Supported by port operations
Assessing the climate risk in 2015

Original Scope

- Port Botany and Port Kembla.
- Identifying and assessing risks that a changing climate may pose to current & future developments for NSW Ports.
- Determining the adaptation planning approaches that can be implemented to minimise climate change associated risks.
- Based on IPCC 2007 data and in line with the AS:5334 Climate Change Adaptation for Settlements and Infrastructure.
Key climate risk insights identified in 2015

KEY HAZARDS
- Intensive rainfall storm events
- Increase in average temperatures & extreme heat events
- Increased wind events/average wind speed
- Climate change policy affecting import/export revenue

RELATED RISKS
Mostly focused on condition and capacity of infrastructure:
1. Damage to road surfaces and yard pavements
2. Drainage system capacities exceeded
3. HVAC failure for buildings and offices – extreme heat

Some operational and commercial risks identified:
4. Wind and swell impacts on ship movements, mooring security and cargo handling
5. Potential reductions in trade volumes for climate sensitive and emissions intensive cargoes (e.g. grain, coal)

CONCLUSION: Anticipated effects of climate change on NSW Ports should be “manageable” with current engineering and asset management practices combined with some adaptive practices…”
Actions following 2015 risk assessment

- Active monitoring and recording of adverse weather conditions that lead to suspensions of pilotage, port closures, etc.

- Strengthened our Port Kembla breakwaters and seawall in response to weather events. 4-year monitoring program, including above water and below water surveys quantify changes to the breakwater structure, and allows for targeted maintenance.

- Analysed the limiting wind conditions in which the capacity of the existing mooring infrastructure at various berths can safely hold the vessel fleet using those berths.

- Dynamic Under Keel Clearance technology for Port Botany has helped to ensure transit safety by integrating real-time data and AI enhanced forecasts into navigational decision making. This contributes to port resilience in the face of more frequent extreme weather events.
Assessing climate risk today

What’s different?

- Scope now expanded to also include:
  - NSW Ports intermodal terminals
  - All maritime & landside activities and assets.
  - Vulnerability of key connecting freight routes (road and rail) and utilities (e.g. electricity, pipelines)
- Uses National & State data aligned to IPCC 2013 modelling.
- Review the effectiveness of existing control measures and systems, recommending improvements to optimise resilience and adaptive capacity.
- Increased awareness of weather-related impacts on port operations and assets.
# Climate change projections for NSW Ports

<table>
<thead>
<tr>
<th>Hazard type</th>
<th>Data availability</th>
<th>Key data point and source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sea level rise/coastal inundation</td>
<td>GOOD</td>
<td>Under RCP8.5, current day 100 year extreme sea level event to occur once every 5 years by 2050, and 10 times per year by 2100 (RCP8.5; CMSI).</td>
</tr>
<tr>
<td>Extreme winds/storms</td>
<td>DATA DEFICIENT</td>
<td>5-30% reduction in number of East Coast Lows by 2050, but shifting southward with more severe events (IAG &amp; CMSI).</td>
</tr>
<tr>
<td>Swells/wave action</td>
<td>DATA DEFICIENT</td>
<td>Changes likely, localised effects require additional research (CMSI).</td>
</tr>
<tr>
<td>Extreme rainfall</td>
<td>FAIR</td>
<td>Increased peak rainfall intensity, Australian Rainfall &amp; Runoff Guidelines 2019 assumes 5% per degree of warming (AR&amp;R).</td>
</tr>
<tr>
<td>Extreme heat</td>
<td>GOOD</td>
<td>On average across all sites, annual days over 35°C more than tripling by 2065 (NARCliM 1.5).</td>
</tr>
<tr>
<td>Bushfire (indirect)</td>
<td>GOOD</td>
<td>Days per year with extreme fire danger conditions increasing 20% per degree of warming (CMSI).</td>
</tr>
<tr>
<td>Large hail</td>
<td>FAIR</td>
<td>“Marked increasing trend in east and south-east Australia in frequency of hail events exceeding 2cm in diameter”; southward shift of areas at greatest risk (IAG &amp; NCAR).</td>
</tr>
</tbody>
</table>
# 2021 Assessment - Summary of key climate change risks

<table>
<thead>
<tr>
<th>Risk</th>
<th>2035</th>
<th>Δ*</th>
<th>2065</th>
<th>Δ*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swell disrupts pilotage and ship movements</td>
<td>Significant</td>
<td>↑</td>
<td>Significant</td>
<td>↑</td>
</tr>
<tr>
<td>Wind disrupts ship movements, mooring and cargo handling</td>
<td>Moderate</td>
<td>↑</td>
<td>Significant</td>
<td>↑</td>
</tr>
<tr>
<td>Wave damage to breakwaters and revetments</td>
<td>Moderate</td>
<td>↑</td>
<td>Significant</td>
<td>↑</td>
</tr>
<tr>
<td>Disruption due to overloading stormwater system and overland flooding</td>
<td>Moderate</td>
<td>-</td>
<td>Significant</td>
<td>↑</td>
</tr>
<tr>
<td>Extreme heat impacts on power supply, building HVAC systems &amp; equipment</td>
<td>Low</td>
<td>-</td>
<td>Moderate</td>
<td>-</td>
</tr>
<tr>
<td>Road surface and yard pavement damage due to extreme heat</td>
<td>Low</td>
<td>↓</td>
<td>Low</td>
<td>↓</td>
</tr>
<tr>
<td>Long-period waves disrupts mooring (some Port Kembla berths)</td>
<td>Moderate</td>
<td>New</td>
<td>Significant</td>
<td>New</td>
</tr>
<tr>
<td>Hail impacts on cargo (e.g. vehicles) and yard equipment</td>
<td>Significant</td>
<td>New</td>
<td>Significant</td>
<td>New</td>
</tr>
<tr>
<td>Health impacts from exposure to bushfire smoke</td>
<td>Significant</td>
<td>New</td>
<td>Significant</td>
<td>New</td>
</tr>
<tr>
<td>Incursion of new marine pests – subtropical and tropical species</td>
<td>Moderate</td>
<td>New</td>
<td>Significant</td>
<td>New</td>
</tr>
<tr>
<td>Supply chain disruptions due to flooding, bushfire, landslip</td>
<td>Various</td>
<td>New</td>
<td>Various</td>
<td>New</td>
</tr>
</tbody>
</table>

Δ* - change relative to 2015 risk assessment
Example of supply chain infrastructure risk exposure mapping

Road freight exposure to climate related hazards

Legend
- High Landslide Risk
- Medium Landslide Risk
- Low Landslide Risk
- Bushfire prone area
- High
- Medium
- Low
- Overall risk score
  - High
  - Medium
  - Low

Analysis by WSP

NSW Ports
Future Direction of 2021 Climate Risk Report

• Study will be complete in December 2021, but early indications suggest organisational focus on:
  − Building greater understanding and partnership with port and supply chain infrastructure operators / managers.
  − Further analysis of key hazards and assets, especially those impacted by extreme weather events i.e. breakwaters, stormwater systems
  − Assembling long term local data sets regarding weather-related disruptions

• Engage with supply chain infrastructure owners on risk exposure mapping outcomes.

• Incorporate Climate Change Risk Assessment in the context of NSW Ports’ new Sustainability Strategy (2022).
Recent extreme weather events impacting New South Wales

- 2015 & 2018 dust storms over Sydney
- 2016 storm damage at Port Kembla
- 2020 bushfire smoke
- 2021 Nepean/Hawkesbury River flooding
Thank you
International Maritime Hub at COP 26, Glasgow

Practical climate change adaptation challenges and good practice solutions for ports:
Adaptation in practice

3 November 2021

Climate change adaptation for ports in SIDS
- key issues, challenges and approaches

Regina Asariotis
Chief, Policy and Legislation Section, UNCTAD
regina.asariotis@unctad.org
unctad.org/ttl/legal
Seaports are critical for global trade & development but are at risk of climate change

- Over 80% of volume of world trade carried by sea (port-port)
- Ports: key nodes in the network of closely interlinked international supply chains - gateways to global markets and the blue economy
- Globalization: interconnectedness/interdependence

Climate change will have direct and indirect impacts:

Sea-level rise; changes in temperature, humidity, precipitation; extreme storms and floods under climate change likely to:

- affect port infrastructure and operations; hinterland transport; and the broader global supply-chain - significant potential for damage, disruption and delay – extensive economic/trade related losses
- exacerbate other transport-related challenges, including for SIDS/vulnerable economies; increase energy needs and costs

Climate change adaptation and resilience building for ports is of strategic economic importance – especially in the light of growing hazards (Climate change impacts on seaports: a growing threat to sustainable trade and development, UNCTAD2021)

https://www.shipmap.org/
Hazard projections for global ports under CV & C: Extreme sea level (ESL)

All global ports affected, with effects worsening as the SWL increases

Even under SWL of 1.5 °C, the return period of the baseline 1-in-100 years ESL will decrease to every 1 to 10 years in many S. American, African, Gulf S. East Asian and Pacific ports

Under a SWL of 3 °C, many global ports will experience the baseline 1-in-100 years ESL several times per year

Projected changes in the return period of the baseline (mean of 1986-2014) 1-in-100 years ESL under CV & C for about 3700 global ports. Key: SWL (Specific Warming Level) in °C above pre-industrial times. Tr (years) return period. Seaport location from World Port Index 2019 https://msi.nga.mil/Publications/WPI; hazard modelling results from JRC-EC
Hazard projections for global ports under CV & C: Extreme Heat

All global ports will be affected, with the effects worsening as the SWL increases.

Even under a SWL of 1.5 °C, the return period of the baseline (1976-2005) 1-in-100 years extreme heat event will decrease (down to every 1 to 5 years) in most tropical/subtropical settings.

Under a SWL of 3 °C, most global ports (except some ports in higher latitudes) will experience the baseline 1-in-100 years event at least every 2 years.

- Important implications for health & safety; energy needs/costs
- Energy efficiency/renewables/decarbonization: Important co-benefits

Projected changes in the return period baseline (mean of the period 1976-2005) 1-in-100 years extreme heat event at about 3700 global ports. Key: SWL (Specific Warming Level) in degrees (°C) above pre-industrial times. Tr (years) = return period.
<table>
<thead>
<tr>
<th>Factor/hazard changes</th>
<th>Impacts on Seaports</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean sea level rise (SLR)</td>
<td>Permanent inundation risk making ports inoperable without port elevation/coastal protection; changes in port and key transit access (e.g. the Kiel Canal); insurance issues</td>
</tr>
<tr>
<td>Increased extreme sea levels (ESLs); changes in wave energy/direction</td>
<td>Increasing frequency/depth of facility flooding and damages; losses due to operational delays; breakwater instability, scouring and overtopping from storm waves; increasing protection costs; wave penetration affecting operations; navigation channel silting-higher dredging requirements; insurance issues</td>
</tr>
<tr>
<td>Precipitation: Changes in means and/or in the intensity, type and frequency of extremes causing pluvial/fluvial flooding</td>
<td>Infrastructure flooding and damages; poor manouvrability of locks and vessels from changes in water level and speed; poor visibility from increasing fogs</td>
</tr>
<tr>
<td>Temperature: Higher means; heat waves; changes in warm/cool days</td>
<td>Deterioration of paved areas; inoperable cranes; navigational equipment/cargo damages; higher energy consumption for cooling; health/safety issues for personnel/passengers</td>
</tr>
<tr>
<td>Reduced arctic snow cover and ice</td>
<td>New arctic shipping routes, longer seasons, lower fuel costs; reductions in snow/ice removal costs; but arctic seaports will face increasing sea storm hazards</td>
</tr>
<tr>
<td>Permafrost degradation</td>
<td>Ground subsidence, slope instability, drainage issues, affecting port structural integrity</td>
</tr>
</tbody>
</table>
| Wind: Changes in frequency/intensity of extreme events                               | Damages to terminals and navigation equipment; problems for vessel navigation and port berthing; difficult crane operations above certain wind speeds                                                                 7
Respondent ports collectively handle more than 16% of global seaborne trade

Survey revealed:
• Majority of respondents had been impacted by weather/climate related events, including by extremes
• Important gaps in information available to seaports of all sizes and across regions with implications for effective climate risk assessment/adaptation

Key messages: Better data/information needed; mainstream CC considerations; ‘piggyback’ climate resilience when upgrading infrastructure/operations

Other surveys related to transport/ports provide similar results (e.g. UNECE, 2013; NaviCC 2020)
Transportation Infrastructure: Timeframes vs. Climate Impacts

Source: Savonis, 2011
The special case of the SIDS

- Small (land mass/economies/population), remote & highly vulnerable to external shocks; large dependency on imports (i.e. international transport); high transport costs

  *Key concerns: connectivity and transport costs (accessibility/affordability)*

- High exposure to natural disasters and CV & C; low adaptive capacity

- Ports (and coastal airports): critical lifelines for external trade, food, energy, tourism and DRR - These assets are threatened by sea level rise and extreme events (storms)

**Climate-resilience of ports is vital for the sustainable development of SIDS**

*Ports within 50 km of tropical sea storm tracks (1960–2010) Data: Knapp et al. (2010). (Becker et al., 2013)*
Port Risk under Climate Variability and change (CV & C)

Risk of impacts is a function of:

**Climatic hazards** - changing climatic factors, dependent on climate scenario/emissions

**Exposure** of port infrastructure/operations to hazards

**Vulnerability** – depends on capacity to respond to factors that make ports prone to damages/losses from hazards, e.g. availability of technologies and materials for port defenses, elevation; human and financial resources; policy, legislation and management

Note: The IPCC risk definition differs from that of the Insurance Industry which defines risk as a function of the probability of the damaging event(s) and the magnitude of damages/losses: low probability events incurring large losses are high risks
Marine flood maps:
(a, c, e) George Charles Int. Airport; Castries seaport; (b, d, f) Hewanorra Int. Airport; Vieux Fort seaport for the: 1-100 year extreme sea level event, ESL100 (1.5°C SWL, 2030); 1-50 year extreme sea level event, ESL50 (2050, RCP4.5); ESL100 (2100, RCP8.5). (Monioudi et al, 2018, Reg Env Change; IPCC 2018; IPCC SROCC 2019)

Exposure - Coastal flooding projections under CV & C:

SIDSport-ClimateAdapt.unctad.org – 8 Ports and Airports in Jamaica and Saint Lucia

Exposure needs to be understood to adapt effectively

Requires assessment at local / facility level

All international transport assets (seaports/airports) of Saint Lucia are at high risk, under all scenarios, and from as early as 2030s
Exposure – Operational Disruptions under CV & C:

SIDSport-ClimateAdapt.unctad.org
Exposure – Operational Disruptions under CV & C:

SIDSport-ClimateAdapt.unctad.org

The operational thresholds method

- Identify operational thresholds
- Collect climate data (historical and future projections)
- Determine exposure to temperature, precipitation, and other climate hazards
- Assess current exposure (historical and present disruptions)
- Assess future exposure (future disruptions)

Gathering Operational Thresholds

<table>
<thead>
<tr>
<th>Component</th>
<th>Hazard</th>
<th>Example Threshold</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ports</td>
<td>Extreme heat</td>
<td>1°C warming = 5% increase in energy costs</td>
<td>Energy costs</td>
</tr>
<tr>
<td></td>
<td>Flooded</td>
<td>Deterioration of infrastructure</td>
<td>Inundation of infrastructure</td>
</tr>
<tr>
<td></td>
<td>Coasts</td>
<td>Heavy rain</td>
<td>Inundation of infrastructure</td>
</tr>
<tr>
<td></td>
<td>Hurricanes</td>
<td>Storm surge</td>
<td>Deterioration of infrastructure</td>
</tr>
<tr>
<td></td>
<td>Wind</td>
<td>Sustained winds</td>
<td>Deterioration of infrastructure</td>
</tr>
<tr>
<td></td>
<td>Airports</td>
<td>Extreme conditions</td>
<td>Deterioration of infrastructure</td>
</tr>
</tbody>
</table>

1Heat index is a function of temperature and relative humidity. See http://www.weather.gov/wxc/sahhi/heat_index.shtml. For a relative humidity of 70%, a heat index over 32°C (90°F) is “hazardous” for human health.
Operational thresholds method

**SIDSport-ClimateAdapt.unctad.org** – 8 Ports and Airports in Jamaica and Saint Lucia

*On how many days per year will identified operational thresholds be exceeded under climate change?*

**Some key findings** – at 1.5°C Specific Warming Level, by 2030

- **Staff working outdoors at ports** and airports will be at ‘high’ risk for 5 days/year (Jamaica) and 2 days/year (Saint Lucia)

  N.B. Depending on climate scenario, high risk days **may increase to 30 d/y and 55 d/y** (2081-2100)

- **In Jamaica**, Boeing 737-800 **aircraft** will have to **decrease their take-off load** for 65 d/y at SIA and 24 d/y at NMIA

- **Baseline energy requirements** will increase by 4% for 214 d/y at Jamaican ports and 168 d/y at Saint Lucian ports

Energy efficiency, decarbonization and renewables may offer important co-benefits for adaptation, energy security and costs
Action needed to adapt and build resilience

Accelerate action to ensure that by 2030 critical transport infrastructure is climate resilient to 2050 (cf. MPGCA Milestones for ‘Transport’ and ‘Resiliency’) - will be key in achieving progress on many SDGs (incl. 9, 13, 14 and 1.5)

High-quality risk and vulnerability assessments, based on the best available science/data needed to improve understanding of impacts on ports, guide effective adaptation responses and prioritization of resources

• Improve data collection/availability; plan early (asset lifespan); adopt systems approach; avoid maladaptation/over-engineering;

• Mainstream CC considerations in port infrastructure planning/operations;

• Ensure funding for technical studies to inform priorities, effective policies, plans, action;

• Increase capacity building (human resources, at local levels) and better access to affordable climate finance;

• Ecosystem approaches to adaptation: important elements in any future strategy;

• Successful adaptation strategies need to be underpinned by strong legal, regulatory and policy frameworks; as well as standards (eg ISO 14090), guidance (eg PIANC), methodological tools (eg UNCTAD)

• Integrate relevant considerations into National Adaptation Plans and NDCs
Many thanks!
**UNCTAD PLS: climate change implications for maritime transport**

<table>
<thead>
<tr>
<th>Year</th>
<th>Follow-up</th>
<th>Event</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>Follow-up</td>
<td>Joint UNECE-UNCTAD Workshop: <em>Climate change impacts and adaptation for international transport networks</em>&lt;br&gt;UNECE Group of Experts on Climate Change Impacts and Adaptation for International Transport Networks&lt;br&gt;2013 EG Report - <em>Climate Change Impacts and Adaptation for International Transport Networks</em>&lt;br&gt;2020 EG Report - <em>Climate Change Impacts and Adaptation for International Transport Networks</em></td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td></td>
<td>UNCTAD Ad Hoc Expert Meeting: <em>Addressing the Transport and Trade Logistics Challenges of SIDS: Samoa Conference and Beyond</em>&lt;br&gt;UNCTAD Multiyear Expert Meeting: <em>Small Island Developing States: Transport and Trade Logistics Challenges</em></td>
<td></td>
</tr>
<tr>
<td>2017-18</td>
<td></td>
<td>UNCTAD Port-Industry Survey on Climate Change Impacts and Adaptation</td>
<td></td>
</tr>
<tr>
<td>2015-2017</td>
<td>Follow-up</td>
<td>UNCTAD DA Project - SIDSport-ClimateAdapt.unctad.org <em>Climate change impacts on coastal transport infrastructure in the Caribbean: Enhancing the adaptive capacity of Small Island Developing States (SIDS)</em>&lt;br&gt;Monioudi et al., <em>Climate change impacts on critical international transportation assets of Caribbean SIDS: the case of Jamaica and Saint Lucia</em>, Reg Environ Change 2018: 2211</td>
<td></td>
</tr>
<tr>
<td>2021</td>
<td></td>
<td>UNCTAD Multiyear Expert Meeting: <em>Climate Change Adaptation for Seaports in Support of the 2030 Agenda</em></td>
<td></td>
</tr>
</tbody>
</table>
Climate Change Adaptation Planning for Ports

Jan Brooke
PIANC – The World Association for Waterborne Transport
Chair, Permanent Task Group on Climate Change
Presentation at Practical Climate Change Adaptation Solutions for Ports conference
COP26 International Maritime Hub, 2nd – 3rd November 2021
• PIANC – the World Association for Waterborne Transport Infrastructure, established 1885 [https://www.pianc.org/]

• Provides the global waterborne transport community with expert guidance and technical advice

• Technical Commissions include MarCom, InCom, RecCom, EnviCom

• Permanent Task Group on Climate Change PTGCC: a cross-Commission group dealing with climate issues and related guidance

• Three recent climate-related guidance documents: carbon management (WG 188), resilience of maritime and inland waterborne transport systems (WG 193) and adaptation planning (WG 178)
Stage 1: Understand context and set objectives

1.3 Indicate the Susceptibility of Assets, Operations and Systems

1.1 Set Goals

1.2 Identify Critical Assets, Operations and Systems

1.4 Identify Relevant Stakeholders and Encourage Ownership

1.5 Determine Adaptation Objectives

1.6 Consider Data Needs and Data Management

STAGE 2
Stage 1: Key considerations

Stage 1: engage with stakeholders, develop goals, prepare inventory of critical infrastructure, establish roles and responsibilities, set objectives

- **Interdependencies**: onward transport, utilities, services, other sectors, local communities, etc. – internal and external collaboration can help to identify mutually beneficial solutions and thus reduce adaptation costs

- **Criticality**: can relate to business continuity needs; network connectivity issues; threshold exceedances; health and safety requirements; etc.

- **Adaptive capacity**: to what extent can an asset or system cope with change? Monitoring and awareness are vital for informed decision making

- **Acceptable level of risk**: the basis for setting adaptation objectives
Stage 2: Collate climate data

2.1 Establish Climate Information Needs

2.2 Understand Baseline Conditions

2.3 Explore Possible Future Climate Conditions

2.4 Analyse Data to Understand the Climate Change Hazard

STAGE 3
Stage 2: Key considerations

Stage 2: understand baseline conditions and future climates (projected changes)

• In addition to projected **trends** in weather-related, hydro-meteorological or oceanographic parameters, take account of increases in the frequency or severity of **extreme events**, and possible **joint occurrences**

• To reduce the risk of **maladaptation** (implementing a measure that proves inadequate or excessive) develop and use a range of plausible climate change **scenarios**; can include ‘most likely’ and ‘worst case’ scenarios

• The **planning horizon** is important!
Stage 3: Assess vulnerabilities & risks

3.1 Agree Approach to Vulnerability Assessment
3.2 Establish Changes in Susceptibility
3.3 Agree on Risk Indicators and Assess Vulnerability
3.4 Select an Appropriate Level of Risk Analysis
3.5 Assess Likelihood
3.6 Assess Consequences
3.7 Summarise Risk Assessment Outcomes

STAGE 4
Stage 3: Key considerations

Stage 3: identify and assess risks, exposure, vulnerability, adaptive capacity, costs and consequences of inaction, timing of impacts, overview of risks

- **Risk assessment** can be simple or complex, but vulnerability assessment may suffice
- Change in climate parameters can have a **range of consequences**, positive as well as negative; direct and indirect
- Preparing a simple **colour-coded matrix**, highlighting the main risks, can be a useful aid to decision making
Stage 4: Assess adaptation options

4.1 Understand Implications of Uncertainty

4.2 Use the Portfolio of Measures

4.3 Screen List of Possible Measures to Derive Options

4.4 Evaluate Shortlist of Options

4.5 Develop Adaptation Pathways

4.6 Prepare Adaptation Strategy

4.7 Implement Adaptation Strategy
<table>
<thead>
<tr>
<th>Physical measures</th>
<th>Social measures</th>
<th>Institutional measures</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Structures</strong>; <strong>systems</strong>; <strong>technologies</strong>; <strong>services</strong></td>
<td><strong>People</strong>; <strong>behaviour</strong>; <strong>operations</strong>; <strong>information</strong></td>
<td><strong>Governance</strong>; <strong>economics</strong>; <strong>regulation</strong>; <strong>policy</strong></td>
</tr>
<tr>
<td>Prioritise maintenance to maximise resilience and improve adaptive capacity</td>
<td>Undertake climate change risk assessment; prepare risk maps</td>
<td>Prepare strategic level climate change adaptation strategies</td>
</tr>
<tr>
<td>Install real time monitoring infrastructure</td>
<td>Prepare and raise awareness of contingency; emergency or disaster response plans</td>
<td>Review and revise relevant codes of practice; standards, specifications or guidelines to accommodate changing conditions</td>
</tr>
<tr>
<td>Relocate vulnerable assets out of high risk areas</td>
<td>Introduce and regularly review warning systems</td>
<td>Review health and safety requirements and revise if needed</td>
</tr>
<tr>
<td>Invest in redundancy; temporary infrastructure or other back-up provision for critical assets (including power and water supply)</td>
<td>Prioritise asset inspection</td>
<td>Introduce penalties for non-compliance with standards</td>
</tr>
<tr>
<td>Reinforce, raise, strengthen or otherwise protect or modify critical assets</td>
<td>Educate workforce; stakeholders; local communities</td>
<td>Require zoning of assets; operations or activities based on risk</td>
</tr>
<tr>
<td>Install or develop new; responsive or demountable infrastructure or equipment</td>
<td>Liaise and coordinate with utilities and other service providers; develop information-sharing protocols</td>
<td>Use local regulations (e.g. byelaws) to reduce risks, especially in multi-use locations</td>
</tr>
<tr>
<td>Install warning equipment</td>
<td>Improve (or instigate) monitoring; record keeping and data management; consider cyber-security issues</td>
<td>Encourage relocation out of high risk areas</td>
</tr>
<tr>
<td>Nominate or provide physical sanctuaries</td>
<td>Undertake trend analysis or forecasting</td>
<td>Collaborate with land-use planning systems (e.g. to introduce set back or buffer areas)</td>
</tr>
<tr>
<td>Increase storage capacity</td>
<td>Develop revised operational protocols; modify working practices as conditions change</td>
<td>Limit new infrastructure development in high risk areas</td>
</tr>
<tr>
<td>Install multi-modal equipment</td>
<td>Introduce and implement adaptive management procedures; base operations or working arrangements on monitoring outputs</td>
<td>Identify; secure and coordinate alternative transport routes or modes</td>
</tr>
<tr>
<td>Apply Nature-Based Solutions; Working with Nature; soft engineering</td>
<td>Allow for flexibility and responsiveness in programming (staffing rotas; vessel scheduling; lock operation; etc.)</td>
<td>Promote reduced insurance premiums if improved resilience is demonstrated</td>
</tr>
<tr>
<td>Install treatment or reception facilities</td>
<td>Revert to traditional; low tech; ways of operating</td>
<td>Set up contingency or disaster response fund</td>
</tr>
<tr>
<td>Incorporate flexibility in new or replacement infrastructure design to allow for modification as conditions change</td>
<td>Ensure availability of transport and accommodation for personnel during an incident</td>
<td>Introduce and enforce build-back-better policy</td>
</tr>
<tr>
<td>Modify material or equipment selection to accommodate changing conditions</td>
<td>Temporarily or permanently restrict activities in high risk areas</td>
<td>Facilitate diversification in facilities; employment as conditions change</td>
</tr>
<tr>
<td><strong>Nominate safe routes and areas; identify diversions</strong></td>
<td>Identify and exploit interconnectivity and intermodal options to maintain business continuity during events</td>
<td>Improve legal protection for vulnerable habitats with risk reduction role (e.g. absorbing wave energy; providing erosion protection)</td>
</tr>
<tr>
<td><strong>Provide training on new tools; codes of practice; procedures or protocols; ensure importance of redundancy is understood</strong></td>
<td>Provide grants or incentives (e.g. for development or maintenance of resilient infrastructure)</td>
<td>Research and develop novel tools and methods</td>
</tr>
<tr>
<td><strong>Facilitate technology transfer</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Stage 4: **Key considerations**

Stage 4: identify, screen, evaluate, implement and monitor measures, prepare an adaptation strategy, manage data effectively

- Consider **consequences of inaction**/incremental cost of climate-resilience
- Climate change will often need **innovative, flexible solutions**
- Prepare **adaptation pathways**; consider temporary or **low-regret** measures
- Retrofitting can be costly and complex; understand **adaptive capacity**
- Option **evaluation** can be simple but note that conventional evaluation methods may not be the most appropriate for use in climate change decision making
Role of monitoring

Develop **monitoring** and **data management** programmes to inform decisions on *when* action is needed

- Monitor **asset condition**, operational characteristics, performance at system level
- Collect data; where relevant develop **real-time** monitoring and **early warning** systems
- Record costs/consequences of extreme events/disruption to support **business case**
- **Monitoring** does not need to be sophisticated; must be **fit-for-purpose**
- Effective data management is critical to **just-in-time** decision making
- Prioritise **maintenance** to maximise resilience, improve adaptive capacity
- **Adaptive management** can help deal with uncertainties but needs data
Thanks for listening!

https://www.pianc.org/publications/envicom/wg178
jan@janbrooke.co.uk
PANEL DISCUSSION
THANK YOU