Climate Resilience

PORT OF AÇU CASE

Overall Context

Ports around the world are already experiencing the consequences of air and water temperature increases, rising sea levels and changes in seasonal precipitation, wind, and wave patterns.

From a global perspective, the climate change effects associated with global warming are projected to escalate in coming decades and will represent a significant risk to business, operations, safety, and infrastructure. Therefore, **is an urgent matter for ports to act in order to strengthen resilience and adapt to future climate conditions.**

Given the global and national perspectives regarding the impacts of climate change, Port Administration coordinated a Work Group to tackle climate resilience at Port of Açu. The project was developed in collaboration with terminal operators - Ferroport, Vast Infraestrutura and GNA -, Port of Antwerp International and technical support of Deltares, and enabled a comprehensive assessment of the port's overall infrastructure and key operations facing future climate scenarios and the identification of its vulnerabilities.

GOALS:

- Evaluate possible future climate scenarios for port region;
- Estimate the vulnerability of key port operations under scenarios and define potential adaptation strategies;
- Incorporate such information into future port planning, providing technical grounds for investments, engineering designs, and enhance port competitiveness.

The Project

The Project covered a series of technical studies undertaken to evaluate potential impacts of climate change effects on the Port's operations and infrastructure, in a three-stage methodological framework to support Port of Açu to understand and plan its adaptation.

Phase 1

Determine the current climate environmental conditions and compile the available projection of possible future scenarios (sea level, winds, waves and precipitation)

Phase 2

Estimate the vulnerability of key port operations under future scenarios

Phase 3

Identify and implement recommendations arising from Phase 2

PHASE 1

Present and future climate scenario at Port of Açu

Emissions scenarios were applied for Port region and modelled at three different timescales: **2040, 2070 and 2100.**

Climate parameters considered:

- SEA LEVEL
- WINDS
- PRECIPITATION REGIMES
- WAVES

Two emissions (IPCC) scenarios considered: Representative Concentration Pathways (RCP)* 4.5 and 8.5 (intermediate and worst-case climate change scenarios)

PHASE 1

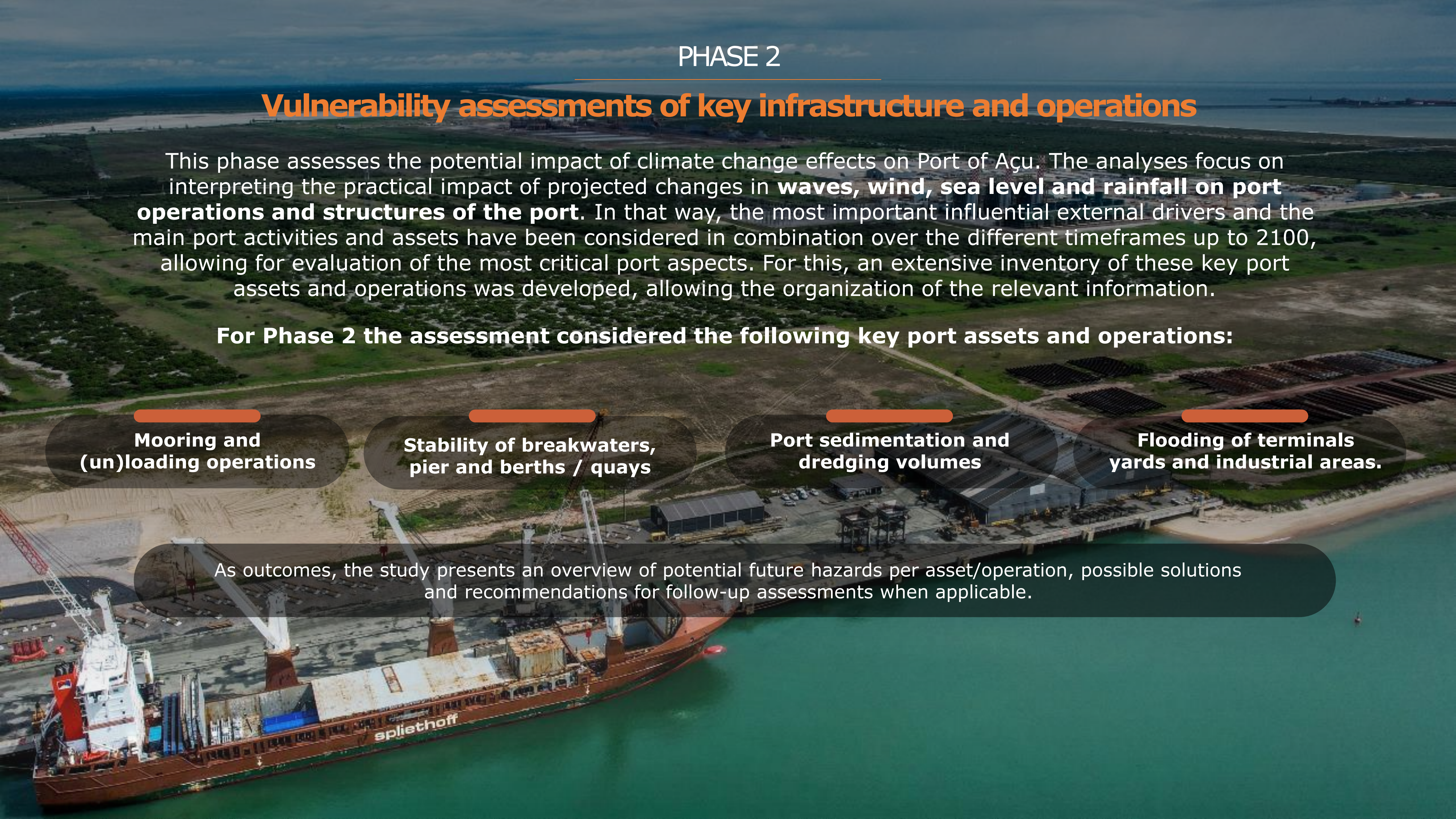
Present and future climate regime at Port of Açu

The projections indicate that the port location is very favorable, showing only limited changes in environmental climate conditions.

The table below summarizes **the changes in analyzed variables by the end of the 21st century**, following the results of the literature cited within the report:

Environmental Conditions	Global Carbon Cenarios (RCP)	Average Regime			Extreme Regime		
		2040	2070	2100	2040	2070	2100
Mean Sea Level	Intermediate	↑0,09m	↑0,26m	↑0,48m	⊖	⊖	⊖
	Worst Case	↑ 0,11m	↑0,38m	↑0,78m			
Wind	Intermediate / Worst Case	+1% change in yearly mean speed	+4% change in yearly mean speed	+10% change in yearly mean speed	⊖	⊖	+2,0% change in highspeed winds
Wave	Intermediate / Worst Case	⊖	⊖	-Mean Wave: negligeble -Significant wave Height; ↑ +3% winter, ↓ -3% summer	⊖	⊖	↑+2,0% change in Significant wave Height
Rainfall	Intermediate	⊖	↓ -2,5% in yearly mean preciptation	↓ -5,0% in yearly mean preciptation	⊖	Annual max. 1-day Preciptation: +2,5%	Annual max. 1-day Preciptation: +2,5%
	Worst Case					Annual max. 1-day Preciptation: +7,5%	Annual max. 1-day Preciptation: +2,5%

Mean Sea Level Wind Wave Rainfall ⊖ Smaler than changes by 2100 (this neglegible)



PHASE 2

Vulnerability assessments of key infrastructure and operations

This phase assesses the potential impact of climate change effects on Port of Açu. The analyses focus on interpreting the practical impact of projected changes in **waves, wind, sea level and rainfall on port operations and structures of the port**. In that way, the most important influential external drivers and the main port activities and assets have been considered in combination over the different timeframes up to 2100, allowing for evaluation of the most critical port aspects. For this, an extensive inventory of these key port assets and operations was developed, allowing the organization of the relevant information.

For Phase 2 the assessment considered the following key port assets and operations:

- **Mooring and (un)loading operations**
- **Stability of breakwaters, pier and berths / quays**
- **Port sedimentation and dredging volumes**
- **Flooding of terminals yards and industrial areas.**

As outcomes, the study presents an overview of potential future hazards per asset/operation, possible solutions and recommendations for follow-up assessments when applicable.

PHASE 2

Vulnerability assessments of key infrastructure and operations

No significant risks to key port assets and operations were identified for the short-term (decade) related to climate change at port area. Presently available projections indicate generally mild effects of climate changes to the analyzed parameters also towards the end of the century (2070+), limiting the consequences to operations and infrastructure. However, climate projection uncertainties become wider over the longer term, making monitoring and update assessments of prime importance within the next decades.

The table below relates climate projections (**hazard**) with the port's critical assets and operations (**vulnerability**).

	SEA LEVEL	WINDS	RAINFALL	WAVES
Projections 2100	0,48m - 0,78m sea level rise	10% increase in yearly mean speed and 2% increase in extreme events	5% decrease in yearly mean precipitation with increase of 2,5% - 20% on extreme events	Significant wave heigh: 3% winter, -3% summer
Vulnerability assessment	No significant risks to key ports assets and operations were identified.	Need close monitoring of cargo handling sensitive to wind and vessels maneuvering - may require adaptation actions on long term.	Dry bulk terminals more vulnerable to extreme rainfall events (i.e. contaminated runoff)	Projected changes are very small - only toward 2100 reaching noticeable effects.

PHASE 3

Projected climate change effects to possible new infrastructures

This phase provides a practical interpretation on projected climate change effects at Port do Açu in relation to possible new infrastructure developments at the port. It considers the key design and operational environmental variables influenced by climate change: water level, waves, wind, and precipitation.

Changes in mean conditions may be combined with changes in extremes for operational assessments, including downtime assessments. Extreme conditions are typically governing for stability analyses of, e.g., structures. The timescale of assessing the projected changes in conditions should be consistent with the project timescales (e.g., design lifetime of the structure).

The robustness of the present-day layout of a port, and how much ‘margin’ is included in the design of structures and in facilitating port operations, will form a large factor in how much impact projected changes in ambient conditions may have on that port in the future.

PHASE 3

Recommendations to increase port climate resilience

The results of the study were incorporated on Port’s Management by Port Administration:

- Investments on improving Port’s **meteoceanographic monitoring system**
- Maintain and **improve data collection of climate parameters**
- Implement **early warning system** integrated to Weather forecast at Port’s control center
- Incorporate the assessment results in the **engineering criteria for new port developments**
- Implement additional monitoring to further **understand the sediment dynamics**
- Update the assessments every 10 - 20 years to verify trends and developments

Main takeaways

- The Location of Port of Açu can be considered favorable from a climate change perspective. The results also indicate that possibly more relevant changes are projected to occur in the long term (2070+) in mean sea level, wind, and precipitation conditions.
- No new adaptation measures were anticipated to be necessary in the short and medium term. The port will be able to maintain and improve its operability and performance in the short term, remaining vigilant and prepared for possible changes in environmental conditions in the future.
- The results obtained were incorporated into future port planning, providing technical grounds for new investments, engineering designs, and enhance port resilience.
- The methodology of the climate resilience study of the Port of Açu can be used for other ports. It emphasizes the importance of using local analysis as it differentiates local effects of climate change from global averages.