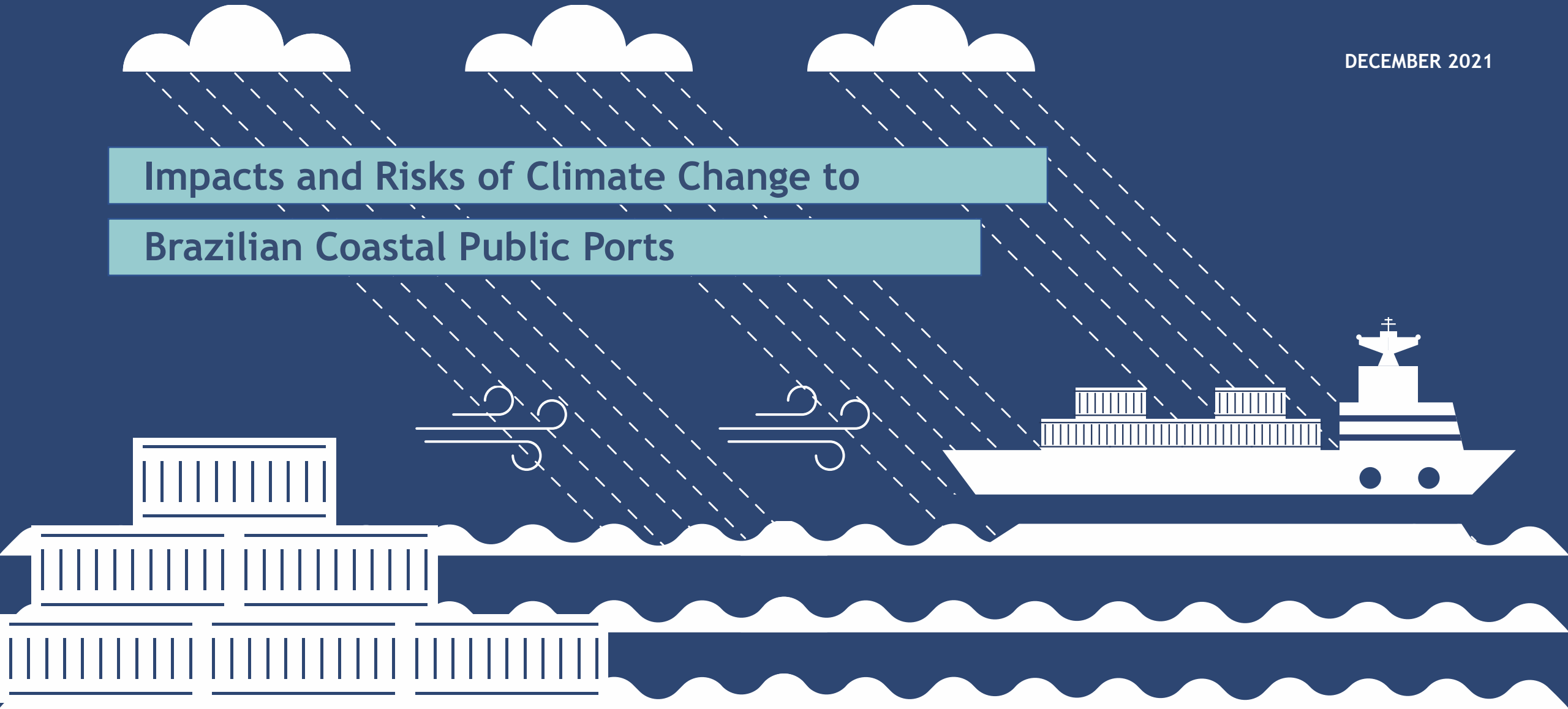
DECEMBER 2021

Impacts and Risks of Climate Change to Brazilian Coastal Public Ports



On behalf of:
Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
of the Federal Republic of Germany

Implemented by:
giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

PROADAPTA | CSI
Climate Change Adaptation

INPE

ANTAQ
Agência Nacional de Transportes Aquaviários

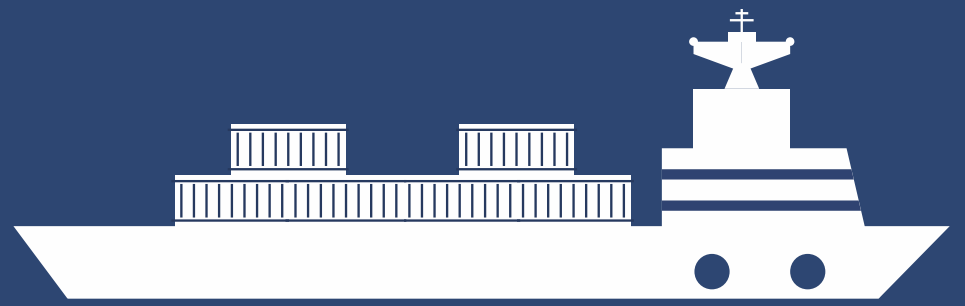
MINISTÉRIO DO MEIO AMBIENTE

MINISTÉRIO DA INFRAESTRUTURA

MINISTÉRIO DA ECONOMIA

PÁTRIA AMADA BRASIL
BRAZILIAN GOVERNMENT

2. OBJECTIVES



Identify the impacts and risks of climate change to public ports on the Brazilian coast, and to offer general recommendations of adaptation measures.

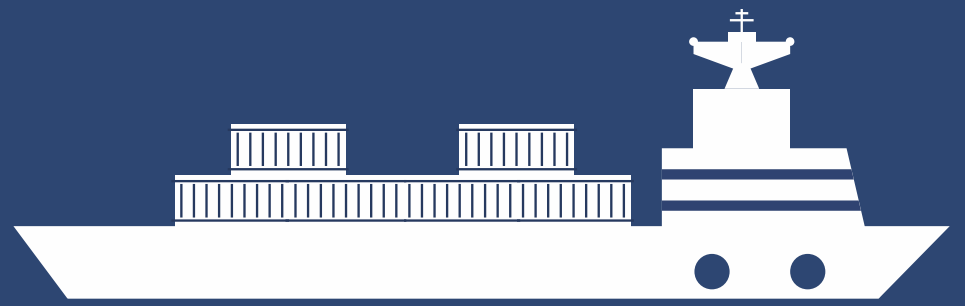
21 PUBLIC COASTAL PORTS

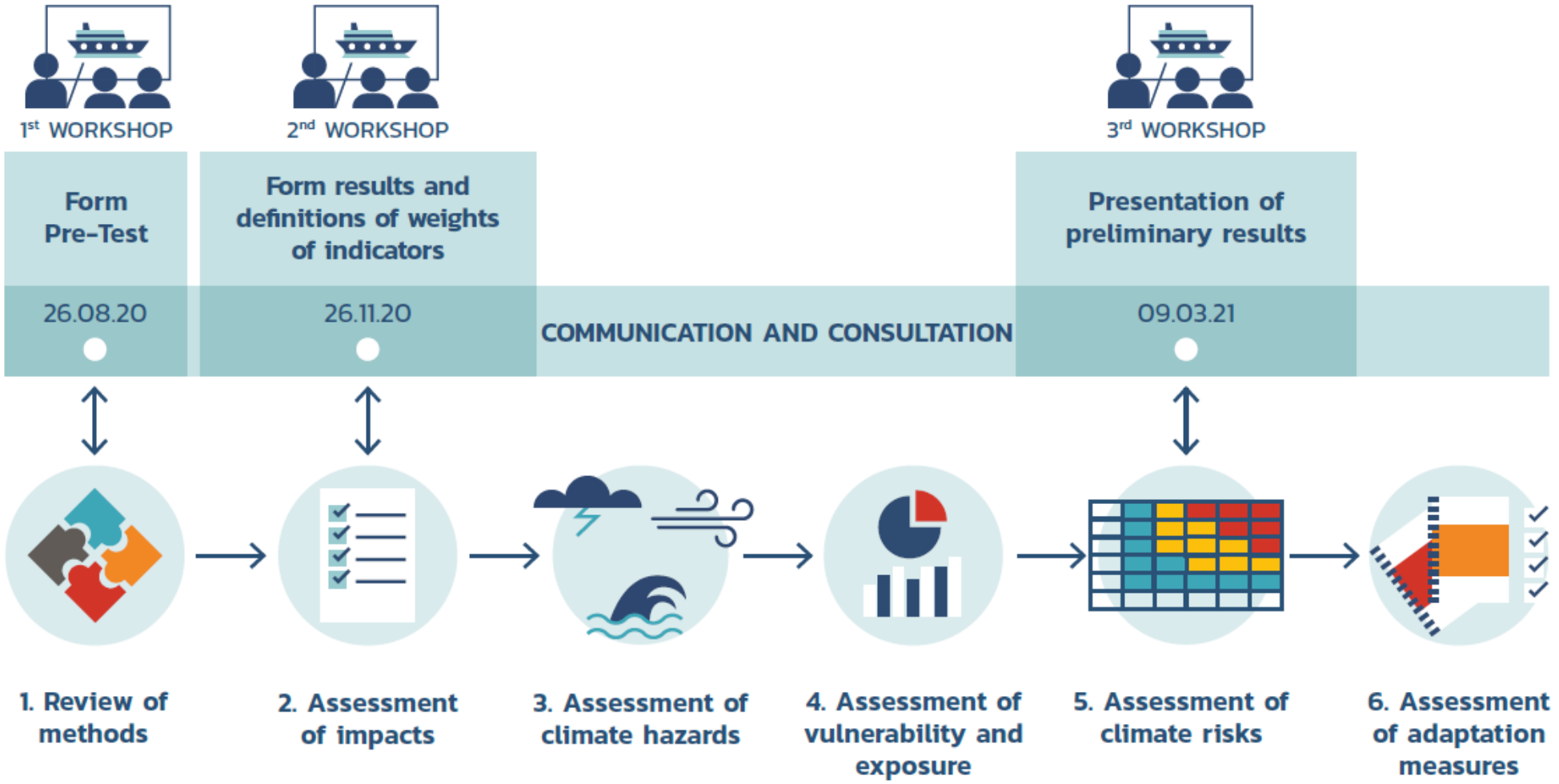
- Angra dos Reis;
- Aratu-Candeias;
- Cabedelo;
- Fortaleza;
- Ilhéus;
- Imbituba;
- Itaguaí;
- Itajaí;
- Itaqui;
- Natal;
- Niterói;
- Paranaguá;
- Recife;
- Rio Grande;
- Rio de Janeiro;
- Salvador;
- Santos;
- São Francisco do Sul;
- São Sebastião;
- Suape;
- Vitória.

ID	Porto	ID	Porto
1	Itaqui	12	Rio de Janeiro
2	Fortaleza	13	Itaguaí
3	Natal	14	Angra dos Reis
4	Cabedelo	15	São Sebastião
5	Recife	16	Santos
6	Suape	17	Paranaguá
7	Aratu	18	São Francisco do Sul
8	Salvador	19	Itajaí
9	Ilhéus	20	Imbituba
10	Vitória	21	Rio Grande
11	Niterói		

Prepared by: WayCarbon, GIZ, ANTAQ (2021).

3. METHODOLOGY





Prepared by: WayCarbon, GIZ and ANTAQ (2021).

CLIMATE HAZARDS SELECTED

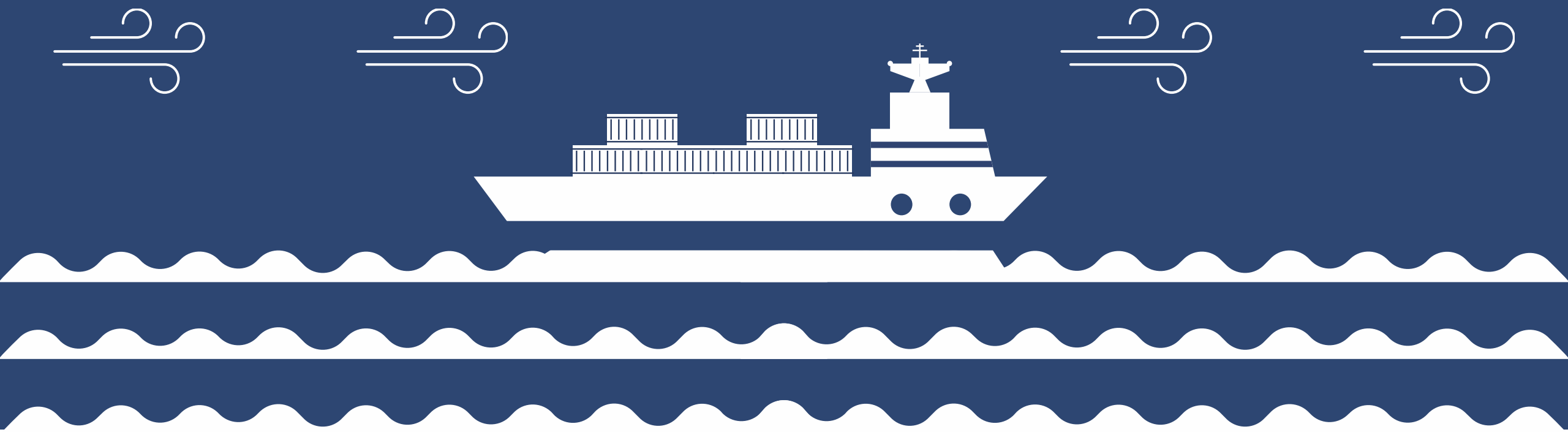
STRONG WINDS

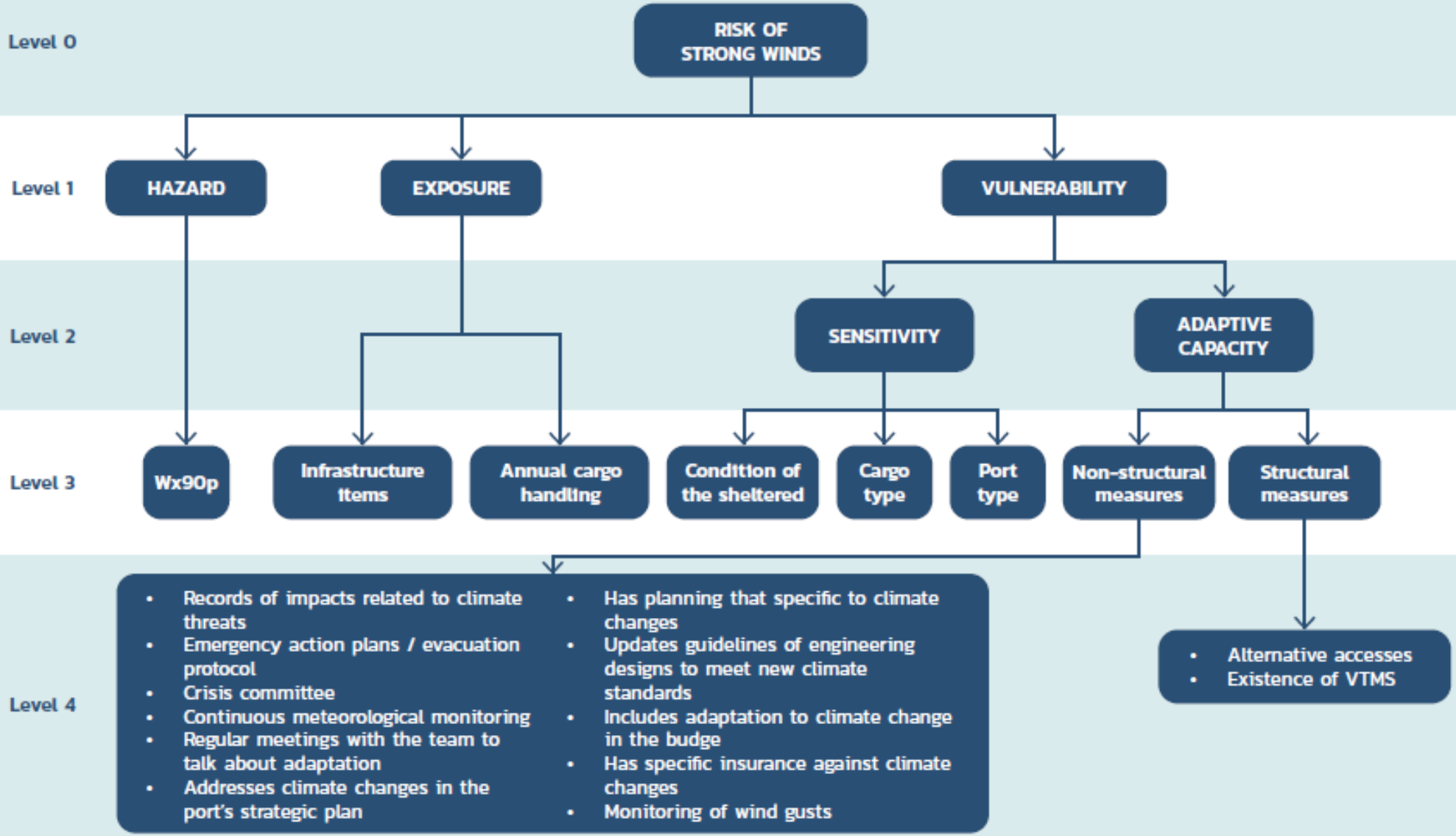
THUNDERSTORMS

SEA LEVEL RISE

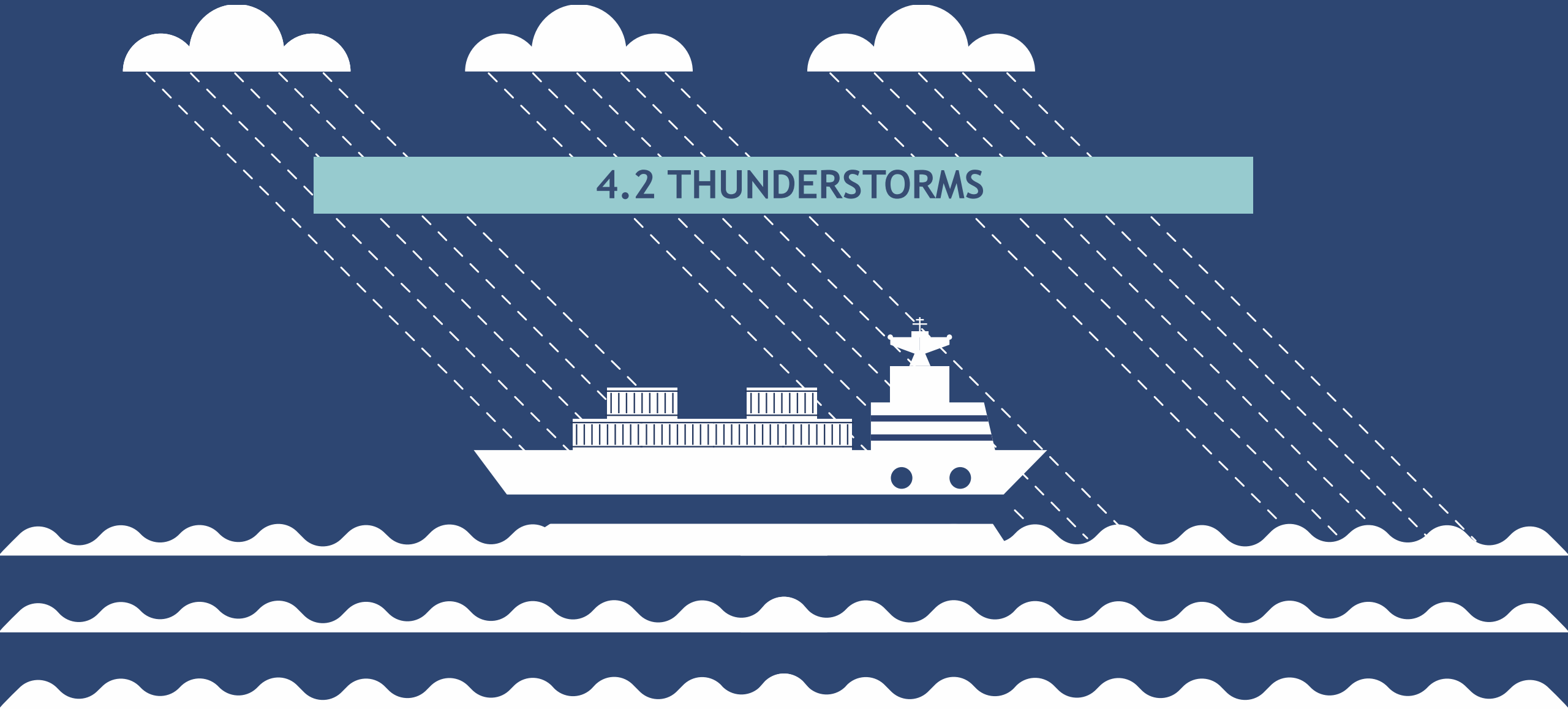
IPCC (2014)

4.1 STRONG WINDS

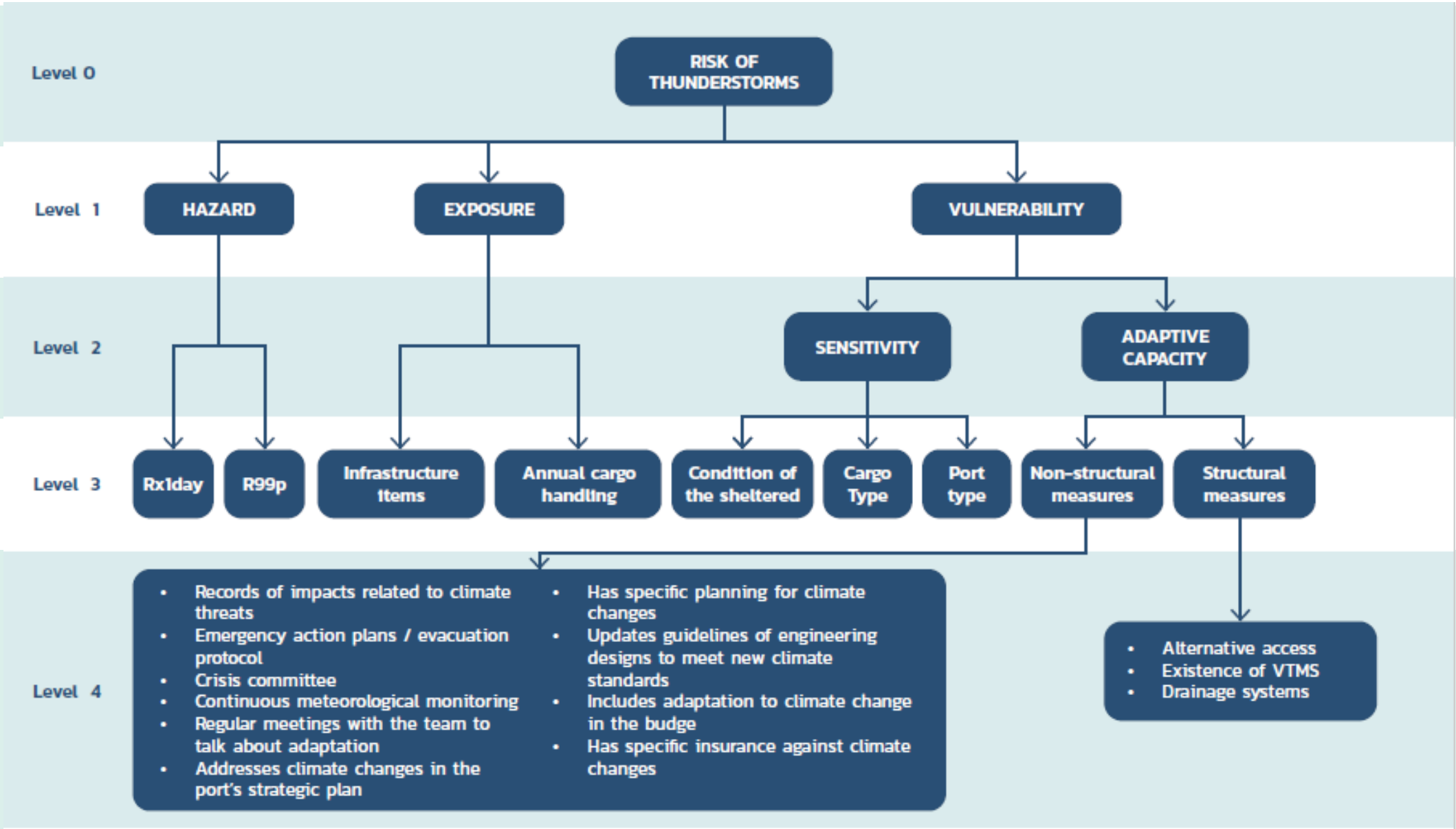



Level 0
RISK OF STRONG WINDS
Level 1
HAZARD
EXPOSURE
VULNERABILITY
Level 2
SENSITIVITY
ADAPTIVE CAPACITY
Level 3
Wx90p
Infrastructure items
Annual cargo handling
Condition of the sheltered
Cargo type
Port type
Non-structural measures
Structural measures
Level 4
• Records of impacts related to climate threats
• Emergency action plans / evacuation protocol
• Crisis committee
• Continuous meteorological monitoring
• Regular meetings with the team to talk about adaptation
• Addresses climate changes in the port's strategic plan
• Has planning that specific to climate changes
• Updates guidelines of engineering designs to meet new climate standards
• Includes adaptation to climate change in the budge
• Has specific insurance against climate changes
• Monitoring of wind gusts
• Alternative accesses
• Existence of VTMS

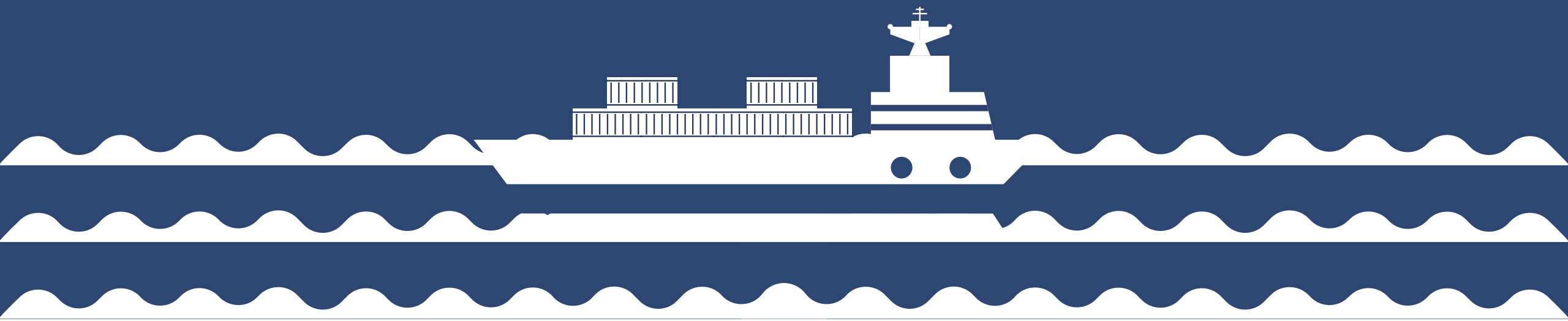
4.2 THUNDERSTORMS

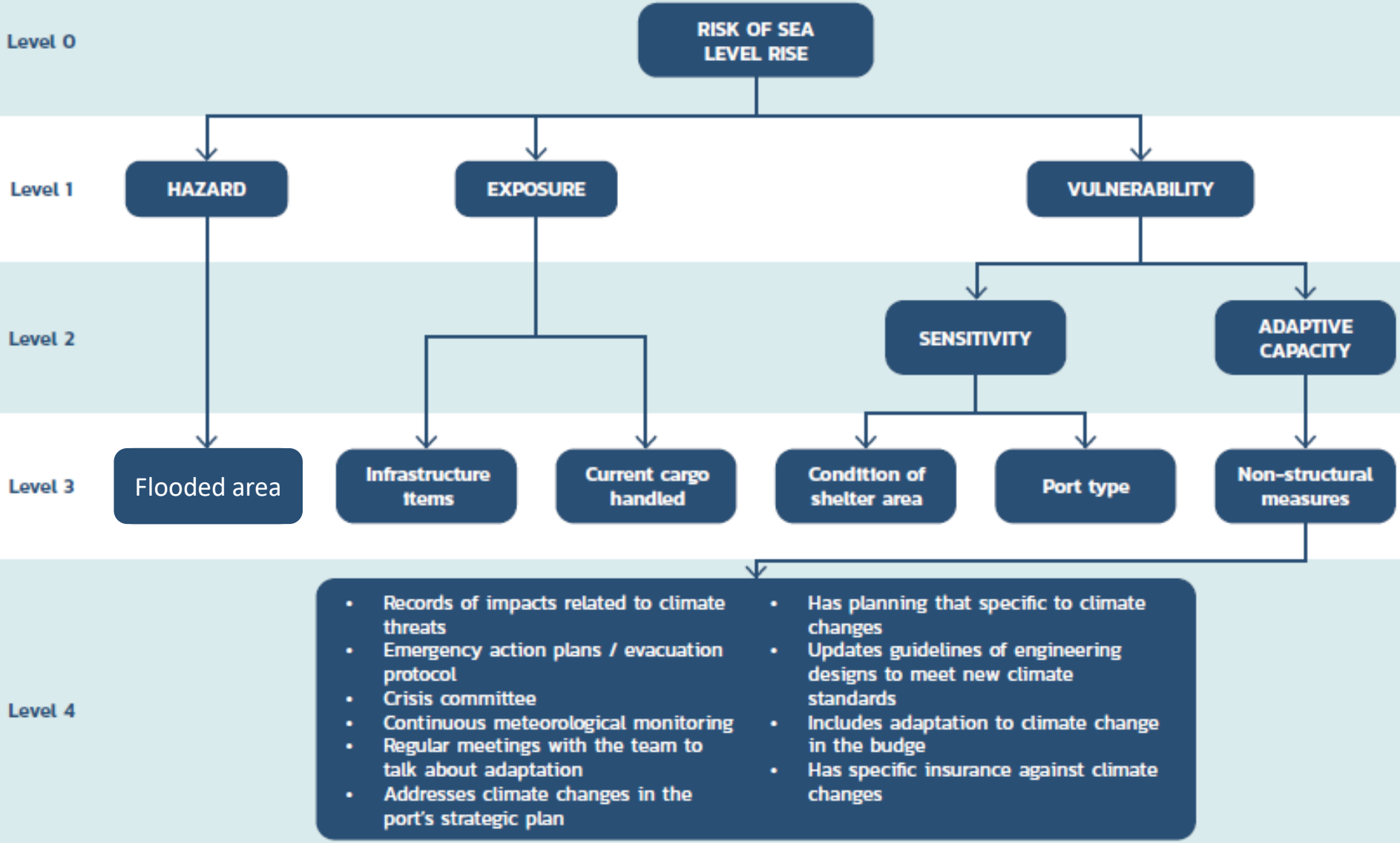


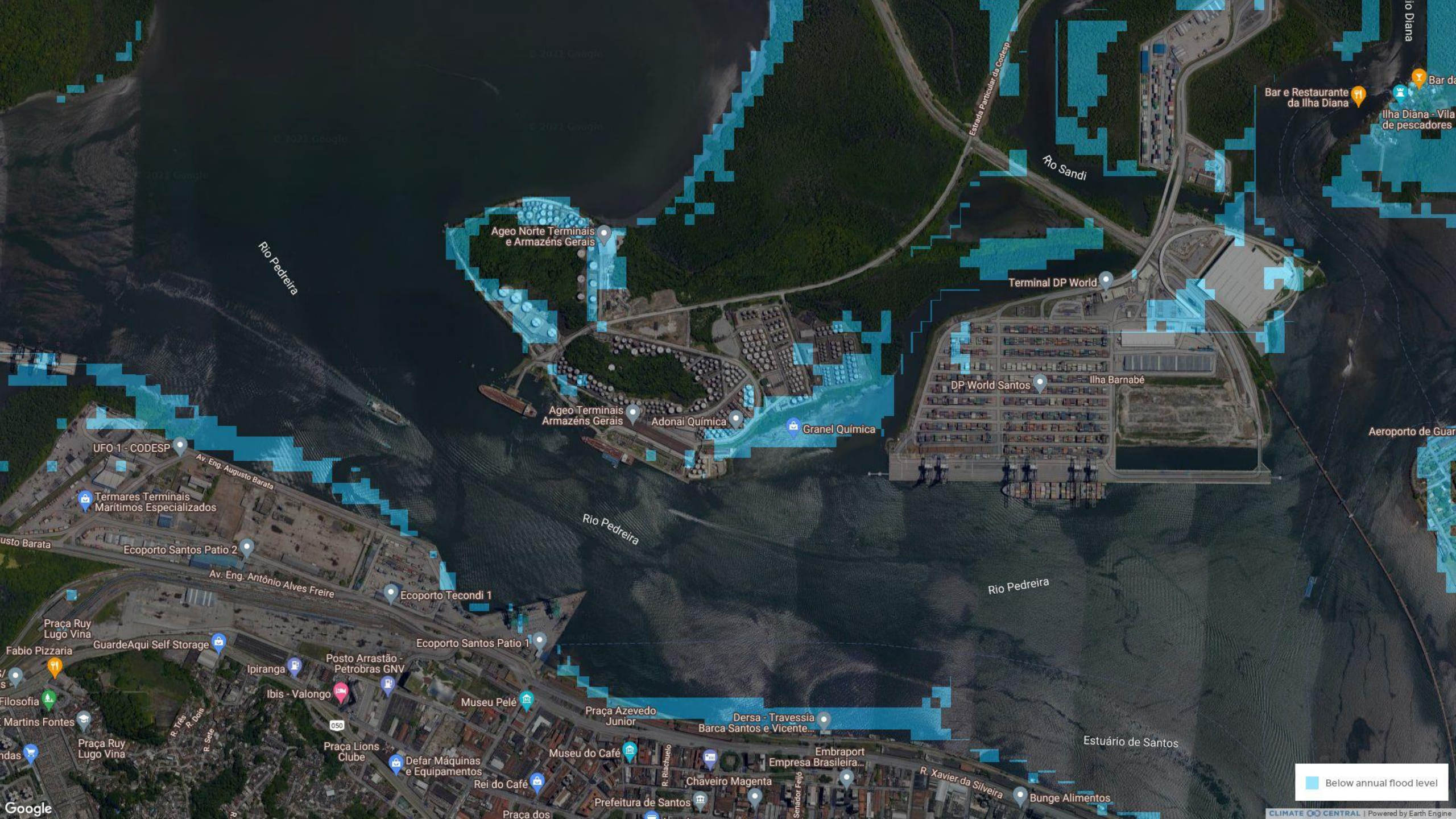
4 CLIMATE RISK METHODOLOGY



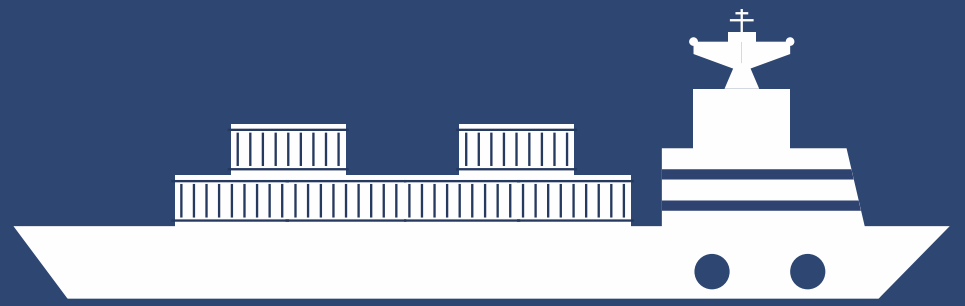
4.3 SEA LEVEL RISE



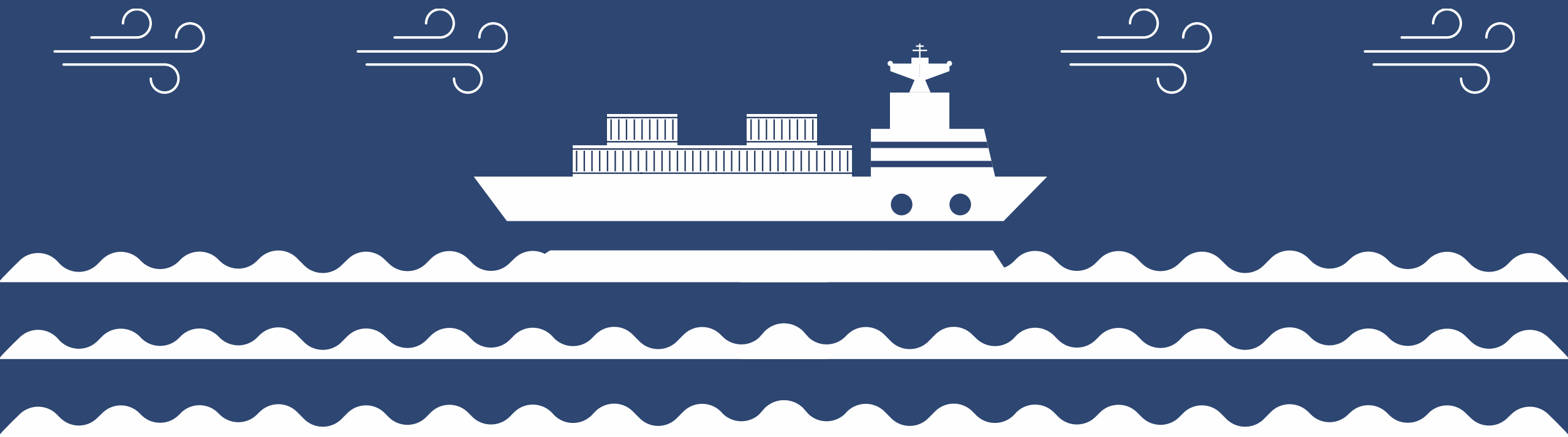

Level 0
RISK OF SEA LEVEL RISE
Level 1
HAZARD
EXPOSURE
VULNERABILITY
Level 2
SENSITIVITY
ADAPTIVE CAPACITY
Level 3
Flooded area
Infrastructure items
Current cargo handled
Condition of shelter area
Port type
Non-structural measures
Level 4
• Records of impacts related to climate threats
• Emergency action plans / evacuation protocol
• Crisis committee
• Continuous meteorological monitoring
• Regular meetings with the team to talk about adaptation
• Addresses climate changes in the port's strategic plan
• Has planning that specific to climate changes
• Updates guidelines of engineering designs to meet new climate standards
• Includes adaptation to climate change in the budge
• Has specific insurance against climate changes


Rio Pedreira
Rio Sandi
Estrada Particular da Codesp
Ageo Norte Terminais e Armazéns Gerais
Terminal DP World
DP World Santos
Ilha Barnabé
Ageo Terminais Armazéns Gerais
Adonai Química
Granel Química
Bar e Restaurante da Ilha Diana
Ilha Diana - Vila de pescadores
Aeroporto de Guar
UFO 1 - CODESP
Av. Eng. Augusto Barata
Termares Terminais Marítimos Especializados
Ecoporto Santos Patio 2
Av. Eng. Antônio Alves Freire
Ecoporto Tecondi 1
Ecoporto Santos Patio 1
Praça Ruy Lugo Vina
GuardeAqui Self Storage
Fabio Pizzaria
Ipiranga
Posto Arrastão - Petrobras GNV
Ibis - Valongo
Museu Pelé
Praça Azevedo Junior
Dersa - Travessia Barca Santos e Vicente...
Estuário de Santos
Martins Fontes
Filosofia
R. Três
R. Dois
R. Sete
050
Praça Lions Clube
Defar Máquinas e Equipamentos
Museu do Café
R. Riachuelo
Embraport Empresa Brasileira...
R. Xavier da Silveira
Rei do Café
Chaveiro Magenta
Senador Feijó
Prefeitura de Santos
Bunge Alimentos
Praça dos
Google
Below annual flood level
CLIMATE CENTRAL | Powered by Earth Engine

5. RESULTS



5.1 STRONG WINDS



5 RESULTS – RISK INDEX FOR STRONG WINDS

Port	E	V	Obs.		RCP4.5				RCP8.5			
					2030		2050		2030		2050	
			A	Ř	A	Ř	A	Ř	A	Ř	A	Ř
Angra dos Reis	0,5	0,5	0,6	0,364	0,7	0,397	0,7	0,440	0,7	0,406	0,8	0,449
Aratu-Candeias	0,8	0,4	0,6	0,496	0,7	0,578	0,8	0,599	0,8	0,615	0,9	0,723
Cabedelo	0,7	0,5	0,6	0,445	0,7	0,568	0,8	0,617	0,8	0,604	1,0	0,737
Fortaleza	0,6	0,6	0,6	0,534	0,7	0,638	0,8	0,692	0,7	0,662	0,8	0,754
Ilhéus	0,5	0,7	0,6	0,595	0,7	0,663	0,7	0,703	0,7	0,699	0,8	0,789
Imbituba	0,6	0,8	0,6	0,761	0,6	0,776	0,7	0,804	0,7	0,799	0,7	0,835
Itaguaí	0,7	0,6	0,6	0,618	0,7	0,670	0,7	0,747	0,7	0,696	0,8	0,764
Itajaí	0,6	0,4	0,6	0,334	0,6	0,345	0,7	0,350	0,7	0,351	0,7	0,361
Itaqui	0,8	0,3	0,6	0,426	0,7	0,487	0,8	0,525	0,8	0,536	0,9	0,580
Natal	0,7	0,5	0,6	0,467	0,8	0,607	0,8	0,681	0,8	0,643	1,0	0,802
Niterói	0,4	0,5	0,6	0,324	0,6	0,351	0,7	0,388	0,7	0,369	0,7	0,400
Paranaguá	0,9	0,5	0,6	0,634	0,7	0,686	0,7	0,717	0,7	0,695	0,7	0,741
Recife	0,7	0,7	0,6	0,728	0,7	0,840	0,7	0,873	0,7	0,872	0,8	1,000
Rio de Janeiro	0,8	0,5	0,6	0,581	0,6	0,628	0,7	0,694	0,7	0,660	0,7	0,715
Rio Grande	0,9	0,5	0,6	0,698	0,7	0,721	0,7	0,741	0,7	0,719	0,7	0,737
Salvador	0,7	0,7	0,6	0,676	0,7	0,771	0,7	0,794	0,8	0,813	0,9	0,944
Santos	1,0	0,5	0,6	0,733	0,7	0,777	0,7	0,842	0,7	0,796	0,7	0,857
São Francisco do Sul	0,6	0,6	0,6	0,592	0,7	0,626	0,7	0,638	0,7	0,631	0,7	0,661
São Sebastião	0,6	0,6	0,6	0,532	0,7	0,562	0,7	0,614	0,7	0,582	0,7	0,629
SUAPE	0,9	0,4	0,6	0,494	0,7	0,560	0,7	0,575	0,7	0,579	0,8	0,653
Vitória	0,8	0,3	0,6	0,288	0,7	0,333	0,8	0,377	0,8	0,357	0,8	0,396

FUTURE SCENARIOS:

1 regional climate model forced by 6 global climate models CMIP5

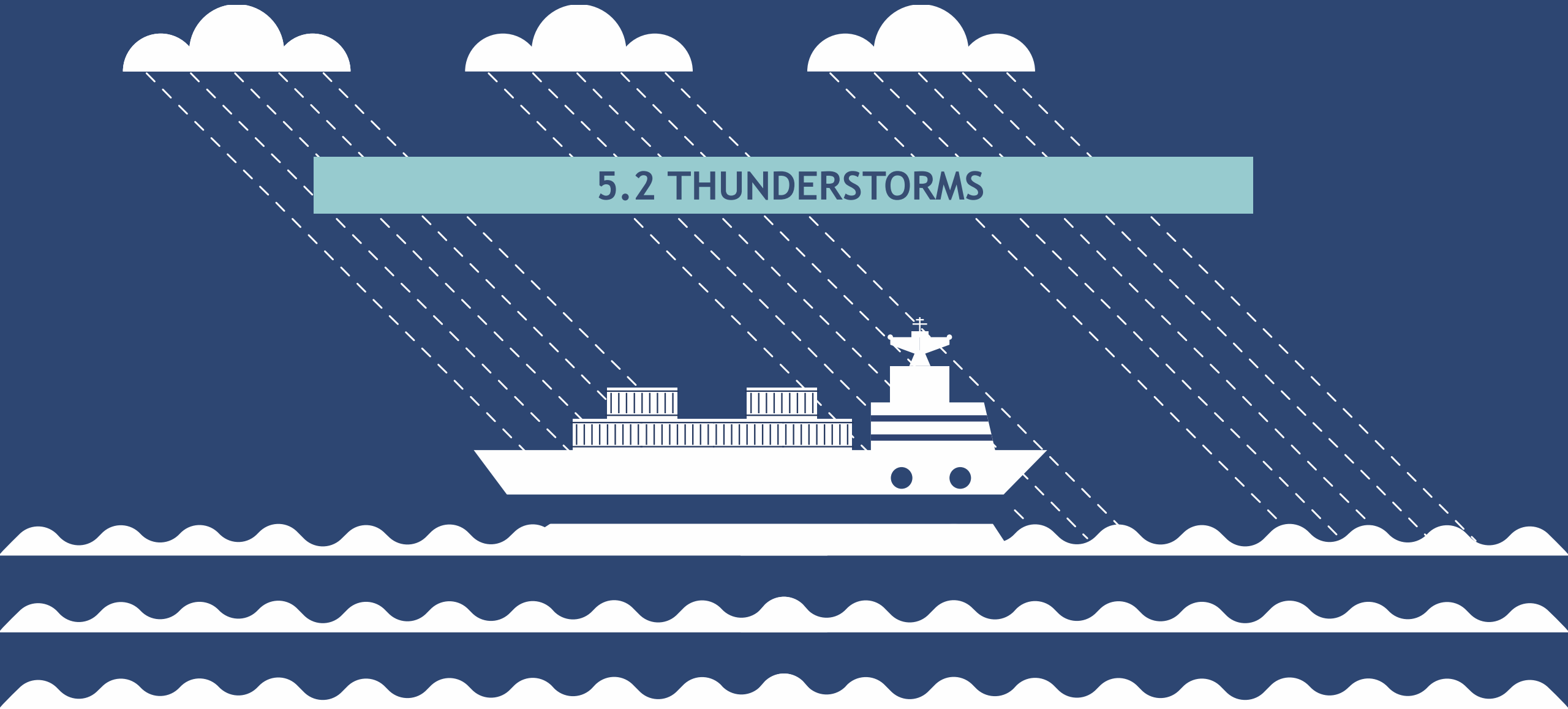
CLASS	RANGE
0 – 0,199	Very low
0,2 – 0,399	Low
0,4 – 0,599	Medium
0,6 – 0,799	High
0,8 – 1,000	Very high

	RANKING – STRONG WINDS					
	RCP4.5			RCP8.5		
	Obs	2030	2050	Observado	2030	2050
Imbituba	1°	3°	3°	1°	3°	4°
Santos	2°	2°	2°	2°	4°	3°
Recife	3°	1°	1°	3°	1°	1°
Rio Grande	4°	5°	6°	4°	5°	11°
Salvador	5°	4°	4°	5°	2°	2°
Paranaguá	6°	6°	7°	6°	8°	9°
Itaguaí	7°	7°	5°	7°	7°	7°
Ilhéus	8°	8°	8°	8°	6°	6°
São Francisco do Sul	9°	11°	12°	9°	12°	14°
Rio de Janeiro	10°	10°	9°	10°	10°	13°
Fortaleza	11°	9°	10°	11°	9°	8°
São Sebastião	12°	15°	14°	12°	15°	16°
Aratu-Candeias	13°	13°	15°	13°	13°	12°
SUAPE	14°	16°	16°	14°	16°	15°
Natal	15°	12°	11°	15°	11°	5°
Cabedelo	16°	14°	13°	16°	14°	10°
Itaqui	17°	17°	17°	17°	17°	17°
Angra dos Reis	18°	18°	18°	18°	18°	18°
Itajaí	19°	20°	21°	19°	21°	21°
Niterói	20°	19°	19°	20°	19°	19°
Vitória	21°	21°	20°	21°	20°	20°

CONSIDERATIONS

- Half of the ports already have a risk classified as “high”
- Under the moderate emissions scenario, 57% of the ports have a “high” or “very high” risk in 2030. In 2050, this increases to 67%
- Regarding the high emissions scenario, 76% may have a “high” or “very high” risk level in the 2050 period. Santos, Imbituba, Natal, Salvador and Recife may be the most affected
- Strong winds can lead to port standstill due to instability in equipment operations and closure of access to port

5.2 THUNDERSTORMS



5 RESULTS - RISK INDEX FOR THUNDERSTORMS

Port	E	V	Obs.		RCP4.5				RCP8.5			
					2030		2050		2030		2050	
			A	Ř	A	Ř	A	Ř	A	Ř	A	Ř
Angra dos Reis	0.5	0.3	0.6	0.283	0.6	0.285	0.6	0.282	0.6	0.277	0.6	0.284
Aratu-Candeias	0.8	0.5	0.8	0.993	0.8	1.000	0.8	0.992	0.8	0.977	0.8	0.977
Cabedelo	0.7	0.6	0.7	0.856	0.7	0.880	0.7	0.882	0.7	0.864	0.7	0.851
Fortaleza	0.7	0.5	0.5	0.509	0.5	0.537	0.5	0.544	0.5	0.536	0.5	0.553
Ilhéus	0.5	0.4	0.6	0.426	0.6	0.426	0.7	0.436	0.6	0.427	0.7	0.429
Imbituba	0.7	0.5	0.6	0.618	0.6	0.638	0.6	0.632	0.6	0.628	0.6	0.637
Itaguaí	0.8	0.3	0.5	0.397	0.5	0.406	0.5	0.401	0.5	0.401	0.5	0.410
Itajaí	0.6	0.3	0.6	0.308	0.6	0.312	0.6	0.308	0.6	0.304	0.6	0.309
Itaqui	0.8	0.3	0.4	0.292	0.4	0.319	0.4	0.333	0.4	0.318	0.5	0.349
Natal	0.7	0.5	0.8	0.792	0.8	0.793	0.8	0.809	0.7	0.788	0.7	0.766
Niterói	0.5	0.3	0.6	0.249	0.6	0.256	0.6	0.250	0.6	0.251	0.6	0.256
Paranaguá	0.9	0.4	0.6	0.661	0.6	0.666	0.6	0.663	0.6	0.658	0.6	0.670
Recife	0.7	0.4	0.8	0.750	0.8	0.779	0.8	0.774	0.8	0.787	0.8	0.767
Rio de Janeiro	0.8	0.3	0.6	0.481	0.6	0.494	0.6	0.483	0.6	0.484	0.6	0.495
Rio Grande	0.9	0.6	0.5	1.000	0.5	0.983	0.5	0.987	0.5	0.998	0.5	0.991
Salvador	0.7	0.3	0.8	0.461	0.8	0.464	0.8	0.462	0.8	0.456	0.8	0.458
Santos	1.0	0.3	0.6	0.627	0.6	0.636	0.6	0.622	0.6	0.620	0.6	0.639
São Francisco do Sul	0.7	0.6	0.6	0.792	0.6	0.801	0.6	0.791	0.6	0.785	0.6	0.798
São Sebastião	0.6	0.5	0.6	0.596	0.6	0.604	0.6	0.591	0.6	0.582	0.6	0.601
SUAPE	0.9	0.2	0.9	0.604	0.9	0.625	0.9	0.622	0.9	0.630	0.9	0.617
Vitória	0.8	0.3	0.6	0.398	0.6	0.400	0.6	0.394	0.6	0.393	0.6	0.394

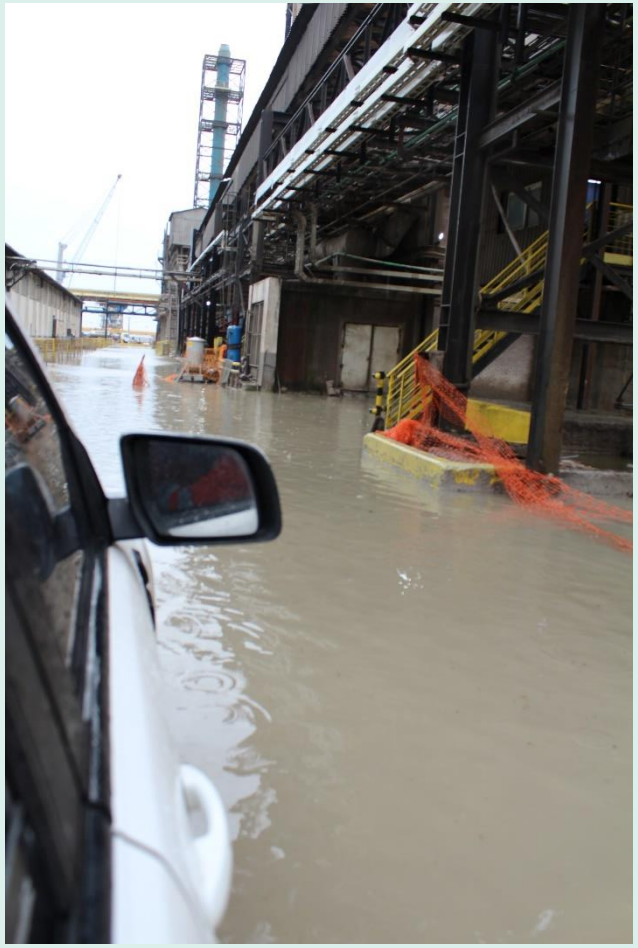
CLASS	RANGE
0 – 0,199	Very low
0,2 – 0,399	Low
0,4 – 0,599	Medium
0,6 – 0,799	High
0,8 – 1,000	Very high

	RANKING – THUNDERSTORMS				
		RCP4.5		RCP8.5	
	Obs	2030	2050	2030	2050
Rio Grande	1°	2°	2°	1°	1°
Aratu-Candeias	2°	1°	1°	2°	2°
Cabedelo	3°	3°	3°	3°	3°
Natal	4°	5°	4°	4°	6°
São Francisco do Sul	5°	4°	5°	6°	4°
Recife	6°	6°	6°	5°	5°
Paranaguá	7°	7°	7°	7°	7°
Santos	8°	9°	9°	10°	8°
Imbituba	9°	8°	8°	9°	9°
SUAPE	10°	10°	10°	8°	10°
São Sebastião	11°	11°	11°	11°	11°
Fortaleza	12°	12°	12°	12°	12°
Rio de Janeiro	13°	13°	13°	13°	13°
Salvador	14°	14°	14°	14°	14°
Ilhéus	15°	15°	15°	15°	15°
Vitória	16°	17°	17°	17°	17°
Itaguaí	17°	16°	16°	16°	16°
Itajaí	18°	19°	19°	19°	19°
Itaqui	19°	18°	18°	18°	18°
Angra dos Reis	20°	20°	20°	20°	20°
Niterói	21°	21°	21°	21°	21°

CONSIDERATIONS

- In the current climate, 10 ports present a climate risk considered high or very high
- No considerable changes in the level of risk due to thunderstorm have been identified under the periods and scenarios analyzed
- Two ports may have the risk increased in the 2050 period under the high emissions scenario
- Thunderstorms can cause port standstill due to instability in equipment operations and closure of access to port, as well as floods, storm surges and operation shutdown of solid bulks

Port of Rio Grande - 09/13/2021



Access to the pier at Yara Terminal flooded

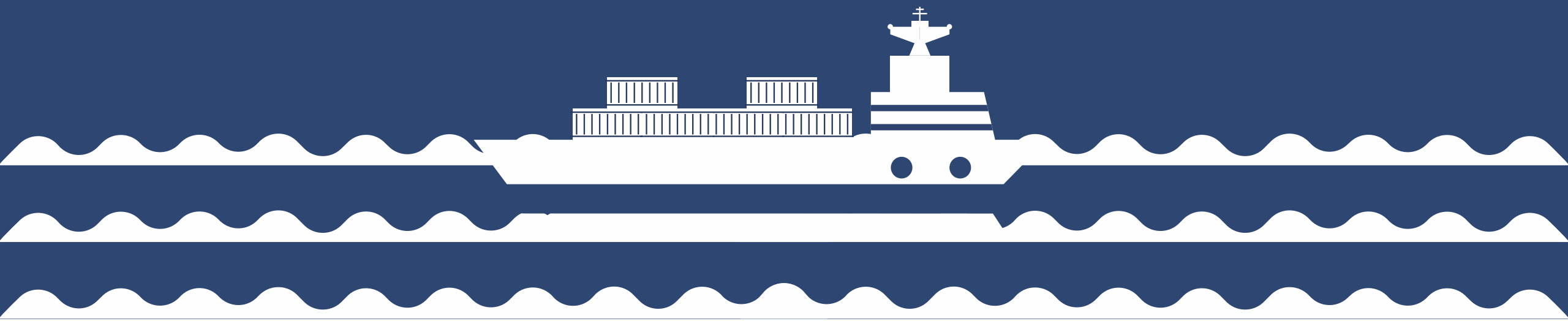
Pier at Yara Terminal flooded

Port of Santos - 09/16/2021 and 09/17/2021

Berth next to Suzano, paralyzed due to the rains.

TERMAG

5.3 SEA LEVEL RISE



Port	E	V	RCP4.5				RCP8.5			
			2030		2050		2030		2050	
			A	Ř	A	Ř	A	Ř	A	Ř
Angra dos Reis	0,5	0,5	0,0	0,000	0,0	0,000	0,0	0,000	0,0	0,000
Aratu-Candeias	0,8	0,6	1,0	1,000	1,0	1,000	1,0	1,000	1,0	1,000
Cabedelo	0,7	0,5	1,0	0,640	1,0	0,640	1,0	0,640	1,0	0,640
Fortaleza	0,7	0,6	1,0	0,778	1,0	0,778	1,0	0,778	1,0	0,778
Ilhéus	0,5	0,4	1,0	0,499	1,0	0,499	1,0	0,499	1,0	0,499
Imbituba	0,7	0,5	1,0	0,705	1,0	0,705	1,0	0,705	1,0	0,705
Itaguaí	0,7	0,5	1,0	0,731	1,0	0,731	1,0	0,731	1,0	0,731
Itajaí	0,6	0,1	1,0	0,127	1,0	0,127	1,0	0,127	1,0	0,127
Itaqui	0,8	0,3	1,0	0,463	1,0	0,463	1,0	0,463	1,0	0,463
Natal	0,7	0,3	1,0	0,416	1,0	0,416	1,0	0,416	1,0	0,416
Niterói	0,4	0,4	0,0	0,000	0,0	0,000	0,0	0,000	0,0	0,000
Paranaguá	0,9	0,4	1,0	0,834	1,0	0,834	1,0	0,834	1,0	0,834
Recife	0,7	0,4	1,0	0,637	1,0	0,637	1,0	0,637	1,0	0,637
Rio de Janeiro	0,8	0,4	0,0	0,000	0,0	0,000	0,0	0,000	0,0	0,000
Rio Grande	0,9	0,5	1,0	0,963	1,0	0,963	1,0	0,963	1,0	0,963
Salvador	0,7	0,3	1,0	0,471	1,0	0,471	1,0	0,471	1,0	0,471
Santos	1,0	0,4	1,0	0,811	1,0	0,811	1,0	0,811	1,0	0,811
São Francisco do Sul	0,7	0,6	1,0	0,805	1,0	0,805	1,0	0,805	1,0	0,805
São Sebastião	0,6	0,6	1,0	0,678	1,0	0,678	1,0	0,678	1,0	0,678
SUAPE	0,9	0,3	1,0	0,573	1,0	0,573	1,0	0,573	1,0	0,573
Vitória	0,8	0,4	1,0	0,595	1,0	0,595	1,0	0,595	1,0	0,595

CLASS	RANGE
0 – 0,199	Very low
0,2 – 0,399	Low
0,4 – 0,599	Medium
0,6 – 0,799	High
0,8 – 1,000	Very high

	RANKING – SEA LEVEL RISE			
	RCP4.5		RCP8.5	
	2030	2050	2030	2050
Aratu-Candeias	1°	1°	1°	1°
Rio Grande	2°	2°	2°	2°
Paranaguá	3°	3°	3°	3°
Santos	4°	4°	4°	4°
São Francisco do Sul	5°	5°	5°	5°
Fortaleza	6°	6°	6°	6°
Itaguaí	7°	7°	7°	7°
Imbituba	8°	8°	8°	8°
São Sebastião	9°	9°	9°	9°
Cabedelo	10°	10°	10°	10°
Recife	11°	11°	11°	11°
Vitória	12°	12°	12°	12°
SUAPE	13°	13°	13°	13°
Ilhéus	14°	14°	14°	14°
Salvador	15°	15°	15°	15°
Itaqui	16°	16°	16°	16°
Natal	17°	17°	17°	17°
Itajaí	18°	18°	18°	18°
Angra dos Reis	19°	19°	19°	19°
Niterói				
Rio de Janeiro				

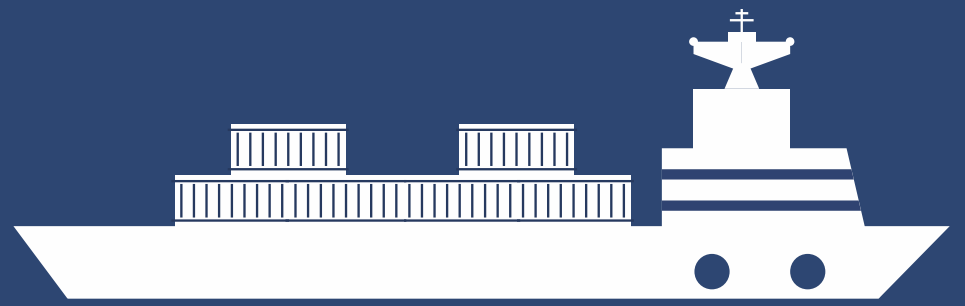
CONSIDERATIONS

- Sea level rise may already affect the ports in the upcoming decade
- 11 ports will have the risk of sea level rise classified as “very high” or “high” in 2050
- Sea level rise can cause damages to port infrastructure, and increase the frequency of floods, storm surges and coastal erosion

Port of Santos - 09/16/2021 and 09/17/2021

Sea Level Rise: SPA commented on the lack of freeboard readings between wharf structures, dolphins, bridges and tidal variation. Different ages and types of port structures. Examples of bridges to access dolphins and the railway bridge to access terminals in Guarujá.

6. ADAPTATION MEASURES



6 STRUCTURAL ADAPTATION MEASURES

Measure	SLR	Thunder storms	Strong Winds	PDZ	% of ports that adopt the measure
Adequacy of structures for new weather patterns	✓	✓	✓	PIP	N/A
Diversification of land connections to the port/ terminal	✓	✓	✓	PIA	N/A
Increase in the shelter infrastructure dimensions	✓	✓		PIP	N/A
Construction of shelter infrastructure	✓	✓		PIP	N/A
Reinforcement of rockfill structures	✓			PIP	N/A
Automation of logistical tasks		✓	✓	MO	N/A
Implementation of VTMS		✓	✓	MO	4,76%
Reinforcement of shelter infrastructure	✓			PIP	N/A
Raising of shelter infrastructure	✓			PIP	N/A
Protection of cargoes against flooding	✓			PIP/PRA	N/A
Inclusion of sea level rise projections in future infrastructure designs	✓			MO	N/A

INITIALS	SIGNIFICANCE
MO	Operational Improvements
PIP	Port Investment Proposition
PRA	Area Reorganization Proposition

Adjustment of berth structures at sea level	✓			PIP	N/A
Increase in port elevation quota	✓			PIP	N/A
Expansion of the dredging process	✓			MO	N/A
Improved quality of access to the port/terminal	✓			MO	N/A
Consideration of sea level rise in infrastructure remodeling and replacement inventories	✓			PIP	N/A
Improvement in drainage systems		✓		PIP	N/A
Renovation of infrastructure or equipment vulnerable to flooding		✓		PIP	N/A
Consideration of watershed-level landscape planning and ecosystem-based adaptation options for flood risk reduction		✓		PIP	N/A
Implementation of SuDS		✓		PIP	N/A
Use of automatic wind monitors on ship loaders			✓	MO	N/A

INITIALS	SIGNIFICANCE
MO	Operational Improvements
PIP	Port Investment Proposition
PRA	Area Reorganization Proposition

6 NON-STRUCTURAL ADAPTATION MEASURES

Measure	SLR	Thunder storms	Strong Winds	PDZ	Current scenario
Provision of emergency plans to drivers	✓	✓	✓	MG	N/A
Review of contingency plans	✓	✓	✓	MG	N/A
Modification in the arrangement of structures in the organized port area	✓	✓	✓	PRA	N/A
Working together with insurance companies	✓	✓	✓	MG	N/A
Purchase of specific insurance against climate change	✓	✓	✓	MG	0%
Creating a network for sharing information	✓	✓	✓	MG	N/A
Holding meetings to discuss adaptation	✓	✓	✓	MG	28,57%
Addressing climate change in the port's strategic plan	✓	✓	✓	MG	28,57%
Adoption of specific planning for climate change	✓	✓	✓	MG	9,52%
Including climate change adaptation in the budget	✓	✓	✓	MG	4,76%
Updating engineering design guidelines to meet new climate standards	✓	✓	✓	MG	14,29%
Record of impacts related to climate hazards (dates, consequences or costs)	✓	✓	✓	MG	4,76%
Adoption of emergency action plans/evacuation protocol	✓	✓	✓	MG	9,52%
Establishment of a crisis committee	✓	✓	✓	MG	9,52%
Implementation of its own continuous meteorological monitoring/Cooperation with other institutions	✓	✓	✓	MO	23,81%
Carrying out operational-capacity assessments	✓	✓		MO	N/A

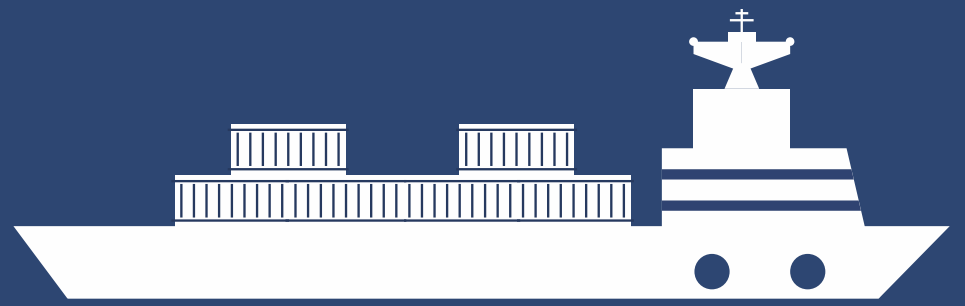
INITIALS	SIGNIFICANCE
MO	Operational Improvements
MG	Management Improvements
PIP	Port Investment Proposition
PRA	Area Reorganization Proposition

Change of work schedule during extreme events		✓	✓	MG	N/A
Forming partnerships with local weather stations		✓	✓	MG	N/A
Adoption of good work practices		✓	✓	MG	N/A
Review of critical operational thresholds for cargo handling equipment		✓	✓	MO	N/A
Maintenance Program Review and Adjustment		✓		MG	N/A
Engagement of stakeholders to plan flood management options		✓		MG	N/A
Review of alert systems		✓		MO	N/A
Adjustments to storm-sensitive cargo storage		✓		MO	N/A
Use of exclusive PPE for flooded areas		✓		MG	4,76%
Implementation of warning systems			✓	MO	N/A
Implementation of wind speed prediction system			✓	MO	N/A
Reduction of stacking height of containers			✓	MO	N/A
Review of crane braking and fastening systems			✓	MO	N/A
Review of conveyor belts, lighting systems and general infrastructure			✓	MO	N/A
Equipment maintenance and contingency plan			✓	MG	4,76%
Improvement of management for the prevention of windthunderstorm risks			✓	MG	N/A
Monitoring of wind in the port/operational area			✓	MO	4,76%
Monitoring of wind by lifting equipment			✓	MO	N/A

INITIALS	SIGNIFICANCE
MO	Operational Improvements
MG	Management Improvements
PIP	Port Investment Proposition
PRA	Area Reorganization Proposition

- There is a need for regulation efforts
- Few ports implement adaptation measures. The most common are:
    - Hidro-meteorological monitoring
    - Addressing climate change in the strategic plan
    - Holding meetings to discuss adaptation
- No port reported the adoption of insurance

7. CONCLUSIONS



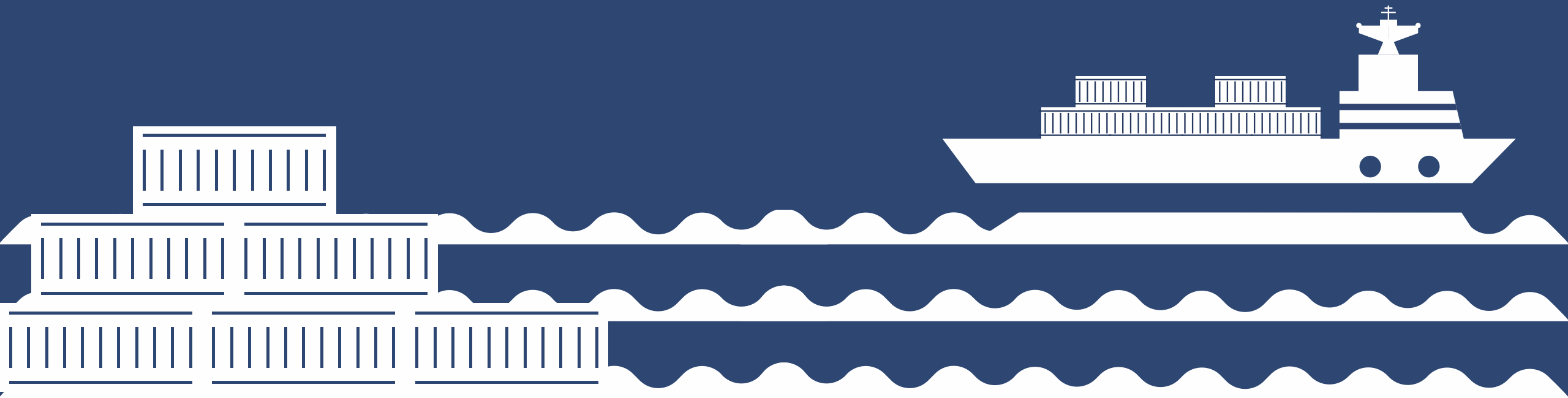
- Climate risk and adaptation assessments for ports are scarce
- There is no standard for recording climate-related impacts on Brazilian ports
- The Brazilian port sector is already suffering the effects of climate change, especially due to thunderstorms and strong winds
- The risks due to climate change are likely to increase in the future, especially due to strong winds and sea level rise
- Only few ports adopt any kind of climate change adaptation measure
- This study represents a major step towards the inclusion of the climate change adaptation topic in the port sector in Brazil
- This study will support the development of policies to guarantee the resilience of the port sector in Brazil, allowing for more focused regulation and inspection on this important issue.

- The participation and engagement of the port authorities were crucial to the success of this study
- The contributions of the National Institute for Space Research (INPE) was key to achieve the state-of-the-art in developing climate change scenarios
- Do not rely only on climate model data. The use of observational data provided a more realistic condition of the current climate and risk level
- Strong winds and thunderstorms are difficult to model. There is a need for including more climate models in future assessments in order to estimate the uncertainties
- Although not reported by the ports, sea level rise should not be underestimated

AXIS 2

- Customized climate risk and adaptation assessments will be conducted at the port level for **Santos, Rio Grande e Aratu-Candeias.**
- These case studies will be the basis for developing a **guideline** for assessing climate risks and adaptation measures, which should be used and applied by all other ports
- Conclusion in **July 2022**

THANK YOU!



On behalf of:
Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
of the Federal Republic of Germany

Implemented by:
giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

PROADAPTA | CSI
Climate Change Adaptation

INPE

ANTAQ
Agência Nacional de Transportes Aquaviários

MINISTÉRIO DO MEIO AMBIENTE

MINISTÉRIO DA INFRAESTRUTURA

MINISTÉRIO DA ECONOMIA

PÁTRIA AMADA BRASIL
BRAZILIAN GOVERNMENT