Sustainable Growth Initiative - Annual Grand Challenge 2025-2026

Resilience by Design, Strengthening Climate Resilience for Coastal Communities and Commerce

Climate Adaptation Pathways for Ports in Developing Economies: Case Study of the Port of Aratu-Candeias, Brazil

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I. Abstract/Executive Overview

Ports represent single points of failure that concentrate high-value coastal assets and can trigger cascading disruptions across regional and international supply chains. Protecting these strategic nodes is a major challenge for developing nations, where resource constraints and limited long-term planning capacity can delay investments. These countries are also most at risk from climate-change-related events, which significantly increase risks for low-income coastal communities. Brazil—ranked 27th out of 180 in the Global Climate Risk Index 2021—faces elevated social vulnerability, with nearly 30% of the population below the national poverty line and 8% in extreme poverty, compounding exposure to climate shocks (Eckstein et al., 2021; Tokarnia, 2022). Port-focused climate adaptation arises as a high-leverage resilience strategy for these nations (US EPA, 2016; da Veiga Lima & de Souza, 2022).

To examine how climate adaptation can be operationalized under these constraints, this report assesses climate risk and implementation barriers at the Port of Aratu-Candeias (Bahia), a bulk-handling hub supporting petrochemical, steel, and fertilizer value chains in the Salvador metropolitan region (CODEBA, 2026). In 2019, the port handled 6,368,990 tons of cargo, accounting for ⅔ of fuels and chemical products handled in the state (Ministry of Infrastructure for Brazil, 2021).

Using a port-specific climate risk profile derived from national and Aratu-focused assessments as a baseline (Federative Republic of Brazil, 2021, 2023), this report identifies high-priority hazard-impact pathways and the environmental, social, and institutional factors shaping operational vulnerability. It then proposes two solutions: (i) a digital monitoring system to adapt to increasing risks of natural disasters, and (ii) nature-based solutions to support the port and nearby coastal communities, both supported by success indicators. The report then proposes mechanisms for governance and public-private coordination, along with an investment and financing strategy aligned to prioritized risks. The intent is to provide a transferable template for resilience planning in ports operating under similar socioeconomic and institutional constraints.

II. Climate-Risk Profile of the Port of Aratu-Candeias

A. Climate Hazards and Effects on Port Infrastructure

The port of Aratu-Candeias faces a “very-high” risk index for sea-level rise—the highest in Brazil—and ranks second nationally for thunderstorm risk (Federative Republic of Brazil, 2023; Federative Republic of Brazil 2021). Based on national and site-specific assessments (2021, 2023), these hazards converge on four critical systems: berthing, handling equipment, storage, and landside logistics.

Hydrological Extremes (SLR, Surge, Flooding): Chronic sea-level rise (SLR) and acute storm surges amplify wave loads and corrosion on berthing structures. Aratu has already sustained structural damage to berths from extreme water-level events. These hazards, combined with fluvial inundation, threaten low-lying quays and the internal road/rail network, risking pavement failure and moisture damage to moisture-sensitive solid-bulk (TGS I & II).

Atmospheric Disruptions (Wind, Storms, Fog): While regional rainfall is slightly decreasing, the intensity of thunderstorms and "moderate" winds (>3 m/s) is increasing. These drive operational stoppages, visibility-driven channel closures, and structural risks to lightweight storage covers, bollards, and fenders. High winds also create dust and safety constraints for pulverulent (powdery) bulk handling.

Thermal and Safety Risks (Heat & Lightning): Extreme heat compromises worker safety and elevates fire risk for the Liquid Bulk (TGL) and Gas (TPG) terminals. Lightning is a primary threat; in this high-risk zone, it creates a significant danger of fire or explosion during the handling of chemical and fuel products.

B. Resilience Gaps

Despite high physical risks, Aratu-Candeias suffers from critical “resilience gaps” where infrastructure expansion is outpacing climate-risk integration.

Data Scarcity: Current assessments rely on qualitative accounts and a limited data window (2019-2021). Without a long-term time series linking hydrometeorological conditions to specific operational shutdowns/asset damages, the port lacks the "preventative power" of correlation analysis.

Misaligned Investment: Recent modernization efforts (R$800 million in 2024) have prioritized capacity expansion over resilience (Letícia, 2024). This focus creates a "sunk cost" vulnerability: the port is building more assets without the data-collection systems (wind, sea level, rain) needed to protect them.

Bay Shielding Myth: Institutional inertia is compounded by a narrative of "bay shielding." This perceived geographic protection creates a dangerous disconnect, as it directly contradicts Aratu’s status as the nation's most at-risk site for sea-level rise and second-most for thunderstorms (Federative Republic of Brazil, 2021).

Social Blind Spots: Existing reports focus exclusively on internal operations. They fail to account for the distributional impacts to the local community and at the international scale.

C. Socio-Environmental Performance

Evidence from community reporting suggests the port–industrial complex has generated a profound governance and trust deficit. While the port serves as an economic hub, the adjacent communities (e.g. Ilha de Maré) bear disproportionate environmental burdens with minimal commensurate gains. This creates a critical "social license" risk that manifests in three primary pathways:

Public Health and Livelihoods: Elevated levels of cadmium and lead in local children is linked to water contamination that also threatens subsistence fishing and shellfishing livelihoods across the Baía de Todos-os-Santos (Rada, 2021). Exacerbated by acute incident history, such as in the 2013 *Golden Miller* spill, that contaminates local ecosystems (Bledsoe 2019).

Legal and Regulatory Exposure: Allegations of mangrove destruction and the absence of Environmental Impact Assessments (EIA/RIMA) for key projects create a state of "chronic litigation risk." (Bledsoe, 2019). These licensing deficiencies leave the port vulnerable to court-ordered stoppages and reputational damage.

Operational Disruption: Years of stalled dialogue regarding basic compensatory measures (e.g., daycares, training, safety fencing) have escalated into episodic social conflict (including direct action such as protest/blockage of site access to force negotiations). These direct actions demonstrate that local social vulnerability is a direct pathway to operational stoppage (Martins, 2023).

D. Distributional Impacts and Global Spillover Risk

Using satellite-derived vessel-tracking datasets from *PortWatch*, an open-source initiative developed by the International Monetary Fund and the University of Oxford, this data analysis identifies a high-consequence seasonal risk convergence. Disruptions at the Port of Aratu-Candeias do not occur in isolation; they propagate through a network of domestic and international stakeholders.

Seasonal Vulnerability: Monthly time series (2014–2024) reveal that export volumes peak from March to October (≈603,000 metric tons/month) (see Appendix 2). Crucially, this high-activity window overlaps almost entirely with the regional rainy season (March–September) (Federative Republic of Brazil, 2023). This means weather-related shutdowns occur exactly when the "cost of closure" is highest, maximizing cargo delays and downstream volatility.

Upstream Exposure: A one-week shutdown compromises ~700,000 metric tons of upstream flow. While domestic ports like Santos are most affected, international hubs like Tangier-Mediterranean (Morocco) and Houston (USA) face significant exposure, compromising approximately 46,000 and 21,000 metric tons of anticipated cargo per week, respectively (see Appendix 3).

Downstream Exposure: Downstream international partners, such as Cartagena (Colombia) and Las Palmas (Spain), rely on Aratu for critical industrial inputs (petrochemicals and fertilizers). A seven-day disruption risks a ~728,000 metric ton shortfall across these nodes (see Appendix 4).

Aratu-Salvador Connection: This analysis assumes that shutdown events are shared across Aratu and Salvador, since both ports are managed by CODEBA and sit within the same ~50km corridor. A single extreme weather event acts as a systemic shock, simultaneously paralyzing two of Brazil's vital maritime gateways.

Figure I: Aratu-Candeias Port

Source: Jornal Grande Bahia (2020)

III. Proposition: Preventive Systems and Nature-Based Solutions

A. Prevention and Adaptation Through Data

As established in the risk profile, Aratu-Candeias currently operates with a significant predictive deficit. While our preliminary analysis of open-source data already identified critical seasonal risk convergences and global spillover vulnerabilities, the port lacks the granular, site-specific data required for informed decision-making. We propose the establishment of a centralized Climate Intelligence Unit (see section IV.C) within CODEBA to operationalize the following "no-regret" measures:

Table I: Implementation Matrix (as per 2023 Risk Assessment on Aratu Port):

Implementation Suggestion	Cost	Complexity	Urgency	Description
Implement Monitoring Authority	Medium	Medium	High	• Recording and forecasting authority that supports decision-making based on the following port data: 1. Operational shutdowns 2. Infrastructural damage 3. Cargo-handling forecasts 4. Meteorological and marine hydrology data • Allows for multiple stakeholders (Navy, operators, ANTAQ, Port Authority, pilotage).
Climate Data Collection Through Meteorological Station at the Port	Medium	Medium	High	• Increasing telemetry, remote sensing, and online/RFID data transmission to improve data integrity. • Systematic projections improve operational planning and decision-making for critical events. • Ensures service continuity and operational safety. • Critically, enables updated risk assessments.
Database on Operational Stoppages or Infrastructure Damage	Low	Medium	High	• To diagnose climate impacts on operations. • Enables time-series analysis for decision-making. • Operational and infrastructural characteristics tracked across cargo types. • Requires effort to create a reporting culture.

Improve Communication and Knowledge about Cargo Seasonality	Low	Low	High	• Requires a monitoring system and an infrastructural damage database. • Helps develop information/studies that improve efficiency, especially when climate factors are considered.

Long-term, this data will become the port's primary asset for securing external adaptation funding. International lenders increasingly mandate rigorous "climate-proofing" evidence before releasing capital. Furthermore, data integrity is becoming a prerequisite for market access. For example, the recently implemented **EU Carbon Border Adjustment Mechanism (CBAM)** requires importers to prove the sustainability of their supply chains (European Commission, 2025). Precise carbon and climate data will be essential to ensure that Aratu's petrochemical and steel value chains remain competitive and avoid significant non-compliance fees.

Indicators For Success:

To ensure that the proposed Climate Intelligence Unit delivers both operational value and continuous data accumulation, its activities are paired with a structured indicator framework. To create applicable success indicators, we use the SMART framework, as detailed in Figure II. This framework was developed by the Inter-American Development Bank and is currently used to create indicators for monitoring and evaluation in other ports (IDB Invest, 2021).

Figure II. SMART Indicators

Source: (IDB Invest, 2021)

By adhering to these principles, the port shifts from a reactive stance to a data-sovereign one. This framework eliminates ambiguity for leadership, ensuring every investment in the Climate Intelligence Unit produces a clear and concrete return on resilience. To maintain accountability and ensure long-term ROI, we propose a dual-track monitoring model overseen by CODEBA. This structure positions CODEBA as an auditing body, ensuring that adaptation efforts remain aligned with the port's evolving risk profile.

Table II: Monitoring Model

Indicator Category	Description	Responsibility
Implementation Progress	Tracks the progress, delivery, and increase in power of implementations. Success is gauged using indicators tied to project deliverables and timelines.	**CODEBA Audit:** 3-4 times annually to ensure operational continuity
Resilience Performance	Evaluates the actual efficacy of adaptations during climate events. Success is measured by comparing past historical impact with current impact. Resilience performance requires longevity in modelling, since climate is unpredictable and events have a wide range in severity.	**Event-Based Tracking:** Conducted after every major hydrometeorological event.

Table III: Proposed Climate Intelligence Unit Indicators

Type of Indicator	Indicator Suggestion	Description	How Tracking the Indicator Benefits Aratu-Candeias
Implementation Progress	% of vulnerable shoreline monitored by CIU	Tracks the percentage of vulnerable shoreline that is analyzed during CIU projections	Leadership will have a better understanding of how extensively they are tracking climate variables. Relatively easy and inexpensive to update as more tracking technology is installed, as per Table I.
Implementation Progress	% of assets covered by CIU	Tracks the percentage of physical assets that are monitored by the CIU.	The CIU should not only monitor and inform decisions to protect the shoreline, but it must also perform these actions for the port's assets.
Resilience Performance	Climate change correlations	Tracks the broad results of CIU activity, including whether climate change activity is affecting the port over time and how	Allows the port to determine if continued CIU is worth investing in. Whether climate change is affecting the port or not, being able to gather data that informs

		these effects might impact port operation.	future decision-making is vital for Aratu-Candeias and proves the CIU's worth
Resilience Performance	Protection of assets during climate events	An indicator that might only come into effect further down the line. Tracks port assets that have had changes in infrastructure or protocol as a result of CIU activity	Determines if the CIU's activities provide a positive ROI. If assets are able to be adapted to new climate environments, then there will be less port downtime

B. Nature-Based Solutions (NBS) for Community Engagement

Our second approach tackles environmental problems caused by the port in the region, leveraging nature-based solutions to deliver a feasible, cost-effective solution that will yield long-lasting benefits for both Aratu-Candeias' resilience and the surrounding community. This is achieved by planting and restoring mangroves in the surrounding bay. To deliver this at scale, the platform will partner with **RISCO (Restoration Insurance Service Company)**, an innovative nature-based adaptation platform that designs, restores, and maintains mangrove systems as long-term protective infrastructure.

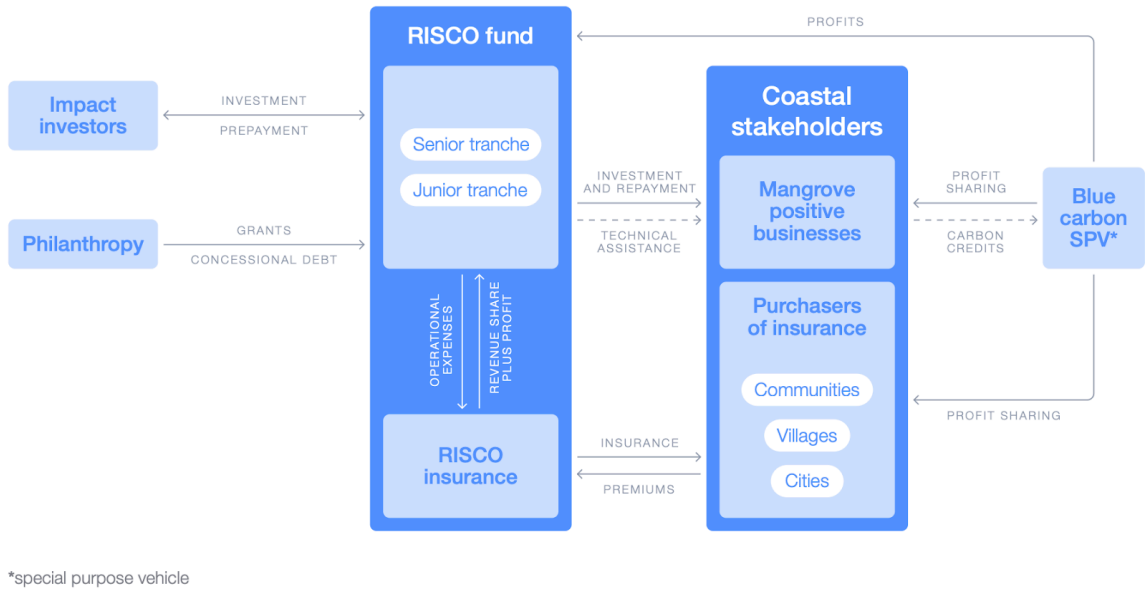
Under this partnership, RISCO will provide:

1. **Inclusive enterprise financing:** low-interest loans, technical support, and training.
2. **Co-benefit monetization**: RISCO forms a blue carbon SPV used to generate income from selling the carbon credits gained from the amount of CO2 sequestered. Profits will be shared among both RISCO and CODEBA.
3. **Insurance provision:** RISCO will promote parametric or risk-transfer insurance products to the Bahia municipality and businesses.

(World Economic Forum, 2025)

Once contracted, RISCO will lead site identification and ecological feasibility, work with CODEBA and the **Brazilian Institute of Environment and Renewable Natural Resources (IBAMA)**, which oversees strategic environmental projects for the Bahia area. RISCO will support licensing requirements, coordinate restoration through local contractors and community participation, and enforce the monitoring framework developed in section III. Channelling the port's renewed commitment towards engaging with the surrounding community, CODEBA will employ Bahia residents and coordinate with local fishermen to plant mangroves. This operation will be facilitated by the community representative (see section IV.C).

Figure III: RISCO Business Model



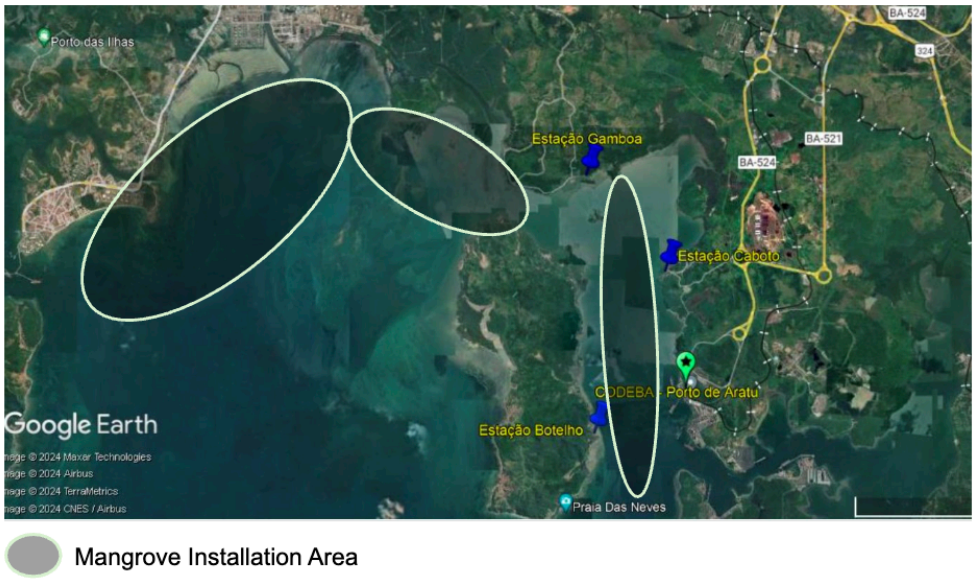
Source: *The resilience opportunity: Unlocking climate resilience through public-private collaboration* (World Economic Forum, 2025).

Beyond its protective and climate-mitigation functions, mangrove restoration addresses two acute community-level harms linked to port activity in Aratu-Candeias: water contamination and the degradation of marine livelihoods. As described in our Risk Profile, surrounding communities have borne the social and health costs of industrial expansion in Baía de Todos os Santos, while receiving few of its economic benefits. Mangroves play a proven role in mitigating such harms by filtering heavy metals, hydrocarbons, and other pollutants from coastal waters, improving water quality and reducing human exposure to toxins (Kumari et al., 2020). Investing in mangrove rehabilitation, therefore, represents not only an environmental intervention but a tangible step toward restoring community wellbeing and rebuilding trust between CODEBA and its neighbouring populations.

Moreover, mangrove restoration supports the recovery of collapsed local fisheries, which have undermined food security and livelihoods across the Bay of All Saints. Residents have reported dramatic declines in shrimp collection and fishing yields—by more than tenfold in some areas—over recent decades, as port expansion and repeated toxic spillages have degraded marine habitats (Bledsoe, 2019). Mangroves serve as critical nurseries and protective habitats for fish, crustaceans, and other marine species, supporting biodiversity and replenishing coastal fisheries (Sunkur et al., 2023). Their loss has accelerated ecosystem degradation, compounding the pressures on fishing-dependent households. Rehabilitating mangrove ecosystems, therefore, helps restore the ecological foundations that sustain local livelihoods. Moreover, mangroves in Baía de Todos os Santos support native oyster populations, which, in turn, function as a complementary nature-based solution: adult oysters can filter up to 50 gallons of water per day, further enhancing water quality and ecosystem health (Luz et al., 2017; O'Neil et al., 2016). By prioritizing mangrove restoration, CODEBA can

address environmental degradation and social harm simultaneously, aligning port resilience with community recovery and long-term ecological regeneration.

Figure IV: Mangrove Installation & Restoration



Source: Google Earth

Table IV: Proposed Nature-Based Approach Indicators

Type of indicator	Indicator suggestion	Description	How the indicator benefits Aratu-Candeias
Implementation Progress	Mangrove population tracking	Tracks mangrove restoration in the area. (percentage of area restored or the number of mangrove trees planted).	Keeps track of the amount of progress made in equipping the port with a nature-based solution that protects its operations while helping the community
Implementation Progress	# of community members involved	A simple indicator that keeps track of how many members of the local community are involved in restoration efforts	Gauges community interest in the project, where higher engagement means that the public has a positive

			outlook on the port and its activities
Resilience Performance	Water quality levels	Tracks water quality changes as a result of mangrove tree presence. Facilitated by CIU.	Allows leadership to determine if the mangrove trees are improving community health.
Resilience Performance	Coastal erosion	Tracks the coastal erosion on the port shoreline. Becomes more significant with time.	Gauges how effective the mangroves are in enhancing long-term resilience.
Resilience Performance	Community satisfaction with implementation	Qualitative surveys that are sent out to determine how the community feels with regards to the mangrove plan. Can also measure community health changes as a result of improved water purity.	Quantifies community engagement and satisfaction.

IV. A Coordinated Approach to Align Governance and Public-Private Investments

A. Leveraging the Resilient Landlord Model to Embed Sustainable Practices in CODEBA's Operations

The port operates under a dual regime comprising both public-use facilities, which are managed under a Landlord model, and private-use facilities (Ludwig, 2022). This dual regime has enabled the private sector to take on a direct role in managing the port; however, Brazilian port public-private partnerships (PPPs) have historically prioritized operational efficiency and capacity expansion, often relying on weak sustainability clauses that fail to enforce performance indicators or impose penalties tied to social and environmental outcomes (Cunha et al., 2024).

Recent analyses of CODEBA's sustainability performance reveal a gap: failure to implement sustainability initiatives, such as the Global Reporting Initiative (GRI) or ISO 14001, which provide structured approaches to support operations with sustainability practices (Cunha et al., 2024). This is driven by barriers including a lack of precise regulation, uncertainty, and investor confidence, necessitating reforms that standardize sustainability not just as rhetoric but as practice.

Thus, we suggest a reform to bridge the sector-wide gap between sustainability and Aratu's port performance. It will be driven by the new proposed Chief Sustainability Officer (CSO), who will serve as the primary executive driver and coordinate key collaborations. This reform is built upon the following key pillars:

FIGURE V: Proposed Governance and Public-Private Partnership (PPP) Reform

1. Embedding Sustainability Clauses

Objective: To eliminate vague sustainability dialogue by mandating the adoption of measurable and internationally recognized frameworks as non-negotiable industry benchmarks.

1. Mandate that all operators publish sustainability reports aligned with the **Global Reporting Initiative (GRI)** and the International Sustainability Standards Board (ISSB)
2. Reports must incorporate the **Sustainability Accounting Standards Board (SASB)** guidelines
3. Require operators to obtain and maintain internationally recognized certifications for environmental management, such as ISO 14001
4. Mandate that operators disclose climate-related risks and opportunities in line with the **Task Force on Climate-related Financial Disclosures (TCFD)** recommendations

2. Aligning Public-Private (PP) Incentives

Objective: To reframe compliance as a strategic advantage and tool to drive commercial resilience rather than an administrative burden.

1. Introduce a tiered "Eco Status Benefits", with Bronze/Silver/Gold levels where better sustainability performance unlocks better commercial advantages.
   - I. Lease Renewal Options
     - I. Preferred or automatic renewal options or longer lease terms..etc.
   - II. Discounted Lease and Fees
   - III. Operational Priorities

3. Governance and Monitoring

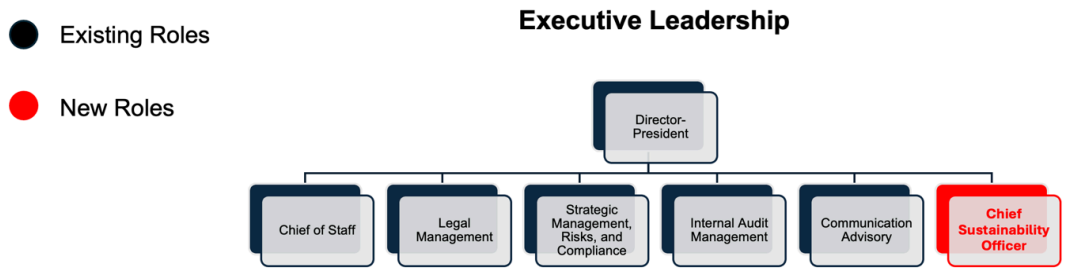
Objective: To ensure that actions are consistent with contractual obligations.

1. Require detailed documentation of participation and compliance with sustainability clauses that are to be submitted to the Sustainability Directorate of CODEBA
2. Develop and enforce specific key performance indicators (KPIs) in line with international sustainability standards. See Section V.
   - I. % of port land/assets accounted for in emergency planning
   - II. % of assets made "flood-resistant"

B. Establishing a Chief Sustainability Officer to Institutionalize Resilience

We propose creating a Chief Sustainability Officer (CSO) position within CODEBA's executive leadership team. The CSO would serve as a horizontal integrator of sustainability across departments, ensuring that sustainability considerations are embedded into strategic planning, infrastructure investment, and daily port operations.

Figure VI: Proposed CODEBA Executive Leadership Structure



Source: Organizational Structure (CODEBA (2026a))

A CSO is a critical actor in ensuring compliance with the frameworks outlined in pillar 1 of our proposed reform. Without a dedicated role for these highly technical frameworks, the work risks fragmentation across leadership, leading to gaps in accountability, inconsistent data, and diminished credibility. Serving as the executive driver for sustainability integration into the ports' operations and contractual agreements, this will allow the other executive members to focus on their core mandates. For the GRI, stakeholder engagement is a key focus; thus, it supports the case for a CSO who can identify and engage with relevant parties, incorporating their concerns into strategy, metrics, and reporting (Fuller Academy, 2024).

The CSO would be directly responsible for:

- Setting and tracking sustainability and climate-resilience indicators (see Table III), aligned with national port regulations and international best practices.
- Designing and overseeing the implementation of long-term climate adaptation and mitigation plans, including flood risk management, emissions reduction, and ecosystem protection.
- Coordinating cross-departmental collaboration to reduce siloed decision-making, ensuring that all units work toward shared sustainability objectives.
- Leading data collection and reporting on ESG performance, improving transparency and institutional learning.
- Acting as CODEBA's primary liaison with federal agencies, academic institutions, and international partners on sustainability, innovation, and climate resilience initiatives.

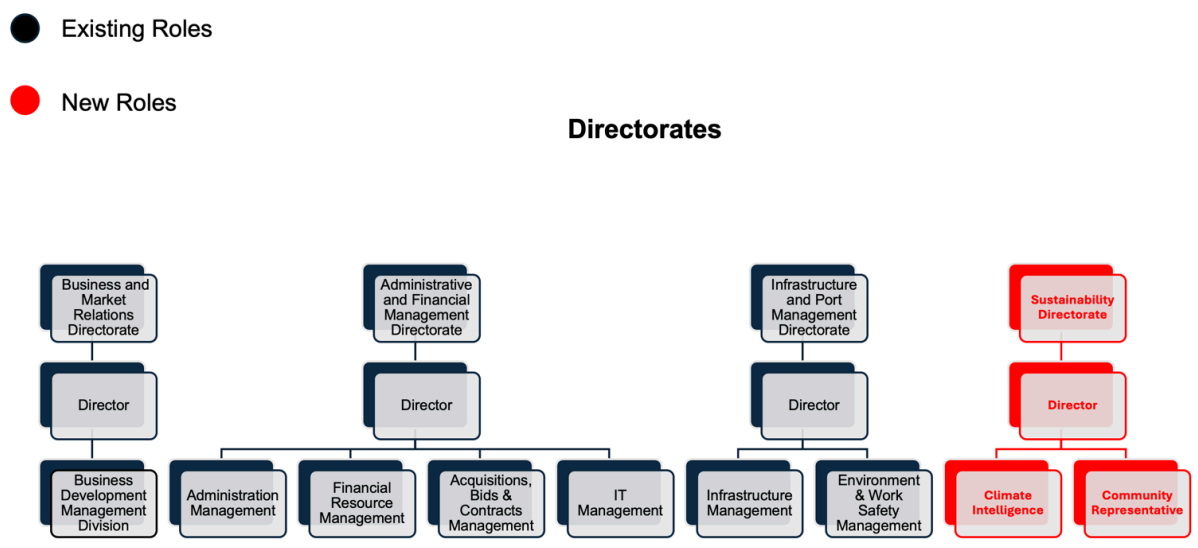
C. Institutionalizing Engagement in CODEBA'S Governance by Investing in Data Collection and Giving Voice to the Community

As per section II.C, deficiencies in port–community relations in Aratu-Candeias result in marginalized communities experiencing disproportionately low social benefits alongside adverse health and environmental externalities (Rada, 2021). The absence of formal mechanisms for community input has contributed to insufficient consideration of local impacts in decision-making. For example, this has manifested in the Ilha de Maré community's hours-long obstruction of port operations in 2014 (Bledsoe, 2019), an episode that underscores how unresolved grievances and the absence of structured dialogue can escalate into disruptive conflict.

As outlined in III.A, investing in a Climate Intelligence team is crucial for strengthening climate resilience. The 2023 report on Port Aratu indicates that the lack of data systematization is a critical barrier to achieving climate resilience and operational efficiency, as without a centralized dataset for hydrometeorological and operational data (See Appendix II.B), Port Aratu will remain in a reactive rather than an adaptive state, unable to link climate events to financial losses or infrastructure failures.

To address these deficiencies, we propose creating a Sustainability Directorate comprising a director, a Data & Analytics Team, and a Local Community Representative.

.**Figure VII: Proposed CODEBA Directorate Structure**



Source: Organizational Structure (CODEBA (2026a))

The Data & Analytics Team would be responsible for:

- Resilience Monitoring and Tracking

    - Implementing a set of measurable indicators and a monitoring framework to track progress, such as days of port downtime, recovery time after climate-related events, and assets saved, etc (see Section III)
- Economic Analysis of Impacts
    - Quantifying financial losses of both climate-related interruptions and proposed adaptation measures through cost-benefit analysis, impact assessments, or other economic valuation techniques to understand long-term effects
- Data-Driven Decision Support
    - Using digital tools to help decision makers understand trade-offs under uncertainty

The Local Community Representative, who may reside in any of the communities surrounding Aratu-Candeias, including—but not limited to—Ilha de Maré, Caboto, and Passé, would be responsible for:

- Conveying community concerns and priorities to port leadership during planning and policy discussions
- Serving as a formal channel between CODEBA and local populations, helping to institutionalize community engagement rather than treating it as an ad hoc consultation
- Participating in reviews of projects with significant environmental or social impacts, particularly those affecting public health and livelihoods
- Supporting the development of community benefit agreements, local employment initiatives, and health-monitoring programs

D. Preventing Entrenchment Through a Fixed Term Rotation for Community Representation

To ensure that community representation remains both practical and adaptive, we propose that the Local Community Representative serve a fixed, non-renewable term of ten years, which provides sufficient time to build institutional knowledge, participate in long-term planning cycles, and avoid inequitable decision-making. This design is supported by a longitudinal study of the Port of Antwerp's development (1960–2010), which demonstrated similar findings (Dooms et al., 2013).

The decision to embed sustainability through data and community into CODEBA's operations is a strategic move for long-term sustainability and commercial longevity. We acknowledge that this transition, which requires institutional and financial reform, may initially appear daunting, but it is a necessary investment. Sustainability clauses will unlock new capital from the growing pool of investors who prioritize clear Environmental, Social, and Governance (ESG) performance, and data will equip the port to mobilize resources effectively, allowing the Port of Aratu-Candeias to shift from reactive environmental management to proactive, strategic resilience planning.

V. Financing Strategy: A Pooled Platform for Nature-Based and Long-Term Resilience

Nature-based solutions are central to Aratu's resilience plan because they are a cost-effective way to protect the coast and nearby communities. Near-term priorities are funding these solutions and building the internal delivery capacity, but CODEBA also needs a longer-term financing structure to make the wider resilience pipeline bankable and to support future infrastructure and continuity protection.

CODEBA is working with IBAMA to structure bay-area projects under the Investment Partnerships Program, which aims to expedite environmental licensing for strategic federal infrastructure. IBAMA has a backlog of over 4,000 licenses and prioritizes the best-managed projects, so strong project preparation by CODEBA is critical (CODEBA, 2026). The RISCO partnership also depends on concessional capital to fund early modelling, community engagement, and product development, reinforcing the need for upfront de-risking and soft capital to catalyze high-potential resilience models.

Our financing strategy is a regional resilience platform that treats Aratu Candeias as part of a cluster approach for Todos-os-Santos Bay and the wider Bahia coastline. The initial pool includes the Ports of Aratu-Candeias, Salvador, the Terminal Marítimo de Madre de Deus, and the Port of Ilhéus, with scope to add more terminals over time. Our pooling strategy creates enough scale to (1) standardize project preparation, (2) bundle small capex packages into a financeable portfolio, and (3) purchase continuity protection once for the region instead of forcing each port to negotiate alone. Our goal with this structure is that it will serve as a template for regions of ports to collaborate on protecting themselves against shared climate risks.

A Three-Layered, Pooled Financing Strategy

Layer 1: Launching the Bahia Resilience Facility (BRF) to sustain short - long term investment

<u>Core Functions:</u>

- **A.** Immediately fund NBS installation and new hires. In the long term, it will fund engineering designs, climate stress testing, procurement, packaging, and monitoring and evaluation for a pipeline of adaptation projects at cluster ports.
- **B.** Prioritize funding for frequent disruptions: drainage and water management, protection or elevation of electrical assets, equipment hardening against humidity, and simple monitoring/early-warning systems.
- **C.** Use a standardized template for cost estimates, performance targets, and avoided downtime across all ports.

Layer 2: A blended capex stack designed for small ports

Once projects are packaged, the second step is to apply a blended financing stack across all four ports and terminals. The stack is as follows:

A. Catalytic (public/concessional) portion that will cover early enabling works and reduce overall cost

Novo Pac will be a critical source of public investment; however, given the government's lacklustre track record with infrastructure investment and the relatively small size of Aratu-Candeias, our blended finance approach allows the port to diversify away from public reliance by building partnerships through layers B and C of the stack.

B. Core senior loan layer for bulk of capex: sourcing capital from domestic and international private sector

Domestic long-term lending capacity can be anchored through the Brazilian Development Bank (BNDES) support for the port sector (BNDES, n.d.). BNDES is an effective partner because it already plays this role in Brazilian infrastructure, including port-related financing.

With regard to private capital, it will come from three places that have direct incentives in Bahia; port lessees, domestic banks/infrastructure investors, and cargo owners. In that latter bucket, we have identified a significant opportunity for CODEBA to leverage the Salvador port's relationship with the Chinese electric-vehicle manufacturer, BYD. BYD has committed a major investment in Bahia, with a new manufacturing facility serving as the base for its planned Brazilian expansion; this creates a straightforward rationale for co-investing in the resilience of the port system that supports its ramp-up (Folha de S.Paulo, 2025). Practically, this can be structured as a targeted resilience co-investment tied to shared infrastructure, or as a long-term offtake or throughput-linked contribution that helps finance upgrades across the pooled platform, rather than a one-port donation.

Figure VIII: BYD Manufacturing Facility in Bahia

Source: BYD opens factory in Bahia, but for now only the air in the tires will be Brazilian (Folha de S.Paulo, 2025)

C. Guarantee Layer

Lastly, a narrow guarantee layer that targets the risks lenders actually fear in small ports, mainly construction completion, performance of new systems, and short-term revenue volatility during retrofit periods (Brandon et al., 2025). Resilience requirements should be embedded into leases and modernization windows under PPI projects, so obligations and accountability are contractually clear (PPI, 2026).

Layer 3: Continuity protection that benefits business and communities and separates insurance from emergency funding

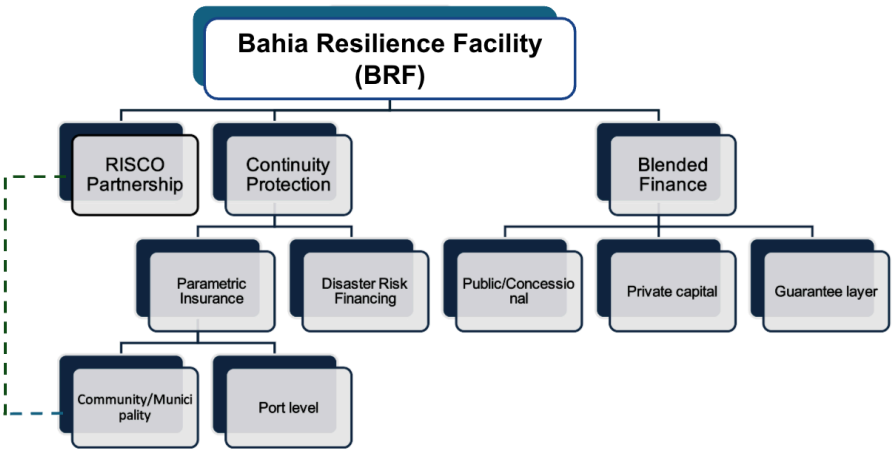
A. Pooled parametric insurance for frequent disruptions:

While RISCO helps provide parametric insurance for the wider community, we have also devised a way for the port to obtain coverage. For frequent, short disruptions, the cluster should buy a pooled parametric insurance program that pays quickly when objective thresholds linked to operational shutdowns are exceeded. Brazil has precedent for parametric placements, including Aon's placement of a large private parametric wildfire policy for Faber-Castell, showing trigger-based products can be executed when risk is clear (Aon, 2025).

B. Disaster Risk Financing (DRF) for large shocks

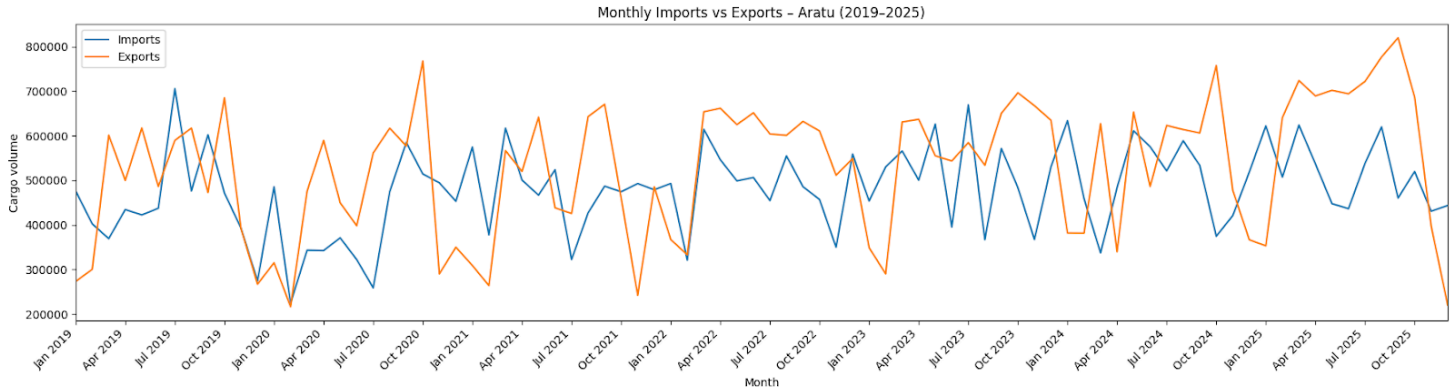
For major shocks or prolonged disruption, the cluster requires a shared emergency funding backstop. Disaster risk financing provides rapid liquidity that is repaid over time. In Latin America, the Inter American Development Bank offers catastrophe protection under its Flexible Finance Facility, enabling fast payouts after predefined events (IDB, n.d.). Under the pooled model, Brazil would secure this protection once at the sovereign level and channel payouts to a Bahia small ports resilience platform for rapid repair and restart across the cluster. This builds on Brazil's existing use of national systems and public development channels for disaster response, but arranges financing in advance and links it explicitly to port continuity (World Bank, 2022; Government of Brazil, 2024).

Figure IX: Proposed BRF Structure

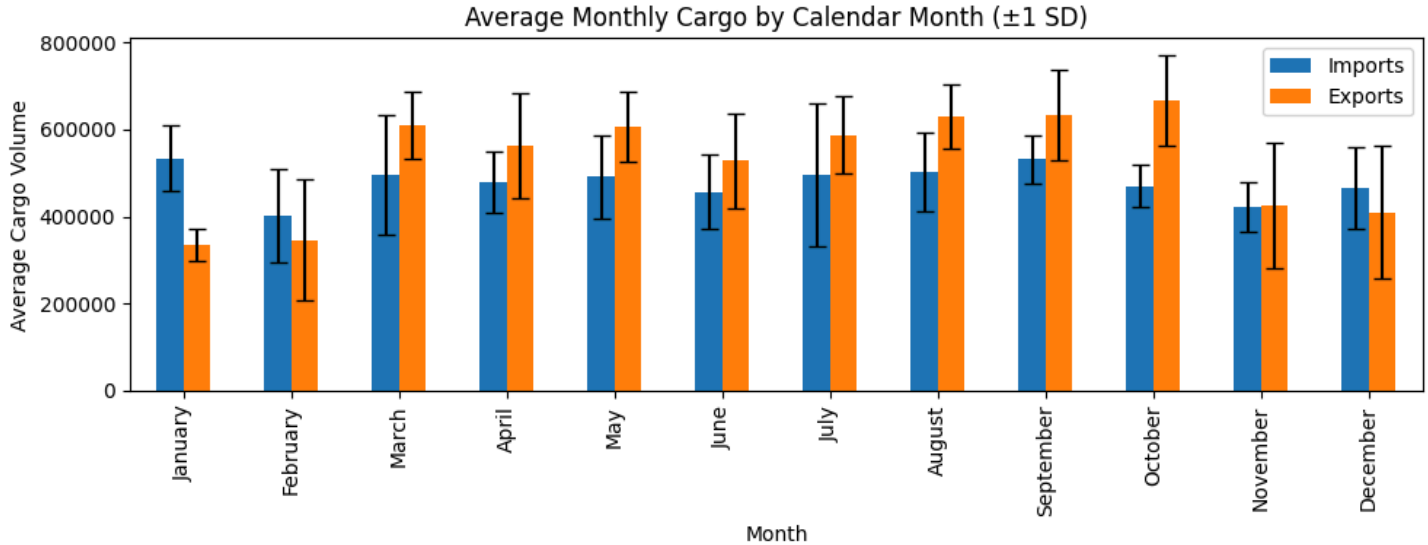


VI. Appendix

A1: Monthly Imports and Exports for the Port of Aratu (2019-2025)



A2: Average Monthly Cargo for the Port of Aratu (2019-2025)



A3: Most Significant Upstream Ports (10) at risk due to shutdowns at Aratu and Salvador

Port Name	Country	Daily Capacity at Risk (mt)	Weekly Capacity at Risk (mt)	Percentage of Total Losses
Rio De Janeiro	Brazil	20119.36	140835.53	20.18
Porto De Suape	Brazil	9097.30	63681.10	9.13
Santos	Brazil	6532.91	45730.35	6.55
Tangier-Mediterranean	Morocco	5859.57	41017.02	5.88
Madre De Deus	Brazil	4978.27	34847.89	4.99

Porto de Itaguai	Brazil	3119.22	21834.54	3.13
Sao Sebastiao	Brazil	3082.82	21579.76	3.09
Houston	United States	3068.20	21477.41	3.08
Porto Pecem	Brazil	2961.25	20728.73	2.97
Itaqui	Brazil	2463.89	17247.25	2.47

A4 Most Significant Downstream Ports (10) at risk due to shutdowns at Aratu and Salvador

Port Name	Country	Daily Capacity at Risk (mt)	Weekly Capacity at Risk (mt)	Percentage of Total Losses
Santos	Brazil	14598.84	102191.87	14.07
Madre De Deus	Brazil	13985.92	97901.41	13.48
Porto De Suape	Brazil	10278.94	71952.57	9.90
Porto Pecem	Brazil	8923.00	62460.99	8.60
Rio De Janeiro	Brazil	5453.45	38174.16	5.25
Cartagena	Colombia	4726.20	33083.41	4.55
Tangier-Mediterranean	Morocco	3604.58	25232.06	3.47
Las Palmas (de Gran Canaria)	Spain	2117.21	14820.47	2.04
Paranagua	Brazil	2075.57	14528.99	2.00
Vitoria	Brazil	1528.13	10696.90	1.47

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