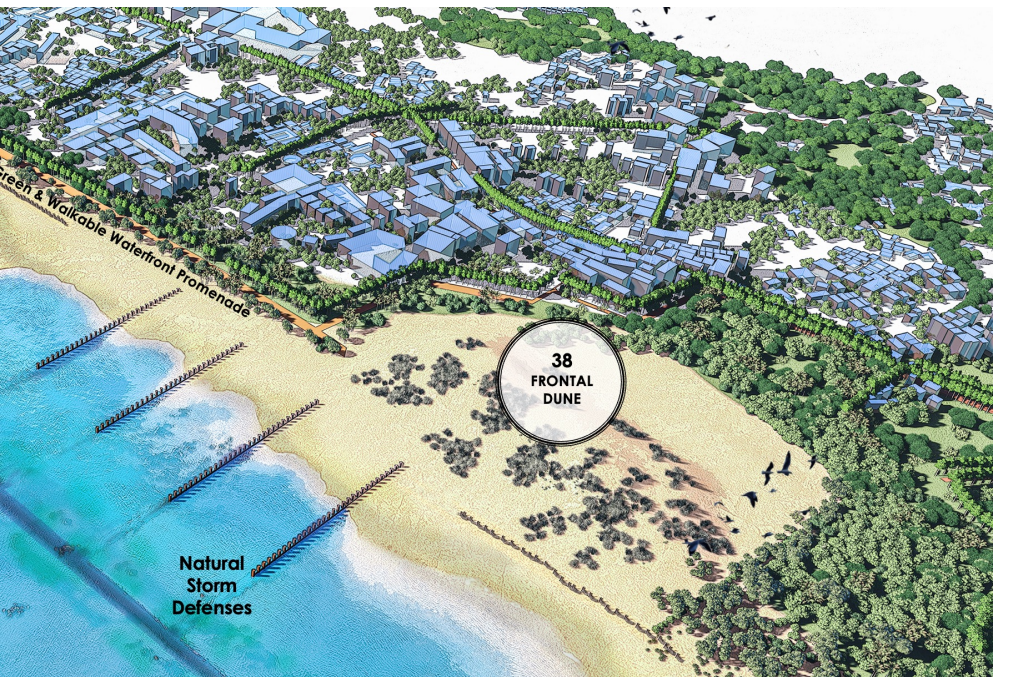


## NbS-38: FRONTAL DUNE



**LANDSCAPES SUPPORTED**






## ECOSYSTEM-BASED DISASTER RISK REDUCTION

## ECOSYSTEM RESTORATION

## GREEN INFRASTRUCTURE

## MAIN PROBLEMS ADDRESSED



Frontal dune implementation focuses on the proactive establishment of dune systems as a Nature-Based Solution to enhance coastal resilience. This approach employs natural and eco-engineered techniques, including the planting of native vegetation with deep root systems to stabilize sand, and the use of biodegradable geotextiles and sand fences to encourage dune formation. These initiatives serve as natural buffers against storm surges and rising sea levels, providing sustainable protection for coastal communities while supporting biodiversity. The implementation process often integrates frontal dunes with adjacent habitats, such as mangroves and seagrass meadows, creating interconnected ecosystems that reduce sediment runoff, improve water quality, and foster ecological balance.

## ECOSYSTEM SERVICES AND ACTIONS

## SUPPORTING

- Establishment of habitats for diverse flora and fauna, including dune-specific species and coastal wildlife.
- Supports interconnected ecosystems, such as mangroves, seagrass beds, and coral reefs, creating corridors for species movement.
- Stabilizes sandy substrates, preventing erosion and supporting the formation of fertile dune soils.

## PROVISIONING

- Provides sustainable resources such as plant biomass, which can be used for traditional practices or crafts.
- Enhances fish and shellfish populations by stabilizing nearby ecosystems, like seagrass beds, which serve as nurseries.

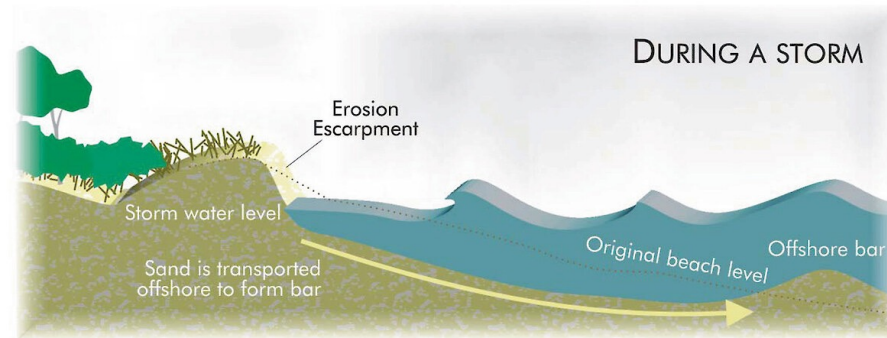
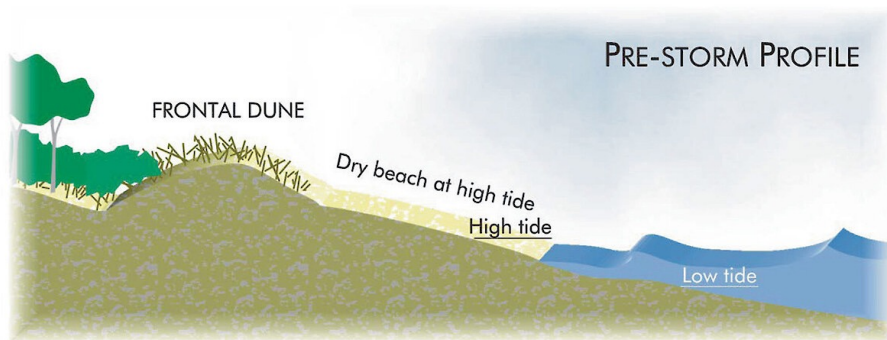
## SOCIAL BENEFITS

- Enhances the safety and livelihoods of local populations by reducing exposure to coastal hazards and supporting ecosystem-based income sources.
- Creates aesthetic and accessible coastal landscapes, attracting eco-tourism and providing spaces for leisure activities.

## REGULATING

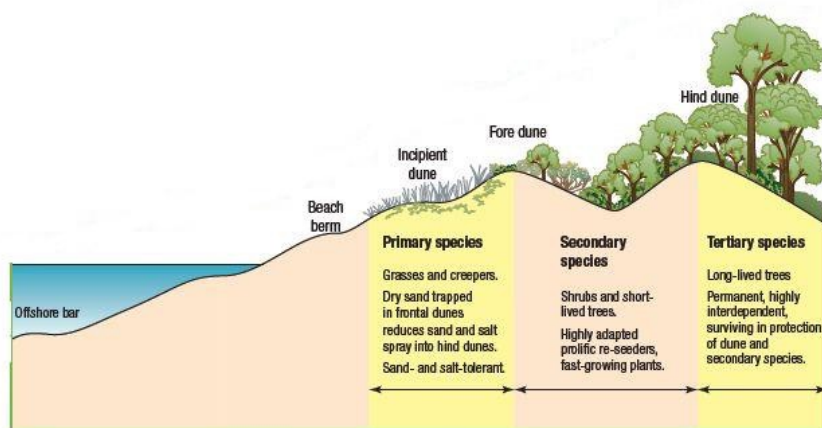
- Acts as a natural barrier against storm surges, high waves, and flooding, reducing risks to inland areas.
- Prevents sand loss through vegetation that anchors the substrate and traps wind-blown sand.
- Minimizes sediment runoff into marine ecosystems.

# NbS-38: FRONTAL DUNE



Natural dune dynamics

Source : Coastal restoration trust of New Zealand



Dune protective vegetation

Source : Springer Nature Link

## PROJECT'S CHALLENGES & RISKS

- ❖ **Site Suitability:** Sandy beach environments vary in stability, wave energy, and sediment supply, making it challenging to select suitable sites for dune formation.
- ❖ **Maintenance Needs:** Dunes require ongoing maintenance to address erosion, invasive species, or damage caused by extreme weather events.
- **Climate Impacts:** Rising sea levels and increasing storm intensity may reduce the effectiveness or longevity of dunes as coastal defences.
- **Biodiversity Conflicts:** Introducing dunes in new areas may displace existing ecosystems or conflict with the needs of species that rely on flat, sandy beaches (e.g., turtle nesting sites).

## NbS co-BENEFITS AND THEIR INDICATORS

- **Disaster Risk Reduction:** Assessment of the role of dunes in protecting human populations and infrastructure: reduced vulnerability index for coastal communities.
- **Water Quality Improvement:** Reduction in sediment runoff into coastal waters (measured in turbidity levels) and improvement in water clarity .
- **Flood mitigation** Frequency and severity of coastal flooding events Increase in percolation capacity (l/m2).
- **Soil Stabilization** Rate of soil retention (tons of sediment retained annually).
- **Carbon Sequestration** Carbon stored in dune vegetation and soil. Growth rate of vegetation biomass (kg/year).

## COST ANALYSIS

- **Direct Costs** Planting, materials, labour, monitoring : \$18,500–\$51,000/ha
- **Indirect Costs** Opportunity costs, community engagement.
- **Time Horizon** Short-Term (1–3 years): Initial restoration activities Medium-Term (3–10 years): Ecosystem establishment, monitoring, and adaptive management.
- **Direct Benefits** Coastal protection, biodiversity enhancement, and carbon sequestration.
- **Indirect Benefits** Tourism, community jobs, climate resilience.
- **Risk Assessment** Environmental risks, high initial costs, stakeholder opposition.

## REFERENCES:

**New Zealand**, Ngarahae Bay (restoration of eroded dunes, planting of native vegetation).  
**Australia - Queensland**, Kirra Beach (dune revegetation initiative).  
**The Netherlands**, Hondsbossche Dunes (replacement of outdated dike with dunes).

## IMPLEMENTATION OPPORTUNITIES:

- **Philippines Eastern Seaboard**, Samar and Leyte (Prone to typhoons and wave erosion).
- **Malaysia**, Pahang coastline (impacted by monsoonal erosion).
- **Vietnam**, Phu Yen Province.