CHAPTER 1: Introduction

1.1 Aims of national report

The primary aim of this National Transboundary Diagnostic Analysis (TDA) is to provide a scientifically robust, holistic assessment of the state of the marine and coastal environment in the Gulf of Thailand. This report serves as the fundamental baseline for identifying, quantifying, and prioritizing environmental problems that are transboundary in nature or have significant national implications.

Specifically, this report aims to:

1) **Diagnose the State of the Environment:** Consolidate data on the status of key coastal habitats (mangroves, coral reefs, seagrass, and wetlands), fisheries stocks, and water quality to establish a clear 2024–2025 baseline.
2) **Identify Root Causes:** Analyze the causal chains linking environmental degradation—such as eutrophication in the Upper Gulf or coral bleaching events—to their immediate and root causes, including socio-economic drivers like industrialization in the Eastern Economic Corridor (EEC) and agricultural runoff.
3) **Assess Governance Architectures:** Evaluate the effectiveness of current institutional arrangements, legal frameworks, and financial mechanisms (such as the budgets of the DMCR, DOF, and DNP) in managing these resources.
4) **Prioritize Action:** Provide the evidence base necessary for formulating the National Action Plans (NAPs) and guiding investment into "blue economy" initiatives, ecosystem restoration, and pollution control.

1.1.1 Inputs to the SCS-GOT TDA

This National TDA constitutes Thailand's specific contribution to the regional **Transboundary Diagnostic Analysis for the South China Sea and Gulf of Thailand (SCS-GOT TDA)**. As the Gulf of Thailand is a semi-enclosed sea connected to the South China Sea, the environmental dynamics within Thai waters—including nutrient loads, fish stock migration, and marine debris transport—have direct transboundary implications for neighboring riparian states (Cambodia, Vietnam, and Malaysia).

The inputs from this national report to the regional SCS-GOT TDA framework include:

- **Fisheries Data:** Providing catch reconstruction data and Catch Per Unit Effort (CPUE) trends for the Gulf of Thailand, which helps assess the status of shared transboundary fish stocks and the efficacy of effort control measures (e.g., "Fishing Days" limits).
- **Pollution Hotspots:** Identifying land-based pollution sources, specifically nutrient

loading from major river systems (Chao Phraya, Tha Chin) and plastic leakage, which contribute to regional eutrophication and marine litter problems addressed by mechanisms like COBSEA.

- **Habitat Status:** Contributing data on the extent and health of critical habitats—such as the 255.7 km² mangrove complex in Bandon Bay and the "Larval Source" coral reefs at Koh Losin—which are essential for maintaining regional biodiversity connectivity and genetic refugia.
- **Climate Vulnerability:** Sharing assessments of climate impacts, such as sea-level rise and coral bleaching, to inform regional adaptation strategies.

1.1.2 Analysis to help national reporting to SDG and other international commitments

The data and analysis generated in this National TDA are designed to directly support Thailand's monitoring and reporting obligations under key global and regional frameworks. By harmonizing national indicators with international metrics, this report facilitates compliance with the following commitments:

1) UN Sustainable Development Goals (SDGs):

- **SDG 14 (Life Below Water):** The report's assessment of marine pollution (Indicator 14.1), ecosystem management (Indicator 14.2), and fisheries sustainability (Indicator 14.4) provides the necessary data for Voluntary National Reviews (VNRs).
- **SDG 13 (Climate Action):** The quantification of "Blue Carbon" stocks in mangroves and seagrass beds (e.g., carbon storage estimates for Bandon Bay and Chumphon) directly supports Thailand's climate action reporting.

2) The Kunming-Montreal Global Biodiversity Framework (GBF):

Target 3 (30x30): The evaluation of Marine Protected Areas (MPAs) and Other Effective Area-based Conservation Measures (OECMs), such as the preservation of Koh Losin and underwater pinnacles, supports tracking progress toward protecting 30% of marine areas by 2030.

3) Nationally Determined Contributions (NDCs) under the Paris Agreement:

Climate Vulnerability and Socio-Economic Resilience: The report integrates climate impact assessments with socioeconomic data to inform National Adaptation Plans. It highlights the acute vulnerability of the 18.6 million residents in the Gulf of Thailand's coastal provinces (2020), particularly in high-density provinces like Bangkok (3,562 persons/km^2) and Samut Prakan (1,346 persons/km²). It further analyzes economic exposure, noting that the 2024 cyclone season alone caused estimated damages of USD 904 million. By correlating poverty rates with climate risks, the analysis identifies populations with low adaptive capacity, ensuring that adaptation strategies

prioritize the most vulnerable communities dependent on climate-sensitive sectors like fisheries and tourism.

4) **Regional and Specific Conventions:**

- **Marine Litter:** Supports the *COBSEA Regional Action Plan on Marine Litter (RAP MALI)* by quantifying land-based plastic leakage, monitoring microplastics, and addressing sea-based sources such as Abandoned, Lost, or otherwise Discarded Fishing Gear (ALDFG). In addition, supports the *ASEAN Regional Action Plan for Combating Marine Debris* by quantifying plastic leakage and identifying hotspot areas.
- **Marine Ecosystems:** Supports the COBSEA Marine and Coastal Ecosystems (MCE) Framework by aligning national initiatives on Marine Spatial Planning (MSP) and "Blue Carbon" habitat restoration (mangroves and seagrasses) with regional Sustainable Blue Economy goals and the "30x30" protection targets.
- **Biodiversity Protection:** Provides status updates for species listed under *CITES and the Convention on Migratory Species (CMS),* specifically regarding the Dugong MOU and IOSEA Marine Turtle MOU.
- **BBNJ Agreement:** The governance analysis prepares Thailand for future engagement in the *Biodiversity Beyond National Jurisdiction (BBNJ)* framework by assessing national capacity for high-seas governance.

1.2 Major water related environmental problems

A comparative analysis between the seminal Year 2000 National TDA and the current 2025 assessment reveals a profound shift in the scale and complexity of Thailand's water-related challenges. In 2000, the primary concerns were driven by unchecked resource extraction (mangrove deforestation for shrimp farming) and basic sanitation failures (untreated domestic sewage). By 2025, while legacy issues persist, the landscape is dominated by "cumulative" and "transboundary" threats, including marine plastic debris, climate-induced coral bleaching, and hazardous industrial waste from the Eastern Economic Corridor (EEC).

The following table summarizes the evolution of these environmental priorities over the past 25 years.

Table 1.1 Comparative Assessment of Major Water-Related Environmental Problems (2000 vs 2025)

Environmental Issue	Year 2000 Status & Priority	Year 2025 Status & Priority	Trend & Strategic Shift
1. Freshwater	**High Priority:**	**Medium-High**	**From Local**

Shortage & Management	Acute shortages due to deforestation and conflict between agriculture and golf courses. Lack of "user pay" systems.	**Priority:** Shift to "Water Security" for the EEC industrial hub. Climate-driven droughts remain a threat, but focus has moved to integrated water grid management.	**Scarcity to Strategic Allocation:** Emphasis is now on securing water for high-value economic zones (EEC) amidst climate variability.
2. Marine & Coastal Pollution (Eutrophication)	**High Priority:** Severe eutrophication in Upper Gulf caused by untreated domestic waste and agriculture.	**Critical Priority:** Eutrophication persists in the Upper Gulf (Red Tides). Nutrient loading from agriculture remains high (1.55M tonnes N-fertilizer imported in 2024).	**Persistent & Unresolved:** Basic organic loading remains a core challenge, compounded by denser urbanization in coastal provinces.
3. Marine Debris & Plastics	**Low/Not Prioritized:** Mentioned only as "garbage dumping" or "aesthetic" issues.	**Top Priority (Transboundary):** Thailand ranked among top global contributors. 27.2M tonnes of waste/year with high leakage. Regional focus via COBSEA/ASEAN.	**Emerging Crisis:** Plastic pollution has escalated from a local nuisance to a global transboundary priority requiring circular economy interventions.
4. Fisheries Resources	**Critical Priority:** "Over-exploitation" and "Open Access" regime. Collapse of CPUE to ~14 kg/hr.	**High Priority (Stabilization):** Fleet frozen/reduced; CPUE stabilized (~21 kg/hr in 2023). Focus on IUU combat and "Trash Fish" reduction.	**From Expansion to Control:** Shift from increasing catch volume to effort control (Fishing Days) and combatting IUU fishing.
5. Mangrove Ecosystems	**Critical Priority:** Rapid, widespread	**Medium Priority (Restoration):**	**From Destruction to Valuation:**

	destruction (60% loss) driven by intensive shrimp aquaculture conversion.	Deforestation halted; focus shifted to "Blue Carbon" restoration. Area stabilized at ~2,613 km² (wetlands).	Mangroves are now valued assets for carbon credits and coastal defense rather than land for conversion.
6. Coral Reefs	**High Priority:** Physical destruction (dynamite, anchors) and sedimentation.	**High Priority (Climate):** Mass bleaching events (2010, 2016, 2024) are the primary threat. Nearshore reefs degraded (29% live cover) by tourism/sediment.	**From Local Damage to Global Threat:** Local protection is insufficient against thermal stress; focus is on "Resilience" and "Super Corals".
7. Hazardous/Industrial Waste	**Medium Priority:** Localized contamination (heavy metals) in Samut Prakan.	**High Priority:** Concentrated risk in the EEC (Rayong/Chonburi). 1.63M tonnes of hazardous waste/year.	**Intensification:** The scale of industrial risk has grown exponentially with the EEC development, requiring stricter enforcement.

1.3 Biogeophysical setting

1.3.1 Geomorphology and geological history

The Gulf of Thailand is a shallow, semi-enclosed sea located on the Sunda Shelf, covering an area of approximately 320,000 km² with an average depth of only 45–50 meters and a maximum depth of 85 meters in the central trough. Geologically, the Gulf is defined by a series of Cenozoic rift basins—most notably the Pattani Trough and Malay Basin—which are filled with thick sedimentary sequences (up to 10 km) favorable for hydrocarbon accumulation.

The modern geomorphology of the Gulf is a result of the Holocene marine transgression. During the Last Glacial Maximum (approximately 20,000 years ago), sea levels were roughly 120 meters lower than today, exposing the Sunda Shelf as a vast dry landmass connecting mainland Southeast Asia to Borneo, Sumatra, and Java. The present-day Gulf was then a lowland basin drained by the "Paleo-Chao Phraya" river

system, which flowed southeast into the South China Sea. As sea levels rose during the Holocene (reaching a highstand about 4,000–6,000 years ago, approximately 2.5–4 meters above present levels), the shelf was submerged, creating the current marine environment. This recent geological formation means the Gulf acts as a "sediment trap," receiving massive alluvial loads from the Chao Phraya, Tha Chin, Mae Klong, and Bang Pakong rivers, which form a prograding delta in the Upper Gulf.

1.3.2 Climatology, present and projected

The Gulf of Thailand lies within the tropical monsoon zone, governed by two primary wind regimes that drive oceanographic circulation and rainfall patterns.

Present Climate Regime:

- Southwest Monsoon (May–October): Brings warm, moist air from the Indian Ocean, resulting in the wet season. It drives a general clockwise circulation in the Upper Gulf and influences upwelling along the west coast.
- Northeast Monsoon (November–February): Brings cool, dry air from the Asian continent. This season drives a counter-clockwise circulation and is associated with drier conditions, although heavy rainfall can still occur in the southern peninsula.
- Oceanography: Sea surface temperatures are generally high (28–30°C). Currents are tidal-dominated in nearshore areas, with complex seasonal reversals driven by the monsoons.

Projected Climate Trends (2030–2050):

Climate change modeling under RCP 4.5 and RCP 8.5 scenarios indicates significant shifts for the Gulf region:

- Temperature: Mean annual temperatures are projected to increase by 0.95°C to 3.23°C by the end of the century. By 2050, mean temperatures are expected to rise by approximately 1.5°C.
- Rainfall: Precipitation patterns will become more volatile, with projections suggesting drier winters but more intense rainfall events during the wet season (increasing flood risks).
- Sea Level Rise (SLR): The Upper Gulf is particularly vulnerable due to the synergistic effects of global sea-level rise and local land subsidence (up to 1-2 cm/year in some Bangkok areas). Projections for 2050 estimate a rise of 0.2–0.3 meters, with potential end-of-century rise exceeding 1 meter under high-emission scenarios, threatening coastal megacities and mangrove ecosystems.

1.3.3 Biogeography, endemic and unique marine species

Biogeographically, the Gulf of Thailand belongs to the Sunda Shelf Province within the Indo-West Pacific Realm. This region is a global center of marine biodiversity, yet the Gulf's fauna is geologically young due to the recent Holocene transgression.

Biodiversity and Endemism:

While true deep-evolutionary endemism is limited because the Gulf was dry land until recently, the region supports unique populations and locally adapted species.

- Endemic Invertebrates: *Idiosepius thailandicus* (Thai pygmy squid), discovered in the Gulf, is a notable species found in seagrass and mangrove habitats along the eastern coast.
- Marine Mammals: The Gulf hosts a genetically distinct population of the Irrawaddy Dolphin (*Orcaella brevirostris*). Genetic studies indicate restricted gene flow between the Gulf of Thailand population and those in the Andaman Sea, classifying it as a distinct management unit requiring specific conservation measures
- Fish Diversity: A recent checklist (2023) recorded 131 fish species from bottom trawls, including new records like the lizardfish *Saurida fortis*. Other key species include the Brownbanded bamboo shark (*Chiloscyllium punctatum*) and the Whale shark (*Rhincodon typus*), which frequents the biodiversity hotspots of Koh Tao and Chumphon pinnacles.
- Mangrove Flora: The Gulf's wetlands harbor critically endangered flora such as *Bruguiera hainesii* and *Sonneratia griffithii*, which are extremely rare globally but found in the Welu River Estuary and other focal sites.

This unique biogeographical setting, combining high productivity with specific genetic refugia, highlights the Gulf's critical role as a "biological pump" for the wider South China Sea ecosystem.

1.4 Assessment Methodology

The methodology employed for the 2025 National TDA represents a significant evolution from previous assessments, moving beyond simple resource inventorying to a holistic, ecosystem-based risk assessment. This transition is necessitated by the increasing complexity of transboundary threats, particularly climate change and marine plastic pollution, which require an integrated analysis of socio-ecological systems.

1.4.1 Conceptual Framework

The assessment adopts a modified **"Concentric Circles of Risk"** framework to conceptualize the relationship between anthropogenic drivers and ecosystem health:

1) **Core (The Ecosystem):** The physical and biological state of coastal resources (e.g., live coral cover, mangrove biomass, water quality). The assessment focuses on "Ecological Integrity" and "Service Provision" (e.g., carbon storage) rather than just extent or quantity.

2) **Inner Circle (Direct Pressures):** Immediate stressors acting on the core, such as nutrient loading from the Chao Phraya River, destructive fishing gear (trawlers), and

coastal land conversion.

3) **Middle Circle (Socio-Economic Drivers):** The local and national activities driving the pressures, including the "Blue Economy" sectors (tourism, fisheries), industrialization in the EEC, and urbanization in coastal provinces.

4) **Outer Circle (Global & Regional Forces):** Large-scale, often transboundary drivers such as global climate change (sea-level rise, ocean warming) , global market demand for seafood, and regional plastic waste leakage.

Scale and Scope: The assessment integrates data from local focal sites (micro-scale) up to the national and sub-regional levels (macro-scale), allowing for the identification of "hotspots" where global risks (climate) compound local stressors (pollution).

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1.4.2 Subnational Geographic Divisions used in the Analysis

The 2025 TDA refines the geographic scope to focus specifically on the Marine and Coastal Zone of the Gulf of Thailand, departing from the watershed-heavy focus of the Year 2000 report.

- **Administrative Division:** The primary unit of socio-economic analysis comprises the **17 Coastal Provinces** bordering the Gulf of Thailand. These are stratified into three economic clusters: the Industrial Core (Eastern Seaboard), the Developing South, and the Tourism Hubs.

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- **Ecological Focal Sites:** To ground-truth the national data, the assessment utilizes five specific "Focal Sites" in the Gulf of Thailand representing distinct ecosystem types and pressure profiles:
  1) **Welu River Estuary (Chanthaburi):** Represents a "Managed Ecosystem" with community forestry.
  2) **Bandon Bay (Surat Thani):** Represents a complex, high-use seascape (aquaculture + carbon sink).
  3) **Pak Phanang Bay (Nakhon Si Thammarat):** Represents an estuary affected by hydrological alteration.
  4) **Samut Prakan Coast:** Represents a "Urban/Industrialized Delta" with extreme pollution stress.
  5) **Don Hoi Lot (Samut Songkhram):** Represents a Ramsar site with unique biodiversity values.

1.4.3 List of Indicators by Component (Comparative Assessment)

The selection of indicators reflects a paradigm shift from "Resource Exploitation" (2000) to "Ecosystem Health and Resilience" (2025).

Table 1.2 Comparative List of Assessment Indicators (2000 vs. 2025)

Component	Year 2000 Indicators (Resource Focus)	Year 2025 Indicators (Resilience Focus)
Fisheries	- Total Catch Volume (Tonnes) - Number of Vessels - CPUE (kg/hr)	- **Catch Composition:** Ratio of "Trash Fish" vs. Commercial Species - **Effort Control:** "Fishing Days" per vessel class - **Stock Health:** Spawning Stock Biomass (SSB) trends
Mangroves	- Total Forest Area (ha) - Rate of Deforestation - Charcoal/Timber Production	- **Blue Carbon Stock:** Soil Organic Carbon (tonnes C/ha) - **Biodiversity:** Species Diversity Indices (Shannon-Wiener) - **Regeneration:** Seedling density and restoration success rate
Coral Reefs	- Percentage of Dead Coral - Physical Damage (Dynamite/Anchors)	- **Live Coral Cover (%)** stratified by depth - **Resilience:** Dominance of stress-tolerant forms (*Porites* spp.) - **Bleaching Response:** Severity and recovery rates

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Pollution	- BOD/COD Loads - Coliform Bacteria counts - Heavy Metals (Mercury/Lead)	- **Nutrient Flux:** Nitrogen/Phosphorus loading estimates - **Marine Debris:** Microplastic density (particles/m³) and composition - **Eutrophication Potential:** Frequency of Red Tides/Algal Blooms
Socio-Economics	- Fishery Income - Water Use Demand	- Demographics: Coastal population, population density - Human wellbeing: Coastal poor, HDI - Economic activities: GDP, fisheries contribution to GDP - Climate related threats: Number of tropical cyclones per year, total damage due to tropical cyclones

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1.4.4 Assessing Risks to Ecosystems, People, and Livelihoods

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The synthesis of these indicators reveals a landscape of compounded risks. The assessment determines risk levels by overlaying **Hazard Exposure** (Pollution/Climate) with **Vulnerability** (Ecosystem Sensitivity/Social Adaptive Capacity).

1) **Ecosystem Risk:**

- **High Risk:** Nearshore reefs in the Upper Gulf (e.g., Koh Si Chang) and estuaries in Samut Prakan. These areas face a "double burden" of acute land-based pollution (hypoxia, sedimentation) and thermal stress from climate change. The dominance of stress-tolerant species indicates low resilience to future shocks.

- **Moderate Risk:** Mangrove systems in Bandon Bay. While carbon stocks are high, the conversion pressure from aquaculture remains a latent threat, moderated by active community restoration.

2) Socio-Economic and Livelihood Risk:

- **Climate-Poverty Nexus:** The Deep South (Pattani/Narathiwat) is identified as a high-risk zone. High poverty rates (up to 23%) combined with reliance on climate-sensitive small-scale fisheries create a "poverty trap" where resource degradation directly exacerbates social deprivation.
- **Economic Exposure:** The Eastern Economic Corridor (Rayong/Chonburi) faces high *financial* risk. While adaptive capacity is high due to wealth, the sheer value of assets exposed to sea-level rise and storm surges (infrastructure, ports, tourism real estate) poses a significant liability to the national economy.

3. Integrated Governance Implication:

This risk stratification underscores the need for differentiated governance.

- **For High-Risk Ecosystems (Upper Gulf):** Immediate, stringent pollution control (TMDL enforcement) and strict zoning are required to prevent collapse.
- **For High-Risk Livelihoods (Deep South):** Interventions must focus on social safety nets, livelihood diversification, and community-based resource management rather than top-down regulation alone.
- **For Climate Adaptation:** "Blue Carbon" financing mechanisms must be prioritized to fund the restoration of buffers (mangroves/seagrass) that protect both the wealthy industrial zones and vulnerable coastal communities.

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